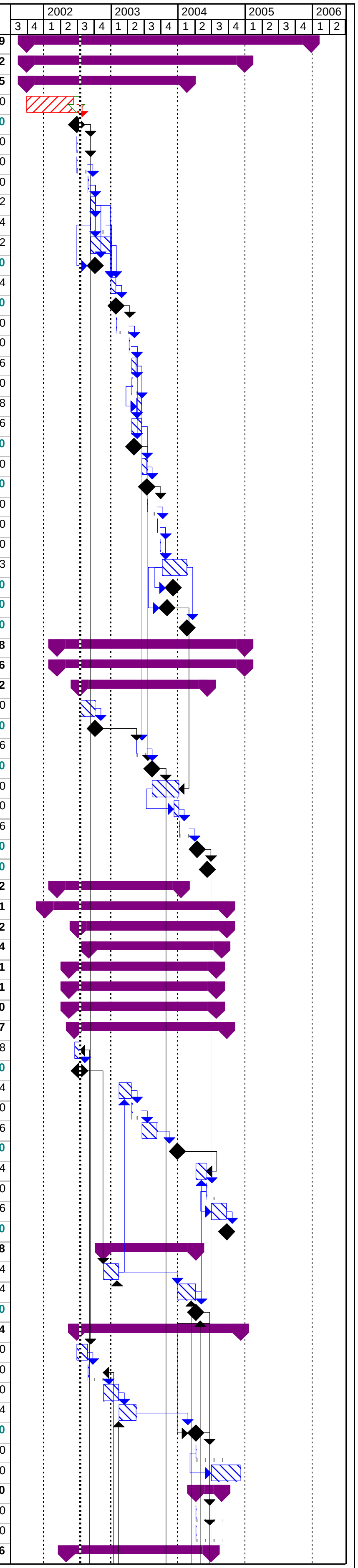
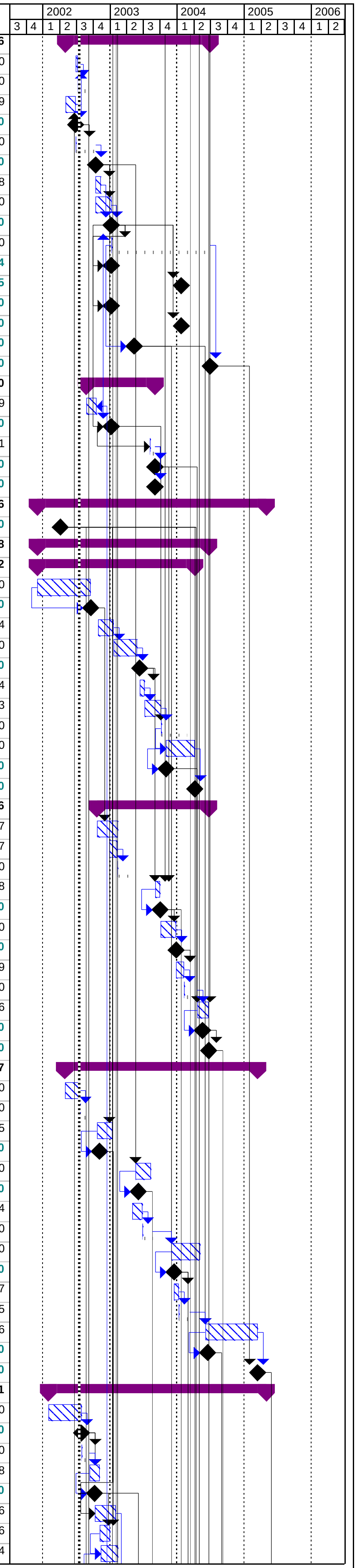
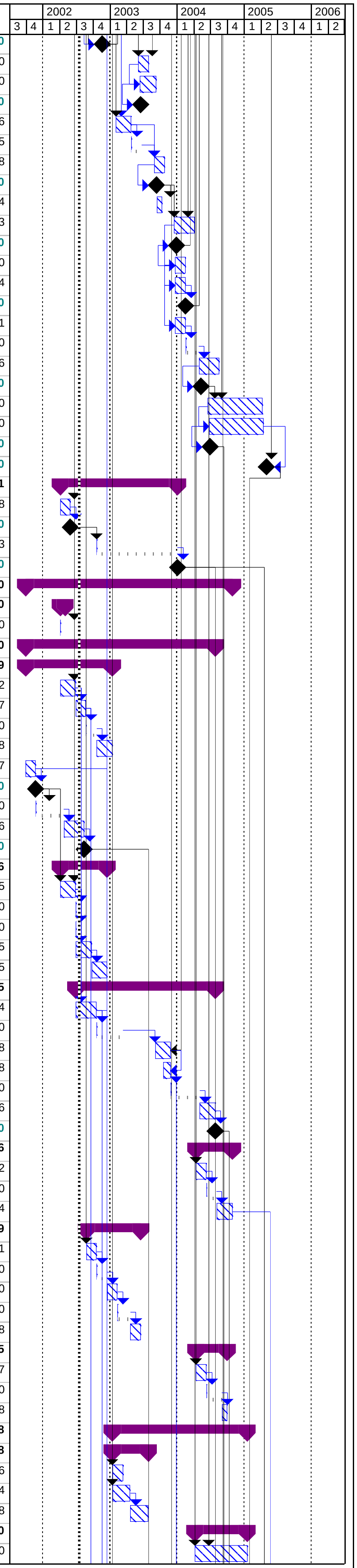
ID	WBS	Task Name	Start	Finish	Duration	Cost
1	1.1	Run 2b Silicon Project	Mon 7/2/01	Tue 9/27/05	1055 days	$13,328,319
2	1.1.1	DAQ	Mon 7/2/01	Fri 10/1/04	810 days	$6,030,702
3	1.1.1.1	SVX4 Chips	Mon 7/2/01	Fri 11/21/03	600 days	$1,071,335
4	1.1.1.1.1	1st chip: layout	Mon 7/2/01	Mon 4/1/02	187 days	$135,880
5	1.1.1.1.2	1st Chip submission (eng. Run)	Mon 4/1/02	Mon 4/1/02	0 days	$0
6	1.1.1.1.3	1st chip: documentation	Mon 4/1/02	Mon 4/22/02	15 days	$15,000
7	1.1.1.1.4	1st Chip: manufacturing	Mon 4/1/02	Tue 5/28/02	40 days	$58,000
8	1.1.1.1.5	1st Chip: postprocessing	Tue 5/28/02	Tue 6/11/02	10 days	$10,000
9	1.1.1.1.6	1st Chip: engineering evaluation at FNAL	Wed 6/12/02	Wed 7/10/02	20 days	$8,152
10	1.1.1.1.7	1st Chip: engineering evaluation at LBL	Tue 6/11/02	Thu 9/5/02	60 days	$27,624
11	1.1.1.1.8	1st Chip: evaluation	Wed 6/12/02	Thu 10/3/02	80 days	$3,072
12	1.1.1.1.9	1st Chip ready for hybrids	Wed 7/10/02	Wed 7/10/02	0 days	$0
13	1.1.1.1.10	2nd Chip: layout	Thu 10/3/02	Thu 10/31/02	20 days	$116,224
14	1.1.1.1.11	2nd Chip: submission (eng. Run)	Thu 10/31/02	Thu 10/31/02	0 days	$0
15	1.1.1.1.12	2nd Chip: manufacturing	Thu 10/31/02	Thu 1/9/03	40 days	$125,000
16	1.1.1.1.13	2nd Chip: postprocessing	Thu 1/9/03	Thu 1/23/03	10 days	$11,250
17	1.1.1.1.14	2nd Chip: engineering evaluation at FNAL	Fri 1/24/03	Thu 2/20/03	20 days	$4,076
18	1.1.1.1.15	2nd Chip: engineering evaluation at LBL	Thu 1/23/03	Thu 3/13/03	35 days	$12,000
19	1.1.1.1.16	Setup for production chip testing	Thu 2/20/03	Thu 3/20/03	20 days	$8,958
20	1.1.1.1.17	2nd Chip: evaluation	Fri 1/24/03	Thu 3/20/03	40 days	$1,536
21	1.1.1.1.18	2nd Chip ready for hybrids	Thu 2/6/03	Thu 2/6/03	0 days	$0
22	1.1.1.1.19	Production Chip: layout	Thu 3/20/03	Thu 4/17/03	20 days	$69,660
23	1.1.1.1.20	Production chip Submission	Thu 4/17/03	Thu 4/17/03	0 days	$0
24	1.1.1.1.21	Production Chip: manufacturing	Thu 4/17/03	Fri 6/13/03	40 days	$422,500
25	1.1.1.1.22	Production Chip: postprocessing	Fri 6/13/03	Fri 6/27/03	10 days	$20,000
26	1.1.1.1.23	Production Chip: engineering evaluation at LBL	Fri 6/27/03	Mon 8/4/03	25 days	$9,000
27	1.1.1.1.24	CDF chips: Test	Tue 7/8/03	Fri 11/21/03	98 days	$13,403
28	1.1.1.1.25	CDF chips: 1/2 chips tested	Mon 9/8/03	Mon 9/8/03	0 days	$0
29	1.1.1.1.26	Production Chips ready for hybrids	Mon 8/4/03	Mon 8/4/03	0 days	$0
30	1.1.1.1.27	Chip testing Complete	Fri 11/21/03	Fri 11/21/03	0 days	$0
31	1.1.1.2	Hybrids	Fri 12/14/01	Fri 10/1/04	693 days	$2,038,538
32	1.1.1.2.1	Outer layers	Fri 12/14/01	Fri 10/1/04	693 days	$1,752,946
59	1.1.1.2.2	Layer 0	Tue 4/16/02	Thu 3/11/04	470 days	$285,592
60	1.1.1.2.2.1	Prototype#1 L0 hybrid: Layout	Tue 4/16/02	Wed 7/10/02	60 days	$0
61	1.1.1.2.2.9	Prototype#1 L0 hybrid: Submission	Wed 7/10/02	Wed 7/10/02	0 days	$0
62	1.1.1.2.2.2	Prototype#1 L0 hybrid: manufacturing	Thu 2/20/03	Thu 4/17/03	40 days	$142,796
63	1.1.1.2.2.3	Prototype#1 L0 hybrid Available	Thu 5/15/03	Thu 5/15/03	0 days	$0
64	1.1.1.2.2.4	Prototype#1 L0 hybrid: evaluation and final design	Fri 5/16/03	Tue 10/7/03	100 days	$0
65	1.1.1.2.2.5	Production L0 Hybrid: final layout	Wed 9/10/03	Tue 10/7/03	20 days	$0
66	1.1.1.2.2.6	Production L0 hybrid: manufacturing	Tue 10/7/03	Thu 12/4/03	40 days	$142,796
67	1.1.1.2.2.7	Production L0 hybrid available	Thu 1/15/04	Thu 1/15/04	0 days	$0
68	1.1.1.2.2.8	Production L0 hybrid complete	Thu 3/11/04	Thu 3/11/04	0 days	$0
69	1.1.1.3	Bus Cables	Fri 12/14/01	Tue 10/21/03	460 days	$61,502
81	1.1.1.4	Mini Port Card	Wed 10/10/01	Fri 6/25/04	670 days	$614,181
100	1.1.1.5	Junction Port Cards	Tue 4/9/02	Fri 6/25/04	550 days	$315,902
123	1.1.1.6	Junction Cards	Wed 6/5/02	Fri 5/28/04	490 days	$135,934
140	1.1.1.7	Cables	Tue 2/19/02	Thu 4/29/04	545 days	$320,541
141	1.1.1.7.1	Cables from MPC to JPC	Tue 2/19/02	Thu 4/29/04	545 days	$173,371
155	1.1.1.7.2	Cables from JPC to Crates	Tue 2/19/02	Thu 4/29/04	545 days	$147,170
169	1.1.1.8	FTMs	Tue 3/19/02	Fri 6/25/04	565 days	$183,707
170	1.1.1.8.1	modify existing FTM for milestone #1	Tue 3/19/02	Tue 4/16/02	20 days	$408
171	1.1.1.8.2	FTM ready for milestone #1	Tue 4/16/02	Tue 4/16/02	0 days	$0
172	1.1.1.8.3	Prototype FTM: spec, design and layout	Fri 11/15/02	Thu 1/23/03	40 days	$22,064
173	1.1.1.8.4	Prototype FTM: procurement	Thu 1/23/03	Thu 3/20/03	40 days	$39,000
174	1.1.1.8.5	Prototype FTM: assembling and evaluation	Fri 3/21/03	Fri 6/13/03	60 days	$8,206
175	1.1.1.8.6	Production go ahead on FTMs	Tue 9/30/03	Tue 9/30/03	0 days	$0
176	1.1.1.8.7	Production FTM: spec, design and layout	Fri 1/9/04	Thu 3/4/04	40 days	$22,064
177	1.1.1.8.8	Production: procurement	Thu 3/4/04	Thu 4/29/04	40 days	$78,000
178	1.1.1.8.9	Production: assembling and evaluation	Fri 4/2/04	Fri 6/25/04	60 days	$13,966
179	1.1.1.8.10	Production FTMs complete	Fri 6/25/04	Fri 6/25/04	0 days	$0
180	1.1.1.9	DAQ Testing & Readiness	Wed 8/21/02	Thu 1/8/04	335 days	$173,748
181	1.1.1.9.1	Testing of Prototype DAQ Chain	Wed 8/21/02	Thu 11/14/02	60 days	$66,114
182	1.1.1.9.2	Testing of Preproduction DAQ chain	Tue 9/30/03	Thu 1/8/04	60 days	$107,634
183	1.1.1.9.3	Milestone#4: DAQ Production Go-Ahead	Thu 1/8/04	Thu 1/8/04	0 days	$0
184	1.1.1.10	Power Supply system	Tue 4/2/02	Tue 9/7/04	605 days	$733,114
185	1.1.1.10.1	Selection of New Supplies	Tue 4/2/02	Tue 5/28/02	40 days	$0
186	1.1.1.10.2	Procure sample supplies	Tue 5/28/02	Wed 8/21/02	60 days	$20,000
187	1.1.1.10.3	Test general features of Power supplies	Thu 8/22/02	Thu 11/14/02	60 days	$0
188	1.1.1.10.4	Evaluate power supplies	Fri 11/15/02	Thu 2/20/03	60 days	$8,994
189	1.1.1.10.5	Power supply go ahead	Thu 1/8/04	Thu 1/8/04	0 days	$0
190	1.1.1.10.6	Procurement of supplies	Thu 1/8/04	Fri 6/11/04	110 days	$683,000
191	1.1.1.10.7	Testing	Fri 4/2/04	Tue 9/7/04	110 days	$21,120
192	1.1.1.11	SVT upgrade	Thu 1/8/04	Fri 5/28/04	100 days	$382,200
193	1.1.1.11.1	Upgrade SVT trackfitters	Thu 1/8/04	Fri 5/28/04	100 days	$273,000
194	1.1.1.11.2	Upgrade SVT merger boards	Thu 1/8/04	Fri 5/28/04	100 days	$109,200
195	1.1.2	Sensors	Mon 2/4/02	Wed 3/31/04	535 days	$2,296,246



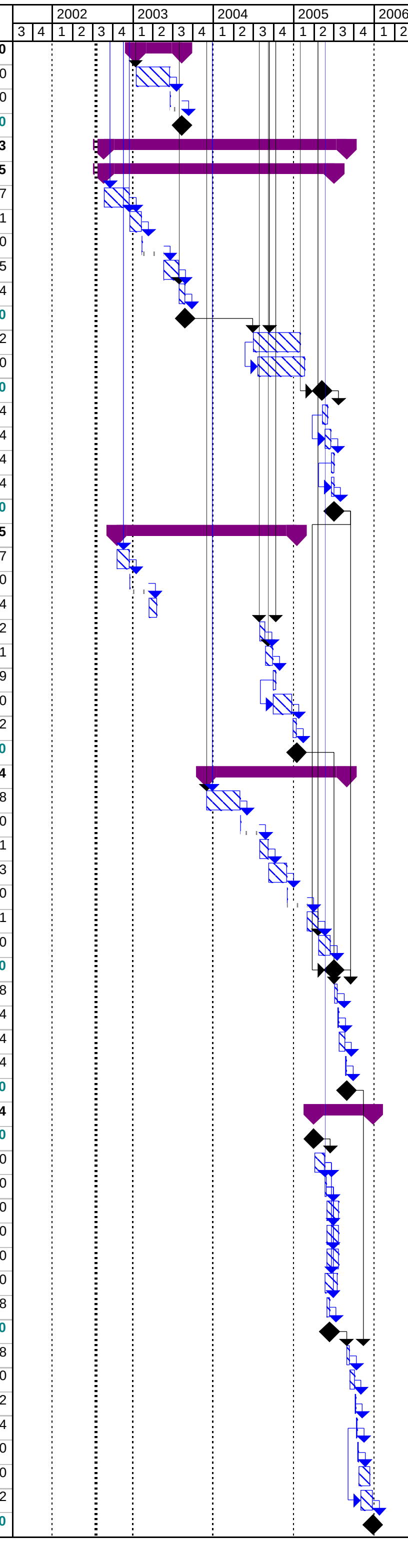
ID	WBS	Task Name	Start	Finish	Duration	Cost
196	**1.1.2.1**	**Outer layers**	**Mon 2/4/02**	**Wed 3/31/04**	**535 days**	**$2,150,566**
197	1.1.2.1.1	Dummy Sensors: layout	Mon 4/1/02	Fri 4/12/02	10 days	$0
198	1.1.2.1.2	Dummy Sensors: manufacturing	Fri 4/12/02	Mon 6/10/02	40 days	$12,750
199	1.1.2.1.3	Prototype Sensor Layout	Mon 2/4/02	Fri 3/29/02	40 days	$22,369
200	**1.1.2.1.4**	**Prototype Sensors: submission**	**Fri 3/29/02**	**Fri 3/29/02**	**0 days**	**$0**
201	1.1.2.1.5	Prototype Sensor manufacturing	Fri 3/29/02	Tue 7/16/02	75 days	$178,420
202	**1.1.2.1.6**	**Prototype Sensors Available**	**Tue 7/16/02**	**Tue 7/16/02**	**0 days**	**$0**
203	1.1.2.1.7	Sensor final design work	Wed 7/17/02	Tue 8/13/02	20 days	$3,388
204	1.1.2.1.8	Prototype Sensor tests	Tue 7/16/02	Wed 10/9/02	60 days	$8,880
205	**1.1.2.1.9**	**Silicon Production Sensor ready to order**	**Wed 10/9/02**	**Wed 10/9/02**	**0 days**	**$0**
206	1.1.2.1.10	Production Sensors manufacturing	Wed 10/9/02	Wed 3/31/04	360 days	$0
207	**1.1.2.1.11**	**Axial sensor order (1st half)**	**Wed 10/9/02**	**Wed 10/9/02**	**0 days**	**$662,634**
208	**1.1.2.1.15**	**Axial sensor order (2nd half)**	**Mon 10/27/03**	**Mon 10/27/03**	**0 days**	**$635,635**
209	**1.1.2.1.12**	**Small Angle Stereo (1st half)**	**Wed 10/9/02**	**Wed 10/9/02**	**0 days**	**$626,490**
210	**1.1.2.1.15**	**Small Angle Stereo (2nd half)**	**Mon 10/27/03**	**Mon 10/27/03**	**0 days**	**$0**
211	**1.1.2.1.13**	**Production Sensors Available**	**Wed 2/12/03**	**Wed 2/12/03**	**0 days**	**$0**
212	**1.1.2.1.14**	**Production Sensors Complete**	**Wed 3/31/04**	**Wed 3/31/04**	**0 days**	**$0**
213	**1.1.2.2**	**layer L0**	**Tue 5/28/02**	**Thu 6/5/03**	**255 days**	**$145,680**
214	1.1.2.2.1	L0 Sensor final design work	Tue 5/28/02	Tue 7/23/02	40 days	$22,369
215	**1.1.2.2.2**	**L0 Production sensor order**	**Wed 10/9/02**	**Wed 10/9/02**	**0 days**	**$0**
216	1.1.2.2.3	L0 Sensor Production	Wed 5/7/03	Thu 6/5/03	20 days	$123,311
217	**1.1.2.2.4**	**L0 Sensors Available**	**Thu 6/5/03**	**Thu 6/5/03**	**0 days**	**$0**
218	**1.1.2.2.5**	**L0 Sensors Complete**	**Thu 6/5/03**	**Thu 6/5/03**	**0 days**	**$0**
219	**1.1.3**	**Construction (Modules and staves)**	**Mon 9/3/01**	**Mon 1/31/05**	**842 days**	**$2,241,206**
220	**1.1.3.4**	**Beginning of Mechanical Project**	**Mon 1/7/02**	**Mon 1/7/02**	**0 days**	**$0**
221	**1.1.3.1**	**L0 Construction (cables and modules)**	**Mon 9/3/01**	**Wed 3/24/04**	**631 days**	**$499,738**
222	**1.1.3.1.1**	**L0 analogue signal cables**	**Mon 9/3/01**	**Thu 1/8/04**	**577 days**	**$307,882**
223	1.1.3.1.1.1	L0 cables technology testing	Mon 9/3/01	Fri 6/21/02	200 days	$57,520
224	**1.1.3.1.1.2**	**L0 Test cables Available**	**Fri 6/21/02**	**Fri 6/21/02**	**0 days**	**$0**
225	1.1.3.1.1.3	L0 cable preproduction design	Thu 8/1/02	Thu 10/24/02	60 days	$23,894
226	1.1.3.1.1.4	L0 preproduction fabrication	Fri 10/25/02	Thu 2/27/03	80 days	$0
227	**1.1.3.1.1.5**	**L0 Preproduction cable available**	**Thu 3/13/03**	**Thu 3/13/03**	**0 days**	**$0**
228	1.1.3.1.1.6	L0 Preproduction evaluation	Fri 3/14/03	Thu 4/10/03	20 days	$4,014
229	1.1.3.1.1.7	L0 production cable design	Fri 4/11/03	Mon 7/7/03	60 days	$33,553
230	1.1.3.1.1.8	L0 cable production	Mon 7/7/03	Tue 11/25/03	100 days	$188,900
231	1.1.3.1.1.9	L0 Cable Production Test	Tue 8/5/03	Thu 1/8/04	100 days	$0
232	**1.1.3.1.1.10**	**L0 cables Available**	**Tue 8/5/03**	**Tue 8/5/03**	**0 days**	**$0**
233	**1.1.3.1.1.11**	**L0 cables Complete**	**Thu 1/8/04**	**Thu 1/8/04**	**0 days**	**$0**
234	**1.1.3.1.2**	**layer 0 modules**	**Thu 7/25/02**	**Wed 3/24/04**	**409 days**	**$191,856**
235	1.1.3.1.2.1	L0 modules R&D and Prototype	Thu 7/25/02	Thu 11/14/02	80 days	$25,757
236	1.1.3.1.2.2	L0 module: fixtures design	Tue 10/1/02	Mon 11/11/02	30 days	$16,777
237	1.1.3.1.2.3	L0 module: material and fixtures	Mon 11/11/02	Mon 1/20/03	40 days	$30,000
238	1.1.3.1.2.4	L0 preproduction module construction	Fri 6/6/03	Thu 7/3/03	20 days	$9,118
239	**1.1.3.1.2.5**	**L0 Preproduction modules available**	**Thu 7/3/03**	**Thu 7/3/03**	**0 days**	**$0**
240	1.1.3.1.2.6	L0 preproduction modules evaluation	Mon 7/7/03	Mon 9/29/03	60 days	$2,880
241	**1.1.3.1.2.7**	**Milestone#2: L0 preproduction module ready**	**Mon 9/29/03**	**Mon 9/29/03**	**0 days**	**$0**
242	1.1.3.1.2.8	Production L0 module: fixture design	Tue 9/30/03	Mon 11/10/03	30 days	$17,029
243	1.1.3.1.2.9	Production L0 module: material and fixtures	Mon 11/10/03	Wed 1/21/04	40 days	$75,000
244	1.1.3.1.2.10	L0 Module production	Thu 1/22/04	Wed 3/24/04	45 days	$15,296
245	**1.1.3.1.2.11**	**L0 modules available**	**Wed 2/18/04**	**Wed 2/18/04**	**0 days**	**$0**
246	**1.1.3.1.2.12**	**L0 Module Production complete**	**Wed 3/24/04**	**Wed 3/24/04**	**0 days**	**$0**
247	**1.1.3.2**	**Outer layer modules**	**Wed 1/30/02**	**Thu 12/16/04**	**719 days**	**$537,827**
248	1.1.3.2.1	Prototype Module: fixtures design	Wed 1/30/02	Tue 4/23/02	60 days	$44,330
249	1.1.3.2.2	Prototype Module: material and fixtures	Tue 4/23/02	Wed 6/19/02	40 days	$33,750
250	1.1.3.2.3	Prototype Module: Assembling	Thu 7/25/02	Thu 10/17/02	60 days	$37,975
251	**1.1.3.2.4**	**Prototype modules available**	**Wed 8/7/02**	**Wed 8/7/02**	**0 days**	**$0**
252	1.1.3.2.5	Contingency Module: Assembling	Fri 2/21/03	Thu 5/15/03	60 days	$0
253	**1.1.3.2.6**	**Contingency modules available**	**Thu 3/6/03**	**Thu 3/6/03**	**0 days**	**$0**
254	1.1.3.2.7	Preproduction Module: fixtures design	Mon 2/3/03	Fri 3/28/03	40 days	$29,554
255	1.1.3.2.8	Preproduction Module: material and fixtures	Fri 3/28/03	Fri 5/23/03	40 days	$57,750
256	1.1.3.2.9	Preproduction module: Assembling	Wed 9/3/03	Thu 2/5/04	100 days	$80,390
257	**1.1.3.2.10**	**Preproduction modules available**	**Tue 9/16/03**	**Tue 9/16/03**	**0 days**	**$0**
258	1.1.3.2.11	Production Module: contingency fixtures design	Wed 9/17/03	Tue 10/14/03	20 days	$14,777
259	1.1.3.2.12	Production modules: material and fixtures	Tue 10/14/03	Thu 12/11/03	40 days	$70,125
260	1.1.3.2.13	Production Modules: Assembling	Fri 3/5/04	Thu 12/16/04	200 days	$169,176
261	**1.1.3.2.14**	**Production modules available**	**Thu 3/18/04**	**Thu 3/18/04**	**0 days**	**$0**
262	**1.1.3.2.15**	**Module Production complete**	**Thu 12/16/04**	**Thu 12/16/04**	**0 days**	**$0**
263	**1.1.3.3**	**Outer layer Staves**	**Fri 11/2/01**	**Mon 1/31/05**	**798 days**	**$1,203,641**
264	1.1.3.3.1	Prototype stave :Structural and cooling R&D	Fri 11/2/01	Wed 5/1/02	120 days	$135,110
265	**1.1.3.3.2**	**Prototype Stave Design complete**	**Wed 5/1/02**	**Wed 5/1/02**	**0 days**	**$0**
266	1.1.3.3.3	Prototype Stave: material and fixtures	Wed 5/1/02	Thu 6/13/02	30 days	$99,000
267	1.1.3.3.4	Prototype Stave: mechanical construction	Fri 6/14/02	Fri 8/9/02	40 days	$21,948
268	**1.1.3.3.5**	**Prototype Stave: mechanicals available**	**Fri 7/12/02**	**Fri 7/12/02**	**0 days**	**$0**
269	1.1.3.3.6	Prototype Stave: mechanical testing	Mon 7/15/02	Mon 11/4/02	80 days	$25,336
270	1.1.3.3.7	Prototype Stave: electrical assembly	Thu 8/8/02	Thu 10/3/02	40 days	$29,976
271	1.1.3.3.8	Prototype Stave: electrical testing	Thu 8/15/02	Thu 11/14/02	65 days	$10,394



ID	WBS	Task Name	Start	Finish	Duration	Cost
272	**1.1.3.3.9**	**MILESTONE#1: Prototype Stave available**	**Wed 8/21/02**	**Wed 8/21/02**	**0 days**	**$0**
273	1.1.3.3.10	Contingency Stave: electrical assembly	Fri 3/7/03	Thu 5/1/03	40 days	$0
274	1.1.3.3.11	Contingency Stave: electrical testing	Fri 3/14/03	Fri 6/13/03	65 days	$0
275	**1.1.3.3.12**	**MILESTONE#1*: Contingency Stave available**	**Thu 3/20/03**	**Thu 3/20/03**	**0 days**	**$0**
276	1.1.3.3.13	Production Stave: final design	Tue 11/5/02	Mon 1/27/03	50 days	$35,096
277	1.1.3.3.14	Production Stave: material and fixtures	Mon 1/27/03	Mon 3/24/03	40 days	$415,125
278	1.1.3.3.15	Preproduction Stave: mechanical construction	Mon 6/2/03	Mon 7/28/03	40 days	$26,588
279	**1.1.3.3.16**	**Preproduction Stave: mechanicals available**	**Fri 6/13/03**	**Fri 6/13/03**	**0 days**	**$0**
280	1.1.3.3.17	Preproduction Stave: mechanical testing	Mon 6/16/03	Mon 7/14/03	20 days	$6,334
281	1.1.3.3.18	Preproduction Stave: electrical assembly	Wed 9/17/03	Thu 1/8/04	70 days	$52,213
282	**1.1.3.3.19**	**Preproduction Stave: electricals available**	**Tue 9/30/03**	**Tue 9/30/03**	**0 days**	**$0**
283	1.1.3.3.20	Preproduction Stave: electrical testing	Wed 9/24/03	Tue 11/18/03	40 days	$6,960
284	1.1.3.3.21	Evaluation of preproduction staves	Wed 9/24/03	Tue 11/18/03	40 days	$21,384
285	**1.1.3.3.22**	**MILESTONE#2: Stave Production go-ahead**	**Tue 11/18/03**	**Tue 11/18/03**	**0 days**	**$0**
286	1.1.3.3.23	Production Stave: modification to the final design	Wed 9/24/03	Tue 11/18/03	40 days	$21,301
287	1.1.3.3.24	Production Stave: contingency material and fixtures	Tue 11/18/03	Thu 1/29/04	40 days	$69,000
288	1.1.3.3.25	Production Stave: mechanical construction	Fri 1/30/04	Thu 5/20/04	80 days	$48,536
289	**1.1.3.3.26**	**Production Stave: mechanicals available**	**Thu 2/12/04**	**Thu 2/12/04**	**0 days**	**$0**
290	1.1.3.3.27	Production Stave: electrical assembly	Fri 3/19/04	Mon 1/10/05	200 days	$144,540
291	1.1.3.3.28	Production Stave: electrical testing	Fri 3/26/04	Mon 1/17/05	200 days	$34,800
292	**1.1.3.3.29**	**Production Staves Available**	**Thu 4/1/04**	**Thu 4/1/04**	**0 days**	**$0**
293	**1.1.3.3.30**	**Stave Production Complete**	**Mon 1/31/05**	**Mon 1/31/05**	**0 days**	**$0**
294	**1.1.4**	**Beampipe**	**Mon 1/7/02**	**Mon 10/6/03**	**440 days**	**$237,771**
295	1.1.4.1	Design beampipe	Mon 1/7/02	Fri 3/1/02	40 days	$12,878
296	**1.1.4.2**	**Beampipe design complete**	**Fri 3/1/02**	**Fri 3/1/02**	**0 days**	**$0**
297	1.1.4.3	procure beampipe	Tue 7/23/02	Mon 10/6/03	300 days	$224,893
298	**1.1.4.4**	**Beampipe available**	**Mon 10/6/03**	**Mon 10/6/03**	**0 days**	**$0**
299	**1.1.5**	**Support Mechanics**	**Mon 7/2/01**	**Fri 7/30/04**	**766 days**	**$1,579,240**
300	**1.1.5.1**	**Mechanical Infrastructure**	**Mon 1/7/02**	**Fri 2/1/02**	**20 days**	**$200,000**
301	1.1.5.1.1	Procure 3m CMM	Mon 1/7/02	Fri 2/1/02	20 days	$200,000
302	**1.1.5.2**	**Silicon Support Structures**	**Mon 7/2/01**	**Wed 4/28/04**	**701 days**	**$1,134,490**
303	**1.1.5.2.1**	**Bulkheads**	**Mon 7/2/01**	**Wed 10/16/02**	**326 days**	**$437,999**
304	1.1.5.2.1.1	Bulkhead Initial Concept studies	Mon 1/7/02	Fri 3/29/02	60 days	$36,442
305	1.1.5.2.1.2	Bulkhead Prototype: Design	Mon 4/1/02	Fri 5/24/02	40 days	$25,757
306	1.1.5.2.1.3	Bulkhead Prototype: fabrication	Fri 5/24/02	Tue 7/23/02	40 days	$75,000
307	1.1.5.2.1.4	Bulkhead Prototype: assembly and testing	Wed 7/24/02	Wed 10/16/02	60 days	$26,868
308	1.1.5.2.1.5	Bulkhead: Final Design	Mon 7/2/01	Fri 8/24/01	40 days	$25,757
309	**1.1.5.2.1.9**	**Bulkhead Final Design Complete**	**Fri 8/24/01**	**Fri 8/24/01**	**0 days**	**$0**
310	1.1.5.2.1.6	Bulkhead: fabrication	Fri 8/24/01	Thu 1/24/02	100 days	$195,000
311	1.1.5.2.1.7	Bulkhead: assembly, testing	Fri 1/25/02	Thu 5/16/02	80 days	$53,176
312	**1.1.5.2.1.8**	**Bulkheads Complete**	**Thu 5/16/02**	**Thu 5/16/02**	**0 days**	**$0**
313	**1.1.5.2.2**	**screens**	**Mon 1/7/02**	**Wed 9/18/02**	**180 days**	**$398,746**
314	1.1.5.2.2.1	Design outer screen	Mon 1/7/02	Fri 3/29/02	60 days	$38,635
315	1.1.5.2.2.2	Barrel outer screen: fabrication	Fri 3/29/02	Fri 5/24/02	40 days	$75,000
316	1.1.5.2.2.3	Support tube fabrication	Fri 3/29/02	Fri 5/24/02	40 days	$135,000
317	1.1.5.2.2.4	Design and Fabricate screen installation fixture	Fri 3/29/02	Mon 6/24/02	60 days	$67,555
318	1.1.5.2.2.5	Design and Fabricate support cradle	Mon 6/24/02	Wed 9/18/02	60 days	$82,555
319	**1.1.5.2.3**	**Layer 0**	**Mon 4/1/02**	**Wed 4/28/04**	**515 days**	**$297,745**
320	1.1.5.2.3.1	CF Support Prototype: design	Mon 4/1/02	Tue 7/23/02	80 days	$51,514
321	1.1.5.2.3.2	CF Support Prototype: manufacturing	Tue 7/23/02	Fri 12/13/02	100 days	$75,000
322	1.1.5.2.3.3	CF Support Prototype: evaluation and testing	Fri 6/6/03	Fri 8/29/03	60 days	$26,868
323	1.1.5.2.3.4	CF Support: Design	Mon 7/21/03	Fri 8/29/03	30 days	$19,318
324	1.1.5.2.3.5	CF Support: manufacturing	Fri 8/29/03	Wed 2/4/04	100 days	$75,000
325	1.1.5.2.3.6	CF Support: assembly and test	Thu 2/5/04	Wed 4/28/04	60 days	$50,046
326	**1.1.5.2.3.7**	**L0 Supports Complete**	**Wed 4/28/04**	**Wed 4/28/04**	**0 days**	**$0**
327	**1.1.5.3**	**Transportation Fixtures**	**Thu 1/15/04**	**Fri 7/30/04**	**140 days**	**$67,636**
328	1.1.5.3.1	transportation fixture: updating design	Thu 1/15/04	Wed 3/10/04	40 days	$13,552
329	1.1.5.3.2	transportation fixture: fabrication	Wed 3/10/04	Wed 5/5/04	40 days	$30,000
330	1.1.5.3.3	transportation fixture: final assembling and test	Thu 5/6/04	Fri 7/30/04	60 days	$24,084
331	**1.1.5.4**	**Positioning system (inchworms)**	**Tue 5/28/02**	**Wed 3/19/03**	**200 days**	**$66,009**
332	1.1.5.4.1	positioning jacks(inchworms): design	Tue 5/28/02	Tue 7/23/02	40 days	$18,981
333	1.1.5.4.4	positioning jack prototype manufacturing	Tue 7/23/02	Wed 9/18/02	40 days	$9,000
334	1.1.5.4.5	Prototype positioning jack testing	Thu 9/19/02	Wed 11/13/02	40 days	$0
335	1.1.5.4.2	positioning jacks: manufacturing	Wed 11/13/02	Wed 1/22/03	40 days	$30,000
336	1.1.5.4.3	positioning jacks: Assemble and test	Thu 1/23/03	Wed 3/19/03	40 days	$8,028
337	**1.1.5.5**	**Installation of SVXIIb into ISL**	**Thu 1/15/04**	**Thu 7/1/04**	**120 days**	**$111,105**
338	1.1.5.5.1	Design Fixtures for removal of SVXII and installation of S	Thu 1/15/04	Wed 3/10/04	40 days	$25,757
339	1.1.5.5.2	Fabricate fixtures for SVX removal and installation of SVX	Wed 3/10/04	Thu 6/3/04	60 days	$75,000
340	1.1.5.5.3	Assembly and Test fixtures for SVX removal and installati	Fri 6/4/04	Thu 7/1/04	20 days	$10,348
341	**1.1.6**	**Cooling and Monitoring**	**Wed 10/16/02**	**Tue 10/19/04**	**496 days**	**$213,238**
342	**1.1.6.1**	**Cooling systems**	**Wed 10/16/02**	**Wed 4/30/03**	**130 days**	**$153,238**
343	1.1.6.1.1	Update Sidet cooling system	Wed 10/16/02	Fri 12/13/02	40 days	$26,056
344	1.1.6.1.2	Build internal manifolds	Wed 10/16/02	Wed 1/22/03	60 days	$54,084
345	1.1.6.1.3	production chiller components, manifolds, control valves	Wed 1/22/03	Wed 4/30/03	70 days	$73,098
346	**1.1.6.2**	**Interlocks**	**Thu 1/8/04**	**Tue 10/19/04**	**200 days**	**$30,000**
347	1.1.6.2.1	Upgrade existing system	Thu 1/8/04	Tue 10/19/04	200 days	$30,000



ID	WBS	Task Name	Start	Finish	Duration	Cost
348	**1.1.6.3**	**Position Monitoring**	**Thu 10/17/02**	**Wed 5/14/03**	**140 days**	**$30,000**
349	1.1.6.3.3	Rasnik Prototype manufacturing and test	Thu 10/17/02	Wed 3/19/03	100 days	$0
350	1.1.6.3.1	Rasnik Production	Wed 3/19/03	Wed 5/14/03	40 days	$30,000
351	**1.1.6.3.2**	**Rasniks Complete**	**Wed 5/14/03**	**Wed 5/14/03**	**0 days**	**$0**
352	**1.1.7**	**Final Assembly (Installation and Integration)**	**Fri 5/24/02**	**Tue 5/31/05**	**746 days**	**$676,943**
353	**1.1.7.1**	**Stave Intallation (Outer)**	**Fri 5/24/02**	**Mon 4/4/05**	**706 days**	**$317,855**
354	1.1.7.1.1	Prototype stave installation fixture: R&D	Fri 5/24/02	Wed 9/18/02	80 days	$70,757
355	1.1.7.1.2	Stave installation fixtures: design	Thu 9/19/02	Wed 11/13/02	40 days	$18,981
356	1.1.7.1.3	Stave installation fixtures: fabrication	Wed 11/13/02	Wed 2/19/03	60 days	$105,000
357	1.1.7.1.4	Stave installation fixture: setup and Alignment	Thu 2/20/03	Wed 4/30/03	50 days	$21,635
358	1.1.7.1.5	Bulkhead installation and alignment	Thu 5/1/03	Thu 5/29/03	20 days	$10,974
359	**1.1.7.1.6**	**Ready for stave installation**	**Thu 5/29/03**	**Thu 5/29/03**	**0 days**	**$0**
360	1.1.7.1.7	Installation of staves	Fri 4/2/04	Tue 11/2/04	150 days	$57,282
361	1.1.7.1.8	Installation of Stave: electrical testing	Fri 4/23/04	Tue 11/23/04	150 days	$0
362	**1.1.7.1.9**	**Stave installation complete**	**Mon 2/7/05**	**Mon 2/7/05**	**0 days**	**$0**
363	1.1.7.1.10	Final system tests	Tue 2/8/05	Mon 3/7/05	20 days	$17,704
364	1.1.7.1.11	Installation outer screen	Tue 2/22/05	Mon 3/21/05	20 days	$6,334
365	1.1.7.1.12	Installation of barrel in spacetube	Tue 3/22/05	Mon 4/4/05	10 days	$5,174
366	1.1.7.1.13	dressing of cables and cooling	Tue 3/22/05	Mon 4/4/05	10 days	$4,014
367	**1.1.7.1.14**	**Outer Detector Complete**	**Mon 4/4/05**	**Mon 4/4/05**	**0 days**	**$0**
368	**1.1.7.2**	**L0 Installation (Inner)**	**Wed 7/24/02**	**Fri 10/15/04**	**554 days**	**$150,645**
369	1.1.7.2.1	L0 module installation fixtures: design	Wed 7/24/02	Wed 9/18/02	40 days	$25,757
370	1.1.7.2.2	L0 module installation fixtures: fabrication	Wed 9/18/02	Fri 12/13/02	60 days	$60,000
371	1.1.7.2.3	L0 module installation fixtures: assembly and test	Mon 12/16/02	Wed 1/22/03	20 days	$6,334
372	1.1.7.2.4	Install L0 supports on beam pipe	Thu 4/29/04	Thu 5/27/04	20 days	$9,722
373	1.1.7.2.5	Installation of L0 Modules	Fri 5/28/04	Wed 6/30/04	24 days	$6,381
374	1.1.7.2.6	Dressing of HDIs	Thu 7/1/04	Thu 7/15/04	10 days	$2,659
375	1.1.7.2.7	L0 System Tests	Thu 7/1/04	Fri 9/24/04	60 days	$31,230
376	1.1.7.2.8	Installation of Screens	Mon 9/27/04	Fri 10/15/04	15 days	$8,562
377	**1.1.7.2.9**	**Inner Detector Complete**	**Fri 10/15/04**	**Fri 10/15/04**	**0 days**	**$0**
378	**1.1.7.3**	**Integration**	**Tue 9/2/03**	**Tue 5/31/05**	**431 days**	**$208,444**
379	1.1.7.3.1	Prototype Inner Detector Installation Fixtures: design	Tue 9/2/03	Wed 2/4/04	100 days	$16,098
380	1.1.7.3.2	Prototype Inner Detector Installation Fixtures: fabrication	Wed 2/4/04	Wed 4/28/04	60 days	$30,000
381	1.1.7.3.3	Prototype Inner Detector Installation Fixtures: test	Thu 4/29/04	Thu 6/10/04	30 days	$7,761
382	1.1.7.3.4	Inner Detector Installation Fixtures: Final Design	Fri 6/11/04	Fri 9/3/04	60 days	$33,553
383	1.1.7.3.5	Inner Detector Installation Fixtures: fabrication	Fri 9/3/04	Wed 12/1/04	60 days	$30,000
384	1.1.7.3.6	Inner Detector Installation Fixtures: test	Thu 12/2/04	Fri 1/21/05	30 days	$7,761
385	1.1.7.3.7	Fabricate beampipe supports	Fri 1/21/05	Fri 3/18/05	40 days	$56,270
386	**1.1.7.3.8**	**Ready to integrate inner and outer detectors**	**Mon 4/4/05**	**Mon 4/4/05**	**0 days**	**$0**
387	1.1.7.3.9	Combine Inner and Outer Detectors	Tue 4/5/05	Mon 4/18/05	10 days	$5,708
388	1.1.7.3.10	Final survey	Tue 4/19/05	Mon 4/25/05	5 days	$5,174
389	1.1.7.3.11	Final Cooling and electrical Tests	Tue 4/26/05	Mon 5/23/05	20 days	$12,104
390	1.1.7.3.12	Close top of SVX extention cylinders (final dressing, posit	Tue 5/24/05	Tue 5/31/05	5 days	$4,014
391	**1.1.7.3.13**	**SVX2b Ready for Installation**	**Tue 5/31/05**	**Tue 5/31/05**	**0 days**	**$0**
392	**1.1.8**	**Transportation and Installation**	**Mon 1/3/05**	**Tue 9/27/05**	**188 days**	**$52,974**
393	**1.1.8.1**	**Run 2a Ends**	**Mon 1/3/05**	**Mon 1/3/05**	**0 days**	**$0**
394	1.1.8.2	CDF to Assembly Hall/ Plugs Opened	Tue 1/4/05	Mon 2/21/05	35 days	$0
395	1.1.8.3	SVX2a Extracted and Moved to SiDet	Tue 2/22/05	Mon 2/28/05	5 days	$0
396	1.1.8.4	Install/test JPC	Tue 3/1/05	Mon 4/25/05	40 days	$0
397	1.1.8.5	Install/test new inner cables	Tue 3/1/05	Mon 4/25/05	40 days	$0
398	1.1.8.6	Install/test new Outer Cables	Tue 3/1/05	Mon 4/25/05	40 days	$7,680
399	1.1.8.7	install/test new power supplies and FTMs	Tue 2/22/05	Mon 4/18/05	40 days	$7,680
400	1.1.8.8	Remove SVXII/L00/BP	Tue 3/1/05	Mon 3/14/05	10 days	$5,708
401	**1.1.8.9**	**ISL ready for SVX2b**	**Mon 3/14/05**	**Mon 3/14/05**	**0 days**	**$0**
402	1.1.8.10	Install & Align SVX2b in ISL	Wed 6/1/05	Tue 6/14/05	10 days	$8,028
403	1.1.8.11	Fasten/Test ISL Junction Cards	Wed 6/15/05	Wed 7/6/05	15 days	$3,480
404	1.1.8.12	Extension Cylinders Installation and beampipe supports	Thu 7/7/05	Mon 7/11/05	3 days	$1,712
405	1.1.8.13	Transport SVX2b to B0 & Install in CDF	Tue 7/12/05	Mon 7/18/05	5 days	$2,854
406	1.1.8.14	Inner cables connected	Tue 7/19/05	Mon 7/25/05	5 days	$0
407	1.1.8.15	Plugs Closed/CDF to Collision Hall	Tue 7/26/05	Tue 9/13/05	35 days	$0
408	1.1.8.16	Connect and Test	Tue 8/2/05	Tue 9/27/05	40 days	$15,832
409	**1.1.8.17**	**SVX2b Project Complete**	**Tue 9/27/05**	**Tue 9/27/05**	**0 days**	**$0**



1 **Run 2b Silicon Project**
Table summarises the number of parts needed to the project:

Layer	Type	Φ-seg.	Z-seg.	Length	Width	Pitch	Total
5	A	30	6	96.4	40.5	75/37.5	360
5	A	30	6	96.4	40.5	75/37.5	360
4	A	24	6	96.4	40.5	75/37.5	288
4	2.5°	24	6	96.4	43.1	80/40	288
3	A	18	6	96.4	40.5	75/37.5	216
3	2.5°	18	6	96.4	43.1	80/40	216
2	A	12	6	96.4	40.5	75/37.5	144
2	2.5°	12	6	96.4	43.1	80/40	144
1	A	6	6	96.4	40.5	75/37.5	72
1	A	6	6	96.4	40.5	75/37.5	72
0	A	12	6	96.4	14.8	50/25	144

	Sensors	Modules	Staves	4-chips hybrids	2-chips hybrids	MPC	JPC
Outer Axials	1512	756	180	1080	0	180	40
Outer Stereo	648	324					
L0	144	72	0	0	72	0	16
TOTAL	2304	1152	180	1080	72	180	56

3 **SVX4 Chips**
Runs:
1. Prototype (Hybrid #1)
2. Contingency (Hybrid #2)
3. Production (Preproduction and Production hybrids)

Need **4,464** chips for the project

4 **1st chip: layout**
Cost:
This is labor cost at LBL as from Henrik Van Der Lippe
project file svx4_0202.mpp of March 20 2002:
$241,028 to be equally split between CDF and D0.
Labor:
LBL provided an equivalent of 1 engineer for 1.6 years to the project (Costed as R&D)
FNAL provided an equivalent of 1 engineer for 3 months on the project (Costed as Labor)
INFN-Padova provided 1 engineer for 12 months on the project (Not Costed)

5 **1st Chip submission (eng. Run)**
Schedule:
This is the first submission of the new svx4 chip on 0.25um technology.
The minimum order is for ~10wafers and is a joint CDF,D0 and BTeV submission (not equally divided).

6 **1st chip: documentation**
Labor:
This is labor at LBL associated with producing the necessary documentation for the chip.

7 **1st Chip: manufacturing**
Schedule:
8 weeks for fabrication at TSMC
Cost:
total cost is 200K$ for 10 wafers minimum order. This order is split between CDF, D0 and BTeV
Cost for CDF is 50K$ for masks + 8K$ for chips

8 **1st Chip: postprocessing**
Schedule:
2 weeks for backgrounding, backplating and dicing
Cost:
Total is 15K$ (Engineering Estimate). CDF part is 5K$

9 **1st Chip: engineering evaluation at FNAL**
Labor:
This is FNAL labor only. It included enginnering type tests and more higher level type tests.

10 **1st Chip: engineering evaluation at LBL**
Labor:
This is labor cost at LBL as from Henrik Van Der Lippe and Ray Yarema (3/19/02)
project file svx4_0202.mpp of March 20 2002.
Tests performed at LBL include radiation damage assesment. Other tests including radiation damage assesment will also be performed at INFN-Padova.

11 **1st Chip: evaluation**
General:
This is the evaluation of the chip with CDF Data Aquisition System. Also we will evaluate the performance of the chip with real sensor using both a laser and a radiactive source.
Labor:
1) Postdocs (150%) for testing the chip with the real DAQ, modify programs etc.
2) electrical technician (20%) needed for support with electrical board stuffing/testing.
3) Scientist (50%) to coordinate the effort

12 **1st Chip ready for hybrids**
Schedule:
This is 1 month after receiving the Eng.run parts.
This is agressive and assumes the chip works without major problems.

13 **2nd Chip: layout**
This starts after chip evaluation completes, but it could start earlier.
Labor:
moslty LBL labor
FNAL will provide 1 engineer for 20 days during this period

14 **2nd Chip: submission (eng. Run)**
General:
This is the 2nd engineering run submission with only svx4 devices. If changes are minor wrt 1st chip, all production wafers might be ordered at this time. For the purpose of this schedule we will order here 5 wafers worth of svx4 chips for CDF

15 **2nd Chip: manufacturing**
Cost:
The minimum order cost is 200K$ which yields 10 wafers worth of chips.
100K$ is the CDF part. We also may want to order extra wafers to get us through the rpeproduction phase. The extra cost is 25K$ (10 wafers) which we have as contingency.

16 **2nd Chip: postprocessing**
Schedule:
2 weeks for backgrounding, backplating and dicing
Cost:
Total is 15K$ (Engineering Estimate). CDF part is 7.5K$

17 **2nd Chip: engineering evaluation at FNAL**
Most of the "low level" testing will be performed at LBL.
FNAL labor is mostly in testing the chip with the final DAQ chain at SiDet and Feynman.

18 **2nd Chip: engineering evaluation at LBL**
Labor:
This is labor cost at LBL as from Henrik Van Der Lippe
project file svx4_0202.mpp of March 20 2002.
Tests performed at LBL include radiation damage assesment.

19 **Setup for production chip testing**
Schedule:
This is time for getting programs setup and procedures worked
out for testing chips on wafers.
Labor:
Same crew as for the final production testing.
We assume that 1 scientist, 1 technician and 1 research associate will work full time on this task which is both for CDF and D0.
Below is the CDF share:
1. Scientist (50%)
2. Elect. Technician (50%)
3. postdoc (25%) support to CDF
4. Research Associate (50%)
5. Elect. Engineer (5%) chip designer expert
Cost:
Cost is for probe cards, equipment and material. Total (engineering estimate) is $7,500 plus $2,500 for contingency.
CDF share is 50% :
$3,750 EQ
$1,250 CONT.

20 **2nd Chip: evaluation**
General:
This is the evaluation of the chip with CDF Data Aquisition System. Also we will evaluate the performance of the chip with real sensor using both a laser and a radiactive source.
Labor:
1) Postdocs (150%) for testing the chip with the real DAQ, modify programs etc.
2) electrical technician (20%) needed for support with electrical board stuffing/testing.
3) Scientist (50%) to coordinate the effort

21 **2nd Chip ready for hybrids**
Schedule:
This is 1 month after receiving the Eng.run parts.
This is agressive and assumes the chip works without major problems.

22 **Production Chip: layout**
Labor:
moslty LBL labor.
FNAL will provide help with an engineer 100% for 15 days during this period.

23 **Production chip Submission**
Milestone not linked to anything, it could start as early as 40
days after receiving the engineering run chips

24 **Production Chip: manufacturing**
Cost:
Based on MOSIS (TSMC) price.
We need about 5000 chips in the detector + 2,000 spares
We order 14,000 chips to include yield. This is a conservative yield of 50%.
Masks cost is 150K$ (to be split with D0) and 50K$/lot (1lot = 10 wafers). Need to order 5 lots.
Total = 75K$ + 250 K$ = 325K$

25 **Production Chip: postprocessing**
Schedule:
2 weeks for backgrounding, backplating and dicing.
Cost:
Total cost is $200 per wafer (Engineering Estimate). For 50 wafers = 10K$

26 **Production Chip: engineering evaluation at LBL**
Labor:
This is labor cost at LBL as from Henrik Van Der Lippe
project file svx4_0202.mpp of March 20 2002.
Tests performed at LBL include radiation damage assesment.

27 **CDF chips: Test**
Schedule:
We are assuming 44 wafers, 320 chips/wafer, and testing rate of 0.5 wafer/day (includes classifying and sorting chips). It will take 88 days.
2 weeks days added for dicing at the end.
1 week added for setup time at the beginning.
Labor:
1 scientist, 1 technician and 1 research associate will workfull time on this which is both for CDF and D0.
Below is the CDF share:
1. Scientist (50%)
2. Elect. Technician (50%)
3. Research Associate (25%) support to CDF
4. Research Associate (50%)
5. Elect. Engineer (10%) chip designer expert

29 **Production Chips ready for hybrids**
Schedule:
1st chips are available 4 weeks after start of testing to take into account the testing, dicing and logging necessary.

31 **Hybrids**
The Hybrid is a BeO substrate (2cmx3.9cm).
Included in the bydrids are:
1. 4 SVX4 chips.
2. miscellanea components (capacitors,resistors, thermistor).

Runs (4 chips hybrids):
1. Prototype#1 (milestone #1 "electrical stave test")
2. Protoype#2-Contingency (milestone #2 "contingency electrical stave test")
3. Preproduction (milestone #3 "preproduction electrical stave test")
4. Production (milestone #4 "Production electrical stave test")

Need **1,080** 4-chips hybrids and **72** 2-chips hybrid for the project

32 **Outer layers**
Runs (4 chips hybrids):
1. Prototype (milestone #1 "prototype electrical stave test"), Proto#1 chip
2. Contingency (milestone #2 "contingency electrical stave test"), Proto#2 chip
3. Preproduction (milestone #3 "preproduction electrical stave test"), Production chips
4. Production (milestone #4 "Production electrical stave test"), Production chips

Need **1,080** hybrids

59 **Layer 0**
Runs:
1. Prototype
2. Production

Need **72** 2-chips hybrids.

60 **Prototype#1 L0 hybrid: Layout**
Schedule:
Layout can start as soon as the first outer layer hybrid has been submitted for fabrication.
Labor:
Costed in the manufacturing.

62 **Prototype#1 L0 hybrid: manufacturing**
General:
72 needed for entire production. We assume that prototype#1 coincides with pre-production.
The risk should be highly mitigated by the experience gained with the outer hybrid.
Schedule:
For the L0 project we assume that the prototype#1 L0 hybrid are pre-production type.
The preproduction of L0 hybrid goes with the 2nd round of chips (final chips arrive too late for the pre-production). The pre-production hybrid is submitted for fabrication when the 2nd round of chips (Contingency chips) have been fully

evaluated.
The above might change if the 1st round of svx4 chips are fully functional. In this case we could proceed with the fabrication of the L0 hybrid as soon as we are confindent
Cost:
Estimated from LBL Hybrid-Stave-R+D-V3(1).

63 Prototype#1 L0 hybrid Available
This is 20 days after substrates are available.
This order could cover the full production.
These will have final chips.

64 Prototype#1 L0 hybrid: evaluation and final design
Labor:
LBL labor only (no FNAL effort)

65 Production L0 Hybrid: final layout
Labor:
Labor cost included in the manufacturing

66 Production L0 hybrid: manufacturing
Cost:
Based on "production cost for CDF Run2b Hybrids & stave bus"
V3.0 Mar-24-2002 (C.Haber, LBL)
Total cost is $95,197. Includes yield, labor, overhead and tests

69 Bus Cables
Outer layer Bus cable is a Kapton based cable with signal and power traces to electrically connect the mini-PC to the hybrids. It also provides a ground shield plate to minimise noise pick-up from the sensors and the sensor bias connection.

Runs:
1. Prototype (milestone #1 "electrical stave test")
2. Preproduction (milestone #3 "Preproduction electrical stave test")
3. Production (milestone #4 "Production electrical stave test")

Need **360** bus cables for the project.

Labor:
All LBL labor. No FNAL efforts for the Bus Cable

81 Mini Port Card
The MPC is a BeO hybrid (2"x1.55"). Included in the miniportcards are:
1. components (including tranciever chips), connectors etc.
2. short kapton cables (2 cables, one for power and one for data)
3. cable wing (one kapton cable that connects the top MPC to the bottom stave bus cable)

Runs:
1. Prototype (milestone #1 "electrical stave test")
2. Contingency (milestone #2 "contingency electrical stave test")
3. Preproduction (milestone #3 "preproduction electrical stave test")
4. Production (milestone #4 "Production electrical stave test")

Need **180** Mini Port Cards for the project

100 Junction Port Cards
The JPC is an FR4 board (possibly 2 boards) for signal and power distribution.
JPC includes:
1. components (capacitors, resistors, power filters, FPGA, connectors etc.)

Runs:
1. Prototype#1 (milestone#1 "prototype electrical stave test")
2. Prototype#2 - contingency
2. Preproduction (milestone#3 "preproduction electrical stave test")
3. Production (milestone#4 "production electrical stave test")

Each port card can serve up to 5 mini-PC.
Total number of JPC for the project (inlcuding L0) is **46.**

Junction Port Cards

Layer	Φ-seg.	MPC (each side)	JPC (Total)
5	30	30	12
5	30		
4	24	24	10
4	24		
3	18	18	8
3	18		
2	12	12	6
2	12		
1	6	6	4
1	6		
0	12	0	6
Total JPC			46

123 Junction Cards
This is a passive card (or just a simple connector) that allows the cable transition from inside to outside of the tracking volume (it's roughly located where we now have the Junction Cards for runiia). It should not have any components but it could have some power filtering.
This card is linked to the finilization of the mechanical structure which dictates dimensions and support. This is the reason for having 2 prototypes.

Runs:
1. Prototype#1 (just functionality)
2. Prototype#2 (specified for the final mechanical design)
3. Production

1 JC per stave + L0
Need **180** (Outer) + **24** (L0) = **204** Junction Cards for the project.

140 Cables
We will replace all cables going from the silicon detector to the DAQ and Power Supplies racks.
There are 2 sets of these cables:
- from the mini Port Card (end of stave) to the Junction Port Card
- from the Junction Port Card to the racks.

141 Cables from MPC to JPC
These are in reality 2 sets of cables.
One set from the end of the MPC pig-tail to the Junction card (signal + power) and a second set from the Junction card to the Junction Portcard (signal + power).
First set is about 3 feet long
Second set is about 9 feet long.
The Junction Card connects the 2 sets.
In production we will need 180*2 = **360** sets of cables.

155 Cables from JPC to Crates
There are 4 types of cable:
1. signal (JPC to FTM/FIB)
2. power (JPC to Power Supply)
3. High Voltage (JPC to Power Supply)
4. sensing wire for the LV power (JPC to Power Supply)
The High Voltage cable and sense cable could be the same as the Power cable (all going to Power Supplies).
Total length is about 60 feet.

169 FTMs
New FTMs are needed because we are not using optical transmitter/receiver for the data.
Old FTMs can be easily made "new" by simply substituting the old optical tx/rx part with standard tx/rx.
Here we estimate the highest price of making a complete new card.
There is one FTM every 2 JPC.

Runs:
1. Prototype
3. Production

Need **23** FTM for the project

170 modify existing FTM for milestone #1
General:
this is just a modification of one existing FTM card, replacing the optical tx/rx part with a copper conventional one.

172 Prototype FTM: spec, design and layout
Schedule:
This is intended to be the final FTM design (i.e. preproduction) and comes at the end of the testing of the prototype DAQ chain.

173 Prototype FTM: procurement
Need 10 cards as preproduction.
Cost:
based on the price of the IIa FTM card.
$3,000 per board (includes components, assembling, connectors etc.).

174 Prototype FTM: assembling and evaluation
Labor:
assembling labor is costed in the manufacturing.
Labor here is just for testing the card with the DAQ system.

175 Production go ahead on FTMs
Schedule:
Linked to the production go-ahead for cables.

177 Production: procurement
Cost:
based on FTM cost for IIa.
$2,000 per board (includes components, assembling, connectors etc.).
Need 23 + spares = 30 FTM.
Total $60,000

178 Production: assembling and evaluation
Labor:
assembling labor is costed in the manufacturing.
Labor here is just for testing the card with the DAQ system.

179 Production FTMs complete
40days lag time allowed for adding connectors and testing.
We need 40 sets for the detector.

180 DAQ Testing & Readiness
Cost:
Here is the cost of all electrical testing (M&S) at FNAL. Includes DAQ stands, Burn-in stations, computers, miscellanea PC boards and material, cables, tools and instrument (oscilloscope etc. is needed).
added 50% contingency

181 Testing of Prototype DAQ Chain
Test begins when 1st prototype electrical stave is available.
These are specific tests aimed at understanding the functionality of the stave concept.
Cost:
Here is calculated the cost of all electrical testing (M&S) at FNAL up to this phase.
Includes upgrade to DAQ stands and Burn-in stations, new computers, bench power suppplies, miscellanea boards and material, cables, tools and instruments.
Most of the above equipment is already available from the IIa effort. This is moslty to upgrade and modify what is already there.
Labor:
This is the labor specifically assigned to understand the DAQ issues and get all the testing equipment ready for production. It is in parallel with the labor assigned to test chips, hybrids, modules and staves.

182 Testing of Preproduction DAQ chain
Test begin when 1st preproduction stave is available.
All various pieces should be ordered for production quantities based on this final test.
Decision to proceed with ordering production quantities parts is marked by milestone #4
Cost:
Here is the cost of further electrical testing (M&S) equipment at FNAL. Includes DAQ stands, Burn-in stations, computers, miscellanea PC boards and material, cables, tools and instrument (oscilloscope etc. if needed).
added 50% contingency

183 Milestone#4: DAQ Production Go-Ahead
This date marks the end of all decisions regarding ordering production quantities for all DAQ parts.

186 Procure sample supplies
We need to have these ready to use for preproduction testing of DAQ
which starts Oct. 15.

187 Test general features of Power supplies
These tests are aimed at checking that the functionality of the new system is compatible with the runiib deisgn and needs. Done in Italy.

188 Evaluate power supplies
This is the final System test with the electrical stave and everything. Is is done at FNAL

190 Procurement of supplies
These are off the shelf supplies so delivery should not be limited.
We need to power 200 staves (400 HV channels and 700 LV channels)
There are 10 channels/supply = 40 for HV and 70 for LV.
Plus we need supplies for test stands and spares.
This price is based on Caen quote in email and includes crates
and 654 LV channels, 408 HV channels and 10 crates.
$33K added for indirect costs (16.6% on the first $500K)

191 Testing
Labor:
this is estimated from the runiia experience
We assume that 2 power supplies can be tested per day.
~110 supplies needed

192 SVT upgrade
The SVT is part of the trigger system for CDF. The upgrade consists in making more of boards already existing and/or modifying existing boards.
University of Chicago and INFN-Pisa are providing engineering time, labor and equipment for these parts.

193 Upgrade SVT trackfitters
This is for 17 track fitter boards including spares 210k$.
Labor:
should be provided by INFN-Pisa and U. Chicago.
No FNAL labor.

194 Upgrade SVT merger boards
Build 12 additional merger boards (no additional spares) 84k$
Labor:

195 Sensors
The table below summarises the type and number of sensors needed:

Silicon Sensors

Layer	Type	Φ-seg.	Z-seg.	Length	Width	Pitch	Total
5	A	30	6	96.4	40.5	75/37.5	360
5	A	30	6	96.4	40.5	75/37.5	360
4	A	24	6	96.4	40.5	75/37.5	288
4	2.5^{o}	24	6	96.4	43.1	80/40	288
3	A	18	6	96.4	40.5	75/37.5	216
3	2.5^{o}	18	6	96.4	43.1	80/40	216
2	A	12	6	96.4	40.5	75/37.5	144
2	2.5^{o}	12	6	96.4	43.1	80/40	144
1	A	6	6	96.4	40.5	75/37.5	72
1	A	6	6	96.4	40.5	75/37.5	72
0	A	12	6	96.4	14.8	50/25	144

	Sensors Quantity	Total (+ 20% spares)
Outer Axials	1512	1814
Outer Stereo	648	778
L0	144	172
TOTAL	**2304**	**2764**

196 Outer layers
We are going to prototype the outer stereo and Axials sensors.
Runs:
1. Prototypes Axials and Small Angle Stereo (30 grade "A"+30 grade "B" each)
2. Production (Axials, SAS and L0)

Need **1512** Axials and **648** Small Angle Stereo for the project.

197 Dummy Sensors: layout
Labor:
This is to prepare masks for dummy sensors (1 metal mask)
Schedule:
work can start once the real prototype sensor layout is finished.

198 Dummy Sensors: manufacturing
These are metallised dummy sensors for bonding and mechanical tests.
We are also going to have real mechanicals (just silicon) which is diced at Fermilab.
Cost:
based on quotation from different companies (C.Haber 1/25/2002):
1. 6" Silicon 50 wafers @ 30.00 each = $1,500
2. 1 mask (metal) @ 2,500
3. processing is about $65.00/wafer = $3,250
4. dicing is about $20.00/wafer = $1,000
50 wafers should yield 50 detectors axials and 50 detectors stereo.

199 Prototype Sensor Layout
Labor:
most of the work is in the general mechanical layout of the sensors. Also lots of detailing is needed

201 Prototype Sensor manufacturing
Cost:
Based on quotation n. 03062002 from Hamamatsu (March 6 2002)

Prototype Sensors

Sensors	Type	Quantity	Unit Price	Total Price
Outer Axial	Grade "A"	30	$792.00	$23,760.00
	Grade "B"	30	$475.00	$14,250.00
	Material, NRE	1	$43,000.00	$43,000.00
Outer Stereo	Grade "A"	30	$792.00	$23,760.00
	Grade "B"	30	$475.00	$14,250.00
	Material, NRE	1	$43,000.00	$43,000.00
TOTAL				**$162,200.00**

Outer
Outer Axial ordered from U. of Tsukuba
Outer Stereo ordered from FNAL

203 Sensor final design work
We are assuming that nothing should change in the design of the sensors. This re-work is scheduled only for very minor modifications if needed.

204 Prototype Sensor tests
Labor:
This is done mostly in Japan.
Here we'll just verify some of the measurements and perform radiation damage tests.
Cost:
This is to setup some radiation damage test (special boards), and tests at the probe station
Estimated from IIa
$100 each rad-test board (10 boards)
$500 box of needles for the probe station
$1,500 computer for labview controlling of the probestation data.
$1,000 miscellanea cables and connectors.
Total $4,000

205 Silicon Production Sensor ready to order
Schedule:
We can order production silicon (also L0) after test of the prototype.

206 Production Sensors manufacturing
Schedule:
Hamamatsu promised 200 detectors/month after a lag time of 4 months from
receipt of order. 2,592 detectors/200/month = 13 + 4 month = 340 days
We need to add 1 month for the L0 production (see "L0 sensor production")
Total months 18 = 360 days

207 Axial sensor order (1st half)
Cost:
Based on quotation n. 03062002 from Hamamatsu (March 6 2002)
1512 needed +20% spares = 1814 * $460 + $57,143 (masks + NRE +Silicon).
Total = **904,003 USD**.
150,065 USD added for indirect costs (16.6%)
Contingency is 30%
split order in half to reflect Japanese funding profile:
452,001.5 + 75,032.5 indirect

208 Axial sensor order (2nd half)
order split to better match Japanese funding profile

209 Small Angle Stereo (1st half)
Cost:
Based on quotation n. 03062002 from Hamamatsu (March 6 2002)
648 needed +20% spares = 778 * $484 + $50,794 (masks + NRE +Silicon).
Total = **427,346 USD**.
70,940 USD added for indirect costs (16.6%)
Contingency is 30%

210 Small Angle Stereo (2nd half)
order split to better match Japanese funding profile

213 layer L0
Given the small number of detectors needed and the use of the same technology as for the Outer sensors we order directly the production.
Need **144** for the project.

214 L0 Sensor final design work
This work is linked with the mechanical understanding of the L0 structure.
Labor:
most of the work is in the general mechanical layout of the sensors. Also lots of detailing is needed

216 L0 Sensor Production
Schedule:
172 detectors needed. This is ~1 month worth of production.
We assume here this "dedicated" month to be May 2003.
Cost:
Based on quotation n. 03062002 from Hamamatsu (March 6 2002)
144 sensors needed + 20% spares = 172*$222 (35 KYen) + $45,930 (Masks, NRE, Silicon)
Total **84,114 USD**.
13,963 USD added for indirect costs (16.6%)
Contingency is 30%

219 Construction (Modules and staves)
added 50% cont. to cost on each costed item

220 Beginning of Mechanical Project
This marks the ends of the conceptual work and the beginning of the specific realization of mechanical parts.

221 L0 Construction (cables and modules)
Required quantity for the L0 detector is 72 modules. We should schedule and cost 100 production modules based on the L00 experience

222 L0 analogue signal cables
THese are the analogue signal cables L00 style.
We assume we will have 2 long (580mm), 2 medium (400mm) and 2 short (220mm) cables per sector (12*2 sectors in total).
Runs:
1. many small test run just to adjust the process
2. preproduction
3. production

223 L0 cables technology testing
These are multiple runs with very few cables (L00 style) each just to test the quality of the process.
Most of the work done in Japan. Here we just repeat some of the measurements.

224 L0 Test cables Available
These are the L00 design cables. They can be used for electrical test.

225 L0 cable preproduction design
This design goes in parallel with the CF support structure design.
The preproduction design should be also the final design for L0.

228 L0 Preproduction evaluation
Total number od cables for producti

229 L0 production cable design
Labor:
we assume some minor mosifications needed to the mecahnics of the cable design

230 L0 cable production
6 types of cables, 24 of each type for the whole detector
Cost is estimated from email quote from (KeyCom?) itsuo on June 8th 2001
type A: 450k NRE + 1440k yen = $15,500 [220mm long]
type B: 650k NRE + 2160kyen = $22,480 [400mm long]
typeC: 750k NRE + 2400kyen = $25,250 [580mm long]

Another estimate (in Japanese) from KeyCom (20% higher than pure 100um pitch cables)
type A: 456k NRE + 62.4k yen/cable = 4.2Myen=$31,668 [220mm long, 48 needed, 60 ordered]
type B: 588k NRE + 72.6kyen/cable = 4.9Myen =$36,946 [400mm long, 48 needed, 60 ordered]
typeC: 636k NRE + 90.0kyen/cable = 6.04Myen=$45,542 [580mm long, 48 needed, 60 ordered]

Total is = 114,156 $

$18.9K added for indirect costs (16.6%)

231 L0 Cable Production Test
Labor:
Non FNAL labor. Tests will be performed in Japan and Korea. Some tests are part of the production of the cables and have been priced together with the cable.

235 L0 modules R&D and Prototype
This work is to establish whether the L0 electrical concept is sound. We just need some hybrid, some (old) signal cable and some detector.

237 L0 module: material and fixtures
Schedule:
we need to have fixtures ready when sensors, hybrids and signal cables for L0 are ready
(March 2003).
Cost:
1. 2 fixtures for sensor to sensor and cable gluing at 7.5K/fixture =15k
2. 5k for misc. stuff. (material and other small fixtures)

238 L0 preproduction module construction
This is done with Preproduction L0 hybrids, Preproduction cables and Production detectors.
Represents the FIRST milestone for the L0 project.
We will make 6 modules to test the final concept.

240 L0 preproduction modules evaluation
This is the important test for L0, establishing that everything is working properly and that we can proceed to the production phase

243 Production L0 module: material and fixtures
Cost:
1. We need 4 fixtures for detector to detector gluing at 7.5k each = 30k
2. 20k of misc fixtures and supplies.

244 L0 Module production
Schedule:
We assume a rate of 2 L0 modules a day => ~45 days (need 72 modules, we'll build ~90)
Labor:
we need one technician. All other personnel are for support.

246 L0 Module Production complete
72 modules for the whole detector. Assume we can make 4/day = 25 days for 100 modules

247 Outer layer modules
It consists of 2 sensors glued together "head-on". On top of one sensor one hybrid and one pitch adapter is also glued. Module is wirebonded and put on a G-10 frame for testing.
Need **882** modules for the project.

248 Prototype Module: fixtures design
Labor:
This is for fixture designing and also to get all other support material in place for prototype module construction (support are: boxes, storage, designing G-10 frames for holding/testing modules, programming the CMM machines etc.)

249 Prototype Module: material and fixtures
Schedule:
These are the fixtures for prototype module construction in summer 2002.
Cost:
1. detector/detector alignment fixtures (5K each)
2. hybrid/pitch adapter gluing fixture (3k each)
3. wirebonding fixture (2k each)
4. testing mechanical setup (2k each) [*2]

5. G-10 frames (0.025k each) [*180]
6. miscellanea material 4k

250 Prototype Module: Assembling
Schedule:
30 modules to be built. We assume 0.5 modules/day for the prototypes.
Labor:
1. postdoc (75%) support
2. mech. technician (100%) gluing/aligning
3. wirebonder (50%)
4. mech. technician (50%) for miscellanea (boxes, storage etc.)
5. mech. engineer (25%) support
6. draftsman (20%) for miscellanea boxes, storage, modifications to fixtures etc.
7. scientist (25%) support

252 Contingency Module: Assembling
Schedule:
30 modules to be build and tested (5 staves). We assume 0.5 modules/day for the prototypes.
Labor:
No labor since if we are here means that we did not use the prototype assembling labor.
Just a shift in the schedule.

254 Preproduction Module: fixtures design
This is for fixture re-designing and also to get all other support inplace for productionmodule construction (support are: boxes, storage, designing G-10 frames for holding/testing modules, programming the CMM machines etc.)
Labor:
1. Mech engineer (75%) fixtures and supervision
2. Draftsman (75%) support for mech. engineer
3. postdoc (50%) support
4. mech. technician (25%) support
5. Elect. Engineer (25%) designing test boards
6. Elect. technician (25%) support

255 Preproduction Module: material and fixtures
Schedule:
These are the fixtures for production of the module construction.
We assume that we can align 6 silicon pairs on a single fixture/day and 1 hybrid/pitch-adapter per day. In preproduction we assume we manufacture the FINAL production fixtures just in a smaller quantity than needed to sustain the final production rate.
Cost:
We assume to have to remake all fixtures used for the prototype phase.
1. fixtures for detector-detector (5k each) [*2]
2. fixture for hybrid/pitch to detector (3k each) [*4]
3. fixture for wirebonding modules (2k each) [*2]
4. testing mechanical setup (2k each) [*2]
5. G-10 frames (0.025k each) [*180]
6. miscellanea materials, boxes, storage cabinets (4K total)

256 Preproduction module: Assembling
We need to provide enough modules to sustain the ramp up stave
production from June to October 2003 = 24 staves = 144 modules.
Rate is ~1.5 modules/day
Labor:
1. mech. technician (100%)
2. mech. technician (100%) a second equivalent mech tech. is accounted here to be taught the job.
3. wirebonder (100%)
4. postdoc (75%) support
5. mech engineer (25%) support
6. CMM programmer (10%)

258 Production Module: contingency fixtures design
This is for fixture re-designing and also to get all other support in place for production module construction (support are: boxes, storage, designing G-10 frames for holding/testing modules, programming the CMM machines etc.)
Labor:
1. Mech engineer (25%)
2. Draftsman (50%)
3. mech. technician (25%)
4. Elect. Engineer (10%)
5. Elect. Technician (25%)
6. postdoc (50%)

259 Production modules: material and fixtures
Cost:
We assume a similar final design for the fixture and small modifications of the pre-production fixtures in quantity suitable for the production rate.
We assume that we can align up to 6 silicon pairs on a single fixture/day and 1 hybrid/pitch-adapter per day on a single fixture.
1. fixtures for detector-detector (5k each) [*0] we don't need extra for production
2. fixture for hybrid/pitch to detector (3k each) [*6]
3. fixture for wirebonding modules (2k each) [*2]
4. testing mechanical setup (2k each) [*0] we don't need extra for production
5. G-10 frames (0.025k each) [*750]
6. miscellanea materials, boxes, storage cabinets (6K total)

260 Production Modules: Assembling
Schedule:
we need to sustain >~1 stave/day >~ 6 modules/day.
For 200 staves we need 1200 modules = 200 days.
Labor:
1. mech technician (200%)
2. wirebonder (100%)
3. Scientist (25%) support
4. mech engineer (10%) support
5. technician specialist (25%) support
6. mech technician (50%) mechanical support
7. postdoc (75%) support

264 Prototype stave :Structural and cooling R&D
Cost:
we estimated here the cost for parts and fixtures to test various concepts and materials and to sustain a minimum R&D effort on these important issues.
Labor:
includes all labor needed to come up with the final design of the stave and fixtures to build staves.

265 Prototype Stave Design complete
Both the stave and fixtures.

266 Prototype Stave: material and fixtures
Schedule:
This is the time needed at the machine shop to prepare all fixtures. It also includes the time needed for assembling, inspecting atc. the fixtures. Some fixture will require more time but we assume here that we get at least 1 fixture for flavour in order to start the assembling process.
Cost:
1. mecahnical stave related material and intermediate fixtures (7k total)
2. mechanical stave core assembly fixture (5k total)
3. laminating the bus cable fixture (5k)
5. One set of axial and stereo module alignment fixtures (10k each=20k)
6. stave wirebonding fixture (3k each) [*2]
7. stave inspection fixture (3k each)
8. stave storage boxes (0.5 each) [*20]
9. miscellanea material, testing boxes, storage cabinets etc. (10k total)

267 Prototype Stave: mechanical construction
This is to prepare a few (~ 30) mechanical staves with the prototype design
as part of the electrical stave prototypes milestone.
Schedule:
The start date is driven by the availability of the prototype bus cable. The end date is drivern
by being ready for stave prototype construction when all the other parts are ready.
Labor:
1. Mech Tech Specialist (100%) laminating CF sheets, gluing the stave on the mold
2. Mech Technician (100%) Preparing parts.
3. Mech Engineer (25%) Support
4. Research Associate (50%) Support

268 Prototype Stave: mechanicals available
This is mechanical staves
269 Prototype Stave: mechanical testing
This is all those tests aimed at making sure that the design and assembling procedures are within our mechanical specs.
270 Prototype Stave: electrical assembly
Schedule:
The beginning of this task is driven by having prototype modules available, which is driven by the sensors. We assume it will take 2 weeks to make the 1st prototype electrical stave.
We are buying enough prototype parts to make 5 electrical staves.
and the duration of 40 days is to make 5 staves.
Labor:
1. Mech Technician (100%) gluing/aligning modules on staves
2. Mech Technician (50%) bonding
3. Mech Tech Specialist (50%) overseeing, troubleshooting etc.
4. Research Associate (50%) Support
5. Mech. Engineer (50%) Support
6. CMM programmer (50%)
271 Prototype Stave: electrical testing
Labor:
This is ALL the electrical testing crew at FNAL. We don't divide it up between hybrid, modules, staves and burn-in stave parts. All SiDet electrical testing (up to the Stave) is considered here in terms of labor. The prototype effort is estimated based on a total of 4 FTE postdocs + 1 FTE scientist + 0.5 FTE electrical techician (for repair) for the PRODUCTION.

272 MILESTONE#1: Prototype Stave available
We assume it will take 2 weeks (10d) to put all the parts together to make the first prototype stave.
273 Contingency Stave: electrical assembly
Labor:
There is no cost and no labor here because this is just a Schedule Contingency.
Cost and labor are already estimated for the milestone #1
274 Contingency Stave: electrical testing
Labor:
This is ALL the electrical testing crew at FNAL. We don't divide it up between hybrid, modules, staves and burn-in stave parts. All SiDet electrical testing (up to the Stave) is considered here in terms of labor. The prototype effort is estimated based on a total of 4 FTE postdocs + 1 FTE scientist + 0.5 FTE electrical techician (for repair) for the PRODUCTION.

275 MILESTONE#1*: Contingency Stave available
We assume it will take 2 weeks (10d) to put all the parts together to make the first prototype stave.
276 Production Stave: final design
This is the final design of the mechanical stave and takes advantage of all possible tests done on the prototype staves.
277 Production Stave: material and fixtures
This is the time needed at the machine shop to prepare all fixtures for production.
Material etc. could be purchaised in advance.
Cost:
We assume we re-do all fixtures in number adequate to sustain production.
1. mecahnical stave related material and intermediate fixtures (120.75k total)
2. mechanical stave core assembly fixture (5k total) [*2]
3. laminating the bus cable fixture (3k) [*4]
5. One set of axial and stereo module alignment fixtures (15k each=30k) [*2]
6. stave wirebonding fixture (3k each) [*2]
7. stave inspection fixture (3k each)
8. stave storage boxes (0.5 each) [*100]
9. miscellanea material, testing boxes, storage cabinets etc. (25k total)

278 Preproduction Stave: mechanical construction
This is to prepare more than 30 mechanical staves with the final design.
Preproduction is to build 24 electrical stave. We should be able to sustain a production rate of ~3 mechanical staves per day. Here we assume that we have a ramp-up at an average rate of ~ 1 stave/day.
Schedule:
The start date is driven by having finished the final stave design and the readiness of the production bus cable. Also we assume that we commit to the final fixture design during the previous tasks. This means that a certain number of identical fixtures need to be machined.
The end date is drivern by being ready for stave preproduction construction when all the
other preproduction parts are ready.
Labor:
1. Mech. tech (200%) preparing parts and assembling
2. Mech. tech Specialist (50%) this is for support and troubleshooting
3. Mech Engineer (25%) support
4. Research Associate (50%) support

279 Preproduction Stave: mechanicals available
This is mechanical staves
280 Preproduction Stave: mechanical testing
This is all those remaining tests aimed at making sure that the design and assembling procedures are within our mechanical specs. Already extensive tests were made on the prototype stave. Nonetheless we need to re-verify for the production
281 Preproduction Stave: electrical assembly
Schedule:
This is driven by having preproduction modules available.
We will use production bus cables, production sensors
preproduction hybrids (we call these preproduction modules)
and preproduction Miniportcards.
We want to build 24 electrical staves during the ramp up period from June to September 2003.
This is a rate of ~2 complete staves/week.
Labor:
Labor:
1. Mech Technician (100%) installing/aligning modules on the stave
2. Mech Technician (50%) bonder
3. Mech Technician (75%) support, inspection etc.
4. Mech. Engineer (25%) support
5. Mech Tech Specialist (50%) support, troubleshooting
6. Research Associate (100%) support

282 Preproduction Stave: electricals available
We assume it will take 2 weeks (10d) to put all the parts together to make the first prototype stave.
283 Preproduction Stave: electrical testing
Labor:
This is ALL the electrical testing crew at FNAL. We don't divide it up between hybrid, modules, staves and burn-in stave parts. All SiDet electrical testing (up to the Stave) is considered here in terms of labor.
It is estimated to be a total of:
1. postdocs (400%)
2. scientist (100%) responsible for quality control
3. electrical techician (50%) for repair and minor support jobs
4. mech technician (25%) for repair/redo bonds
284 Evaluation of preproduction staves
This is both a mechanical and electrical evaluation from the point of view of giving the green light to start production. We assume here minor modification to the entire production structure.
All this labor is ON TOP of the normal electrical testing labor.
285 MILESTONE#2: Stave Production go-ahead
This milestone allows to proceed into stave production.
286 Production Stave: modification to the final design
This is a contingency task to modify the final design of the stave (fixtures etc.) and takes advantage of the tests done on the pre-production phase.
287 Production Stave: contingency material and fixtures
Cost:
we assume that some fixture (or equivalent parts) needs to be redone or modified:
1. set of stave mechanical fixtures (10K)
2. bus cable laminating fixture (6k)
3. stave alignment fixture (20k)
4. more/modify boxes for storing/testing (10k total)
288 Production Stave: mechanical construction
This is to prepare ~200 mechanical staves with the final design.
Schedule:
We assume we can produce 3 mechanical staves/day: 240 staves = 80days
This task should start as soon as the mechanical is shown to work.
Labor:
Work is divided into 3 major sections:
a. preparation of parts (inlcudes bending peek tubing, cutting parts to size etc.)

b. laminating the bus cable to the carbon fiber sheet
c. putting all parts in a mold and glue them
1. Mech. tech (200%) preparing parts and assembling
2. Mech. tech Specialist (25%) this is for support and troubleshooting
3. Mech Engineer (25%) support
4. Research Associate (50%) support

290 Production Stave: electrical assembly
Schedule:
This is driven by having preproduction modules available.
We will use production bus cables, production sensors
preproduction hybrids (we call these preproduction modules)
and preproduction Miniportcards.
We need to build electrical staves at a rate of >= 1 stave/day.
Labor:
1. Mech Technician (100%) installing/aligning modules on the stave
2. Mech Technician (50%) bonder
3. Mech Technician (75%) support, inspection etc.
4. Mech. Engineer (25%) support
5. Mech Tech Specialist (25%) support, troubleshooting
6. Research Associate (100%) support
7. Scientist (50%) supervision

291 Production Stave: electrical testing
This is again ALL the electrical testing crew at FNAL. We don't divide it up between hybrid, modules, staves and burn-in stave parts. All SiDet electrical testing (up to the Stave) is considered here in terms of labor.
It is estimated to be a total of:
1. postdocs (400%)
2. scientist (100%) responsible for quality control
3. electrical techician (50%) for repair and minor support jobs
4. mech technician (25%) bonder, for repair/redo bonds

294 Beampipe
The beampipe is designed to be compatible with the old pipe (it has the same flanges to connect to the Tevatron beampipe). It is constructed from Beryllium for low mass, with short stainless steel sections on the end. We are considering a drilled technology rather than the traditional rolled technique. The pieces are the same OD and ID as the D0 pipe to minimize the total cost of the
CDF + D0 pipe. The pipes are not identical, CDFs is longer and has different flanges on the end.

295 Design beampipe
CDF and D0 agreed on a wall thickness and radius for the Beryllium section of the pipes.
The reduces the total cost and also the delivery schedule.

296 Beampipe design complete
Design finished and sent out for quotations on price for rolled and drilled pipes.

297 procure beampipe
Cost:
based on quotation n13002 Feb. 28, 02
$149,893 for a new drilled Be pipe.
add 50% cont. to cost.

299 Support Mechanics
This section covers infrastucture, the support structures for the staves, barrels, L0, and transportation and installation at B0.
50% cont. is included on all costed items

300 Mechanical Infrastructure
Added appropriate contingency to all costed items

301 Procure 3m CMM
This was paid from by the Japanese in exchange for FNAL payment on sensors later

302 Silicon Support Structures
This task covers the bulkheads which support the staves, the screens which attach the bulkheads to each other, the tube which supprts the barrels (spacetube in Run IIa) and the support structure for L0.

303 Bulkheads
This task is comprehensive of:
1. 2 external and 2 internal CF bulkheads with precision Berillium (internal) and Al (external) mounting features.
2. inner screen
3. fixtures for holding/aligning the bulkheads together

304 Bulkhead Initial Concept studies
2/20/2002
We foresee the need for 4 (2 outer and 2 inner) Carbon Fiber bulkheads. Precision mounting pins with matching holes on the stave ensure alignment.
Prototype bulkheads made from G10 and leftover CF sheets
Labor:
mostly engineer type labor.

305 Bulkhead Prototype: Design
Cost:
This is to finalise the first prototype of a bulkhead design to test the concept.
Details of mounting hardware and fixturing will be included at this stage.
Detailed analysis of Bulkhead structure (FEA) will impact design.

306 Bulkhead Prototype: fabrication
Cost:
we estimate the need for 2 CF bulkheads (inner and outer) plus a G-10 mockup.
This includes the cost of the fixture for locating the presicion pins.

307 Bulkhead Prototype: assembly and testing
This is the labor associated with gluing the precision pins to the bulkheads in correct locations.
The alignment and construction of the fixture will be performed on a CMM.
The stiffness of the bulkheads will be tested. Installationl and positioning in a barrel will also be tested.

308 Bulkhead: Final Design
Design will be modified as needed by the results of the tests

310 Bulkhead: fabrication
Cost:
we estimate the cost to be 20K each CF bulkhead (4 + 2 spares) +10K for extra material.

311 Bulkhead: assembly, testing
Labor:
This includes the labor for gluing the pins to the bulkheads and
to test the quality of the bulkheads

313 screens
These are the Inner and Outer screens for the outer barrel.

314 Design outer screen
This is the outer screen of the barrel. It holds the relative alignment of the bulkheads and provides protection for the staves.

315 Barrel outer screen: fabrication
This is the cost to fabricate the screens, assuming we buy them rather than make them in house.

316 Support tube fabrication
This is the equivalent of the spacetube in runIIa. It supports the barrels and spans the distance between the mounts for SVXIIb on ISL. The cost assumes fabrication outside FNAL

317 Design and Fabricate screen installation fixture
This fixture holds the barrels and screen while the screen is glued to the bulkheads

318 Design and Fabricate support cradle
This cradle supports the space tube while the barrels and installed and aligned. It is mounted on
roller bearings which ride the rails on the CMM. This allows it to move around during installation of the beampipe and during installation into ISL.

319 Layer 0
This is the Carbon Fiber Support for L0. It is mounted on outer bulkheads and has an integrated cooling system. This includes the structure which supports and cools the hybrids ouside the end of the barrel.

320 CF Support Prototype: design
The assumption is that the L0 CF support structure design starts together with the design of the bulk head. This includes the support sturcture for the L0 hybrids which extend outside the outer barrel in z.

321 CF Support Prototype: manufacturing
Fabrication of the first prototype of the CF support structure for L0.
The above fabrication is supposed to take 5 months.

322 CF Support Prototype: evaluation and testing
Testing consists of both mechanical and electrical since now pre-production L0 modules are available.

323 CF Support: Design
This is the final design for the L0 Cf support structure and the hybrid support structure

324 CF Support: manufacturing
As for the prototype we assume 5 months for the production of the CF support structure.
The cost assumes we purchase the structure rather than build it in house.

325 CF Support: assembly and test
Tests include alignment and cooling tests for hybrid structure and for silicon supports

327 Transportation Fixtures
This is the fixture for transporting ISL+SVXIIa or ISL+SVXIIb from/to the Assembly Hall.
It has to be finished before runiia ends. The fixtures for Run IIa will be reused as much as possible
328 transportation fixture: updating design
This is the labor cost to update the design of the Run IIa transportation fixture
329 transportation fixture: fabrication
This is the cost to refabricate the transportation fixtures.
330 transportation fixture: final assembling and test
This is the labor for assembly of the transportation fixure
331 Positioning system (inchworms)
This system allows adjustment of the position of the entire silicon detector (ISL+SVXIIb+L0+ beampipe) relative the the outer tracker (COT) and the beamline.
332 positioning jacks(inchworms): design
This is the replacement for the remote positioning system (the inchworms) which attach to the outer flange of ISL and COT. These will be mechanical jacks that can only be adjusted when the plugs are open.
333 positioning jack prototype manufacturing
This is the cost of manufacturing the prototype hardware. This may be covered by Toronto depending on a grant.
334 Prototype positioning jack testing
This will be done by physicists at Toronto
335 positioning jacks: manufacturing
Cost is estimated based on experience with Run IIa, a 50% contingency is included.
Toronto may cover some of the costs.
Esitamte 10k for jacks and 10k for new pieces to attach to COT.
336 positioning jacks: Assemble and test
This assembly and testing will mostly be done at Toronto.
Some eng, and tech. time will be needed for tests and FNAL
337 Installation of SVXIIb into ISL
These are the fixtures that allows for both extracting SVXIIa from IL and inserting SVXIIb into ISL.
Schedule:
This task needs to be done in time for the removal of SVXIIa from ISL

338 Design Fixtures for removal of SVXII and installation of SVXIIB
Schedule:
This task needs to be done in time for the removal of SVXIIa from ISL
339 Fabricate fixtures for SVX removal and installation of SVXIIb
This is the cost to purchase the fixtures from outside
340 Assembly and Test fixtures for SVX removal and installation of SVXIIb
This involves alignment and assembly of fixtures on the cmm at Sidet
341 Cooling and Monitoring
Thisi task covers the cooling system, the monitoring of the cooling and power to the detectors and the position monitors (RASNIKS)
50% cont. is included on all costed items

342 Cooling systems
This task covers updating the cooling system at Sidet and B0 and the cost of new manifolds at the detector.
343 Update Sidet cooling system
This is the cooling system that will be used during barrel construction testing of staves.
344 Build internal manifolds
These are the manifolds that receive a single cooling line from the slots and connect it to multiple stave circuits.
345 production chiller components, manifolds, control valves
These are the costs associated with updating the chillers at B0. The cost is based on an email from Rich Stanek (engineer) in Sept. 01.
346 Interlocks
This is the system that montors the power and temperature of the detectors.
It will resue most of the existing system.
347 Upgrade existing system
This is the cost to upgrade the interlock system for Run IIb. additional temperature and current channels will be needed
348 Position Monitoring
This is to update the esisting position monitoring system (RASNIK).
Cost is based on Run IIa experience and resuing the DAQ already setup.
Labor:
there is no FNAL labor for this task, Toronto is taking on this project
349 Rasnik Prototype manufacturing and test
This covers the cost to make and test a Rasnik module. Toronto will cover some or all of this cost
and will perform the labor with physicists at Toronto.
350 Rasnik Production
Cost is based on cost to fabricate additional modules - Cost/module comes from UCLA experience.
352 Final Assembly (Installation and Integration)
This task covers installation of staves into the barrels, installation of L0 modules on the CF supports
and the integration of L0 and beampipe with the outer barrel
Added 50% contingency to all costed items
353 Stave Intallation (Outer)
This covers installation of all layers except for L0.
354 Prototype stave installation fixture: R&D
This is all the r&d needed to prototype the installation and alignment of staves in the outer barrel.
355 Stave installation fixtures: design
Final Stave installation fixture design will start as soon as the final bulk-head design is finished and the R&D is completed.
356 Stave installation fixtures: fabrication
These fixtures are larger than Run IIa and thus will be more expensive. Cost is estijmated from RunIIa costs (50k)
357 Stave installation fixture: setup and Alignment
This will be setup on a CMM and mechanical staves will be used to test the installation procedures.
358 Bulkhead installation and alignment
Bulkheads must be precisely aligned to each other and to the CMM reference system.
360 Installation of staves
Labor:
estimated based on runII experience.
Installing and aligning/measuring staves should be a rather fast task. We foresee that it will be done in batches (i.e. wait for a certain number of staves to be ready for installation and the install them).
This is a task that spans the 200 days of stave production but in reality it takes less then 200 days to be accomplished.
We assume that the labor is required for 3/4 of the available time (i.e. 3/4*200 = 150 days worth of labor)
361 Installation of Stave: electrical testing
Labor:
This is ALL the electrical testing crew at FNAL. We don't divide it up between hybrid, modules, staves and burn-in stave parts. All SiDet electrical testing (up to the Stave) is considered here in terms of labor. It is estimated to be a total of 4 FTE postdocs + 1 FTE scientist + 0.5 FTE electrical techician (for repair).
This is a task that spans the 200 days of stave production but in reality it takes less then 200 days to be accomplished.
We assume that the labor is required for 3/4 of the available time (i.e. 3/4*200 = 150 days worth of labor)

363 Final system tests
This is the final system test. Goal should be to establish that all staves are working, cooling is working and everything is aligned to specs.
364 Installation outer screen
Schedule:
based on the time required for the iia silicon system
365 Installation of barrel in spacetube
Schedule:
based on the time required for the iia silicon system
The barrels are placed in the space tube and then aligned.

366 dressing of cables and cooling
Schedule:
based on the time required for the iia silicon system

369 L0 module installation fixtures: design
This is the time estimated from Run IIa experience
370 L0 module installation fixtures: fabrication
Cost:
2 fixtures at 20k each based on experience with Run iia l00 design

371 L0 module installation fixtures: assembly and test
This task involves testing installation and alignment procedures. It is based on Run IIa experience with L00.
372 Install L0 supports on beam pipe
these are stand offs between the beampipe and the inner surface of L0. They may not be needed.
373 Installation of L0 Modules
we expect to do at least 3 modules/day: 144 modules = 24 days

based on Run iia experience with L00
374 Dressing of HDIs
Time estimated from L00 experience
375 L0 System Tests
These tests will determine final grounding and shielding
376 Installation of Screens
This represents an additional electrical shield around L0.
378 Integration
This task incudes the fixtures and labor associated with installing the inner detector (L0) into the outer barrel. All costs and labor are estimated based on Run IIa experience
379 Prototype Inner Detector Installation Fixtures: design
These are the fixtures for installing the inner detectors into the outer svxiib barrel.
380 Prototype Inner Detector Installation Fixtures: fabrication
Cost:
Price is based on L00 installation fixtures
381 Prototype Inner Detector Installation Fixtures: test
This test is setup on a CMM and the alignment is tested
382 Inner Detector Installation Fixtures: Final Design
This covers the redesign/ adjustments to the prototype fixtures
383 Inner Detector Installation Fixtures: fabrication
Cost:
Price is based on L00 installation fixtures

384 Inner Detector Installation Fixtures: test
Setup on CMM and test alignment
385 Fabricate beampipe supports
based on Run IIa experience
387 Combine Inner and Outer Detectors
This assumes the fixtures were already setup and aligned
388 Final survey
relative alignment of the barrels is determined algon with alignment to external reference system
389 Final Cooling and electrical Tests
Large fraction of system will be run
390 Close top of SVX extention cylinders (final dressing, position monitors)
This includes the final dressing of everything, installation of position monitors,
beampipe supports, deflection limiters, etc)
394 CDF to Assembly Hall/ Plugs Opened
Based on runiia experience, it takes 35 days to move CDF from the collision hall to the assembly hall.
Labor:
This labor is traditionally provided by CDF operations
395 SVX2a Extracted and Moved to SiDet
Labor:
this labor is traditionally provided by CDF operations.
396 Install/test JPC
JPC are installed onto the COT repeater card ring.
Task to be performed in the Assembly Hall.
Schedule:
We have ~40 JPCs and we assume an insallation/testing rate of 1/day.
JPC, inner cables and outer cables installation tasks are performed in parallel by a single crew.
Test is done using an external DAQ/PS unit and a "test wedge" 5 staves unit.
Labor:
is computed into the "Install/test Outer Cables" task.

397 Install/test new inner cables
These are the cables from the JPC to the JC.
Task to be performed in the Assembly Hall.
Schedule:
We have ~40 bundles and assume insallation/testing rate of 1/day.
JPC, inner cables and outer cables installation is performed in parallel.
Test is done using an external DAQ/PS unit and a "test wedge" 5 staves unit.
Labor:
is computed into the "Install/test Outer Cables" task.
398 Install/test new Outer Cables
These are the cables from the JPC to the PS.
Task to be performed in the Assembly Hall.
Schedule:
We have ~40 bundles and assume insallation/testing rate of 1/day.
JPC, inner cables and outer cables installation is performed in parallel.
Test is done using an external DAQ/PS unit and a "test wedge" 5 staves unit.
Labor:
1. Research Associate (400%) they install the cables and perform the testing
2. Elect. Technician (100%) support
Logistic support is provided for by CDF operations.

399 install/test new power supplies and FTMs
Task to be performed in the Collision Hall
Schedule:
This means remove old crates, install new crates, installing and testing new power supplies.
We have ~100 new power supplies to install and ~40 FTMs.
This work can start as soon as there is access to the collision hall and has to finish before CDF is rolled back into the collision hall.
We will use a passive "load box" for the testing of the PS.
Labor:
1. Research Associate (300%) installation and testing
2. Elect. Technician (100%) support
400 Remove SVXII/L00/BP
Task to be performed at SiDet.

402 Install & Align SVX2b in ISL
Task to be performed at SiDet.

403 Fasten/Test ISL Junction Cards
Task to be performed at SiDet.

404 Extension Cylinders Installation and beampipe supports
Task to be performed at SiDet.

405 Transport SVX2b to B0 & Install in CDF
Task to be performed in the Assembly Hall.
406 Inner cables connected
Inner cables are connected to JCs.
This is essentially part of the installation process. NO TESTING is performed at this time.
Labor:
1. Research Associate (200%)
407 Plugs Closed/CDF to Collision Hall
Labor:
This labor is traditionally provided by CDF operations.
408 Connect and Test
Cables from the JPC are connected to the PS and rest of the DAQ system.
Then the final system tests.
Tests are aimed at identifying problems and troubleshooting them
Also we should try to identify the best "grounding" configuration for the detector.
We assume we can test a section of the detector corresponding to a JPC per day.
Labor:
Based on IIa experience we calculated 2 crews of 2 post-docs each + 2 post-docs for running the testing programs. All other personnel is for support and help in troubleshooting.