CDF Silicon in Run 2b

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Meeting 4

August 8, 2000

- Agenda
- Guidelines and Dates
- Summary of last meeting
- Layouts

Agenda

- 9 am: Joe Incandela: Re-cap
- 9:45 am: Amit Lath: SVXII L2 ladder lifetime
- 10 am: Sergio Zimmerman: simplified readout scheme
- 10:30 am: Maurice Garcia-Sciveres: LBNL SVX4 translation status
- 11:30 am: William Wester: Pixels update

- 12:30 – 2:00 pm: Break

- 2:00 – 3:15: Discussion of options, work remaining, outline and authors of document for Run 2b committee
- 3:15 – 4:15: Meet with D0 to discuss common chip development

PAC Request

- What are the relative merits and implications of several strategies:
  - Replace only Layer 00
  - Replace Layer 00 and only the inner 1 or 2 layers of SVXII
  - Complete rebuild of Layer 00 and SVXII
- Need detailed response by Fall. (Early October)
  - We should aim for a proposal with cost and schedule.
- PAC Meeting is Nov. 3-4

Proposed Boundary Conditions

The Laboratory has proposed to the PAC a set of boundary conditions for the Run 2b upgrade projects.

- The budget for the replacement of silicon vertex detectors should be 2.5M$ per experiment, with contingency
- The new detectors must be designed with the confidence that they will operate effectively throughout Run 2b, with an anticipated luminosity of at least 15 fb^{-1}
- The installation of all detector upgrades must occur during a single shutdown of no more than six months duration, with roll-out and roll-in tentatively scheduled between October 2003 and March 2004.

Draft Committee Charge

The charge to the committee is to review proposals for the replacement of radiation-damaged silicon detectors and other upgrades to ensure effective operation during the high-luminosity Tevatron Run 2b. The committee is requested to provide recommendations to the Spokespersons, and the Collaboration on how best to act on these proposals. The goal of the reviews should be to establish the physics benefits, cost and schedule of the various proposals, and to recommend their relative priorities. While the details of these conditions are still under discussion, they give a good indication of how the Laboratory intends to proceed on these upgrades. The committee should evaluate the feasibility of complying with these guidelines and possibly suggest modifications to be requested during the November 3-5, 2000 PAC meeting.

Funding for these upgrades will be limited. It is possible that additional funds may become available in the future either from DOE or from other sources if the physics case can be made. Cost and prospects for funding should be considered as part of the review. The committee is requested to establish a procedure for carefully and fairly reviewing and evaluating the proposals and set the time table for preparation of written Run 2b proposals and cost estimates.

The committee should provide interim recommendations by October 2, 2000 and an overall written report of their recommendations to the collaboration by the Spring of 2001.

PAC Aspen

- John Marriner's Presentation:

Integrated Luminosity for CDF and D0 2001-2007

Scenario	Integrated Luminosity (fb^{-1})
Collider (CDF and D0)	14.95
Collider & NuMI	12.67
Collider & NuMI & BTeV	9.41
Collider & NuMI & BTeV & Kaon	8.10

Assumes NuMI starts 2003

Assumes BTeV starts simultaneous operation with B0 and D0 IN 2005

Assumes Kaon starts in 2005

Review

- Lifetimes
  - As of last meeting, the line was drawn in the third layer of SVXII (L2)
    - We estimated a lifetime of 12 fb^{-1}: (Amit agreed to prepare something.)
  - DOIMs are also marginal - May be able to avoid optical elements (Sergio Zimmerman)
- Components
  - SVX3 to SVX4 sub-micron translation: LBNL has made significant progress
  - Hybrids - Carl has initial design
  - Cables (lightweight, fine traces) - Itsuo has found a promising vendor
- Performance Questions
  - What about vertexing online ? Can we get away with the two inner layers beyond Layer 00 being 90 degrees and all others shallow stereo or do we need more 90 deg layers ?
  - Pixels – Many questions, but also much potential.
- Layout
  - Full replacement and

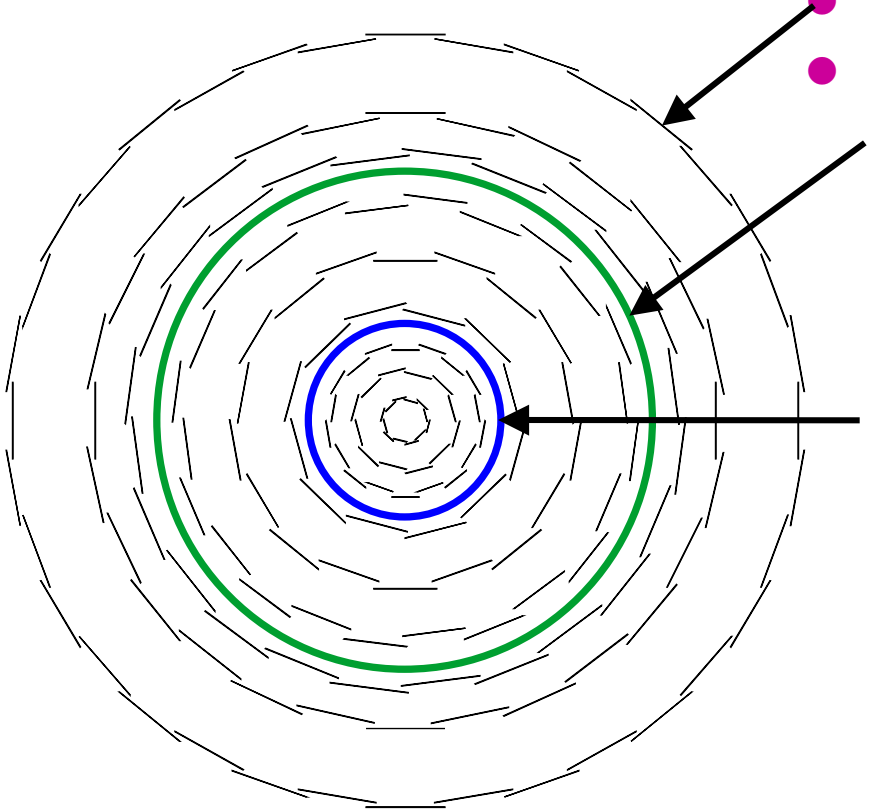
One-for-One

- Replacement of only those layers which are damaged
  - Technical Challenges: How much disassembly & re-assembly ? How much time ?
  - Required shutdown could be long and may involve some risks
    - Handling, disassembling, and rebuilding SVXII barrels carries schedule risks: requires reconstruction and testing time during the shutdown period.
      - **Extract ISL and transport to SiDet**
      - **Remove SVXII spacetube and split it open: fair amount of fixture setup and use**
      - **Uncable and remove L00/beampipe: more fixture setup and use**
      - **Remove all 3 Barrels and transfer to barrel assembly fixtures**
      - **Remove ladders**
        - **Could possibly remove only those ladders which are damaged**
        - **If bulkhead alignments are affected or questionable, or if we want to survey locations of newly installed ladders then complete disassembly and re-alignment of bulkheads is required.**
      - **Install new ladders, survey & test**
      - **Reinstallation and barrel to barrel alignment in spacetube**
      - **Reinstallation of Layer 00 and beampipe into SVXII, surveyed and aligned, beampipe mounts installed**
      - **Reinstallation of SVXII into ISL, and ISL into COT, surveyed, aligned, retested**
- Time estimate: 1.5 months in/ 2.5 months out + 5-7 months

Partial versus All

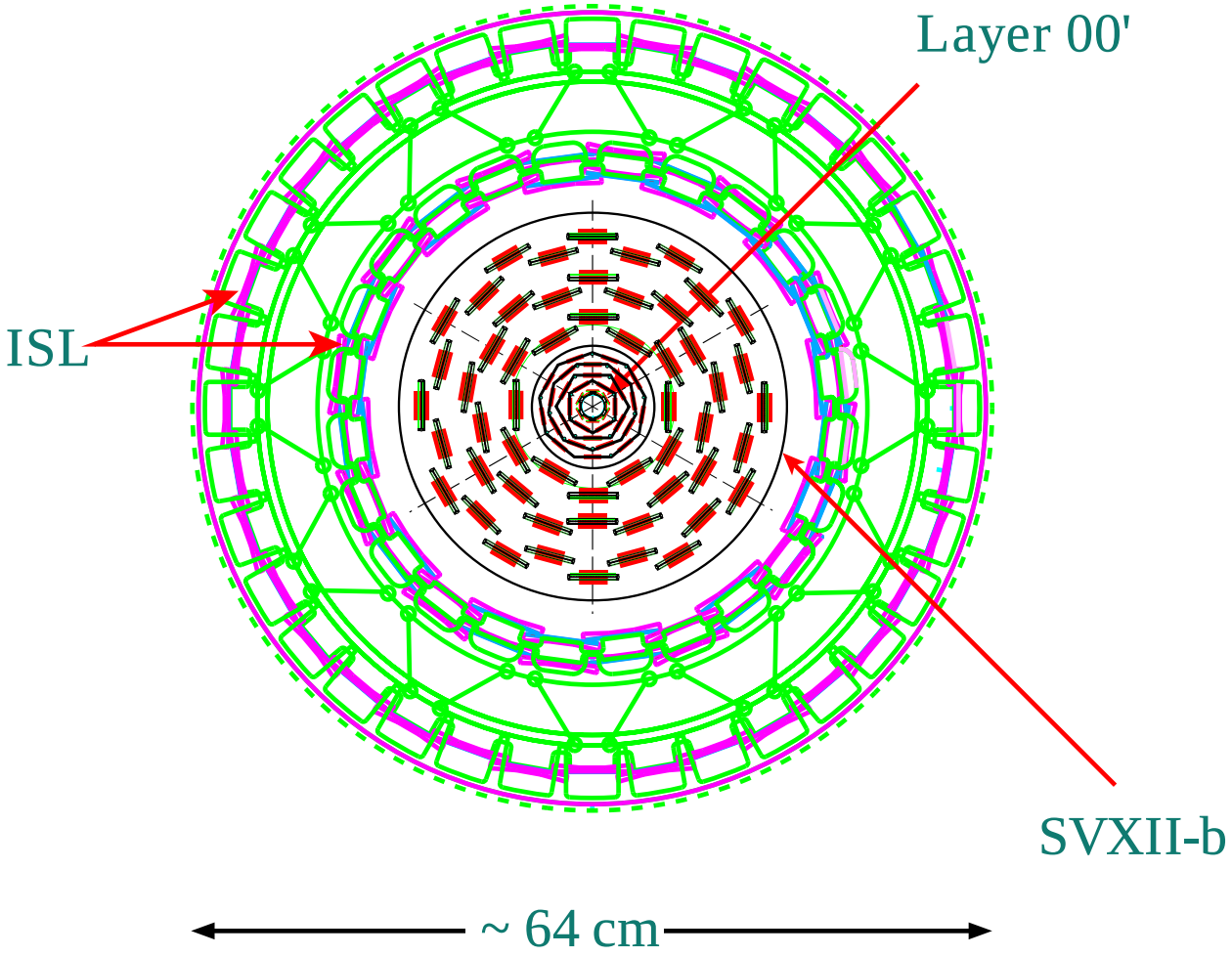
- Both options could have the same inner section
  - Layer 00 = L0 with Single-sided hybrids
    - Single sided, alternating strips
    - Possibly 90 degree stereo using alternating strips on single-sided sensors
    - Possibly Pixels
  - L1, L2, with single-sided hybrids
    - Single sided sensors back-to-back w/ 90 degree stereo
- Partial
  - Make new annular bulkheads to support SVXII
  - Two layers would reuse SVXII layers 3,4
    - Spares needed (~15-25% ?)
  - Pre-assemble as much as possible then transfer ladders from SVXII
- Full
  - Make outer layers (L3,L4,L5) with universal double-sided hybrids, and single-sided silicon back to back. Hybrids inside or possibly outside track volume
  - Radial separation more uniform
  - Rod-like support structures

A Full Replacement Example

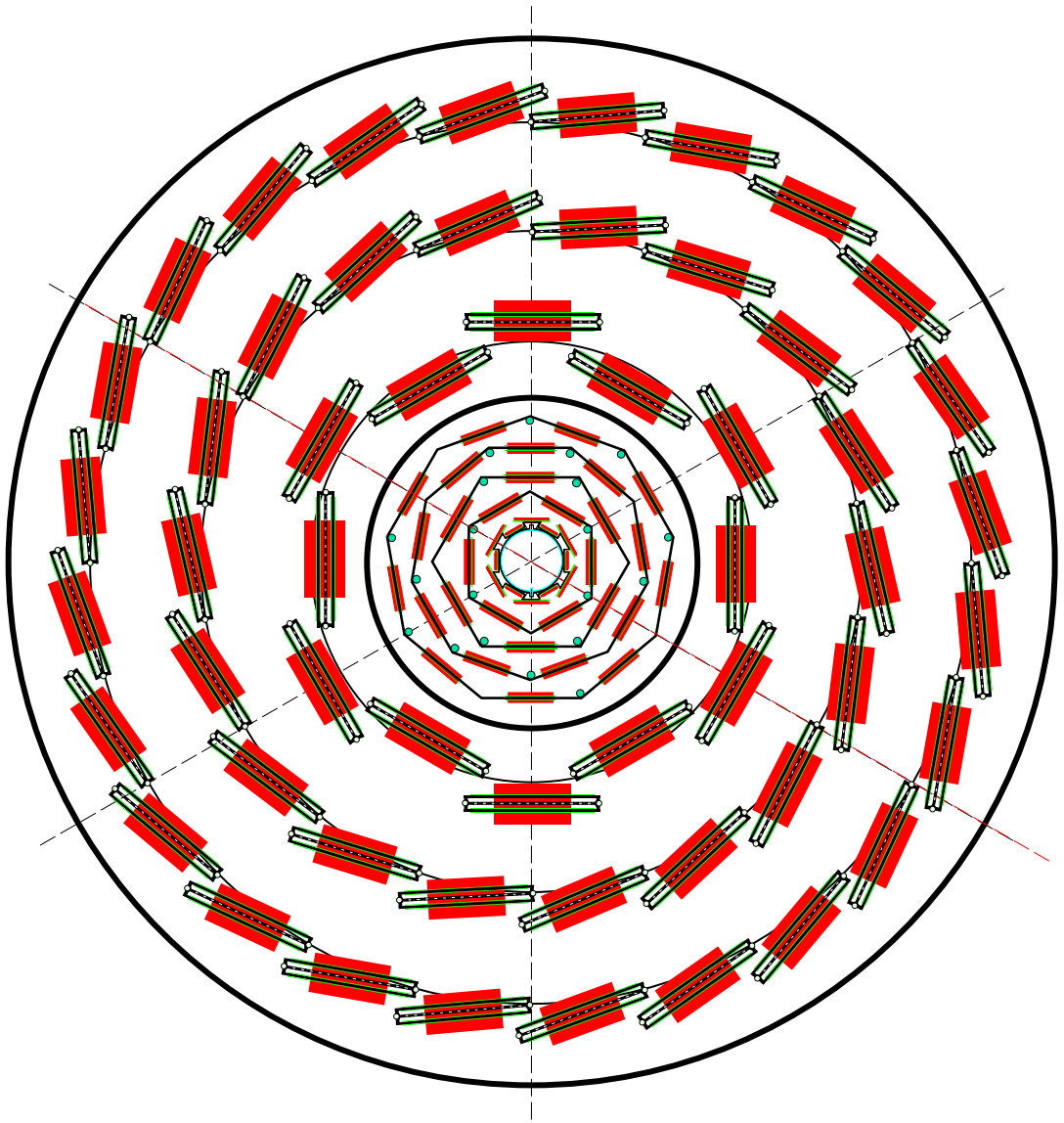


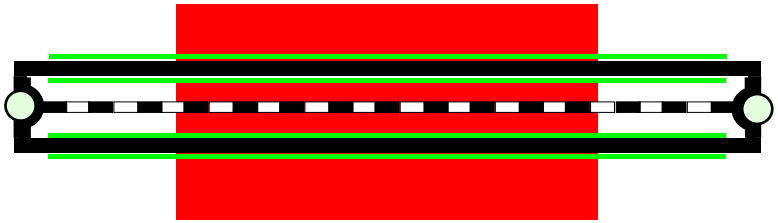
- Goal: Keep or improve functionality
- Retain ISL (~8 krad/fb^{-1})
- 2 New Radial Groups
  - Middle (between blue and green circles)
    - Design to last a long time
    - Simple:
      - **two single-sided sensor designs**
      - **one double-sided hybrid design**
      - **carbon fiber supports with cooling**
  - Inner (within blue circle)
    - Design to last 10-15 fb^{-1}
    - Integrated cooling at lower temp.
    - Two outermost layers w/simple design:
      - **2 single sided sensor designs**
      - **one double sided hybrid design**
    - Innermost layer:
      - **L00 replacement using existing silicon and hybrid designs**
      - **Could use pixels if ready and sufficiently lightweight.**

A Replacement Example (2)



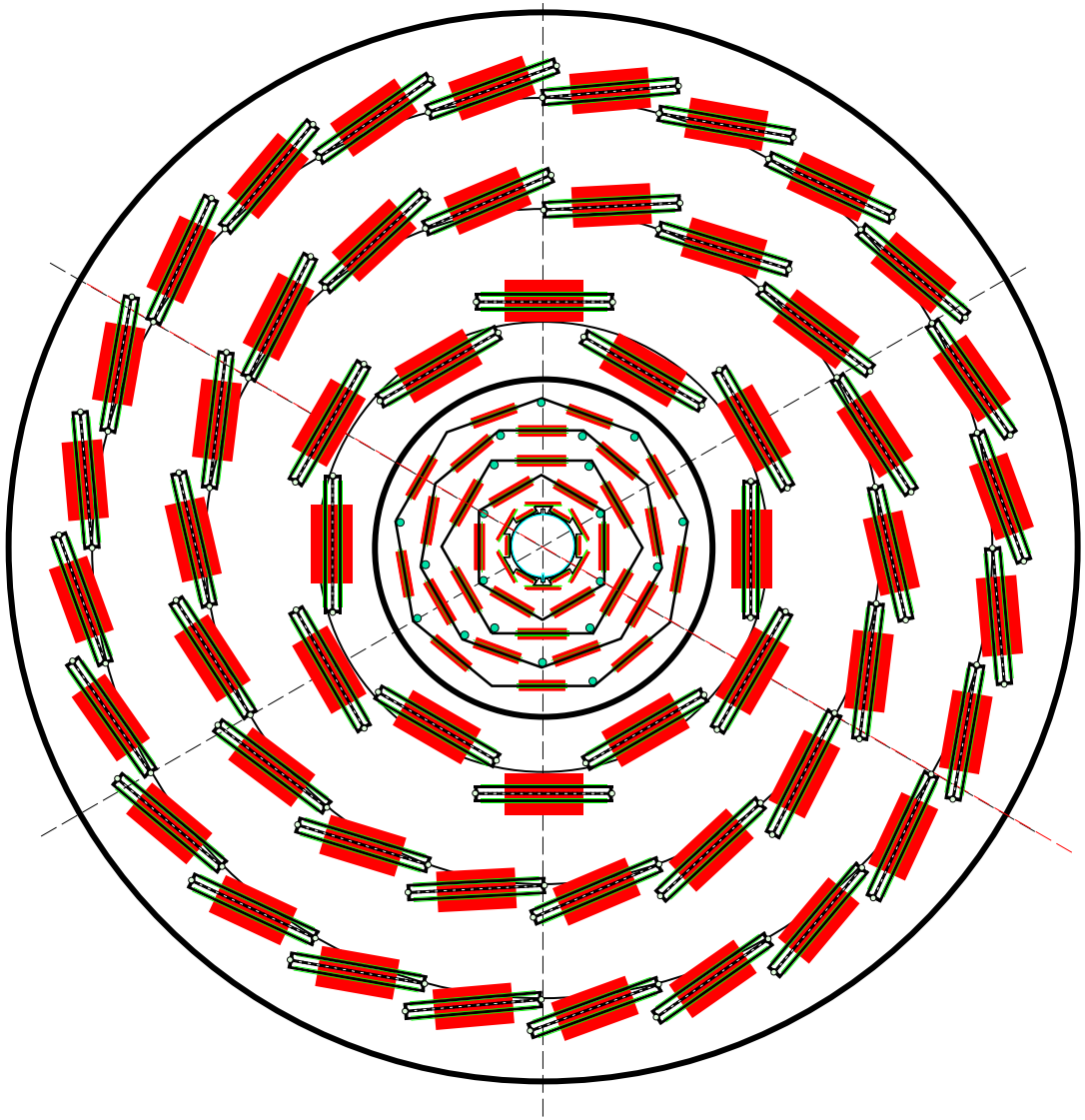
Example Geometry

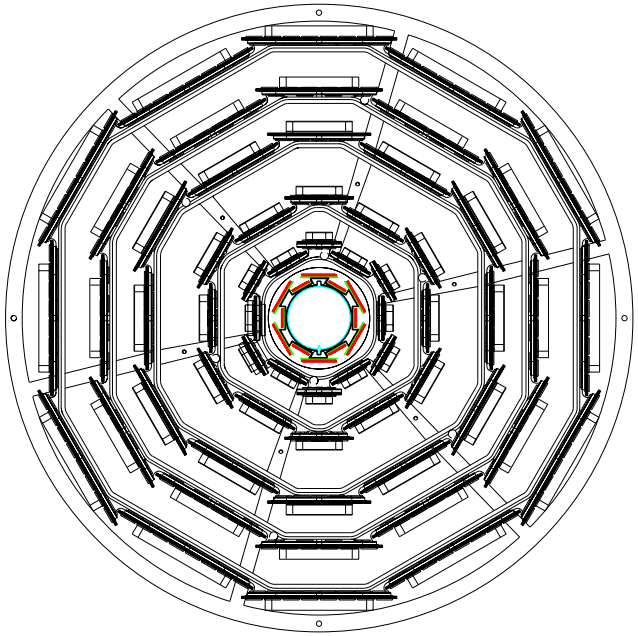




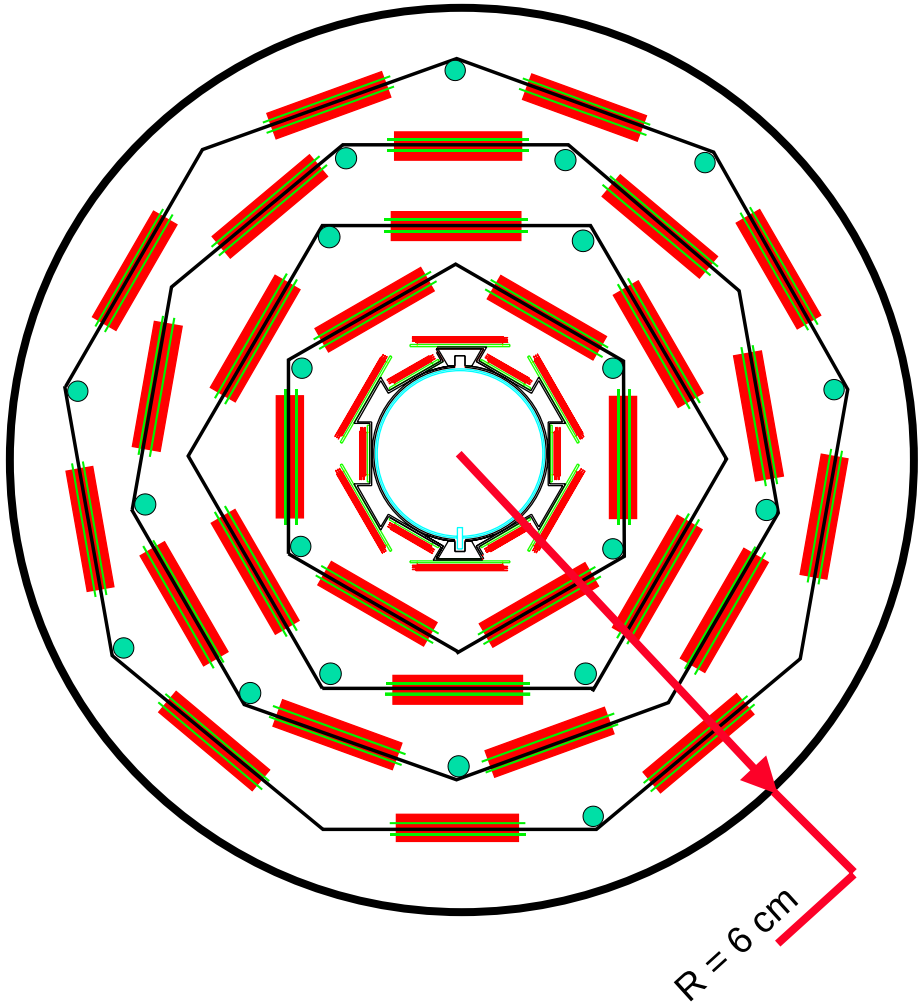
Uses only stereo modules made up of two single-sided modules. These are installed back to back with small overlap in z in boxlike “rod”. Rods install in C-fiber endplate system like COT field sheets. CMS achieves very high precision alignments from one rod to next. They are also easily swapped in and out.

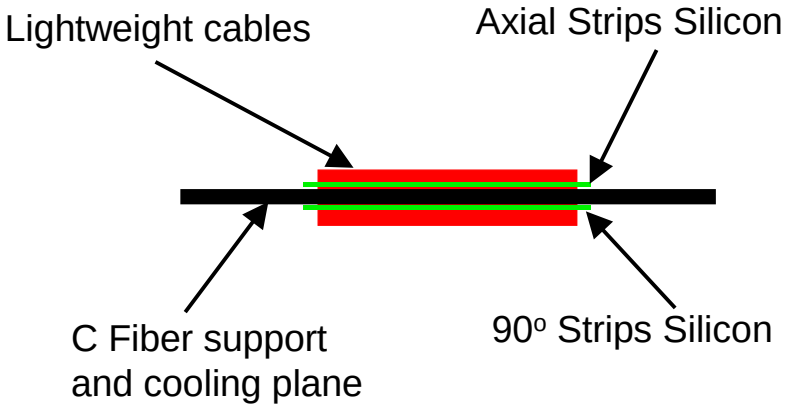
Comparison





Example Replaceable Section





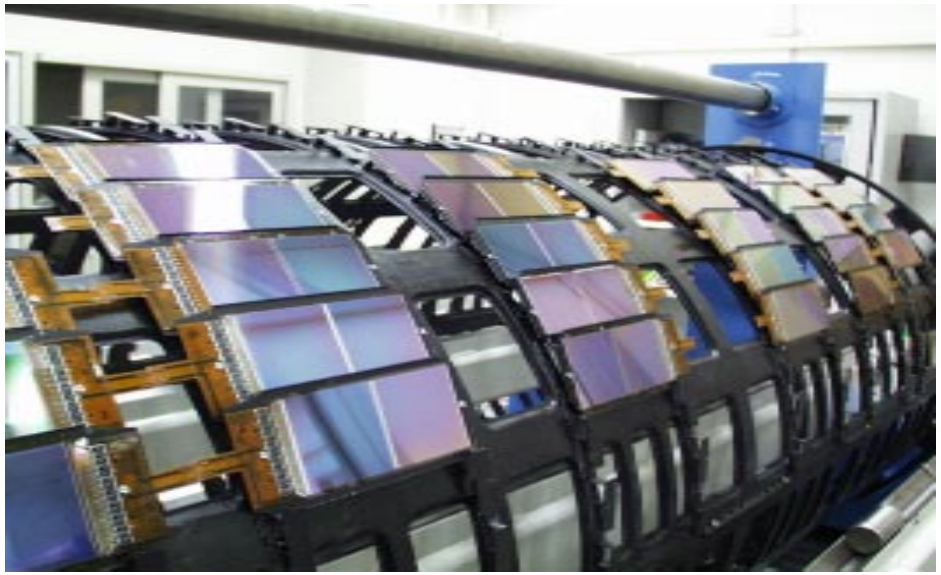
- Innermost layer on beam pipe is the same as Layer 00.
- The other two layers can be like Layer 00 with electronics outside the tracking volume:
  - Low mass inner layers
  - Remove z ambiguities
- Layout shown is only a sketch intended to look at space issues.

Detailed Example

Layer	R [cm]	Nphi	chips	pitch	hybrid pitch	width	total chips	cumulative	phi coverage
L0A-1	1.35	6	1	0.0025	0.005	0.84	36	36	59%
L0A-2	1.65	6	2	0.0025	0.005	1.48	72	108	86%
L1A	3.5	12	2	0.0035	0.007	1.992	144	252	109%
L1S	3.5	12	2	?	0.007	1.992	144	396	109%
L2A	5.25	18	2	0.0035	0.007	1.992	216	612	109%
L2S	5.25	18	2	?	0.007	1.992	216	828	109%
L3A	8	12	4	0.0028	0.0084	4.5008	288	1116	107%
L3S	8	12	3	?	0.0112	4.5008	216	1332	107%
L4A	12	18	4	0.0028	0.0084	4.5008	432	1764	107%
L4S	12	18	3	?	0.0112	4.5008	324	2088	107%
L5A	16	24	4	0.0028	0.0084	4.5008	576	2664	107%
L5S	16	24	3	?	0.0112	4.5008	432	3096	107%

- Total installed chip count of SVXII + L00 = 3168+108 = 3276
- This example has 3096 installed chips.
- Pattern Recognition (A. Yagil)
  - Our silicon system does not compromise tracking at even 10^{33} cm^{-2} s^{-1}
  - Nevertheless Pixels are attractive: improves/simplifies pattern recognition.

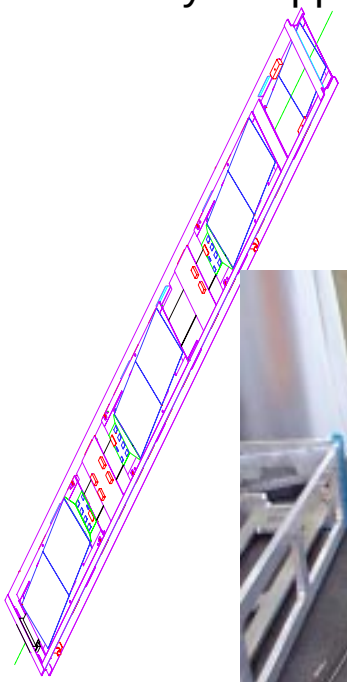
Shell Support Concepts



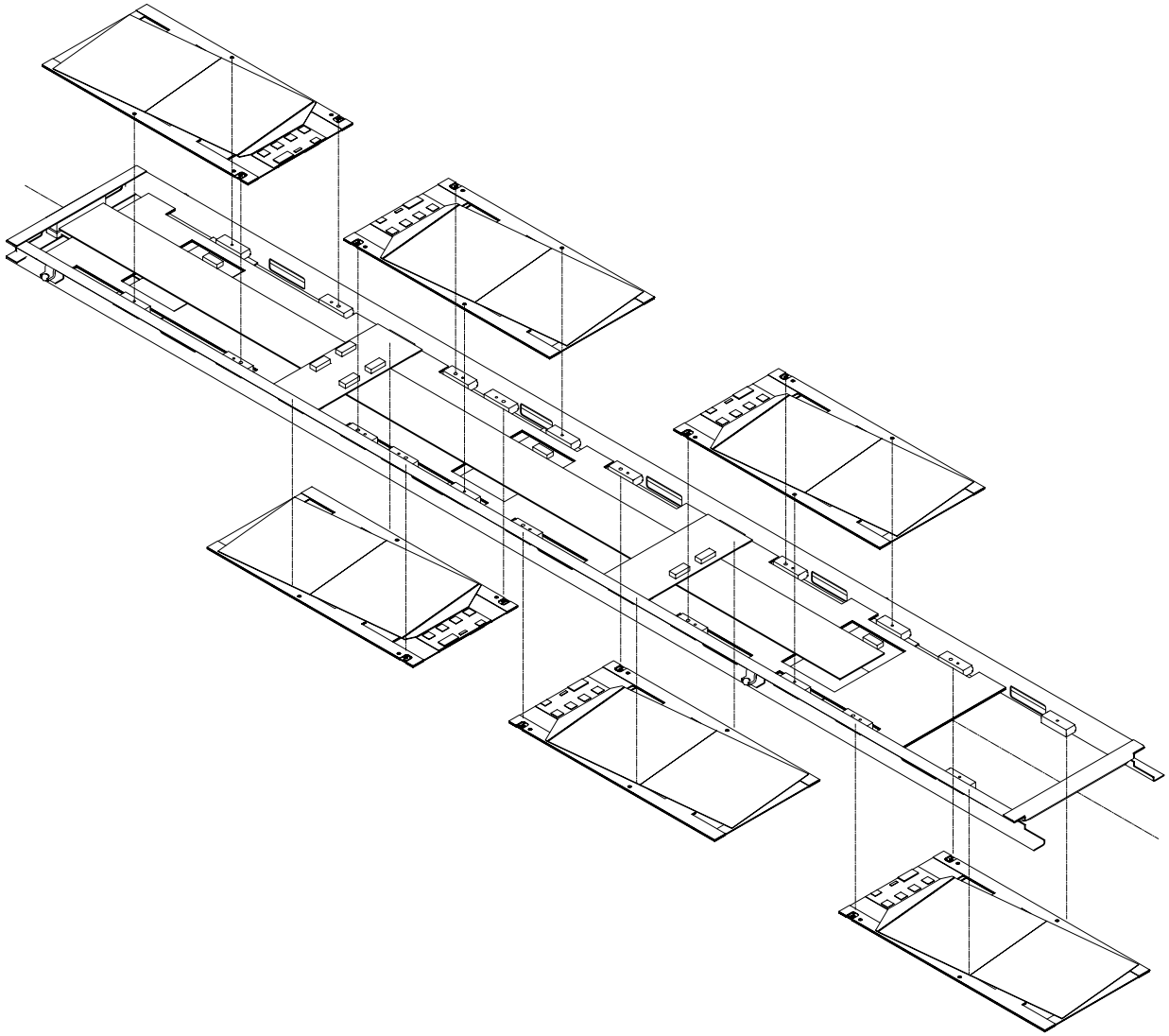
- At small radii, Carbon Fiber shells can be used to support modules
  - CMS is using molded cylinders with integrated cables and cooling
    - Modules are installed on both the exterior and interior in order to maintain z overlap
  - In Layer 00 we use molded shells with cooling tubes running under ledges
    - Silicon is installed on the flat sections and all electronics are outside the tracking region

CMS Rod Support Concept

Uses only stereo modules made up of two single-sided modules. These are installed back to back with small overlap in z in boxlike “rod”. Rods install in C-fiber endplate system like COT field sheets. CMS achieves very high precision alignments from one rod to next. They are also easily swapped in and out.



CMS Rod Assembly



Practical Considerations

- SVX4 sub-micron (0.5 – 1.0 M$):
  - Redesign 2-3 ~2 FTE for ~ 2 y
    - 1.1 M$
  - Translation ~ 500k$? Needs to be refined
  - The alternative is ~1.5 - 2.5 M$ for Honeywell production of SVX3 chips
- New Power Supplies, Portcards and Cables (? $)
- Extra Be beampipe (0.25 M$)
- Silicon (~1 M$)
  - Many manufacturers for rad-hard single sided microstrips.
  - Oxygenation.
  - Have asked for rough quotations.
    - Production time would be short and predictable
    - Quality would be exceptional
      - **99.9% good strips**
      - **$V_{BD} \geq 700V$**
- Module production (~0.75M$)
  - Use all single-sided equivalent modules
    - Stacked for stereo views
  - 1152 single sided equiv. (SS) modules
  - Production requirements are modest. Based on ISL experience:
    - **2 technicians could fabricate, and 1-2 technicians could inspect, wirebond and repair 6 SS modules per day on one CMM (includes contingency)**
    - **6-7 technicians could complete all modules in 26 weeks**
- ~600 Hybrids (~0.6 M$)
    - Off silicon, and use adequate real-estate to make robust, simple, easy to manufacture
- Mechanical Supports (? $)
  - Model after CMS/L00:
    - nested cylinders at small radius
    - rods at intermediate radii