5.1.0 Performance and Validation

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CDF Collaboration Meeting

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Outline

Introduction

Tracking

Muons

Calorimeter and Electrons

Conclusion

Improvements and Validation

5.1.0 Production

- Intended for reprocessing all the data for use in the winter 03-04 conferences
- Improvements made in most areas of the reconstruction code
  - Track, muon and electron reconstruction
  - Calorimeter energy calibrations/corrections and jet finding

Validation Procedure

- Validation by the reconstruction groups
  - Direct comparison of 4.8.4(4.10/4.11) results and 5.1.0 results
  - Verification of the results from new reconstruction code
  - Check yields/efficiencies, purity and resolutions...
- Validation by the physics groups
  - 5.1.0 used to process stripped physics samples
  - Comparison of physics quantities from 4.8.4 and 5.1.0 using identical analysis programs
  - Primarily check yields, purity and resolutions

Document into CDF notes

Tracking Improvements

COT

- New COT alignment
  - Improved resolution, $\mathrm{d_0}$ vs. ϕ and $\mathrm{E/p}$ vs ϕ
- Tighter roads used in final fit: improved resolution
- $\mathrm{dE/dx}$: Optimum calculation done during tracking
- IO tracking: Attach COT hits to forward silicon tracks where possible

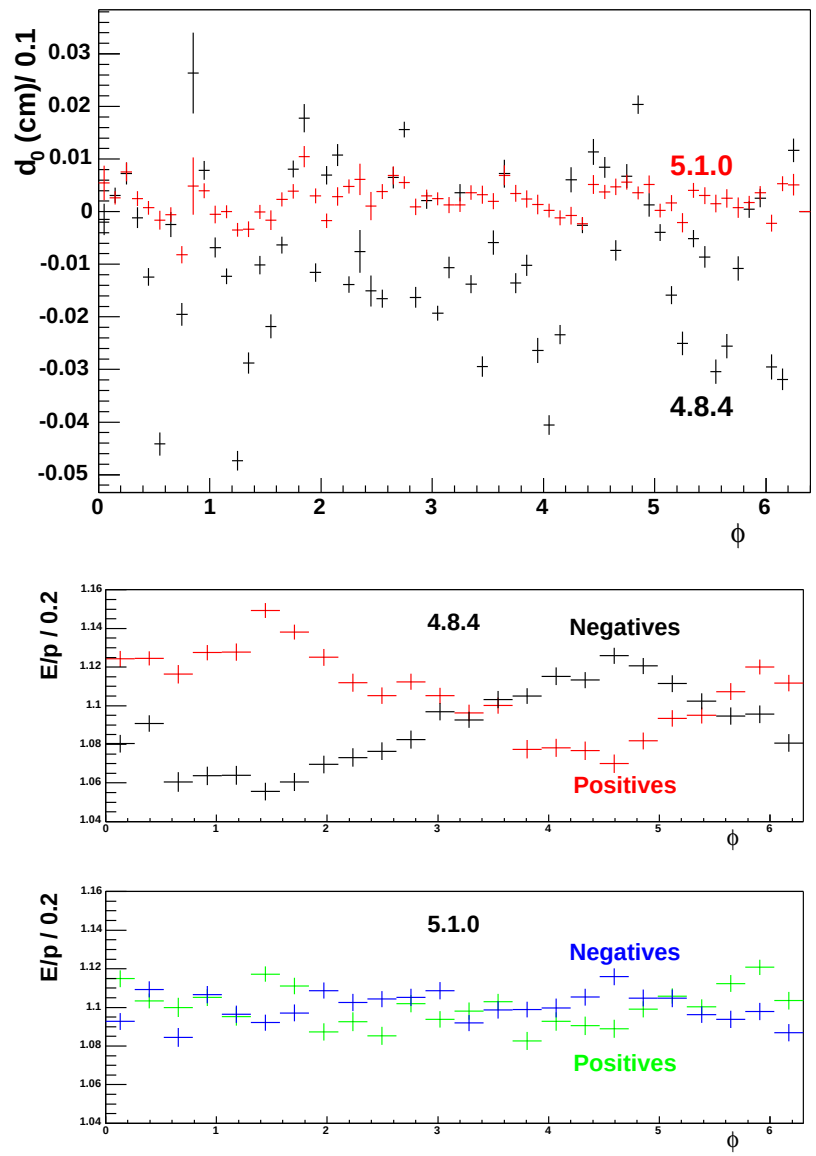
Silicon

- New silicon alignment
  - Less systematic effects: $\mathrm{d_0}$ vs. ϕ improved
  - ISL and L00 alignments improved
- Tracking efficiency, purity and resolution
  - OI tracking efficiency improved by several percent without affecting purity
    Primarily at high momentum
  - Standalone tracking efficiency improved (slightly) - purity and resolution improved
- L00 should be ready for physics use
  - Best clustering done in Production and user methods exist for adding L00
- Phoenix calorimeter seeded tracking performed during Production

COT Tracking Performance

COT performance

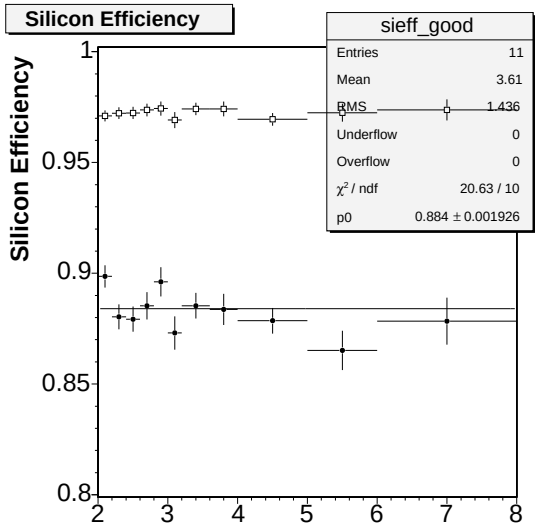
- Improvements primarily due to better alignment
  - Cosmic ray based alignment: Cell tilts/shifts
  - Includes corrections for electrostatics and gravitational effects
- Improved tracking vs. ϕ systematics
  - $\mathrm{E/p}$ vs. ϕ effects
  - $\mathrm{d_0}$ vs. ϕ effects reduced by factor of 4
  - As good as possible with current cosmic samples
- COT resolutions considerably improved
  - J/ψ mass resolution $27\mathrm{MeV} \rightarrow 23\mathrm{MeV}$
- Forward and low $\mathrm{p_T}$ efficiency improved
  - Changed defTrack definition to 2 axial and 2/1 stereo segments with ≥ 5 hits



Silicon Tracking Performance

Silicon Efficiency

- Raised efficiency for isolated tracks and tracks in jets
- Efficiency of attaching silicon for J/ψ muons
  - Efficiency improved from $88.4\% \rightarrow 90.3\%$
  - Primary improvement at high momentum
  - Resolution of 3-hit(5 expected) silicon tracks looks better(adds 3% more)
  - Fake rate the same 1.18%
- Efficiency of attaching silicon for tracks in jets
  - Efficiency at high momentum up: $73.3\% \rightarrow 83.0\%$
  - Fake rate down 1.2%
  - Efficiency down at low momentum: $\sim 2\%$



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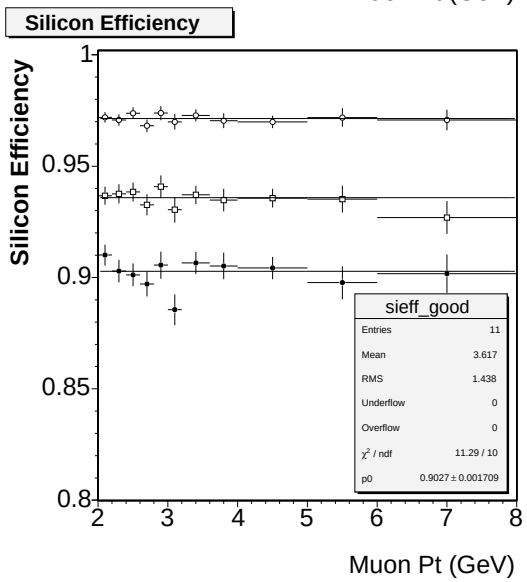
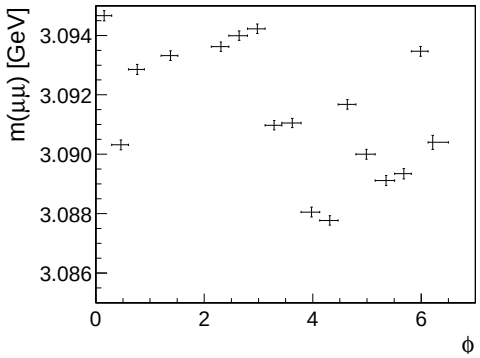


5.1.0

Combined Tracker Performance

COT/Silicon J/ψ Mass resolutions

- COT width: $27\mathrm{MeV} \rightarrow 23\mathrm{MeV}$
- OI width: $15\mathrm{MeV} \rightarrow 14\mathrm{MeV}$
- Phi effects reduced



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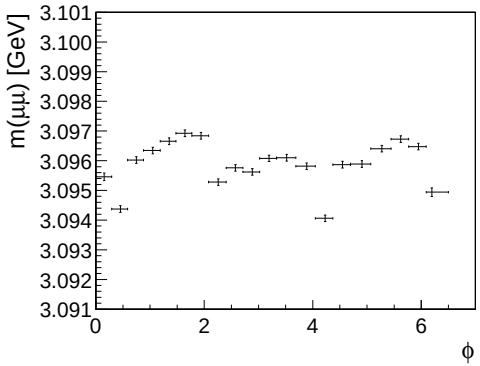

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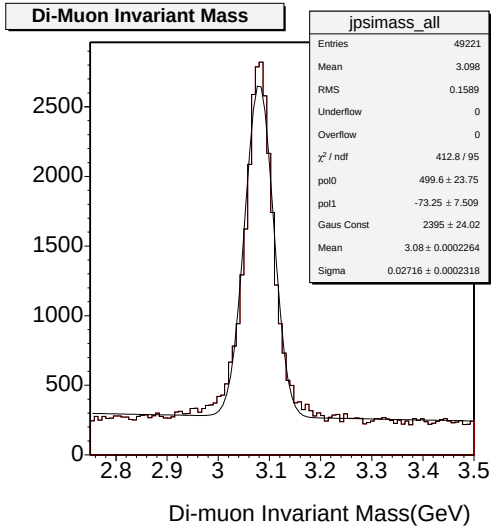

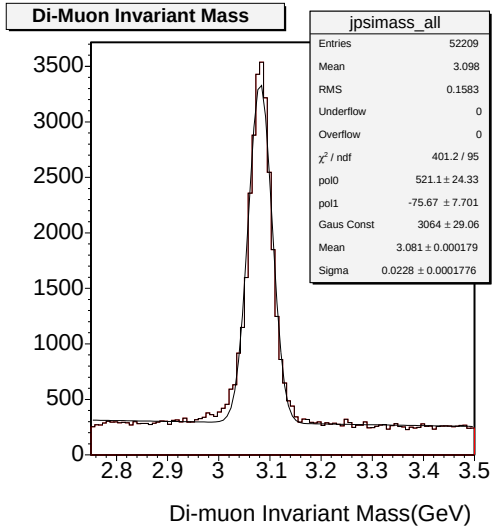

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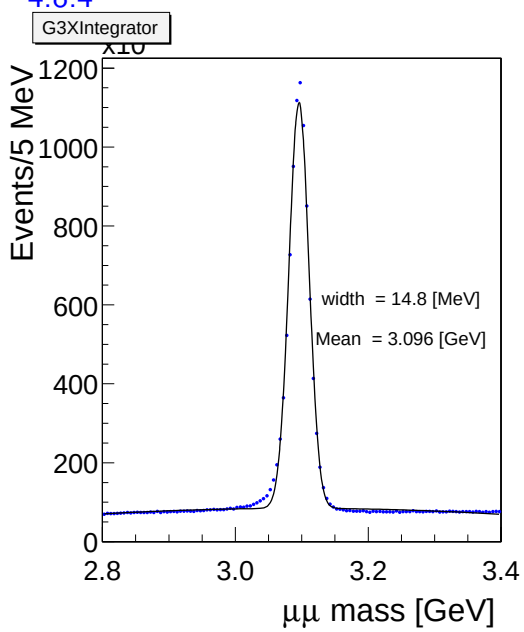

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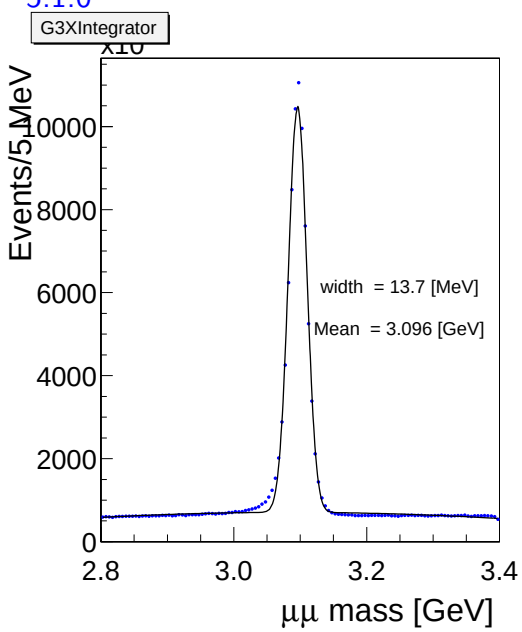
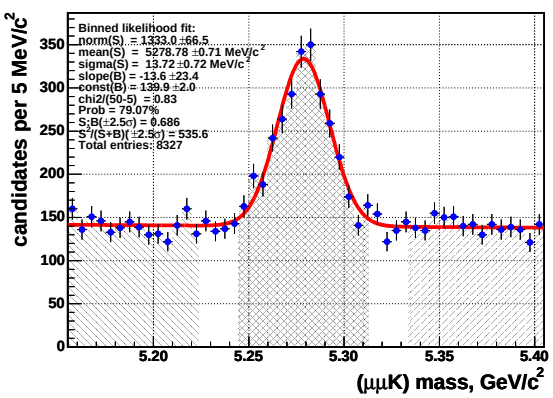
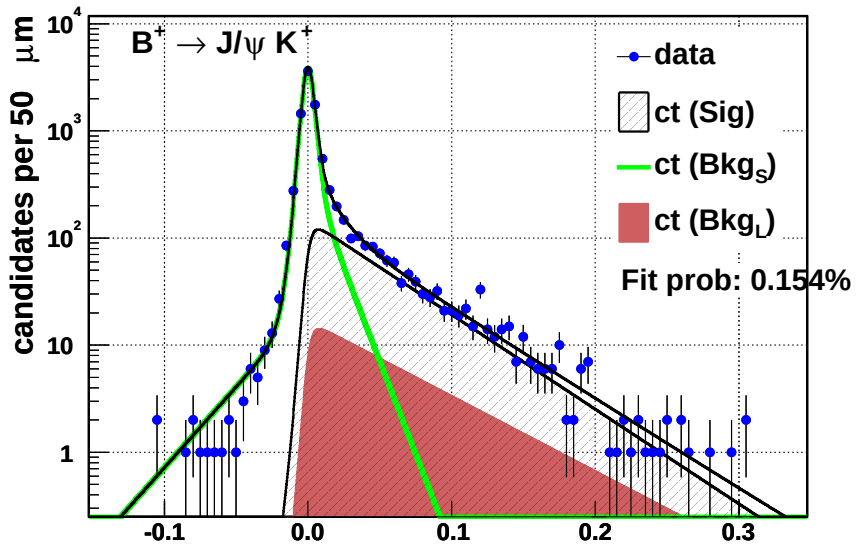


Physics Validation: $\mathrm{B} \rightarrow \mathrm{J}/\psi\mathrm{K}$

Validation Strategy

- 4.8.4 vs. 5.1.0
- Perform $\mathrm{B} \rightarrow \mathrm{J}/\psi\mathrm{K}$ lifetime analysis
- Compare all quantities from fit
- Comparisons of interest
  - Mass width: $16\mathrm{MeV} \rightarrow 14\mathrm{MeV}$
  - ct fit probability $0.15\% \rightarrow 16.5\%$
  - mass fit probability $0.3\% \rightarrow 77.3\%$
  - Notice tail of the $c\tau$ distribution
  - S/N slightly improved





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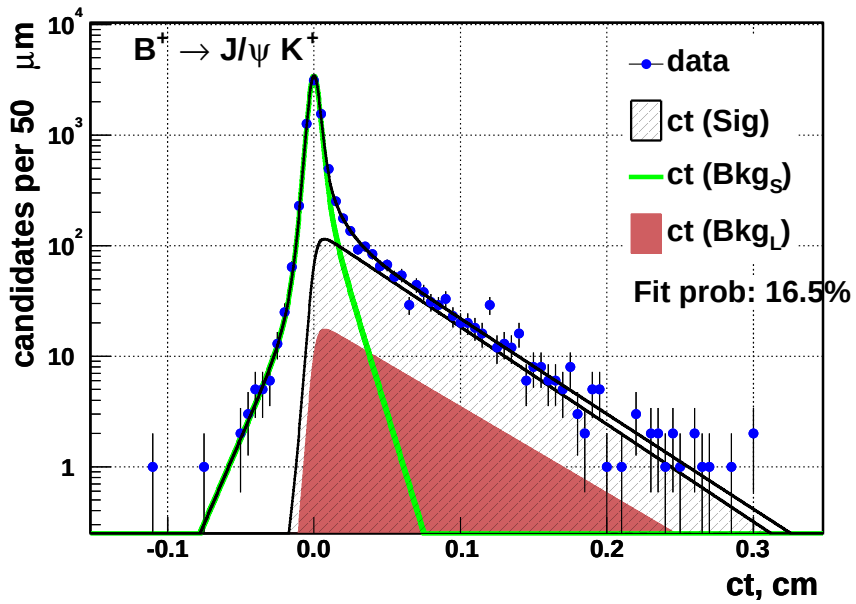
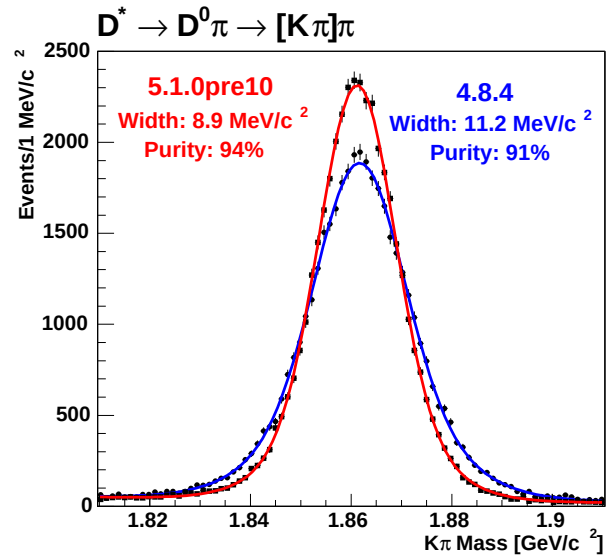


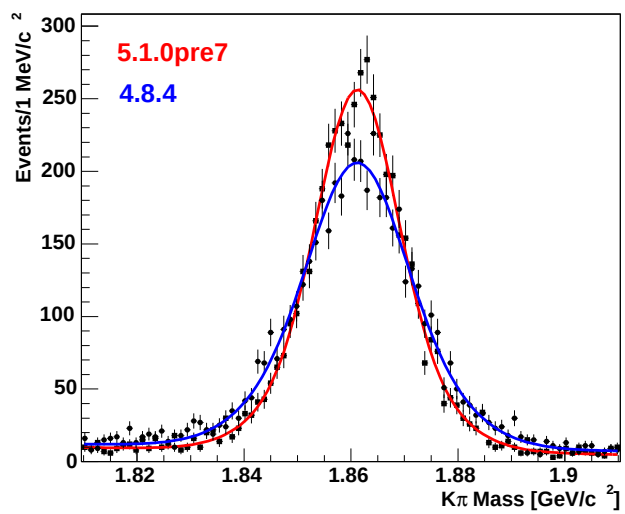
5.1.0

Physics Validation: $D^* \to D^0\pi$

Validation Strategy

- 4.8.4 vs. 5.1.0
- Using pre selected D^*
  - Soft pion: provides validation of low momentum tracking
  - Purity and width improved
  - Found 39920 of 39900 events (a few new candidates)
- Also using unbiased D^* sample
  - Same cuts: Yield 3% higher
  - New defTrack cuts: Yield 9% higher

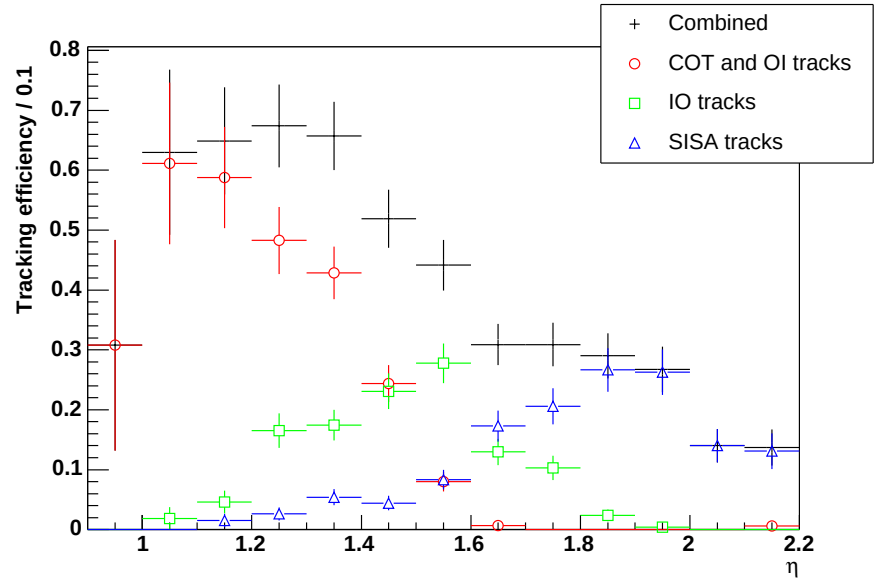


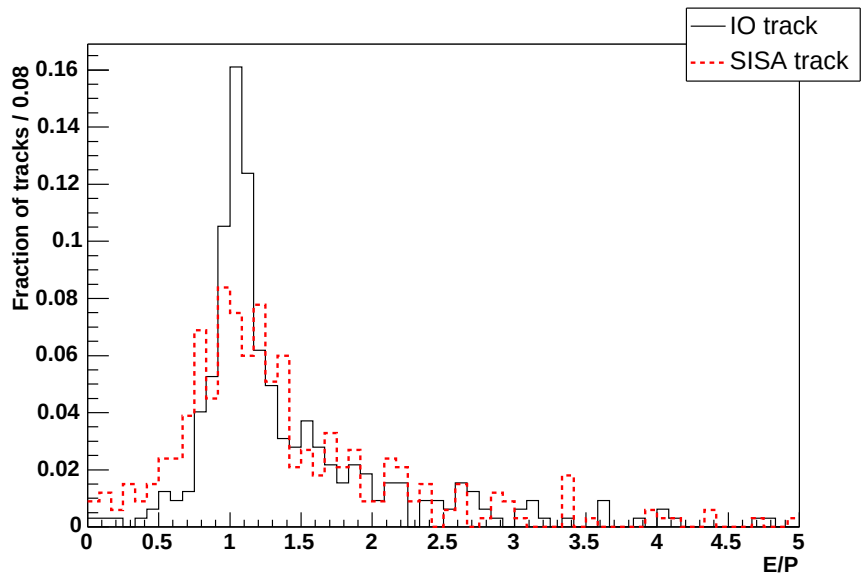


IO Tracking Performance

Introduced a new tracking algorithm: IO

- Attach COT hits to silicon only tracks that cross the COT
- Considerably improved resolution on silicon tracks
  - Curvature resolution improved by factor of 2
  - Other track parameters slightly improved
- IO tracks have very low fake rate
- Also used to removed COT/silicon duplicates
  - No more high momentum fakes silicon tracks in the central region
- Efficiency of combined tracking $\sim 65\%$ at $\eta = 1.3$

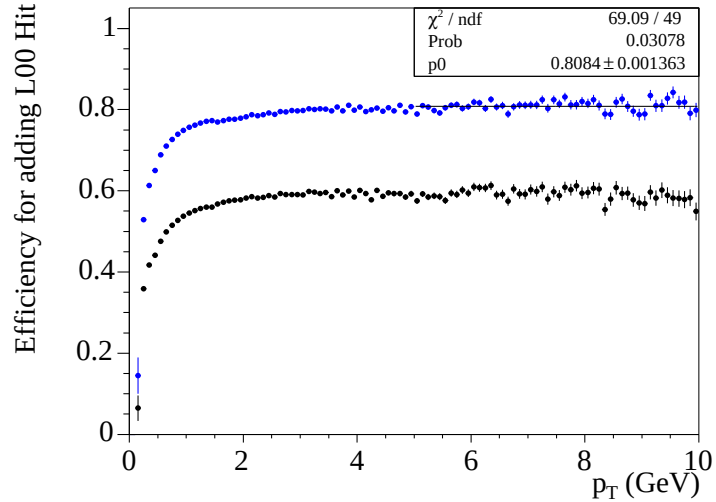


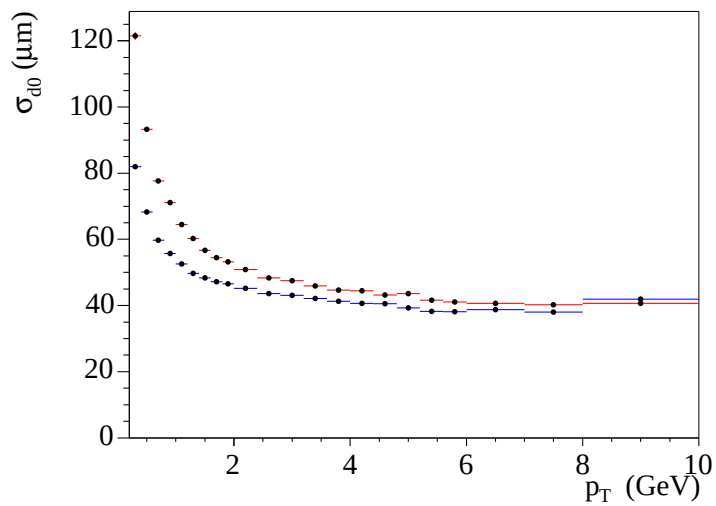


L00

More than one year of work finally starting to pay dividends

- Clustering and alignment
  - Best clusters made by Production
  - Alignment to $30\mu\mathrm{m}$ level
    most ladders $5\mu\mathrm{m}$ level
- Efficiency tracks pointed into active area
  - Max efficiency 80.8%
  - Requiring high quality clusters: 59.2%
- Impact parameter at low momentum improved dramatically
- To do: people needed - and not for physics studies
  - Optimize clustering cuts/Finish alignment
  - Some efficiency might be recoverable
  - Serious study needed for physics use
  - Instructions for use on tracking web page



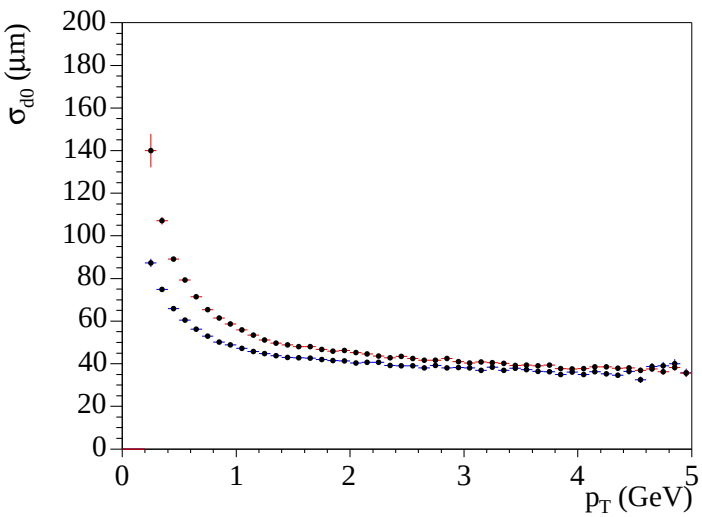


L00 Capabilities

Improvement in impact parameter resolution

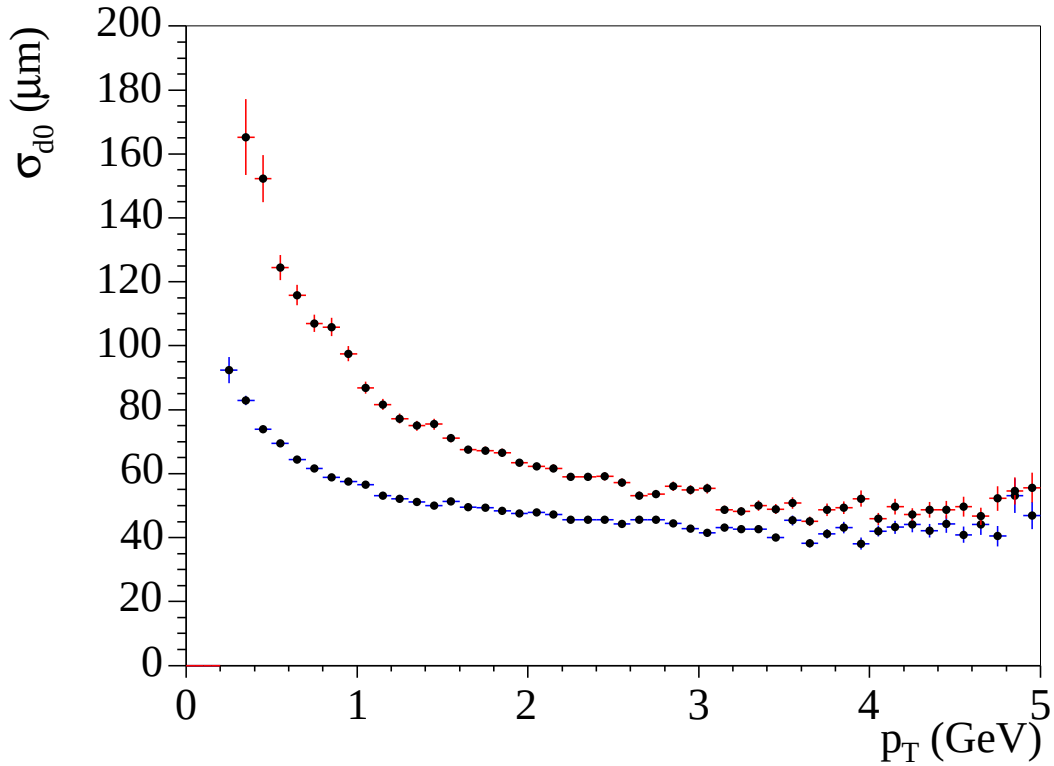
- Consider high vs. low material regions
  - hybrid/bulkhead vs silicon only region

Silicon only: $|z_0| < 8\mathrm{cm}$



Hybrid + silicon: $11 < |z_0| < 19\mathrm{cm}$

With L00 - Without



Muons, Electrons and Calorimeter

Muon Reconstruction

- Improvements in understanding muon fiducial/acceptance
  - Official measurements of CMX efficiency: reconstruction and trigger
- Improvements in BMU/IMU reconstruction
  - 28% higher efficiency! Mostly improvements in BMU code
    $62\% \rightarrow 90\%$

Electrons and Calorimetry

- Calibrations/Corrections
  - Time dependent tower by tower corrections
  - Dead channels in reconstruction code
- Improvements in CES and CPR reconstruction
- Addition of Phoenix electron track reconstructions
- All improvements part of standard 5.1.0 Production

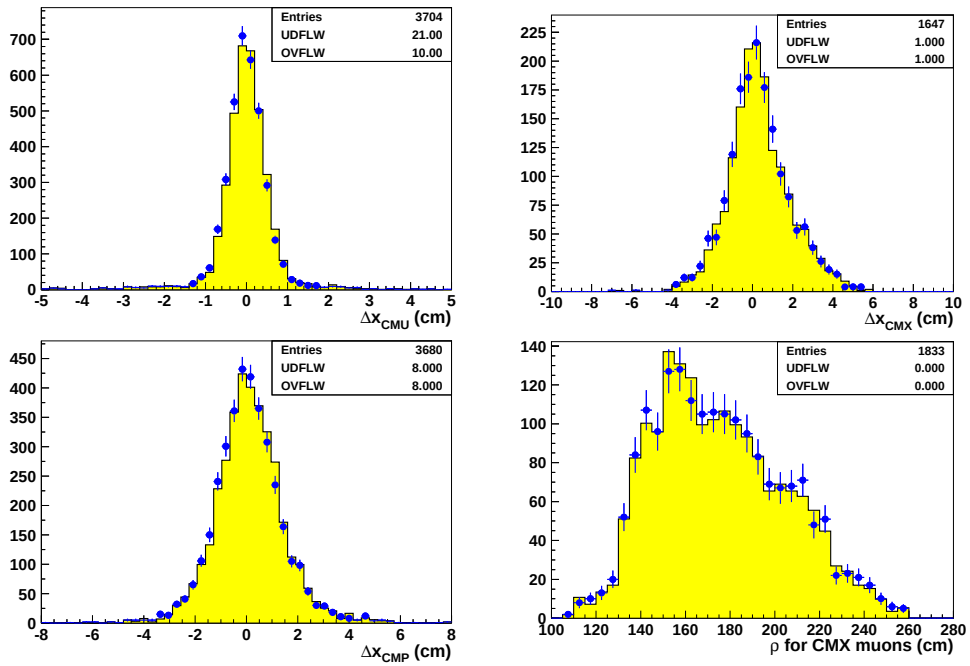
Muon Reconstruction Performance and Validation

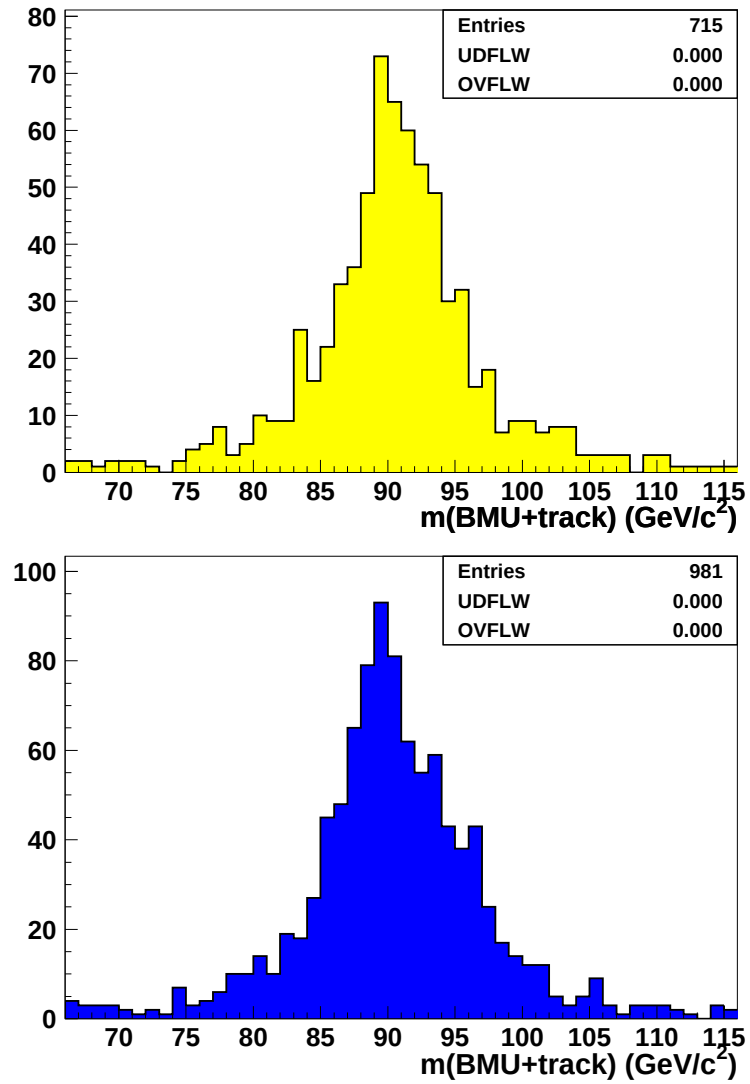
CMU, CMP and CMX

- Compare to previous performance(4.11)
- All analysis variables checked

BMU

- Improved BMU reconstruction efficiency
  - $Z \rightarrow \mu\mu$ Central muon - forward COT track





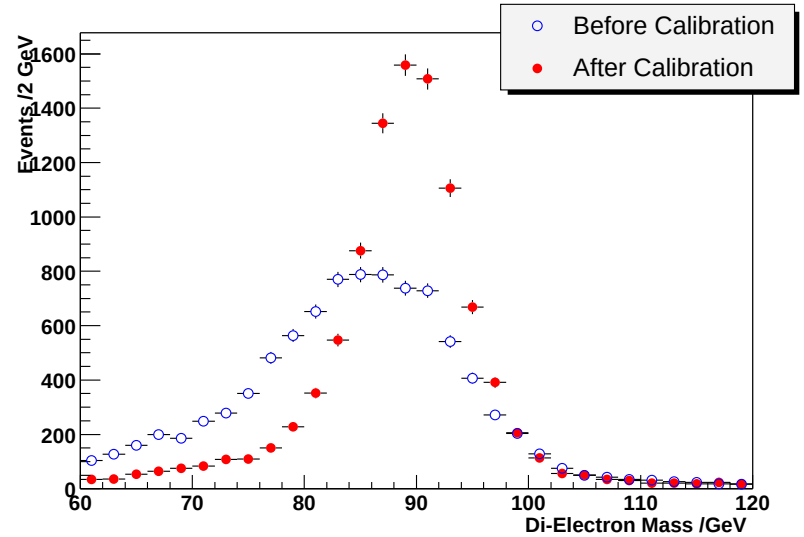
Electron/Calor Reconstruction Performance and Validation

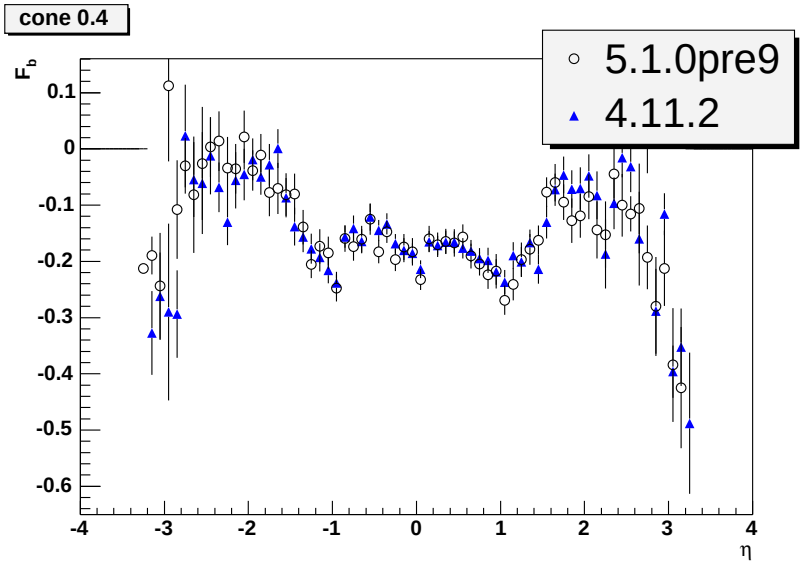
Improvements in calorimeter corrections

- Effect clearly seen on $Z \rightarrow ee$ mass
  - Improvements primarily completed for 4.11
  - Compare to 4.11. for validation
  - Mass - photon jet balancing ...

Several reconstruction problems corrected

- CES: χ^2 and cluster widths
- CPR: Case where two tracks extrapolate to the same cluster
- PES alignment with COT





Conclusions

5.1.0 Production considerably improved

- Tracking, muon, electron and calorimeter code all improved
- Tracking: Efficiency improved and systematics reduced
  IO tracking done and L00 almost ready
- Muons: BMU efficiencies improved
- Electrons: Electron energy resolution from the calorimeter looks good

Most improvements not available without 5.1.0 reprocessing

5.1.0 Processing nearly ready to start

Still work to do

- Do your service work in software
- If you've already completed your service work -
  Do some more work! It will make your analysis better.