Software Status

simulation and reconstruction for the DBD

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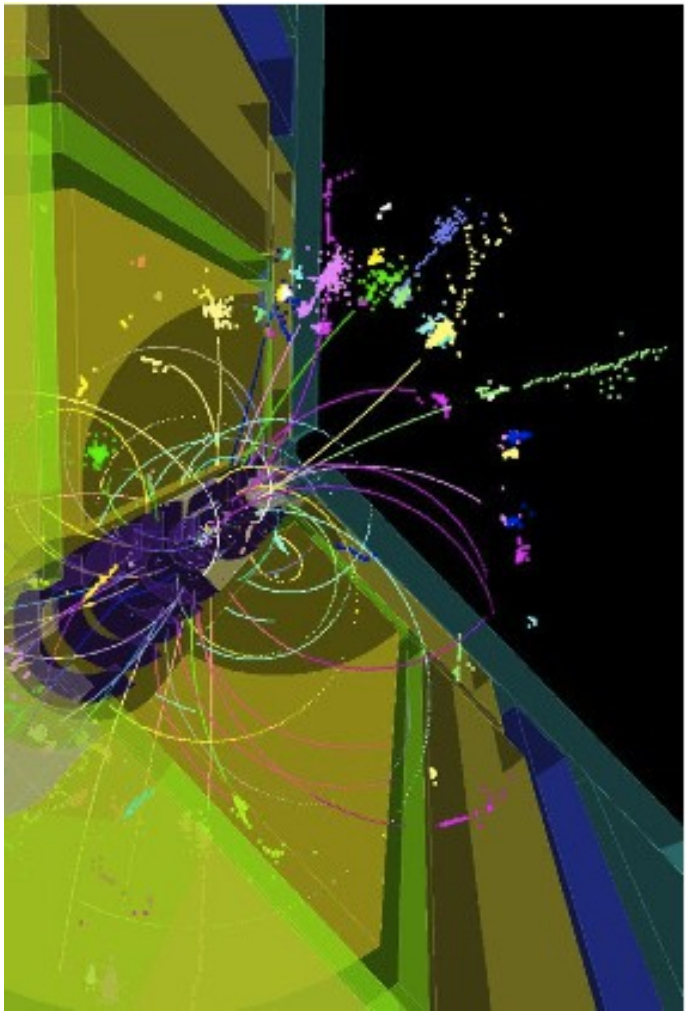
ILDMeeting @ KILC 2012

Daegu, Korea, Apr 23-27, 2012

Outline

- introduction
- simulation
  - validation of subdetectors
- reconstruction
  - FPCCD
  - new tracking
  - PandoraPFA
  - LCFIVertex
- Grid production
- Summary & Outlook



timeline for iLCSoft development

- timeline for iLCSoft development in last 2-3 years was mainly driven by the requirements for the ILD-DBD

5 month	Analysis and Writing	13 month
t0 - 5m	Monte Carlo production finished	
5 month	Grid Production	
t0 -10m	start Monte Carlo production	
3 month	Test, Debug and release ILDsoft	
t0-13m	freeze ILDsoft development	
>1 month	implement baseline in simulation	~20 month
t0-x	ILD baseline defined	
	evaluate technology options develop tracking package develop geometry LCIOv2 improve simulation realism improve reconstruction study machine backgrounds ...	

- this talk: main activities:
  - **improved/adopted core tools**
    - LCIOv2, GEAR, CED,...
  - **improved realism of the simulation**
    - include gaps, imperfection and services
  - **complete re-write of tracking code !**
    - old code unmaintainable and cannot easily cope with high bg
  - adaption of reconstruction algorithms (PFA, Flavor tag) to new technology options (SDHcal, FPCCD,...) [not in this talk]

recent developments in Mokka

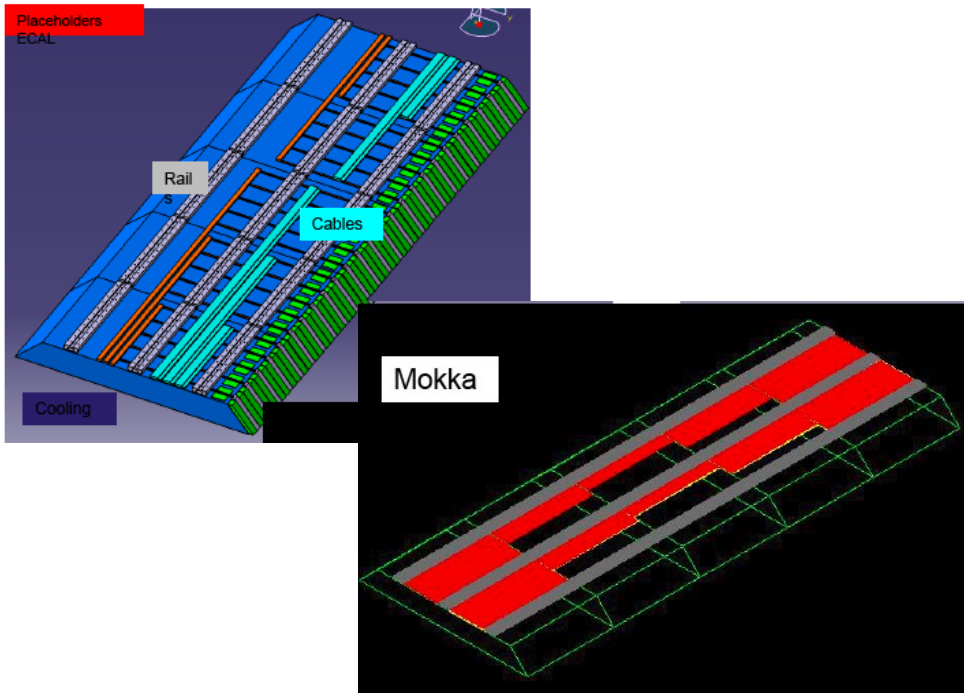
- major rewrite of some sub detector drivers :
  - SIT, SET, ETD - FTD - Muon
  - increased level of detail and realism (incl. services)
- made existing drivers more realistic:
  - TPC, AHCal, Ecal, FCal,...
- new drivers (technology options):
  - SDHCal, SciEcal
- added overall services and cables
- new models for DBD:

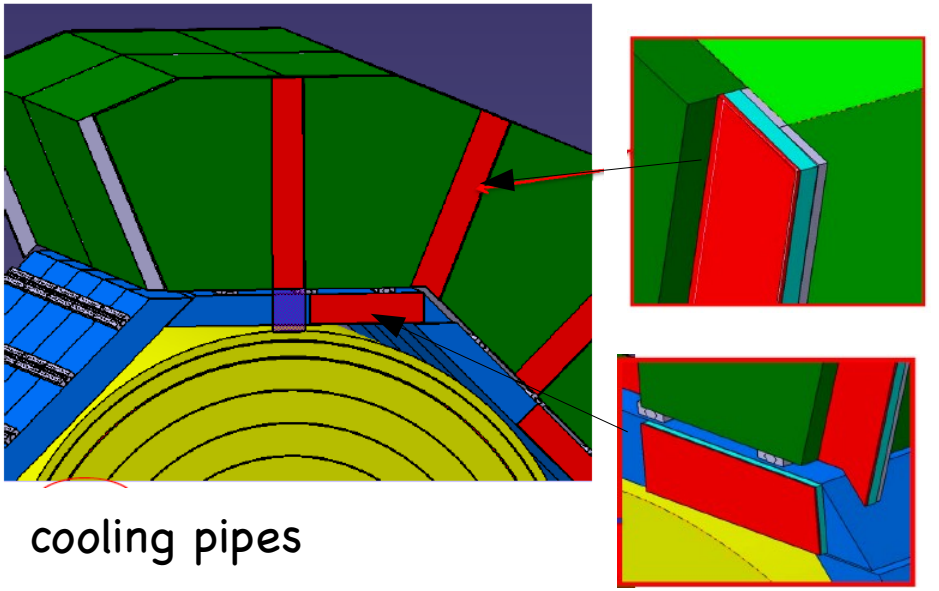
ILD_O1_v01 "ILD simulation reference Model for DBD using Analog HCal"
ILD_O2_v01 "ILD simulation reference Model for DBD using SD HCal"
ILD_O3_v01 "ILD simulation reference Model for DBD using SciW Ecal and Analog HCal"

  - first part ILD_OX - read "ILD - Option X", refers to the choice of sub-detector technology options of the model
  - second part _vXX refers to the software release version that describes this option for ILD

increased realism in ILD_OX models

- added cabling and services for TPC, ECal & Hcal (C.Clerc, G.Musat)
- including inner detector services as defined by R&D groups

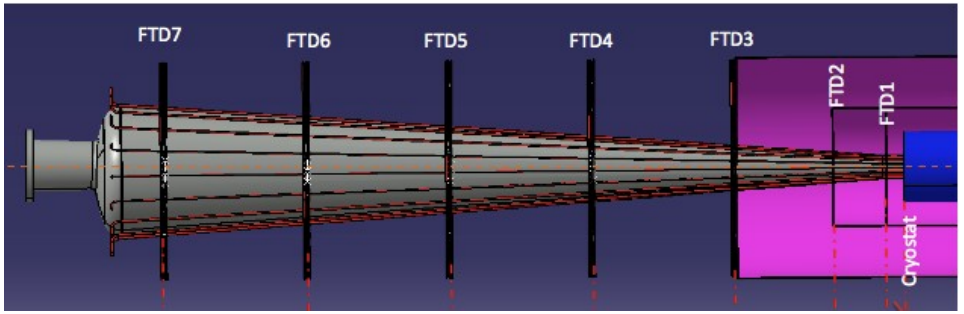




cooling pipes

electronics

big step forward in increasing realism of ILD detector simulation !



power supply cables

validation of Mokka ILD model(s)

- started validation process with volunteers nominated by the subdetector R&D groups, checking the Mokka drivers for:
  - overlaps, consistency w/ engineering model, hit production,..

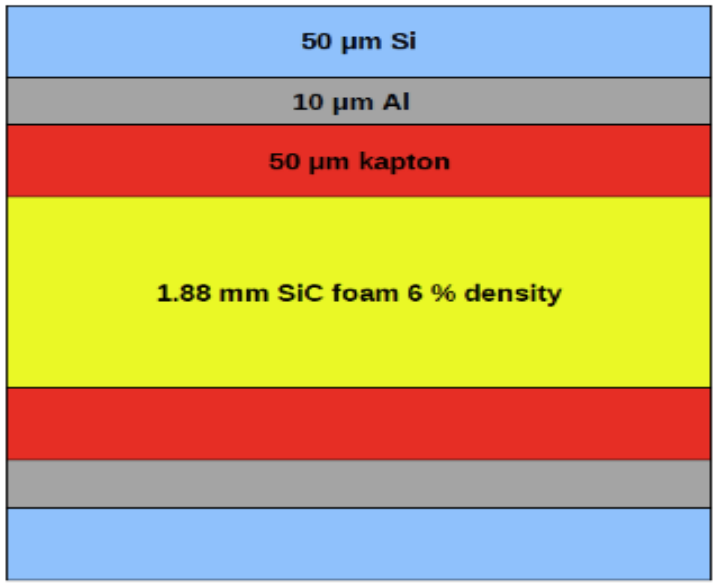
detector	person	status
VXD	G.Voutsinas	ongoing
SIT/SET	K.Androsov	to be done
FTD	J.Duarte	to be done
TPC	S.Aplin	done
ECal	D.Jeans	done
AHCal	Sh.Lu	done
SDHcal	G.Grenier	to be done
FCal	A.Rosca, B.Pawlik	ongoing
Muon	A.Saveliev	ongoing

start MC production, once all sub detectors are 'approved'

overall overlap checking: Ch.Grefe

VXD validation

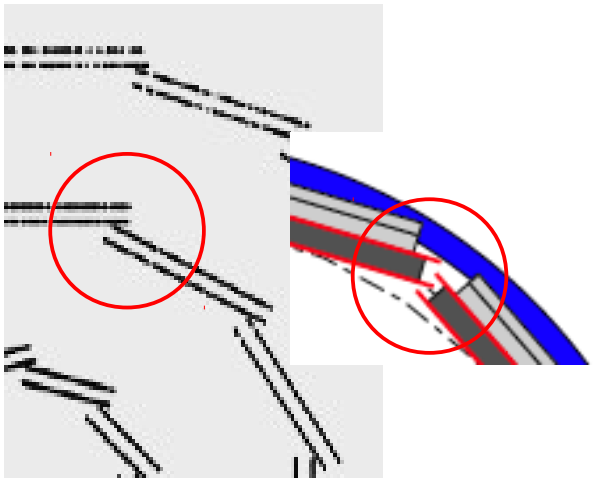
Y.Voutsinas



- 0.053 % x 2 +
- 0.011 % x 2 +
- 0.018 % x 2 +
- 0.130 % =

- 0.294 % X_0 per double layer

simplified in GEAR:
0.2% X0 support
+ 0.1% X0 sensitive
= 0.3% X0 total



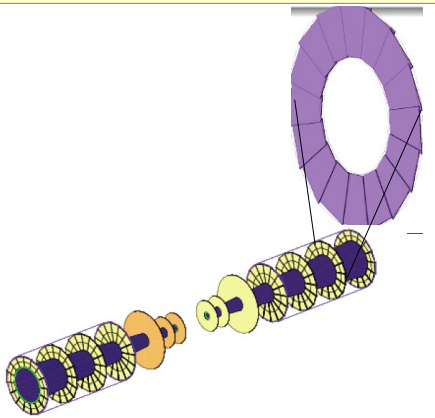
- inconsistency in geometry detected
- potential impact on track finding

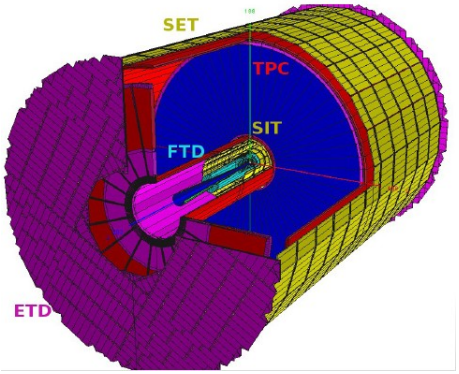
=> will be fixed soon by Yorgos
=> VXD is then validated

SIT/SET& FTD

K. Androsov, J.Duarte

- very detailed new simulation models have been developed for SIT/SET as well as for the FTD (ETD is not in simulation models)
- these models have not quite reached the level of maturity one would need for the DBD mass production
- slightly simplified have been developed in parallel in order to proceed with new C++ tracking code
  - these models have planar wafers, ~realistic support material and work with new tracking





Mokka driver and GEAR

It has been decided to do a simplified version of the current driver (SFtd06) easier to mantain which is going to be the **Baseline for DBD**:

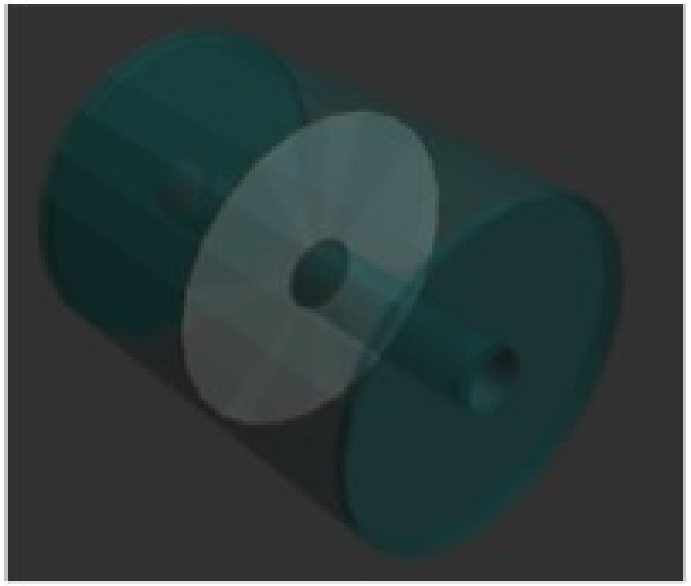
- Keep segmented petals (2 sensor per petal) in a frame-like sopporting structure
- Cabling envelop according to latest description (http://ilcagenda.linearcollider.org/getFile.py/access?contribId=1&resId=0&materialId=slides&confId=5482)
- Pixels simplified (petal-segmented

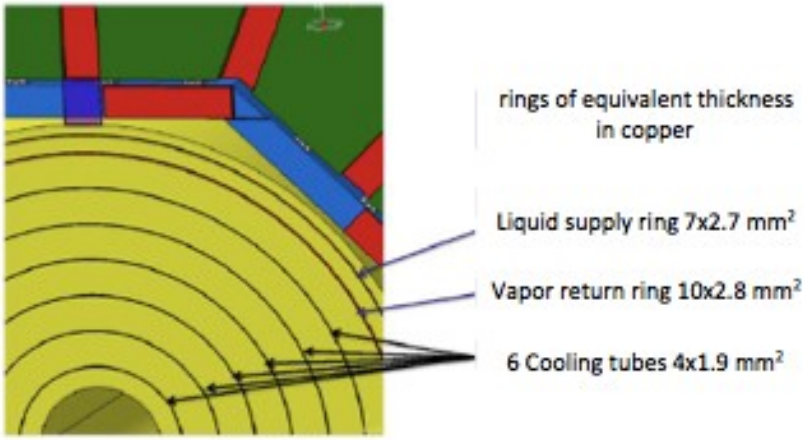
=>SIT/SET validation pending

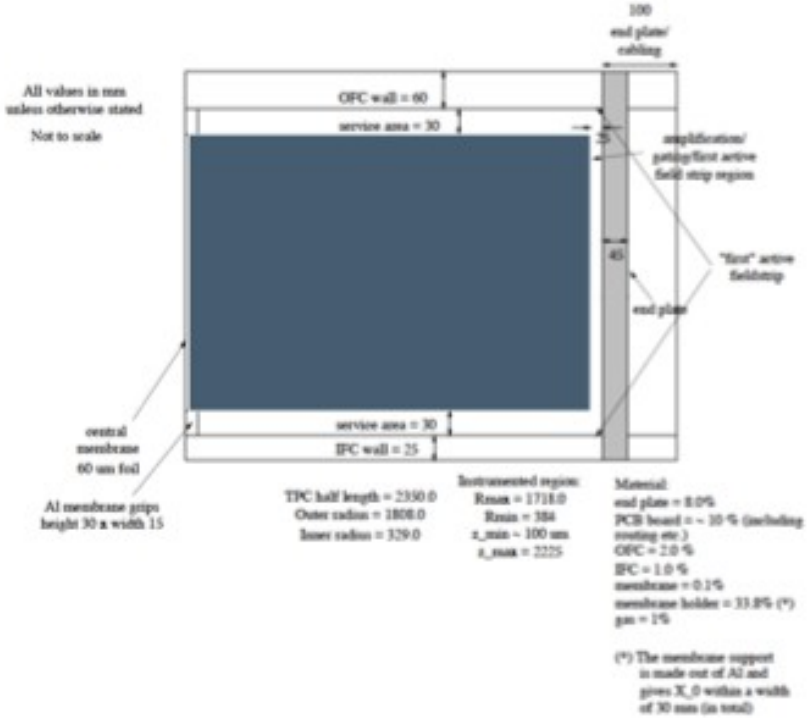
=> FTD validation pending

TPC validation

S.Aplin







End-Plate modeled as discs of material representing components of the readout: GEM structure, Readout, and Support frame.

Cathode constructed from two thin discs, insulator and conductor, held by membrane grip.

Cooling modeled using rings attached to the outside of the end-plate.

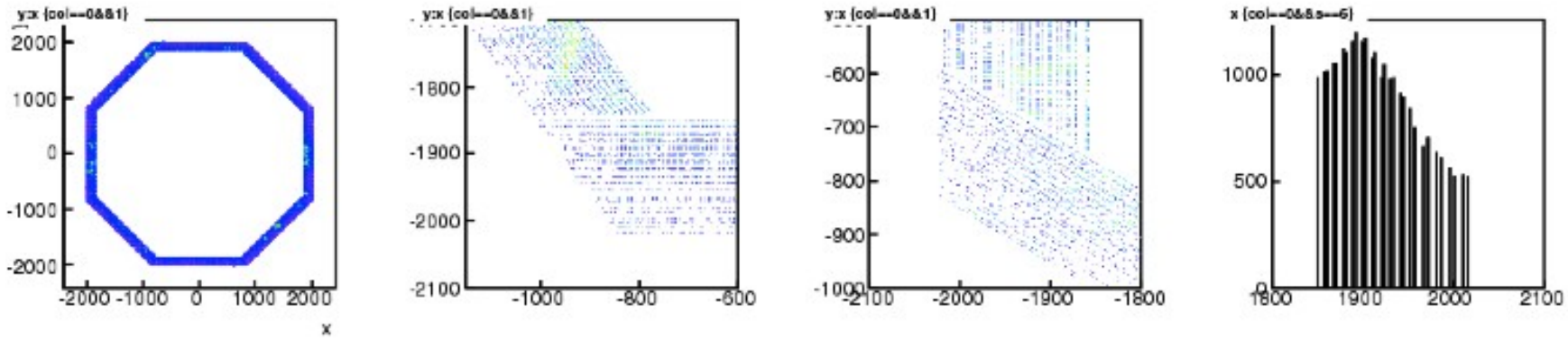
Parameterised digitisation well established in the main reconstruction chain.

=> TPC is validated

SiW Ecal validation

D.Jeans

Engineering design dimensions:
Barrel: Rin=1843, Rout=2028, 1/2 length=2350
Endcap: Rin = 400 (square), Rout=2090 (octogon), Zin=2450, Zout=2635



StepLeng		NextVolume
	0	WorldPhysical
	3	BarrelEcalModule
	2.45	FirstSlab
	0.25	PCBCuShield
pcb	1.3	FirstSlab
	0.1	WaferSi
si	0.5	Ground
	0.1	BarrelEcalModule
cf	0.15	RadiatorSlab
w	2.1	BarrelEcalModule
cf	0.15	Ground
	0.1	WaferSi
si	0.5	SecondSlab
	0.1	PCBCuShield
pcb	1.3	SecondSlab
	0.25	BarrelEcalModule
cf	0.75	RadiatorStruct
w	2.1	BarrelEcalModule
cf	0.75	FirstSlab
	0.25	PCBCuShield
pcb	1.3	FirstSlab
	0.1	WaferSi

Conclusions

Hit positions consistent with engineering design

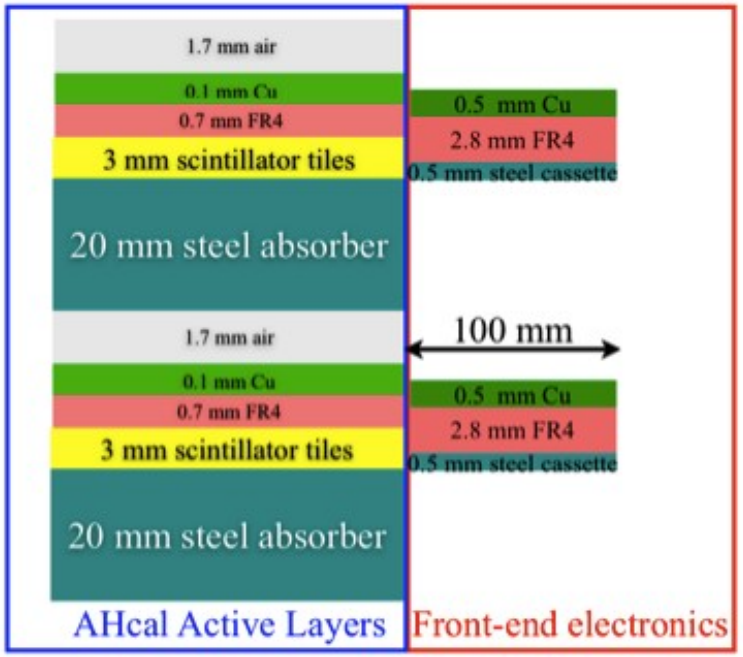
Decoded CellID behave as expected

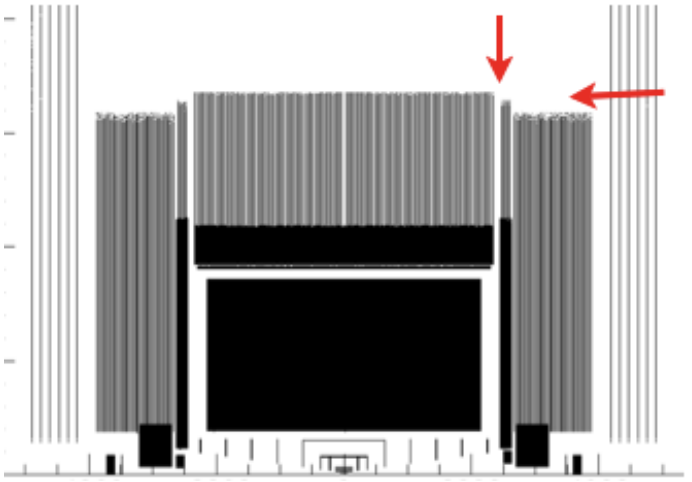
No problems detected in ECAL structure (geantino)

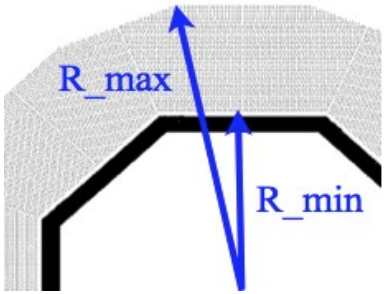
=> Ecal is validated !

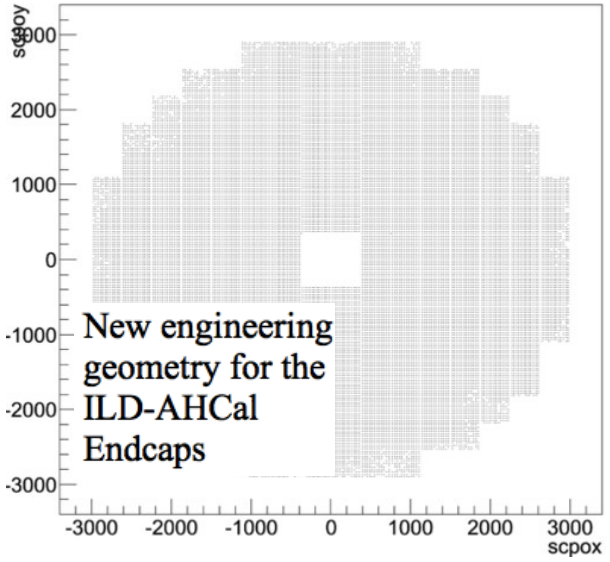
AHcal validation

Sh.Lu









The Mokka drivers for the Barrel and the Endcap have been validated and synchronized with engineering design.

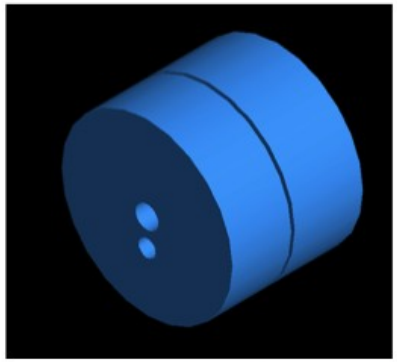
EndcapRing will be checked with engineering design too.

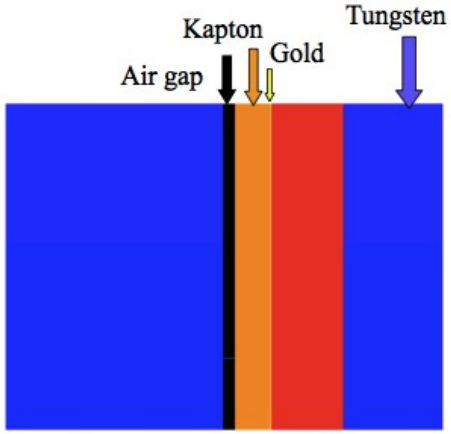
=> AHCal almost validated

Fcal validation

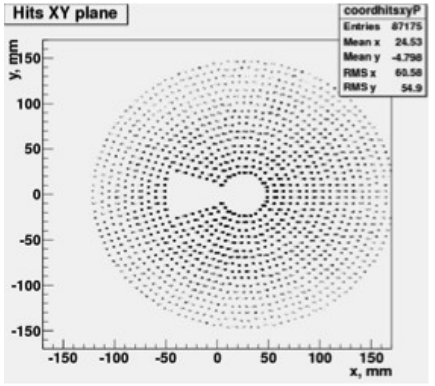
A.Rodca, B.Pawlik

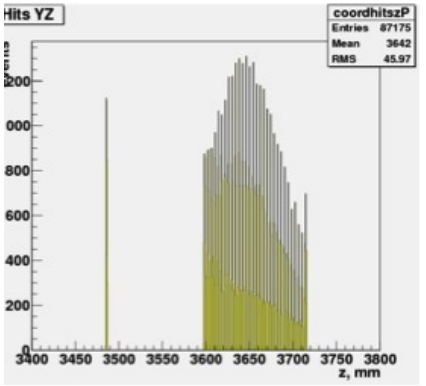
Simulation





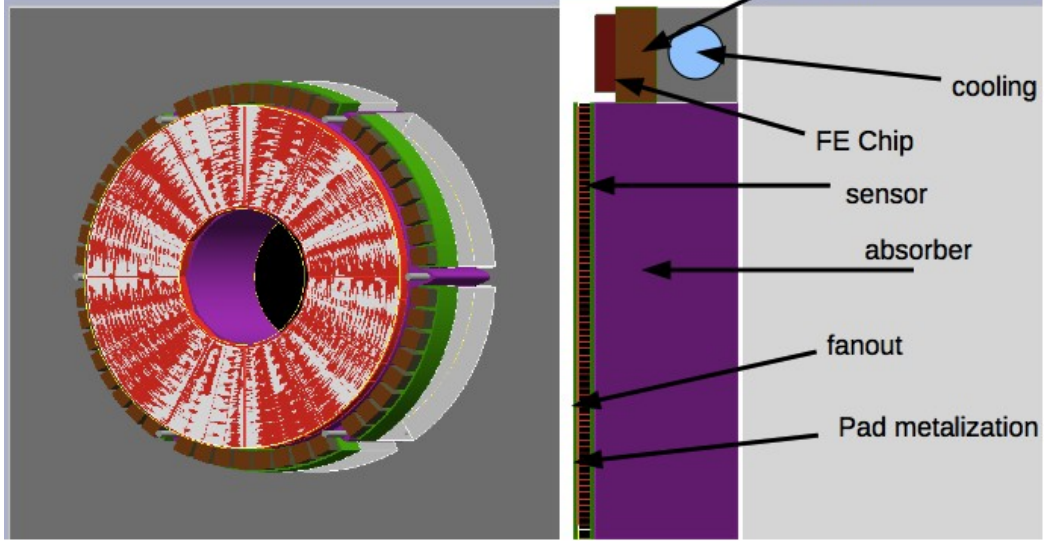
Geometry has been checked for overlaps
– No overlap found.





Z_{in} = 3450 mm in the engineering design and ~3600 mm in the simulation.

Implemented Geometry
(according to official RD)

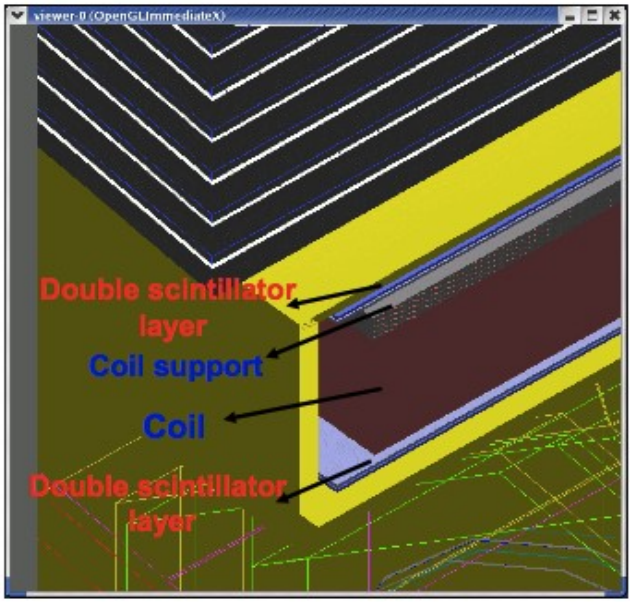


- check impact on physics
-> probably keep value in simulation - and change eng. model accordingly

=> BCal (almost) validated
=> LCal validated

Muon validation

V.Saveliev

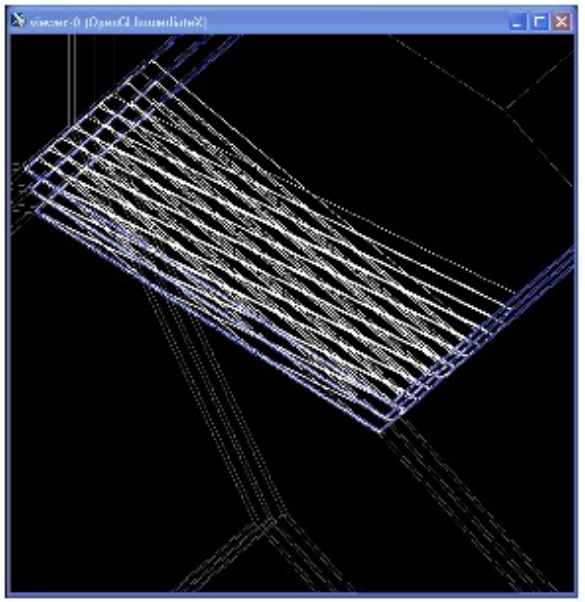


Cryostat: Detailed Geometry
- Instrumentation 2 Double Scintillator Layers

baseline?

Coil: Detailed Geometry,
- Coil Segmentation

Yoke: Detailed Geometry based on Mechanical Design
- Barrel: 10x(100+40) +3x(560 +40) mm
- EndCup: 10x(100+40) +2x(560+40) mm



various readout options exist
- 3x3cm scint. tiles <- used in LOI & Pandora
- 3x3cm RPC <- implemented in ILD_01
- 3xLcm scint. strip stereo <- proposed

=> need decision asap !!

=> muon validation ongoing

Overall Overlap checking

Ch.Grefe

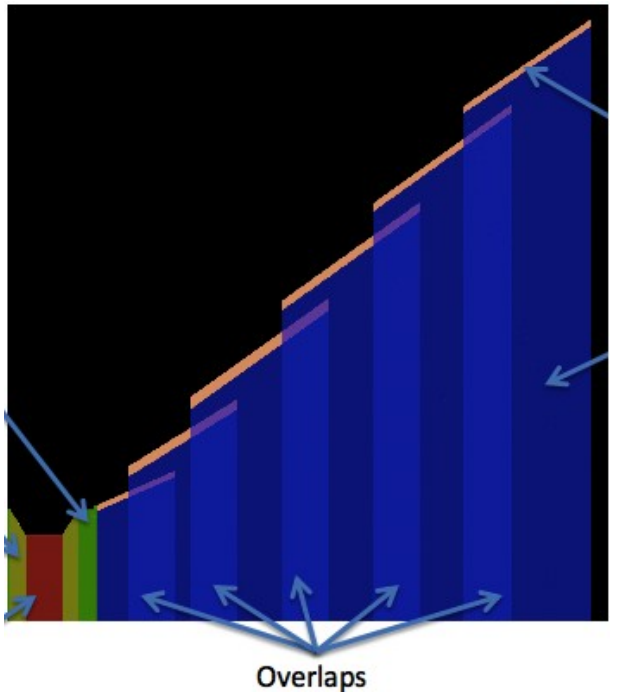
/geometry/test/recursive_test

Gives detailed printout with coordinates of overlaps:

```
GeomTest Error: Overlapping daughter volumes
  The volumes tube_IPOuterBulge[0] and tube_IPOuterBulge[0],
  both daughters of volume WorldPhysical[0],
  appear to overlap at the following point in global coordinates:
    length (cm)  ---------- start position (cm) ----------  ---------- end position (cm) ----------
        16.45          0          0       37.13          0          0       53.58
  Which in the mother coordinate system is:
    length (cm)  ---------- start position (cm) ----------  ---------- end position (cm) ----------
        16.45          0          0       37.13          0          0       53.58
  Which in the coordinate system of tube_IPOuterBulge[0] is:
    length (cm)  ---------- start position (cm) ----------  ---------- end position (cm) ----------
        16.45          0          0       -1.16          0          0       15.29
  Which in the coordinate system of tube_IPOuterBulge[0] is:
    length (cm)  ---------- start position (cm) ----------  ---------- end position (cm) ----------
        16.45          0          0      -21.91          0          0       -5.46
```

Careful: can be false positives / false negatives

Still the best starting point

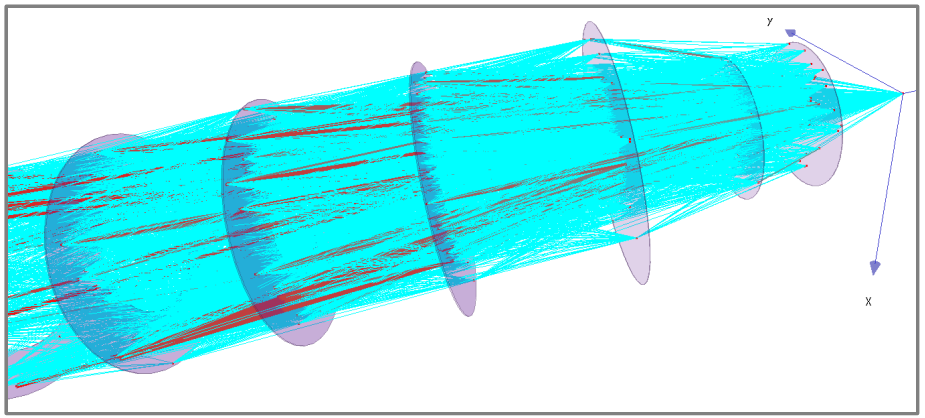


- World volume to small – fixed
- SIT overlaps with FTD – fixed
- Overlapping sensors in SIT and SET – fixed
- Overlaps in FTD – fixed
- Insulators overlap in TPCCathode (?)
- Overlaps in tube_IPinnerTube (?)
- Overlaps in tube_IPOuterBulge
- YokeEndcap overlaps YokePlug – fixed
- Overlaps in HCalServices – fixed
- Chamber1 and Chamber2 overshoot YokeEndcap

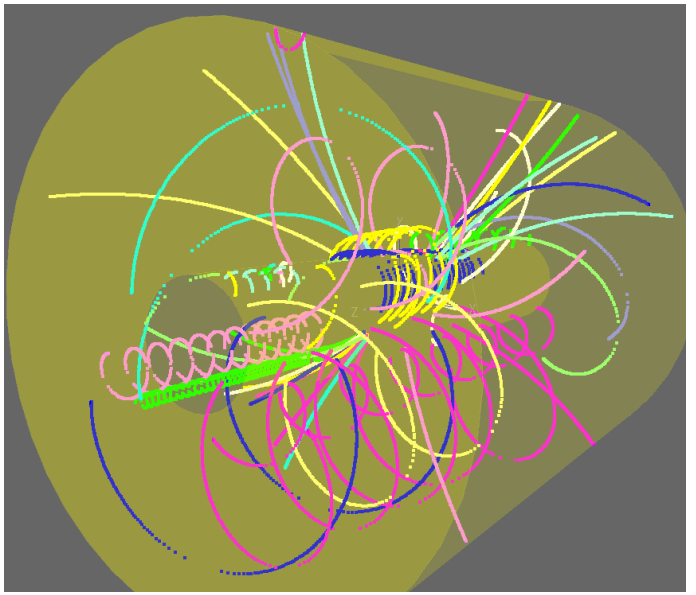
=> ILD_01_v03 should soon be free of overlaps

new C++ tracking: patrec activities

- ForwardTracking
  - new forward tracking patrecusing cellular automaton
    (R.Glattauer)



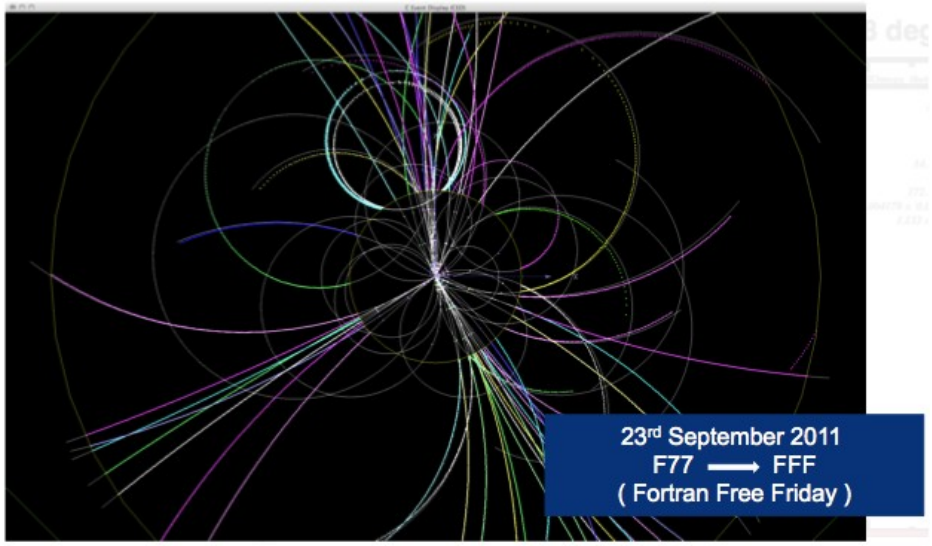
- Clupatra
  - new TPC patrec - recently:
    - fixed memory consumption
    - cleaned up code & algorithm
    - use new IMarlinTrk/MarlinKalTest



- MarlinTrkProcessors
  - rewrite of 'old' SiTracking and FullLDCTracking using MarlinTrk/MarlinKalTest

see dedicated talk on Wednesday

new Si-Tracking - full tracking



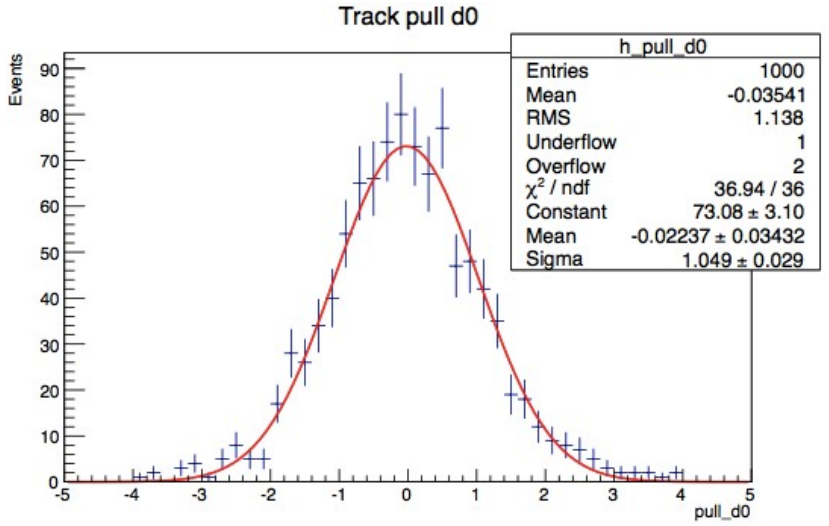
ttbar event @ 500 GeV reconstructed using Clupatra and SiliconTracking_MarlinTrk
then combined into full tracks using FullLDCTracking_MarlinTrk

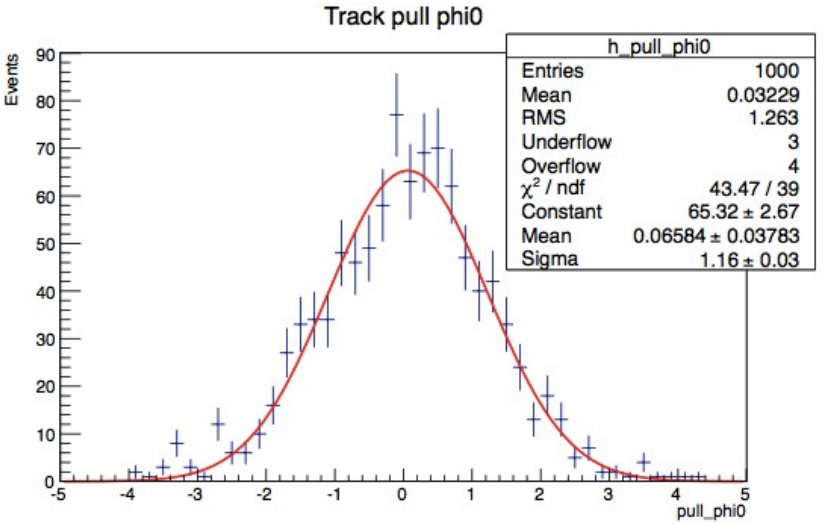
- shown in Granada @ LCWS11:
- re-write of SiliconTracking and FullLDCTracking (from LOI) using the new MarlinTrk track fit
- using 3d space points in SIT/SET and FTD (as was done in LOI) yet with planar wafers

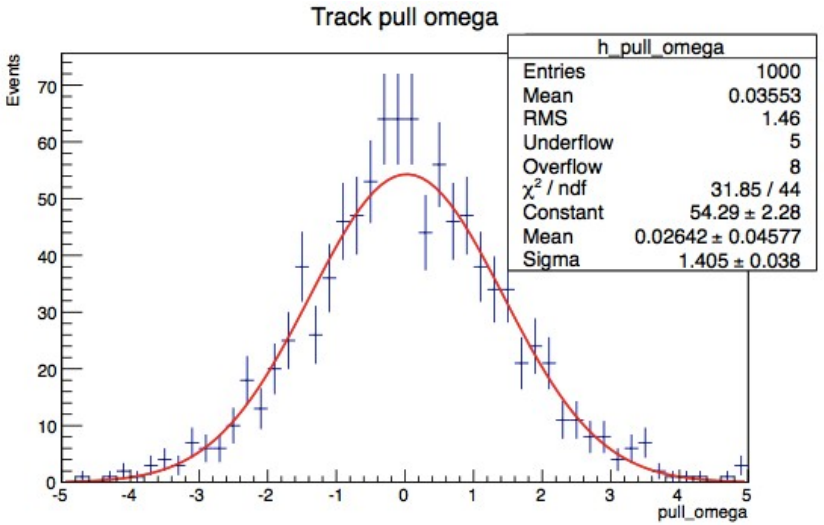
- since then:
  - write out proper 1d strip measurements for Si-Trackers
  - using the new lcio::TrackerHitPlane [x,y,z, u, v, du, dv]
  - implemented 1d fit in MarlinTrkKalTest (KalDet)
  - implemented SpacePointBuilder:
    - combine 1d TrackerHits from double stereo layer into 3d space points -> incl. ghost hits !
    - use 3d point in pat rec but proper 1d strip hit in fit

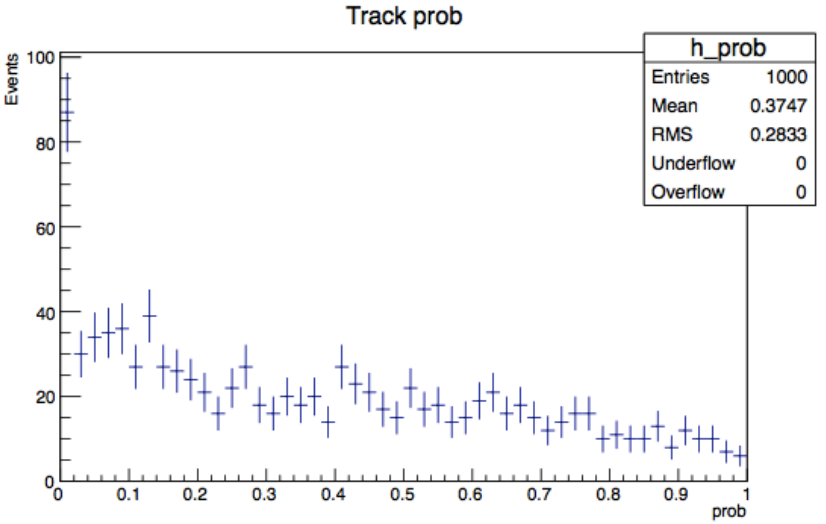
first test of new Si-Track fit

single 3 GeV muons central: VXD/SIT (no TPC)





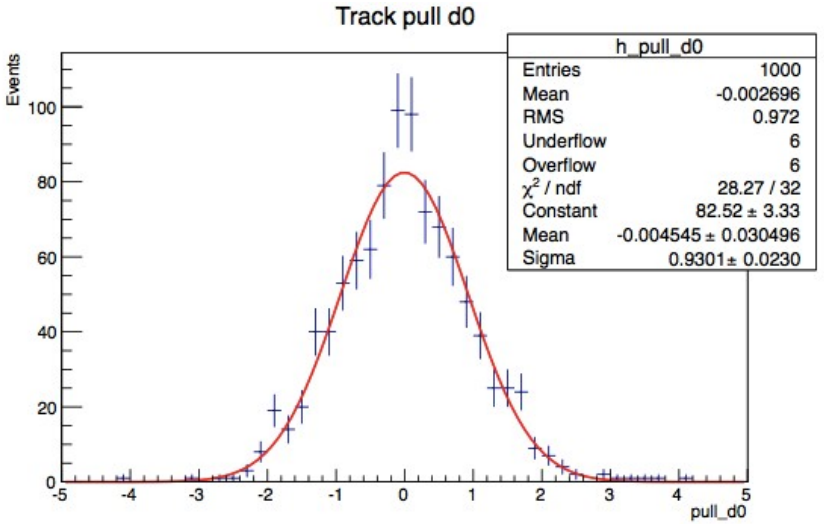


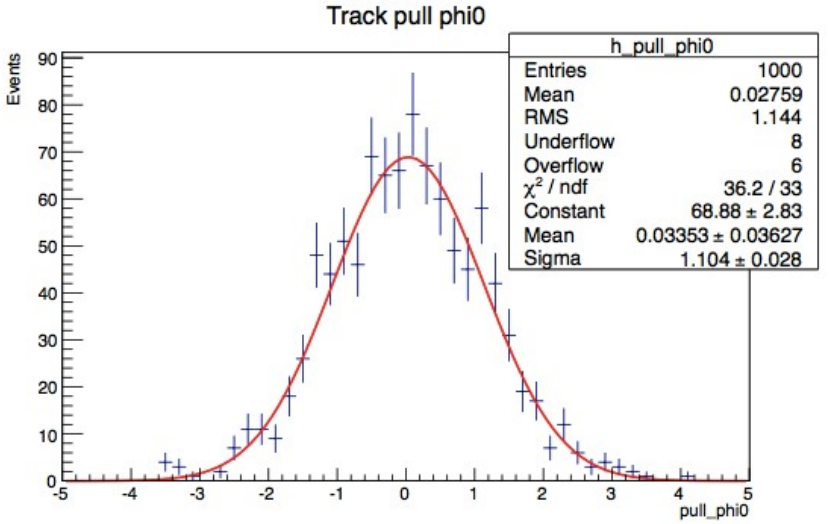


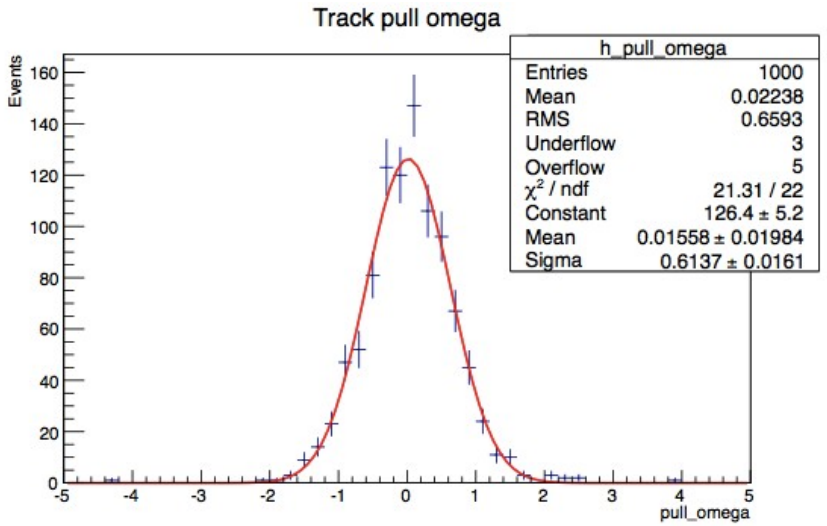
material underestimated !?

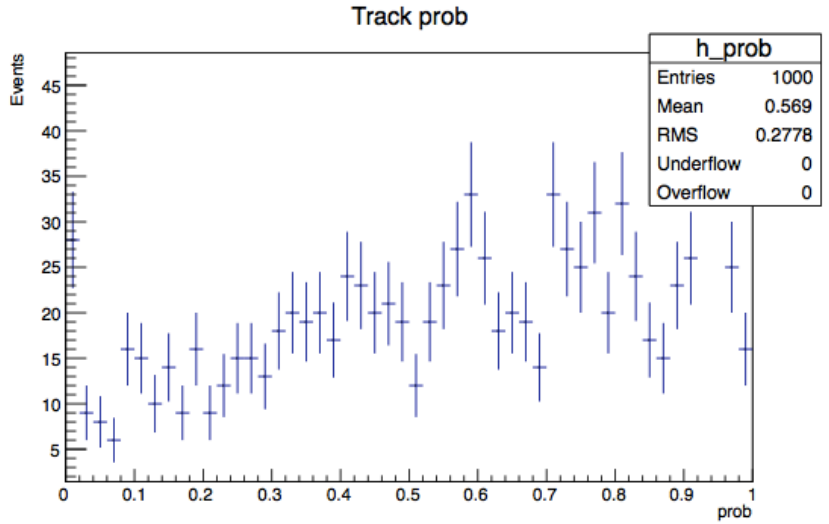
first test of new Si-Track fit

single 3 GeV muons forward: FTD (no TPC)



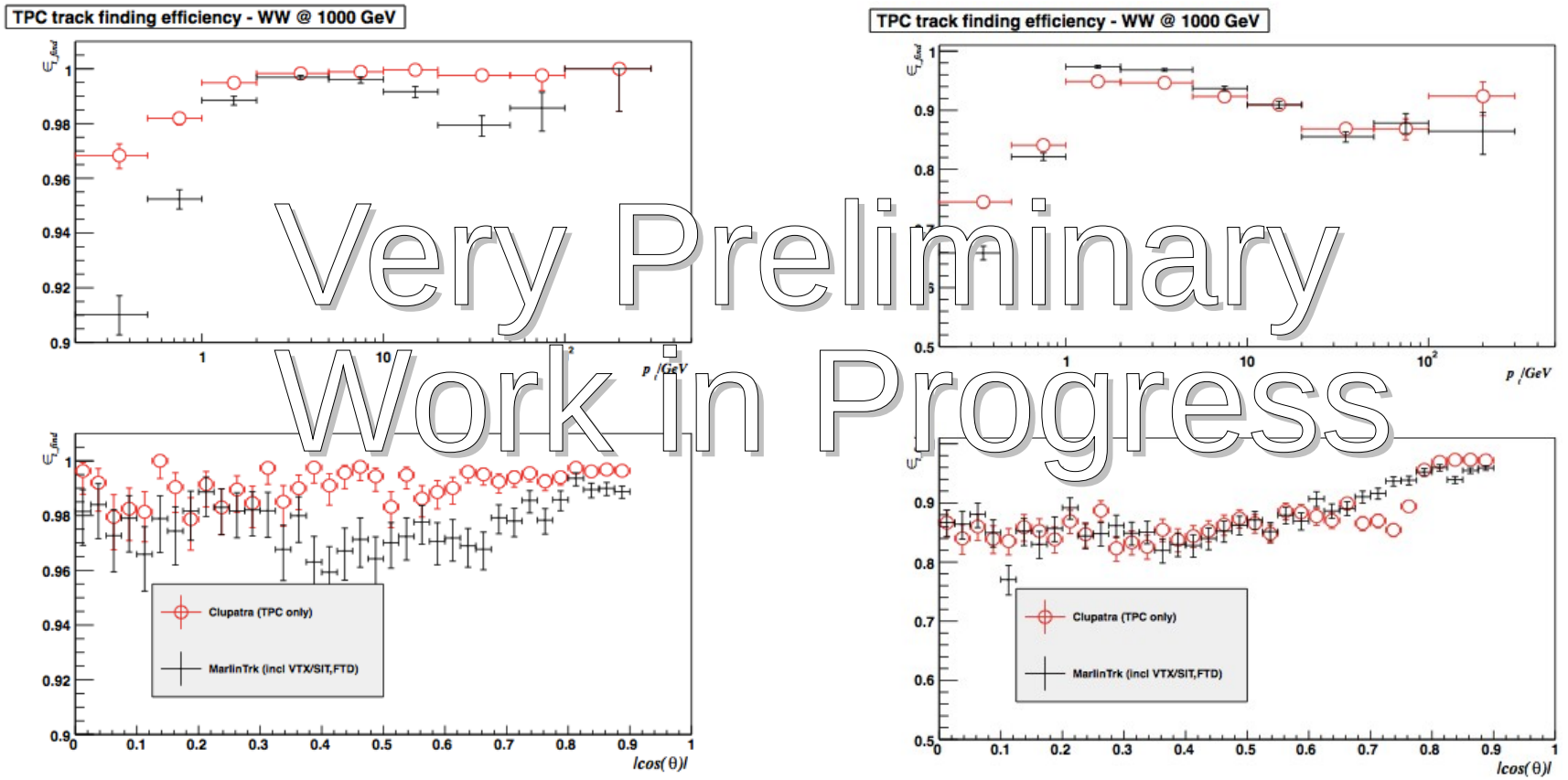






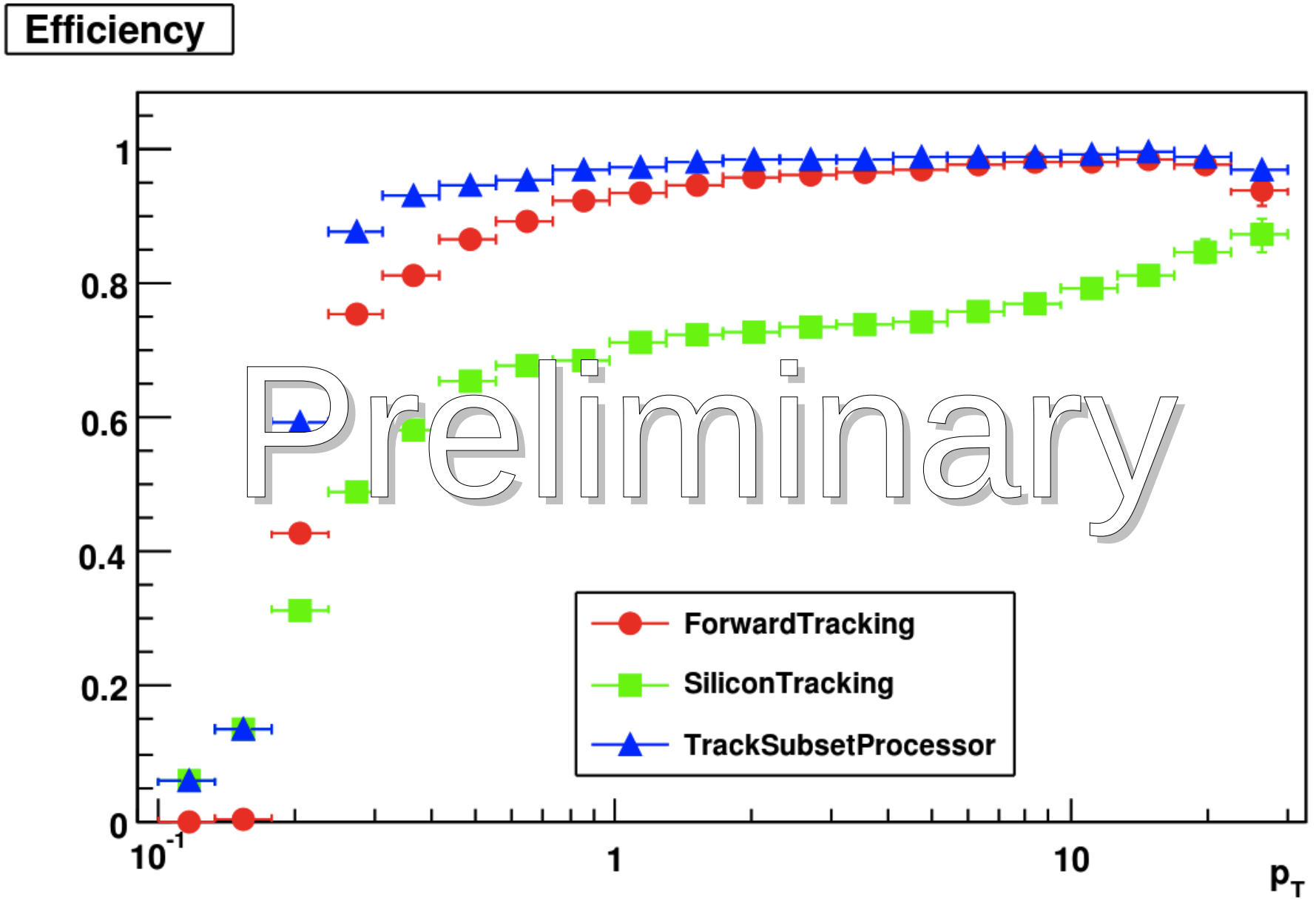
material overestimated !?

first look at efficiencies in v01-13-05



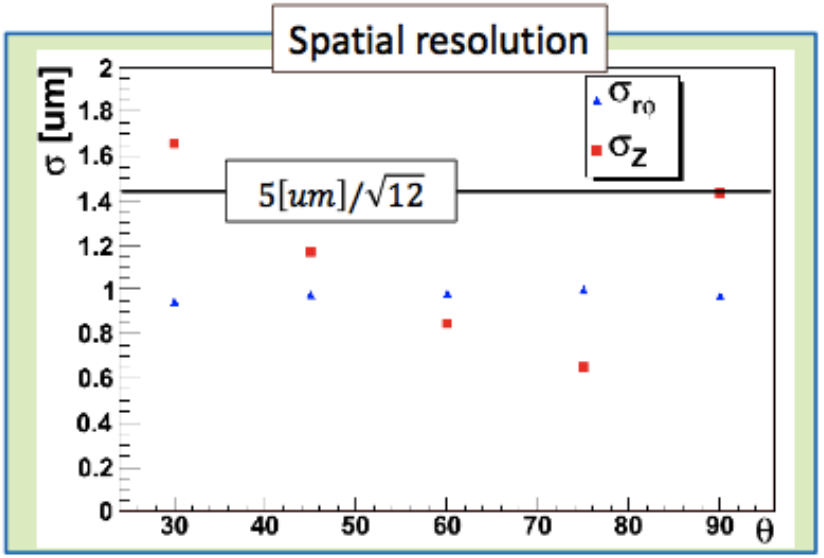
- first look at clupatra efficiencies:
  - would be acceptable (incl. 75% true hit cut - left)
  - but obvious issue w/ split tracks (right)
- first look at MarlinTrk efficiencies (incl. Clupatra):
  - work to be done - loss partially understood:
    - probability cut and poor errors...

forward tracking efficiency

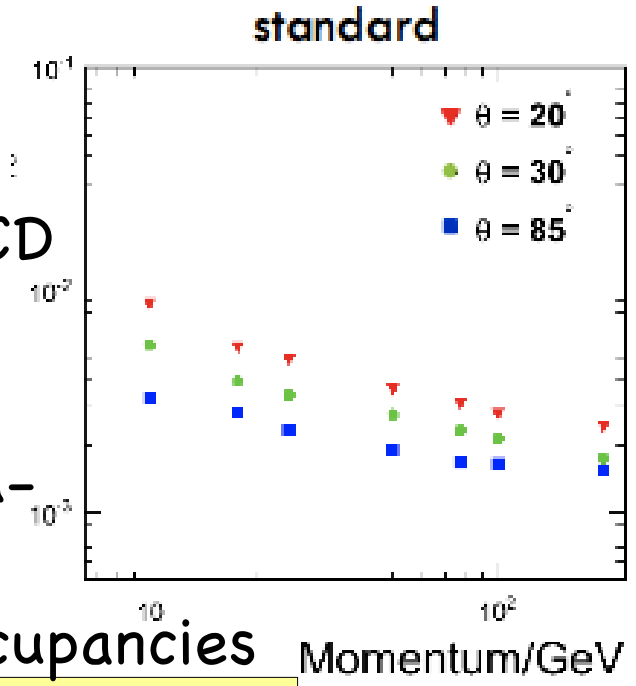


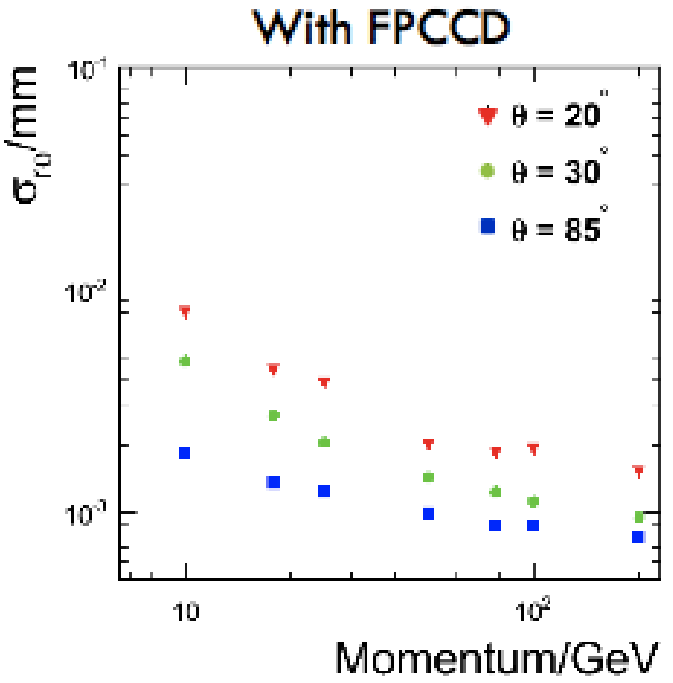
FPCCD - digitzer

D.Kamai



Layer	1TeV Without cut	1TeV With Cut	Sb2009wTF-500 w/ cut
1	20.1 %	15.5 %	3.079 %
2	10.1 %	7.79 %	1.74 %
3	0.854 %	0.674 %	0.0919 %
4	0.458 %	0.363 %	0.0731 %
5	0.145 %	0.116 %	0.017 %
6	0.116 %	0.094 %	0.015 %





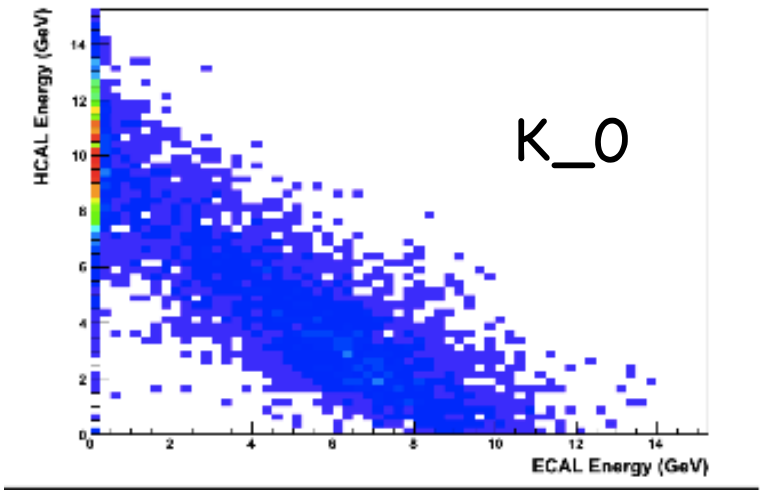
- nice progress in FPCCD digitization and reconstruction
- improved impact parameter resolution at slightly increased occupancies

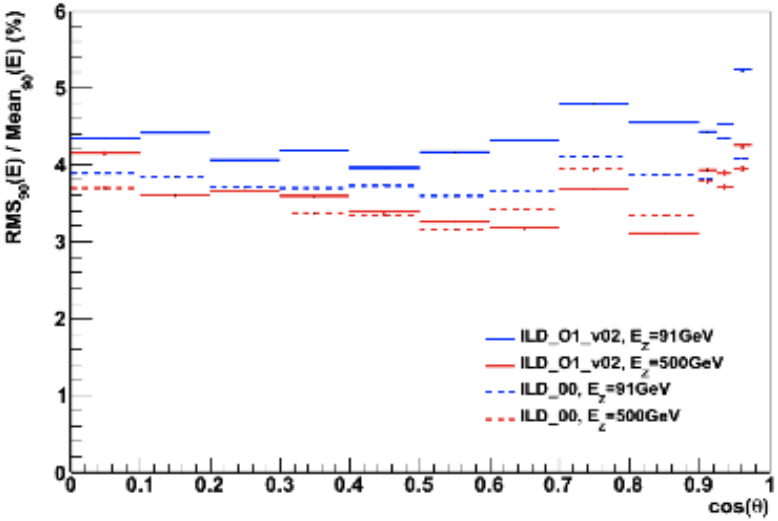
=> could be used in DBD reco !?

PandoraPFA

J.Marshall

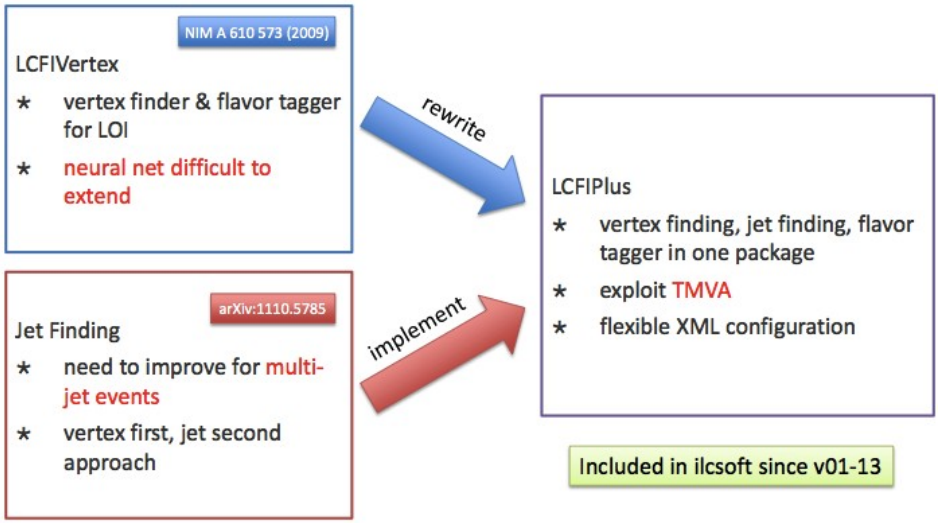
- started to adopt MarlinPandora to new ILD_O1 model
  - re-calibrated with single particles
  - use new tracking -> track state @ IP
  - …
- in v01-13-05 discrepancy seen wrt to LOI - more prominent at lower energies
  - need to study in detail
  - dis-entangle effects from calorimeters and tracking
  - e.g. using TruthTracker

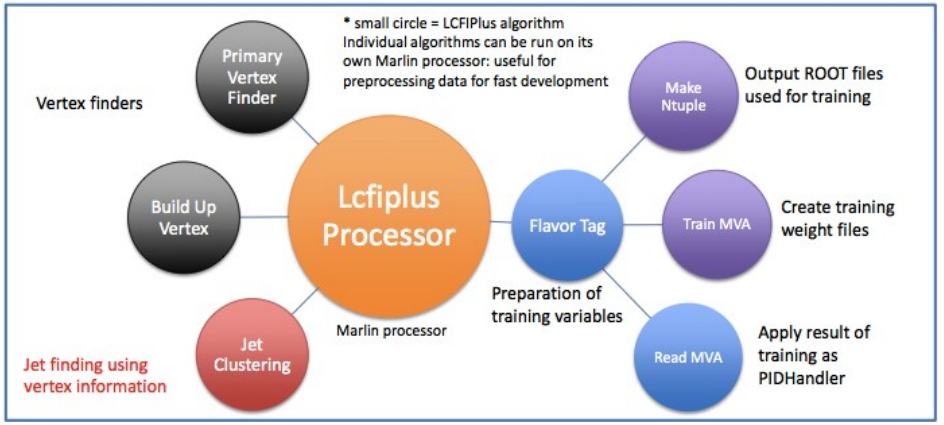




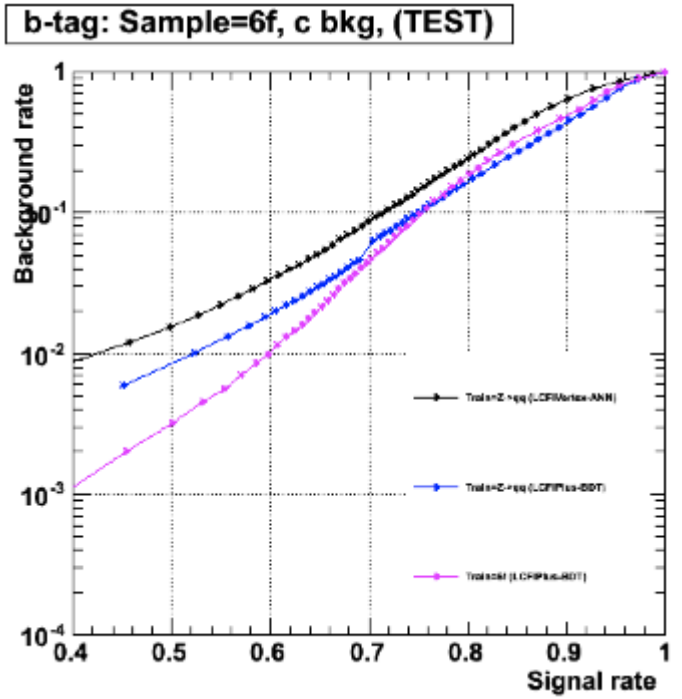
E_z (= 2 * E_j)	91GeV	500GeV
ILD_00, $RMS_{90}(E_j)/mean_{90}(E_j)$ [%]	3.69 ± 0.05	3.40 ± 0.05
ILD_O1_v02, $RMS_{90}(E_j)/mean_{90}(E_j)$ [%]	4.15 ± 0.05	3.48 ± 0.05

new LCFIPlus - flavor tag T.Suehara,T.Tanabe





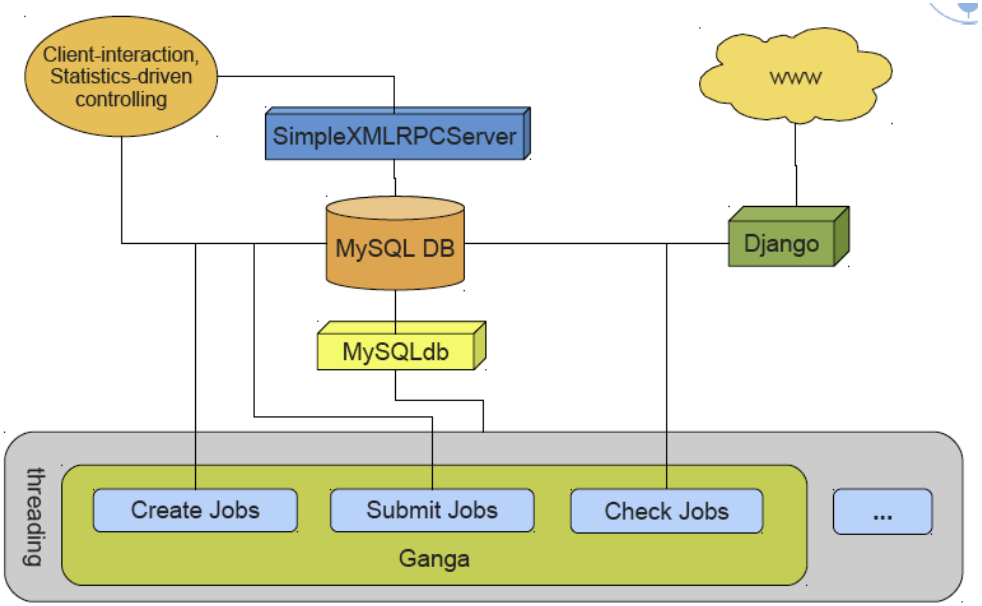
- recently added to iLCSoft
- used by ILD and SID
- added doc and config files for:
  - vertex finding (run centrally)
  - neural net training (run centrally)
  - jet finding (run by users)
  - flavor tag (run by users)
- further improvements of performance ongoing



Grid production

J.Engels

- new grid production system developed (based on experience in LOI)
- currently finalized
  - DB scheme, backup, ...
- provides web based data catalogue



- the production system is effectively ready to go
- major Grid sites (DESY, IN2P3,...) will provide resources

- strategy:
- start with simulation as soon as it is validated
- produce 50% of all requested samples then the other 50%
- finalize reconstruction in the meantime

Summary & Outlook

- very active development in iLCSoft as preparation for the ILD DBD: core software, simulation and reconstruction
- much improved realism in Mokka simulation - currently finalized and validated
- first complete version of new C++ tracking -> needs iteration and finalizing
- adaption of PFA and flavor tag currently addressed
- **we are delayed with respect to original timeline**
- **need to make considerable effort now to make up for this**
- **-> most urgent is the validation of ILD_01**
- hope to start simulation for DBD soon...