iLCSoft - Status and Plans

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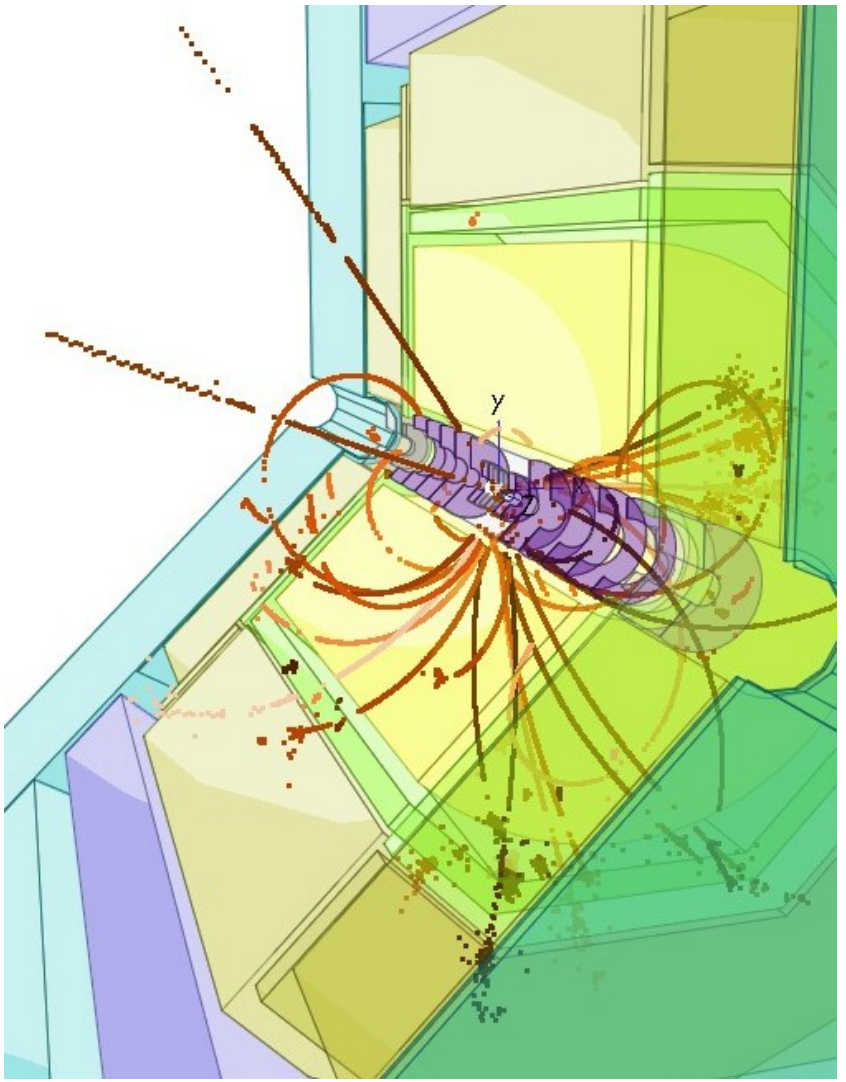
for the ILD software working group

LCWS 2012
Arlington, TX, Oct 22-26, 2012

Outline

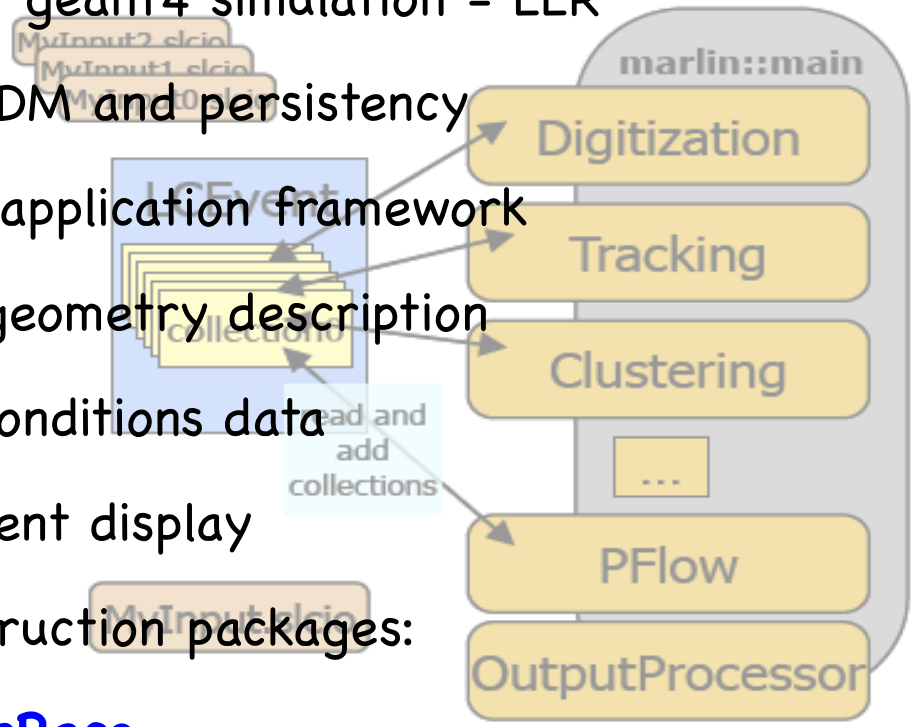
- Overview of iLCSoft
  - software packages and tools
- Developments for the DBD
  - core tools
  - simulation
  - reconstruction
- MC production for the DBD
- Future plans
- Summary & Outlook

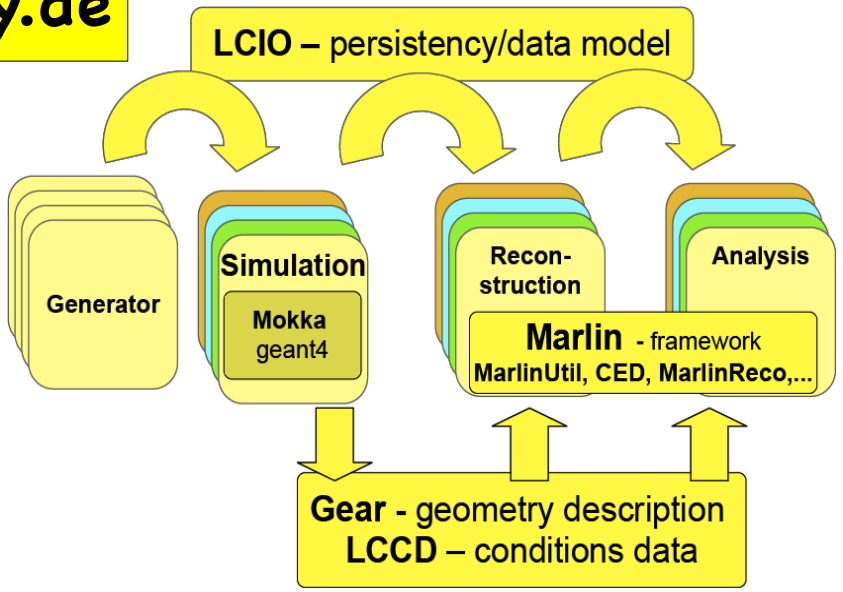


iLCSoft framework - Overview

http://ilcsoft.desy.de

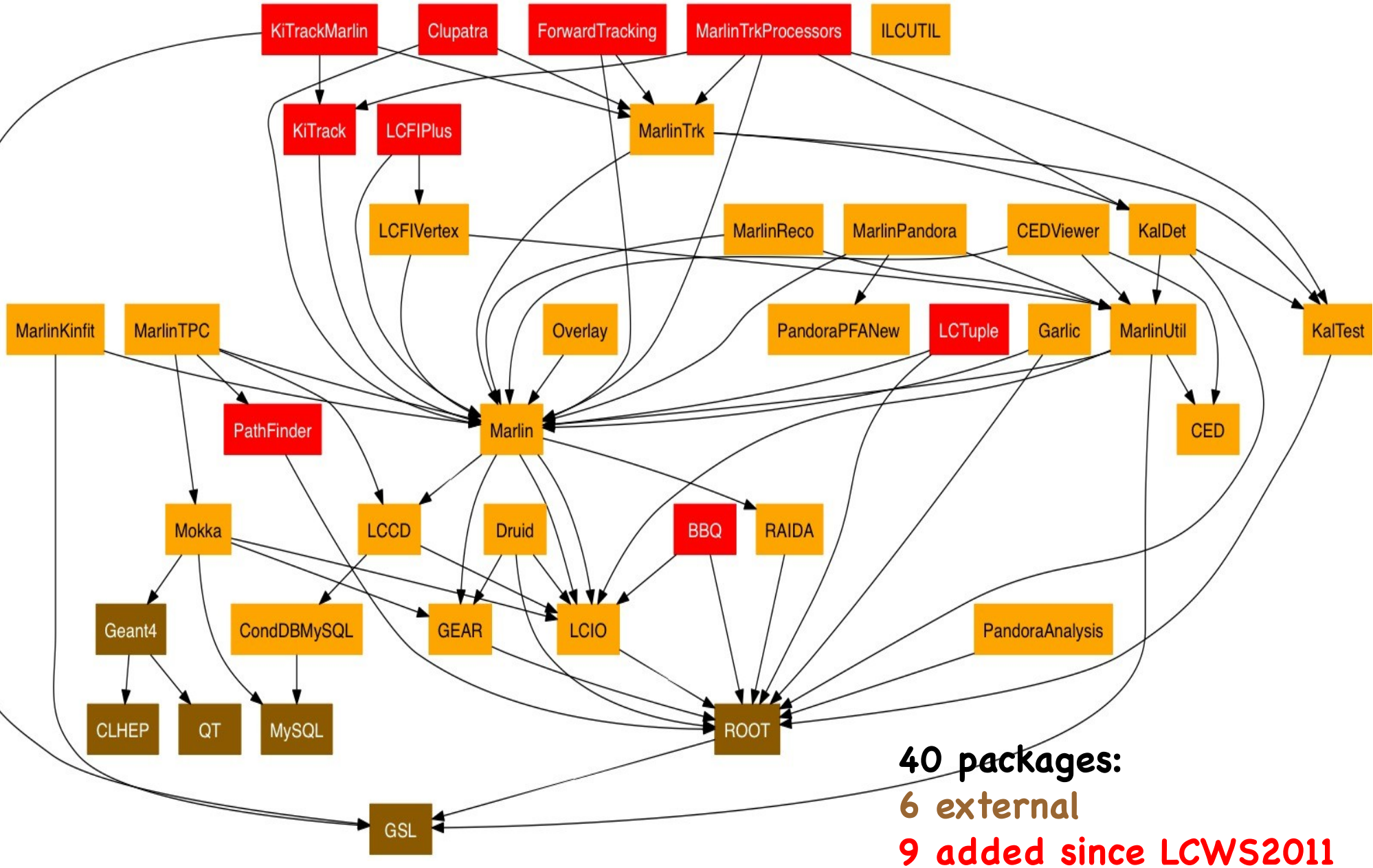
- **Mokka** geant4 simulation - LLR
- **LCIO** EDM and persistency
- **Marlin** application framework
- **GEAR** geometry description
- **LCCD** conditions data
- **CED** event display
- reconstruction packages:
  - **MarlinReco**
  - **MarlinTrk, Clupatra, ForwardTracking,...**
  - **MarlinPandoraPFA**
  - **LCFIVertex, LCFIPlus**
  - **MarlinKinFit**
- many more (see next slide)





- complete sw framework used in Monte Carlo & 'real experiments':
  - **ILD & CLIC** detector concept studies
  - **Calice, LC-TPC, EUTelescope** testbeams
- **synergies between testbeam and global detector optimization**

iLCSoft packages (release v01-16)



40 packages:

6 external

9 added since LCWS2011

afs reference installations

- provide reference installations in afs for usage from anywhere on ScientificLinux and compatible platforms:

/afs/desy.de/project/ilcsoft/sw/_OS_/v01-16

_OS_: **i386_gcc41_sl5** # i386 CPU, 32 bit, gcc4.1, SL5 and compatible
x86_64_gcc41_sl5 # i686 CPU, 64 bit, gcc4.1, SL5 and compatible

- you can directly run from these installations, .eg:

```
. /afs/desy.de/project/ilcsoft/sw/x86_64_gcc41_sl5/v01-13-05/init_ilcsoft.sh
Marlin mysteer.xml
```

- you can link your own libraries against these
- plan to have other OSs in the future (as requested !?)

- you can use ilcinstall tool for your own installation

-> https://svnsrv.desy.de/viewvc/ilctools/ilcinstall/tags/v01-16

ILD standard simulation/reconstruction

gaede — ssh — 88×55

```
##################################################
#
# HOWTO run Mokka and Marlin examples
# with standard configuration
#
# F.Gaede, DESY
#   12/2011: F.G.: updated to new ILD_01_dev model
#   01/2012: J.E.: updated to new ILD_0{1,2,3}_v01 models
##################################################

#  These little examples server as an ultra quick introduction on
#  how to run ilcsoft programs and as a mini-test after installation
#  of a new (complete) ilcsoft release.
#
#  Have a look at the scripts (mokka-wrapper.sh) and the
#  steering files (bbudsc_3evt_stdreco.xml) for more details.
#


# 1. ----  initialize the current ilcsoft release, e.g.  ------

. /afs/desy.de/project/ilcsoft/sw/x86_64_gcc41_sl5/v01-13-05/init_ilcsoft.sh

#-- this sets:
#   MARLIN_DLL=libMarlinReco.so:libPandoraAnalysis.so:libMarlinPandora.so:libLCFIVertex.
so:libCEDViewer.so:libEutelescope.so:libMarlinTPC.so:libOverlay.so
#-- so these packages need to be present in the release for the standard examples

# 2. ---- run a Mokka example  ------
 a)

  export PATH=$PWD/../../MokkaDBConfig/scripts:$PATH
  export MOKKA_DUMP_FILE=$PWD/../../MokkaDBConfig/mokka-dbdump.sql.tgz
  mokka-wrapper.sh -M ILD_01_v02 bbudsc_3evt.steer

# b)
#  the above starts a MySQL server and populates it with a dump of the Mokka central DB
#  you can also run Mokka directly (using the central DB):

  Mokka -M ILD_01_v02 bbudsc_3evt.steer

# c)
#  to make sure that the extra partice tables (for SUSY etc) is loaded:

  Mokka -M ILD_01_v02 -e ../../MokkaDBConfig/particle.tbl bbudsc_3evt.steer
  # OR:
  mokka-wrapper.sh -M ILD_01_v02 -e ../../MokkaDBConfig/particle.tbl bbudsc_3evt.steer


#--   this creates the file:    bbudsc_3evt.slcio

#- example: examine the collections in the file:

  anajob bbudsc_3evt.slcio
                                                                1,1           Top
```

gaede — ssh — 88×38

```
# 3. ----  reconstruct these events:  ------

  Marlin bbudsc_3evt_stdreco.xml

#-- creates:   bbudsc_3evt_REC.slcio
#   and        bbudsc_3evt_DST.slcio

#- example: dump the details of the 2nd event in the DST file:

   dumpevent bbudsc_3evt_DST.slcio 2 | less


# 4. ---- view the result in the event display

# a)

#--- start the event display (server) first:

   glced &


#--- view rec or DST events:

   Marlin bbudsc_3evt_viewer.xml

   Marlin bbudsc_3evt_viewerDST.xml


# b)  (new in v01-10)

# or start both, glced and Marlin in one go:

 ced2go   -d GearOutput.xml  bbudsc_3evt_REC.slcio

                                                          93,0-1        98%
```

- StandardConfig/current sub package with current steering files for ILD
- defines **canonical ILD simulation and reconstruction**
- **README is "shortest introduction to running iLCSoft for ILD"**

Activities in iLCSoft framework

- the timeline for iLCSoft developments since LOI was driven by the requirements for the ILD-DBD *
- main activities:

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 ...	

- **improve/adapt core tools**
  - LCIOv2, GEAR, CED,...
- **improve realism of the simulation**
  - include gaps, imperfection and services
- **complete re-write of tracking code**
- improvements and re-write of reconstruction algorithms **PandoraPFA** and **LCFIVertex/LCFIPlus**
- develop and use **GridProductionSystem**

* original schedule delayed by ~2 months

LCIO v2

- LCIO v2 - improved backward compatible LCIO
- main new features:
  - **direct access to events**
  - **simplified use of LCIO with ROOT**
  - **improved the event data model**
- due to lack of man power needed to de-scope from original plans - postponed:
  - splitting events over files
  - partial reading of events
- v02-00 was released Sep 2011

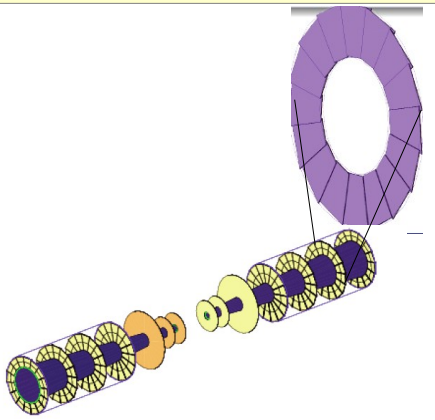
  current: v02-03-01

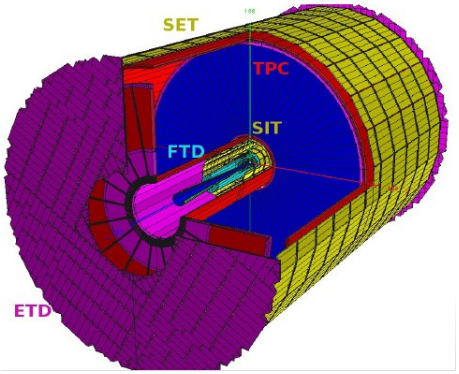
- EDM - API extensions
  - SimCalorimeterHit::getStepPosition(i)
  - LCReader::getNumberOfEvents()
  - Cluster::getEnergyError()
  - float[3] MCParticle::getSpin()
  - int[2] MCParticle::getColorFlow()
  - int (Sim)TrackerHit::getCellID0()
  - int (Sim)TrackerHit::getCellID1()

- extended Track class:
  - store multiple track-states:
  - AtIP, AtFirstHit, AtLastHit, AtCalo
- new TrackerHits for 1D/2D:
  - TrackerHitPlane
  - TrackerHitZCylinder

improved ILD simulation in Mokka

- increased level of detail and realism (incl. services):
- rewrite of Si-Tracking drivers SIT, SET, FTD:
  - moved from simplified cylinders to planar wafers and petals on (space frame) support
  - introduced gaps between sensors and cables
  - create 1D strip hits (digitization)
- made existing drivers more realistic:
  - TPC, AHCal, Ecal, FCal,...
- new drivers for technology options:
  - SDHCal, SciEcal
- added overall services and cables



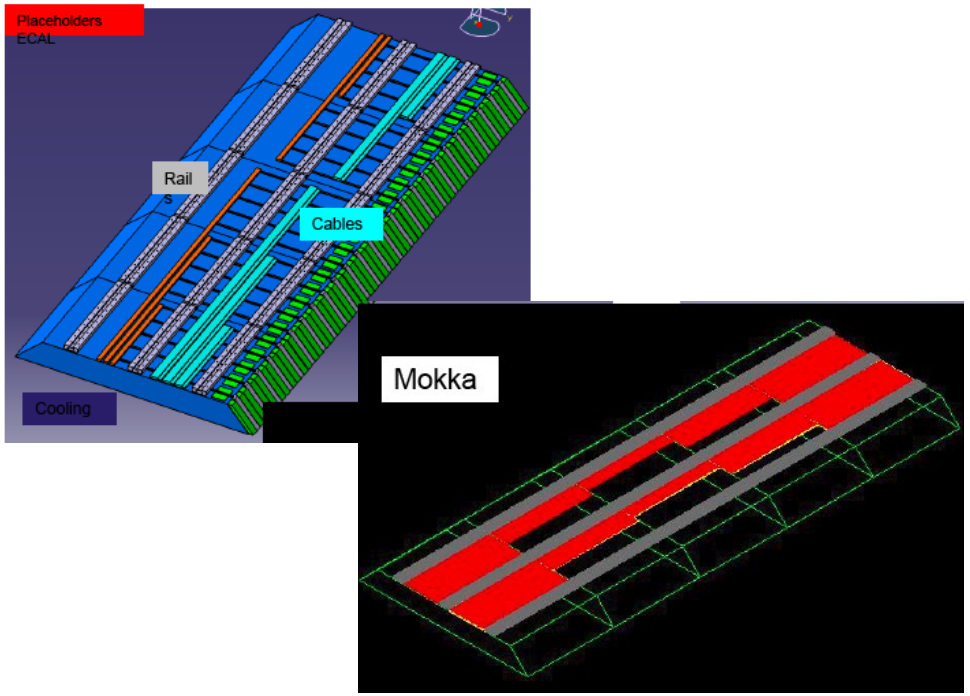


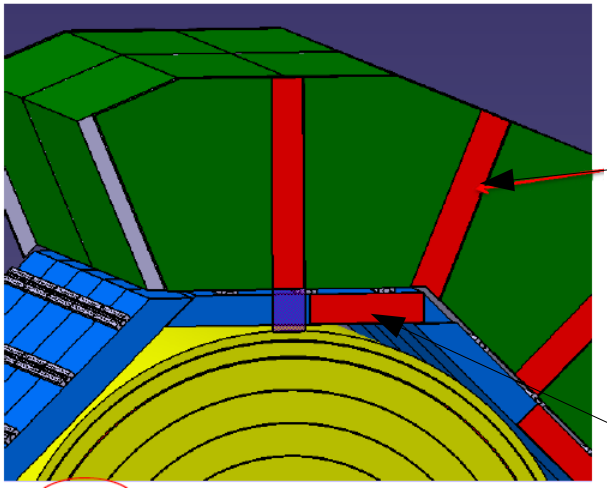
models for DBD:

ILD_O1_v05 "ILD simulation Model for DBD using **AHCal**"
ILD_O2_v05 "ILD simulation Model for DBD using **SDHCal**"
ILD_O3_v05 "ILD simulation Model for DBD using **SciW Ecal** and **AHCal**"

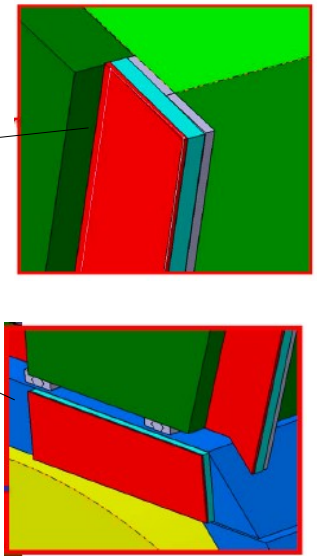
increased realism in ILD_OX models

- added cabling and services for TPC, ECal & Hcal
- including inner detector services as defined by R&D groups



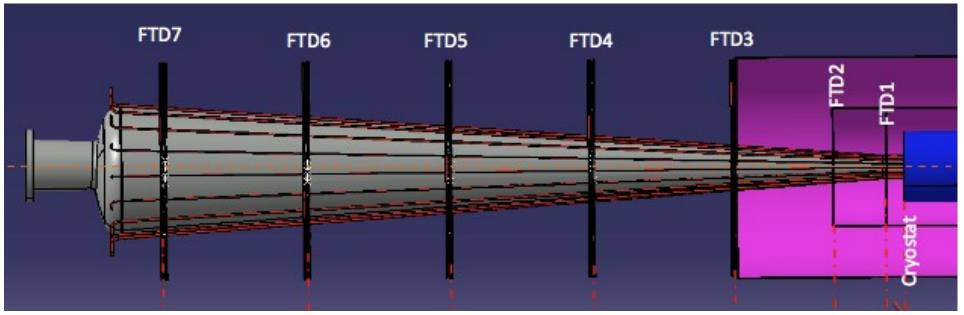


cooling pipes



electronics

considerable increase of the realism of the ILD detector simulation since LOI !

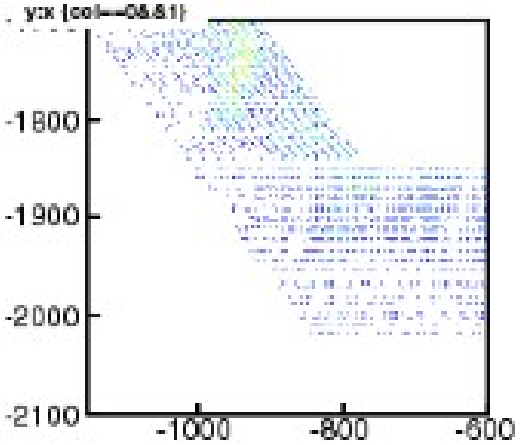


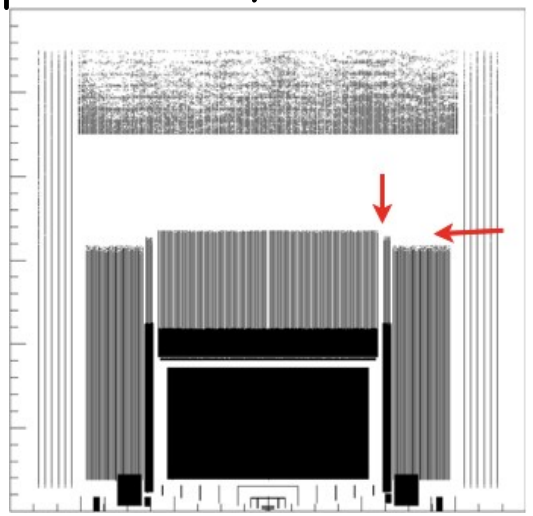
power supply cables

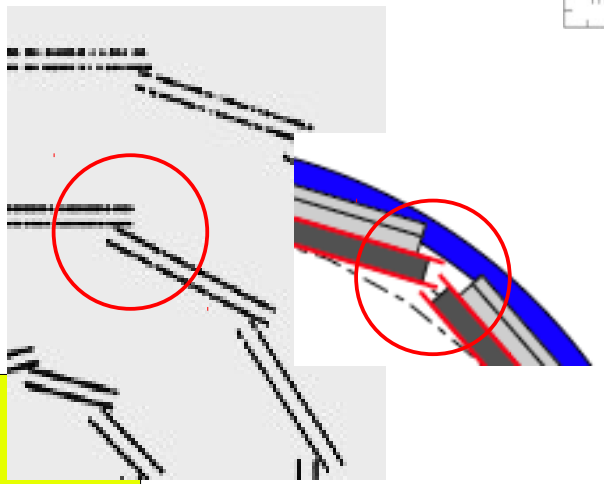
validation of Mokka ILD model(s)

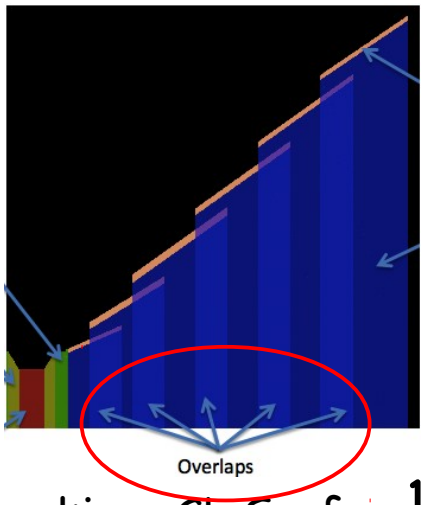
- **ILD simulation models validated by R&D groups**
  - checking: overlaps, consistency w/ engineering model, hit production,..

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





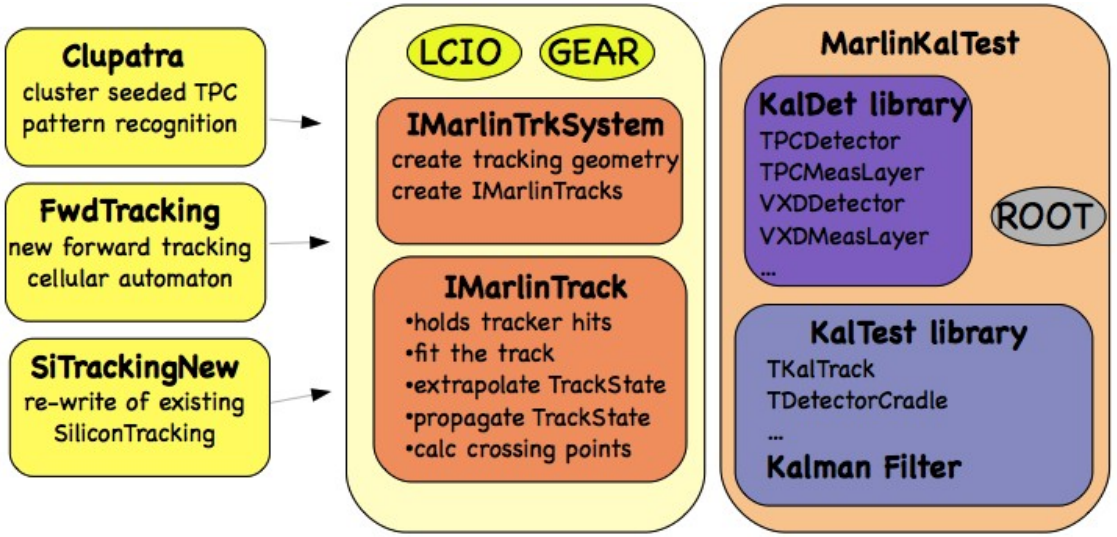




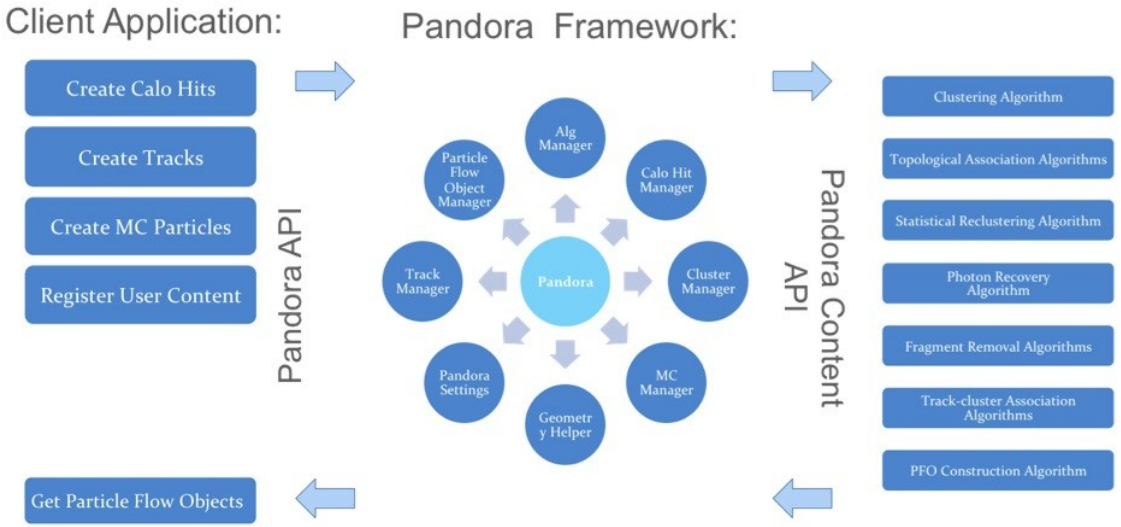
validation process ensured that the simulation models are in synch with the engineering models !

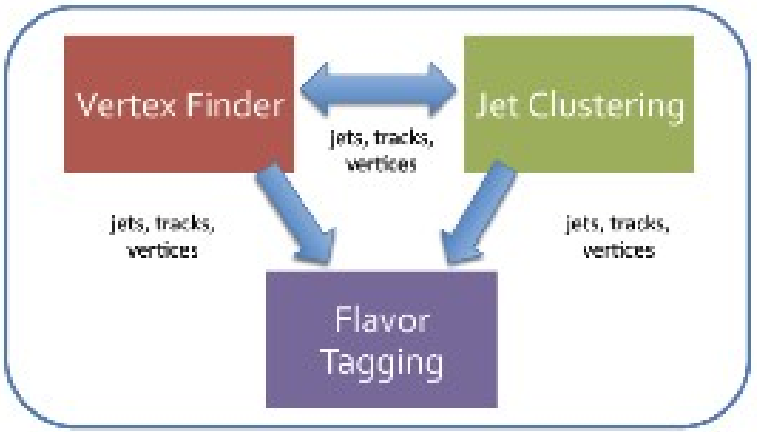
overall overlap checking: Ch.Grefe

improvements of (ILD) reconstruction



- complete new C++ tracking **MarlinTrk** (and friends)
- re-write/re-design of PFA: **PandoraPFANew**
- improvement and extension of LCFIVertex:
  - **LCFIPlus**

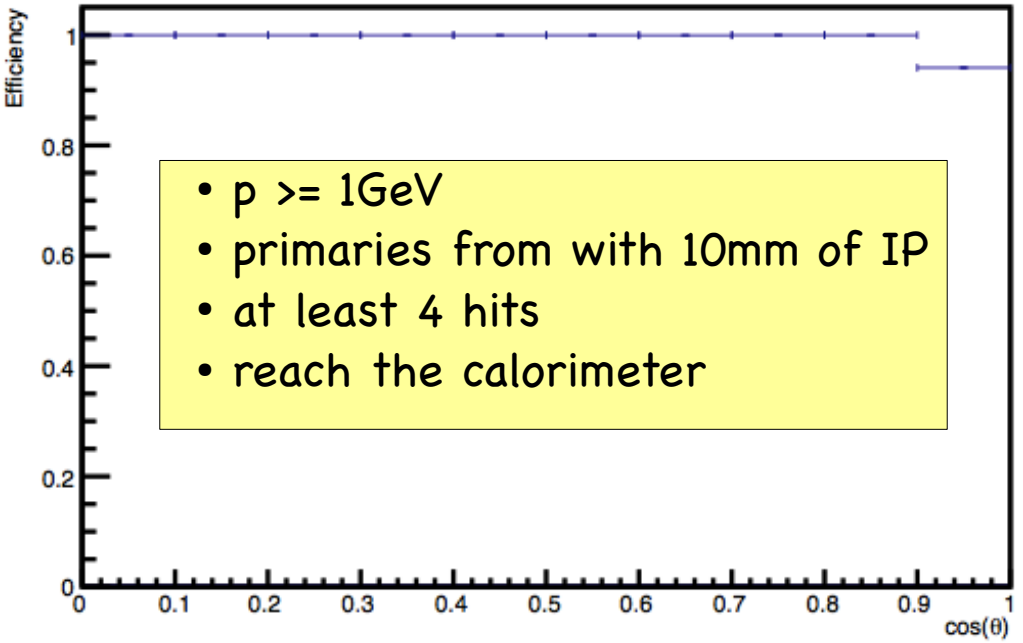




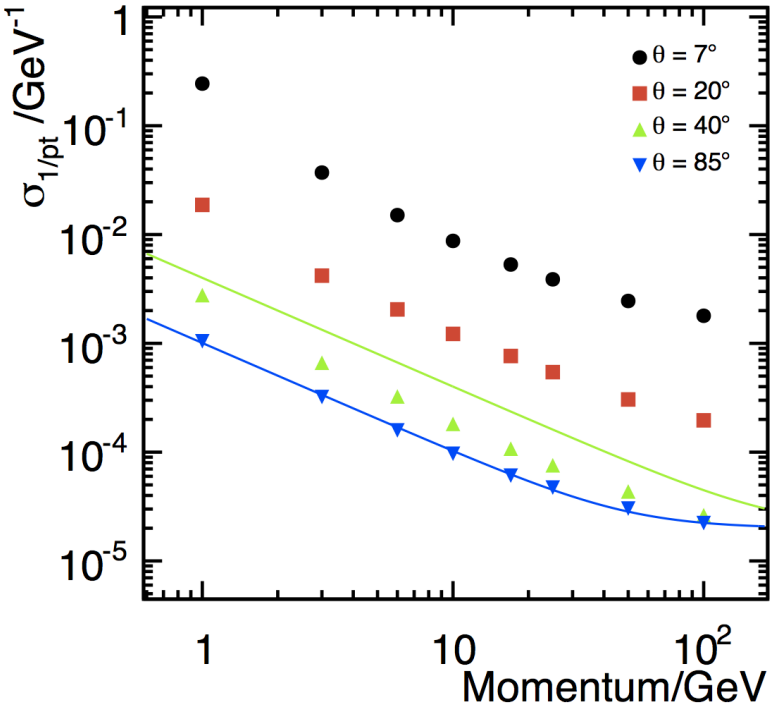
=> see dedicated talks in Thursday

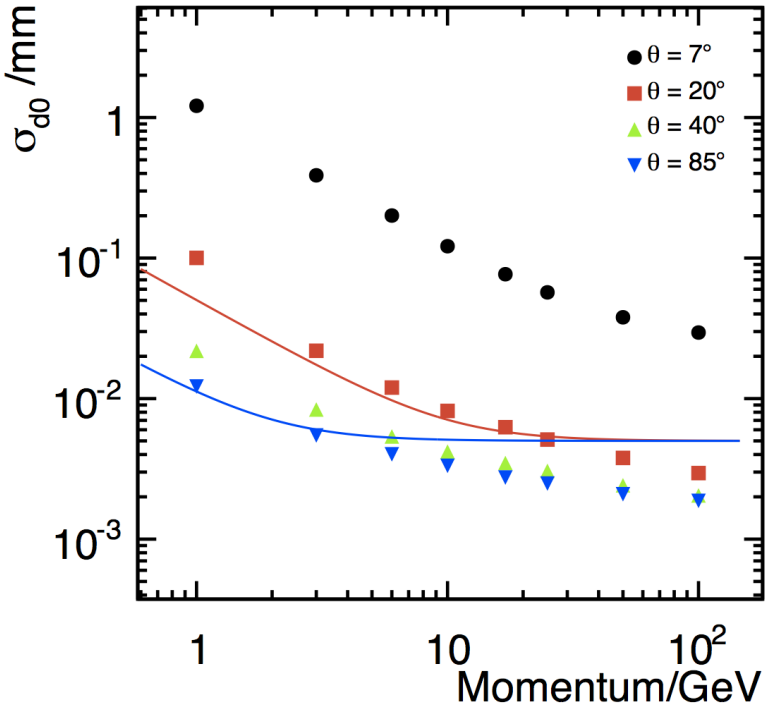
Performance of new ILD tracking

right:
tracking efficiency for prompt particles as function of
| cos(theta) |



below:
sig(1/pt) and sig(rPhi) as function
•of p - single muons
-> achieve asymptotic value
• delta(1/pt) = 2x10-5 GeV-1

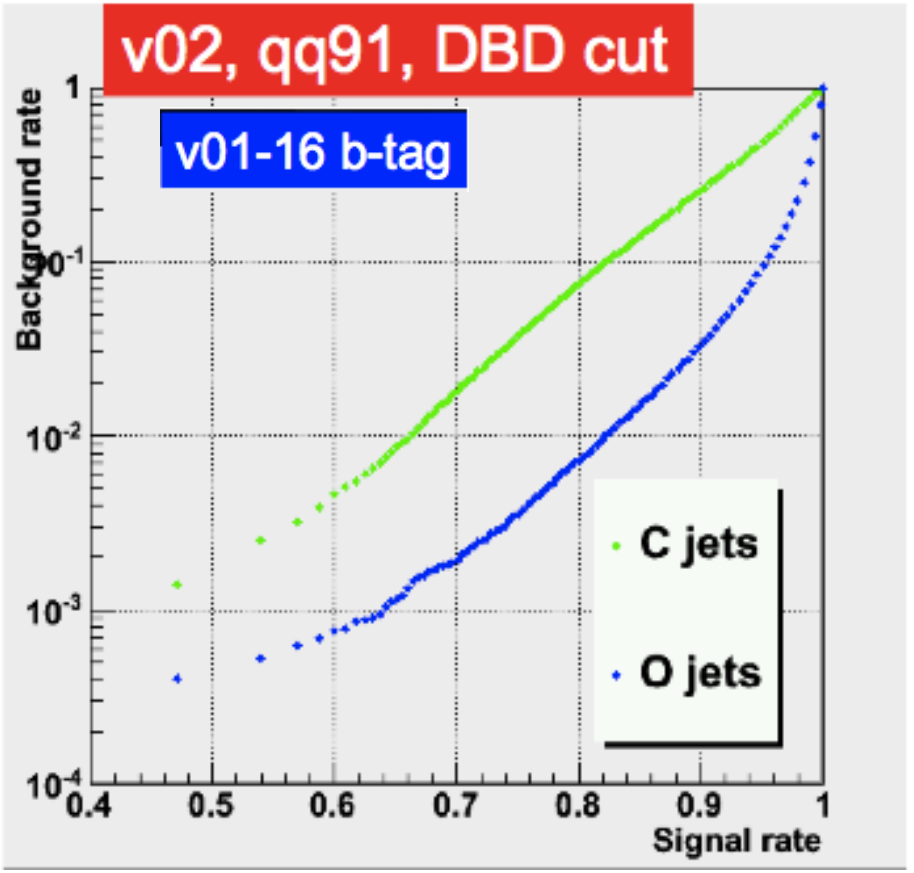




PFA and flavor tag performance

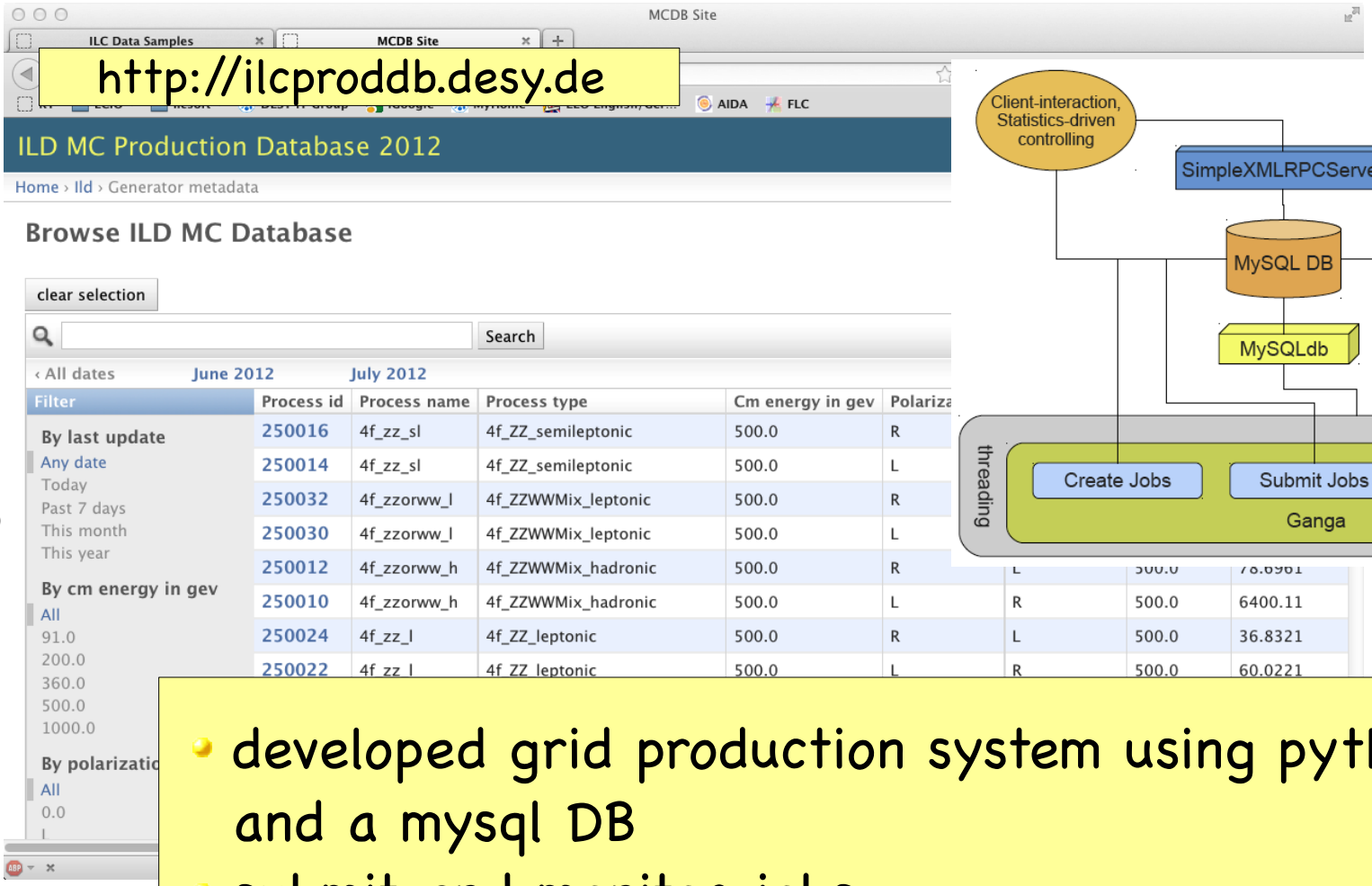
91 GeV	rms90	dE/E [%]*
ILD_00 [LOI]	2.40	3.71+-.05
v01-16	2.32	**3.65+-.05**
500 GeV		
ILD_00 [LOI]	11.10	3.17+-.05
v01-16	10.76	**3.01+-.04**

*dE/E=rms90*sqrt(2)/<E>
cos|th_t|<0.7



- tracks from new tracking with **much increased realism** are used in new PFA and flavor tag
- **same performance (or slightly better) as in LOI reached !**

Grid production system



- developed grid production system using python scripts and a mysql DB
- submit and monitor jobs
- DB serves as data catalog
- web interface allows users to browse and query the catalog

Status of DBD production

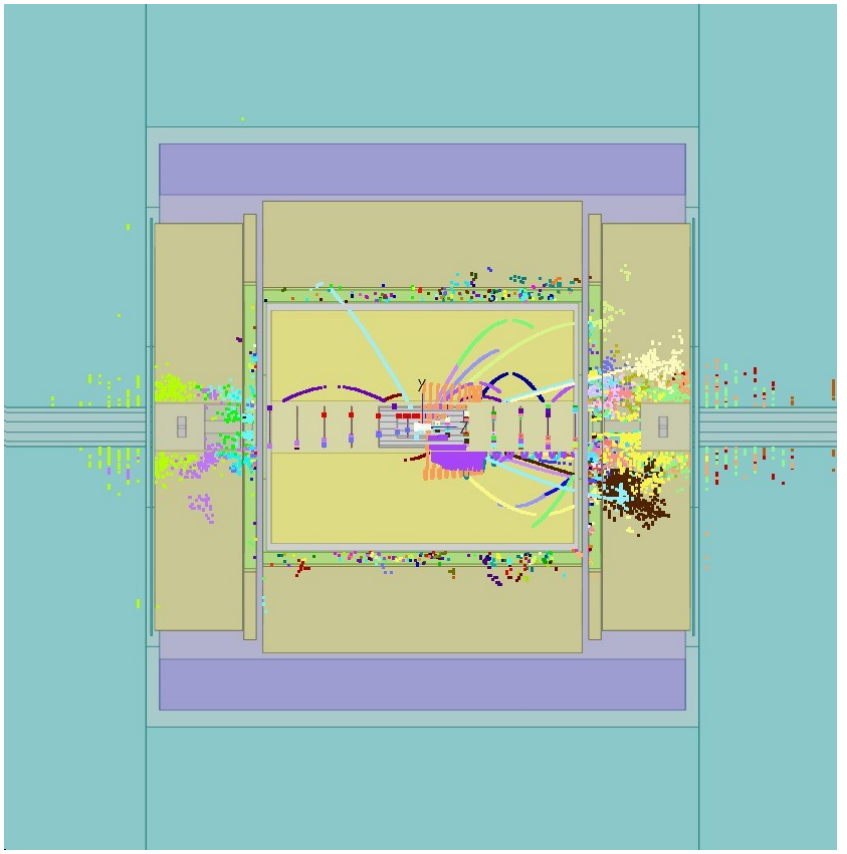
http://ilcsoft.desy.de/dbd/status/REC_ILD_o1_v05.html

- simulated and fully reconstructed

  10M events w/ ILD_O1_v05
- in 50k simulation and 10k reconstruction jobs

- some benchmarks:
  - sim: 5-9 min / event
  - rec: 30-60 sec / event * (w/o background)
  - rec: 45-210 sec / event * (w/ background)

- requested DBD benchmark samples and SM background mostly done >95%



- overlayed 4.1 evt/BX of aa_lowpt bg @ 1TeV
- ~60 GeV per event
- using new LCIO random access to overlay random events from random file

LC-Software beyond the DBD

- broad agreement that the only way forward is to move to common software tools
- process already started after the LOI with Software Common Task Group
- common tools - used by CLIC, ILD and SID:
  - LCIO - common EDM provides base for common tools
  - geant4 (diff. applications)
  - PandoraPFA (diff. applications)
  - LCFIVertex/LCFIPlus (both in Marlin)
  - Root (to various extends)
- in February we had a Linear Collider Software Meeting at CERN with software experts from all groups
- main goal: get agreement on how to start the process after the DBD

Closeout of LC-SW Meeting

Tracking

- general consensus to work towards a common track reconstruction package in C++
- in context of AIDA WP2
- implementation of FTF and TRF like algorithms for Si-Tracking

Frank Gaede, LC Software Meeting, Feb 8, 2012

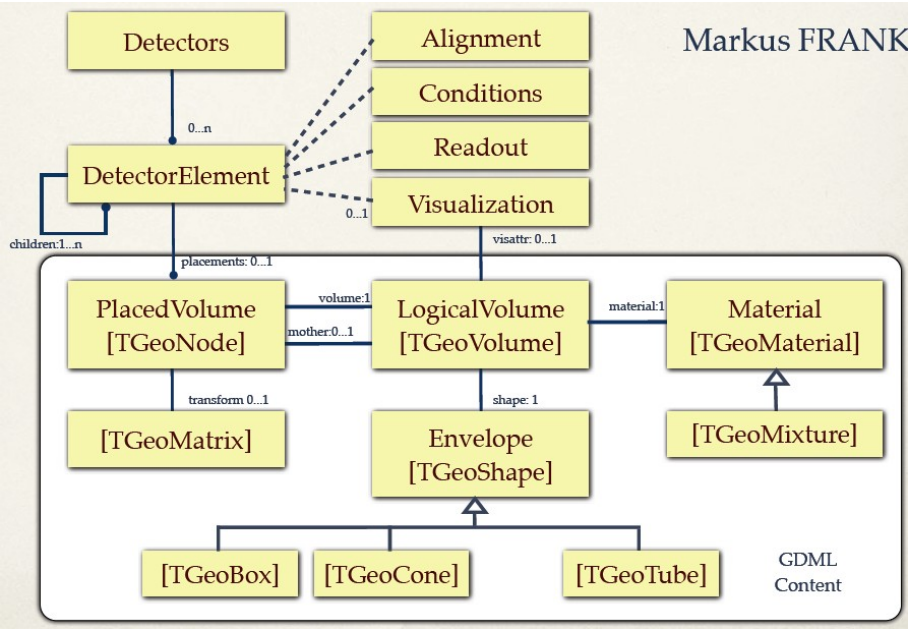
- little activity since then as manpower absorbed in DBD preparation
- should pick up now that software work for the DBD is mostly done

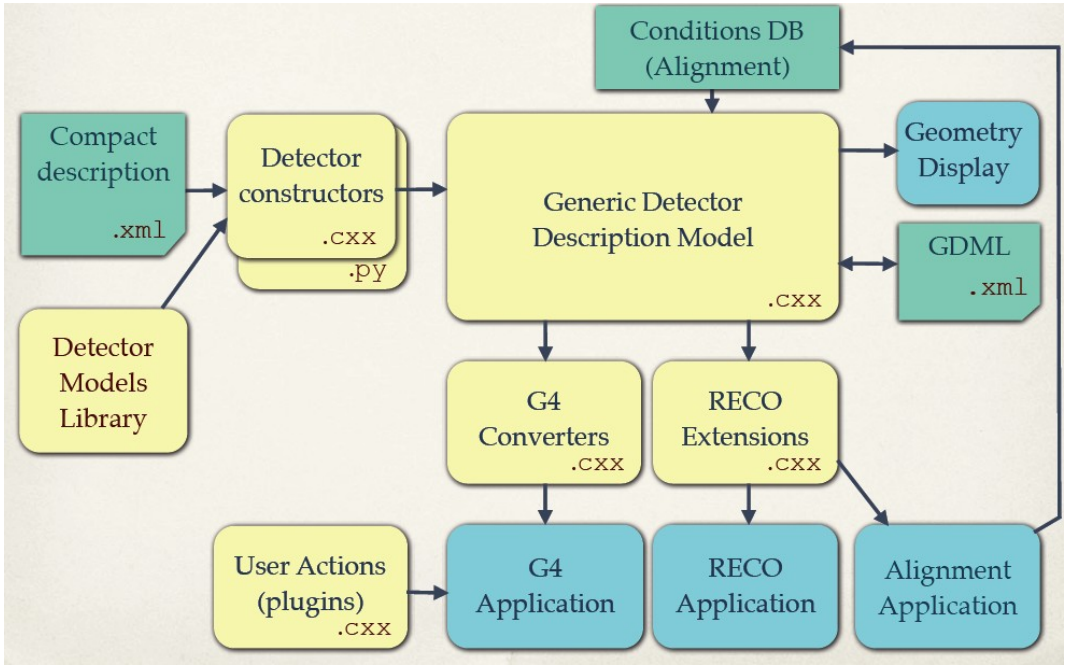
common simulation

- general consensus to work towards a common simulation application
  - build on the ongoing work for detector description and geometry (AIDA WP2)
- setup a working group to work towards that goal
- should start quite soon
  - this summer when DBD software work reduces
- define a geometry API for reconstruction, e.g. Gear

Detector Geometry - DD4Hep

- Tool developed by CERN SFT
  - M.Frank, P.Mato, A.Munnich
- developed in AIDA-WP2
- design finalized - based on C++ plugins (python scripts) and TGeo implementation





- two day meeting at DESY last week
- tool now in a shape where first prototypes with ILD like detectors can be implemented
- goal: to use DD4Hep for (new) LC-Simulation

Parallelization of LC-Software

- LC software community has not yet started to seriously look into parallelization
- LHC and other HEP groups have started, e.g.:
  - Forum on Concurrent Programming Models and Frameworks

    trying to make existing frameworks multithreaded
- could join and start with making multithreaded versions of LCIO and Marlin (Pandora, org.lcsim,...)
  - -> probably not enough to stop at the module/processor level as some few reconstruction tasks (Tracking/PFA/Vertexing) are dominating CPU usage
  - also look into parallelizing some of these algorithms, e.g. Clupatra
- interested to see what other peoples ideas are !

Summary & Outlook

- development activities in iLCSoft framework in the last 2-3 years where driven by preparation for the ILD DBD
  - improve/adapted the core tools
  - mad the simulation much more realistic
  - new development, major improvements and/or re-structuring of all reconstruction algorithms
  - development of a Grid production system
- reached performance which is compatible with that of LOI

Outlook

- we have a window of opportunity now to continue the process of moving to more common software tools
  - need to understand what the manpower situation will permit
- should start thinking about next LC-SW-Meeting now