ILD software status
preparations for the LOI

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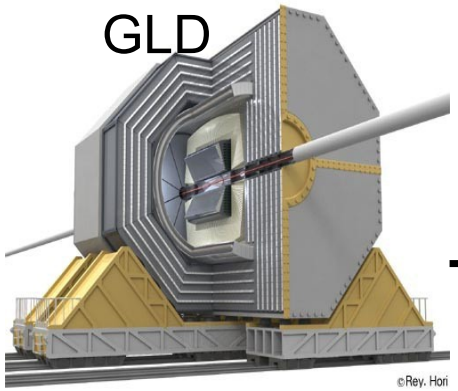
DESY
LCWS 2008, Chicago
November 15-20, 2008

Outline

- Introduction
- LDC & GLD-frameworks
- joined ILD sw framework
- reconstruction tools
  - LDCTracking
  - PandoraPFA
  - LCFIVertex
- Monte Carlo production
  & grid tools
- Summary



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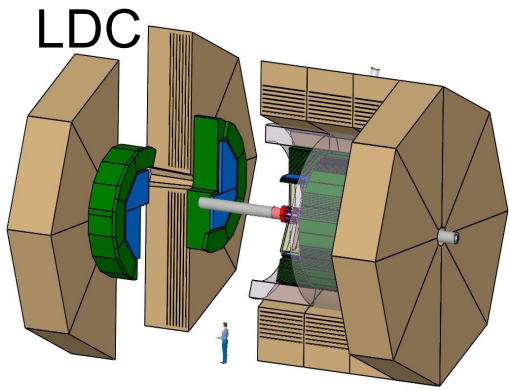

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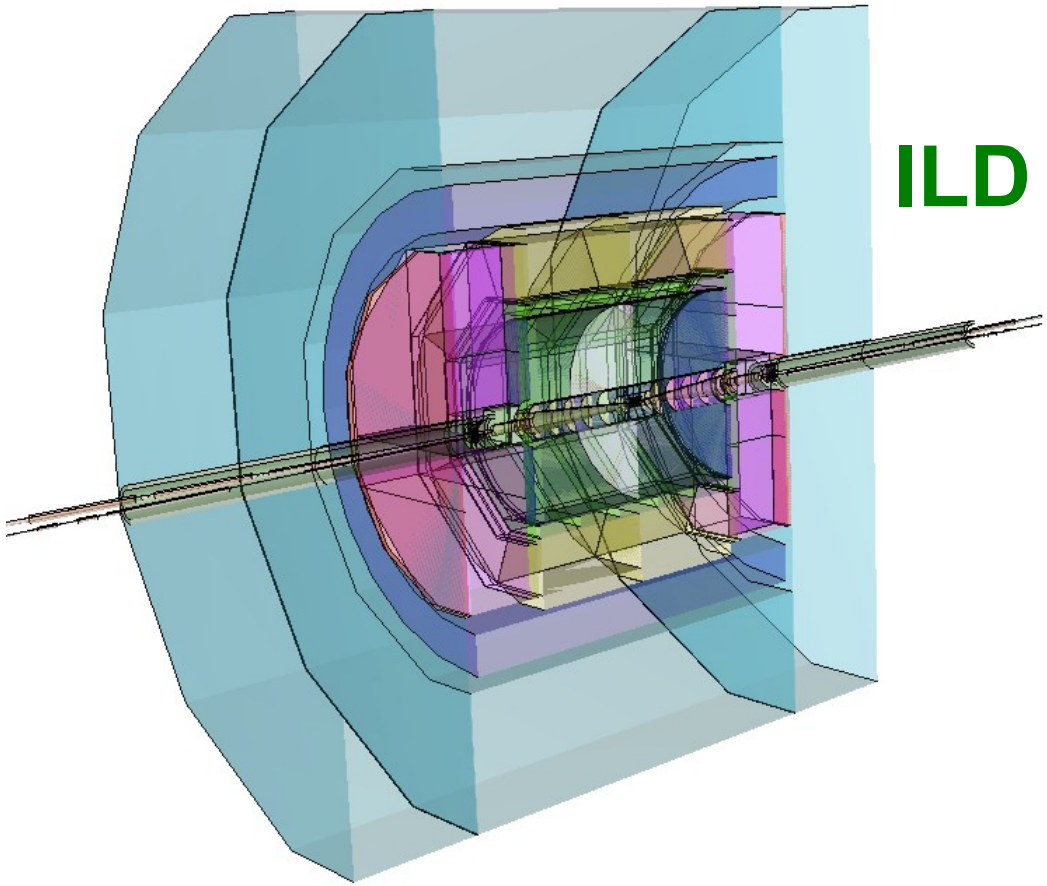
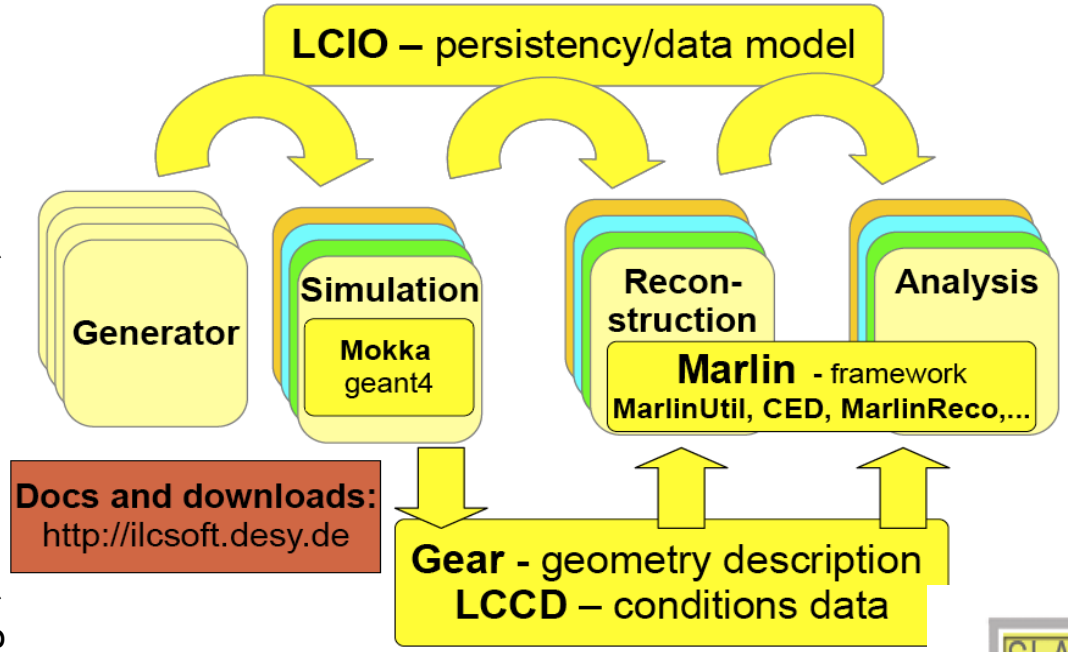
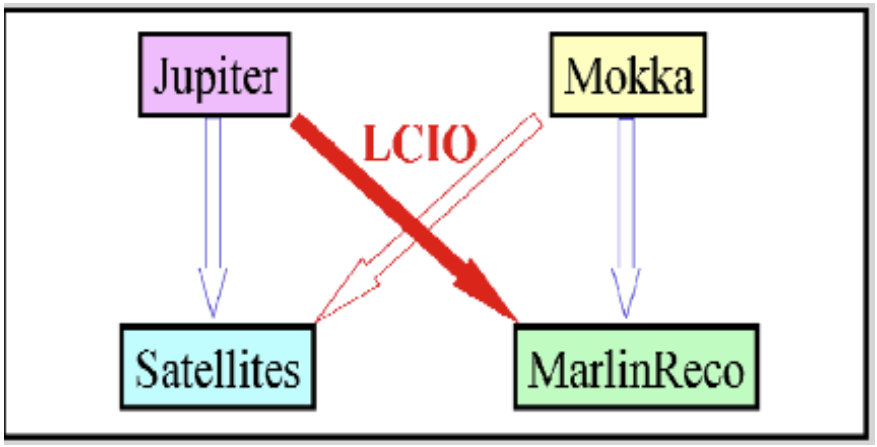
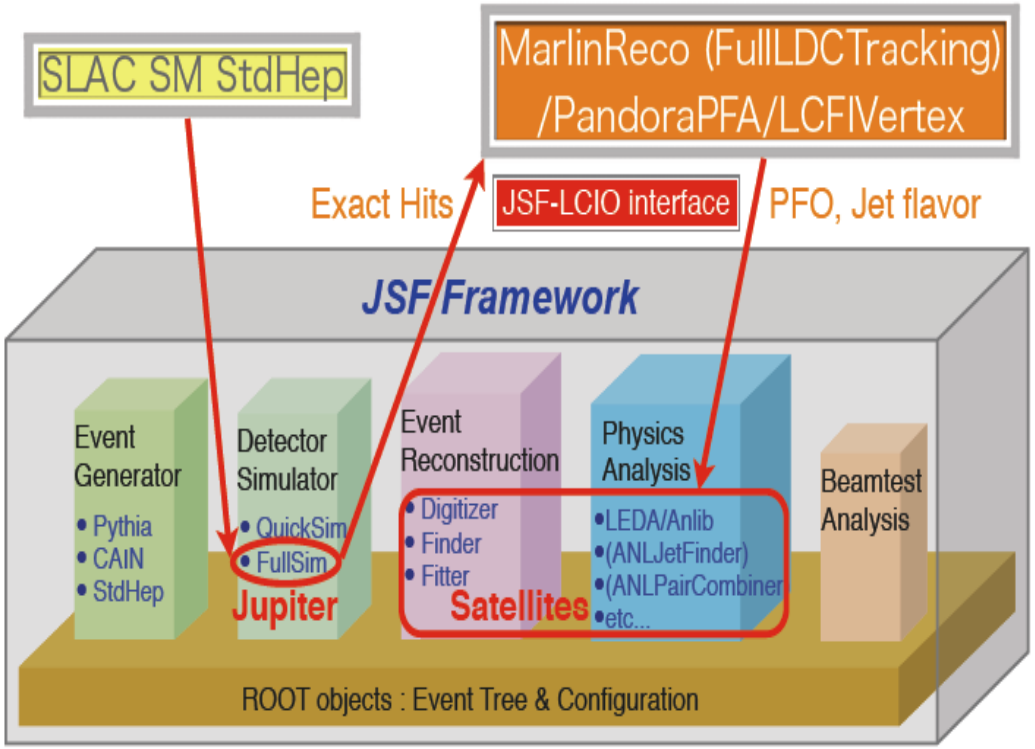


LDC & GLD sw frameworks

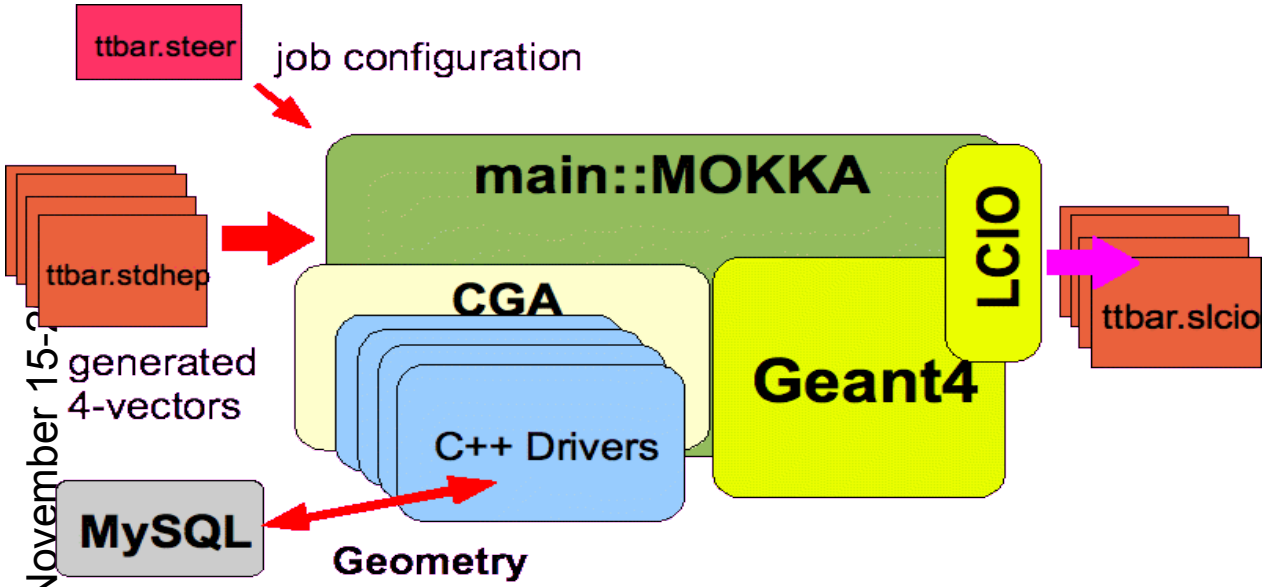


at LCWS 2007 GLD and LDC joined to a common concept **ILD**
two independent software frameworks
-> LCIO & GEAR provide basis for interoperability

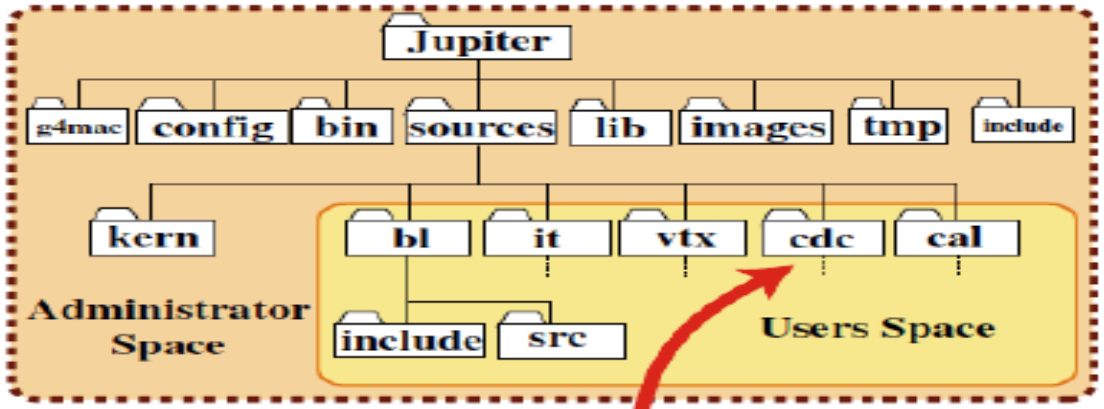


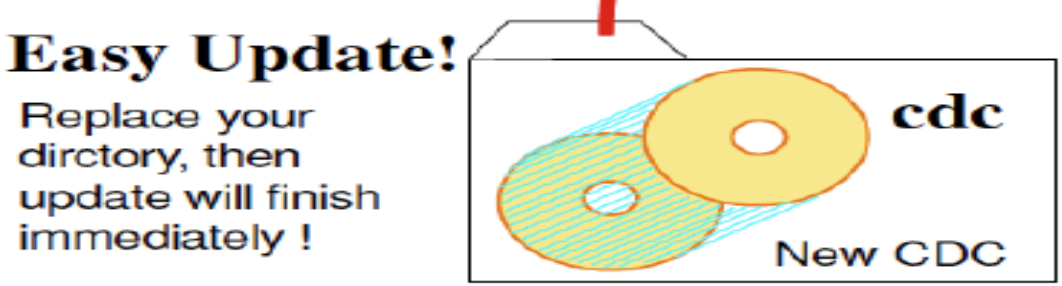


Mokka/Jupiter Geometry



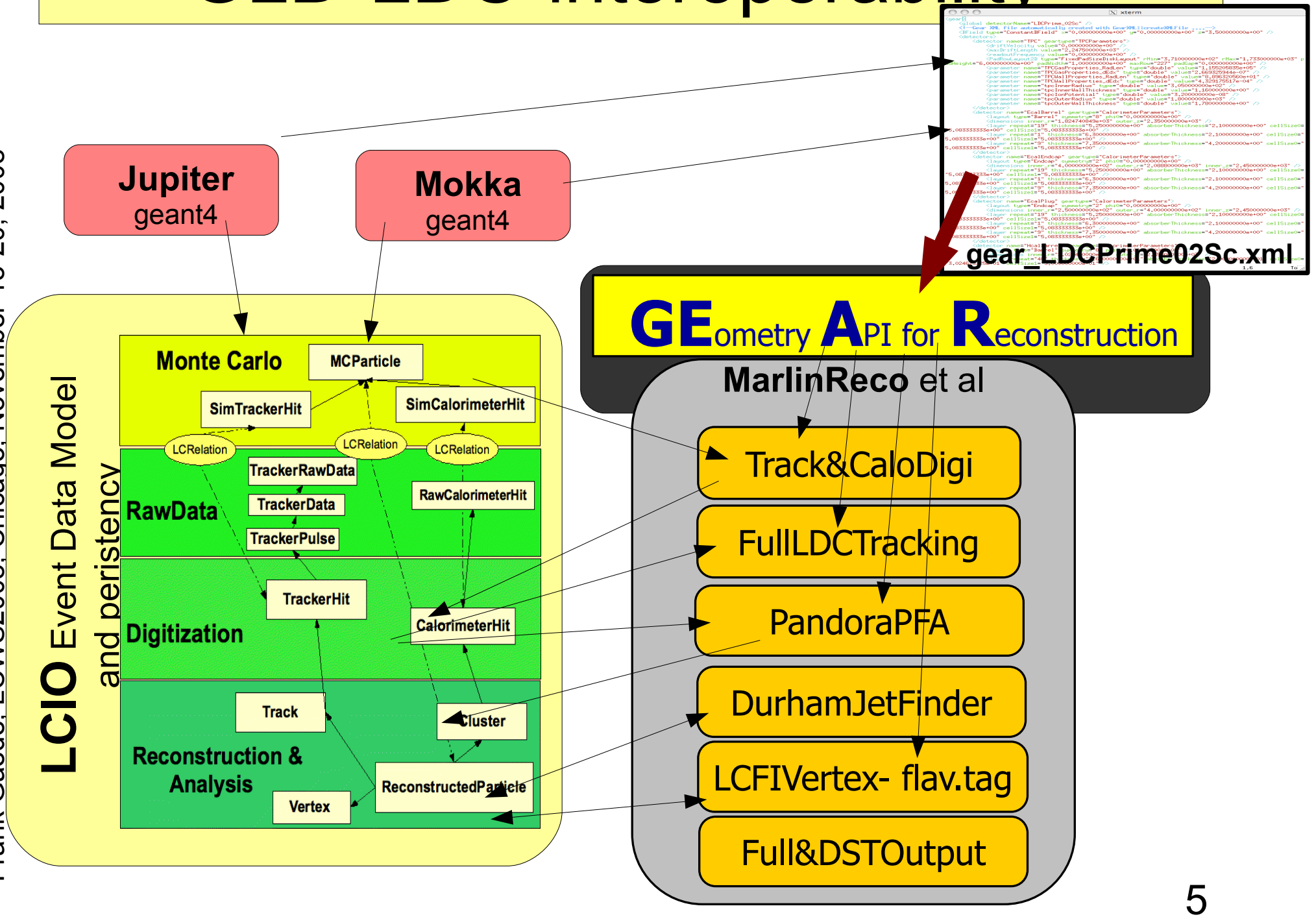
- Mokka geometry definition:
  - parameters in MySQL-db
  - actual placement in C++
  - flexible ,'perfect' bookkeeping
  - partly engineering level of details (Ecal,Hcal,VTX,..)
    - stored in GEAR for reco





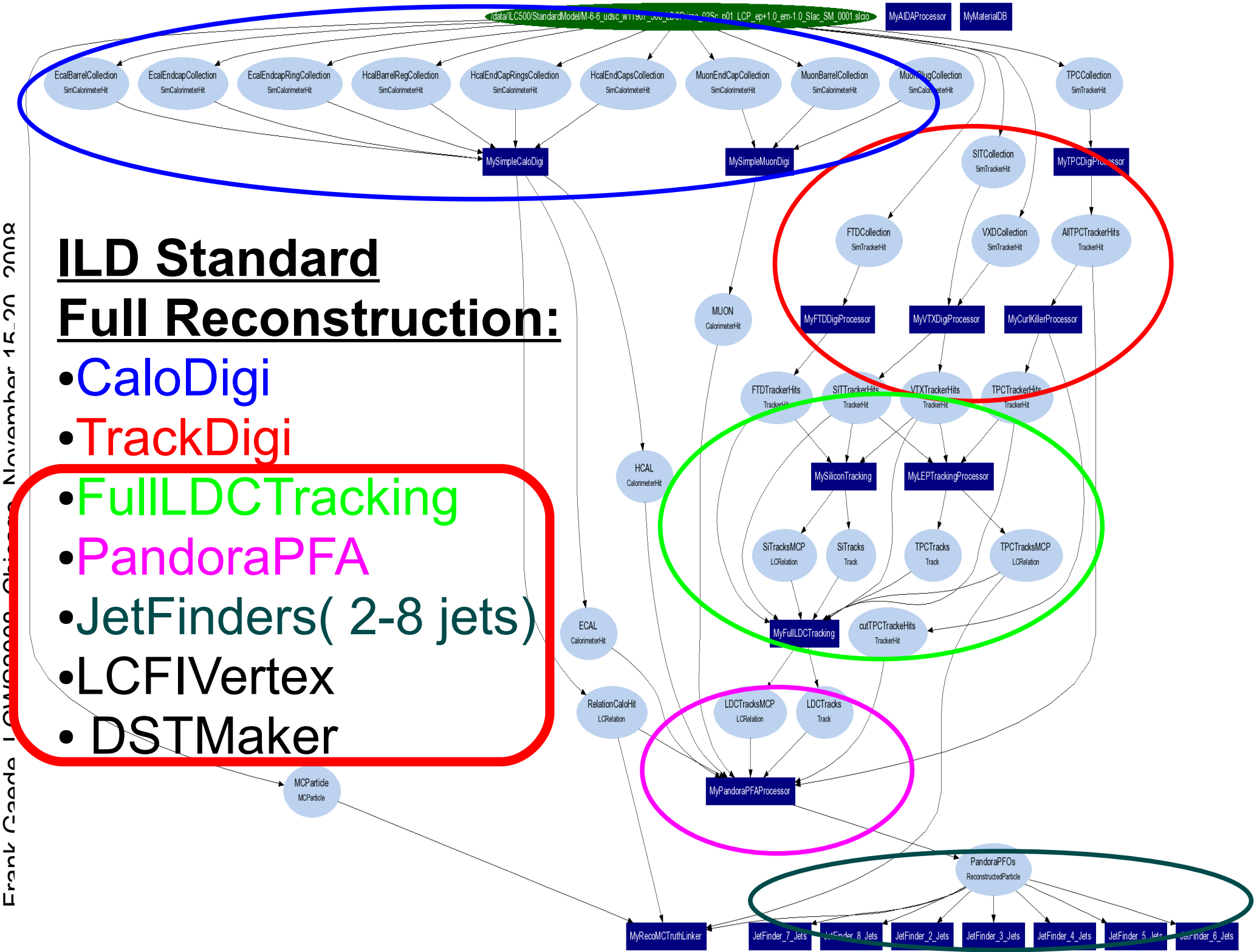
- Jupiter geometry definition:
  - parameters ascii files
  - actual placement in C++ drivers
  - flexible, easy to change
  - simple geometry for fast optimization
    - stored in root for reco

GLD-LDC-interoperability



ILD Standard Full Reconstruction:

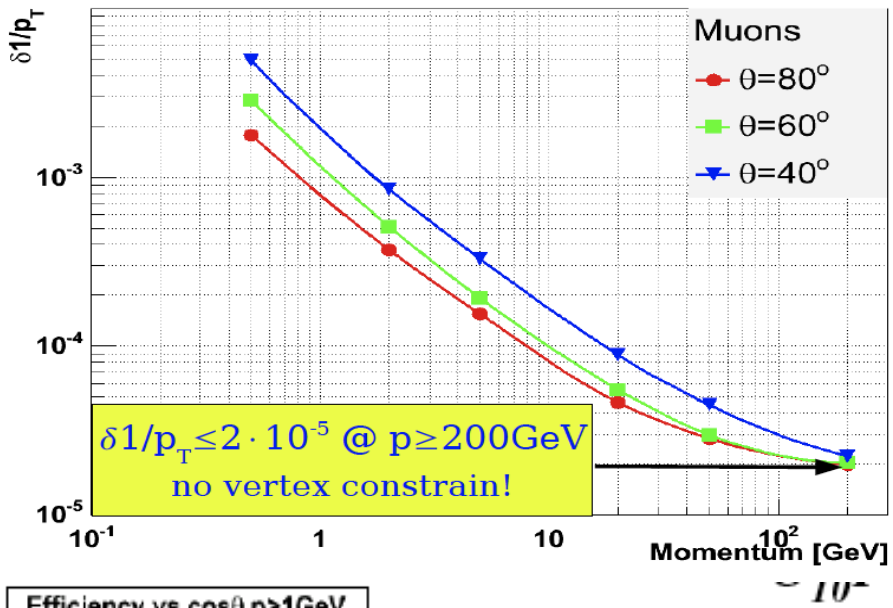
- CaloDigi
- TrackDigi
- FullLDCTracking
- PandoraPFA
- JetFinders(2-8 jets)
- LCFIVertex
- DSTMaker

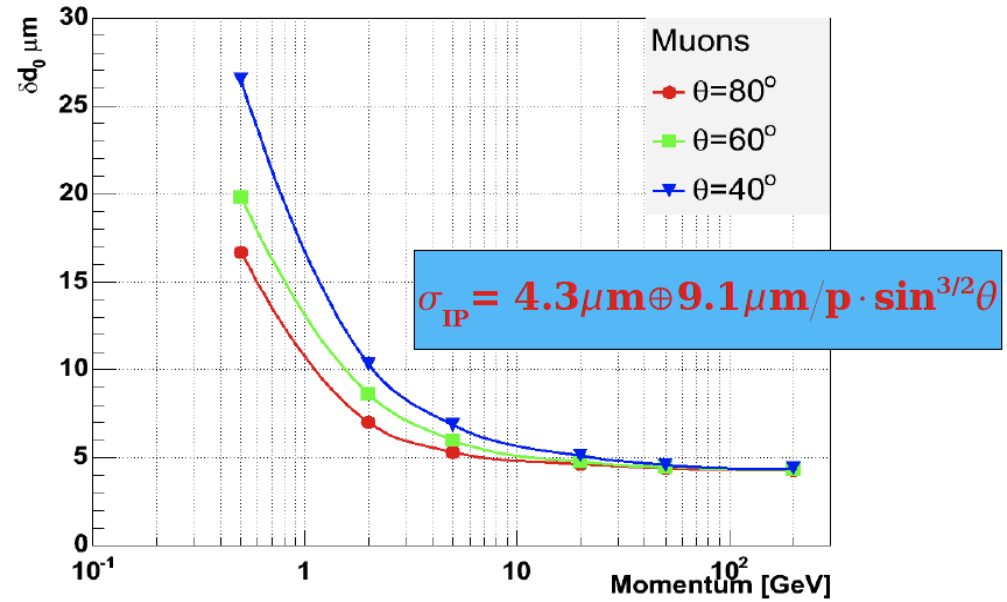


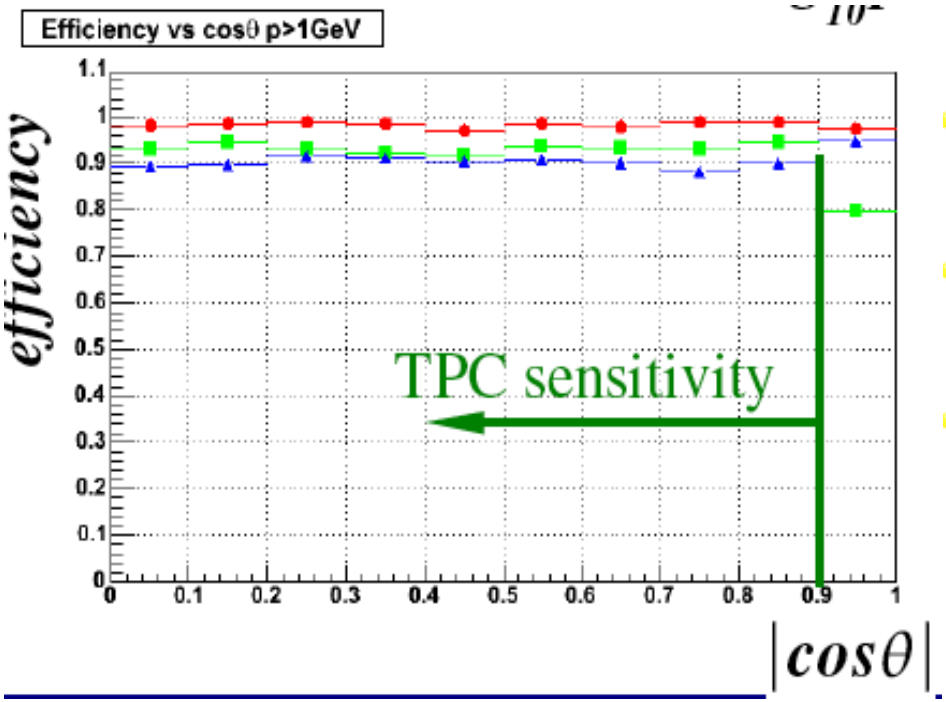
Digitization

- VXD, SIT, FTD, SET, ETD Silicon hits
  - smearing of 3d space points (SimTrackerHits) according to envisaged detector resolutions
    - as established by R&D groups
  - also more detailed digitizers exist for Silicon detectors for dedicated studies
- TPC hits
  - smearing of 3d space points (SimTrackerHits) taking into account drift distance, polar and azimuthal angle of track
    - parameterization from TPC R&D groups
- Ecal,Hcal,Lcal,beamcal,LHcal, Muon Calo hits
  - calibration (single particle resolution)

MarlinReco - FullLDCTracking

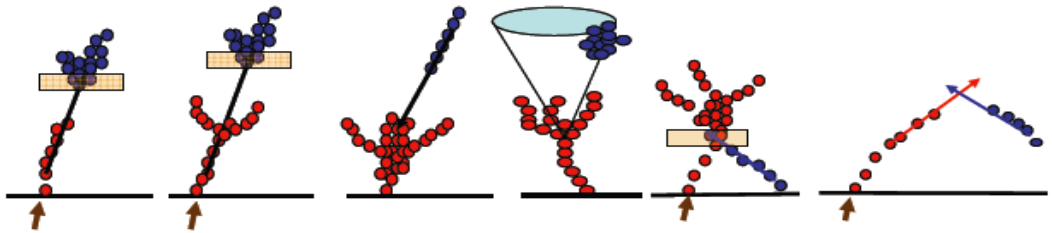


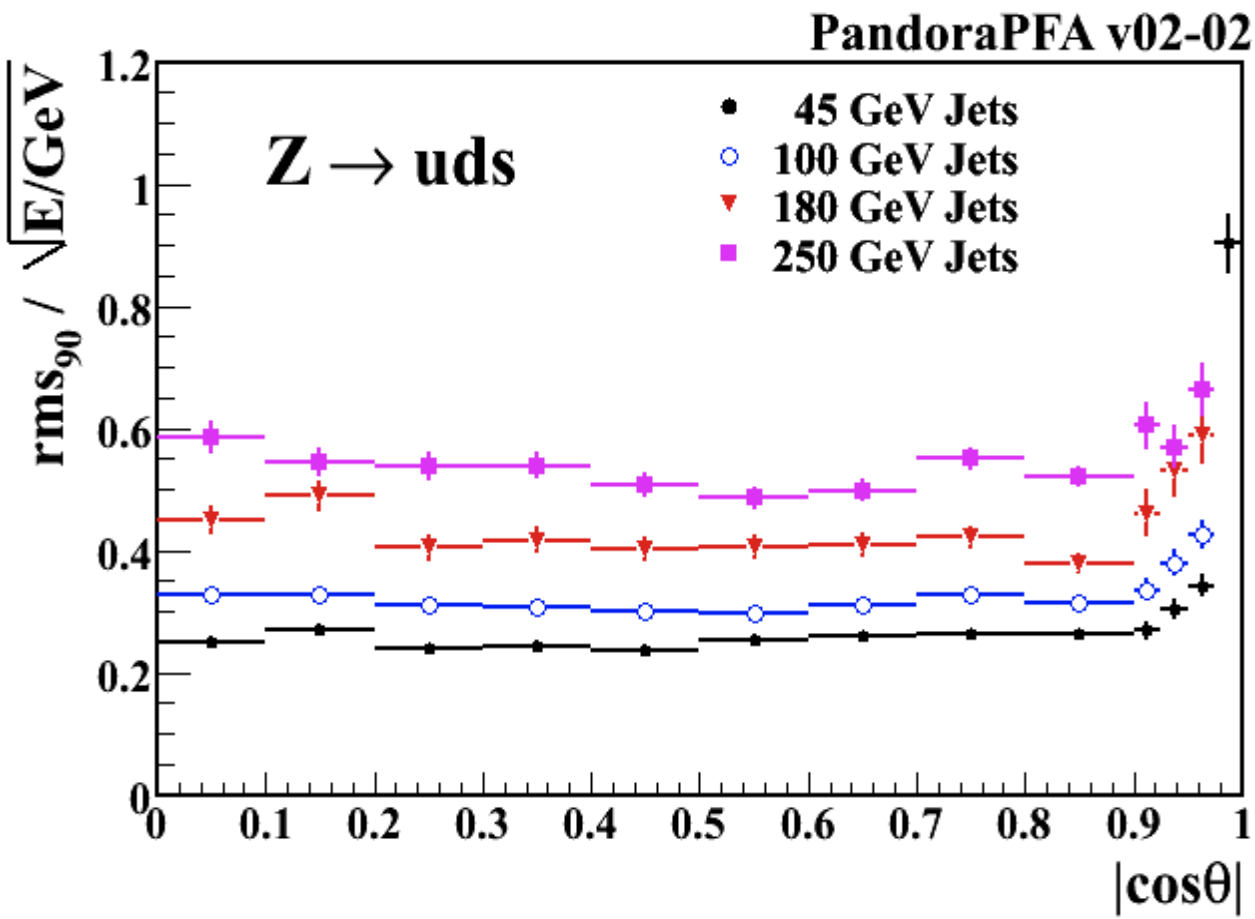




- VTX, SIT, FTD: standalone tracking – track finding and Kalman-Fittter
- TPC: standalone Kalman-Filter based tracking (LEP code)
- Combination of track elements and refit

PandoraPFA





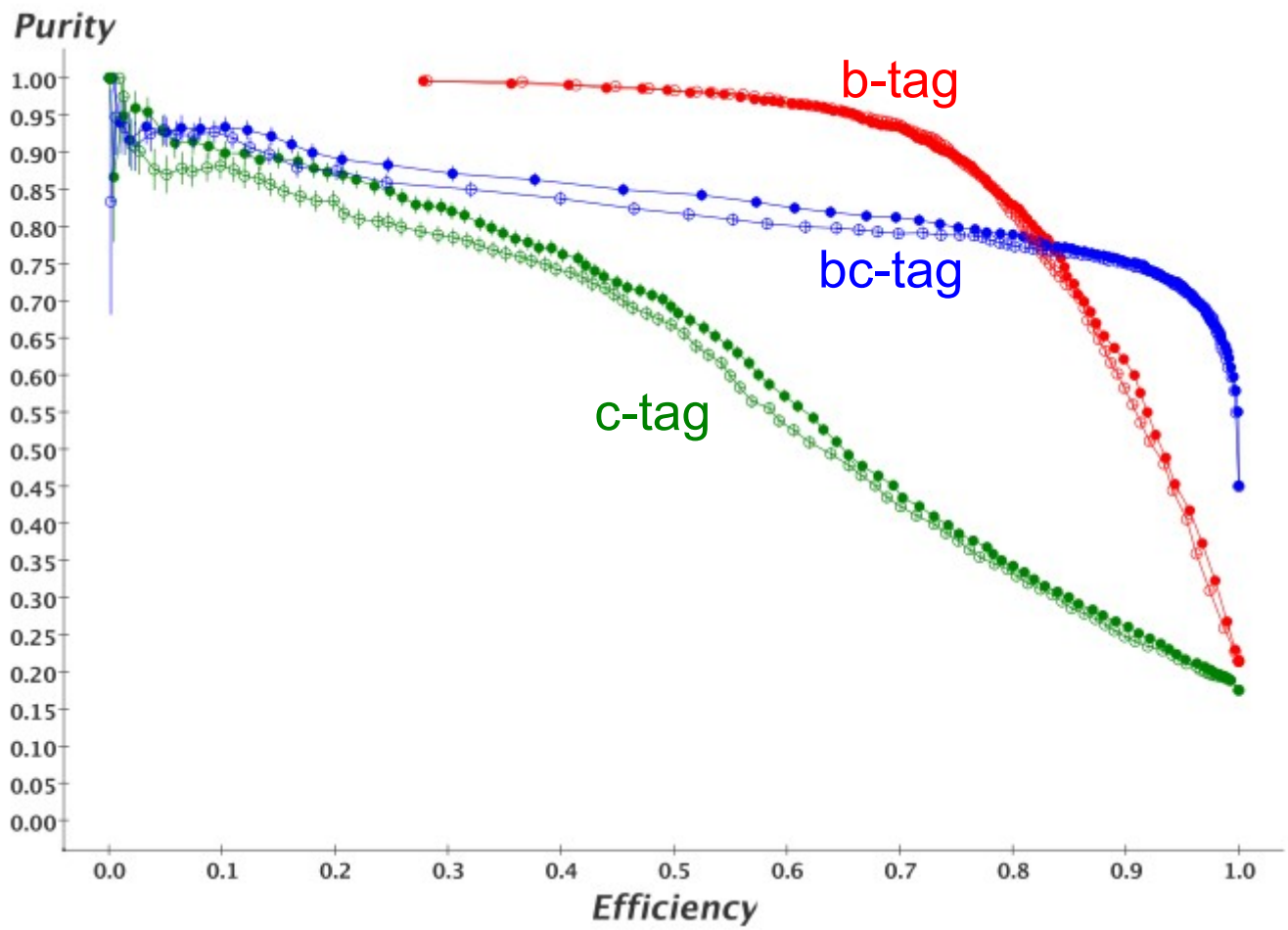
PandoraPFA v02-02

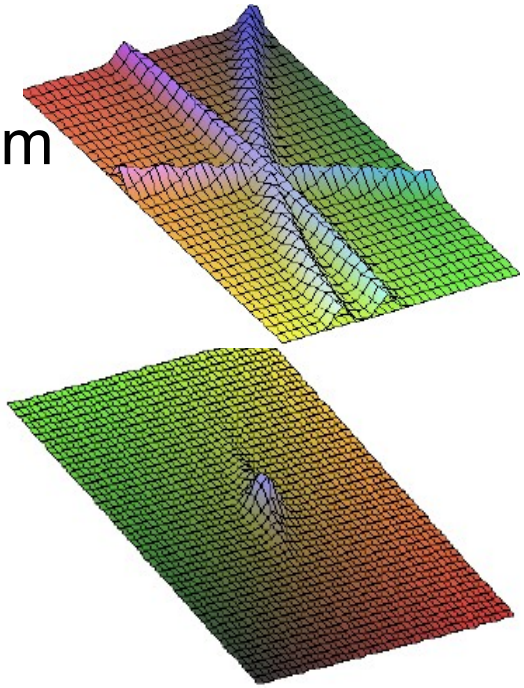
E_{JET}	$\sigma_E/E = \alpha/\sqrt{E_{jj}}$ $\lvert\cos\theta\rvert<0.7$	σ_E/E_j
45 GeV	24.9 %	3.7 %
100 GeV	30.7 %	3.1 %
180 GeV	43.0 %	3.2 %
250 GeV	52.2 %	3.3 %

- PandoraPFA
  - best Particle flow for ILC to date
  - used in many studies for detector optimization
  - demonstration of PFA concept

LCFIVertex

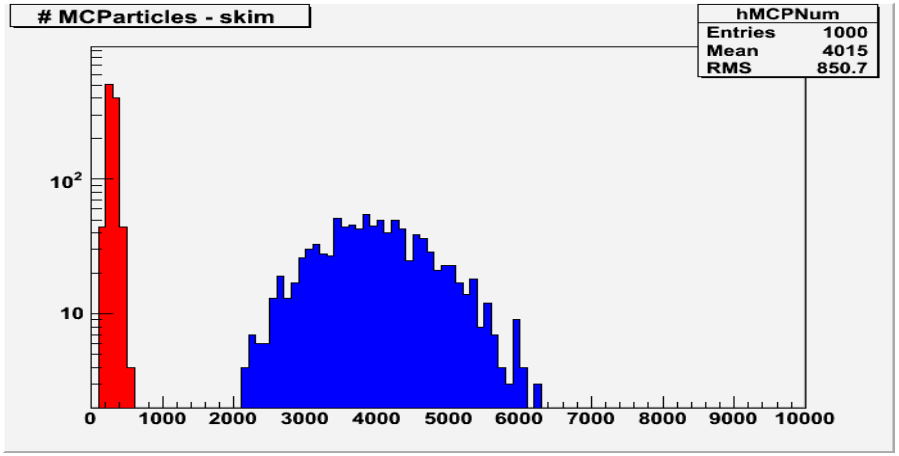
- Implementation of ZVTOP vertex finding algorithm
- Heavy-Flavour Tag based on neural networks
- Vertex-Charge for b and c jets





'DSTs' with LCIO

- DST format defined at Zeuthen:
  - Tracks, Clusters, ReconstructedParticles, Jets
  - MCParticle skim:
    - store full generated event
    - + reconstucted particles & parents
    - decays in flight & conversions
  - store LCFIVertex flavour tag in ParticleID objects
    - flavour tags b,c,b-bg
    - NN input quantities
    - true jet flavour & charge

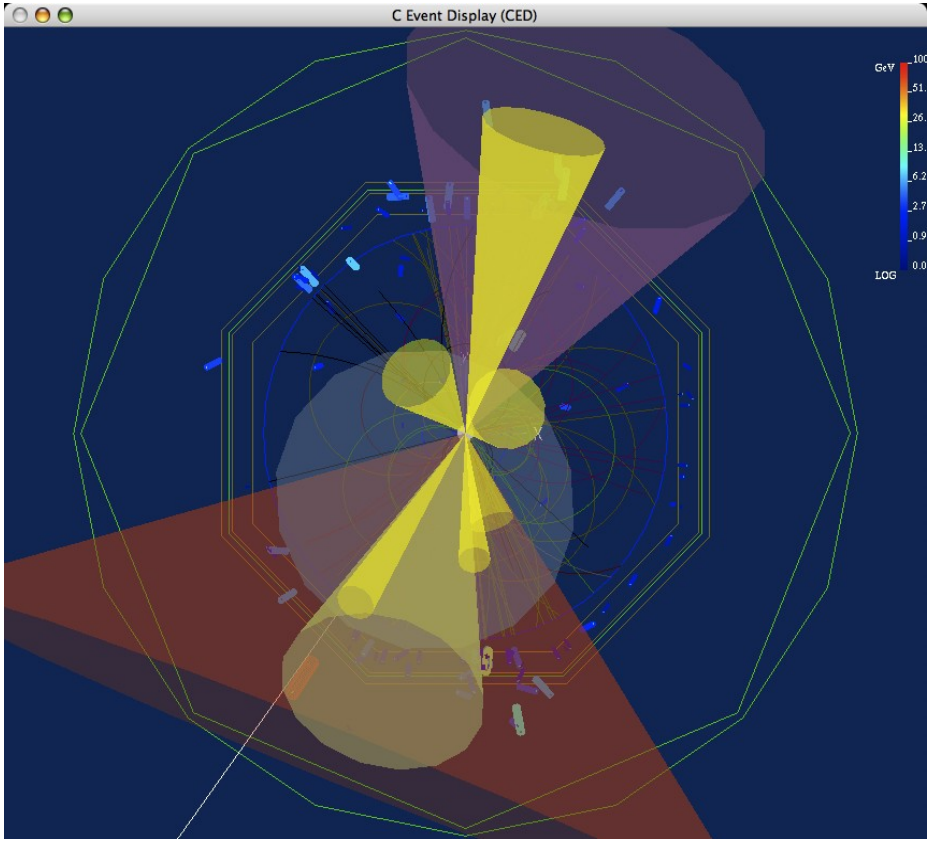


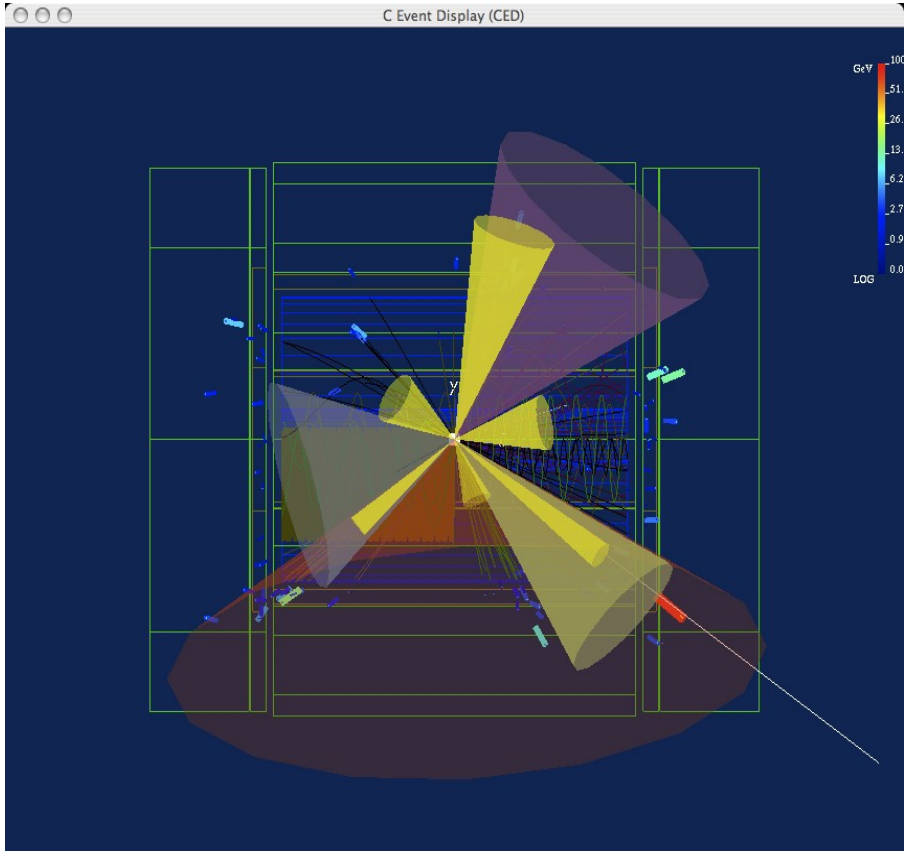

```
//////////////////////////////////////
EVENT: 0
RUN: 2011907
DETECTOR: LDCPrime_02Sc
COLLECTIONS: (see below)
//////////////////////////////////////

-----------------------------------------------------------------------------
COLLECTION NAME              COLLECTION TYPE          NUMBER OF ELEMENTS
=============================================================================
FTFinal_2Jets                ReconstructedParticle          2
FTFinal_3Jets                ReconstructedParticle          3
FTFinal_4Jets                ReconstructedParticle          4
FTFinal_5Jets                ReconstructedParticle          5
FTFinal_6Jets                ReconstructedParticle          6
FTFinal_7Jets                ReconstructedParticle          7
FTFinal_8Jets                ReconstructedParticle          8
IPVertex                     Vertex                         1
LDCTracks                    Track                         70
MCParticlesSkimmed           MCParticle                   202
PandoraClusters              Cluster                       64
PandoraPFOs                  ReconstructedParticle         65
RecoMCTruthLink              LCRelation                    65
ZVRESVertices_2Jets          Vertex                         1
ZVRESVertices_3Jets          Vertex                         1
ZVRESVertices_4Jets          Vertex                         1
ZVRESVertices_5Jets          Vertex                         1
ZVRESVertices_6Jets          Vertex                         1
ZVRESVertices_7Jets          Vertex                         1
ZVRESVertices_8Jets          Vertex                         1
-----------------------------------------------------------------------------
```

some numbers udsc @ 500 GeV		
type	kB/evt	f_I/O /Hz
SIM	950	10
REC	1800	3
DST	23	250

Note: f_I/O numbers are examples only - simple Marlin job on my PC

Visualizing DSTs in CED





- show Tracks as helices
- Clusters as lines & Cylinders (scaled w/ E)
- jets as cones (E,p_t) + particles coloured
- 3 momentum of all particles in the event

ilc sw-installation

- ilc software requirements and complexity has grown
  - ~30 packages with sometimes optional dependencies
- tool to make installation and build process easier:
- **ilcinstall** (python)
  - script to install all of the LDC software in one go
  - "**start script – go to lunch – run application**"
  - fully configurable:
    - versions, dependencies/build options, links to existing packages/tools, e.g. root, CLHEP,...
  - used for reference installations in afs (SL3/SL4)
  - user can link their packages against these
    - even w/o installing any software on their computer

/afs/desy.de/group/it/ilcsoft/v01-05

New

WLCG grid sites with ilcsoft installed

- http://ilcsoft.desy.de/grid/results/User.html

CE	SW-VER	SW-OS	DATE	TIME	SYS	SE	SAM	JOB	TAGGED	HIST-LOGS
cclcgceli01.in2p3.fr	v01-05-pre02	sl4	2008-11-08	14-04-01	OK	OK	OK	OK	VO-ilc-ilcsoft-v01-03-06-sl4 VO-ilc-ilcsoft-v01-04-sl4 VO-ilc-ilcsoft-v01-05-pre02-sl4	History
cclcgceli02.in2p3.fr	v01-05-pre02	sl4	2008-11-08	14-04-01	OK	OK	OK	OK	VO-ilc-ilcsoft-v01-03-06-sl4 VO-ilc-ilcsoft-v01-04-sl4 VO-ilc-ilcsoft-v01-05-pre02-sl4	History
ce.bfg.uni-freiburg.de	v01-05-pre02	sl4	2008-11-08	14-04-01	OK	OK	OK	OK	VO-ilc-ilcsoft-v01-03-06-sl4 VO-ilc-ilcsoft-v01-04-sl4 VO-ilc-ilcsoft-v01-05-pre02-sl4	History
ce01.dur.scotgrid.ac.uk	v01-05-pre02	sl4	2008-11-08	14-04-01	OK	OK	OK	OK	VO-ilc-ilcsoft-v01-03-06-sl4 VO-ilc-ilcsoft-v01-04-sl4 VO-ilc-ilcsoft-v01-05-pre02-sl4	History
ce2.ppgrid1.rhul.ac.uk	v01-05-pre02	sl4	2008-11-08	14-04-01	OK	OK	OK	OK	VO-ilc-ilcsoft-v01-03-06-sl4 VO-ilc-ilcsoft-v01-04-sl4 VO-ilc-ilcsoft-v01-05-pre02-sl4	History
fal-pygrid-18.lancs.ac.uk	v01-05-pre02	sl4	2008-11-08	14-04-01	OK	OK	OK	OK	VO-ilc-ilcsoft-v01-03-06-sl4 VO-ilc-ilcsoft-v01-04-sl4 VO-ilc-ilcsoft-v01-05-pre02-sl4	History
grid-ce3.desy.de	v01-05-pre02	sl4	2008-11-08	14-04-01	OK	OK	OK	OK	VO-ilc-ilcsoft-v01-03-06-sl4 VO-ilc-ilcsoft-v01-04-sl4 VO-ilc-ilcsoft-v01-05-pre02-sl4	History
grid10.lal.in2p3.fr	v01-05-pre02	sl4	2008-11-08	14-04-01	OK	OK	OK	OK	VO-ilc-ilcsoft-v01-03-06-sl4 VO-ilc-ilcsoft-v01-04-sl4 VO-ilc-ilcsoft-v01-05-pre02-sl4	History
lcg-ce1.ifh.de	v01-05-pre02	sl4	2008-11-08	14-04-01	OK	OK	OK	OK	VO-ilc-ilcsoft-v01-03-06-sl4 VO-ilc-ilcsoft-v01-04-sl4 VO-ilc-ilcsoft-v01-05-pre02-sl4	History
lcgce02.gridpp.rl.ac.uk	v01-05-pre02	sl4	2008-11-08	14-04-01	OK	OK	OK	OK	VO-ilc-ilcsoft-v01-03-06-sl4 VO-ilc-ilcsoft-v01-04-sl4 VO-ilc-ilcsoft-v01-05-pre02-sl4	History
svr021.gla.scotgrid.ac.uk	v01-05-pre02	sl4	2008-11-08	14-04-01	OK	OK	OK	OK	VO-ilc-ilcsoft-v01-03-06-sl4 VO-ilc-ilcsoft-v01-04-sl4 VO-ilc-ilcsoft-v01-05-pre02-sl4	History

- these sites used for LOI Monte Carlo production

* v01-05 soon

detector variants in Jupiter/Mokka

Sub-Detector	Parameter	GLD Jupiter	LDCGLD Mokka	J4LDC Jupiter	LDC Mokka	GLD' Jupiter	LDC' Mokka
TPC	R_{inner} (m)	0.44	0.37	0.34	0.37	0.45	0.37
	R_{outer} (m)	1.98	1.93	1.52	1.51	1.80	1.73
	Z_{max} (m)*	2.60	2.50	2.16	2.19	2.35	2.25
Barrel ECAL	R_{inner} (m)**	2.10	2.02	1.60	1.61	1.85	1.83
	Material	Sci/W	Sci/W	Sci/W	Si/W	Sci/W	Si/W
Barrel HCAL	Material	Sci/W	Sci/Fe	Sci/Fe	Sci/Fe	Sci/Fe	Sci/Fe
ECAL EndC	Z_{min} (m)***	2.80	2.70	2.10	2.30	2.25	2.55
Solenoid	B-field	3	3	4.0	4.0	3.5	3.5
VTX	Inner Layer (mm)	17.5	16.5	15	14	16	15

- for optimizing the ILD detector created three models in GLD and LDC framework
- GLD' and LDC' very similar – intermediate size detectors
- massive Monte Carlo production and physics analyses to compare the models

LDC Monte Carlo production on the Grid

	$\sqrt{s}$ (GeV)	Observable	Comments
ZH → eeX	250	σ, m_H	m_H=120GeV, test materials and γ_{ID}
ZH → μμX	250	σ, m_H	m_H=120GeV, test $\Delta P/P$
ZH, H→cc, Z→νν	250	Br(H→cc)	Test heavy flavor tagging and anti-tagging of light quarks and gluon
ZH, H→cc, Z→qq	250	Br(H→cc)	Same as in multi-jet event
Z* → ττ	500	σ, A_{FB}, Pol(τ)	Test π^0 rec. and τ rec. aspects of PFA
tt, t→bW, W→qq'	500	σ, A_{FB}, m_{top}	Test b-tag. and PFA in multi-jet events. m_{top}=175GeV
$\chi^+ \chi^-$, $\chi_2^0 \chi_2^0$	500	σ, m_χ	Pint 5 of Table 1 of BP report. W/Z separation by PFA.

Proposed (preliminary)		
Process	fb^{-1}	#events
ee->6f	500	1197236
ee->4f	50	3358252
ee->2f	20	1192784
ee->hX	500	299278
nn(n*g)	20	841726
ee->ee	0.1	6953510
eg->eg	0.1	344270
gg->X	0.1	554782
ee->gg(n*g)	10	306954
rest	1	517376
Total		15566168

- use the Grid to produce a significant Monte Carlo data set
  - (as proposed by WWS software panel)
- use Standard Model generator files produced at SLAC (DESY)
- -> produced ~15M events for LDCPrime configuration
- + signal samples, detector variations,....
- -> computing infrastructure set up by DESY group
  - job submissions scripts, databases, monitoring tools,...
  - grid software installations

LOI MonteCarlo production LDC

LDCPrime_02Sc			
EventType	NEvent	L[1/fb]	delta_L
2f	1092584	19.89	0.15
4f	2666806	48.88	2.69
6f	446028	471.36	66.21
aa_X	181408	0.28	0.02
ee	6931010	0.1	0
eaea	344270	0.19	0
nnNa	806700	17.45	3.93
aaNa	261954	9.42	0.82
hX	276728	465.86	75.74
other	120000	0	0
Zh_ee_mur	20000	1332.98	0
Zh_qqnn	10000	223.26	0
Zh_qqqq	25000	158.73	0
tautau	100000	22.03	2.8
6f_bbqqqq	450217	486.37	5.42
sp5_ch_ne	82305	464.01	112.54
sp5_x	78570	692	248.26
sps1ap	1617133	891.37	195.94
ZZ	50000	74.59	39.59
total	**15560713**		

LDC01_06Sc			
EventType	NEvent	L[1/fb]	delta_L
4f	4000	46.02	76.38
Zh_ee_mumu	19000	1266.33	66.65
Zh_qqnn	10000	223.26	0
Zh_qqqq	25000	158.73	0
sps1ap	1621157	879.67	190.59
ZZ	55000	82.21	44.76
total	**1734157**		

ilcsoft v01-04

LDC_GLD_01Sc			
EventType	NEvent	L[1/fb]	delta_L
Zh_ee_mumu	20000	1332.98	0
Zh_qqnn	9000	200.94	0
Zh_qqqq	23000	146.03	0
sps1ap	1528657	873.32	197.43
ZZ	55000	82.21	44.76
total	**1635657**		

SM model background sample (SLAC)

canonical signal samples LOI (WWS-SW)

other physics signal samples

massive MC production for 3 LDC like detectors – details at:
http://www-flc.desy.de/simulation/database
http://ilcsoft.desy.de/loi/reco (summary)

total effort: simulation ~2 month
reconstruction ~1 month

generator files to be simulated I

- generator files produced with whizzard at SLAC(DESY)
- Standard Model background @ 250 GeV & 500 GeV
- physics benchmark reactions as defined by WWS
- all detector concepts will (essentially) use the same generator files for the LOI

ILC Data Samples

http://ilcsoft.desy.de/portal/data_samples/

Home | General Documentation | Data Samples | Software Packages | Binary releases | News

ILC Soft ▸ Data Samples

Data Samples

ILC Data Samples

Generator files for LOI Benchmark reactions.

Generator files for LOI SM background (500GeV)

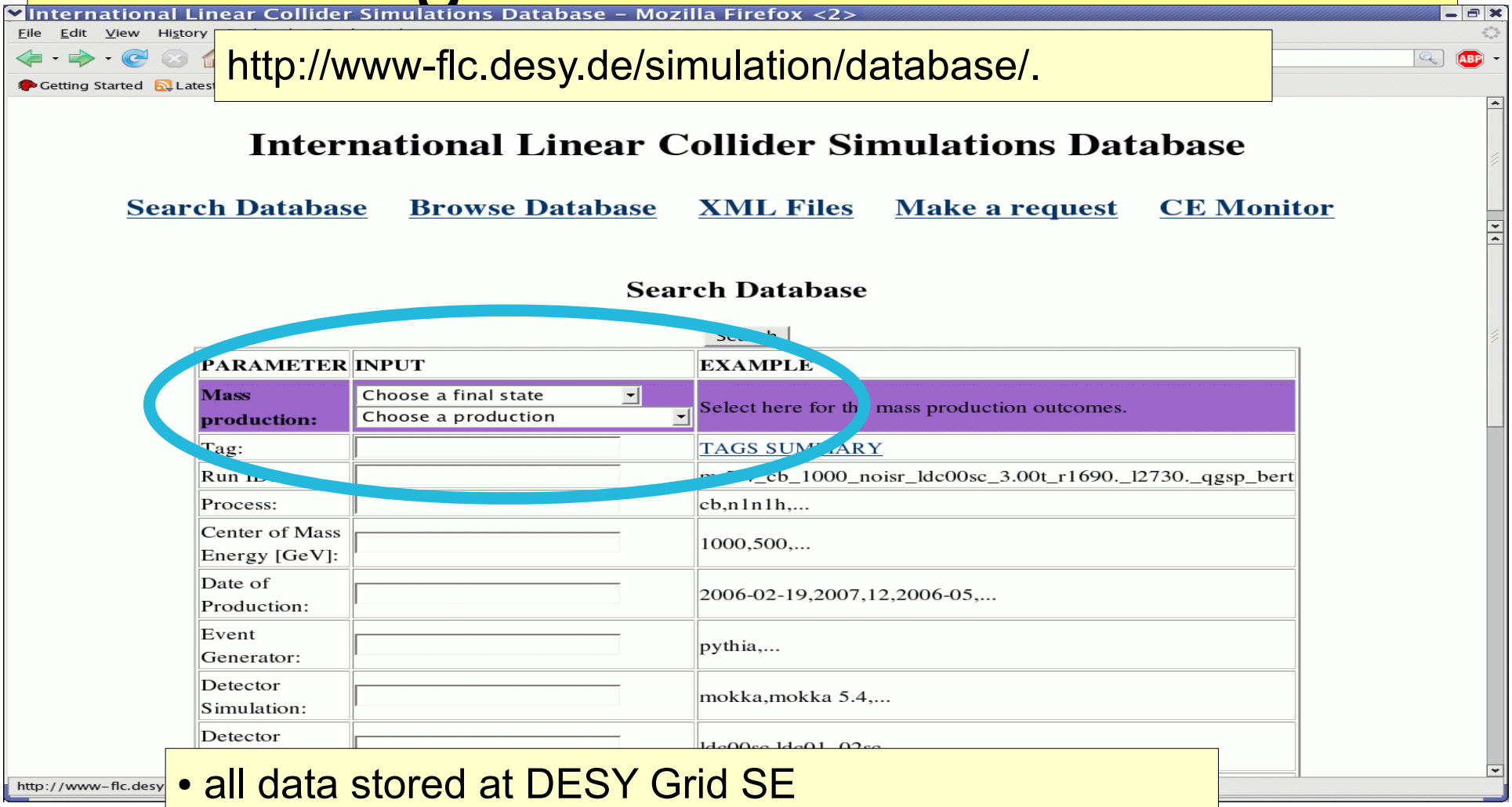
Generator files for LOI SM background (250GeV)

ILD Reconstructed MonteCarlo data sets (LDCPrime)

ILD MonteCarlo Database

This database provides you with information about several Monte Carlo samples of various physics processes using different detector models. The logical filenames retrieved from this database can be used to access the LCIO files using lcg grid tools.

accessing the LDC/ILD data files



- all data stored at DESY Grid SE
- soon also replication to Lyon-in2p3 SE
- browse the LFC data catalogue on the web
- -> retrieve logical grid file name
  - copy the data to your computer using Grid tools
  - or analyze the data on the grid

summary table LOI reconstruction

Reconstructed Monte Carlo Files ILD – Mozilla Firefox

File Edit View Go Bookmarks Tools Help

http://ilcsoft.desy.de/loi/reco

LCIO ilcsoft simulation/geant4 Google Linear Collider Forum: ... DESY IT Group MyHome

Reconstructed Monte Carlo Files ILD

complete file lists per sample REC and DST !

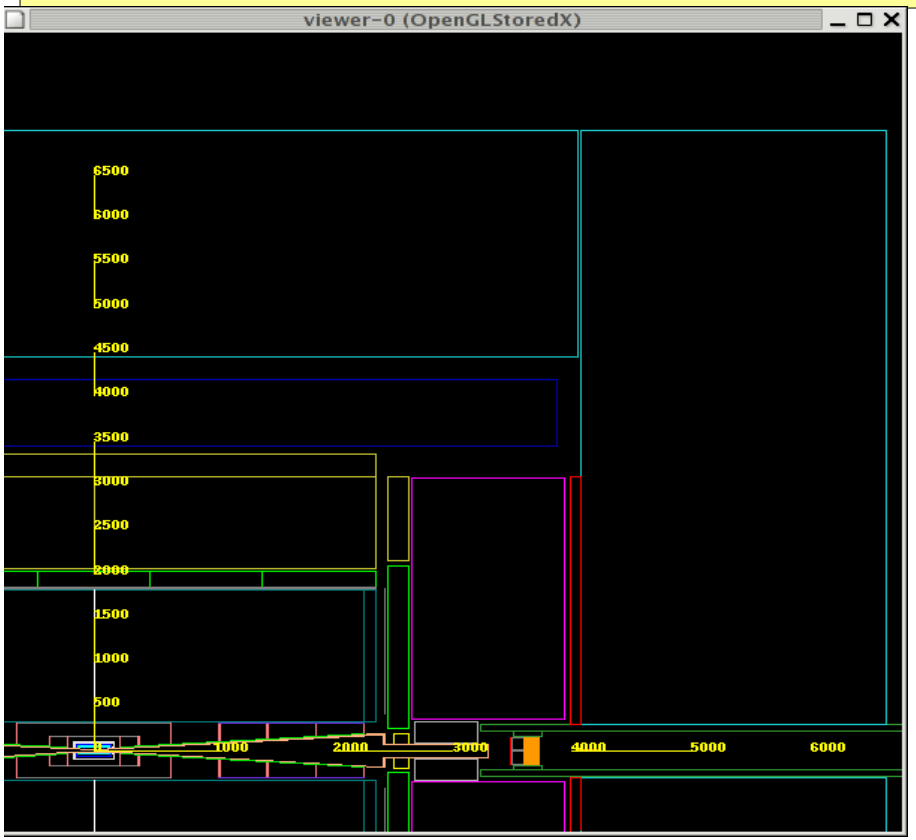
The following tables provide an overview of the physics samples that have been fully simulated and recons
LDCPrime_02Sc, LDC01_06Sc and LDC_GLD_01Sc. The tables show both Standard Model and Signal ev
The events "Sig 1-6:" are the "Benchmark Reactions for the LOI" as defined by the WWS software pan

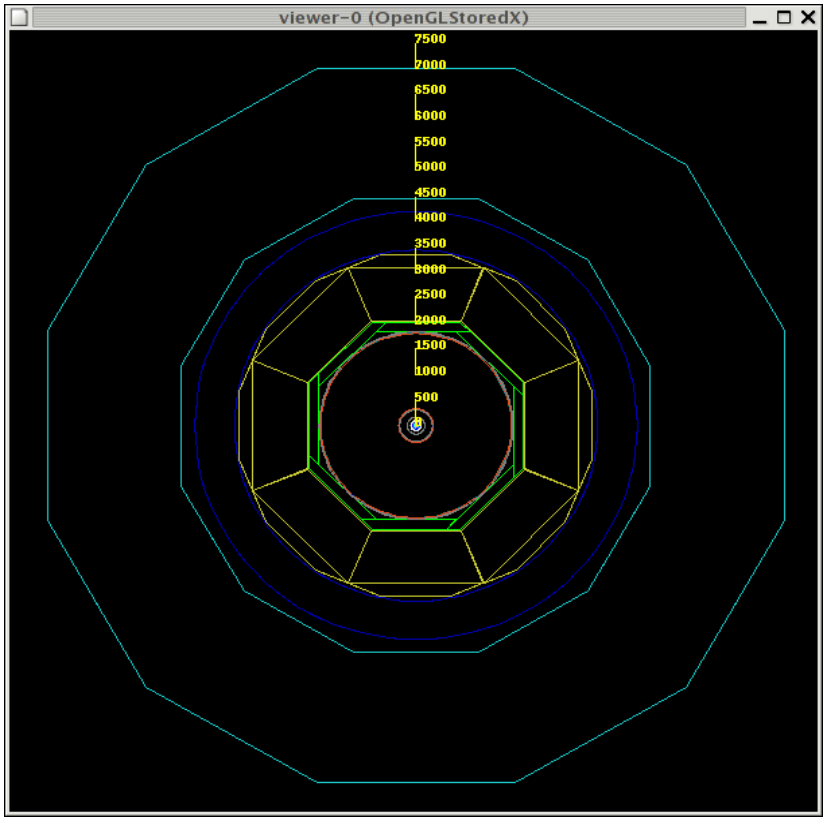
Click on the corresponding links to get a complete list of logical file names for the given type

LDCPrime_02Sc					
EventType	NEvent	L[1/fb]	delta_L	REC_files	DST_files
2f (w/o ee,tautau)	1092584	19.8890	0.1509	2f_LDCPrime_02Sc_REC.list	2f_LDCPrime_02Sc_DST.list
4f	2666806	48.8792	2.6930	4f_LDCPrime_02Sc_REC.list	4f_LDCPrime_02Sc_DST.list
6f (w/o bbqqqq)	446028	471.3608	66.2062	6f_LDCPrime_02Sc_REC.list	6f_LDCPrime_02Sc_DST.list
gg->X	181408	0.2770	0.0212	aa_X_LDCPrime_02Sc_REC.list	aa_X_LDCPrime_02Sc_DST.list
ee	6931010	0.0997	0.0002	ee_LDCPrime_02Sc_REC.list	ee_LDCPrime_02Sc_DST.list
eg->eg	344270	0.1924	0.0005	eaea_LDCPrime_02Sc_REC.list	eaea_LDCPrime_02Sc_DST.list
nn(Ng)	806700	17.4457	3.9255	nnNa_LDCPrime_02Sc_REC.list	nnNa_LDCPrime_02Sc_DST.list
gg(Ng)	261954	9.4225	0.8234	aaNa_LDCPrime_02Sc_REC.list	aaNa_LDCPrime_02Sc_DST.list
hX	276728	465.8559	75.7372	hX_LDCPrime_02Sc_REC.list	hX_LDCPrime_02Sc_DST.list
other	120000	0.0000	0.0000	other_LDCPrime_02Sc_REC.list	other_LDCPrime_02Sc_DST.list
Signal Events:					
Sig1: ZH,H->ee/mumu	20000	1332.9779	0.0000	Zh_ee_mumu_LDCPrime_02Sc_REC.list	Zh_ee_mumu_LDCPrime_02Sc_DST.list
Sig2: ZH,H->qq,Z->nn	10000	223.2641	0.0000	Zh_qqnn_LDCPrime_02Sc_REC.list	Zh_qqnn_LDCPrime_02Sc_DST.list
Sig3: ZH,H->qq,Z->qq	25000	158.7302	0.0000	Zh_qqqq_LDCPrime_02Sc_REC.list	Zh_qqqq_LDCPrime_02Sc_DST.list
Sig4: ee->tautau	100000	22.0349	2.8003	tautau_LDCPrime_02Sc_REC.list	tautau_LDCPrime_02Sc_DST.list
Sig5: ee->tt->bbqqqq	450217	486.3730	5.4159	6f_bbqqqq_LDCPrime_02Sc_REC.list	6f_bbqqqq_LDCPrime_02Sc_DST.list
Sig6: ee->chch,nene[SP5]	82305	464.0133	112.5413	sp5_ch_ne_LDCPrime_02Sc_REC.list	sp5_ch_ne_LDCPrime_02Sc_DST.list

Done

new ILD_00 detector model





- at Cambridge ILD workshop agreement on ILD simulation reference design *("combination of GLD' and LDC' ")*
- new ILD_00 detector model created in Mokka
- started new Monte Carlo production in order to verify results for GLD' and LDC' (this friday)
- for practical reasons use Marlin et al for reconstruction

beyond the LOI

- the short timescale of the LOI and the merging of GLD and LDC into ILD made it impossible to develop a common software framework
- however LCIO provided a good basis for interoperability
- next step: move to a common ILD sw framework
- try and identify strengths and weaknesses in both frameworks and see how things can be merged allowing a 'smooth' transition for the users, e.g.
  - create **ILDReco** merging best tools from MarlinReco and Satelies
  - improve geometry description in simulation and reconstruction
  - think about LCIOv2 with a revised data model (learn from Jupiter&Satelites)
  - ...

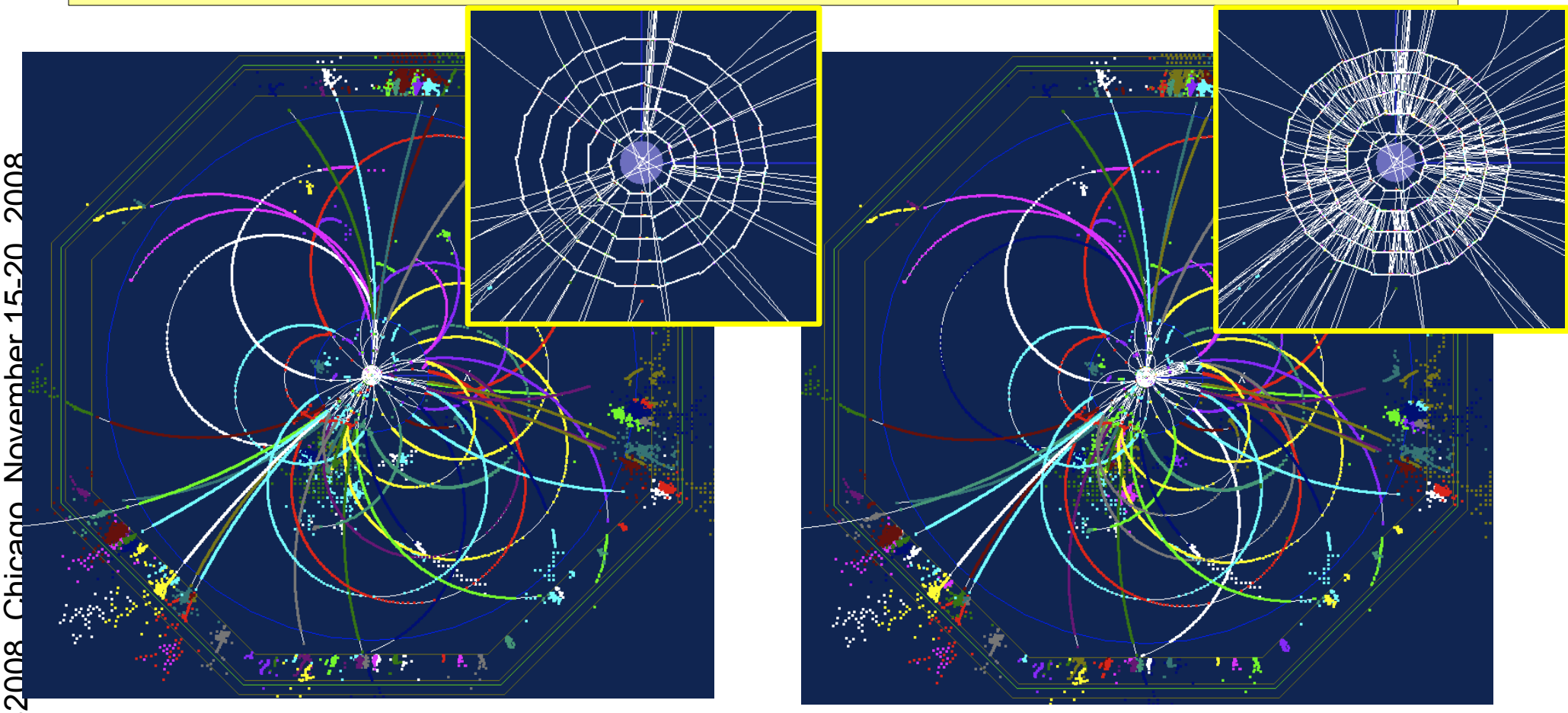
Summary

- ILD detector optimization for the LOI done in two frameworks of GLD and LDC
- six detector variants studied with massive Monte Carlo production
- -> ILD simulation reference design created
- started the next round of LOI production on the Grid

after LOI we will have the time to take on
the next big project:
a **common ILDsoft framework**
that combines the best of the two worlds and allows us to further optimize the ILD detector by studying the different technology options

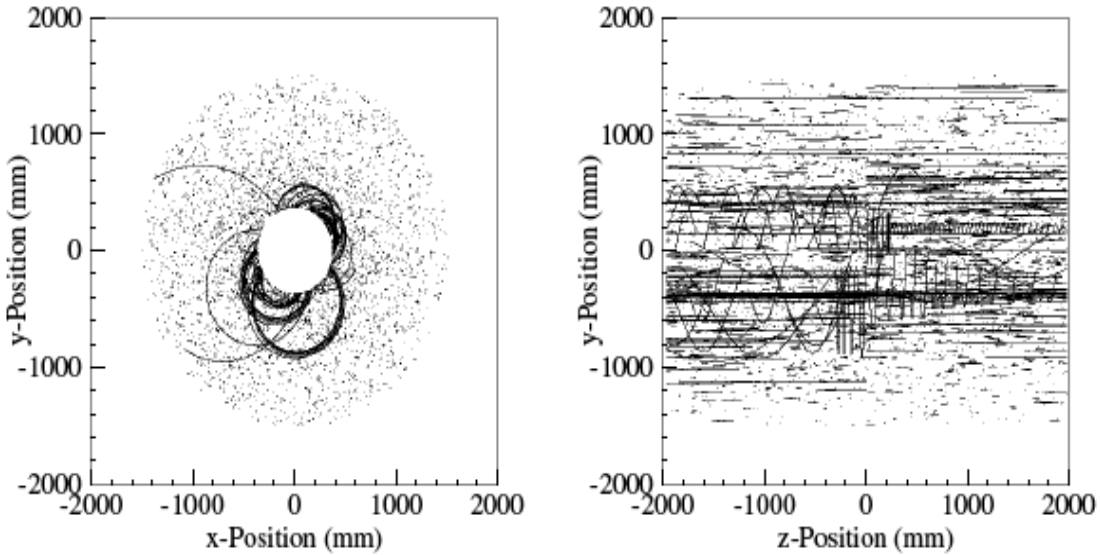
additional material

Random Noise in VTX detector



- example: VTXNoiseHits – processor that adds 'Salt'n Pepper' hits to the VTX,e.g:
- 400,40,15,10,3 hits/cm^2 in layers 1-5
  - SiTracks: 43 -> 1647
  - LDCTracks 54 -> 1658
  - **PandoraPFO 122 -> 131**

Studying machine background II



- include other silicon trackers (SIT, FTD)
- should try and parameterize the 'shape' of the background to get more realistic results !?
  - **need to adopt PatRec & PFA in order to cope with bg !**
    - note: only positive result is to show that we can cope – if not successful we might not have tried hard enough
    - -> this might be difficult on the time scale of the LOI !

GLD physics sample production

				Jupiter samples		
Calibration samples			# Events	gldapr08	gldprim_v04	j4ldc_v04
	Thomson's uds91		10000	done	done	done
	Thomson's uds200		10000	done	done	done
	PythiaZPole uds		10000	done	done	done
	PythiaZPole ccbar		10000	done	done	done
	PythiaZPole bbbar		10000	done	done	done
	jsf's uds 91		2500	done	done	done
	jsf's uds 200		2500	done	done	done
	jsf's uds 500		20000	done	done	done
				Jupiter Production		
	Process	Int. Lum(1/fb)	# Events	gldapr08	gldprim_v04	j4ldc_v04
250 GeV	zh->eeH	250	5000	done	done	done
	zh->μμH	250	5000	done	done	done
	zh->ννH	250	12500	done	done	done
	zh->qqH	250	40000	done	done	done
	zz->eeqq	250	20000	done	done	done
	zz->μμqq	250	20000	done	done	done
	zz->ννqq	250	77500	done	done	done
	zz->qqqq	250	168000	9300	done	93000
	zz->ττqq	250	20000	0	done	0
	ww->enuenu	250				
	ww->munumunu	250				
				Jupiter Production		
	Process	Int. Lum(1/fb)	# Events	gldapr08	gldprim_v04	j4ldc_v04
500 GeV	smuon(e-L)	500	14750	done	done	done
	smuon(e-R)	500	61000	done	done	done
	xcxc(e-L)	500	79000	done	done	done
	xcxc(e-R)	500	500	done	done	done
	xn2xn2(e-L)	500	14750	done	done	done
	bblnqq(e-L)	100	54000	0	done	0
	bblnqq(e-R)	100	24000	0	done	0
	bbqqqq(e-L)	150	126000	0	done	0
	bbqqqq(e-R)	150	51000	0	done	0
	tau-pair	12.4	57500	done	done	done
	tau-pair	100		0	in progress	0

Job summary: http://ilcphys.kek.jp/soft/samples/apr08/

- GLD-ILD focused on producing dedicated physics signal samples
- three detector models for optimization: GLD, GLDPrime, j4LDC
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