EUDET Software

Status and recent developments

Frank Gaede
DESY

EUDET Annual Meeting
Amsterdam October 6-8, 2008

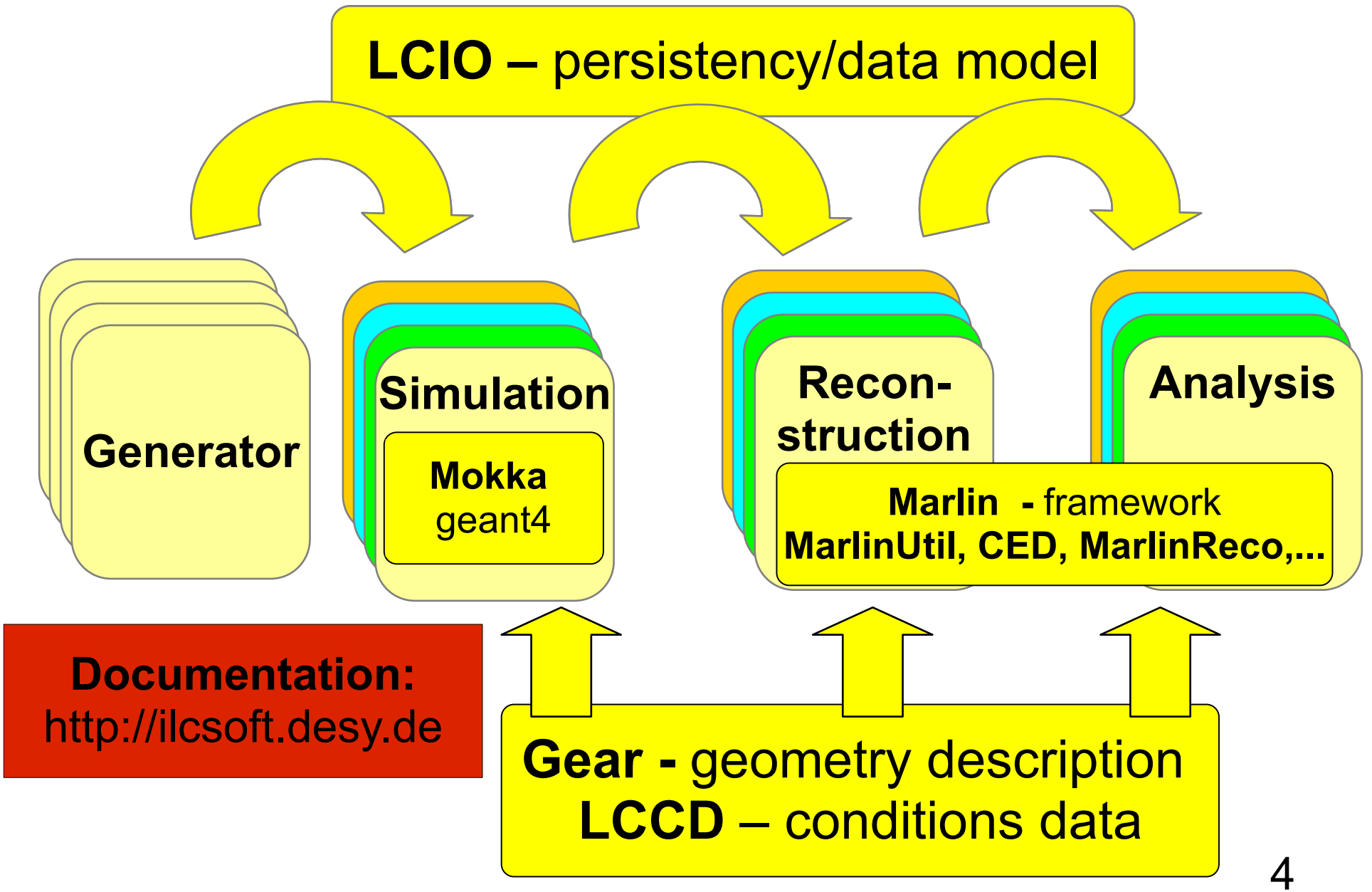
Outline

- EUDET-ILC software framework
  - overview - status
  - new developments
- JRA1 – EUTelescope
- JRA2 – MarlinTPC
- JRA3 – CaliceSoft
- joined session JRA3/NA2
  - 'hadronic shower models'

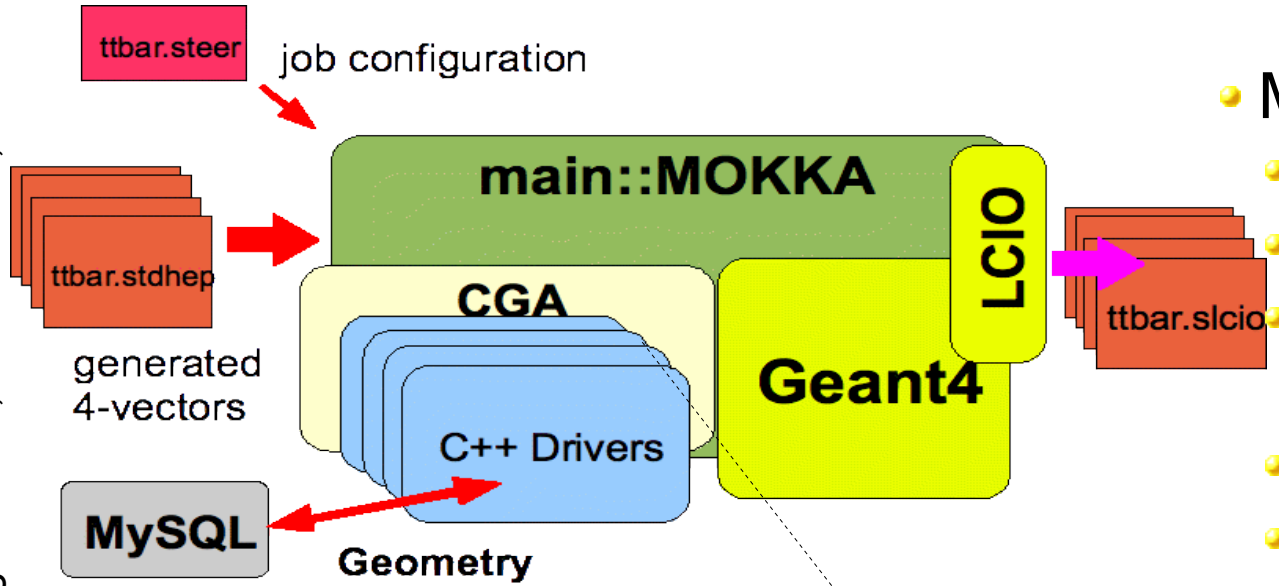
EUDET task ANALYS

- ANALYS: development of a common data analysis and simulation infrastructure
  - development of a software framework for simulation, analysis and comparison of test beam experiments
    - -> have “version 1.0” of framework after 18 months
  - embedded into existing GRID infrastructure
- **strategy**
  - the test beam software effort is tightly integrated with the overall common ILC/LDC software effort !
  - **benefit from synergies where possible**
  - same for grid: integrate with common ILC grid activities

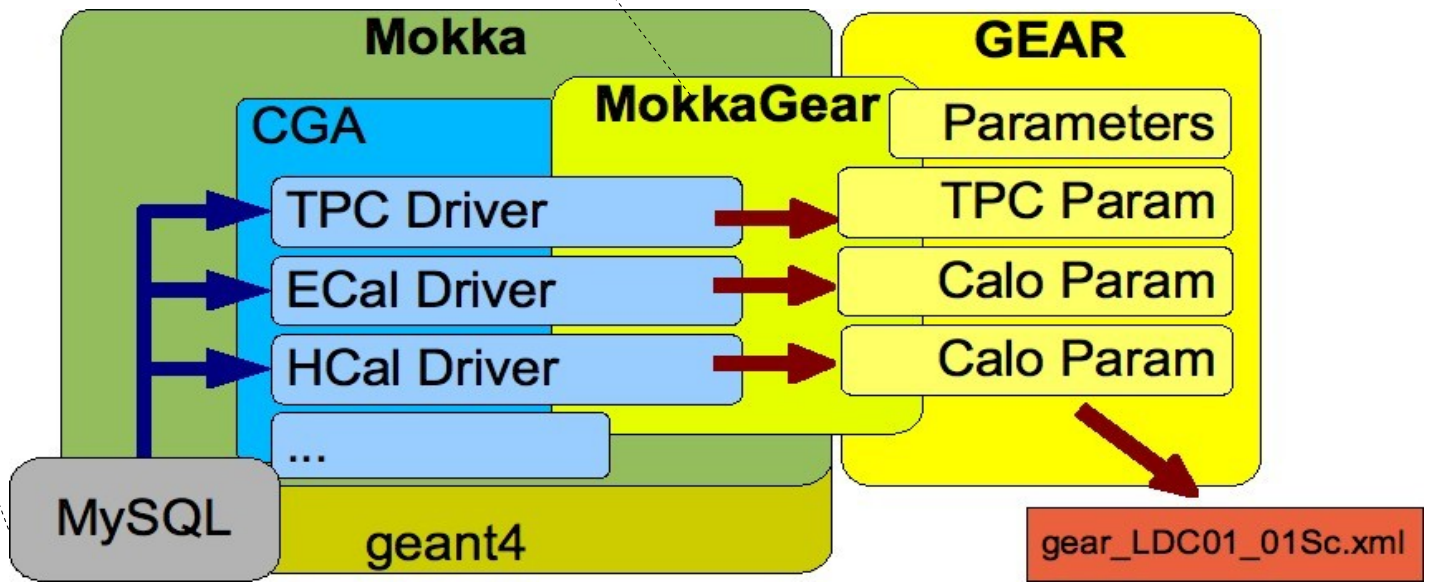
EUDET/LDC SW-framework



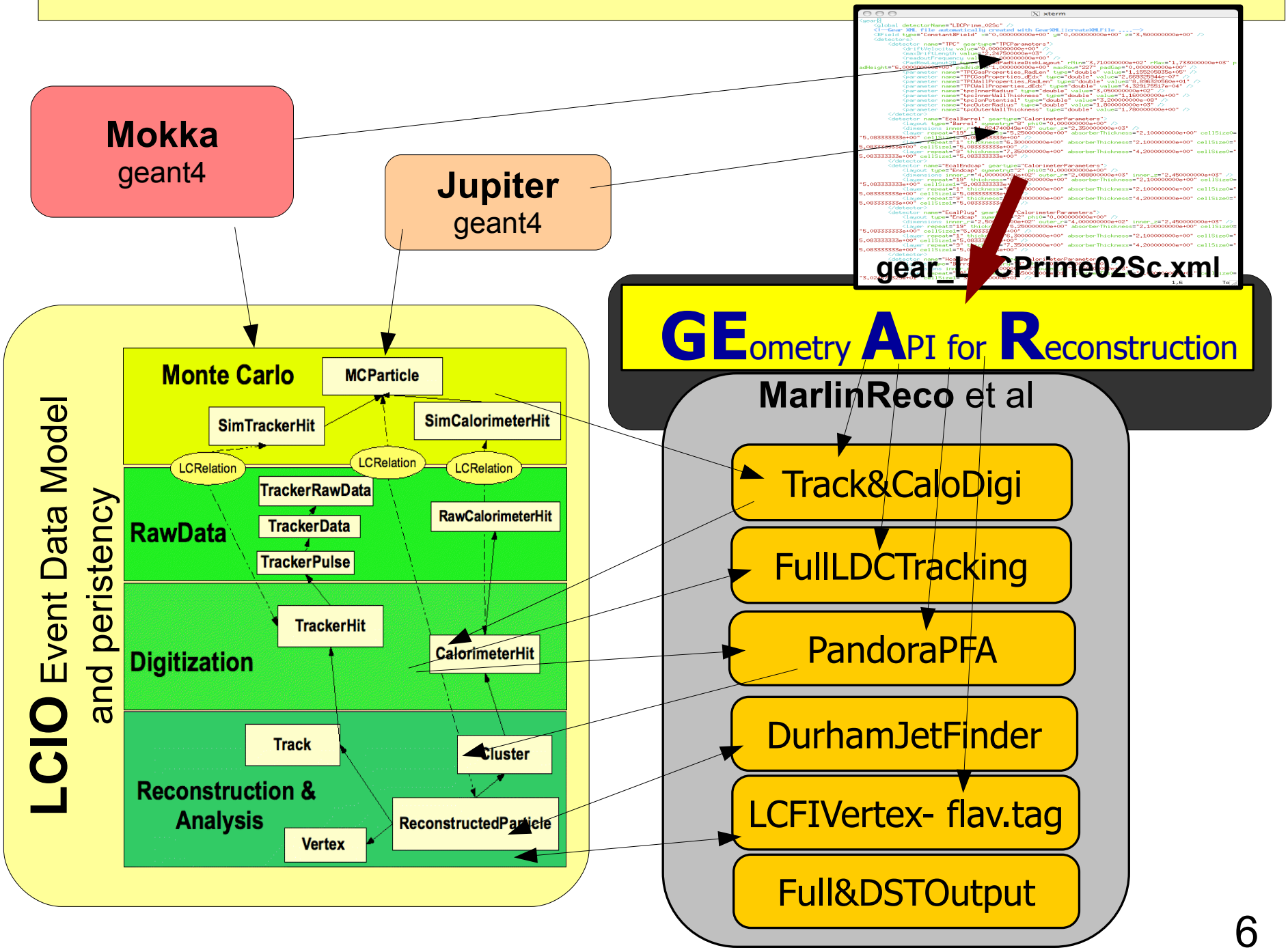
Mokka – geant4 simulation



- Mokka geometry definition:
  - parameters in MySQL-db
  - actual placement in C++
  - flexible ,'perfect' bookkeeping
  - stored in GEAR for reco
  - **one source of geometry**



Marlin-LCIO-Gear



SW-Framework Milestone

- september 2007: v01-00
- 'first' release of fully functional software framework for simulation, reconstruction and analysis of ILC (testbeam) data

Marlin et al - A Software Framework for ILC detector R&D

EUDET-Report-2007-11

F. Gaede*, J. Engels*

December 17, 2007

milestone: “Version 1.0 after 21 month” was reached

however: development should – and has - continued...

recent developments core software

- bug fixes
- improved usability (next slides)
- new features as requested by JRAs:
  - direct access in LCIO
  - event overlay mechanism
- main focus in last 12 month :
  - improve the framework for the detector optimization of ILD detector concept
  - LOI mass production

build & install tools I

Software Installation and Releases

Jan Engels
DESY

ILCInstall

- Python script for installing LDC Software framewor
  - LCIO, GEAR, LCCD, Marlin + modules ...
- Support for external packages
  - CLHEP, GSL, CERNLIB, QT, ...
- Automatic checking of dependencies
- Install whole framework without user-intervention
- Fully configurable (via configuration file)
  - Versions
  - Download related stuff
  - Use/Link/Install packages
  - Dynamic assignment of environment/cmake variables

```
### RAIDA.cfg ######################
# configuration file for installing RAIDA
# into "/data/ilcsoft/RAIDA/v01-03"
####################################
ilcsoft = ILCSoft("/data/ilcsoft")

ilcsoft.useCMake = True

# install RAIDA v01-03
ilcsoft.install( RAIDA( "v01-03" ))

# example for setting cmake build variables
ilcsoft.module( "RAIDA" ).envcmake["BUILD_

# link ROOT
ilcsoft.link( ROOT( "/afs/desy.de/group/it/ilcso

# CMake Modules
ilcsoft.install( CMakeModules( "v01-02" ))

# End of configuration file
```

- start ilcinstall script
- go to lunch
- run ilcsoftware

ILCInstall:

- Current version: v01-02-01
- Currently Supported modules:
  - LCIO, GEAR, LCCD, RAIDA, Marlin, MarlinUtil, MarlinReco, CED, CEDViewer, PandoraPFA, LCFIVertex, SiliconDigi, Overlay, Eutelescope, Mokka, CLHEP/HepPDT, GSL, CERNLIB, CondDBMySQL, QT, CMake, CmakeModules, ROOT, Geant4, AIDAJNI, JAIDA, Java, MySQL

build & install tools II

- ilcinistall tool now used by JRAs
- new developments:
- grid installations:
  - install ilcsoft on (standard LCG Grid sites)
  - -> user can run their jobs much easier
- binary installations
  - tar-files with complete ilcsoft (for SL4)
  - -> http://ilcsoft.desy.de
- new SVN server
  - developed at Zeuthen
  - better/easier code mgmt
    - -> to be activated soon

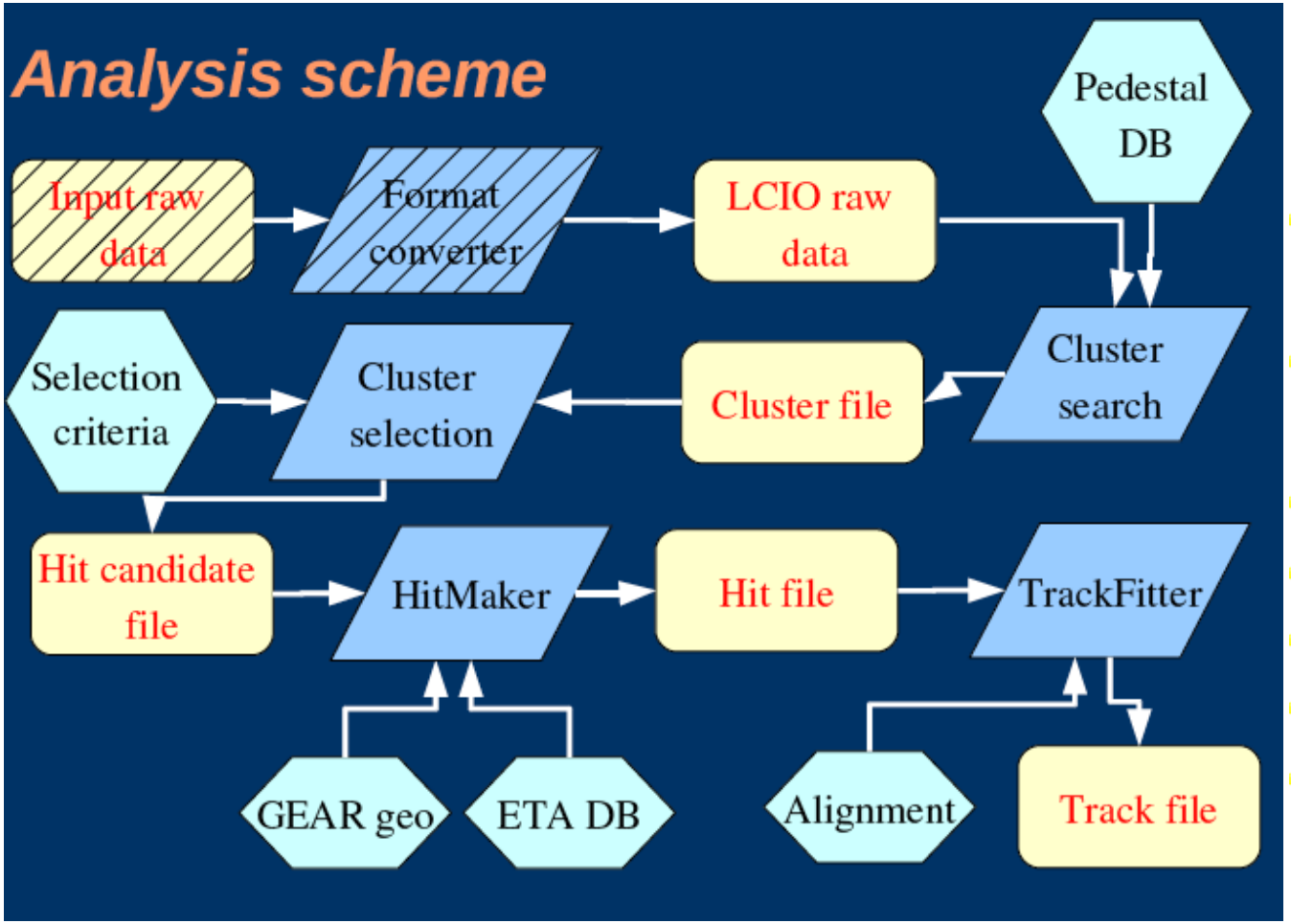
ilcsoft Grid installations

CE	SW-VER	SW-OS	DATE	TIME	SYS	SE	SAM	JOB	TAGGED	HIST-LOGS
cclcgceli01.in2p3.fr	v01-04	sl4	2008-09-25	15-14-43	OK	OK	OK	OK	VO-ilc-ilcsoft-v01-03-06-sl4 VO-ilc-ilcsoft-v01-04-sl4	History
cclcgceli02.in2p3.fr	v01-04	sl4	2008-09-25	15-14-43	OK	OK	OK	OK	VO-ilc-ilcsoft-v01-03-06-sl4 VO-ilc-ilcsoft-v01-04-sl4	History
ce.bfg.uni-freiburg.de	v01-04	sl4	2008-09-25	15-14-43	OK	OK	OK	OK	VO-ilc-ilcsoft-v01-03-06-sl4 VO-ilc-ilcsoft-v01-04-sl4	History
ce.glite.ecdf.ed.ac.uk	v01-04	sl4	2008-09-25	15-14-43	OK	OK	OK	OK	VO-ilc-ilcsoft-v01-03-06-sl4 VO-ilc-ilcsoft-v01-04-sl4	History
ce01.dur.scotgrid.ac.uk	v01-04	sl4	2008-09-25	15-14-43	OK	OK	OK	OK	VO-ilc-ilcsoft-v01-03-06-sl4 VO-ilc-ilcsoft-v01-04-sl4	History
ce01.tier2.hep.manchester.ac.uk	v01-04	sl4	2008-09-25	15-14-43	OK	OK	OK	OK	VO-ilc-ilcsoft-v01-03-06-sl4 VO-ilc-ilcsoft-v01-04-sl4	History
fal-pygrid-18.lancs.ac.uk	v01-04	sl4	2008-09-25	15-14-43	OK	OK	OK	OK	VO-ilc-ilcsoft-v01-03-06-sl4 VO-ilc-ilcsoft-v01-04-sl4	History
grid-ce3.desy.de	v01-04	sl4	2008-09-25	15-14-43	OK	OK	OK	OK	VO-ilc-ilcsoft-v01-03-06-sl4 VO-ilc-ilcsoft-v01-04-sl4	History
grid10.lal.in2p3.fr	v01-04	sl4	2008-09-25	15-14-43	OK	OK	OK	OK	VO-ilc-ilcsoft-v01-03-06-sl4 VO-ilc-ilcsoft-v01-04-sl4	History
lcg-ce1.ifh.de	v01-04	sl4	2008-09-25	15-14-43	OK	OK	OK	OK	VO-ilc-ilcsoft-v01-03-06-sl4 VO-ilc-ilcsoft-v01-04-sl4	History
lcgce02.gridpp.rl.ac.uk										History
polgrid1.in2p3.fr	v01-04	sl4	2008-09-25	15-14-43	OK	OK	OK	OK	VO-ilc-ilcsoft-v01-03-06-sl4 VO-ilc-ilcsoft-v01-04-sl4	History
svr021.gla.scotgrid.ac.uk	v01-04	sl4	2008-09-25	15-14-43	OK	OK	OK	OK	VO-ilc-ilcsoft-v01-03-06-sl4 VO-ilc-ilcsoft-v01-04-sl4	History

if you need ilcsoft on your site – let us know

JRA1: EUTelescope SW

Philipp Roloff (DESY) for the JRA1 analysis group



- started to use the framework last year
- now increased number of users
- improved usability
- using ilcinstall
- use Grid installations
- new features
- -> see next slides

- Based on the existing ILC software framework (Marlin, LCIO, GEAR, (R)AIDA, CED, …)
- Good experience with running on the GRID

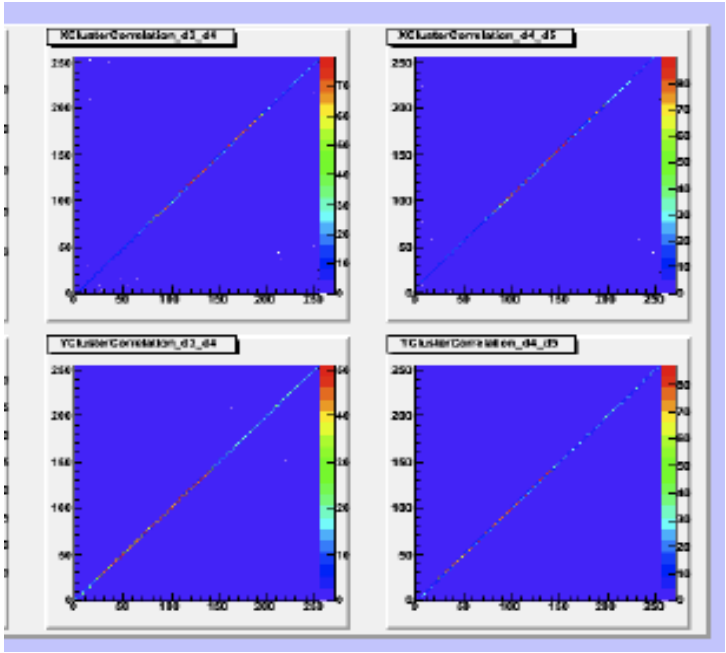
JRA1 – EUTelescope II

- integration of DUT data into telescope data stream:
  - *Integration at DAQ SW level*: The user provides own DAQ hardware, but the data are treated by the EUDAQ software
  - *Integration at trigger level*

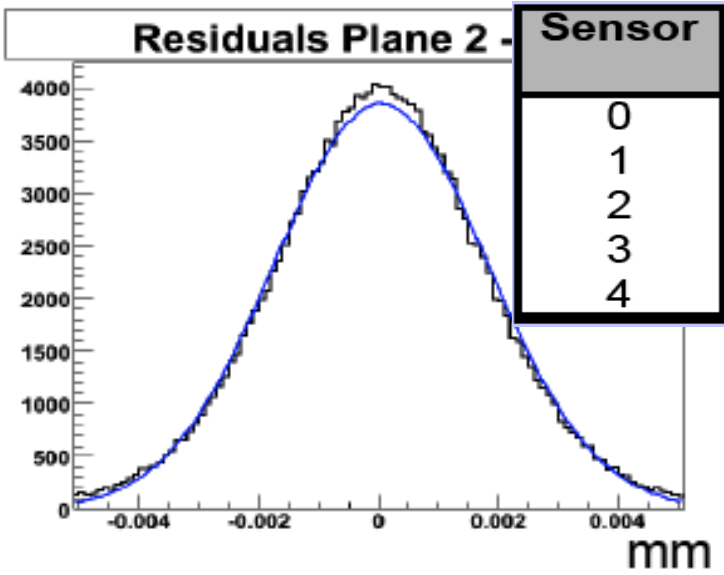
In the first case EUDAQ allows to include DUT data in the native output file → safest possible synchronisation

Universal native reader:
- Very general data reading and conversion processor
- Automatically detects from the native EUDAQ files which sensors were used and converts the information from the native format to LCIO

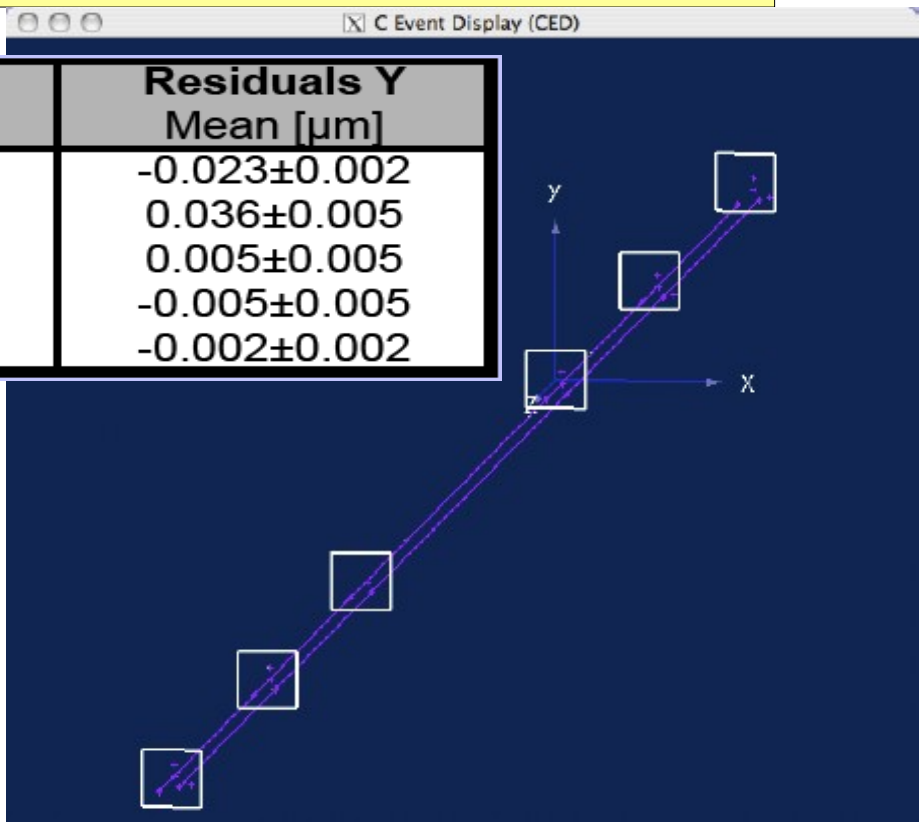
- new feature: correlator:
  - Monitor the data quality
  - Verify the geometry description
  - Check alignment

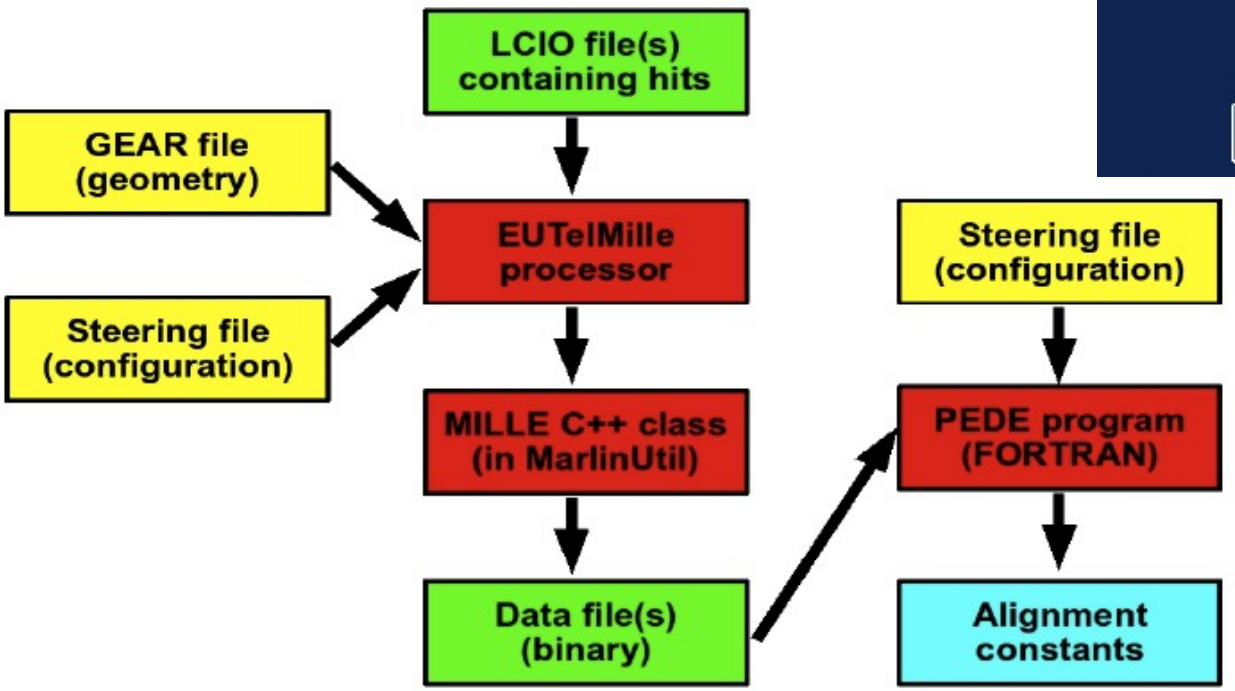


JRA1 – EUTelescope III



Sensor	Residuals X Mean [μm]	Residuals Y Mean [μm]
0	-0.003±0.002	-0.023±0.002
1	-0.012±0.004	0.036±0.005
2	0.032±0.004	0.005±0.005
3	-0.020±0.004	-0.005±0.005
4	0.001±0.002	-0.002±0.002





- new alignment procedure
  - based on millepede
  - implemented !

Jason Abernathy[2], Klaus Dehmelt[3], Ralf Diener[3], Jan Engels[3], Jim Hunt[4],
Matthias Enno Janssen[3], Thorsten Krautscheid[1], Astrid Münnich[5], Stephen Turnbull[6],
Martin Ummenhofer[1], Adrian Vogel[3], Peter Wienemann[1] and Simone Zimmermann[1]

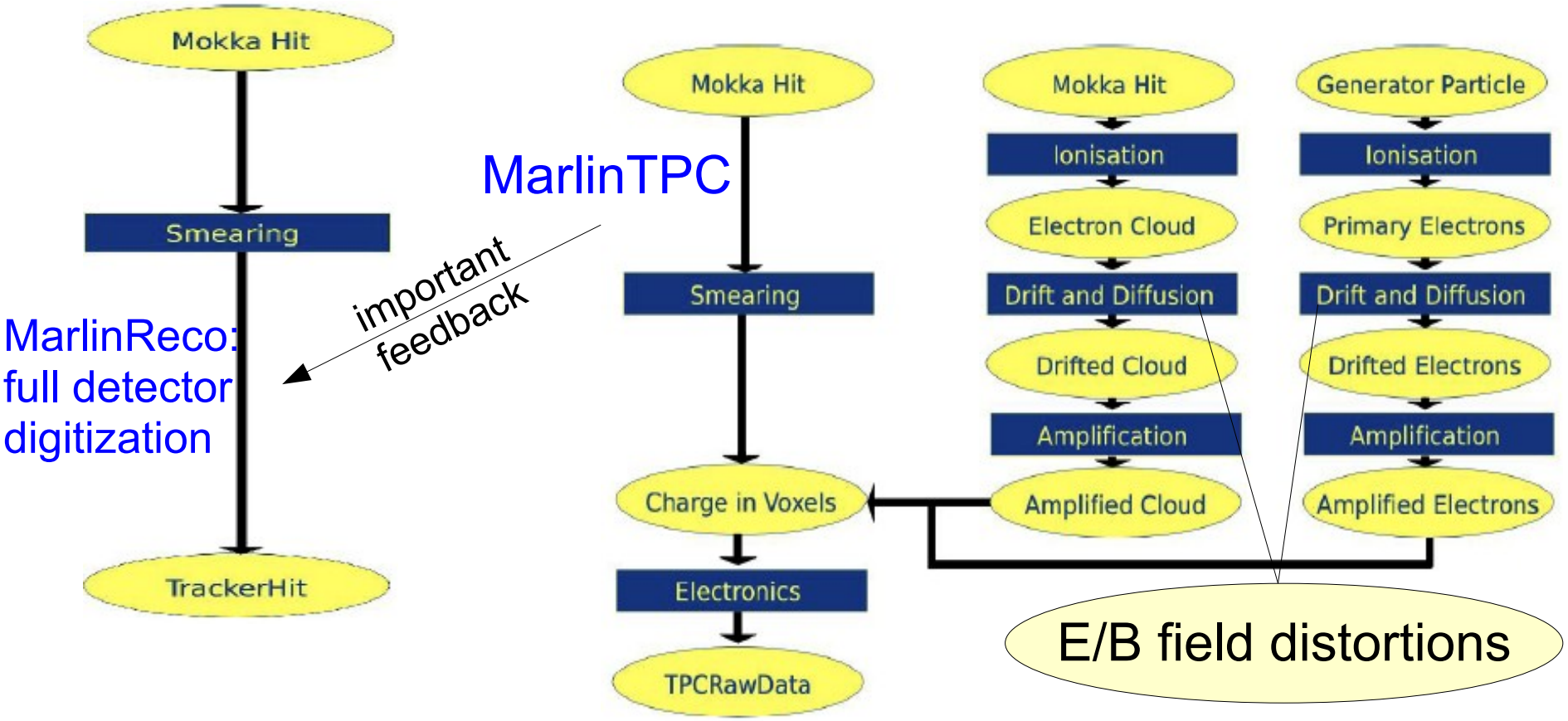
1: University of Bonn — 2: University of Victoria — 3: DESY Hamburg
4: Cornell University — 5: TRIUMF — 6: CEA IRFU Saclay

MarlinTPC:
Reconstruction Software for Time Projection Chambers

- Based on Marlin, LCIO, Gear and LCCD
- Developed in an international effort

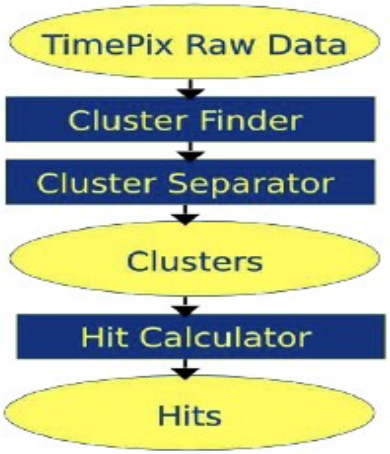
- Highly modular and independent of specific detector, works for:
  - Prototypes and large ILC detector TPCs
  - MICROMEGAS, GEMs and Anode Wires
  - Pad and Pixel (TimePix) readout
  - ADC and TDC read-out electronics

JRA2 – MarlinTPC II

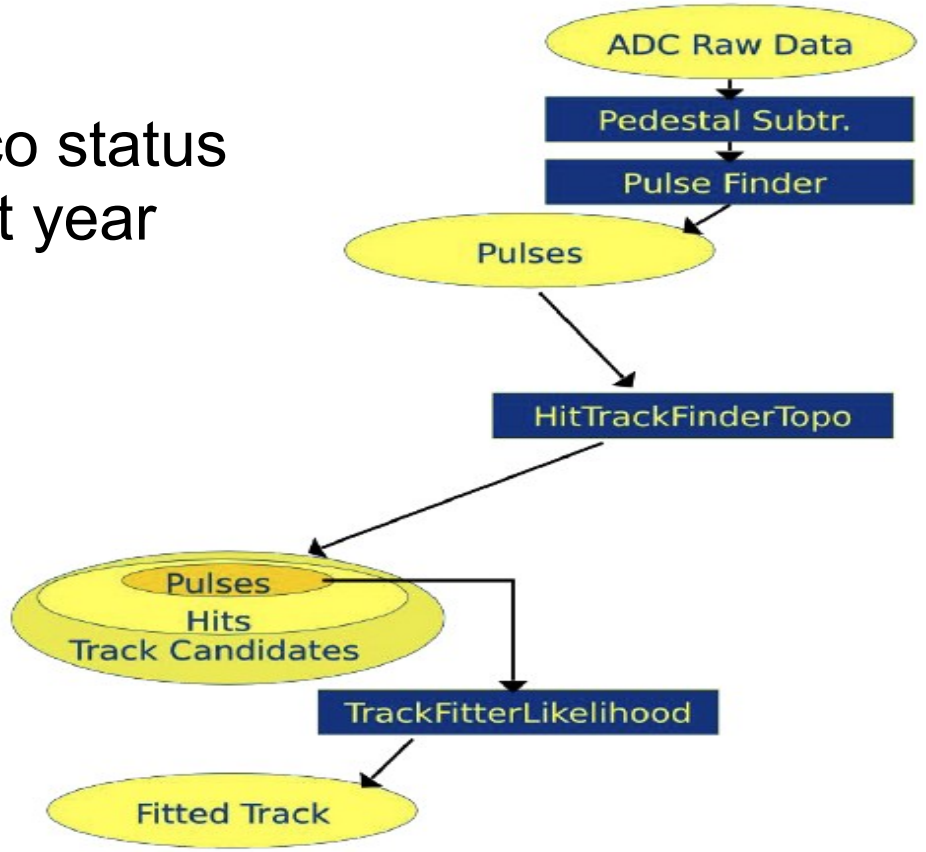


- MarlinTPC simulation with various levels of detail:
  - hit smearing -> charge in voxels
  - electron cloud or primary electron drift
  - effects of either B or E field distortions

JRA2 – MarlinTPC III

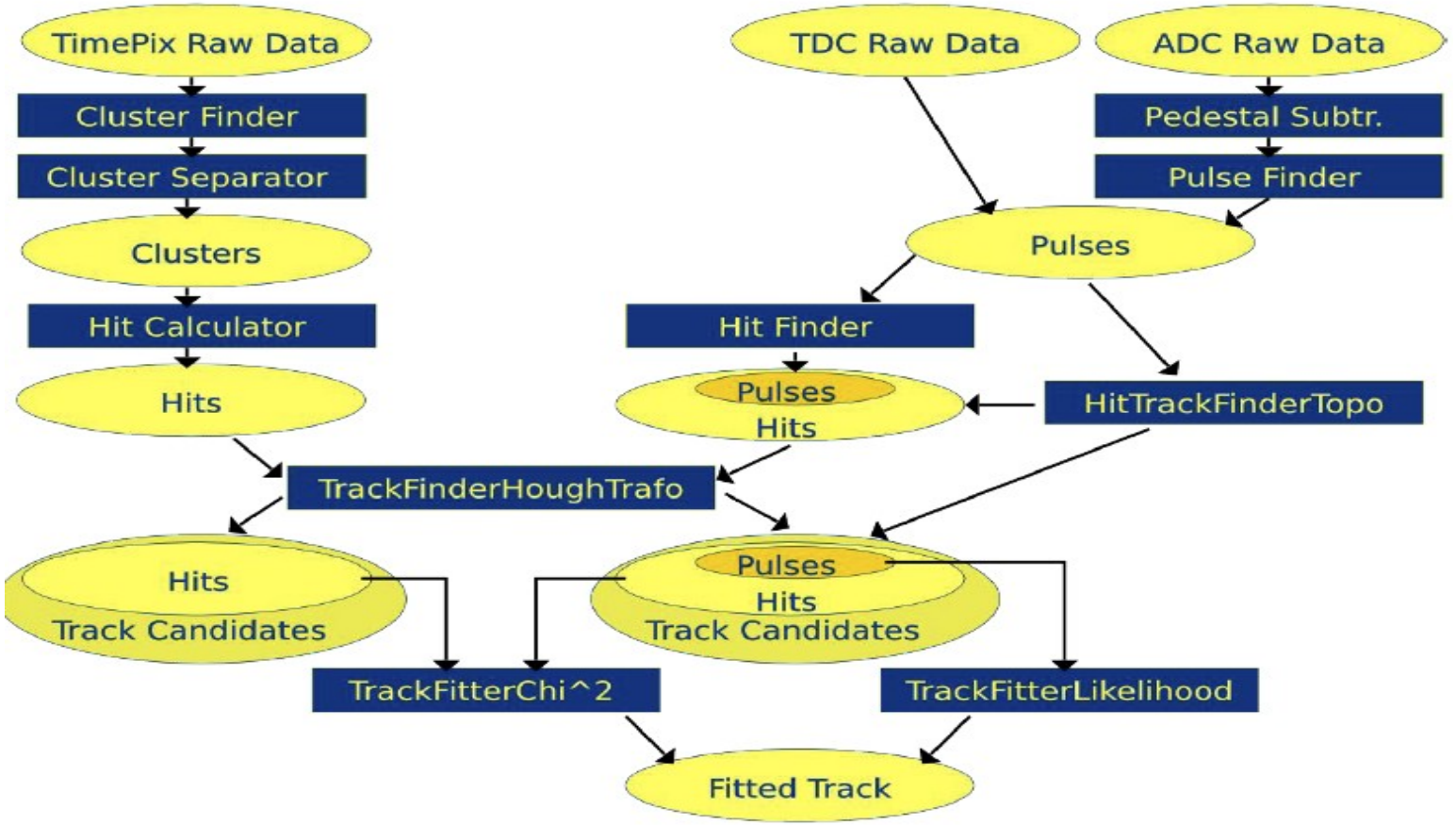


reco status
last year



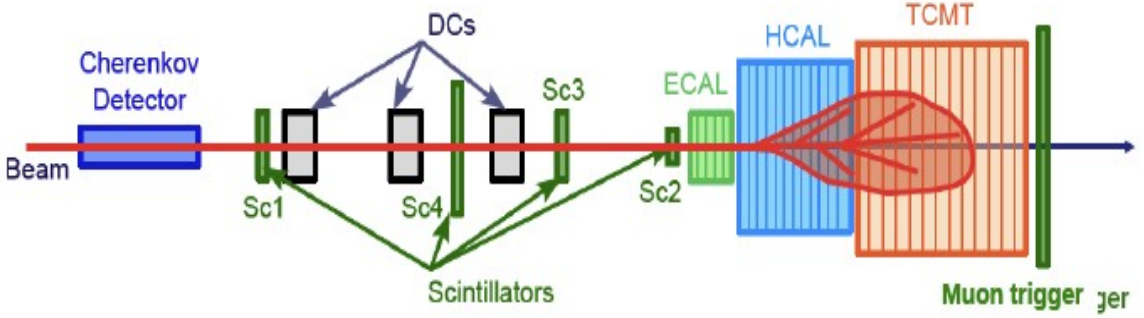
- improved/new reconstruction algorithms:
  - timepix reconstruction
    - hought transform / track fitter
  - TDC reco
  - Hit finder

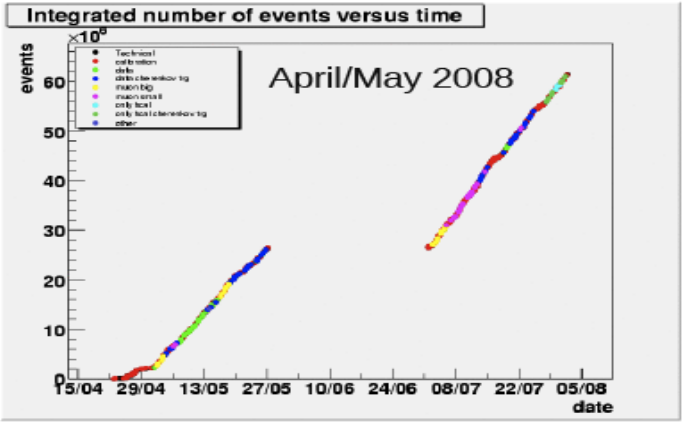
JRA2 – MarlinTPC III

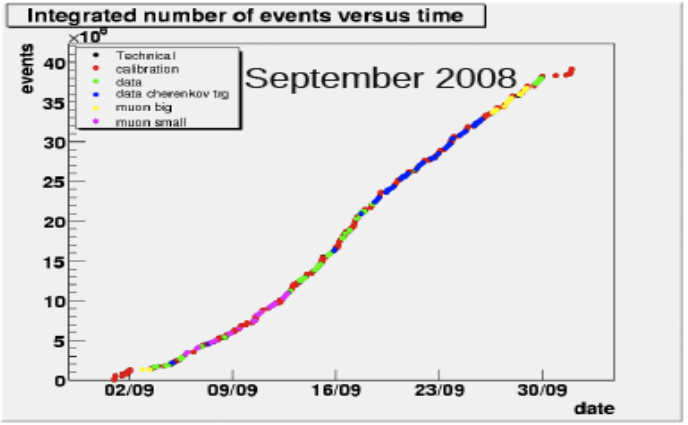


- improved/new reconstruction algorithms:
  - timepix reconstruction
    - hought transform / track fitter
  - TDC reco
  - Hit finder

JRA3 – Calice software I

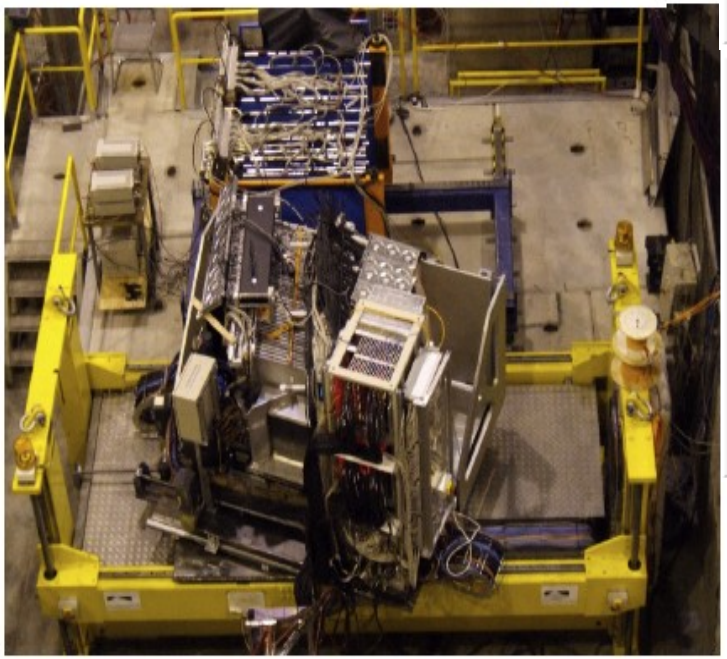






Data recorded:

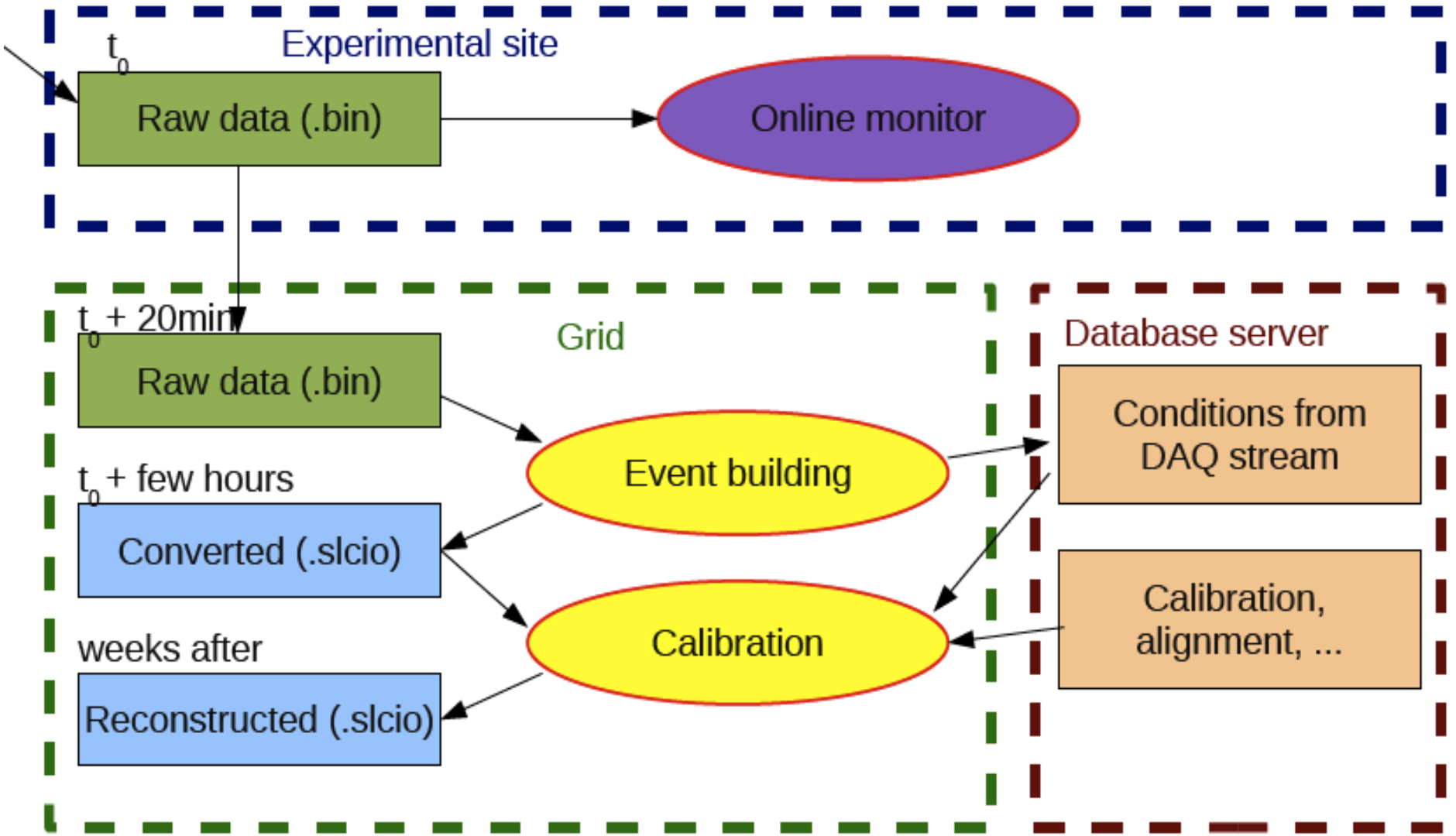
- 2006 – DESY/CERN
- 2007 - CERN
- **2008 – Fermilab MTBF**
- Si-W/Sci-W ECAL, HCAL, TCMT
- e± 1-50 GeV
- μ± (mainly for calibration)
- π± 2-180 GeV
- Various impact points
- Angles of incidence:
  0±, 20±, 30±, 45±
- Typically ~200K events per configuration.



>300 Mio events
~40 TB (incl.MC/processed)

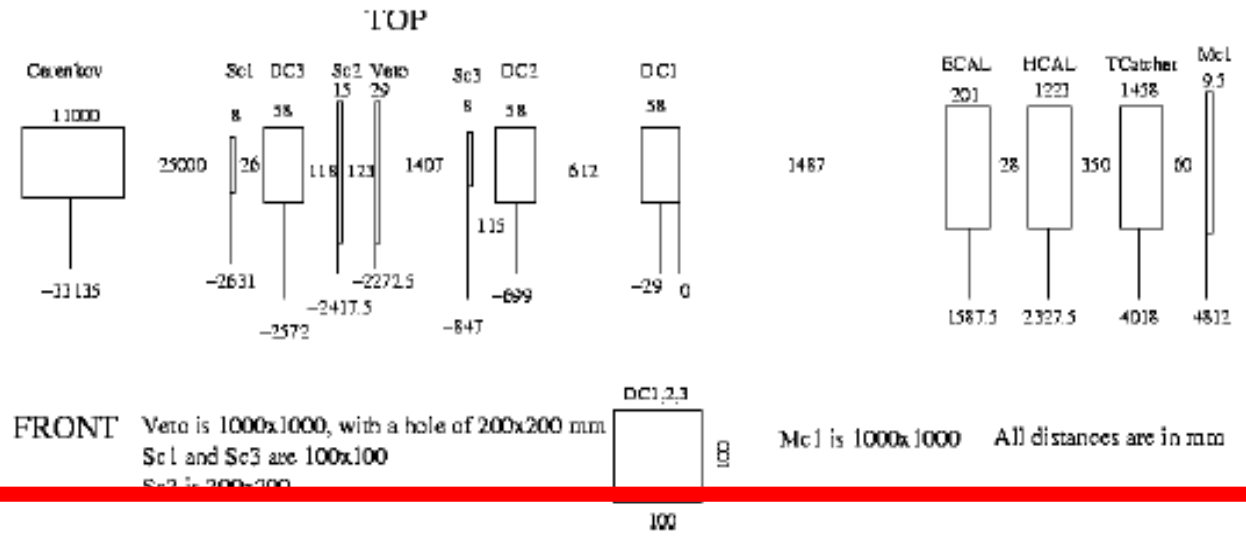
Calice was first collaboration/group to adopt the common software framework serving as a real world “testbed” for developing and improving the framework

JRA3 – Calice software II



JRA3 – Calice software III

- Detailed shower simulation including beam instrumentation using MOKKA/Geant 4



- Hot topic: Independent geometry description in data (LCCD-based conditions) and MOKKA (special database for free parameters)
- Digitization using LCIO/Marlin/LCCD, partially identical reconstruction for data and MC

joined session: NA2-VALSIM and JRA3 Hadronic shower models and Calice testbeam data

Hadron showers: geant4 & Calice I

Development and Validation of Geant4 hadronic models

V. Uzhinsky (CERN and LIT JINR)

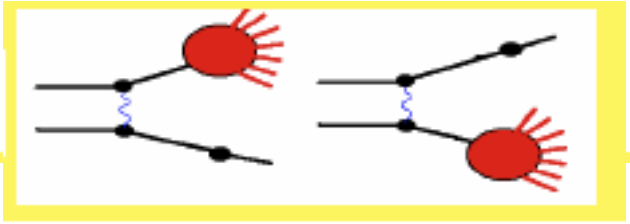
VALSIM project in the Collaboration with the Geant4

Hadronic models in G4: QGSM, E > 10 GeV:

Fritiof (FTF) model, E > 3-5 GeV:

the binary cascade model, E < 9 GeV:

the Bertini cascade model, E < 9 GeV.

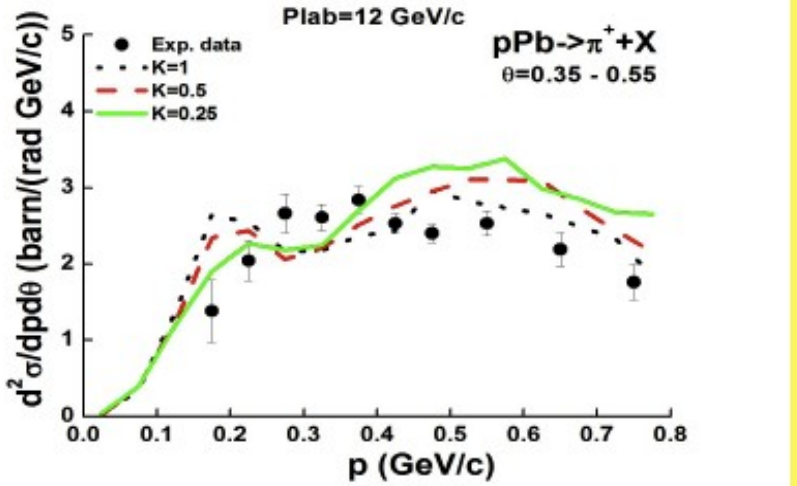


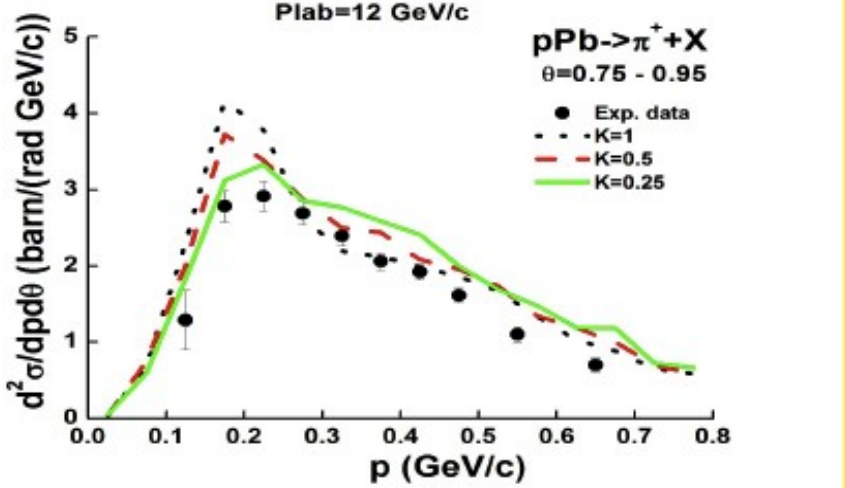
Fritiof: diffractive dissociation

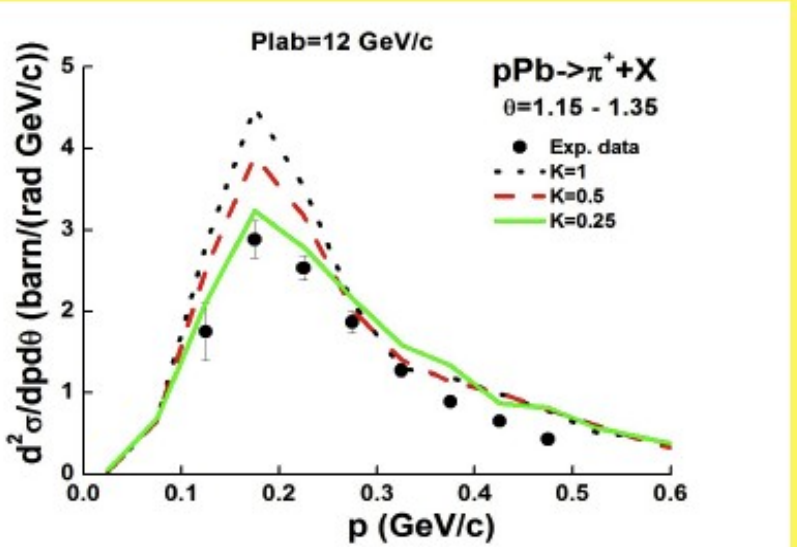
QGS is today the main model for hadronic interactions, used in QGSP & QGSP_BERT physics lists. It has good validation above ~15 GeV (?). A key need is a model spans down to energy ceiling of Geant4 'cascades' (3-10 GeV)

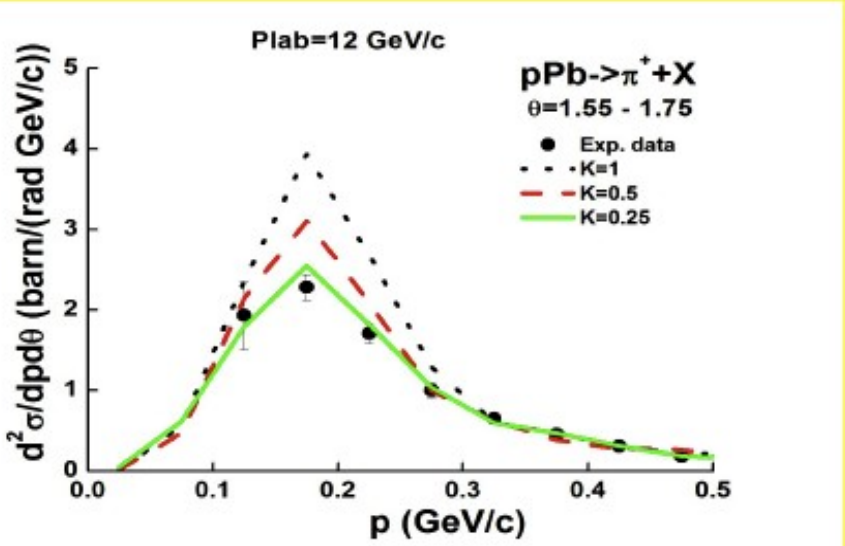
We hoped that an improvement of the Fritiof model would help to solve problems.

Hadron showers: geant4 & Calice II



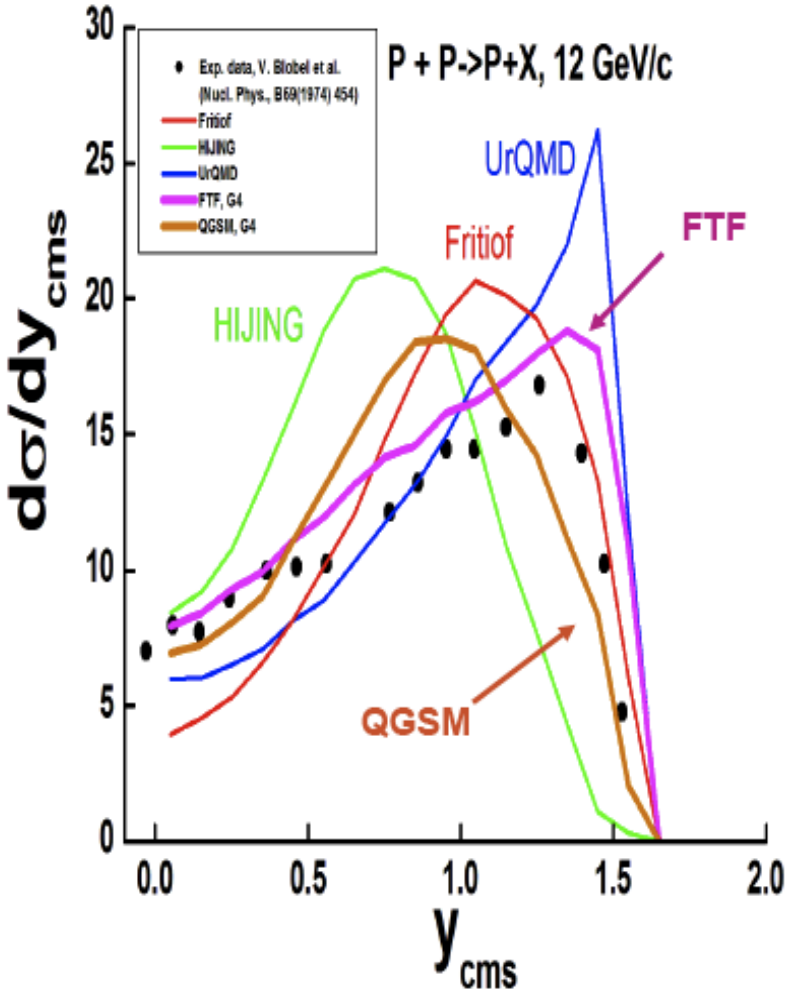


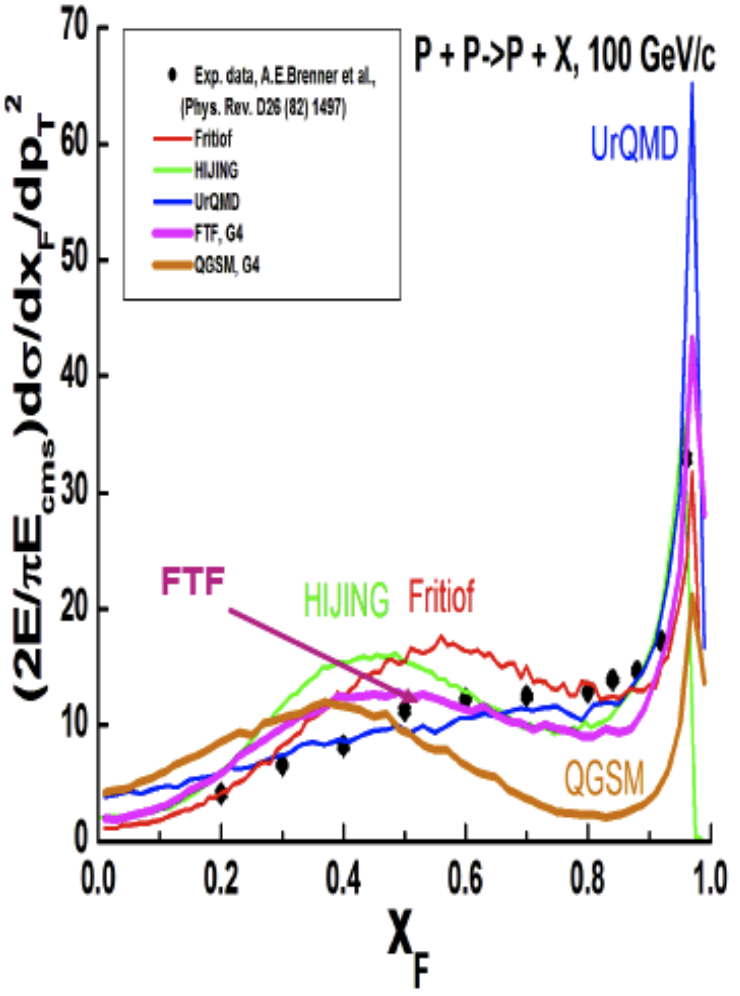




Formation time at string fragmentation was implemented before.

Hadron showers: geant4 & Calice III



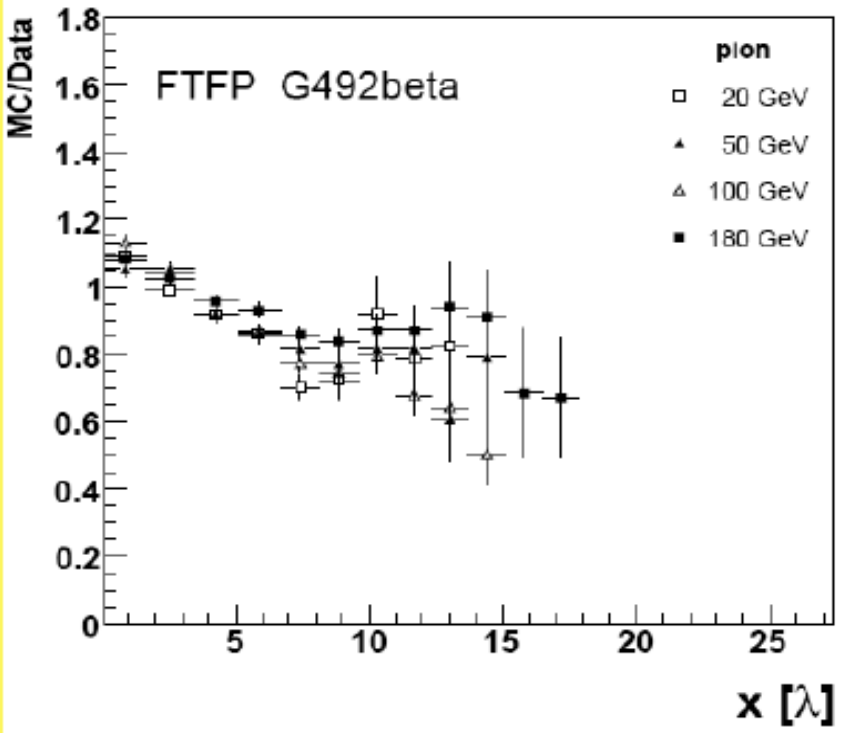


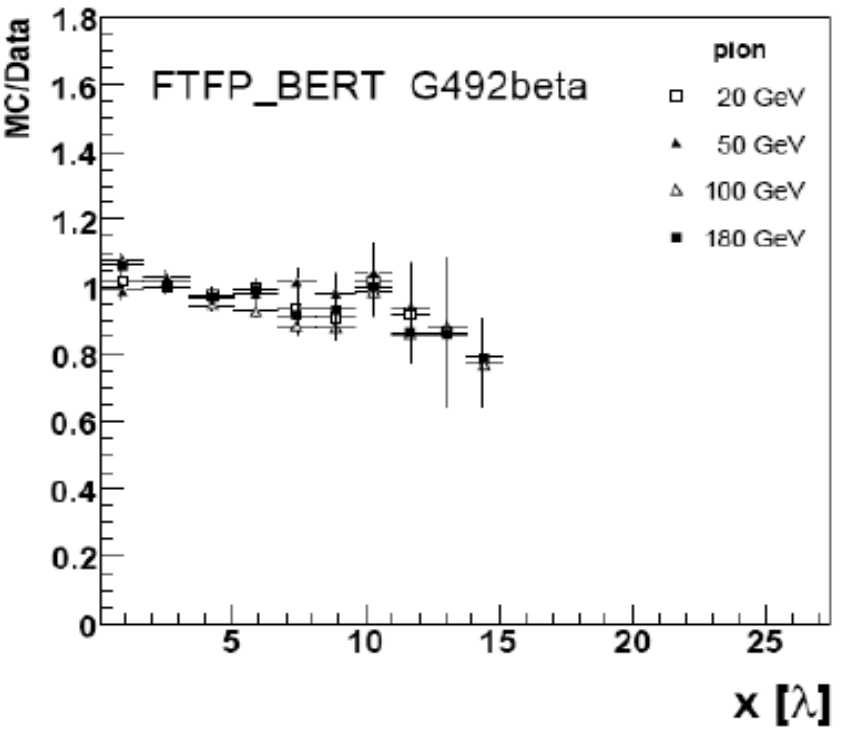
Description of baryon spectra is a problem in all MC models. We have a good solution in FTF.

Hadron showers: geant4 & Calice IV

Comparison of results of Geant4.9.2-beta to ATLAS TileCal test beam data, Margar Simonyan (*LAPP*) Calor 2008

Longitudinal Profile, dE/dx(Monte Carlo)/dEdx(Exp.data)= MC/Data



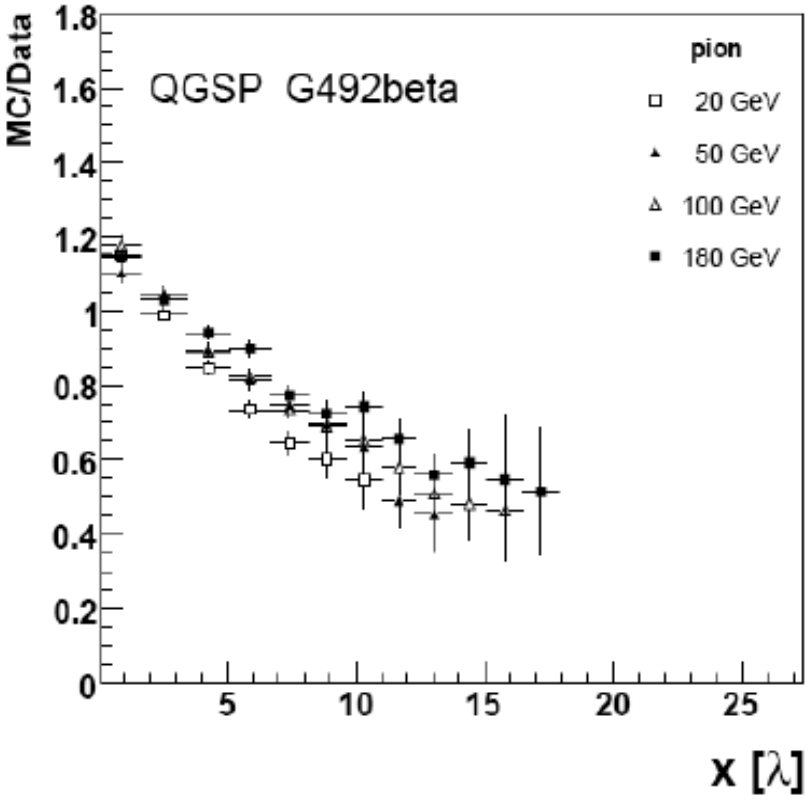


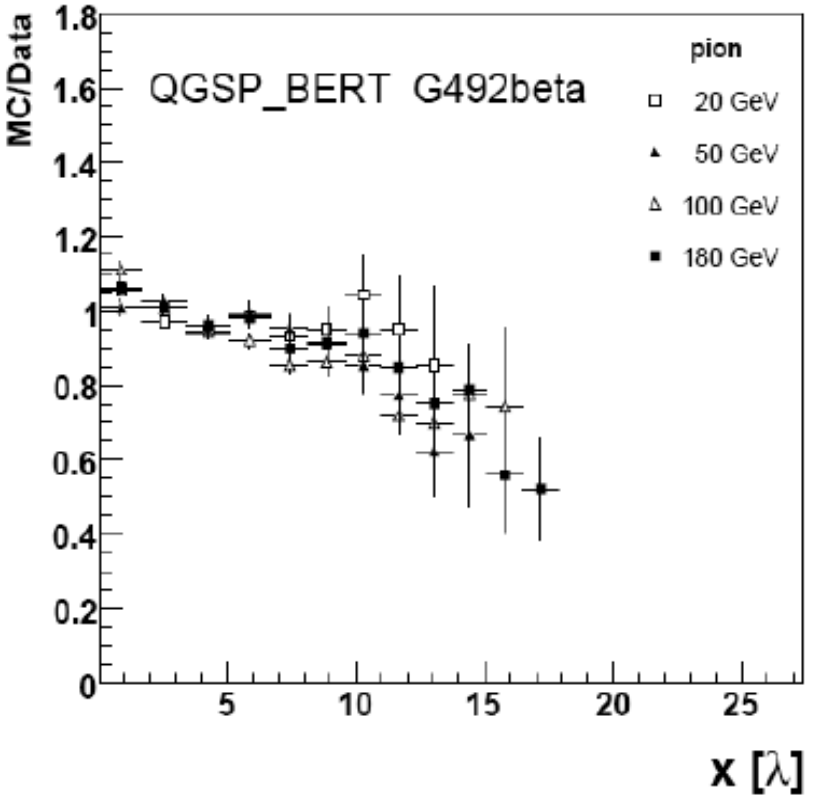
- With Fritiof model showers are a bit shorter, up to 10λ within ±20%.
- With Bertini cascade MC describes data up to 10λ within ±10%.

Hadron showers: geant4 & Calice V

Comparison of results of Geant4.9.2-beta to ATLAS TileCal test beam data, Margar Simonyan (*LAPP*) Calor 2008

Longitudinal Profile, dE/dx(Monte Carlo)/dEdx(Exp.data)= MC/Data

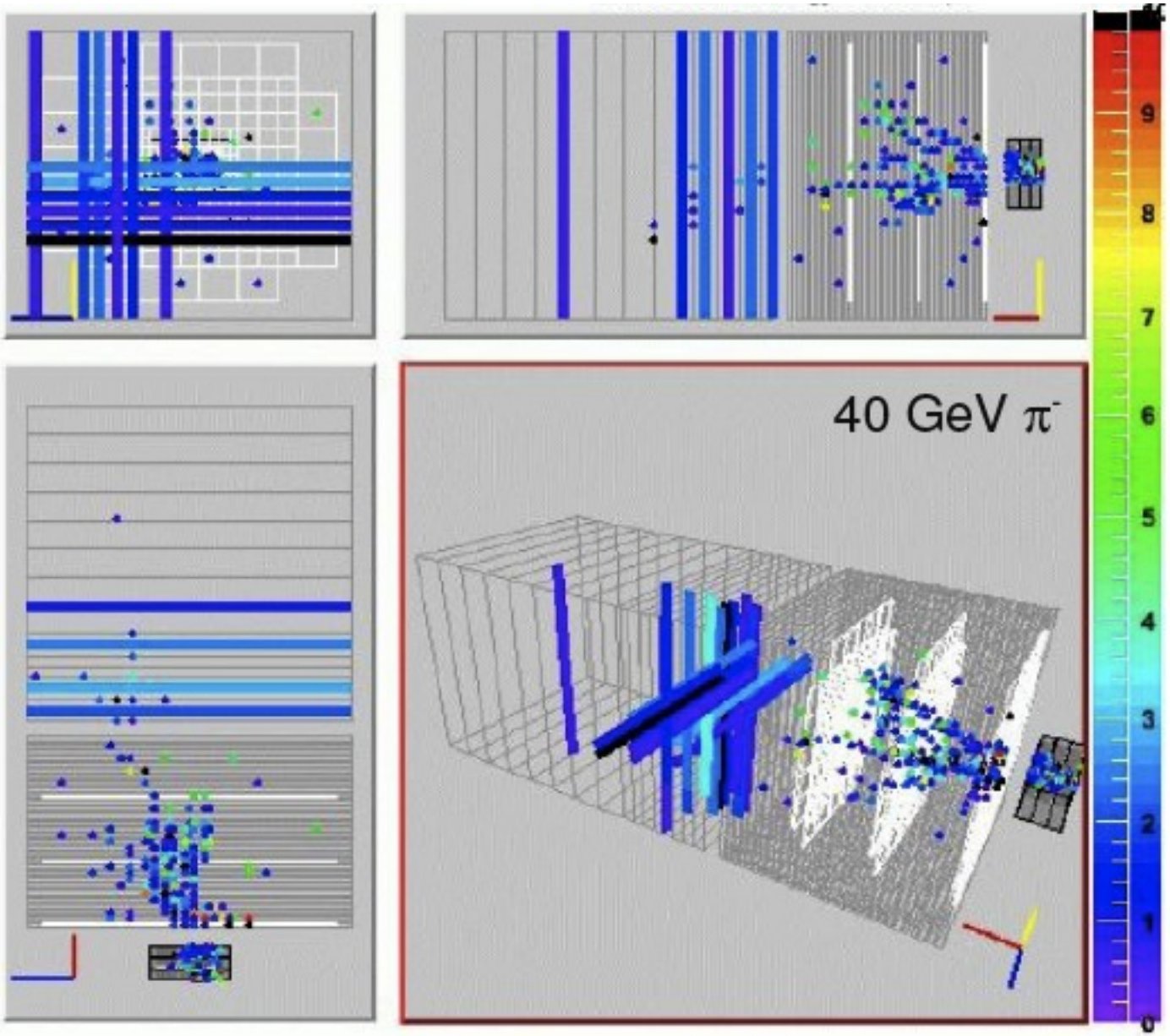




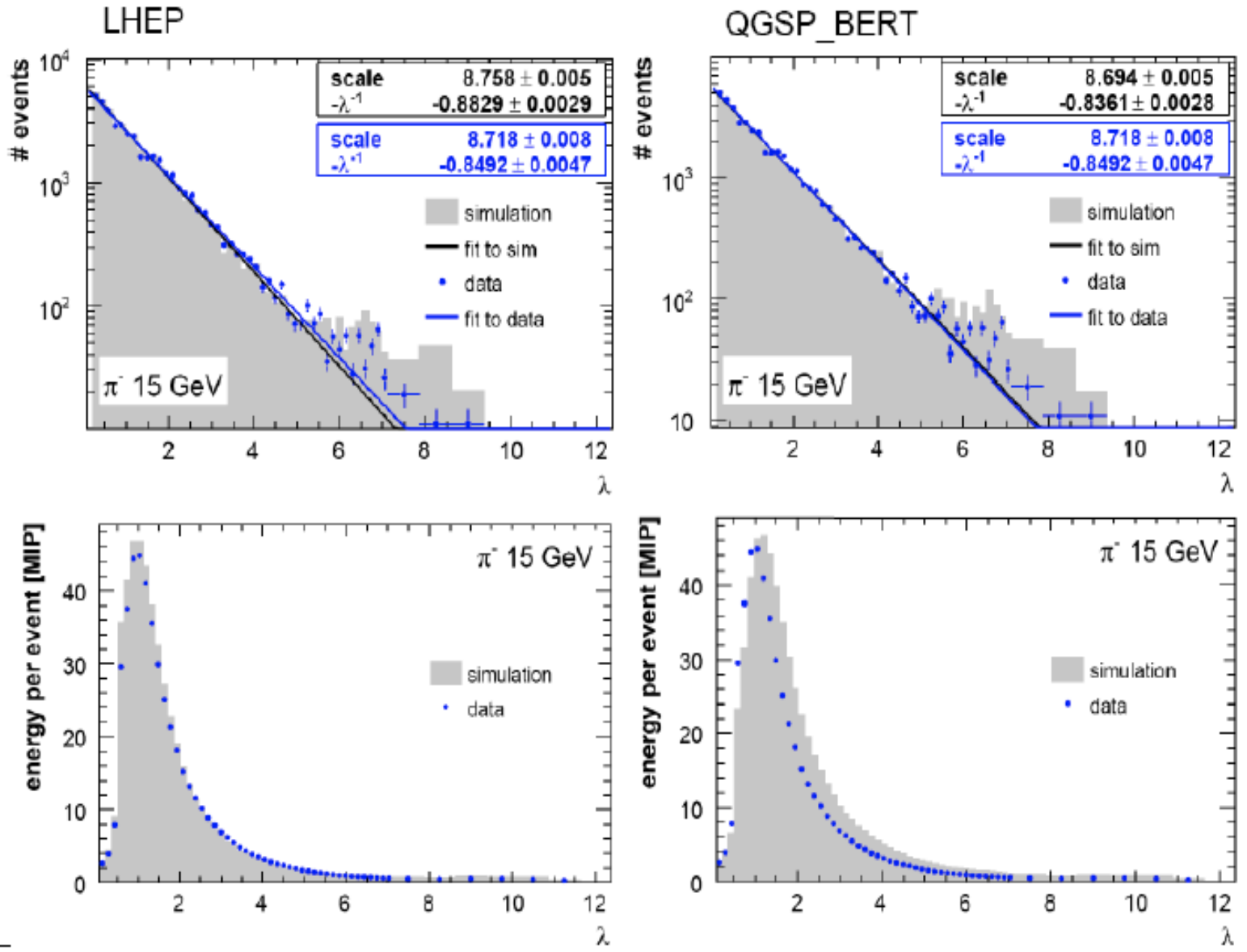
- Showers simulated with QGSP are too short, 20 – 40% less energy at 10λ.
- Adding Bertini makes showers longer, up to 10λ within ±15%.

Hadron showers: geant4 & Calice VI

calice testbeam with imaging calorimeters



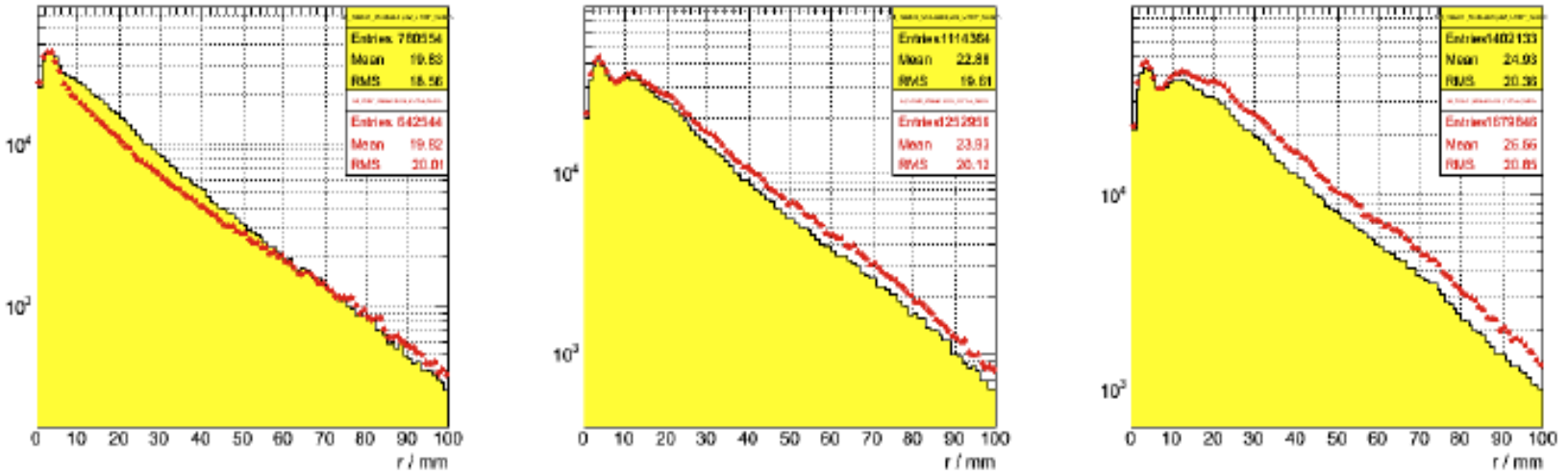
Hadron showers: geant4 & Calice VII



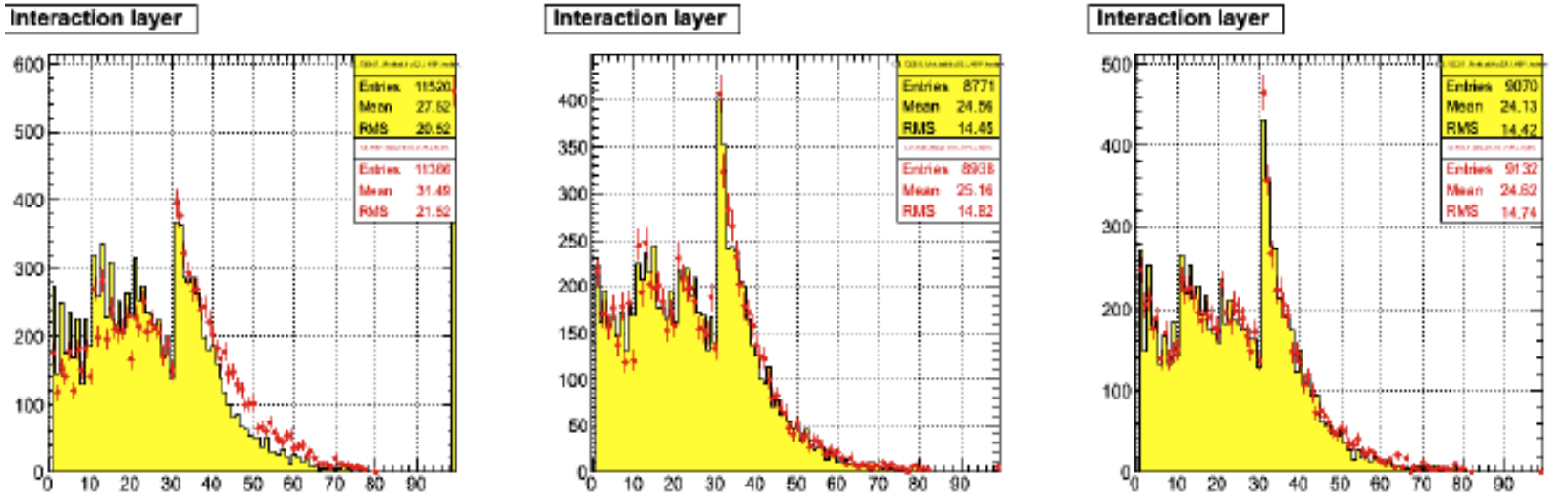
calice started to compare topological shower data to geant4 hadron shower models...

Hadron showers: geant4 & Calice VIII

MC only, compare LHEP with LCPhys



Radial distribution of hits in Ecal



First interaction layer

...and look for variables where geant4 physics lists differ

Hadron showers: geant4 & Calice IX

- CALICE has tens of millions of hadronic events in energy range from 2 to 120 GeV.
- the understanding of the data has reached a precision level of a few %,
- analysis is still focussed on global quantities (linearity, reolutions, profiles), substructure and correlations will be studied next
- suggestions from the model builders for the choice of observables and cuts would be welcomed
- Calice will provide detailed experimental setup to geant4 for independent simulation studies and discuss the existing data
- agreement between CALICE and geant4 to have more regular contact

Summary - Outlook

- "version 1.0" of core framework was ready 2007
  - last year focused on improvements
    - e.g. build and installation tools developed
- all JRAs have software frameworks based on core framework
  - lots of progress in user 'application software' built on the common core tools
- grid is used for data processing and storage
- calice and geant4 started cooperation on hadronic shower simulation
- continue successful cooperation between core software developers and detector R&D groups