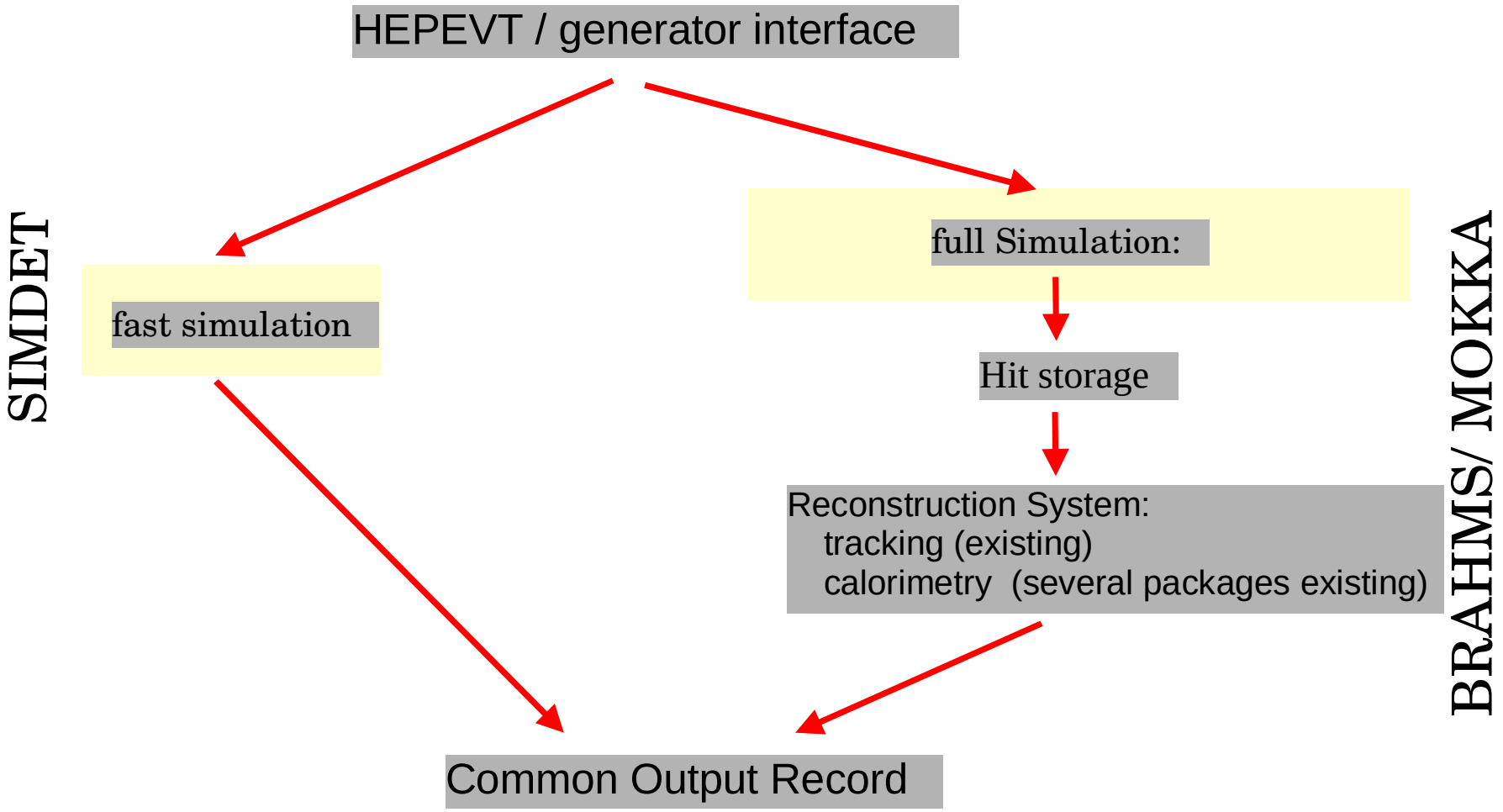
The EU Simulation Environment

Ties Behnke, SLAC/ DESY

- BRAHMS: our trusted, old full simulation package
  - FORTRAN
  - GEANT321
  - grown, not designed
- The new world:
  - MOKKA
  - GEANT4
  - Object oriented
- SIMDET: the fast simulator
  - FORTRAN
  - fast
  - Fairly complete
  - one detector: TESLA TDR
- SGV: fast Simdet alternative

The simulation framework



We are working on defining a common hit storage format between BRAHMS and MOKKA, and between the European and the US frameworks

BRAHMS

The BRAHMS suite contains two programs:

- GEANT3 based simulation code (“BRAHMS proper”)
- The reconstruction program RERECO

technical detail:
simulation and reco may be run together or separately

BRAHMS: The **simulation** program:

- complete implementation of the TDR tracker
- full implementation of the TDR calorimeter
- full implementation of the forward system
- full implementation of the muon system

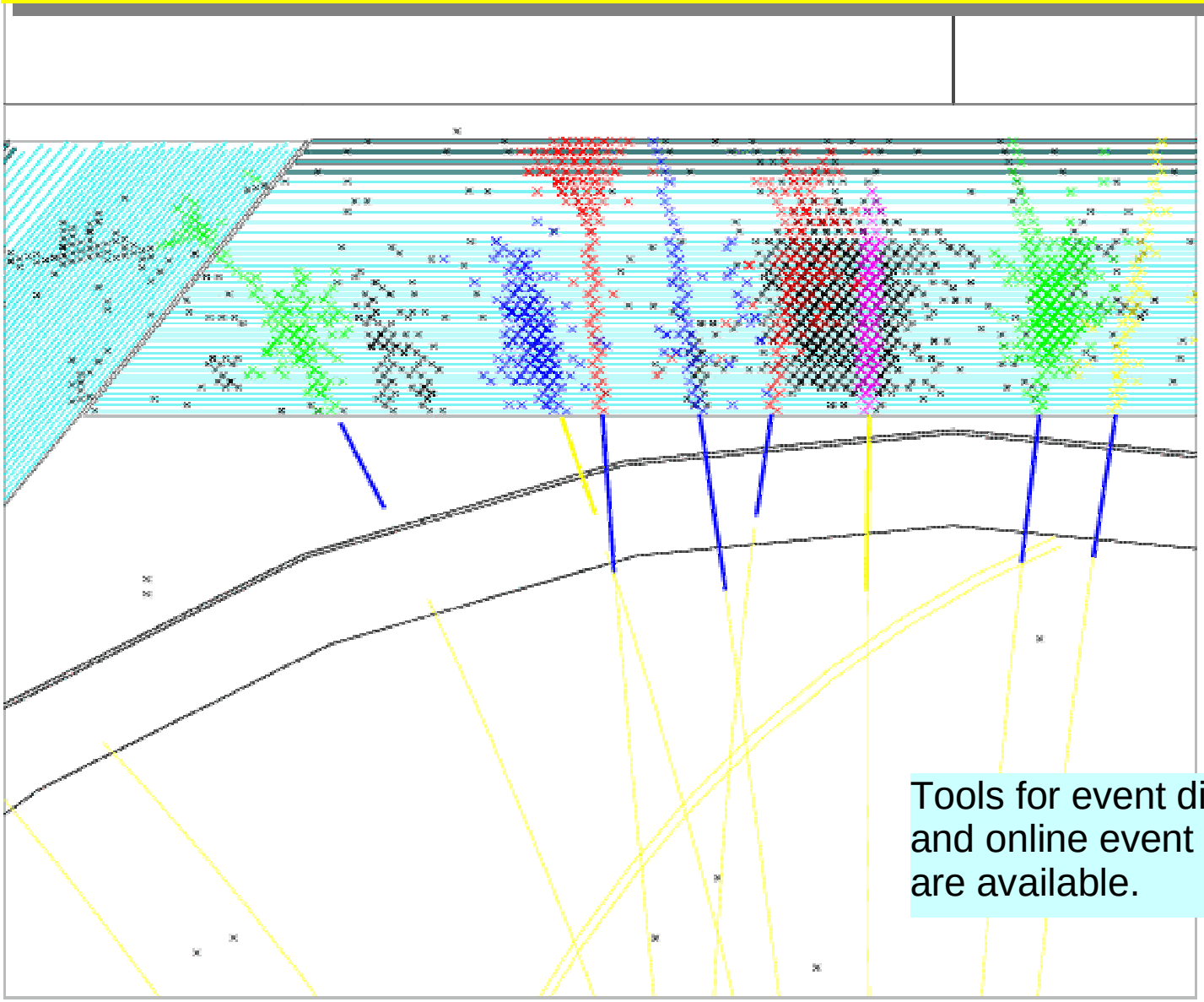
communication between simulation and reconstruction via simple serial gzipped, files

RERECO: The **reconstruction** program

- full track reconstruction and detector merging code
- calorimeter reconstruction code
- full energy flow algorithms (a version of..)

most code is still FORTRAN based

Some details

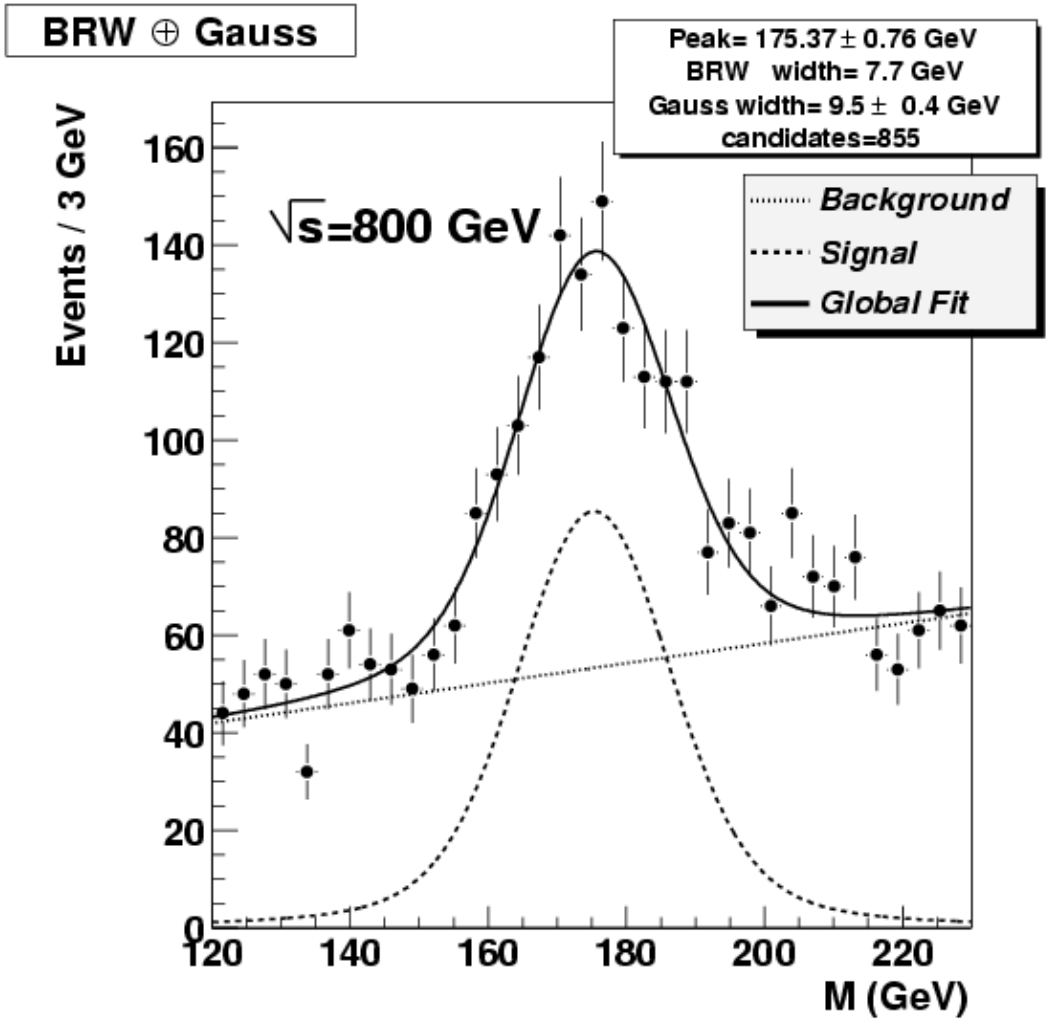


Tools for event display
and online event investigation
are available.

Some Physics Example

Reconstruction of top quark in fully hadronic decay channel:

- Full simulation of signal
- Background using smear mode MC
- No cheating

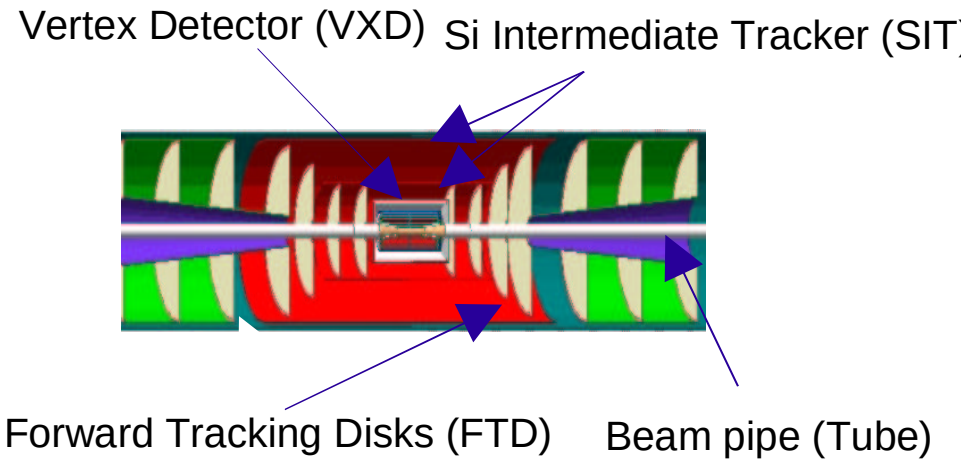


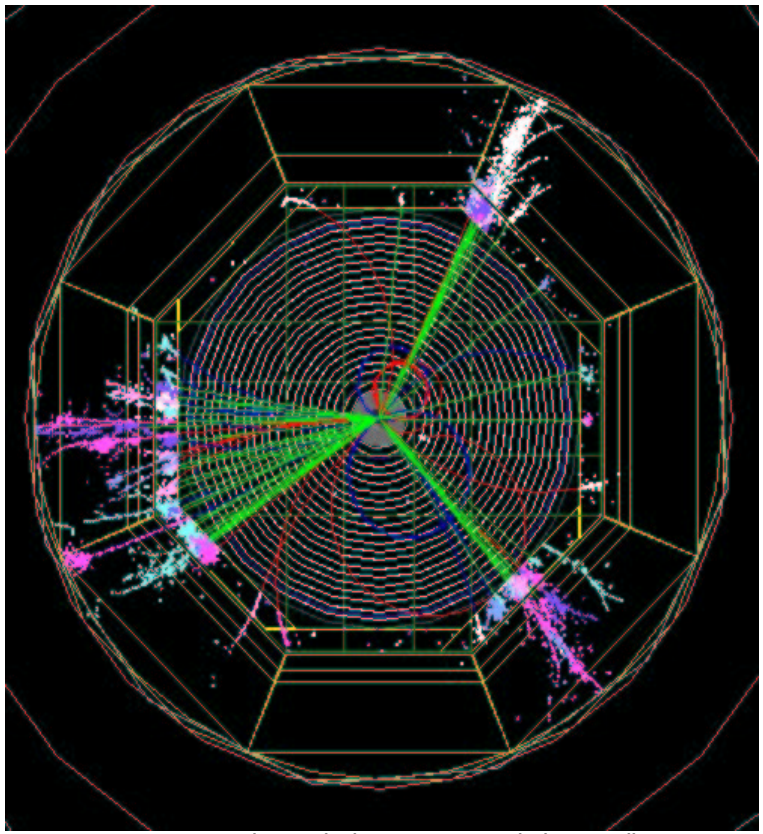
S. Chekanov, V. Morgunov

MOKKA

- MOKKA is a GEANT4 based full simulation framework (main author: P. Moras de Freitas)

- MOKKA has
  - A database based geometry system
  - Detailed calorimeter simulation
  - Tracking detector simulation similar to BRAHMS
  - No reconstruction





Reconstruction behind MOKKA

- MOKKA writes out hits in a simple ASCII format
- Hits are read by reconstruction code
- Currently existing packages (as far as I know)
  - Energy flow reconstruction algorithm (REPLIC, author J.C.Brient)
  - Topological reconstruction in the calorimeter (author P. Gay)
- At the moment there is no full tracking reconstruction package available.

SIMDET V4.0 - Status Report

M. Pohl and H.J. Schreiber

SIMDET is a parametric Monte Carlo program to simulate the detector at TESLA

Main detector components are implemented according to the TESLA technical design report (TDR), with

- a Vertex Detector
- a tracking System
- electromagnetic and hadronic calorimeters, low angle calorimeter and tagger

Using results from the ab initio Monte Carlo program BRAHMS, track parameters and calorimetric deposits are treated in a realistic way. Pattern recognition is emulated using cross references between generated particles and detector response. An energy flow algorithm defines the output of the program.

SGV: fast/slow Monte Carlo

- SGV (author M. Beggren): fast/slow simulation
  - Analytic tracking of particles through detector and fields
  - Simulation of hits along the track
  - Simulation of response of calorimeter
  - Allows the use of realistic tracking packages (not currently implemented)
- Plans for SGV:
  - Currently FORTRAN based system
  - Transistion to OO is starting
  - Michael wants to translate SGV into C/ C++
- SGV is available from the ECFA/DESY simulation WEB pages

News/ Changes II

M. Pohl and H.J. Schreiber

- dE/dx implemented
- IP constraint (optional) implemented
- new CIRCE version
- PYTHIA 6.1 interface implemented
- CLIC version available
- updated note / user guide available

SIMDET Version 4.0 is available from the WEB
(CVS depository zt Zeuthen)

SIMDET acknowledgments

M. Pohl and H.J. Schreiber

Thorsten Ohl	beamstrahlungs code CIRCE
Pable Garcia	PHYTHIA 6.125 implementation
Chris Damerell	CCD vertex detector resolutions
Marco Battaglia	APS vertex detector resolutions CLIC version
Klaus Mönig	BRAHMS tracker resolution, parametrisation of the covariance matrix
Michael Hauschild	dE/dx code
Vassili Djordjadze	BRAHMS ECAL/HCAL response; dE/dx tracking routines
Norbert Tesch, Karsten Büßer	LCAL/ LAT resolutions
Harald Vogt	WWW implementation and many discussions

Next Steps

- basic program development done
- user interface now there (needs to be finalised / extended/ discussed)

- need detailed and systematic performance studies

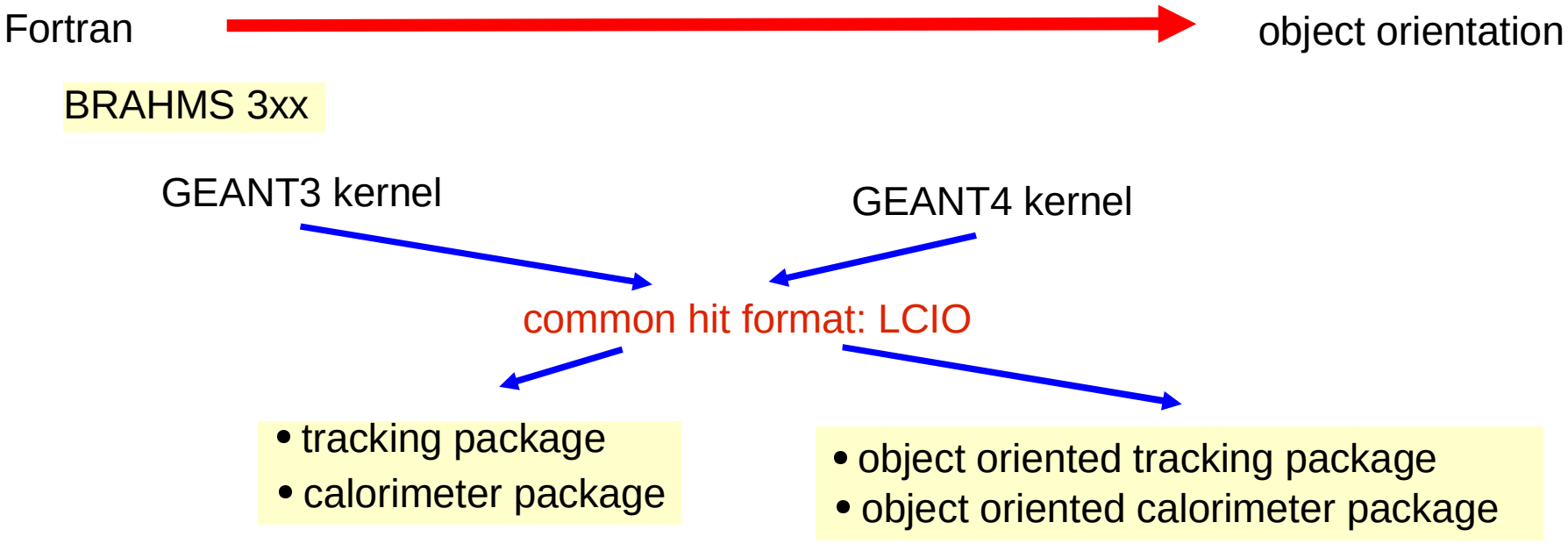
  - ongoing: physics studies (top mass resolution, W mass resolution etc)
    - results (prel) available

  - need much more low-level studies:
    - photon ID
    - hadron ID
    - cluster resolution
    - dependence on internal parameters
    - etc etc .

- Need comparison to GEANT4 studies (MOKKA)

The Goal

- The goal: develop and maintain a modern simulation environment which is
  - flexible
  - maintainable for a long time to come
  - scalable
- At the same time:
  - continue the support for the existing system for still some time to come
- Ideally: maintain a link between the programs to avoid duplication and translation errors



Technical Issues: Formats

- Hits after the simulation and digitisation:
  - stored in “HITS” file

BRAHMS: binary output (c-write routines)
gzip on the fly (ZLIB algorithm)

basic file structure:

- Start of Run record: run/ event number
- “constant record”: detector configuration at simulation time

Start of Event Marker

- Subdetector Hits: Identifier, number of words/event
  - hit record (typically x,y,z,E, but can be more)
  - MC particle record (MC only)
  - GEANT Volume record (MC only)
  - ...

End of Event Marker

Record is at some level self-describing (adding / removing detectors..)
User has to interpret however the information ....

The HITS format

There is a clear need for a standardized format to exchange data between different simulation packages

A discussion on such a format has started.

An agreement has been reached with our american collegues

Work on implementing this agreement is ongoing

Proposal:
- simple packed format, portable, implemented for FORTRAN, C++, JAVA
- mechanism for simple pointer support
- mechanism for “direct access”

We are looking at an extension of the american SIO format (very similar to the current BRAHMS format)

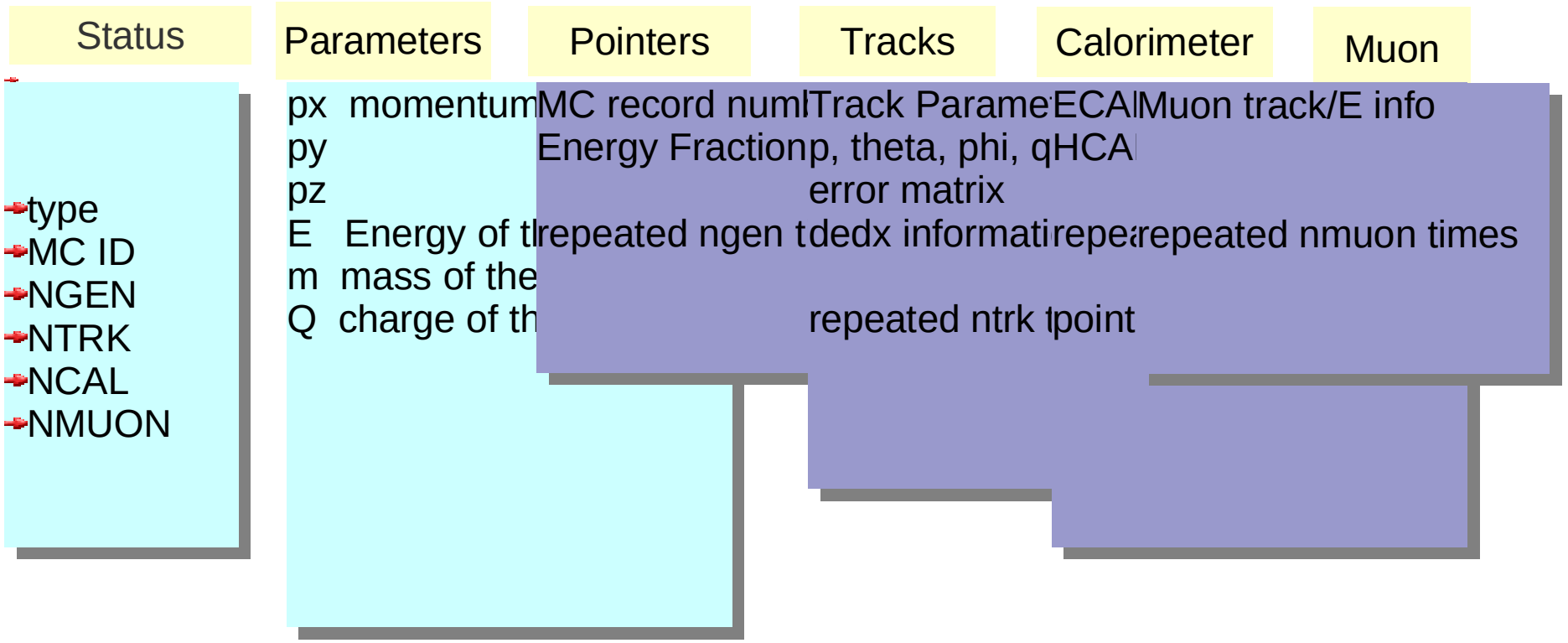
LCIO (see Tony's talk)

The Final Output

- After reconstruction: store “energy flow objects” as main items:
- BRAHMS: adopt scheme already implemented in SIMDET, with some (minor) modifications

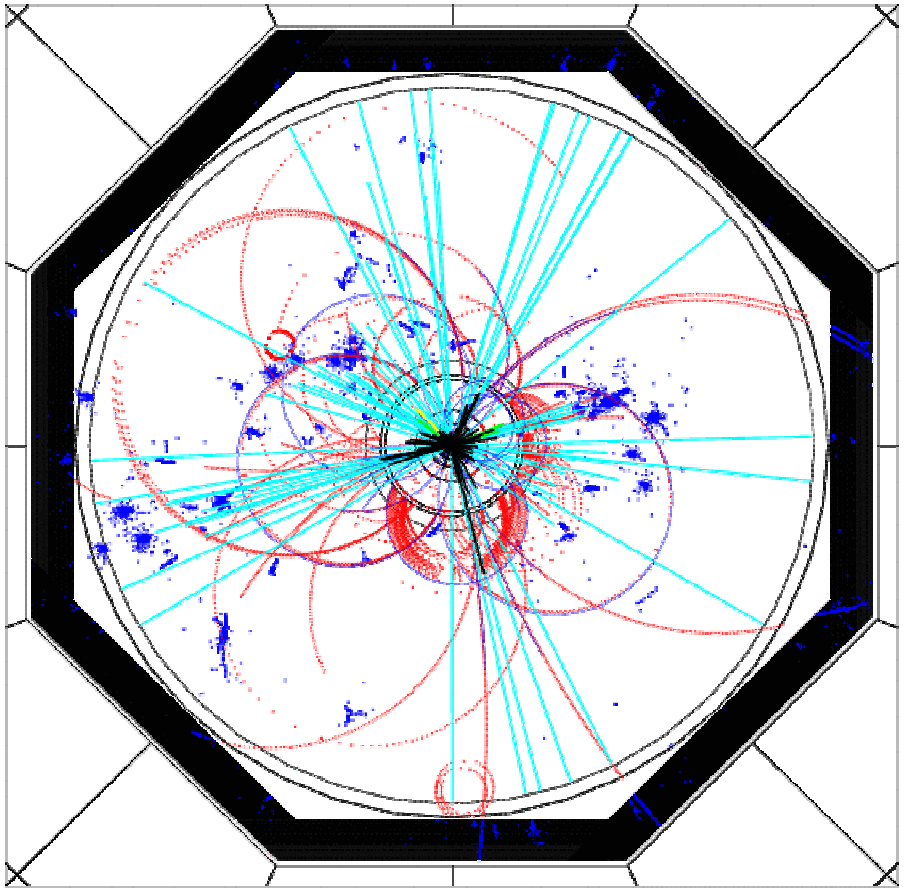
MC record

Eflow record



Combining MOKKA and BRAHMS

- First version of link between MOKKA (Geant4) simulation and BRAHMS reconstruction does exist:
- Tracker working (though there are problems with the MOKKA geometry)
- ECAL working
- HCAL still problematic (tile geometry not implemented in MOKKA)
- Further developments:
  - LCIO package (T. Johnson's talk)
- Such links can save a lot of work in re-implementing packages in different environments



Plot: Frank Gaede, DESY Hamburg

Accessing the information

- The output information is written to file: same format as hit file
  - can read with stand-alone application (FORTRAN, JAVA, C ...)
  - a JAVA interface is under development

- Internally the information is available through FORTRAN statement functions
  - simple array-like syntax, maps onto internal ZEBRA store
  - hides ZEBRA completetly from the user
  - allows the use of “pointers” in FORTRAN
  - fast

```
do neflow=1, nef(1)
 px = ref(1,neflow)
nehit = ief_ne(neflow)
 if ( ref(8,neflow) .ne. 0. ) then

  ..............

 end if
end do
```

Internally the link to the hit information is maintained:
- track hit info
- calo hit info
- muon hit info ...

Accessing the Information

- For non-FORTRAN users
  - Discussions have started to define a data model to be used in C++ and Java

ReconstructedParticle

With pointers to MC info and more detailed tracking and calo info

- Goal: provide a unified interface (as similar as possible) for JAVA (JAS) and C++ (ROOT) users: LCIO package

Try to coordinate this between MOKKA and LCJAS and LCROOT developers

Summary

- The “old fashioned” simulation programs BRAHMS and SIMDET are available and operational
- They are ready for analysis work

- New tools are under development. MOKKA is becoming more complete.

- Reconstruction in the MOKKA frame are starting to be available.

- We seek close collaboration with all developers for a more integrated simulation environment

All tools are available from our Simulation WEB page:

http://www-zeuthen.desy.de/linear_collider/