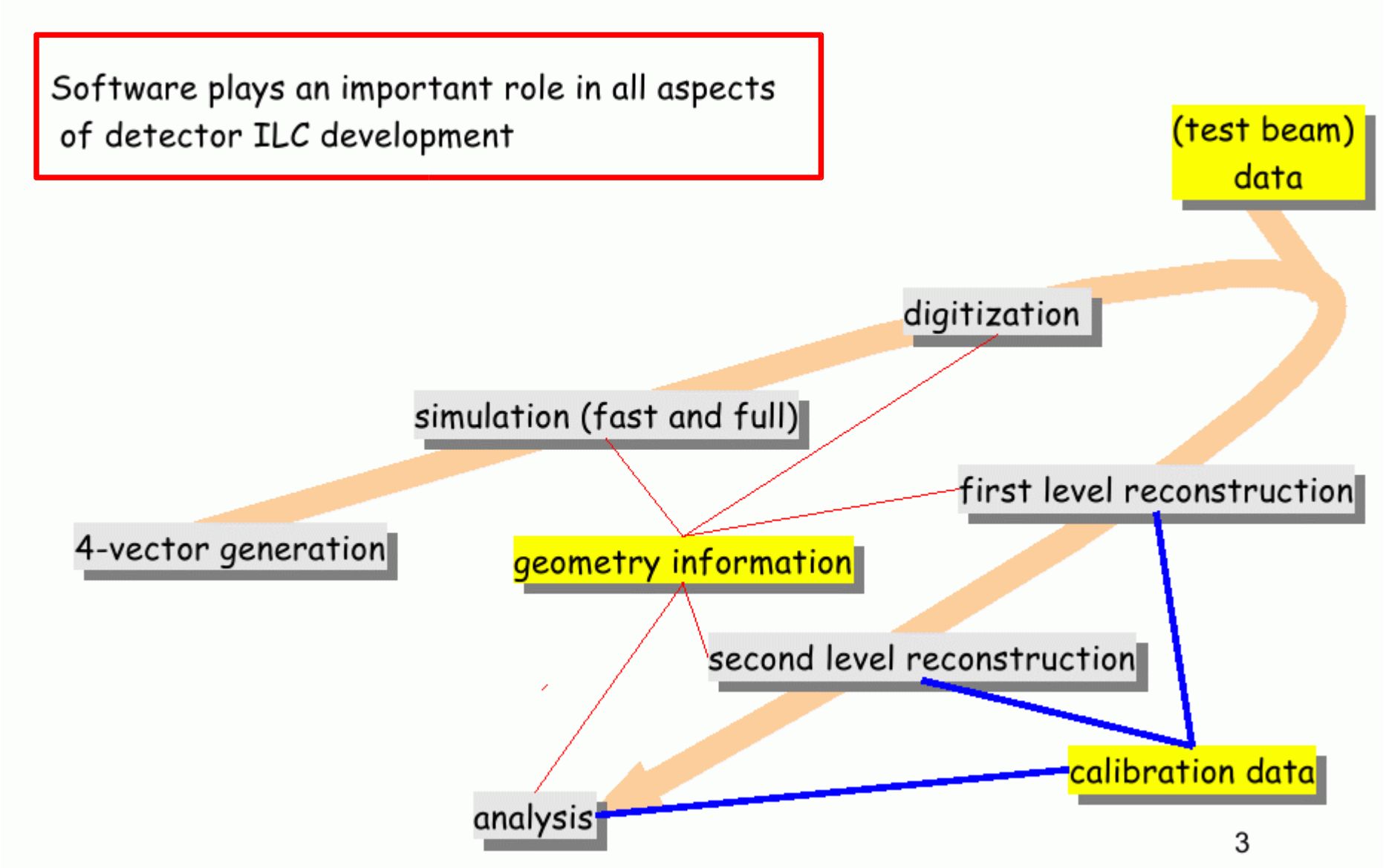
Software Tools for ILD Detector Studies

Status at the eve of the LOI(s)

Roman Pöschl
LAL Orsay

SOCLE Meeting Clermont-Ferrand November 2007

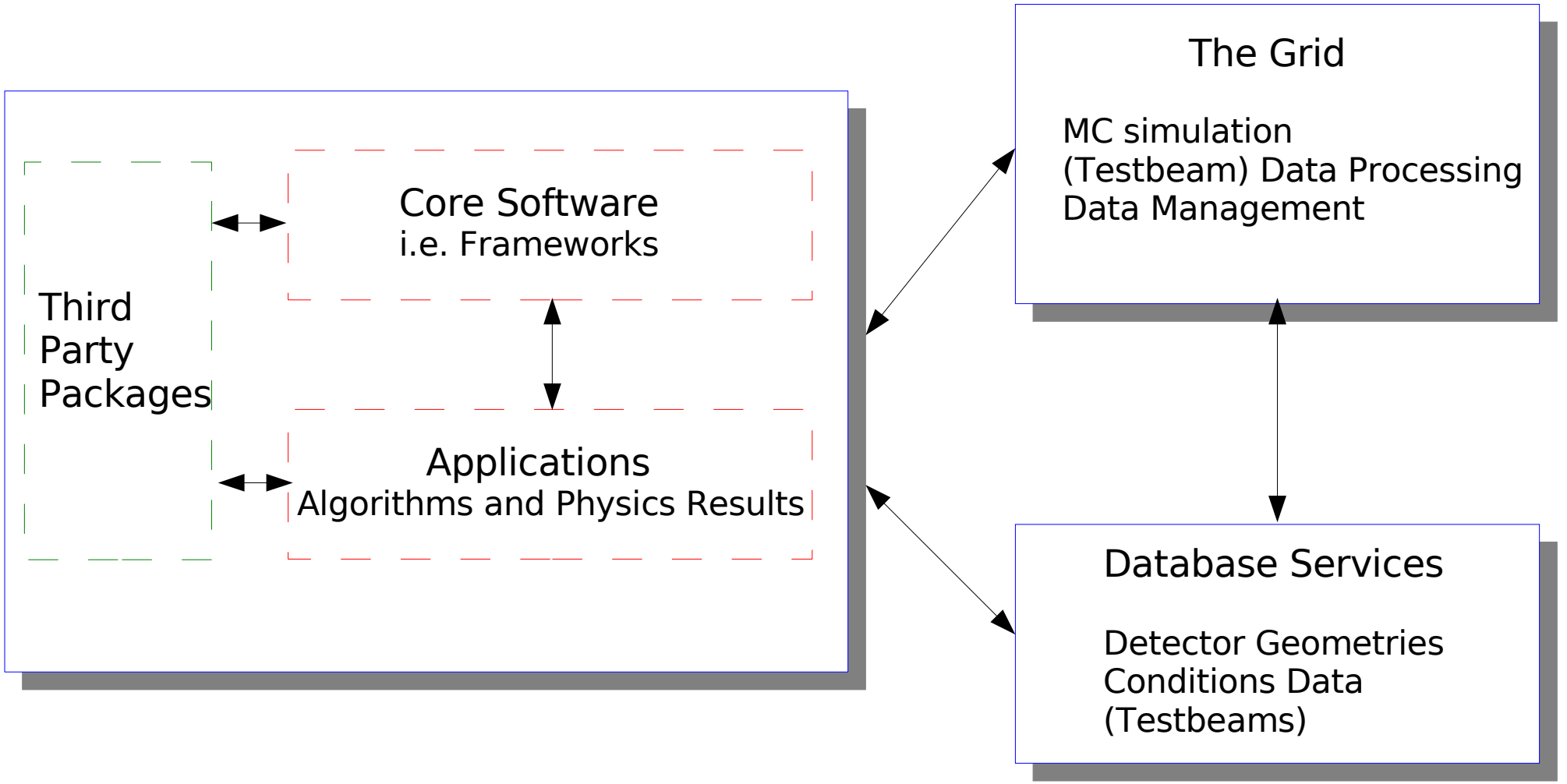
Software for the ILC



ILC(D) Software and Computing - The General Structure

The Actual Software

The Infrastructure



All these pieces are established for ILC

The Actual Software

How far are we?

Role of Software and its employment
for the LOI studies

Will concentrate on the ILD Effort
and the combination LDC and GLD studies

N.B.: A lot of material presented in the talk courtesy of Mark Thomson and Frank Gaede

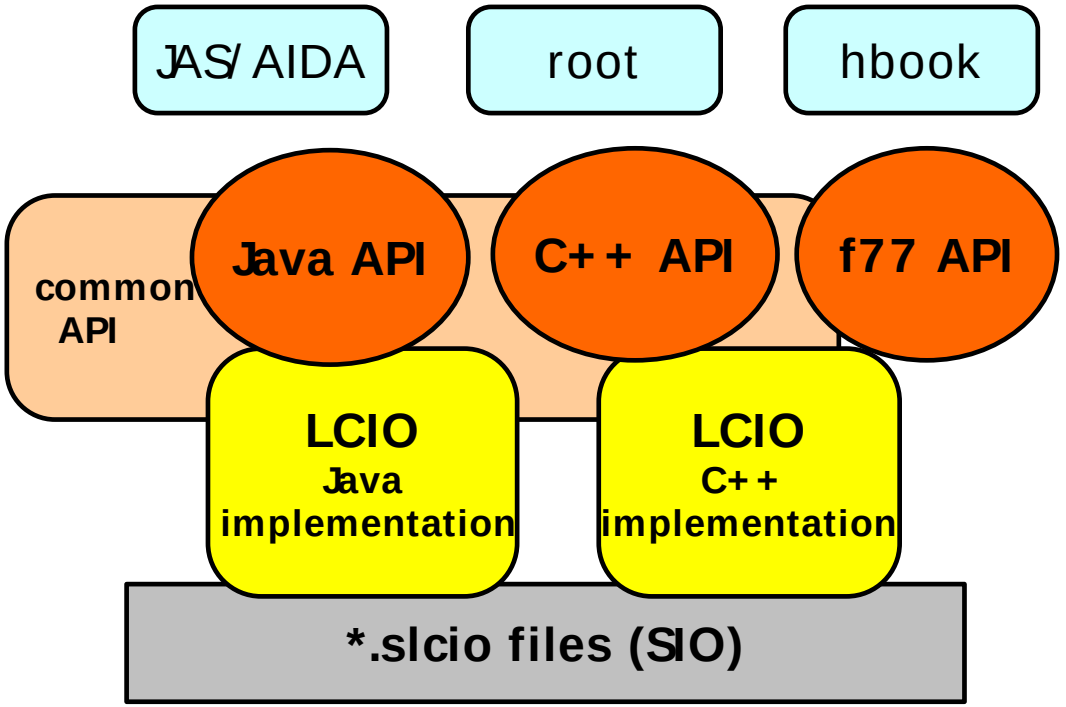
LCIO – A Common 'Language' !?

- Common Project of DESY et SLAC
  - (Current) Basis of ILC software

- Principle properties
  - Java, C++ and f77 (!) API
  - Data Model for simulation studies simulation (and beam tests ?)
  - User code separated from concrete I/O format
  - No dependency on other packages

Standard for
persistency & and data model
of ILC Software

SW Architecture



Current version: **v01-09**

GLD Study (and 4th concept)
base their studies on root
however
Interface to LCIO envisaged

Why LCIO ?

- A common data model facilitates the exchange of results over long distances

Well defined interfaces

Everybody knows what can be expected to be in the file

Local extensions might be useful but we have to maintain a basis for the whole community

New (useful) proposals can/have to be implemented into the data model

- LCIO supports C++, java (and fortran) programming languages

Unique in particle physics

- Testbeam results can be easily transported into full detector studies

- The current status of LCIO is for sure not the final word but a solid basis

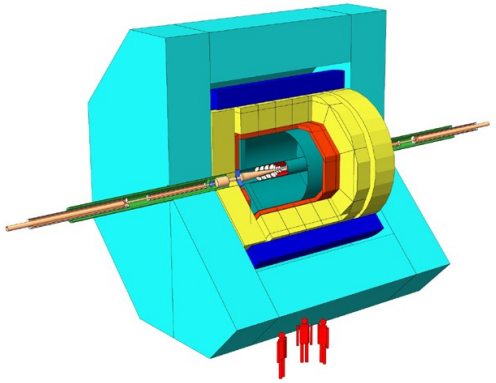
Major improvements concerning file and event handling in last release

Details on I/O layer under investigation

The other common basis - GEANT4

All concepts do exist as a GEANT4 implementation

LDC



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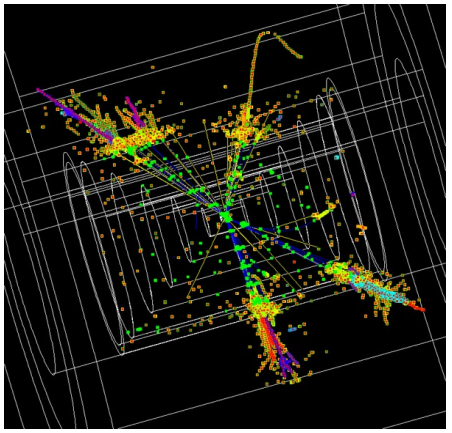
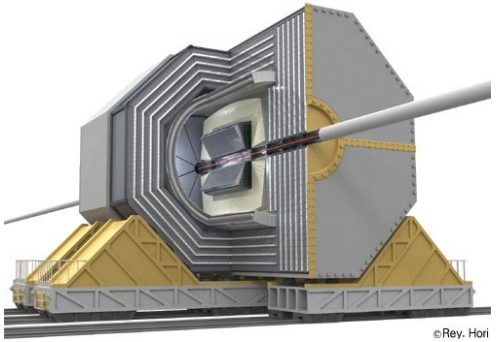
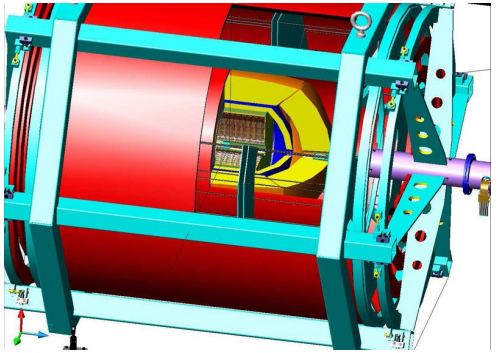


GLD



4th Concept

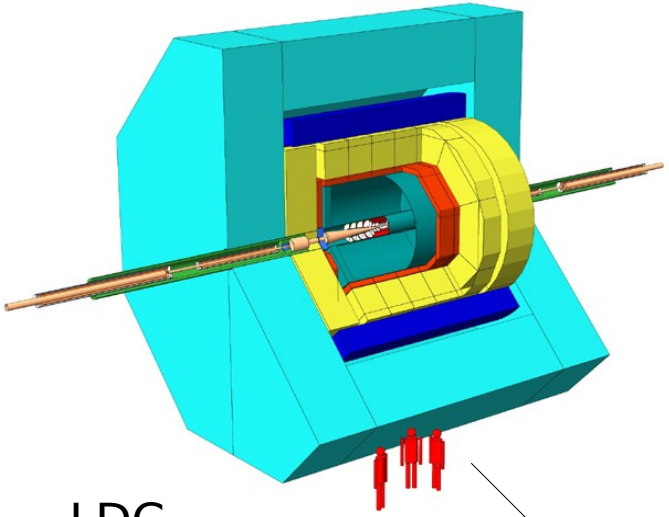


- However these implementations live in different (simulation) frameworks
  - Mokka in the LDC study (More on MOKKA see Gabriel's talk)
  - JUPITER in the GLD study
  - SLIC in SiD/ALCPG study
  - ILCROOT in the 4th concept study

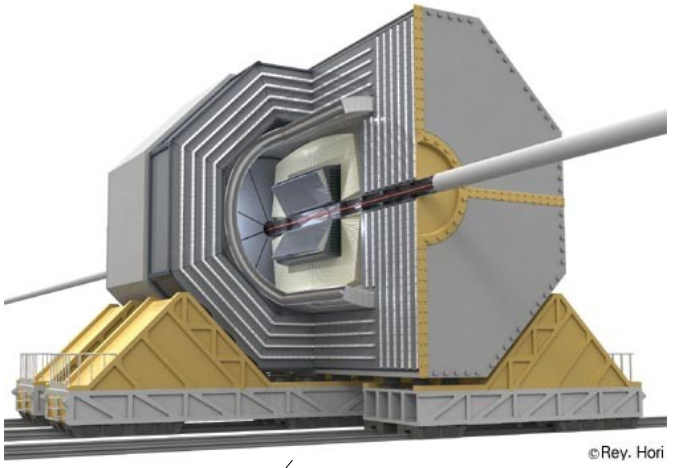
- Attempts to 'cross implementations' in LDC and SiD study
  - No results on comparisons shown at Orsay
  - Difficult to pursue due to lack of manpower

- LDC and SiD/ALCPG produce LCIO files by default
  - (At least) facilitates comparison

The Engagement (Marriage ?)



LDC



GLD

?

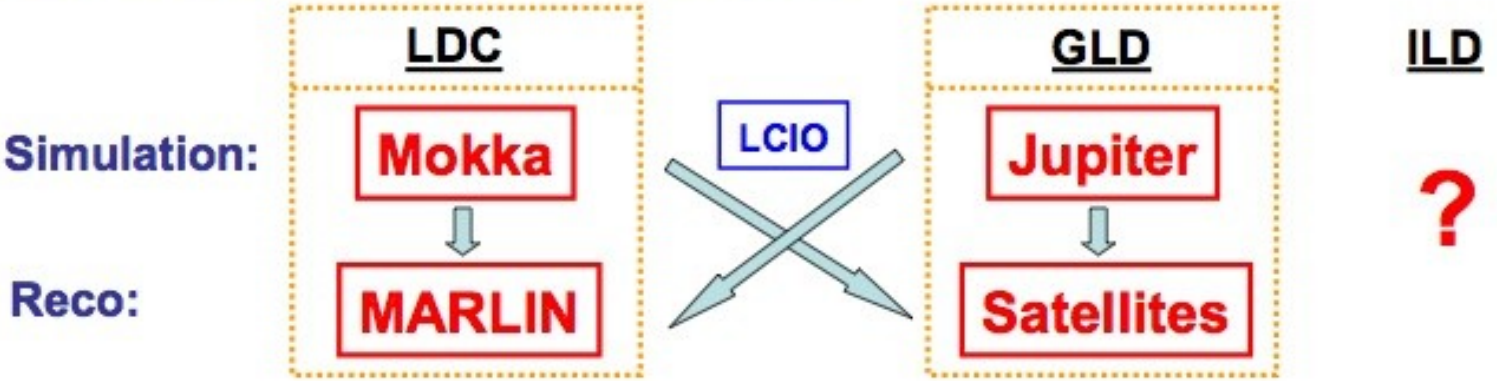
ILD -The Newborn

Fortunately these days one can give birth to children w/o being married!!

Optimisation Studies : How ?

★ Currently GLD and LDC use different G4 simulations/ reconstructin frameworks

★ Connected only by common data format



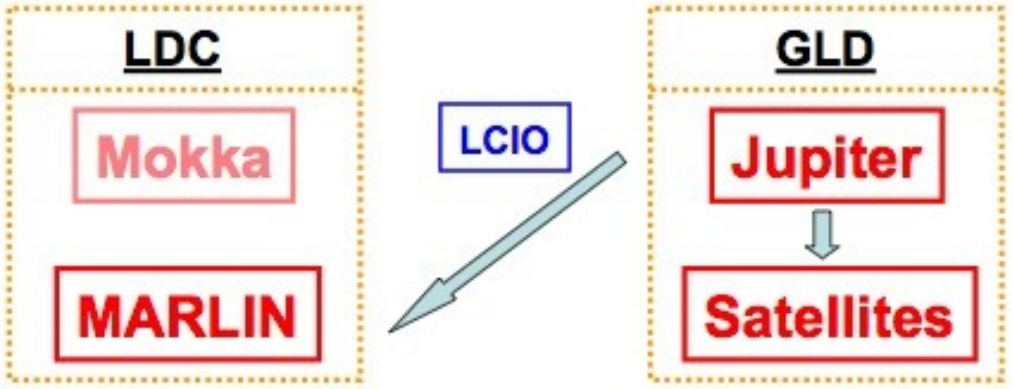
★ Given LoI timescale, decided to perform ILD detector studies in context of both GLD and LDC

★ Study physics performance dependence by changing parameters of GLD and LDC – provide some cross check of conclusions

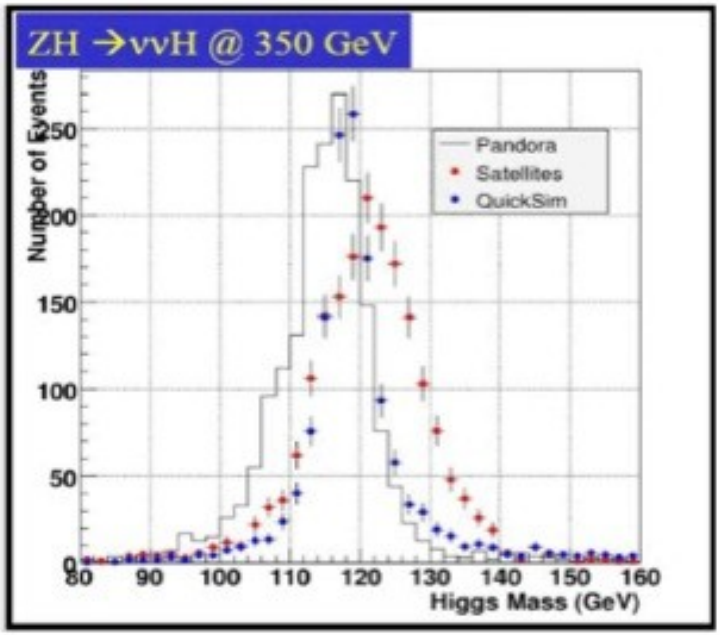
★ Can directly compare results using LCIO…

M. Thomson – ILC Optimization Meeting 31/10/07

e.g.



- Very nice demonstration of Marlin processing of Jupiter GLD events
- Such cross-software studies will be very important in optimisation of ILD detector
- To do this properly – software developers need to ensure that reconstruction is optimised for both LDC and GLD



Message: GLD Detector can be investigated in LDC Framework and vice versa!!!!

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ILC Optimization Meeting 31/10/07

LDC'/GLD' Common Parameters

★ In addition, define and simulate a common point: LDC' and GLD' : a larger version of LDC and a smaller version of GLD

Sub-Detector	Parameter	GLD	LDC	GLD'	LDC'
TPC	R_{inner} (m)	0.45	0.30	0.45	0.30
	R_{outer} (m)	2.00	1.58	1.80	1.80
	Z_{max} (m)*	2.50	2.16	2.35	2.35
Barrel ECAL	R_{inner} (m)**	2.10	1.60	1.85	1.82
	Material	Sci/W	Si/W	Sci/W	Sci/W
Barrel HCAL	Material	Sci/W	Sci/Fe	Sci/Fe	Sci/Fe
Endcap ECAL	Z_{min} (m)***	2.80	2.30	2.55	2.55
Solenoid	B-field	3.0	4.0	3.50	3.50
VTX	Inner Layer (mm)	20	16	18	18

Region between VTX and TPC unchanged – time
*GLD TPC z_{max} = 2.3+0.2 m for readout (included in LDC z_{max})
**Fixed by TPC outer radius – LDC assumes slightly less space
***Fix ECAL z_{min} and allow this to determine TPC z_{max}

Monte Carlo Generation

★ The detector optimisation studies (for different detector parameters) will require multiple large MC data-sets

★ Intend to generate samples centrally (use of GRID will be vital)
- benefit: avoids unnecessary repetition of work
- there already exists a proposal for SM background samples (should be discussed at another meeting)
- base samples on SLAC STDHEP files to provide commonality with other concept studies

★ Ideally run reconstruction centrally (use of GRID will be vital)
- benefit: ensures correct reconstruction versions/steering
- benefit: some physics analysis could start from reconstructed PFOs

★ Backgrounds:
- Ultimately: must include "beam" backgrounds (beam + $\gamma\gamma$) in physics analysis
- Initially: develop analyses without "beam" backgrounds
- In parallel: develop tools for including backgrounds – file merging etc.

More on Grid later

Massive MC Production and Simulation to be started Jan. 2008

status (LDC) core tools

- ilcinstall script to install all of LDC software
  - recently extended to include Mokka w/ geant4 installed (and tbeam software except Calice)
  - reference installations – software releases (v01-01) at
    - /afs/desy.de/group/it/ilcsoft/v01-01
  - used for nightly builds (check recent user code)
- all tools switched to new build tool: Cmake
  - easy configuration, shared libs, plugins,....
- LCIO
  - experimental code for direct access to events
    - (create file directory on open())
    - to be released as v01-08-05
  - working on more elaborated I/O format

Applications of MARLIN et al.

- LDC detector optimization (MonteCarlo)

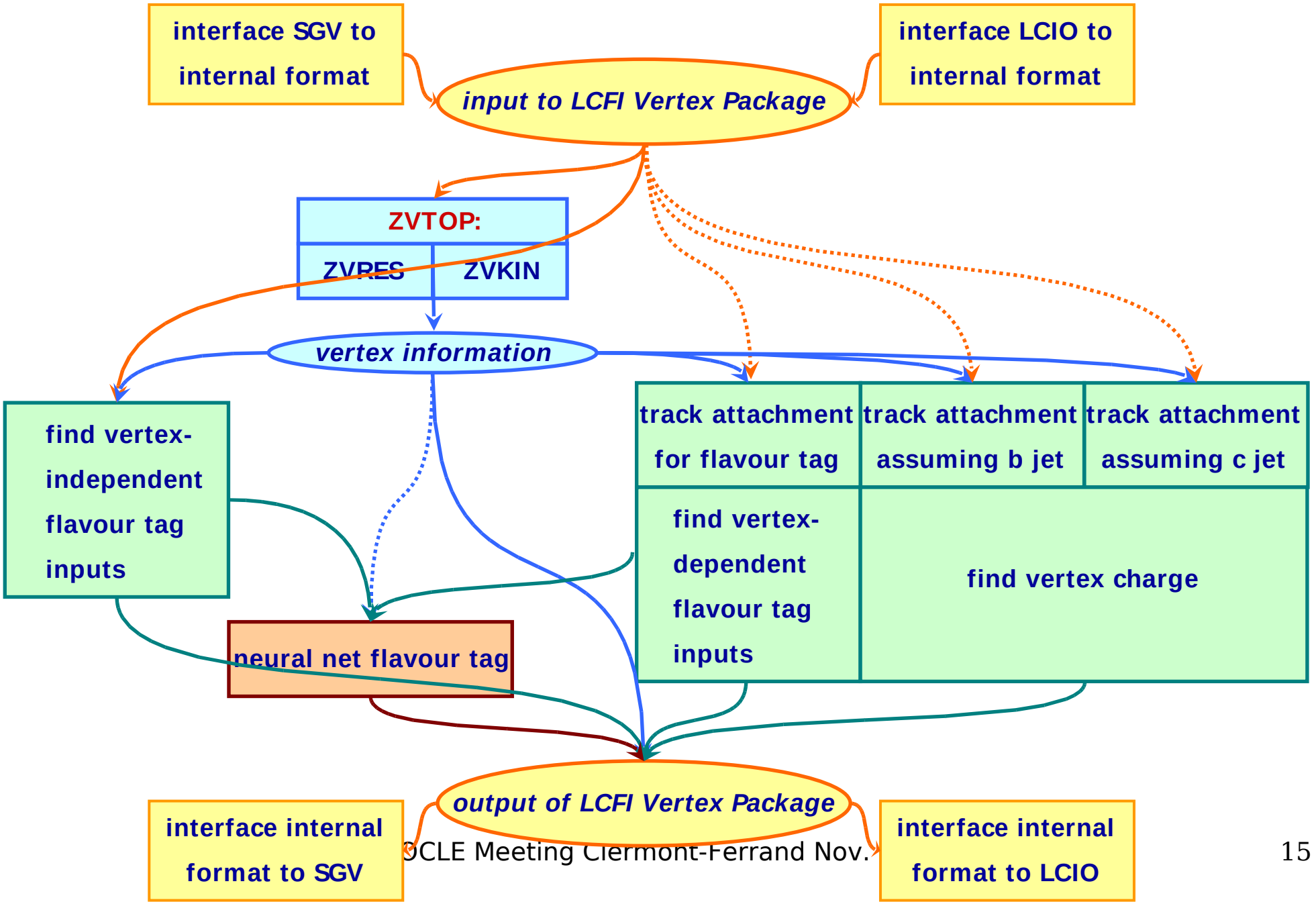
- MarlinReco – full reconstruction suite
  - Digitization Calo,TPC, Silicon, PatternRecognition/Tracking, clustering, ParticleFlow algorithms: **Wolf**, **TrackBased**
- PandoraPFA
  - ParticleFlow algorithm
- LCFIVertex
  - ZVTop/ZVKin vertex finding and fitting algorithms
- various physics analyses ...

Ingredients for full event reconstruction are available !!!

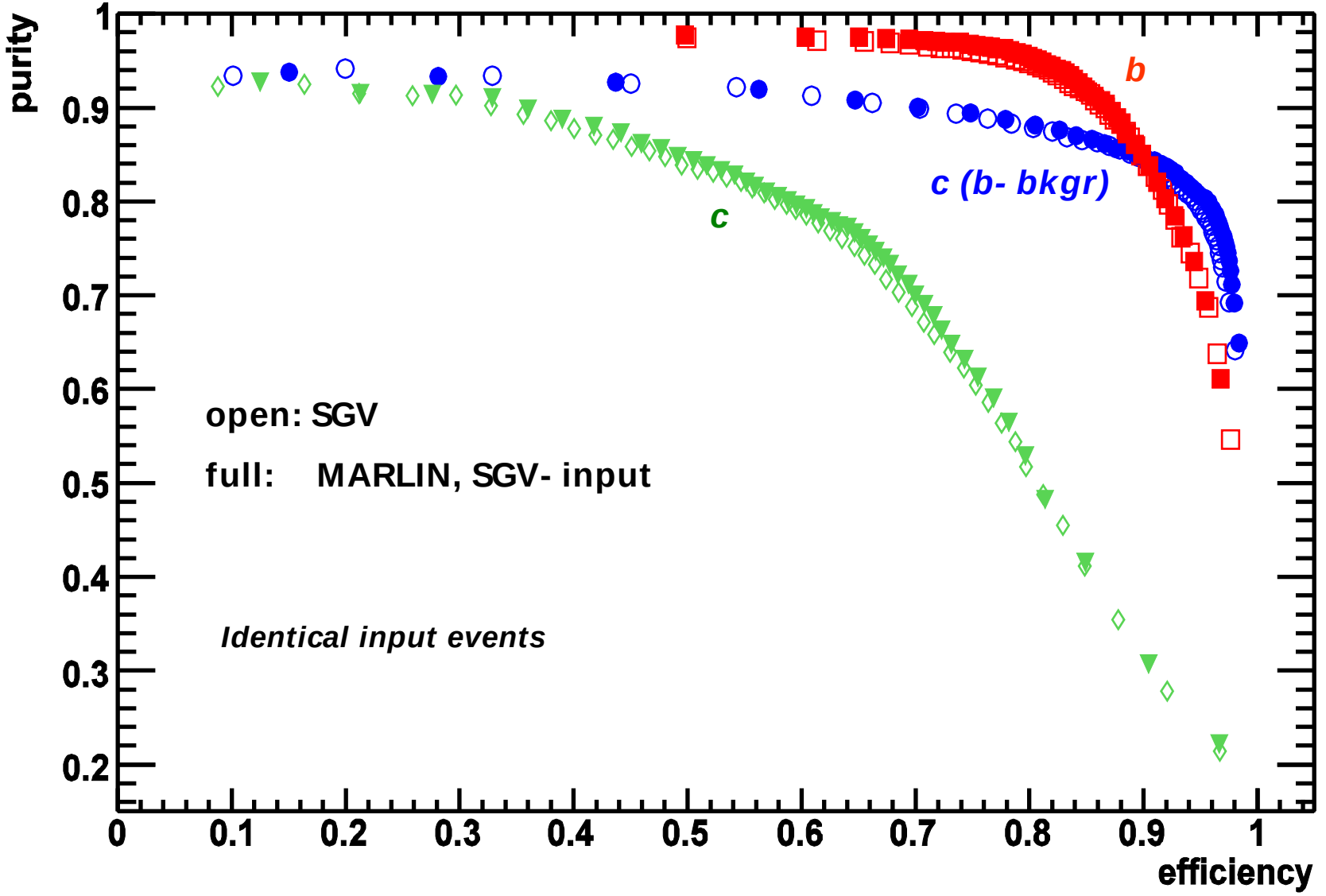
... a closer look

LCFI Vertex Package

ZVTOP Vertex Finder 'for' MARLIN S. Hillert et al.

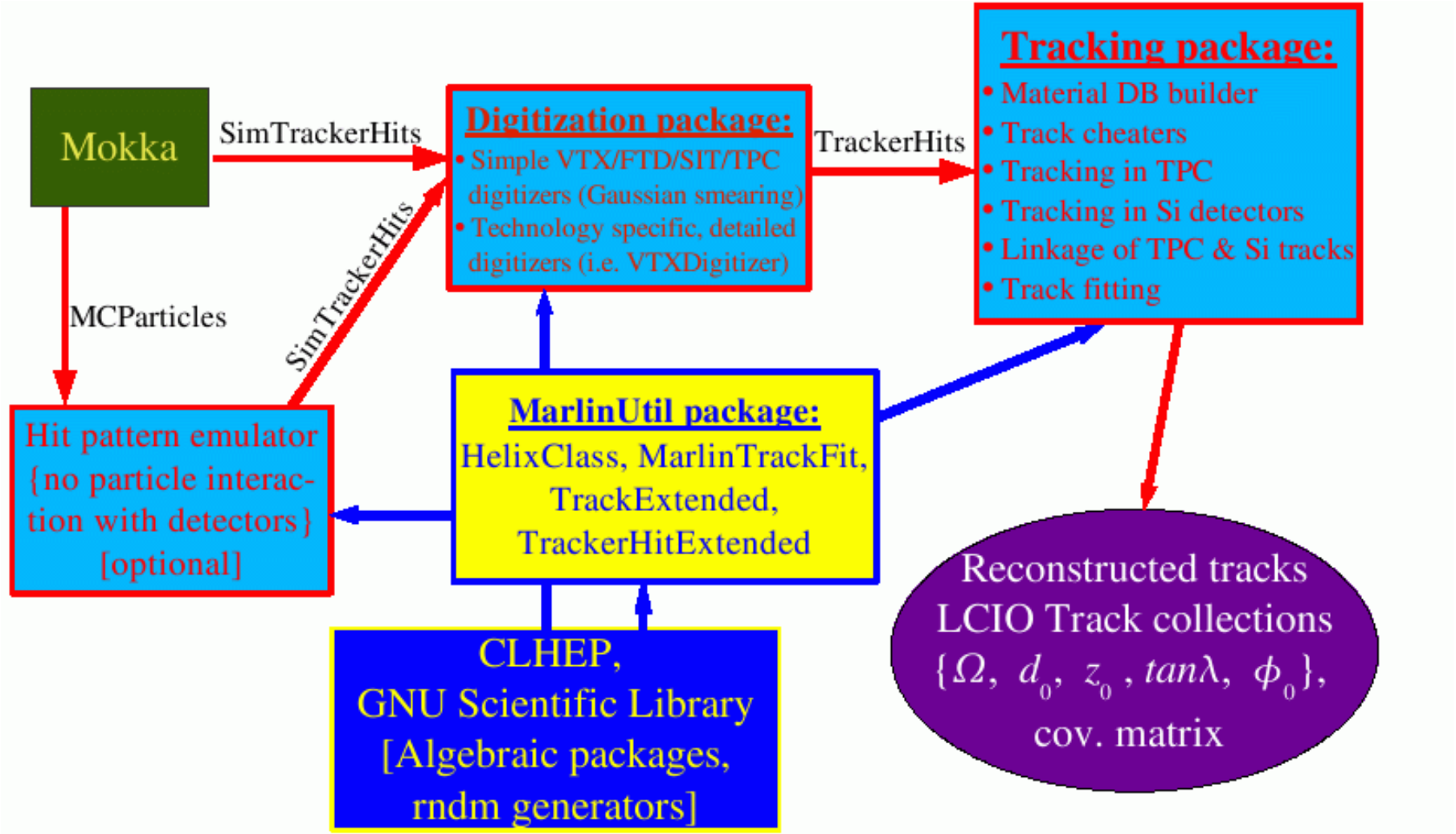


Flavour tag performance at the Z- peak



Excellent agreement between the LCFIVertex Marlin code and SGV!!!

LDC tracking Package – A. Raspereza et al.



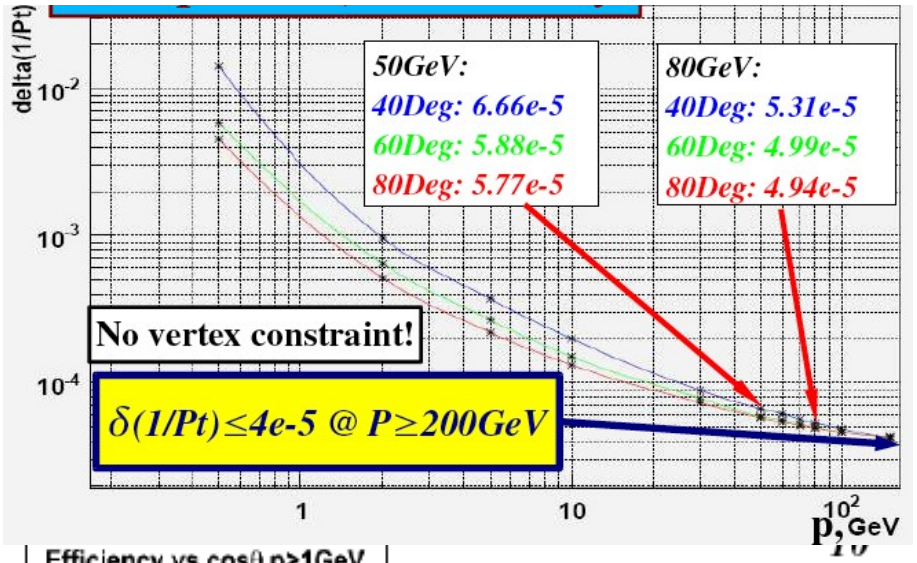
Beautiful Example of interplay of different pieces of LDC Software Chain

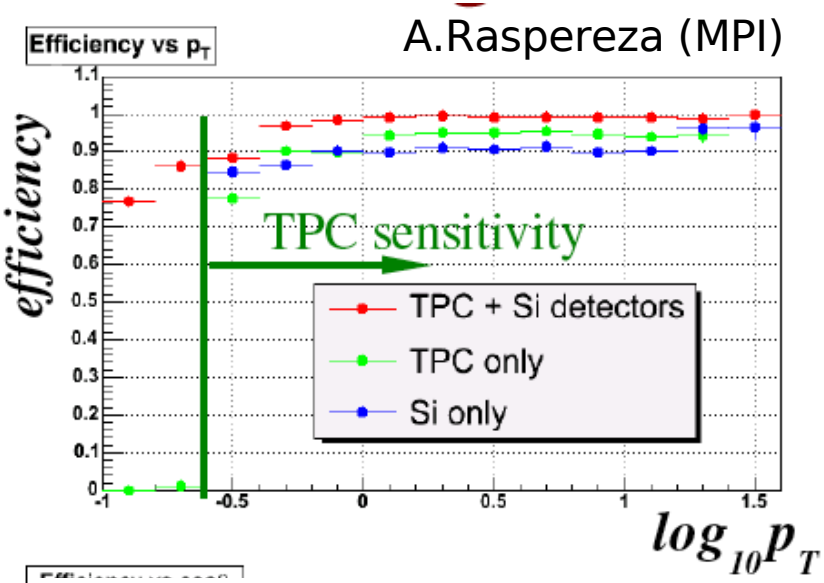
Will be interfaced to new ZVTOP package – See above

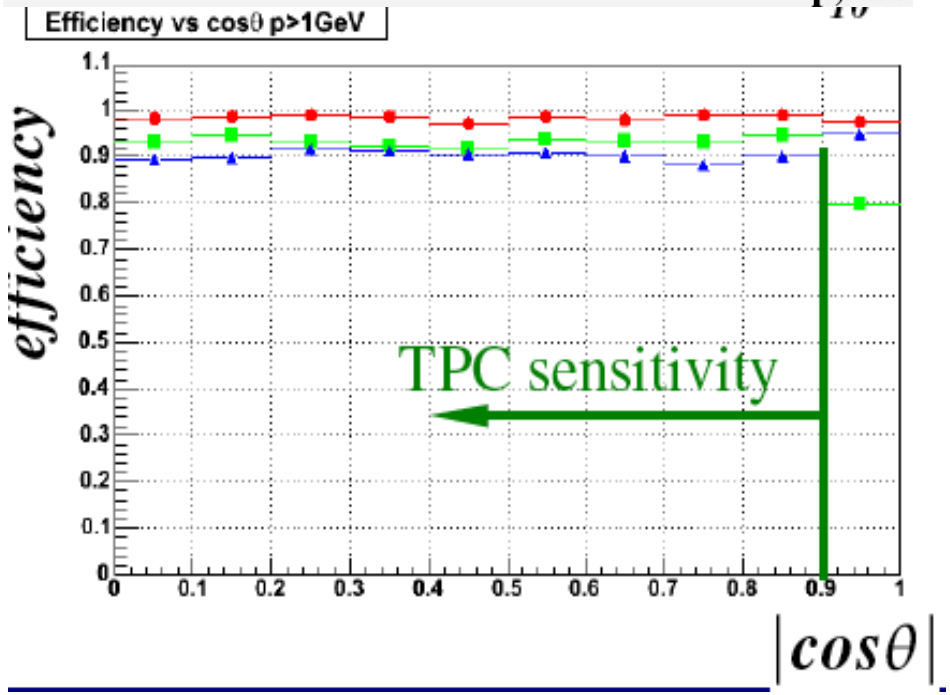
Is/will be used in PFA Studies

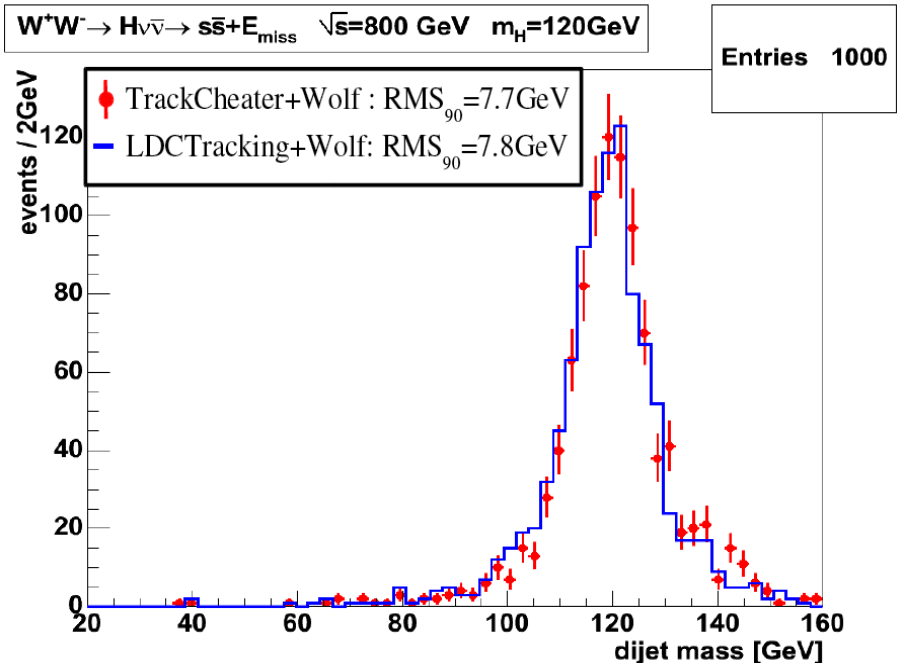
MARLIN Reco Full LDC Tracking

A.Raspereza (MPI)





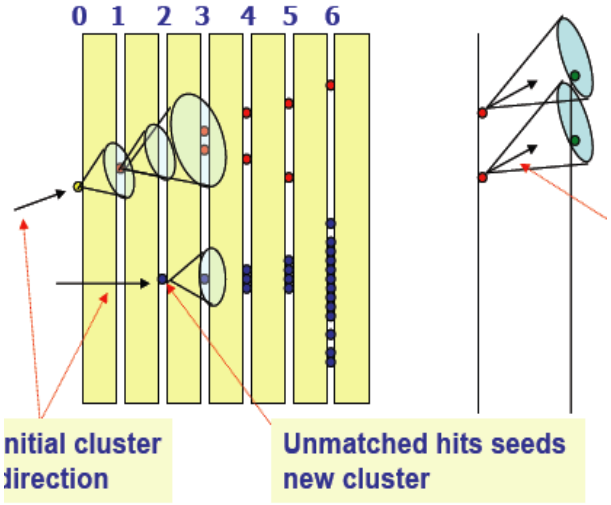


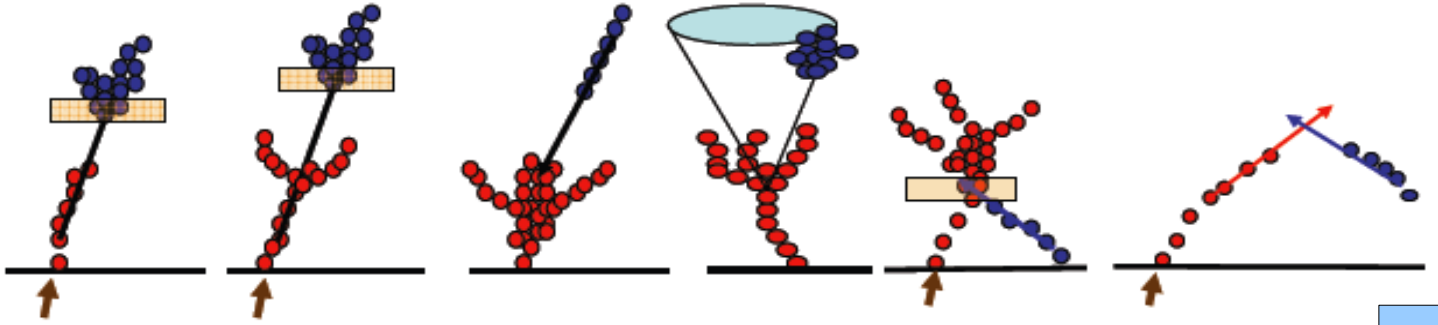


Pandora PFA – M. Thomson

i. Preparation (MIP hit ID, isolation, tracking)
ii. Loose clustering in ECAL and HCAL
iii. Topological linking of clearly associated clusters
iv. Courser grouping of clusters
v. Iterative reclustering
vi. Photon Recovery (NEW)
vii. Fragment Removal (NEW)
viii. Formation of final Particle Flow Objects (reconstructed particles) – not very sophisticated

Order inter-changable





If track momentum and cluster energy inconsistent : RECLUSTER

e.g.

Pandora is the most sophisticated and best performing PFA to date

PANDORA PFA Performance

rms90

E_{JET}	$\sigma_E/E = \alpha/\sqrt{(E/GeV)}$ $\lvert\cos\theta\rvert<0.7$	σ_E/E
45 GeV	0.295	4.4 %
100 GeV	0.305	3.0 %
180 GeV	0.418	3.1 %
250 GeV	0.534	3.3 %

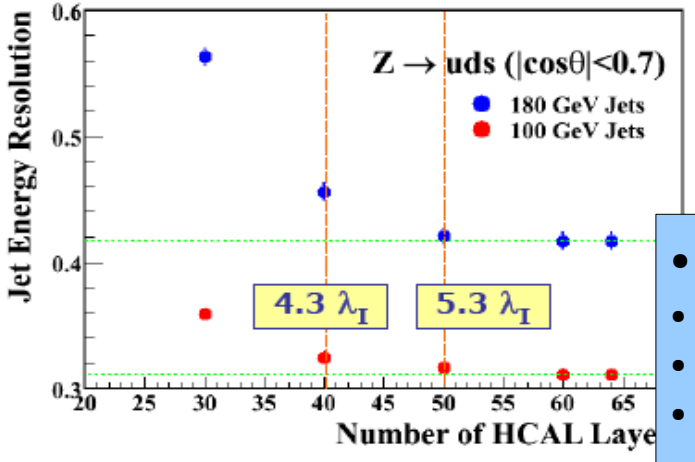
[TrackCheater used] 0.35 at LCWS06

For jet energies < 100 GeV
ILC "goal" reached !!!

★For a Gauge boson mass resolution of order $\Gamma_{W/Z}$

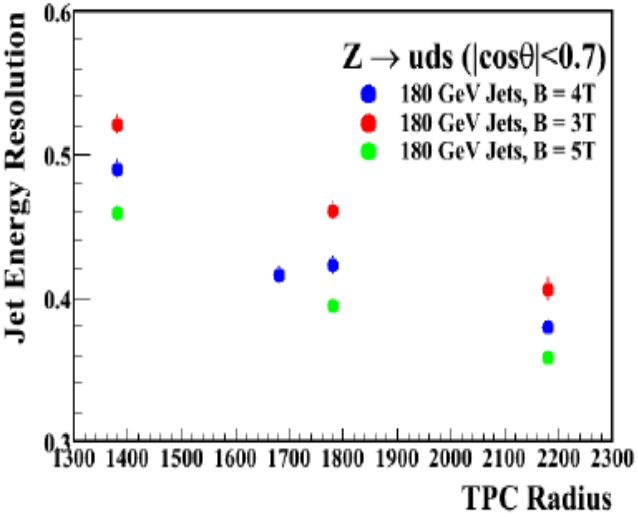
E_{jj}/GeV	$\alpha(E_j)$	σ_{Ej}/E_j
91	< 26 %	3.8 %
200	< 38 %	3.8 %
360	< 51 %	3.8 %
500	< 60 %	3.8 %

'proof of concept' for PFA @ILC
-> use for detector optimization



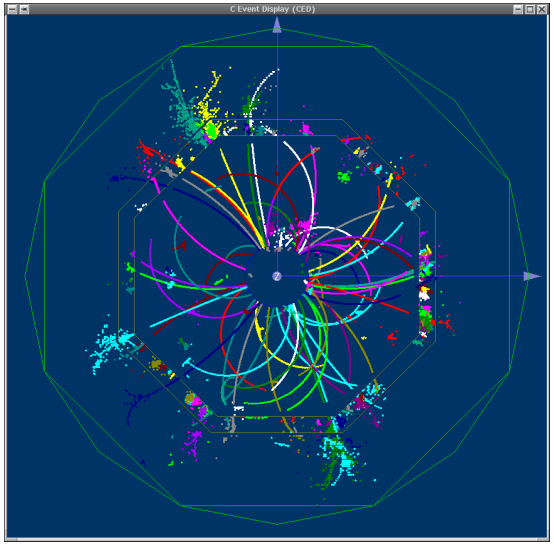
- **PFA improves with:**
- thicker Hcal
- larger Tracking radius
- higher Bfield

- can use PFA for cost conscious optimization



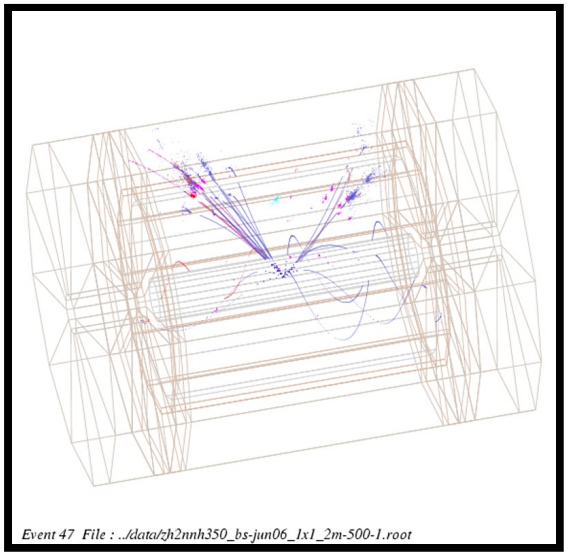
Open Issues – Common Event Display

Each concept is using its own event display



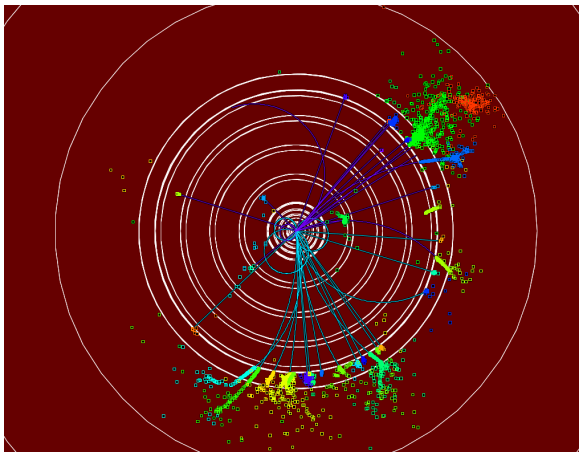
LDC

CED Event Display
Integrated in Marlin



GLD

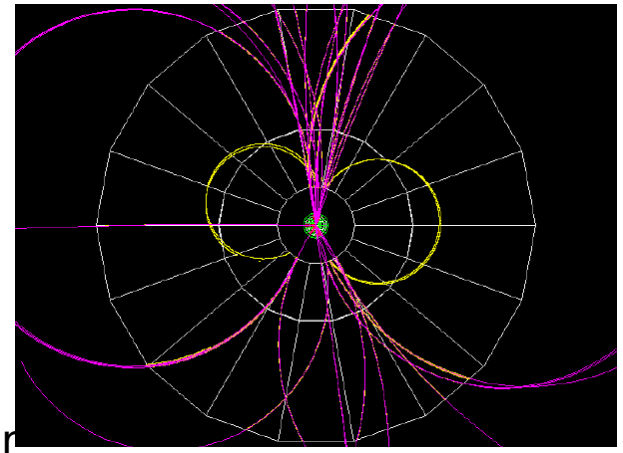
Root Event Display
Integrated
in Uranus



ALCPG/SiD

JAS3/WIRED
Event Display

High Interactivity!
Well coupled to
LCIO
Can be used by other
studies!!!



4th Concept

Root Event Display
Integrated in
ILCROOT

Remarks On Event Displays

- Development of an Event Display is clearly one source where there is a high risk to waste (human) resources

  Attractive piece of work
  Well visible and presentable

- High risk to re-invent the wheel over and over again

  ... but ILC Community is clearly short in manpower!!!!

  will lead to '50%' solutions!!!

- Has to be put in the hands of one or two IT divisions in close collaboration with physicists

  Not to be written by physcists!!!

The Infrastructure

ILC and the Grid – Introductory Remarks

- ILC is on the Grid

The virtual organisations (vo) 'ilc' and 'calice' have been established and are active!!!!

These vo are hosted by DESY

- This is the time to show our presence at the various IT centers around the world

A common task beyond borders of concepts and regions!!!!

Need to obtain clear commitment to support by IT centers
... in particular in view of the LHC start when these centers will be under pressure!!!
On the other hand of course we will benefit from their experience!!!

- Need to make up our minds ourselves

No clear strategy in ILC on how to make use of the (significant) resources
No manpower for management of tasks coming along with grid
Responsibilities for software, data and database management – FTE tasks!!!!
Situation is a bit different for calice

Support for ILC

- ILC is supported by a lot of sites world-wide, mainly Tier-2 sites
- Grid infrastructure is used parasitically, e.g. LCG
- DESY *hosts* the VOs ‘calice’ and ‘ilc’ in it Grid infrastructure which is also used for the HERA experiments as a Tier-2

- A strong commitment to ILC exists
- Sites dedicate resource *shares* to ILC

- Supporting sites are:
  - desy, ifh, freiburg
  - France (lal, Lyon, ecole polytechnique (LLR), saclay)
  - fnal
  - ral, brunel, ic, cam, ox, bham, ucl, manchester, ed, lesc, qmul, rhul, gla
  - tau
  - kek

Why the using Grid??

Neither ILC nor Calice have an 'experimental center' like CERN, DESY etc. and maybe will never have

World wide distributed R&D effort requires distributed computing

- Easy sharing of data by common data storage accessible by everyone from everywhere

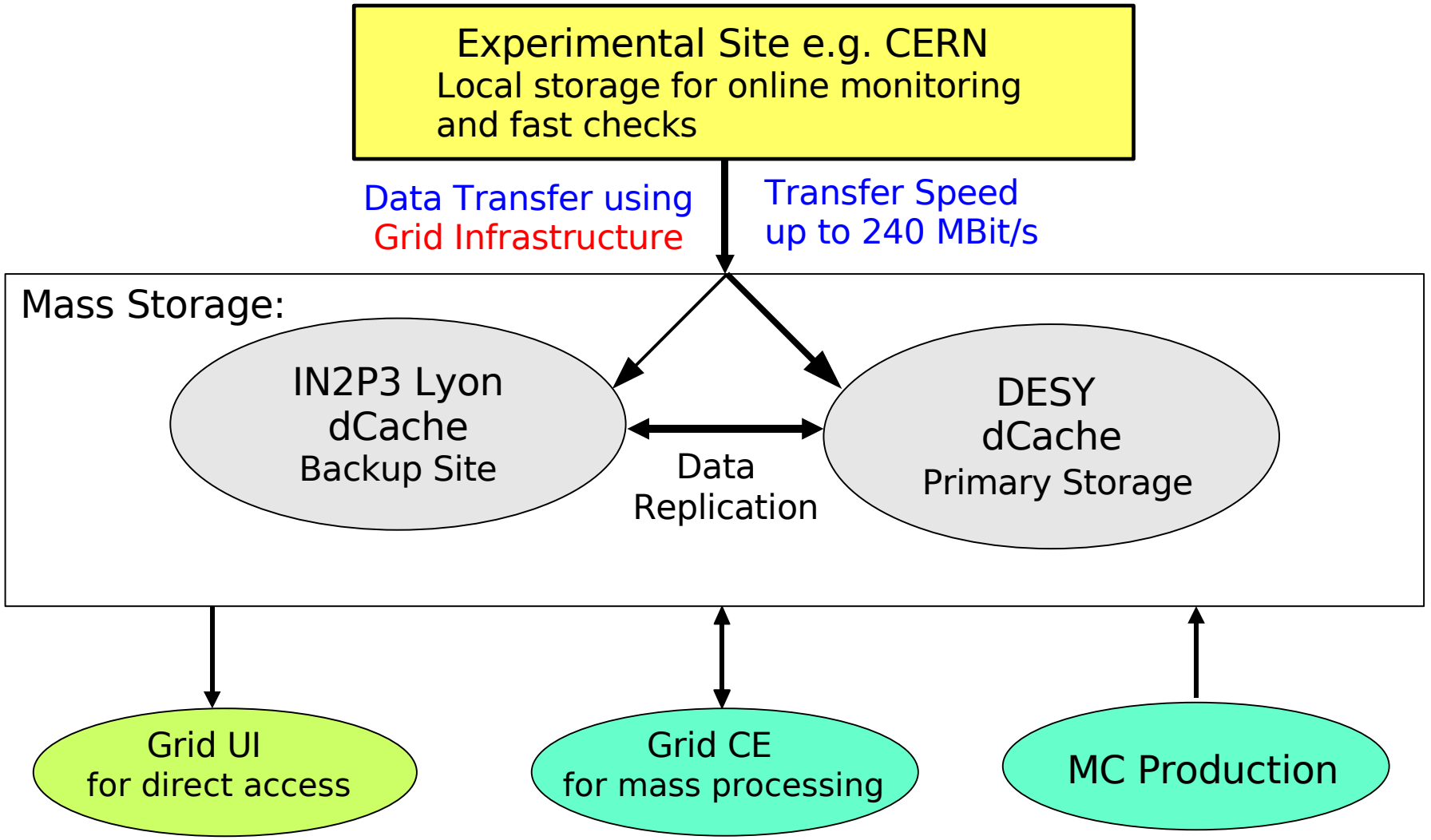
- Exploiting the Grid allows for quick data processing, e.g. Several reconstruction iterations for calice testbeam data

- Large simulation effort to come for the ILC requires large computing ressources

General strategic decision by HEP community and science politics to exploit and invest in Grid computing

- Exploring the Grid can be regarded as an engineering/R&D effort for the ILC just as hardware development or simulation studies (which in turn demand significant computing power)

An Example - GRID usage within Calice



- Grid tools used for data management
- Grid tools used for data processing and MC production

Last but not least - Conditions Data Handling

- LCCD – Linear Collider Conditions Data Framework:
  - Software package providing an Interface to conditions data
    - database
    - LCIO files

    Author Frank Gaede, DESY

First attempt heavily used within calice !!!

The importance of conditions data (not only) for 'real' data renders the development of a fully functional cd data toolkit to be a fundamental !!! piece of the ILC Software

So far no commitment for support visible!!!!

- Efficient storage and access to conditions data

  Browsing, convenient interfaces
- How to 'distribute' conditions data (e.g w.r.t to grid) ?

  BTW.: LHC does have some headache with that!

The Situation in/for/about France

Optimisation Strategy : Who ?

From LDC side (for GLD see Tamaki's talk)

- ★ Currently trying to build a picture of ILD physics interests
- ★ The list below is by no means complete (please email me…)
- ★ Already very encouraging !

Channel/Area	Topic	Groups
$e^+e^- \rightarrow Zh$	Recoil mass l^+l^-X	DESY-Zeuthen/MPI, LAL
	Branching Ratio	Edinburgh, Bristol,
	Direct mass	DESY-Zeuthen/MPI
	Heavy Higgs	DESY
$e^+e^- \rightarrow Zhh$		RHUL
e+e-→selectrons		MPI
e+e-→smuons		MPI, DESY
e+e-→stau stau		DESY, RHUL, LPNHE-LAL
e+e-→WWνν/ZZνν		Cambridge, DESY
e+e-→tt	6 jet final states	RAL
	ttZ tbW vertices	Krakow
de/dx	meta-stable staus	DESY(Schafer)
Single gammas	rad. χ^0	Edinburgh(Martin)
Vertex Charge	c cbar/ b bbar	Oxford(Hillert,Jeffery)
tau polarization		RHUL
Kinks	GMSB	Santa Cruz

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Here, France looks under-represented

Lack of effort?

Lack of visibility – Ignorance of Mark?

Did France miss the launch of the ILD optimization study?

I haven't of course forgotten other activities like Mokka, Calice etc. but anyway

However ...

Detector Optimization Study for e+e- -> HZ (->e+e-)

H.Li LAL

Observations during study for sources for electron radiation in detector material

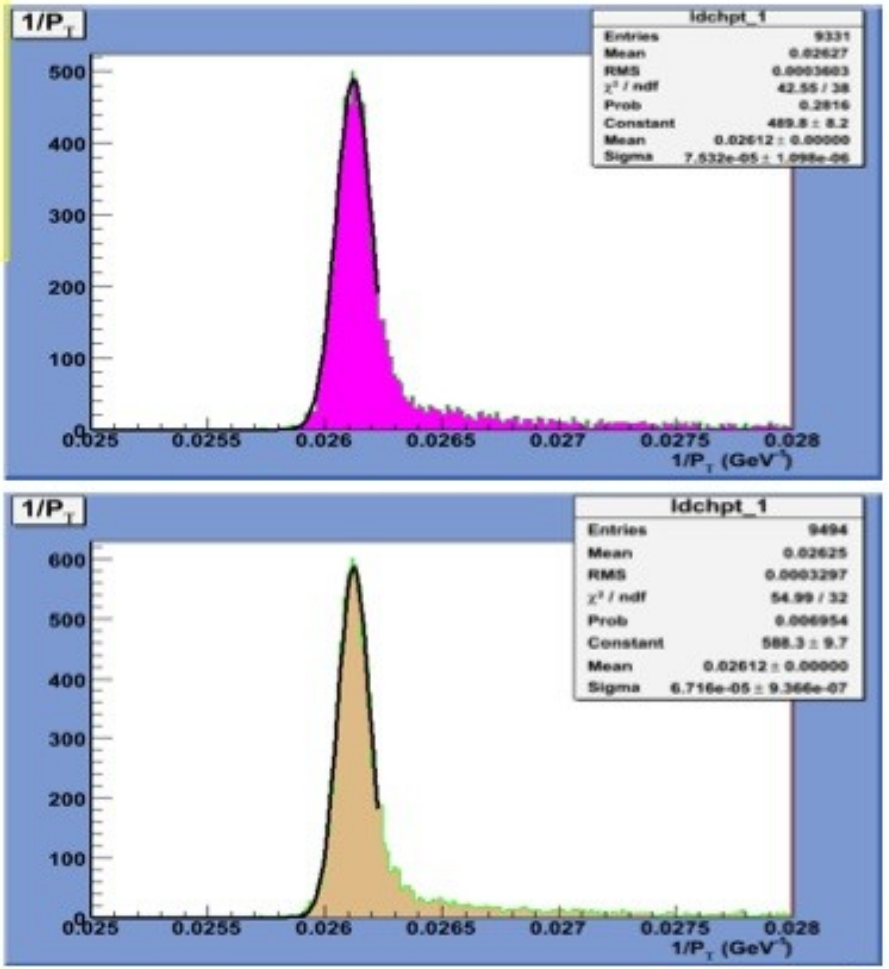
- Strange Material: "silicon_8.72gccm"
  - Atomic number (A=26.98) , same as Silicon
  - Charge number (Z=13) , same as Silicon
  - Density 8.72 g/cm^3 (pure Silicon is 2.33 g/cm^3)
  - Radiation Length (X_0 = 93.7*2.33/8.72 = 25 mm), where 93.7 mm is the radiation length of pure silicon
- Exist since Brahms
  - TESLA Simulation and Reconstruction software
  - To account for the additional effects which are caused accompanying materials come together with the silicon sensors.
- Still Existing in Mokka SIT00 and FTD00 Drivers

A careful look pays always off!!!!

Comparisons of SIT00 and SIT01

10000 Events, single electron, 50° to Z axis, One track events considered

- Reconstructed Transverse Momentum
  - SIT00:
    - Sigma: 7.532×10^{-5}
    - Events # in peak: ~500
  - SIT01:
    - Sigma: 6.716×10^{-5}
    - Events # in peak: ~600
  - Sigma Decrease 10.8%
  - Events # in Peak Increase 20 %



Significant Improvement after correct implementation of detector

Further improvement by correct implementation of FTD (numbers still missing!!!!)

Overview needed!!!!!

- Who in France is working on what (w.r.t ILD!!!)?

  - Technical Studies implementations of detectors?
  - Physics Studies (No presentation at this SOCLE!!!!)
  - Transport of testbeam knowledge into full detector study
  - Manpower situation in general

- Communication to/with ILD Coordinators

  - French position may need to be strengthened

- Do we need a coordination of the french contribution?

  - i.e. A kind of 'french' representant in the study
  - Do we have it???

Computing in France (Main Lines, partially personal view)

- Central installation of ILC software at Lyon

  - Fairly complete installation done by the end of 2006 – No feedback received

    Is such an installation desirable?

- DESY is will remain central computer center for ilc (grid) activities

  - They helped to put ILC computing on the rails
  - Strong commitment to ILC

- CC IN2P3 is/will remain center for ilc (grid) computing in France (and beyond?)

  - Collaboration with CC IN2P3 very good (mainly calice) after a slow start
  - CC IN2P3 should hold replicas of ilc and calice files
  - Bottleneck for data transfer between DESY and CC IN2P3 under investigation (needs to be solved! Soon!!!)
  - Resources needed for ILC not a big deal
  - Hub to Asia?

Conclusion and Outlook

- ILD Optimization Studies is in the launching phase towards the LOI

- Software tools for detailed detector optimization studies exist in a well advanced form

  All sorts of studies can be made

- Challenging timeline

  Main results are to be achieved until May 2008

- ILC is on the Grid

  Efficient employment vital for success of LOI Studies
  cc in2p3 is to play a major role in this activity

- Role and activities of french groups might need to be made more visible