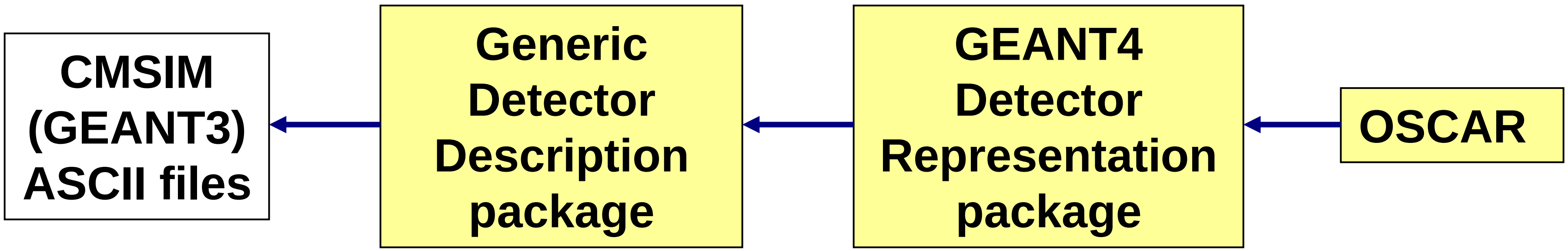
Geometry: Input (II)

New way: automatically building GEANT4 geometry from ASCII files



☺ Easy to understad

- ASCII files with simple tags

```
:VOLU :MB1S  BOX  ”M_B_Air"    3   107.6  20.55 123.55
:POS  :MB1S   1  :MBXX      :R270 :ONLY  430.55 38.3032 -1.25.0
```

☺ Easy to maintain

- Change the ASCII file and no need to recompile

☺ Big flexibility

- Can simulate any detector by changing ASCII file
- `:VOLU :MB1S OFF` and volume :MB1S and its daugthers will not be simulated

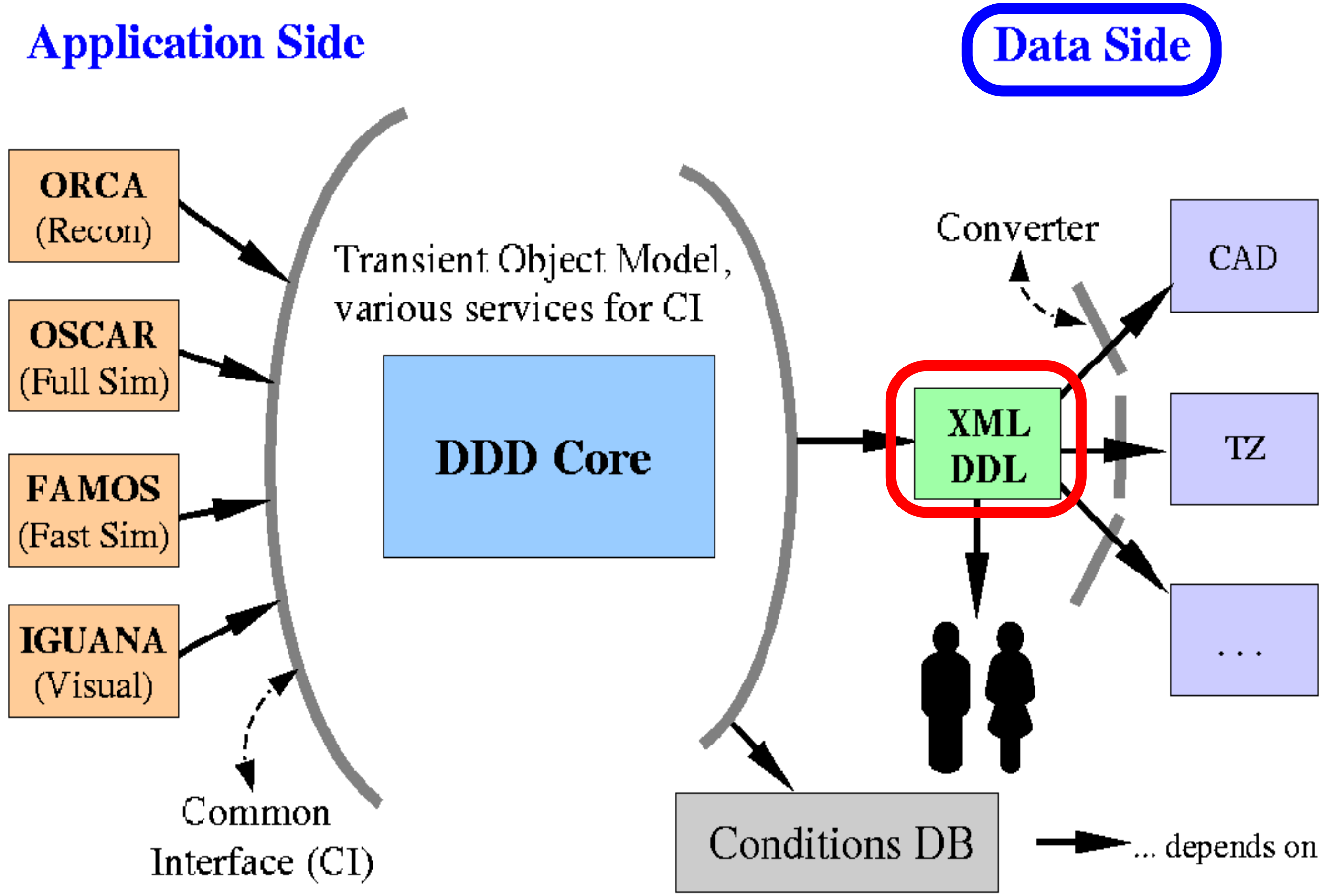
☺ Easy coherence with other packages

- Same files used for GEANT3 simulation, digitisation and reconstruction

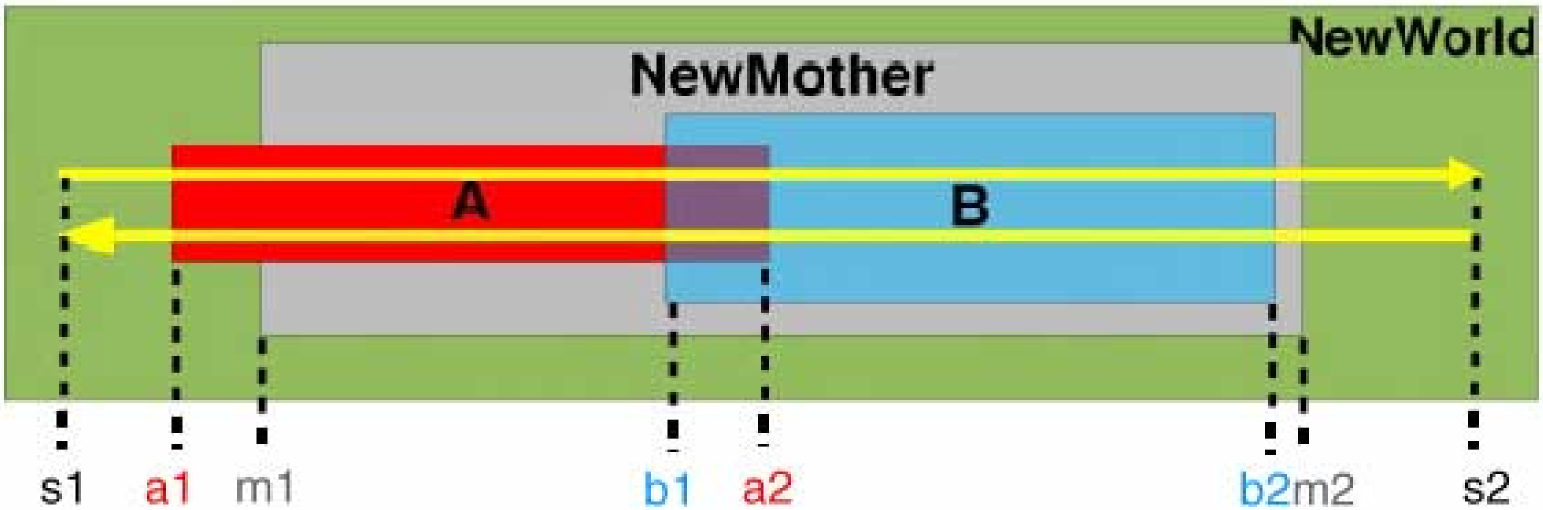
Future way: automatically building GEANT4 geometry from XML files

XML based Detector Description Language (XML DDL)

- Single description inter-
  face for the ideal detector
- Generic description
  . Materials
  . Geometry
  . Component approach
- Attaching specific
  Information to
  . Components
  . Subsets of Volumes
- Human editable/readable
- /expandable



Overlap Detection tool: principle



Hierarchy

NewWorld
|
NewMother
/ \
A B

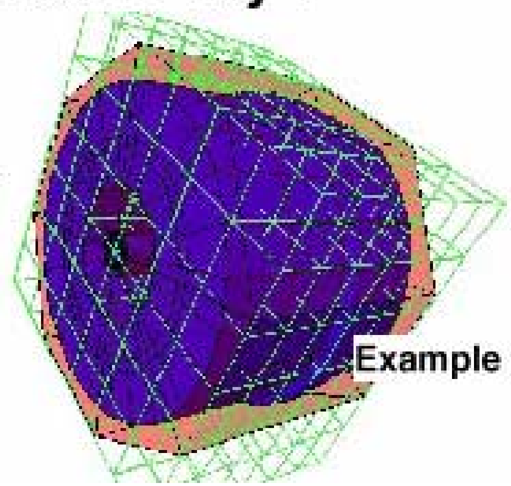
Shooting 2 geantinos in opposite direction along the same 'ray':

s1 to s2:

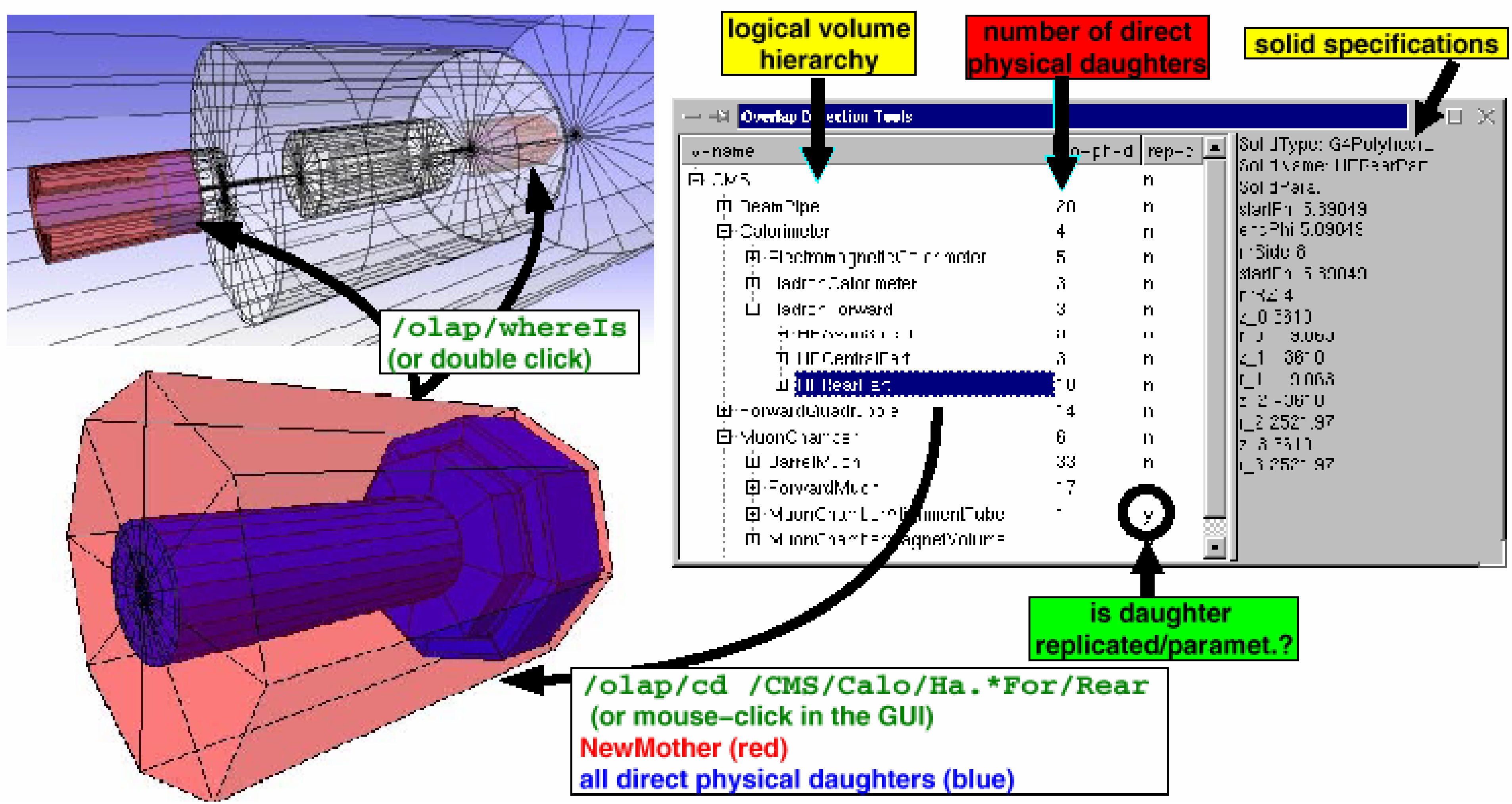
coord.	vol.
m1	World → A
a2	A → B
b2	B → M
m2	M → World

s2 to s1:

coord.	vol. (reversed)
a1	A → World
b1	B → A
b2	M → B
m2	World → M



Overlap Detection tool: GUI, Navigation, Visualisation



GEANT4 error propagator

- **What it does:**
  Needed for track reconstruction:
  - Start with an initial track state (energy, position and direction with their errors) in some subdetector
  - GEANT4e: calculates the track state in another surface of the detector
- **How it does it:**
  - Propagates average trajectory
  - Computes average energy loss (positive or negative)
  - Propagates errors:
    - Propagates errors along the trajectory
    - Adds fluctuation in multiple scattering
    - Adds fluctuation in energy loss
    - Adds errors of magnetic field

GEANT4 error propagator

- **Status:**
  Needed for track reconstruction:
  - Uses G4Transportation to propagate from an initial track state to a user defined surface (infinite plane) in the
    - GEANT4 geometry
    - GEANT4 magnetic field
  - Propagates errors in case of no magnetic field (linear trajectory)

- **Plans**
  - Propagate errors in magnetic field for different trajectory representations
    - Assume helix trajectory?
    - Calculate errors of RungeKutta?

Performance GEANT3 - GEANT4

- 5 events **H** $\rightarrow$ **ZZ** $\rightarrow$ **4**μ
- Full geometry and magnetic field
- Same production, tracking and generator cuts for all particles and materials
- Classical RungeKutta(4) integrator, DeltaChord= 0.1 mm

CMSIM (GEANT3)	OSCAR (GEANT4)
No tracks: 184894	**No tracks: 175545**
TIME: 166.25	**TIME: 152.28**
1112 tracks/s	**1153 tracks/s**

- Performance problems at low eta (big B) and low energy particles
  - GEANT4 magnetic field propagation too precise?
  - Currently tuning it (factor 10-100 in speed)

Milestones

<u>End 2001:</u> Fully Functional Software

- Geometry and hits for all detectors tested
- Persistency for reconstruction
- Performance as good as CMSIM (GEANT3)
- First tests of physics results

<u>End 2002:</u> Production version

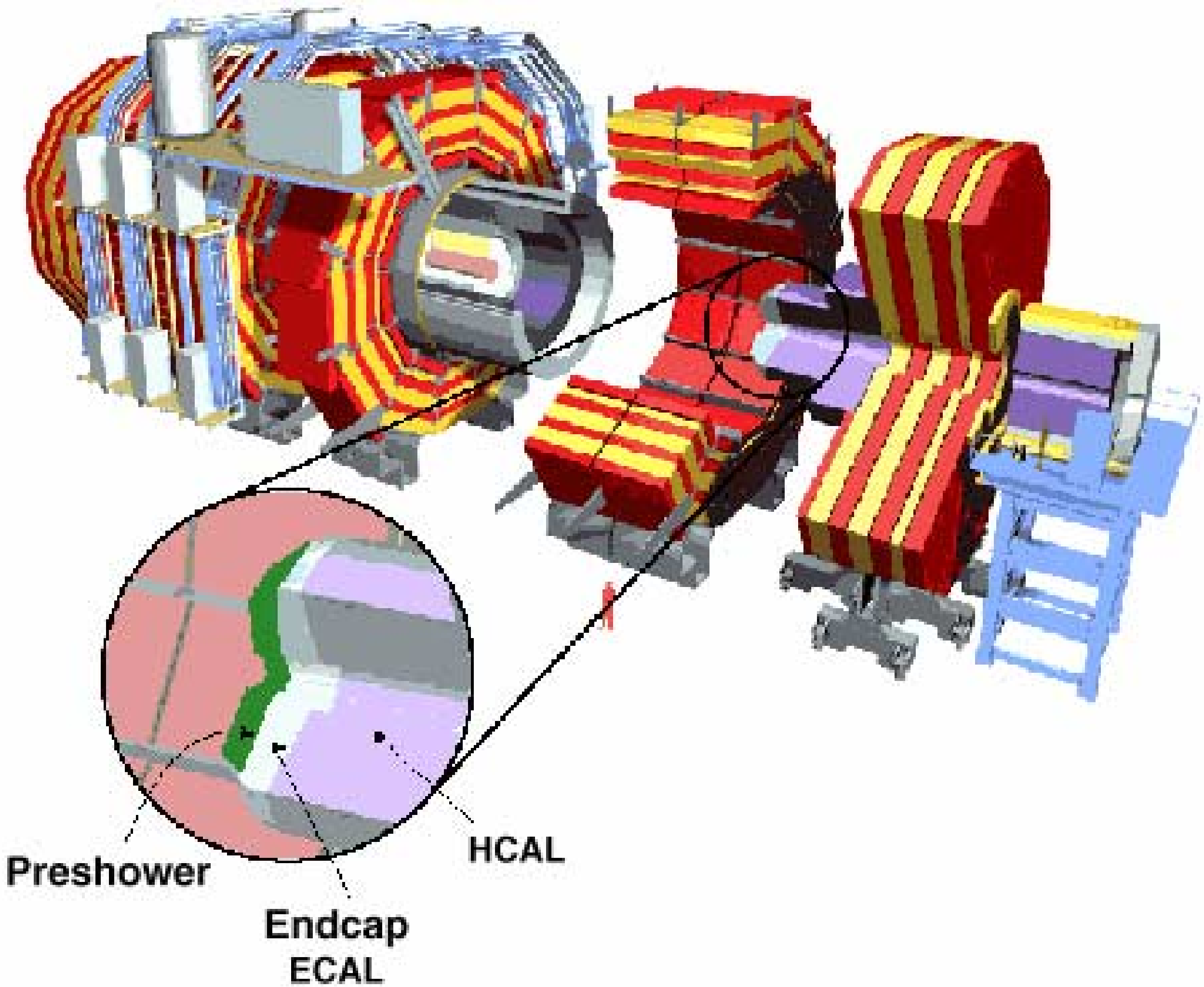
- Geometry rewritten using DDD
- Further tests of physics in OSCAR vs CMSIM
- Further tests of Testbeam data with GEANT4

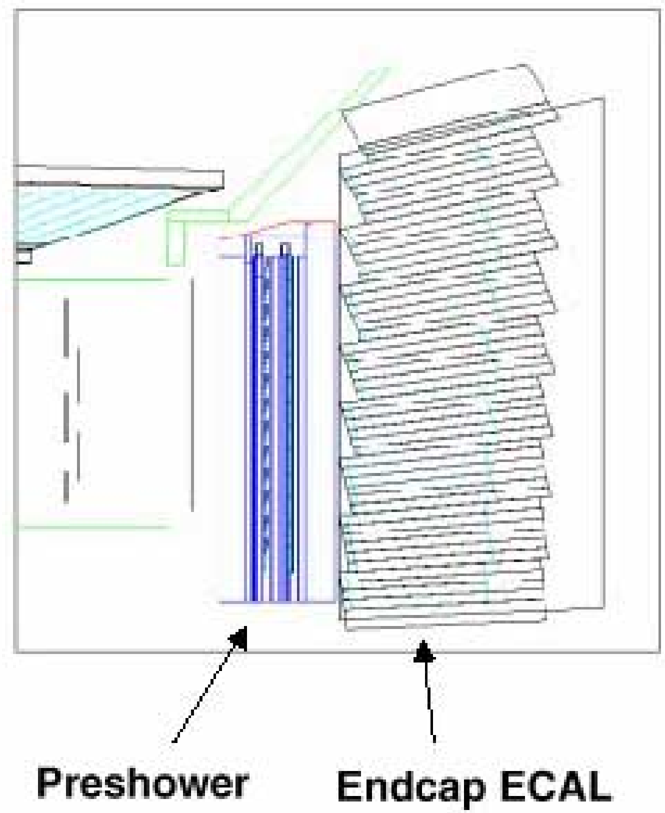
⇒ OSCAR ready for massive production for physics TDR

CMS Physics TDR is planned to be written using OSCAR

(due december 2004)

CMS ECAL testbeam in GEANT4





Simulation cuts

- **Cuts in GEANT4** (only production cuts)
  - **0.005 mm** for every particle and material for preshower shower shape studies
  - **0.5 mm** for energy resolution studies
  - GEANT4.2.ref02

0.5mm	PbWO4 [keV]	Silicon [keV]
e–	640	335
Gamma	60	5

0.005mm	PbWO4 [keV]	Silicon [keV]
e–	34.3	6.6
Gamma	2.6	0.99

- **Cuts in GEANT3** (production and tracking cuts)
  - **10 keV** for e-/e+ and gamma in crystals and preshower
  - Delta rays turned on/off for energy resolution studies
  - Delta rays turned on for preshower shower profiles
  - GEANT3.21/13

Conclusions of Testbeam simulation

- Good agreement between data and GEANT3 or GEANT4 simulation

- Some GEANT4 distributions slightly different from data
  - Need to tune the cuts as they were tuned for GEANT3