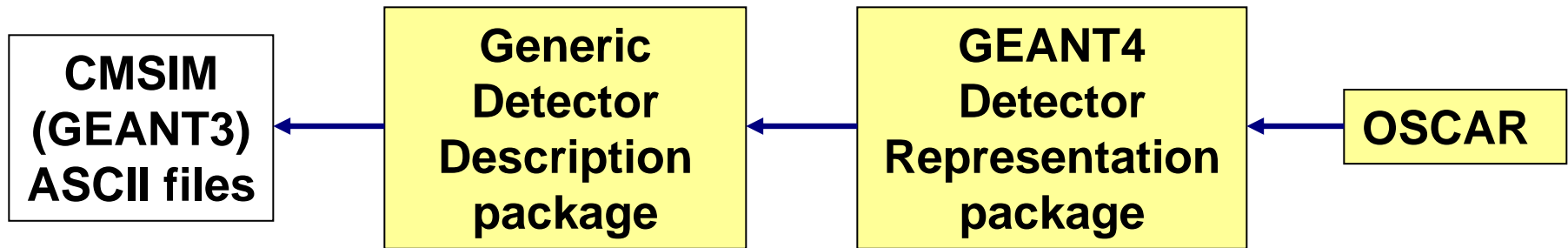


## New way: automatically building GEANT4 geometry from ASCII files



☺ Easy to understand

- 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 daughters will not be simulated

☺ Easy coherence with other packages

- Same files used for GEANT3 simulation, digitisation and reconstruction

# Geometry: Input (III)

Future way: automatically building GEANT4 geometry from XML files

## XML based Detector Description Language (XML DDL)

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

### Application Side

ORCA  
(Recon)

OSCAR  
(Full Sim)

FAMOS  
(Fast Sim)

IGUANA  
(Visual)

Common Interface (CI)

Transient Object Model, various services for CI

DDD Core

### Data Side

Converter

CAD

TZ

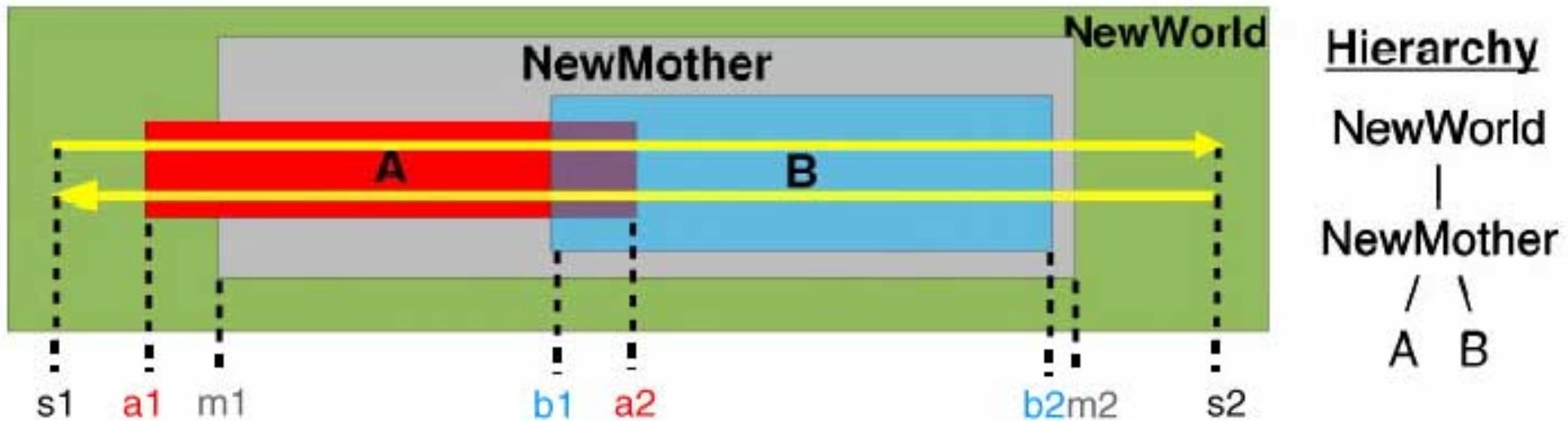
...

Conditions DB

... depends on



# Overlap Detection tool: principle



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

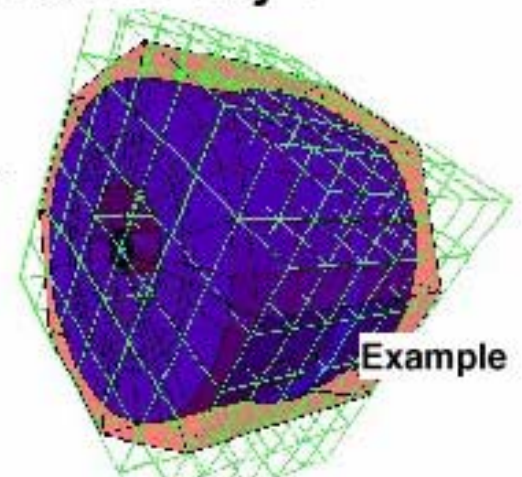
**s1 to s2:**

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

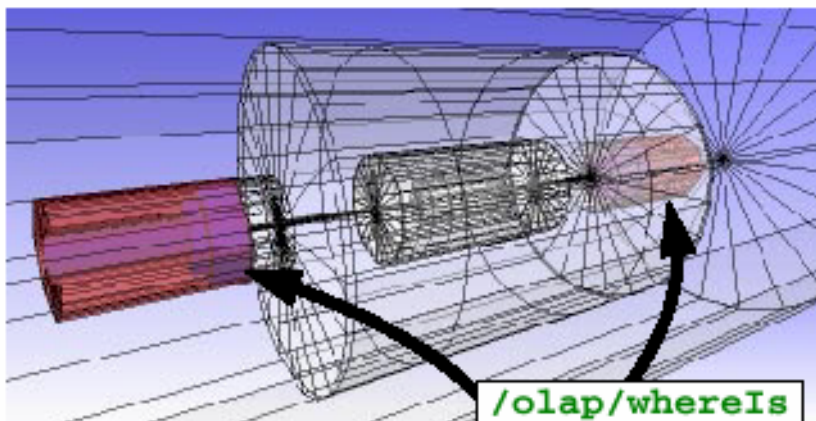


**s2 to s1:**

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



# Overlap Detection tool: GUI, Navigation, Visualisation



`/olap/whereIs`  
(or double click)

logical volume hierarchy

number of direct physical daughters

solid specifications

v-name	n-phys-d	rep-c	Sol IDType: G4Polyhedr...
Root			Sol 1 Name: HEPearPar
BeamPipe	20	n	Sol 3 Para.
Calorimeter	4	n	startPhi 5.39019
ElectromagneticCalorimeter	5	n	endPhi 5.09019
hadronCalorimeter	3	n	1 Side 0
hadronForward	3	n	startPhi 5.30040
HEPForward1	0	n	r=2.4
HEPCentralPart	3	n	z_0 3310
HEPBackward1	0	n	r_1 3.0000
HEPBackward2	0	n	z_1 3810
HEPBackward3	0	n	r_2 3.0000
HEPBackward4	0	n	z_2 -3810
HEPBackward5	0	n	r_3 3.0000
HEPBackward6	0	n	z_3 3521.97
HEPBackward7	0	n	r_4 3.0000
HEPBackward8	0	n	z_4 -3521.97
hadronBackward	4	n	
MuonChamber	6	n	
JawrelMuc	33	n	
ForwardMuc	7	n	
MuonChamberLorentzMomentCube	1	n	
MuonChamberMagnetVolume	1	n	

is daughter replicated/paramet.?

`/olap/cd /CMS/Calo/Ha.*For/Rear`  
(or mouse-click in the GUI)  
NewMother (red)  
all direct physical daughters (blue)

## ★ 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

## ★ 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?

- 5 events  $H \rightarrow ZZ \rightarrow 4\mu$
- 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)

**No tracks: 184894**

**TIME: 166.25**

**1112 tracks/s**

## OSCAR (GEANT4)

**No tracks: 175545**

**TIME: 152.28**

**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)

## End 2001: Fully Functional Software

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

## End 2002: Production version

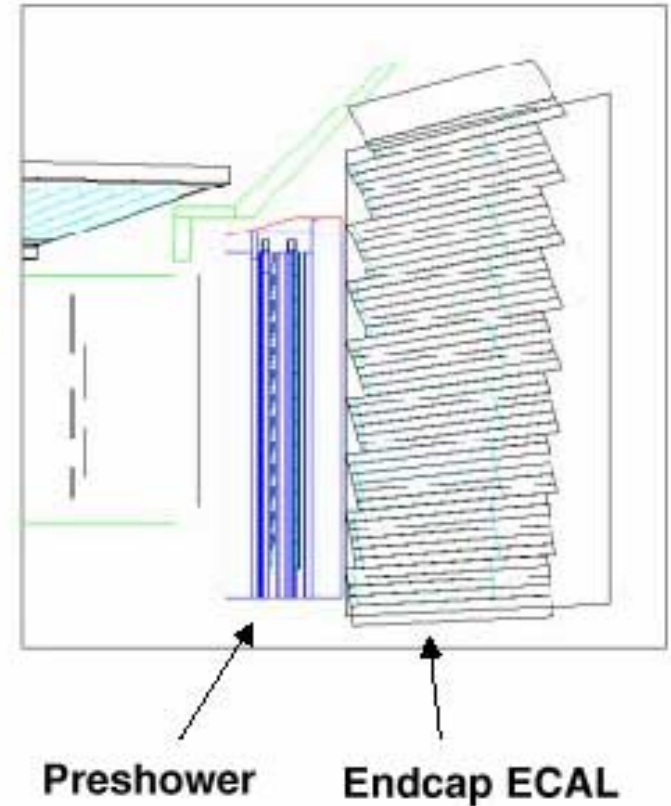
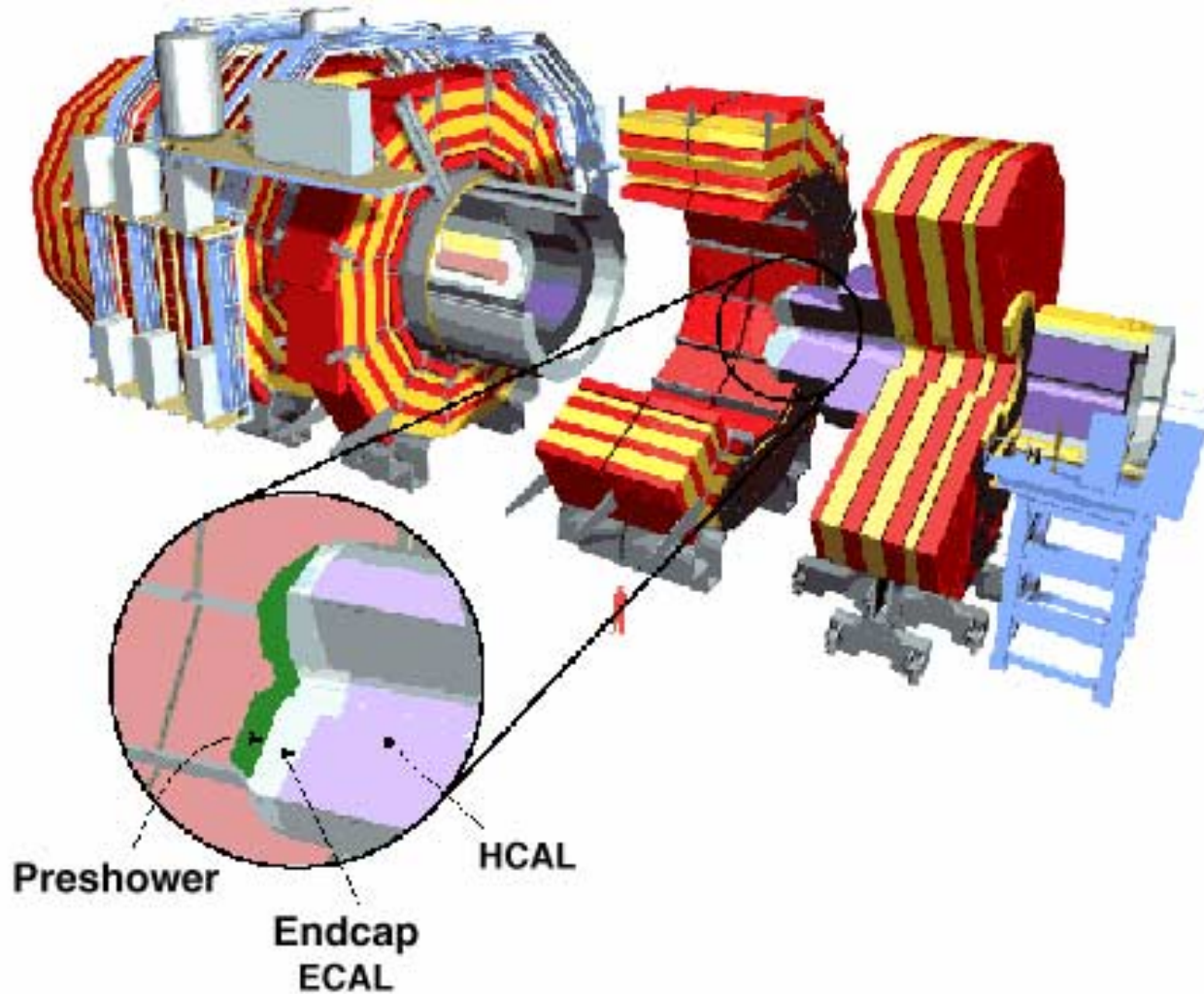
- Geometry rewritten using DDD
- Further tests of physics in OSCAR vs CMSIMM
- Further tests of Testbeam data with GEANT4

⇒ **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



- 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 <sup>-</sup>	640	335
Gamma	60	5

0.005mm	PbWO4 [keV]	Silicon [keV]
e <sup>-</sup>	34.3	6.6
Gamma	2.6	0.99

- Cuts in GEANT3 (production and tracking cuts)
  - **10 keV** for e<sup>-</sup>/e<sup>+</sup> 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