ATLAS Sub-detector Software

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DOE/NSF Review of LHC Software + Computing Projects

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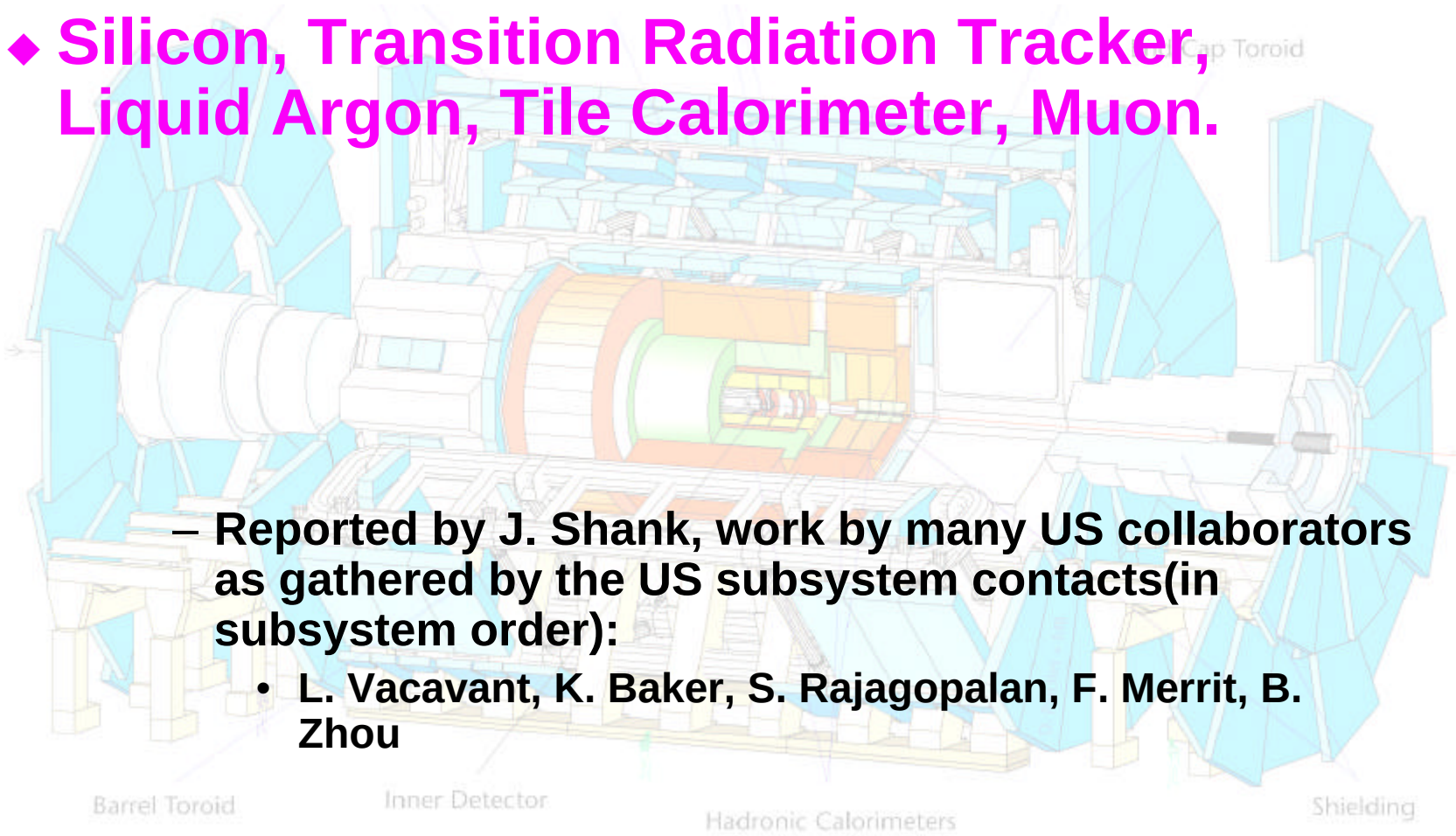
ATLAS Sub-detector Software

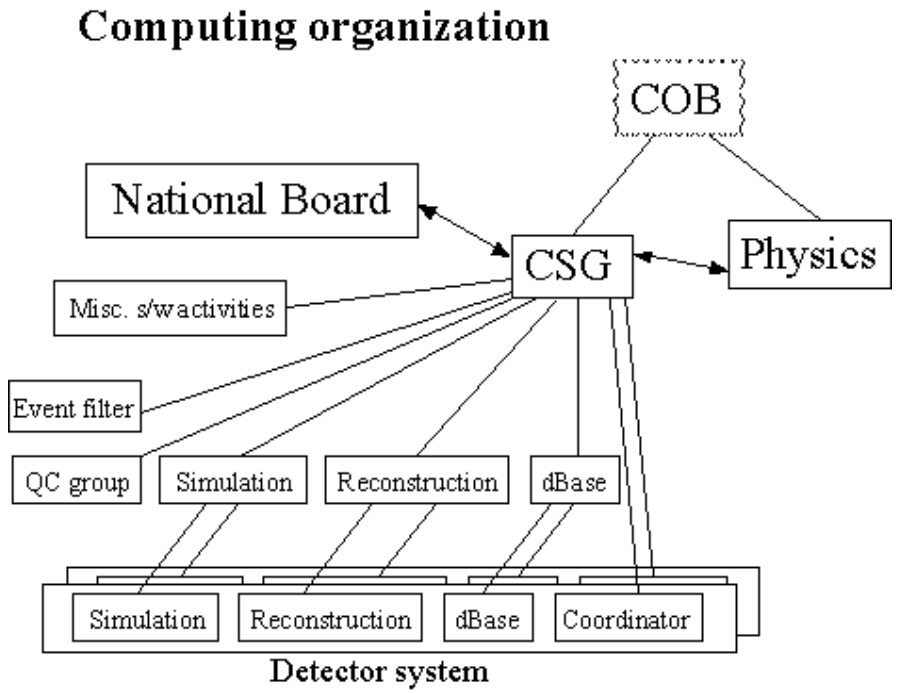
- **US active in all detector subsystems:**
  - **Silicon, Transition Radiation Tracker, Liquid Argon, Tile Calorimeter, Muon.**



    - **Reported by J. Shank, work by many US collaborators as gathered by the US subsystem contacts(in subsystem order):**
      - **L. Vacavant, K. Baker, S. Rajagopalan, F. Merrit, B. Zhou**

ATLAS Computing Org. Ch

- **Proposed (N. McCubbin):**



- **…still under discussion.**
  - **But clearly a strong emphasis on detector systems**

ATLAS Computing organization

	Offline Coordinator	Reconstruction	Simulation	Database
Chair	N. McCubbin	D. Rousseau	A. Dell'Acqua	**D.Malon**/ RD Schaffer
Inner Detector	D. Barberis	D. Rousseau	**F. Luehring**	J. Pater
Liquid Argon	J. Collot	J. Schwindling	**M. Leltchouk**	S. Simion
Tile calorimeter	A. Solodkov	**F. Merritt**	A. Solodkov	**T. LeCompte**
Muon	G. Poulard	J.F. Laporte	A. Rimoldi	**S. Goldfarb**
LVL2 trigger		S. Tapprogge		
Trigger/DAQ	S. George		T. Hansl-Kozanecki	H.P. Beck
Event Filter	V. Vercesi	F. Touchard		

Th

- The “legacy software” results for the Physics Technical Design Report
- Detector Description
  - DB Û XML Û Generic Model
- GEANT4 Simulation
- Reconstruction
- Test-beam

Si Tracker Software

Current activities in the US:

- **Pixel Test-Beam Simulation with Geant4 [LBNL, L.Vacavant]**
  - **redesign of the software (OO)**
  - **validation of G4**
- **Visualization for the reconstruction [UC Santa Cruz, A.Litke]**
  - **involved in the development of ATLANTIS (based on ALEPH's DALI)**
  - **main goal is to check the pattern recognition in the tracker**
- **Activities with old legacy software [LBNL, L.Vacavant]**
  - **No real development activity, some specific studies**
  - **geometrical acceptance of the pixel endcap layout**
  - **impact of misalignment of the pixel disks**

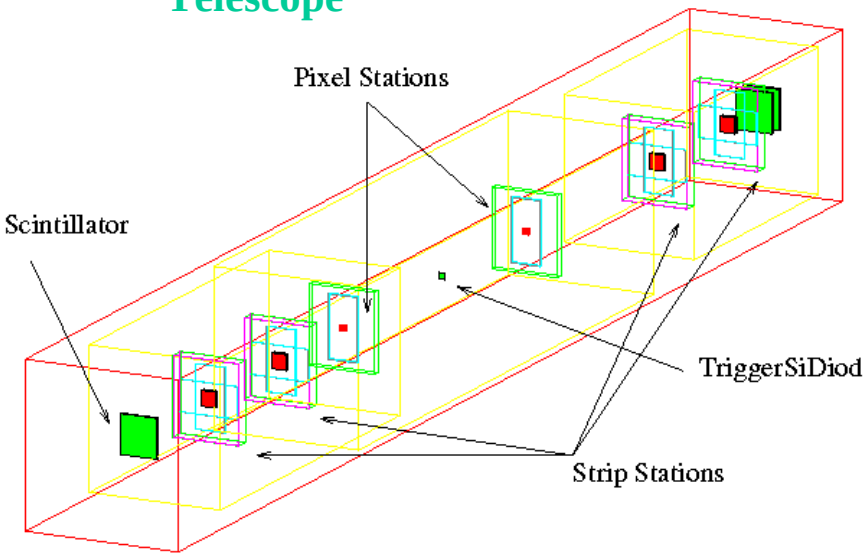
G4 Pixel test beam simulation

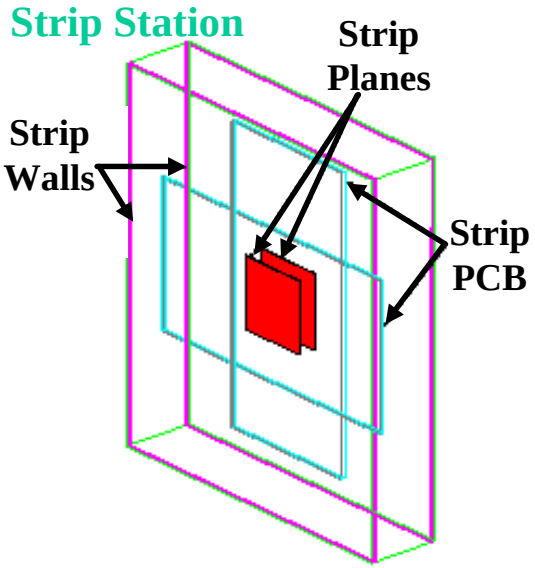
- **Goals:**
  - **To gather experience with OO (new paradigm for most of us) and with GEANT4 + validate G4**
    - **The physics part of G4 is very different from GEANT3. The test-beam simulation project allows us to:**
      - **cross-check G4 vs G3**
      - **cross-check G4 vs Data**
  - **Test-bed for the ATLAS Pixel System**

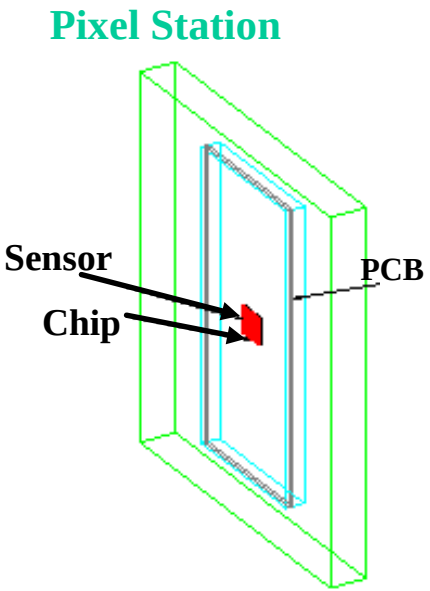
The following parts are currently being developed within the test-beam simulation project and will be re-used directly for the whole pixel system: pixel module geometry, user-defined material management and physics interactions, user-defined tracking and stepping related classes, digitization, infrastructure (histogramming, visualization, GUI).

G4 Pixel test beam simulation

- **Status: Current version (0.2) features:**
  - **As complete as the G3 simulation**
  - **Design allows easy reconfiguration**
    - **STL collection of TelescopeElements (insertable, reposition anywhere)**

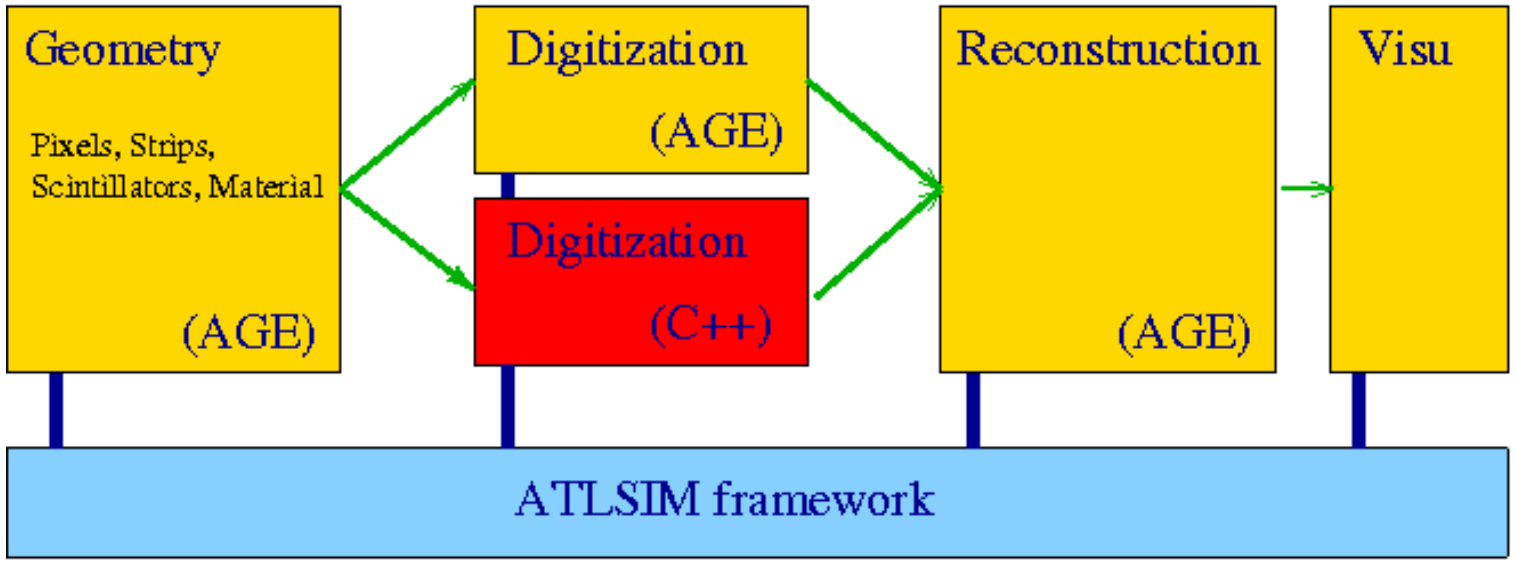






G4 Pixel test beam simulation

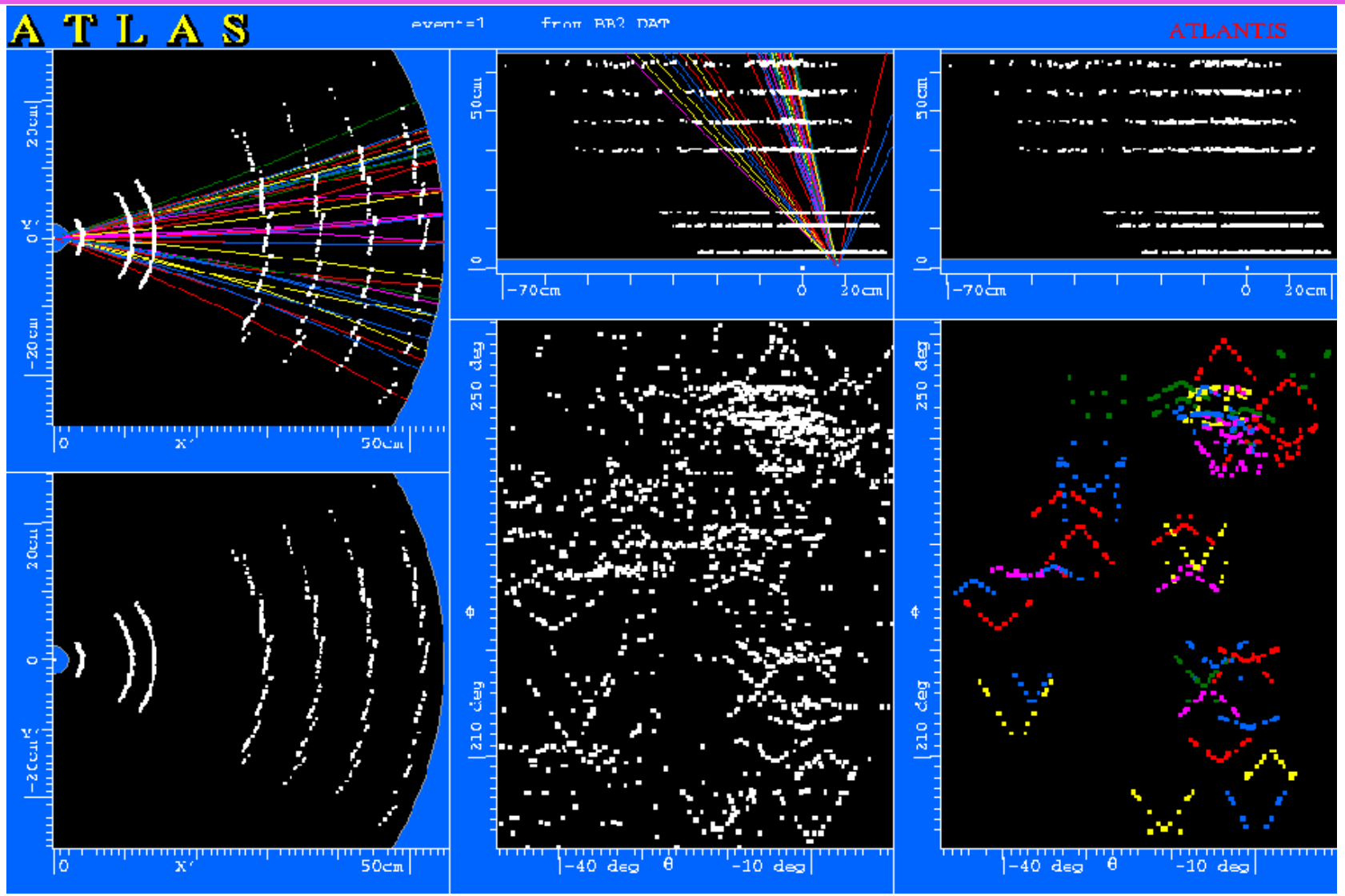
- **Development framework**
  - **For testing, the C++ digitization is being developed independently of G4 and can be run in 3 modes:**
    - **Stand-alone for quick checks. Reads in ASCII file of hits.**
    - **Within ATLSIM for checks against the "old" digitization**
    - **Within GEANT4**



Si Visualization

- **Status**
  - UCSC joined the effort to develop ATLANTIS
  - Working on ID display to check pattern recognition
- **Short term plan:**
  - Interface to read existing simulated events
  - Use to compare existing tracking packages
  - Work on conversion to OO

Si Event Display



Future Activities in Si

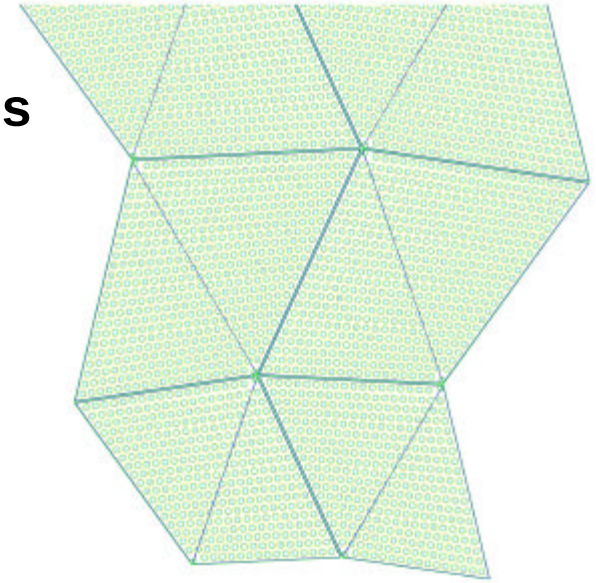
- Pixel test-beam simulation
- Refinements of pixel G4 description
  - Emphasizing correct simulation of the pixel modules
- Design evolution Þ whole pixel simulation
  - Integration in the ATLAS framework
  - Database/detector description
- Coordinate with similar efforts for SCT
- Work on visualization with ATLANTIS

TRT Software

- **Many GEANT3 studies:**
  - **material budgets**
  - **Pile-up studies**
  - **Results in several ATLAS notes and TDRs**
- **Test-beam software**
  - **Comparing G3 with data**
    - **No TR in G3-added by ATLAS**
- **Physics simulations**
  - **With ATLAS fast MC, ATLFAST**
    - **Results in Physics TDR, ATLAS notes.**
      - **SUSY Higgs, e.g.**

TRT GEANT3 WORK

TRT Barrel Modules
Fully Simulated



- **TRT SW Liaison Work:**
  - **Included TRT barrel modules**
  - **Careful tuning of material**
  - **Improved straw response and electronics model**
  - **A fair number of bug fixes**
- **Fake rate and track finding efficiency studies for the Physics TDR.**

Future TRT effort

- G3 Þ G4 starting with test-beam
- Improve e-p separation with neural nets
- Design of the TRT data event model
- Define transient Û persistent mapping

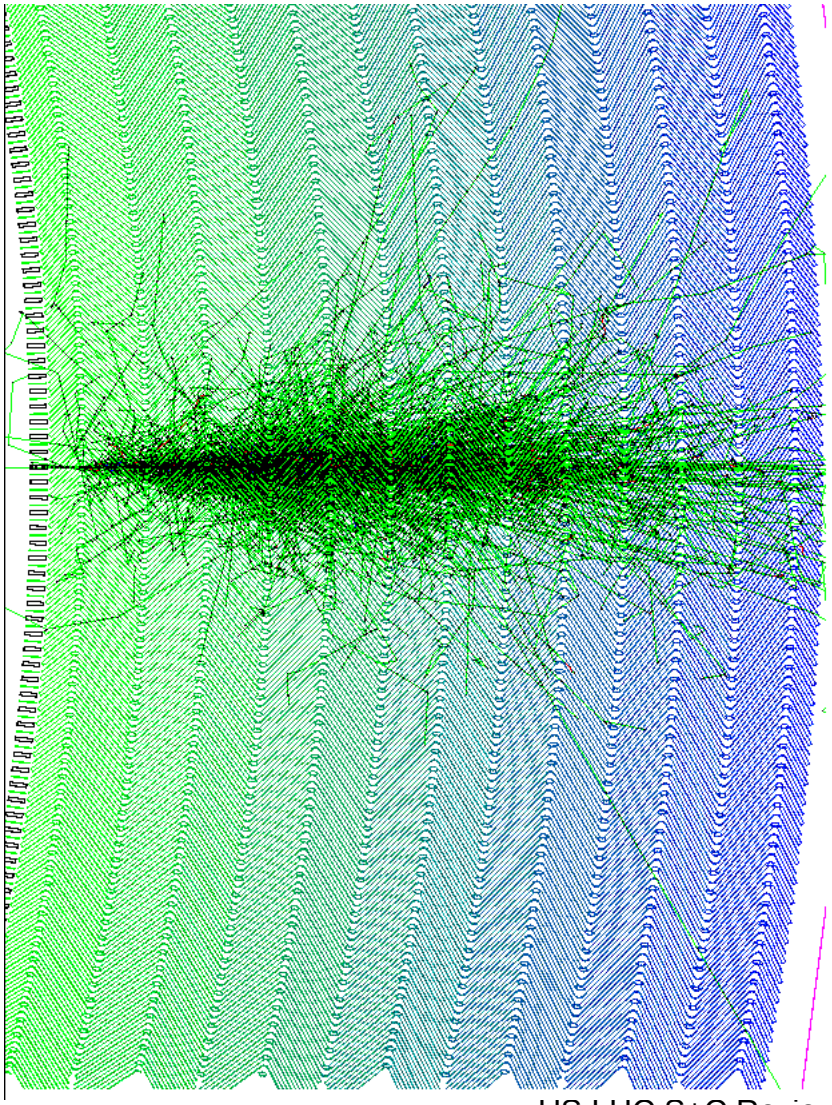
Liquid Argon Software

- **Simulation**
  - **GEANT3 in the Physics TDR**
    - **Optimization of strip width based on p^0 rejection and pointing studies**
    - **Optimal depth and granularity of each of 3 samplings for different Pb thickness**
    - **Simulation of dead material in front of the Cal.**
- **DB/Detector description**
- **Test beam**
- **Calibration**
- **Detector response and physics studies**

Liquid Argon Simulation in G4

- Struggling with the accordion geometry in G4
  - no appropriate shape
- Large memory usage vs long tracking time

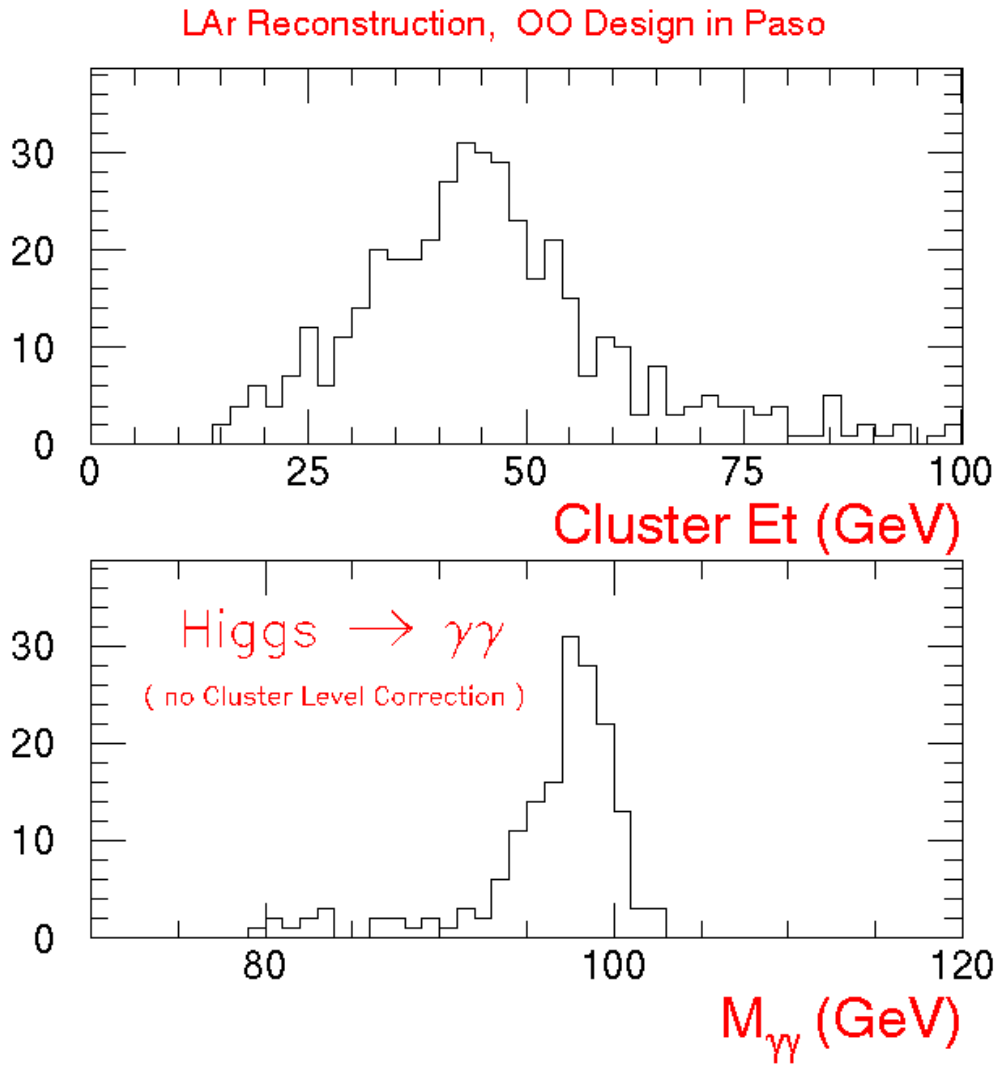
10 GeV shower Þ



LAr Reconstruction (OO)

- **USDP:**
  - Use cases have been developed
  - Prototype designed with UML
  - First implementation in PASO (Provisional Analysis Skeleton for Object oriented software)
  - Reads data from the old GEANT3 simulation
  - Implements basic cell and cluster finding algorithms and outputs the following:

LAr Reconstruction (OO)



TileCal (Hadron Calorimetry)

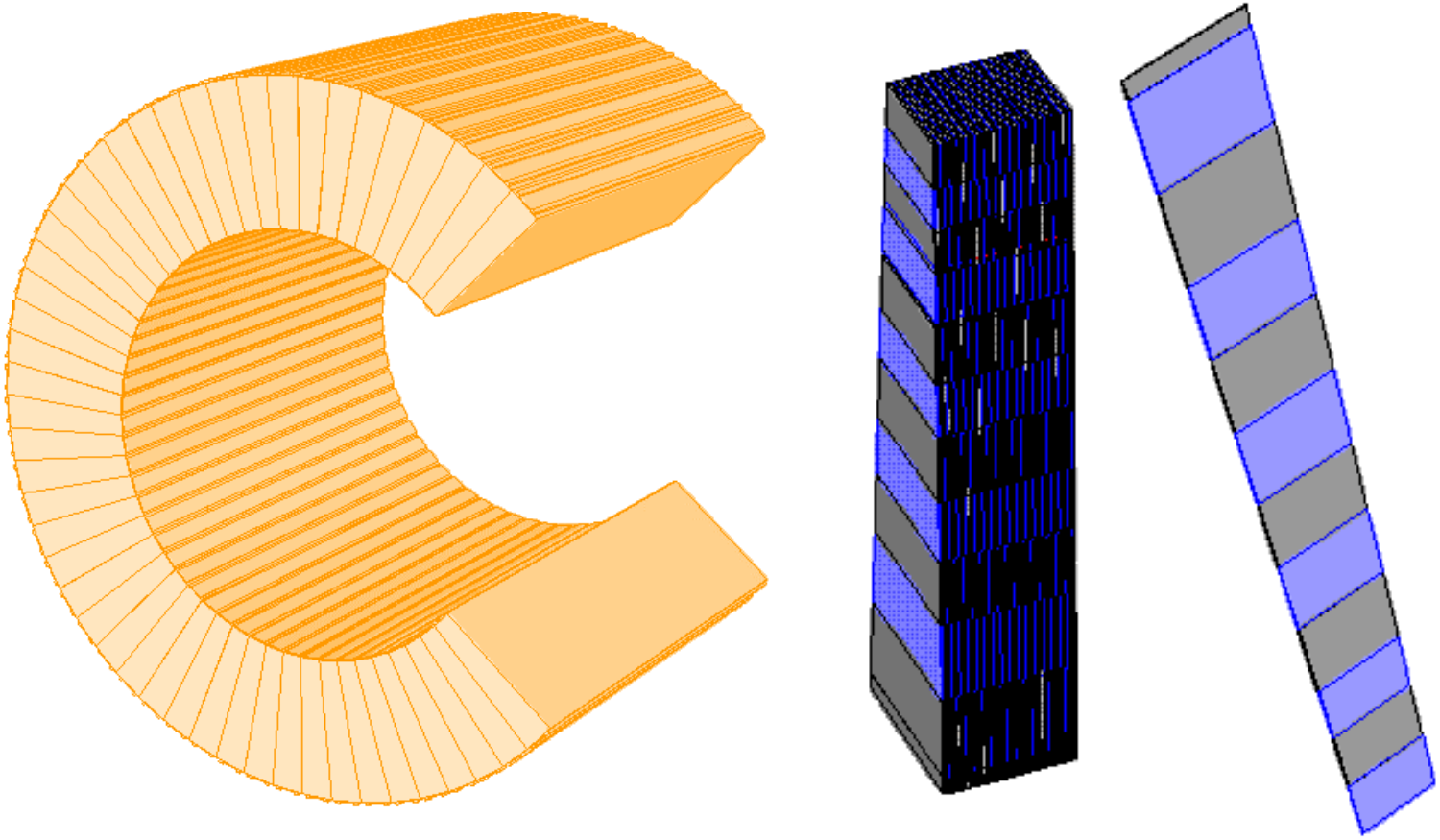
- **Tilecal Pilot Project: test-beam analysis system using OO/C++ and Objectivity, developed by U.S. groups.**
- **Present system has full functionality of old Fortran analysis system.**
  - **All initial Pilot Project goals have been met.**
  - **Tutorial was presented at CERN in Nov 99, with examples and online documentation.**
- **Future development**
  - **Optimal filtering; improvements in structure of code, classes, documentation and user interface**
  - **Added functionality and new analysis tools (E.g., LHC^{++})**
  - **Use in other sub detector test-beams**

TileCal (Hadron Calorimetry)

- **PASO (Provisional Analysis Skeleton in OO)**
  - **This is an off-line analysis framework for the development of OO analysis, able to read Geant3 tapes generated for TDR studies.**
  - **Tilecal work with PASO has begun with development of transient data record for "full ATLAS" Tilecal system.**
  - **Will be able to read Geant3 tapes by Feb 2000.**
  - **Development of cluster-finding techniques during spring 2000.**

TileCal detector description

- XML



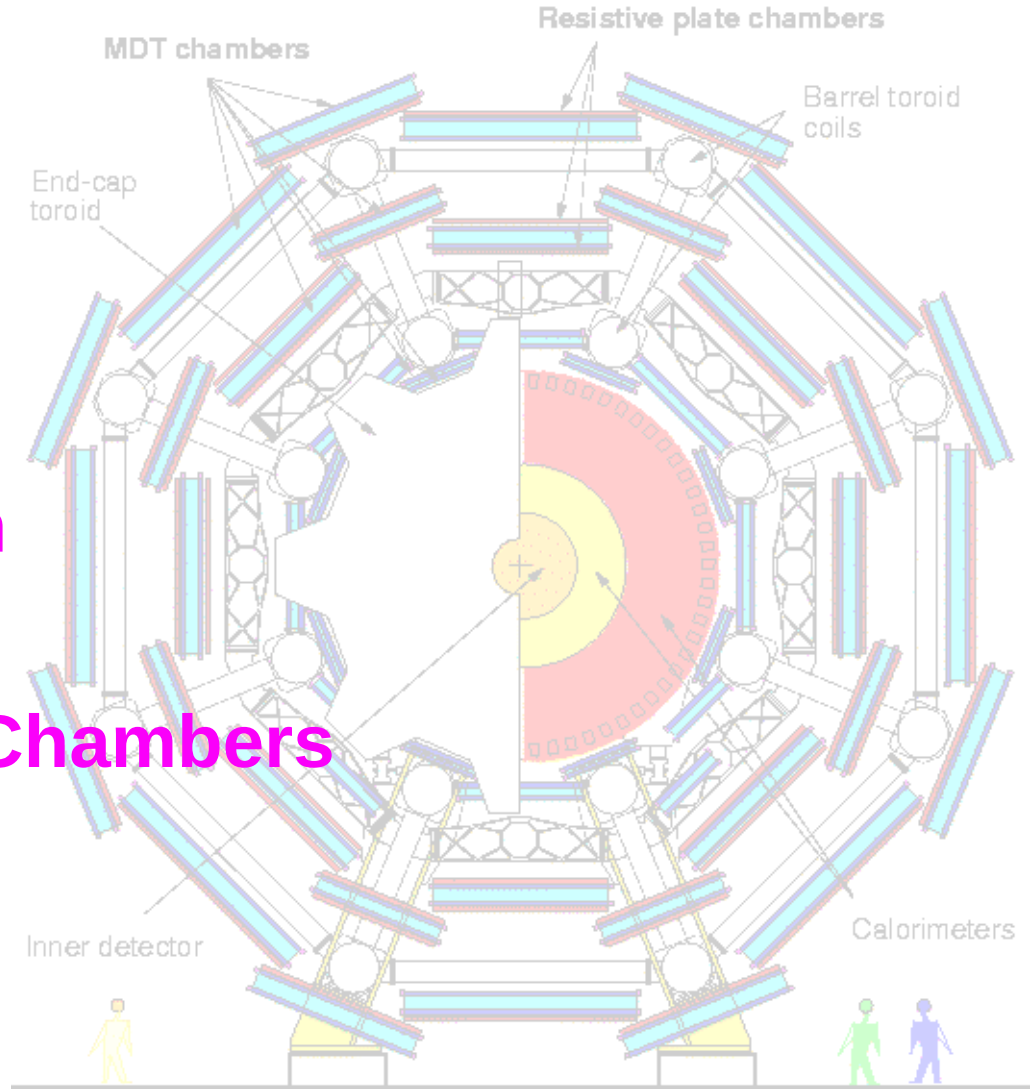
- Work well underway on development of Tilecal detector description using XML (essential for Geant4).

TileCal (Hadron Calorimetry)

- **Discussions underway with LAr group concerning:**
  - **Common data structures for Tilecal and LAr.**
  - **Common or parallel code structure for cluster-finding.**
  - **Combined effort on jet reconstruction and energy resolution.**
  - **To be discussed: combining LAr and Tilecal energies at the cell/tower level, before cluster-finding is carried out.**

Muon Software

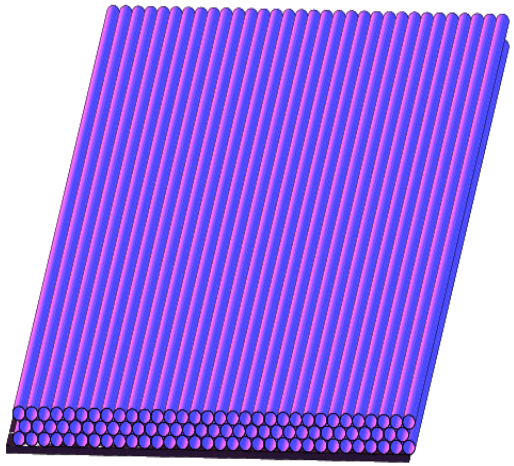
- **Areas of US involvement:**
  - **DB**
  - **Simulation**
  - **Reconstruction**
  - **Trigger**
  - **Cathode Strip Chambers**



Muon DB/Detector description

- **An MDT1 Multilayer Stack in XML:**

```
<composition name="MU_MDT1_OuterTubes">
   <mposZ volume="MU_MDT1_Tube"
          ncopy="32" Z0="-480." dZ="30.0" rot="0 90 0" index="0 0 0" />
</composition>
<composition name="MU_MDT1_Stack">
   <posXYZ volume="MU_MDT1_OuterTubes" X_Y_Z="0  33.48  0" index="0 2 0" />
   <posXYZ volume="MU_MDT1_InnerTubes" X_Y_Z="0   7.50  0" index="0 1 0" />
   <posXYZ volume="MU_MDT1_OuterTubes" X_Y_Z="0 -18.48  0" index="0 0 0" />
   <posXYZ volume="MU_MDT1_Support"    X_Y_Z="0 -40.98  0" />
</composition>
```



Muon DB/Detector description

- **A BMS1 Barrel Station in XML:**

```
<composition name="MU_BMS1_Station">
   <posXYZ volume="MU_BMS1_UpperRPC" X_Y_Z="0  251.96  0" index="0 1 0"/>
   <posXYZ volume="MU_BMS1_UpperMDT" X_Y_Z="0  133.48  0" index="0 1 0"/>
   <posXYZ volume="MU_BMS1_Spacer"   X_Y_Z="0    0     0" />
   <posXYZ volume="MU_BMS1_LowerMDT" X_Y_Z="0 -133.48  0" index="0 0 0"/>
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```
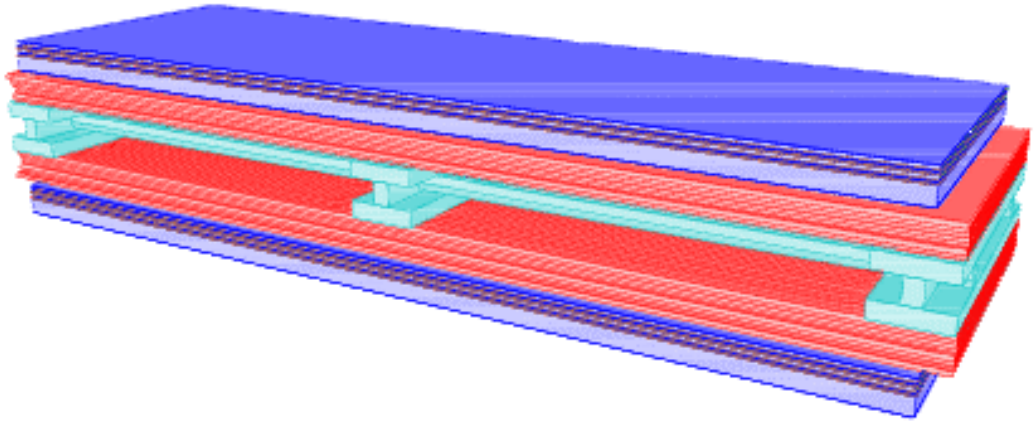
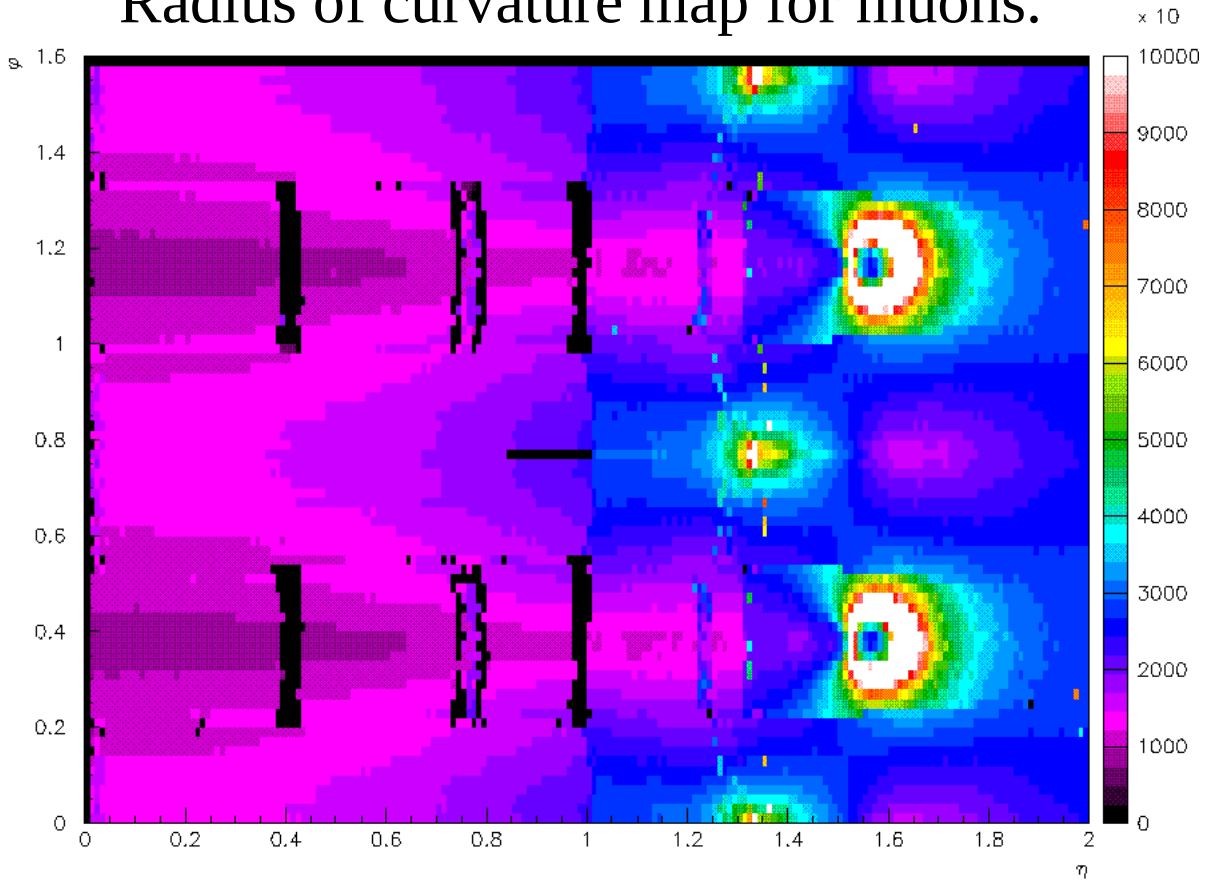



See Goldfarb's web site for full details: http://home.cern.ch/muondoc/software/Database/

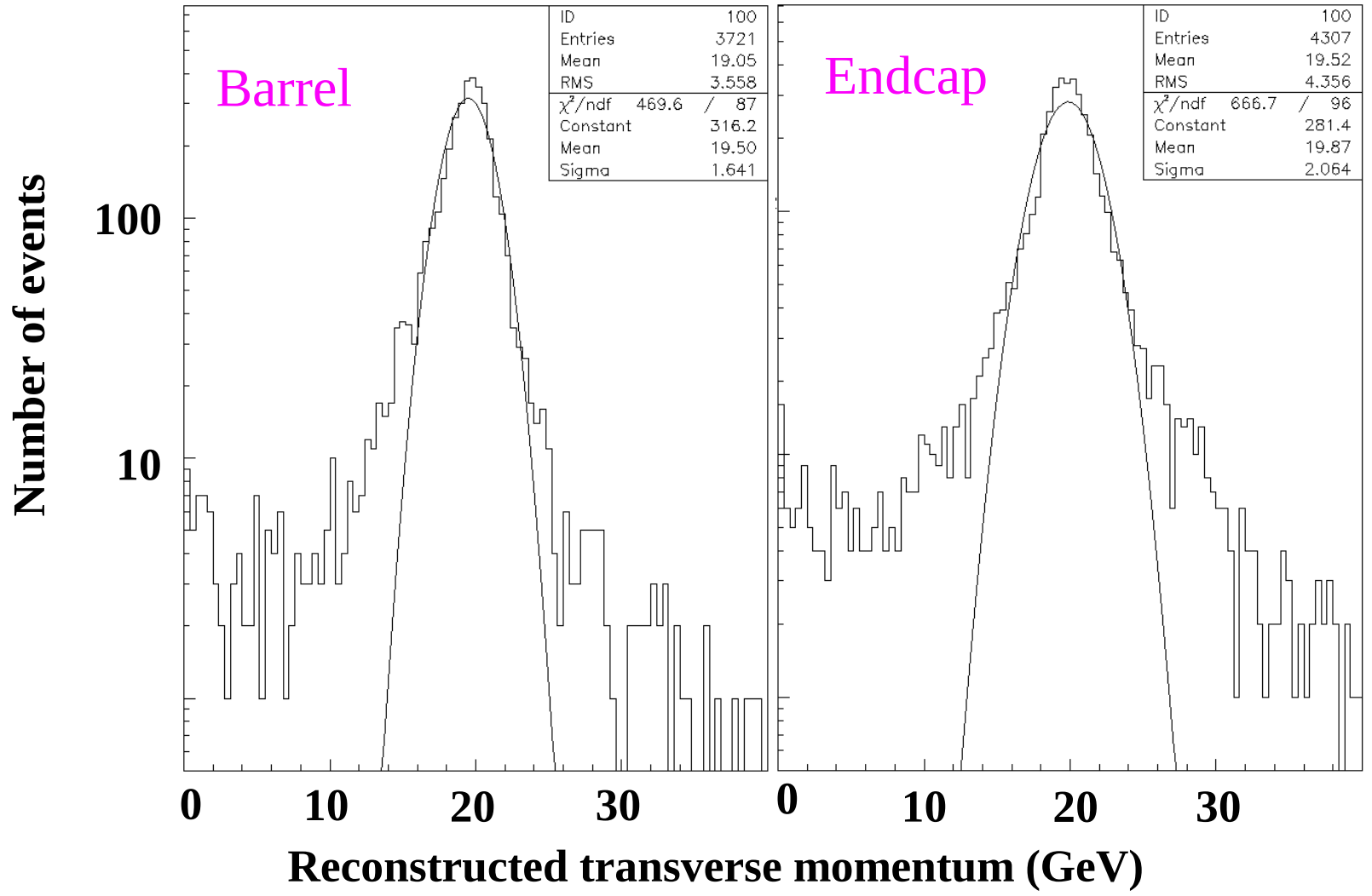
Muon Level 2 Trigger

Radius of curvature map for muons.



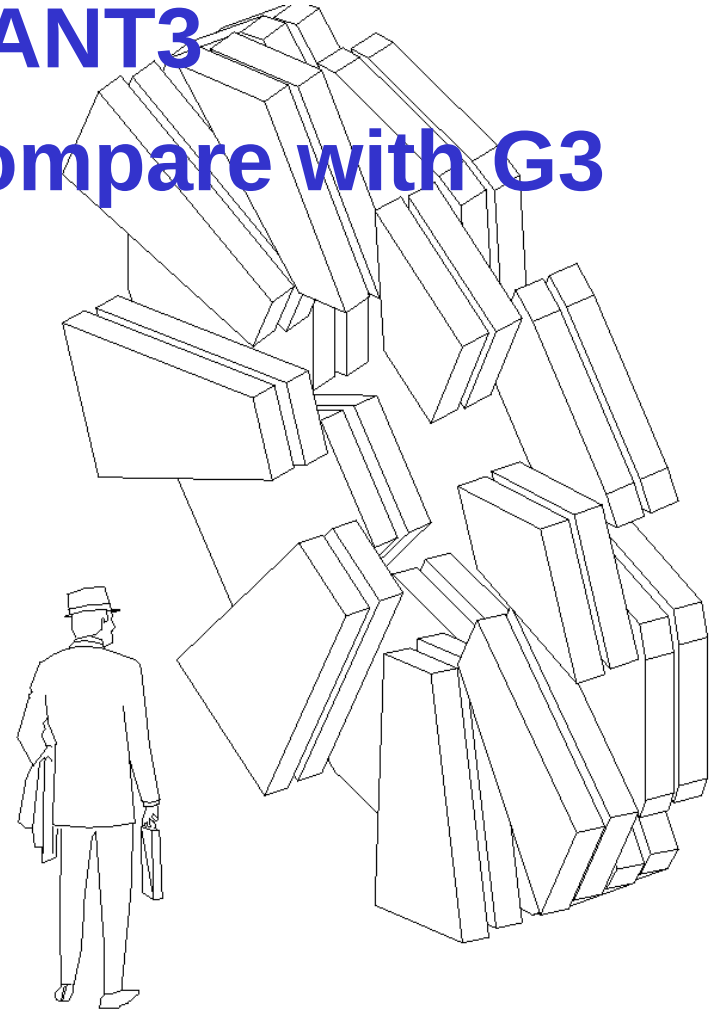
Muon Level 2 Trigger

Level 2 momentum resolution for 20 Gev muons.



Cath

- Many studies with GEANT3
- Development in G4, compare with G3
- Reconstruction in OO
- Test beam

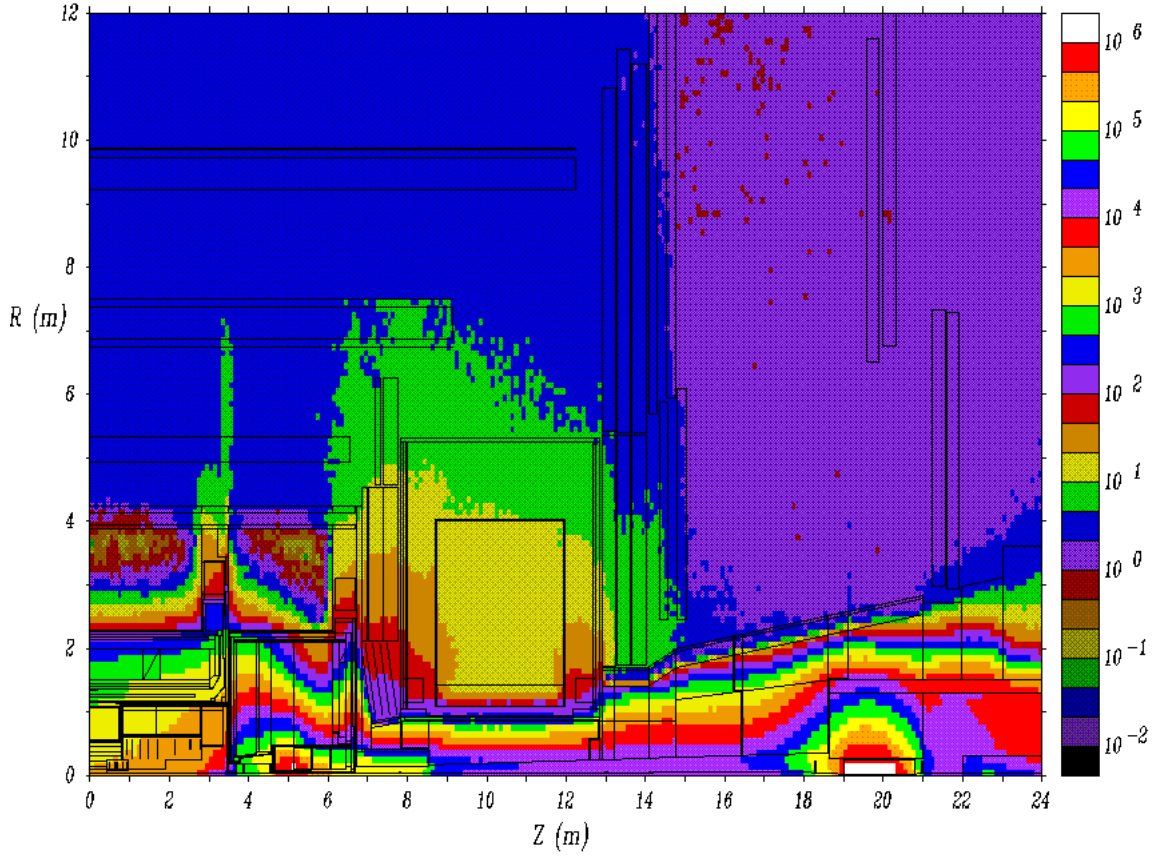


Cath

- **Complete GEANT3 geometry**
  - **Incorporating signal simulation based on photo-absorption ionization model.**
    - **Gas properties and electrode geometry taken into account**
    - **Tuned with test-beam data for position accuracy and high background rate performance**
  - **Adding more details to the geometry now**
    - **Details of frames, corners and dead areas.**

Neutron Background Studies

Total neutron flux KHz/cm^2



Conclusions

- Broad range of activities, well integrated in the whole of ATLAS
- Working closely with US work in core
- Leadership roles in many areas
- Well positioned for future software agreements
  - (we expect subdetector software MOU's to be later than core software MOU's)