Towards a Geant4 and Fluka real-life comparison: The Tile2002 ATLAS test beam

Manuel Gallas, Witek Pokorski, Alberto Ribon

LCG Physics Validation meeting
25 January 2005, CERN

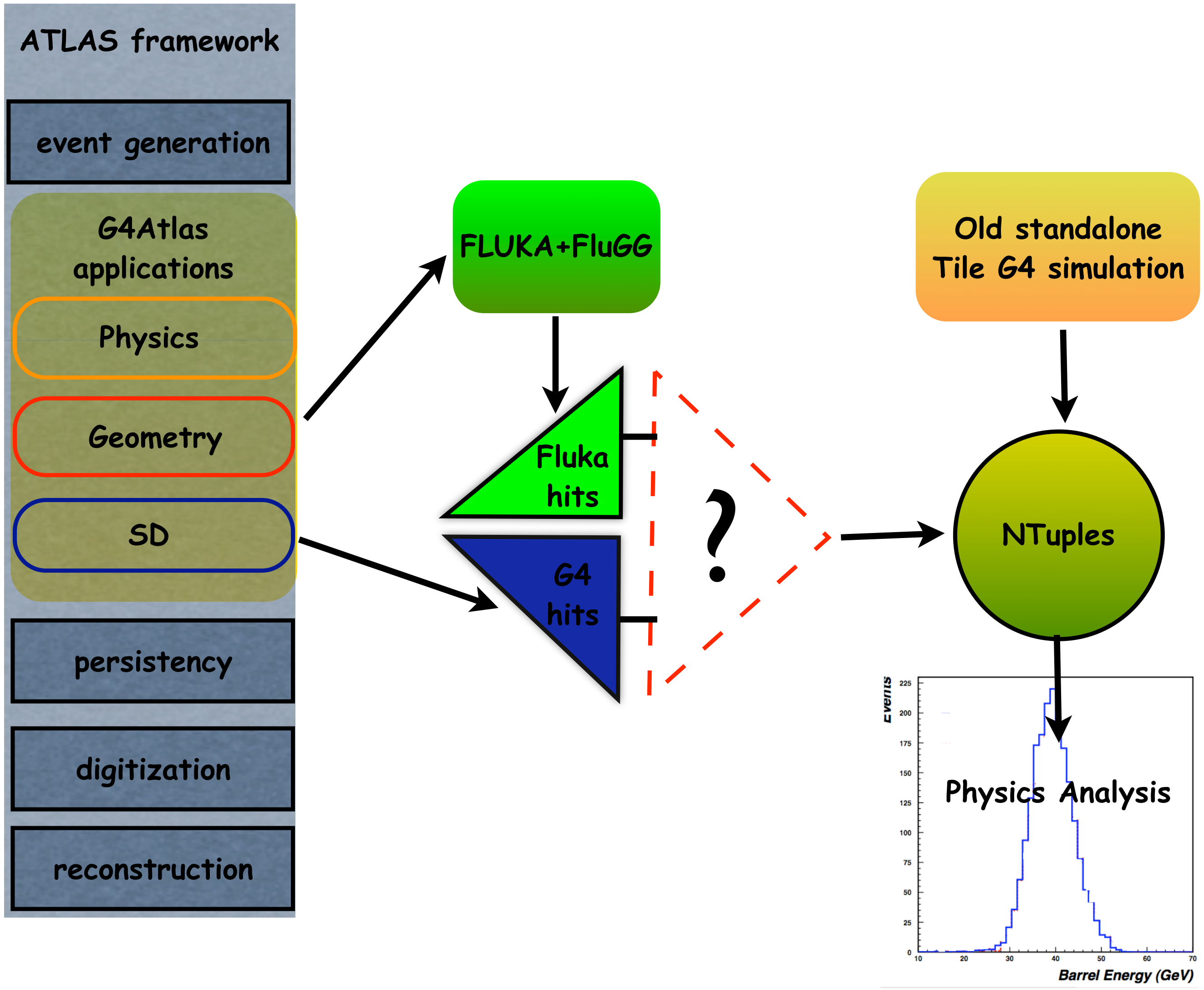
Outline:

- Goal
- RoadMap
- Tile 2002 ATLAS test beam
- Geometry interchange
- G4 simulation and hit analysis
- FLUKA hit analysis
- Development line
- Conclusions

Goal: "Be able to compare simulation results from Geant4 and Fluka in the context of the ATLAS Tile 2002 test beam"

- This talk explains how this can be done and what has been implemented to make it possible.
- No final physics-results yet, although energy distributions in both cases have been obtained.
- It is not yet usable by the users.
- Main principles:
  - Use GDML+FLUKA+FluGG to create FLUKA-hits (see Witek's talk) with the material geometry extracted from the G4 simulation of the TB.
  - Process of the FLUKA-hits within the G4 Sensitive detector in order to access the read-out geometry.
  - Re-use as much as possible the work done for the Geant4 and data comparison: re-create the same ntuples, use the same macros for the analysis.
  - Easy integration with the simulation framework from the experiment. Use what the framework offers. Be as general as possible, minimal intrusion: extrapolation.

RoadMap:



ATLAS framework

event generation

G4Atlas applications

Physics

Geometry

SD

persistency

digitization

reconstruction

FLUKA+FluGG

Fluka hits

G4 hits

?

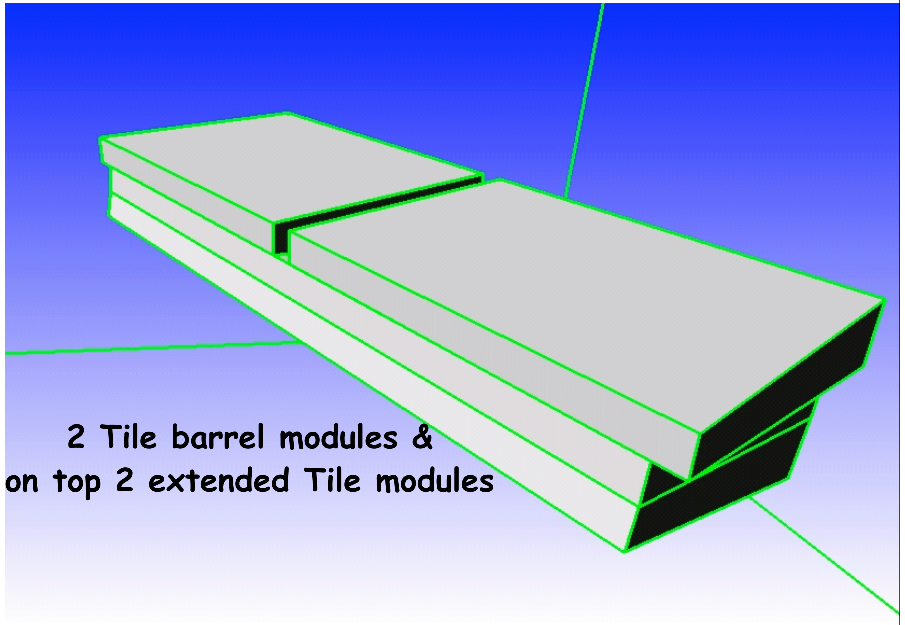
Old standalone Tile G4 simulation

NTuples

Physics Analysis

Tile 2002 ATLAS test beam

- ATLAS Tile calorimeter (iron +scintillating tiles)
  - barrel 5640 mm long, 2-extended modules 2910 mm long
  - radius, Inner=2280 mm, Outer 4230 mm
  - radially segmented into three layers (at η=0, 1.4, 3.9, 1.8 λ)
- Tile TB at CERN SPS H8 2002, 2 barrel and 2 extended barrels



2 Tile barrel modules &
on top 2 extended Tile modules

* 2002 data: pions and electrons 20-180Gev

Manuel Gallas
CERN PH-SFT

Geometry interchange

- The geometry in use by the old Tile 2002 was ported (V. Tsulaia) to the ATHENA framework (ATLAS framework for event processing).
- A G4Atlas application was assembled. The easiest way to use the latest G4 versions and (if needed) access to the digitization and reconstruction.
- Once the geometry is loaded into the Atlas G4 application it can be exported in xml format using the Python GDML writers:
    - A specific ATLAS GDML interface was created
    - For each eta position we produce one different xml file (eta=0.35, the tested snapshot) .
- Fluka+Flugg can read the xml geometry using the GDML C++-readers
- The G4 application uses the original geometry but it could use the xml-exported geometry (some work need, it can be use to cross-check GDML)
- The read-out geometry is implemented in the G4 SD and is not exported.

Geant4 simulation and analysis

- The G4 ATLAS application uses the original TB geometry : 2 barrels + 2 extended barrels.
- Different eta positions are achieved rotating +shift (= projectivity) the geometry.
- The event generation (particle gun) is done using the ATLAS ParticleGenerator.
- The hits are saved in a POOL file (digitization and reconstruction, if needed).
- CPU performance: pions at 50 Gev -> 0.265 s/event in a PIV (1.8Ghz)
- The analysis is done at the level of the hit creation, through a dedicated G4UserAction:
  - Neither digitization nor reconstruction (as Tile does now within ATHENA) are actually done in this first analysis
  - The output are PAW or Root ntuples (AIDA) equal to the ntuples produced during the Tile2002 analysis. PAW ntuples allow the use of old kumac-analysis.

FLUKA hit analysis:

- FLUKA hits = (pre/post_step position, energy, pdg)
- FluggHitContainer stores the hits in a ROOT file with the event number as key (FLUKA writes and G4Atlas reads FLUKA-hits)
- Read-out geometry is not implemented in the FLUKA side.
- The FLUKA hits have to be processed within a G4Atlas Application in order to use the read-out geometry described within the G4 Sensitive Detector.
- The original G4 SD has been extended to cover the FLUKA hit processing (process FLUKA or G4 hits = select flag in top jobOption).
- Shooting geantinos is possible to use all the G4Atlas machinery in order to get the physical geometry, the read-out geometry, G4 hit-collections and persistency.
- The geantinos will not fill the hit-collections (not energy deposit), so we can use the EndOfEvent to process the FLUKA-hits.

FLUKA hit analysis:

- G4TileSD::EndOfEvent is the place to play:
  - yes, intrusive, but not that much.
  - create a "fake" G4 astep with data from the FLUKA-hits (pre/post_step position, energy, pdg).
  - the G4TileSD::ProcessHits is called here with the fake astep and the touchable geometry obtained from the G4Navigator.
  - in this way complex-SD that deal with the touchable history to navigate the geometry can be treated.
  - the TileHitVector is correctly updated and the rest of G4Atlas machinery works (CPU 0.11 s/event in a PIV 1.8Ghz for pions at 50GeV):
    - persistency using POOL files (later we may decide to do digits and reco)
    - the G4UserAction created for the G4 analysis works also here. The ntuples produced in the G4 case are re-created with the FLUKA-hits.

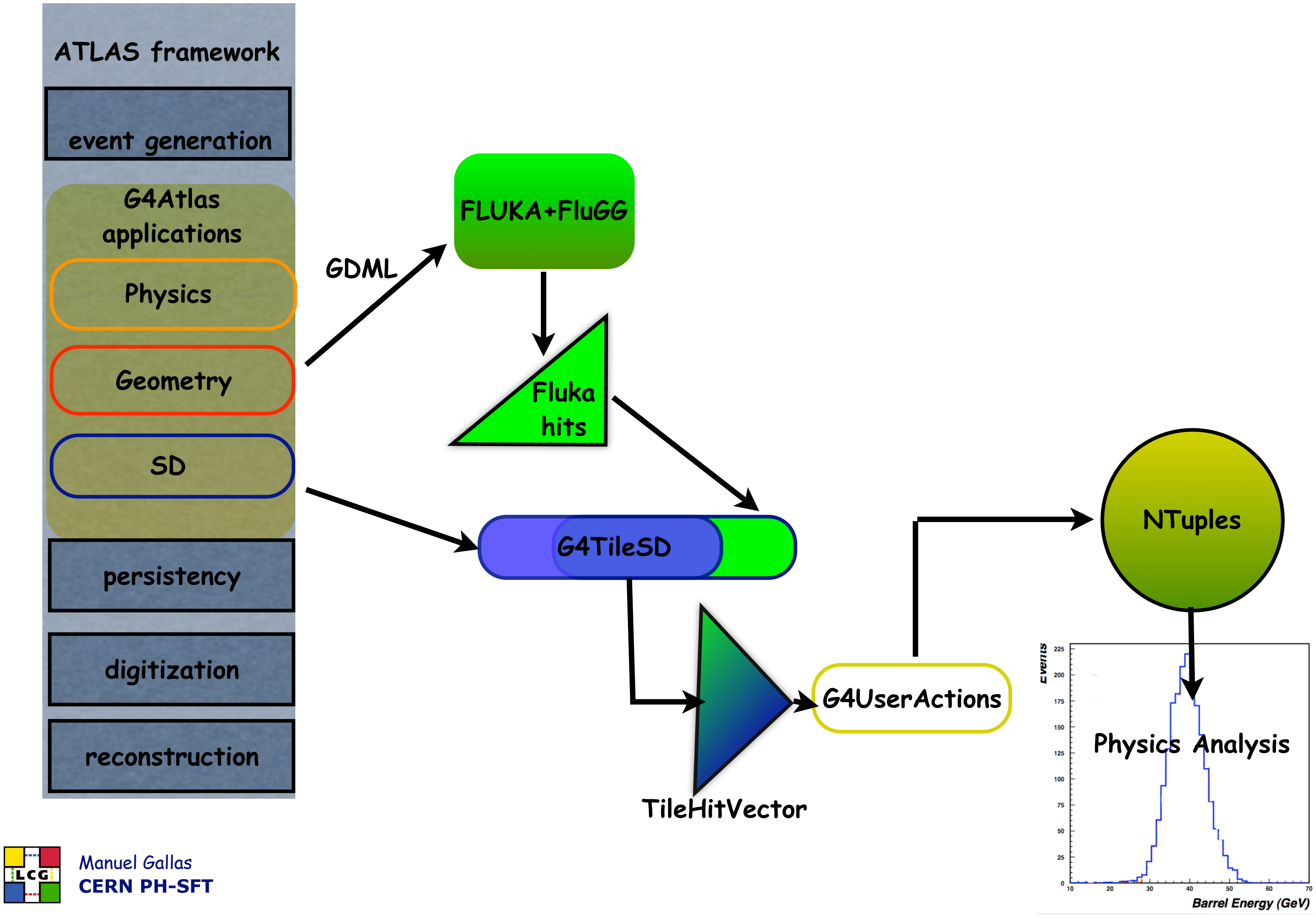
Development line:

- The machinery here described is working but not yet in production mode. Several missing items have to be solved:
  - use of Reflex within ATHENA, in order to have a appropriate access to the ROOT files with FLUKA hits.
  - creation of a External/GDML package, to be used by the ATLAS GDMLInterface (access from ATHENA>Python prompt to the GDML-writers) .
  - pythonization of the Tile simulation application here described.
  - merging of the TileG4SD here created (containing the FLUKA hits processing) with the CVS version from the Tile community.

Conclusions:

- The full chain: G4 simulation, Fluka+FluGG simulation, G4-hit and FLUKA-hit processing is working:
  - The G4 simulation for the old Tile2002 TB works within ATHENA.
  - The FLUKA+FluGG simulation runs external to ATHENA, gets the geometry from ATHENA>G4Atlas and provides hits that are process within G4Atlas.
  - A dedicated G4UserAction allows the direct comparison with the analysis results already obtained by ATLAS Tile community.

RoadMap:



ATLAS framework

event generation

G4Atlas applications

Physics

Geometry

SD

persistency

digitization

reconstruction

GDML

FLUKA+FluGG

Fluka hits

G4TileSD

TileHitVector

G4UserActions

NTuples

Physics Analysis