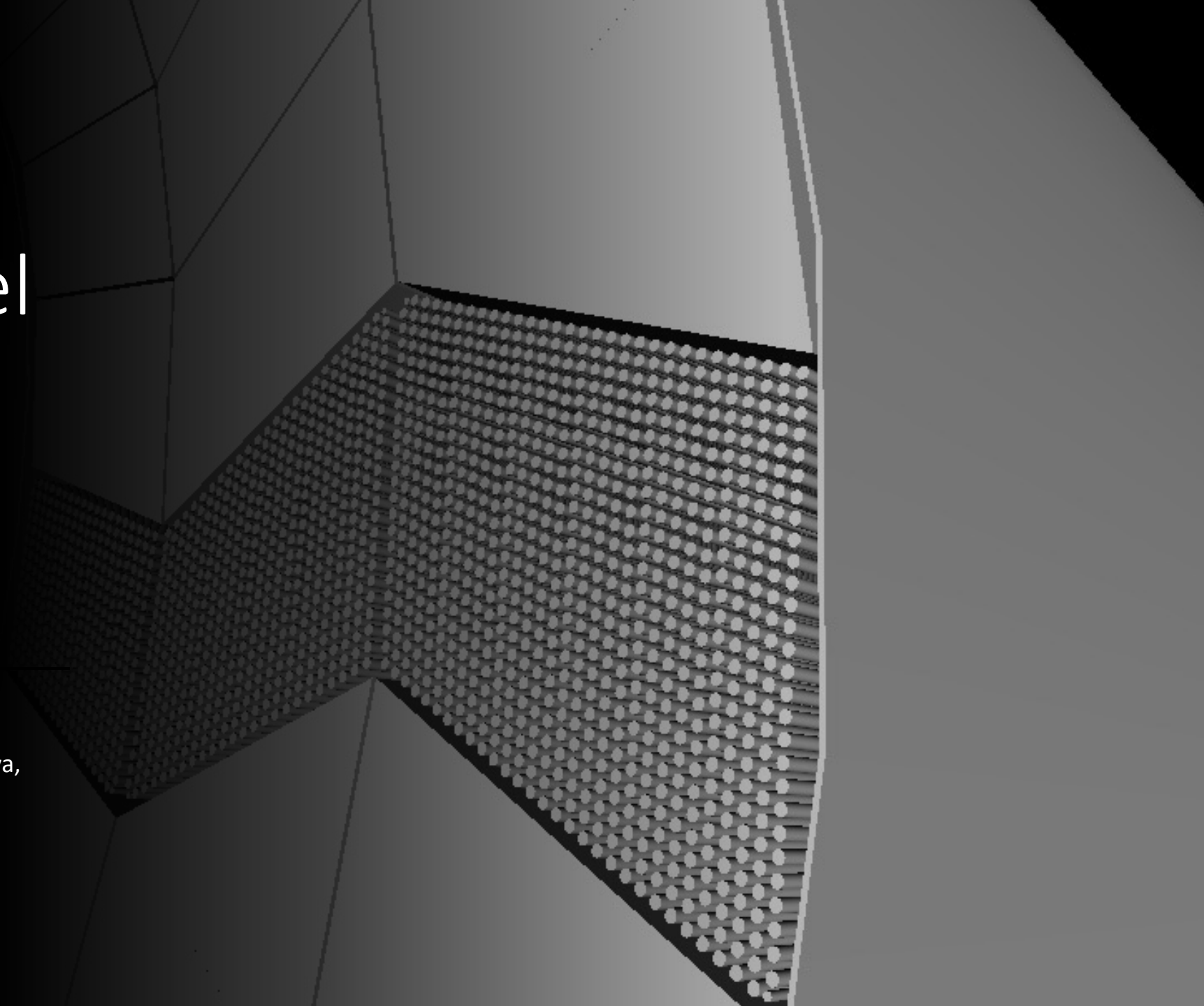
The GeoModel Toolkit for Detector Description



M Bandieramonte, R M Bianchi, J Boudreau, J Junggeburth, N Styles, E Tcherniaev, S Todorova, *V Tsulaia*

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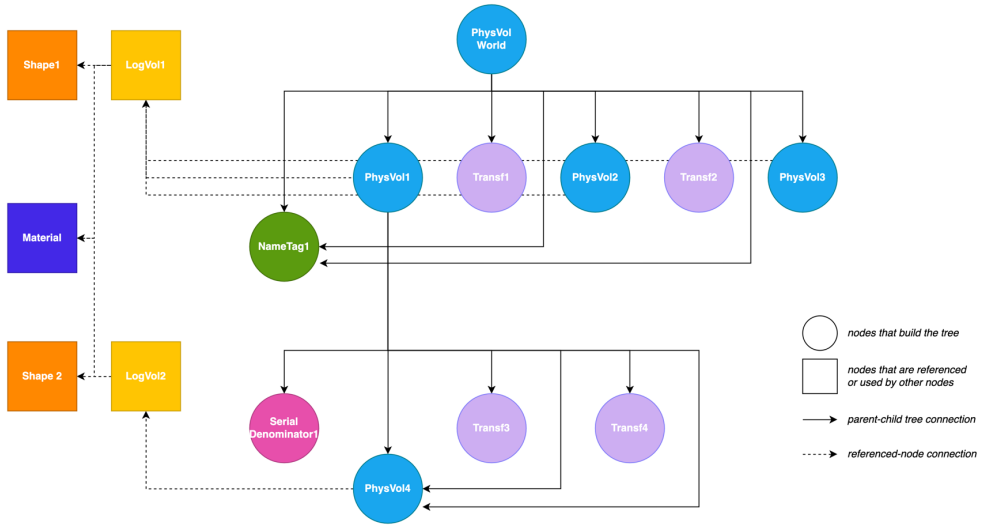
Introduction

- **GeoModel** is a toolkit for describing geometries of large and complex detector systems with minimal memory footprint
- GeoModel has been used by the **ATLAS experiment** since 2004
  - Battle tested for almost 20 years in ATLAS
  - Single source of the ATLAS geometry description
  - Part of every ATLAS job running main production workloads (Simulation, Digitization, Reconstruction). Billions of events processed
- Initially being part of the ATLAS offline software repository, in 2019 GeoModel was repackaged as an independent, experiment-agnostic API
- Dependencies are light
  - *SQLite*, *Eigen*, *XercesC*, *JSON* for the core part
  - *Qt*, *SoQt*, *Coin* for visualization

Kernel Library

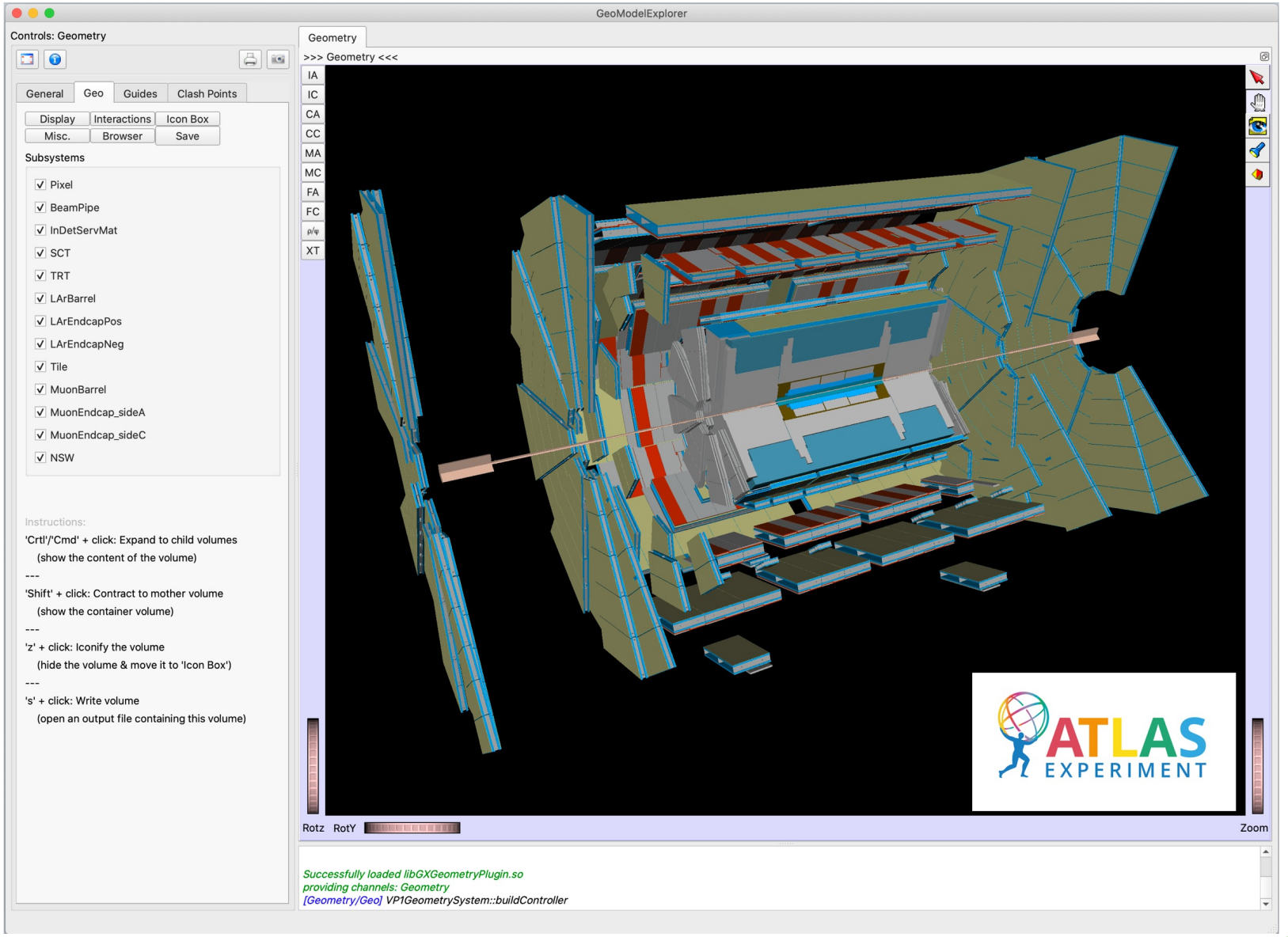
- The Kernel allows for building detector geometry as a **directed, acyclic graph of nodes**
- Various-purpose geometrical primitives:
  - **Volumes** (physical and logical)
  - **Solids** (simple, Boolean, BREP, tessellated)
  - **Identifiers** (string, int)
  - **Transformations** (Regular and *Alignable*)
  - **Elements and Materials**



- Memory-saving techniques:
  - **Shared instances** of nodes in the graph. **Parameterized** volumes (*Serial Transformer*)
- Tools for building detector-specific **readout geometry** (*Full Physical Volume*)
- Tools for applying **alignment corrections** (*Alignable Transformation*)
- Coming soon: **alignable virtual surfaces co-existing with the actual geometry for tracking** (e.g., with ACTS)

Miscellaneous

- Defining detector geometry
  - **XML**. Native GeoModel format (*GeoModelXML*). GDML-to-GeoModel convertor
  - **Custom C++ code** with either hardwired or external input parameters
- Exchanging persistent geometries between applications
  - **SQLite files.** *GeoModelIO* mechanism for writing out to and reading from SQLite databases
    - ATLAS is planning to use GeoModel SQLite files for managing “frozen” geometry layouts
  - **GDML.** For reading GeoModel geometry in Geant4 applications
- Applying alignment corrections
  - A special variant of the GeoModel transform object – *GeoAlignableTransform* – allows for applying deltas on top of the already constructed transform
  - The mechanism supports *having multiple sets of alignment corrections in flight* in multi-threaded applications

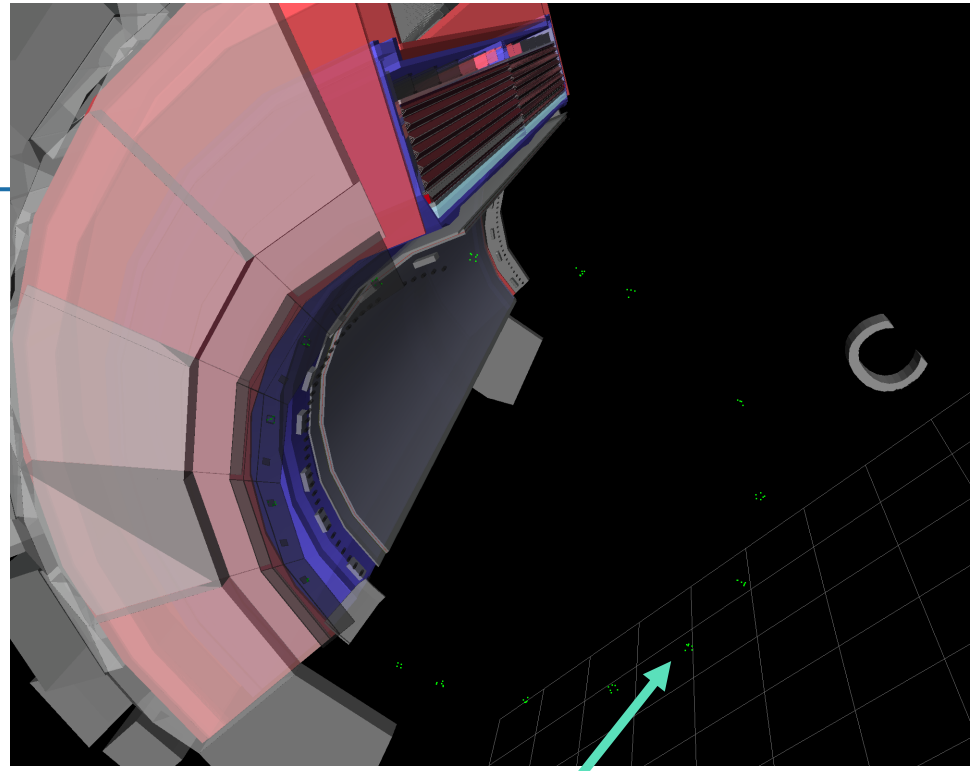

GeoModelExplorer
Controls: Geometry
General
Geo
Guides
Clash Points
Display
Interactions
Icon Box
Misc.
Browser
Save
Subsystems
Pixel
BeamPipe
InDetServMat
SCT
TRT
LArBarrel
LArEndcapPos
LArEndcapNeg
Tile
MuonBarrel
MuonEndcap_sideA
MuonEndcap_sideC
NSW
Instructions:
'Crtl'/'Cmd' + click: Expand to child volumes
(show the content of the volume)

'Shift' + click: Contract to mother volume
(show the container volume)

'z' + click: Iconify the volume
(hide the volume & move it to 'Icon Box')

's' + click: Write volume
(open an output file containing this volume)
Geometry
>>> Geometry <<<
IA
IC
CA
CC
MA
MC
FA
FC
ρ/φ
XT
ATLAS
EXPERIMENT
Rotz
RotY
Zoom
Successfully loaded libGXGeometryPlugin.so
providing channels: Geometry
[Geometry/Geo] VP1GeometrySystem::buildController

Tool Suite



- **Visualization**: Open Inventor Interaction Style
  - Drill down to any level of geometry
  - Cutaway views
  - Save portions of the detector for further studies
- **Standalone detector simulation**: FullSimLight (Geant4-based)
  - In-memory converter from GeoModel to Geant4 – *Geo2G4*
  - Plugin architecture for extensions
- **Command-line utilities (some examples)**
  - **Concatenator.** Combines geometries of several detector subsystems into one
  - **Clash detector**. Based on Geant4. Allows for co-displaying clash points and the geometry
  - **Converter** to/from GDML
  - **Mass calculator s**upporting regular and Boolean solids
  - **Geantino Scan** tool

Final remarks

- This presentation just scratched the surface. For more information …
- Check out our documentation https://cern.ch/geomodel
  - Needs to be updated with recent developments …
- Try the code at https://gitlab.cern.ch/GeoModelDev/GeoModel
  - It can be **compiled** on **Linux** and **macOS** platforms with **minimal third-party dependencies**
  - **Distribution kits** are also built for **Ubuntu** and **macOS**
- Contact the developers: geomodel-core-team@cern.ch
- Come to see our poster tomorrow!
- We would be happy to organize a hands-on tutorial for all interested developers from the FCC software community to demonstrate the capabilities of our toolkit