A scalable new mechanism to store and serve the ATLAS detector description through a REST web API

ATLAS EXPERIMENT

ACAT 2017, Seattle (US)

ATLAS GeoModel

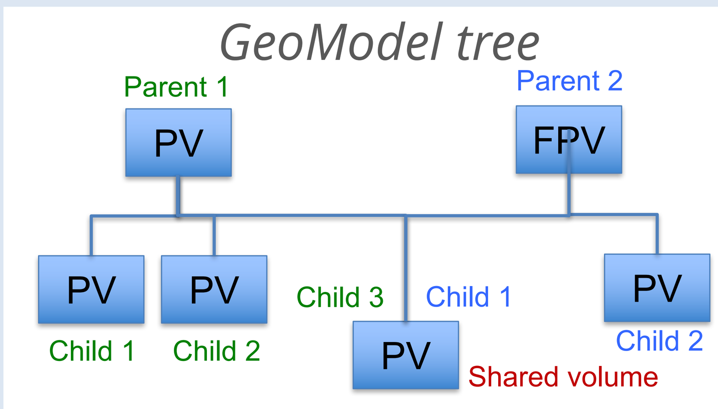
The ATLAS experiment[1] uses **GeoModel**[2] to describe the **geometry tree**: a set of *nodes* connected through *relationships* of different types. The GeoModel tree is **computed on-the-fly** when requested through the experiment framework, and stored **in-memory** only.

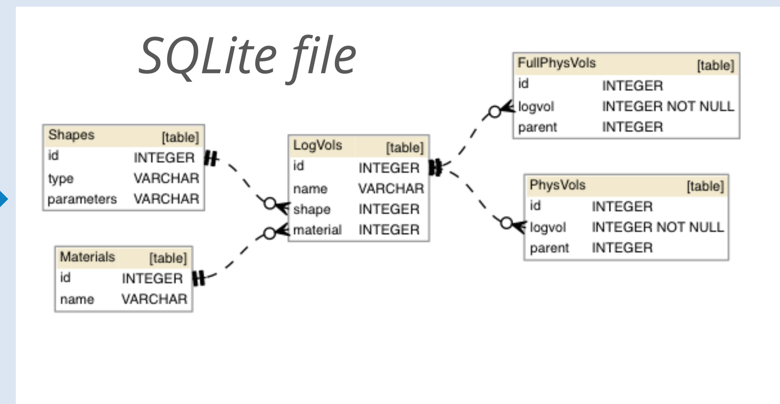
Current limitations

- An online Geometry DB stores primary numbers used to build objects. But no **structure** and **no relationships** are **saved** in the DB; and **no** data are accessible **offline**;
- Very **difficult to debug** the detector description: have to go through the code
- No way to open, explore and use the Detector Description without the **whole experiment's framework**
- **Strong platform dependency** : SLC6 Linux the only platform supported by ATLAS;
- Not possible to interactively query the GeoModel and retrieve matching volumes only.

FRESH, NEW IDEAS for a way to easily **store**, **restore**, **access** and **serve** the experiment's geometry

1st STEP - **Decoupling** and GeoModel **persistification**, so that applications can use the Detector Description without the need of run the full ATLAS framework.
Presented at **CHEP 2016**[3].





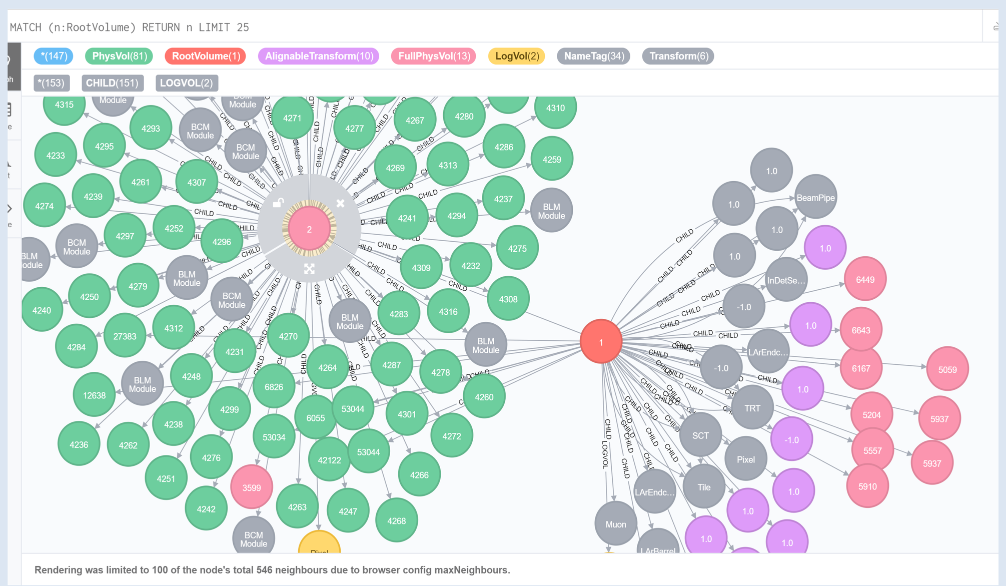
2nd STEP – ***NEW!*** Easy, interactive access to the geometry through a REST API, and retrieval of geometry subsets

TWO GOALS, TWO TECHNOLOGIES to implement a **REST service to serve the geometry,** different approaches

Graph DB (Neo4j[4])

Works on GeoModel nodes

To store, query and visualize the inner structure of the ATLAS **geometry tree**, and all the relationships between its **nodes**.



Neo4j is a **No-SQL DB** based on **nodes** and **relationships**, like GeoModel. *Cypher* is its **query language**, focused on **relationships**, **labels**, **properties**. Users are able to fast query all the instances of GeoModel objects used in the **actual ATLAS geometry**, and all connections and paths between them. The order of all nodes is stored, because it is used by GeoModel while traversing the tree to construct the detector. Also, users can **interactively visualize** the nodes and their connections in a graph, which is extremely useful to **debug** the Detector Description.

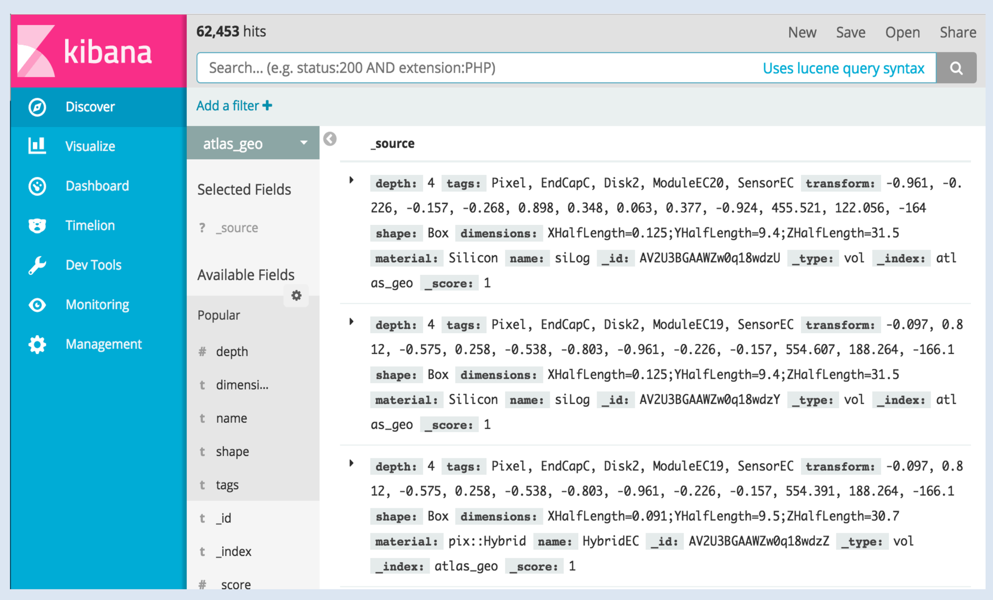
Example queries (on GeoModel *nodes* – easy to construct queries to query the tree structure)

Retrieve a specific GeoModel node (GeoLogVol), based on a node property:
```
match (n:LogVol) where n.name = "TileEndcapNeg" return n;
```
As above, but retrieve the GeoPhysLogVol which uses it:
```
match (n:PhysVol)-[r:LOGVOL]->(m:LogVol) where m.name = "TileEndcapNeg" return m, labels(m),n,r;
```
Get all "Box" Shape nodes used together with "Air" as Material
```
match (s:Shape {type: "Box"})<-[rs:SHAPE]-(l:LogVol)-[rm:MATERIAL]->(m:Material {name: "Air"})
return s,rs,l,rm,m;
```
Get all the children nodes of the RootVolume, and sort them by the 'position' property of the CHILD relationship (order is important in GeoModel because it affects how the tree is traversed)
```
match (n:RootVolume)-[r:CHILD]->(m) with r,m order by r.position return r.position, m;
```

Search Engine (ElasticSearch / Kibana[5])

Works on end physical volumes

For a fast retrieval of the **final objects**: all transformations and attributes are **computed** and accumulated at **indexing time**.



ElasticSearch uses *Lucene* as query language.
Relationships between the nodes and nodes' order are not stored, all object are "**flattened**": all the attributes are collected, and all the space transformations are **computed while inserting the data**. Users then can quickly retrieve the "**final volumes**": physical volumes together with their **absolute positions** and all **attributes** related to it. The **goal** is to let **applications** quickly retrieve geometry objects without having to traverse the geometry tree.

Example queries (on final physical *volumes* – easy to construct queries to fast retrieve volumes)

Retrieve a specific volume
```
name:TileEndcapNeg
```
Retrieve all Pixel volumes in the EndCap side C
```
tags:Pixel AND tags:EndcapC
```
Retrieve all box-shaped volumes whose material is "Air"
```
shape:box AND material:Air
```

Both Neo4j and ES/Kibana have **REST** access as well as **web interfaces** for interactive queries

Comparison

	Offline acces to geometry data	Storage, Query and Visualization of all GeoModel nodes and relationships	Partial retrieval of geometry data (subtrees)	Fast retrieval of final physical volumes with global positions
Current implementation: Geometry DB	X	X	X	X
NEW - Persistent SQLite DB	V	*(with SQL gimmick!)*	*(with SQL gimmick!)*	X
NEWEST! – Neo4j Graph DB	V	V	V	X
NEWEST! – ElasticSearch/Kibana	V	X	V	V

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1: ATLAS Collaboration (2008) JINST 3 S08003
2: Boudreau J, Tsulaia V (2004) CHEP 2004
3: Bianchi RM, Boudreau J, Vukotic I (2016) https://indico.cern.ch/event/505613/contributions/2228522/
4: https://neo4j.com
5: https://www.elastic.co