The Abstract geometry Modeling Language (AgML):
Experience and Roadmap toward eRHIC

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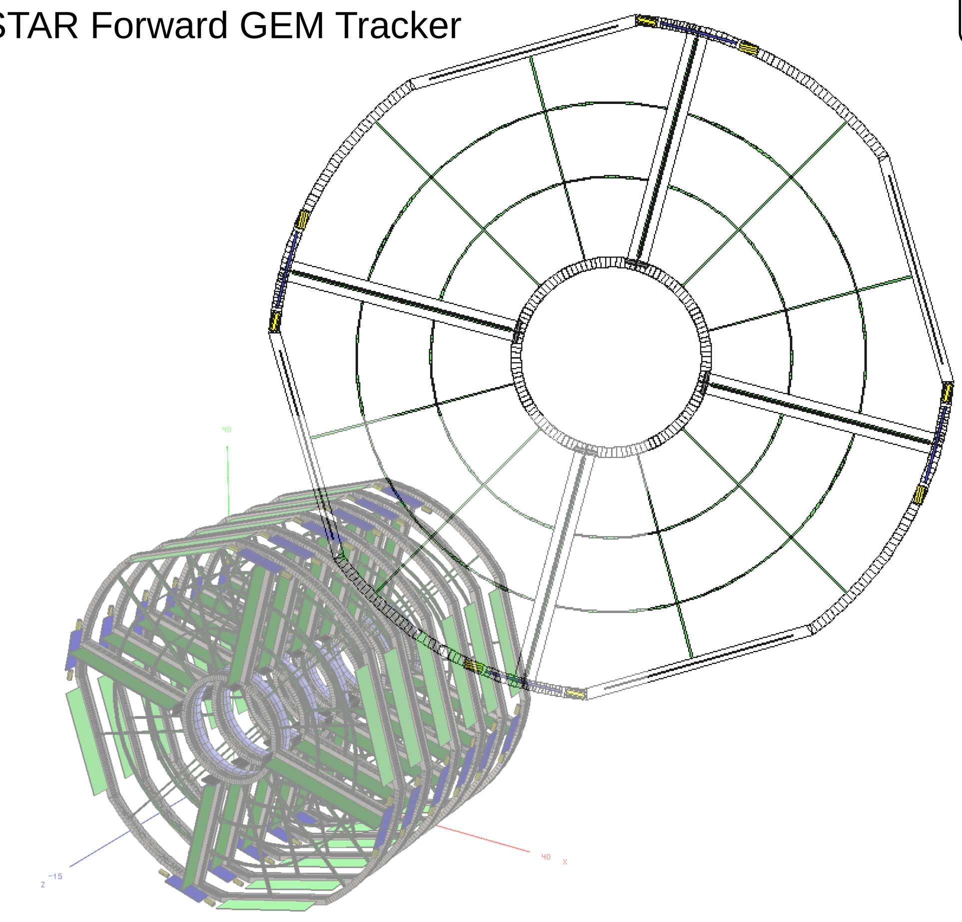
STAR Forward GEM Tracker

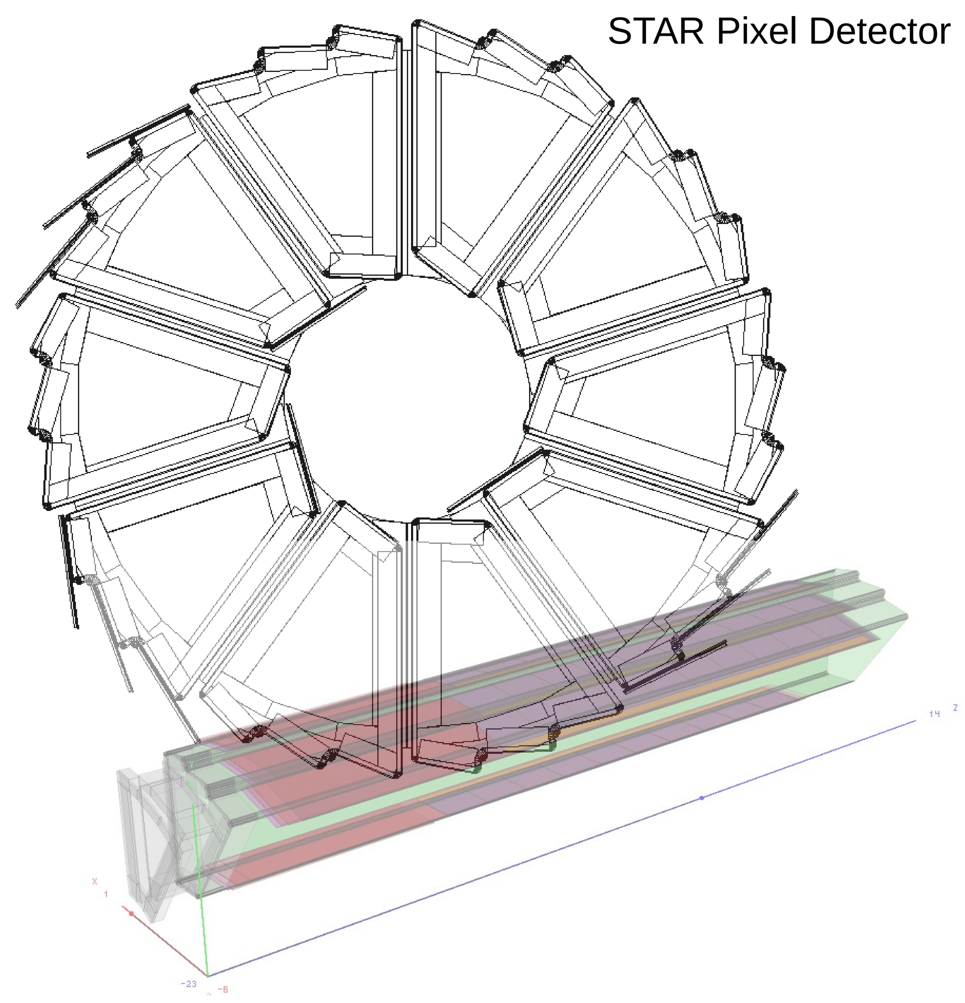


Abstract

The STAR experiment has adopted an Abstract Geometry Modeling Language (AgML) as the primary description of our geometry model. AgML establishes a level of abstraction, decoupling the definition of the detector from the software libraries used to create the concrete geometry model. Thus, AgML allows us to support both our legacy GEANT3 simulation application and our ROOT/TGeo based reconstruction software from a single source, which is demonstrably self-consistent. While AgML was developed primarily as a tool to migrate away from our legacy FORtran-era geometry codes, it also provides a rich syntax geared towards the rapid development of detector models. AgML has been successfully employed by users to quickly develop and integrate the descriptions of several new detectors in the RHIC/STAR experiment including the Forward GEM Tracker (FGT) and Heavy Flavor Tracker (HFT) upgrades installed in STAR for the 2012 and 2013 runs. AgML has furthermore been heavily utilized to study future upgrades to the STAR detector as it prepares for the eRHIC era.

With its track record of practical use in a live experiment in mind, we present the status, lessons learned and future of the AgML language as well as our experience in bringing the code into our production and development environments. We will discuss the path toward eRHIC and pushing the current model to accommodate for detector misalignment and high precision physics.

STAR Pixel Detector



Geometry Language

The Abstract geometry Modeling Language (AgML) is a XML-based language tailored to the domain of creating detector models in nuclear and HEP experiments. It is designed to streamline the process of developing a detector geometry, simplify its long term maintenance, and provide a degree of support for multiple target programming languages.

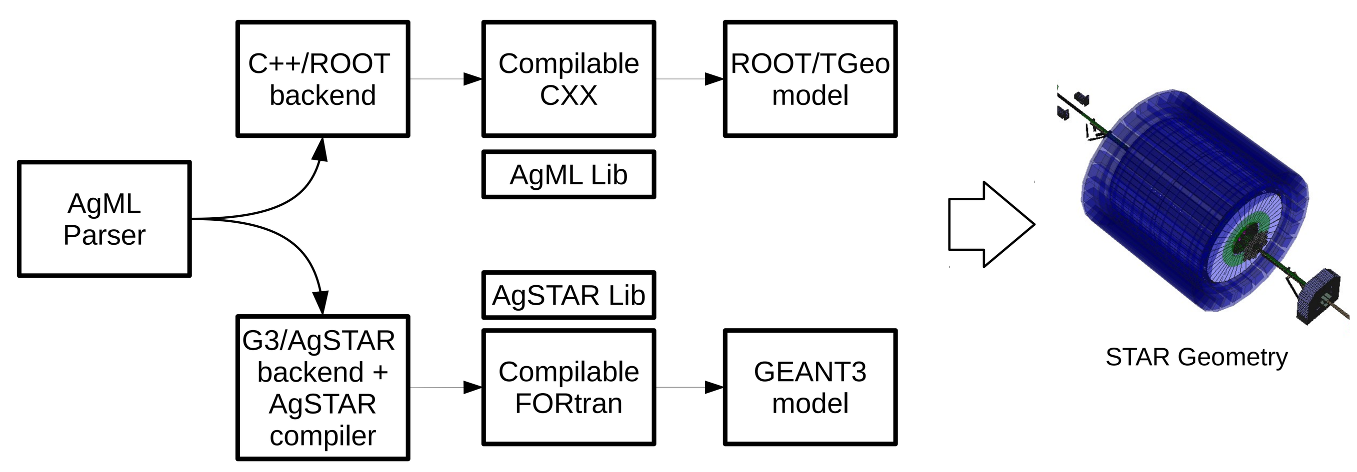
Organization and Syntax

- Detector subsystems are organized into modules
- Volumes are organized as distinct program blocks within each module
- Material, medium, shape and attributes of the volume are traits of the volume block
- The creation and placement of daughter volumes is managed from within the volume

The overall program structure, combined with iteration, flow control and data structures, permits developers to quickly implement complex detector elements in a compact and easy to understand way.

- Inheritance further streamlines the development cycle.
- Volume parameters (i.e. shape, material, medium, attributes) may be omitted
- Missing parameters are inherited from the parent volume
- Changes to the parent volume are automatically propagated to all daughters which inherit from it

Support for Multiple Geometry Models



AgML supports multiple concrete geometry models from a single-source expression of our detector configuration

- AgML source code is parsed, syntax elements identified and dispatched to compiler backends
- Backends emit compilable code, which builds the concrete geometry through calls to a dedicate support library
- Backends and support libraries have been implemented which suppport:
  - C++ and ROOT geometries
  - The AgSTAR language and it's GEANT 3 geometries
- Additional geometry models, such as GEANT 4, can be easily supported by implementing an
- apporpriate backend and support library

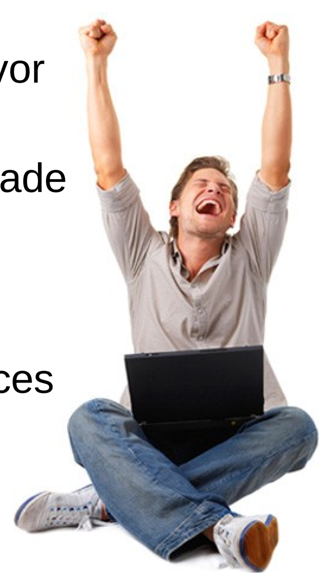
- Additional details can be found in our CHEP 2012 proceedings contribution.

Status

AgML was deployed in STAR in 2012. The transition to the new framework has been smooth, thanks to extensive validation studies (described at CHEP 2012) against our GEANT 3 model.

STAR is pursuing an upgrades program which will extent the experimental reach of the detector, and a letter of intent for eSTAR at eRHIC has been submitted.

- AgML has successfully been used to deploy major new subsystems in our production geometry: the Forward GEM Tracker (upper left) and the Heavy Flavor Tracker's pixel detector (upper right).
- The language is being used to study and optimize detectors for the eSTAR upgrade
  - The improved TPC (iTPC)
  - The Forward Calorimeter System (lower left)
  - The Endcap TOF and TRD (lower right)
- Geometry models have been implemented by developers with diverse experiences ranging from fresh graduate students to seasoned physicists
- The development process is fairly rapid, taking 1-2 months FTE to bring fairly complex detectors to production quality.



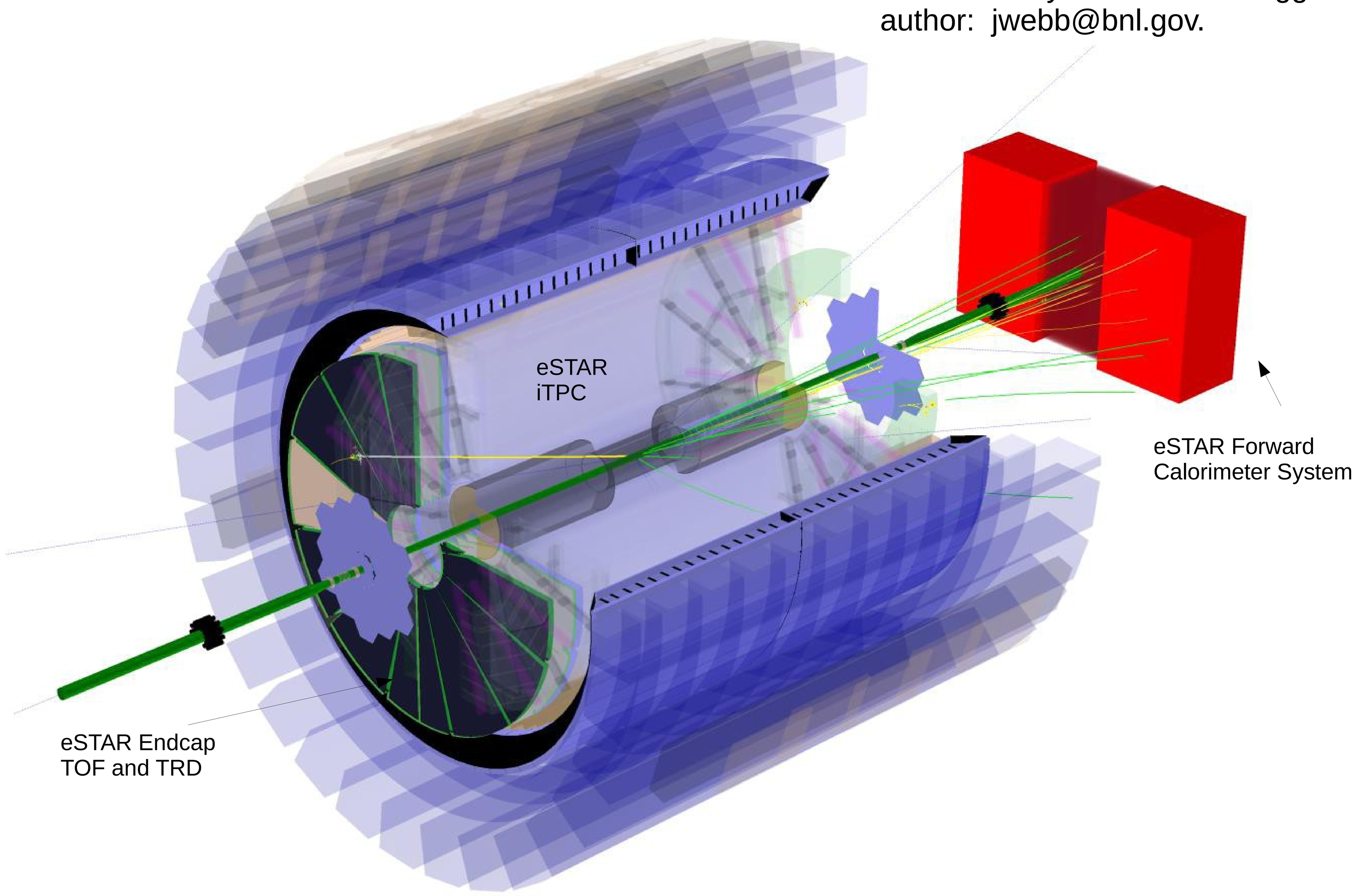
Road Ahead

AgML has been in production for over a year now, and has become an important part of our software stack, providing the single-source geometry description for most of our reconstruction and simulation needs. New detectors have been rapidly brought from CAD drawings to working geometry models by the groups which have designed and built the detectors. AgML has proven to be a robust platform for the implementation of detector geometries, and has many features which will be useful in the development, optimization and eventual implementation of the future eSTAR detector.

AgML has been used successfully to migrate the STAR geometry from its legacy model to ROOT/TGeo. Future work will

- Extend the syntax to support the full capabilities of modern geometry models (such as ROOT and GEANT 4), such as --
  volume assemblies, composite shapes, scaled shapes, etc...
- Leverage the alignment capabilities in AgML for reconstruction and implement them in our legacy simulation package
- Package the compiler and support libraries for use by the wider community, and include direct support for GEANT 4 geometries.

We invite anyone who has suggestions for improvements or is interested in using AgML to contact the author: jwebb@bnl.gov.



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