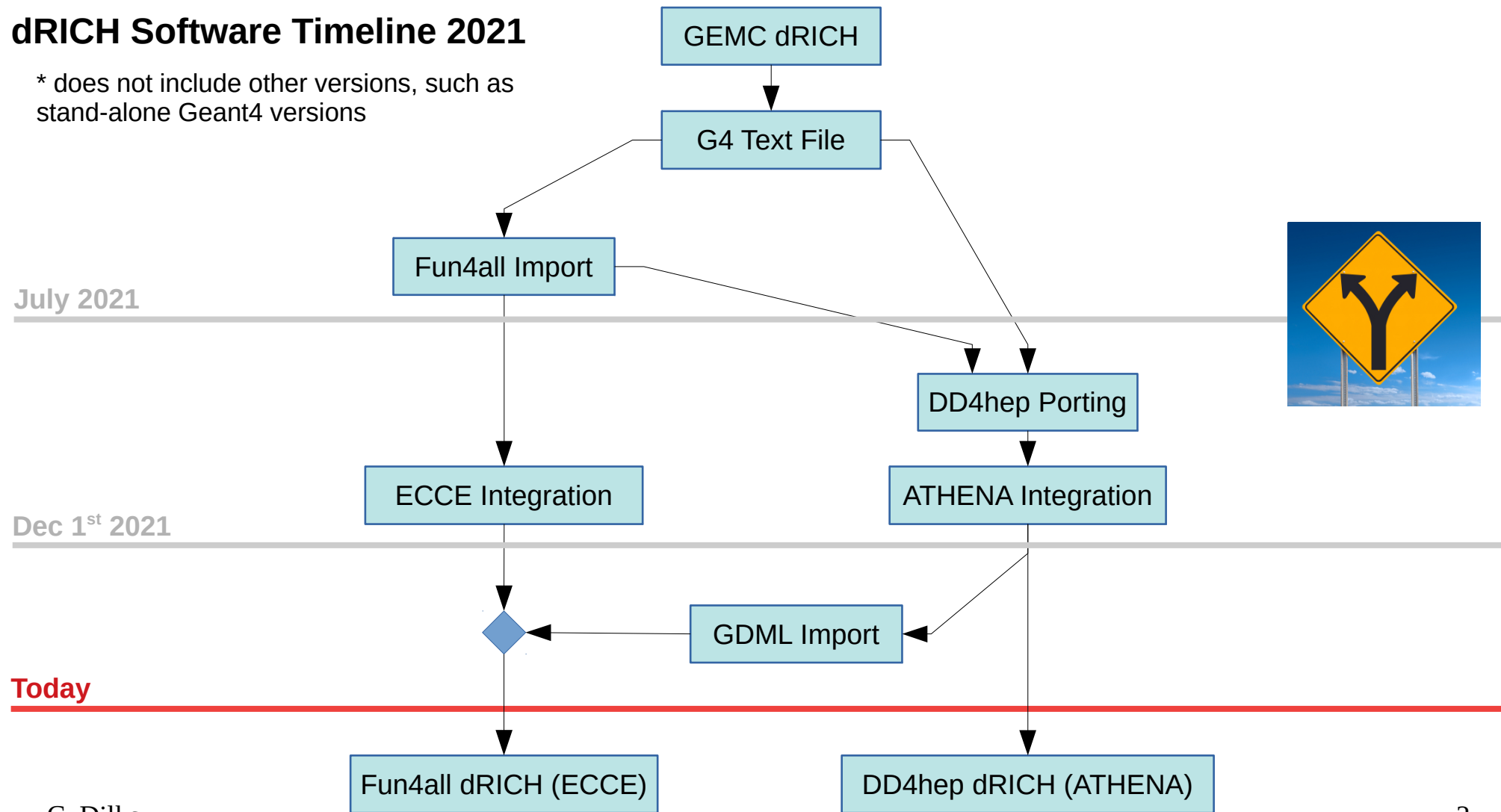


Detector1 dRICH Software Update

Christopher Dilks
Cherenkov PID meeting
17 June 2022

dRICH Software Timeline 2021

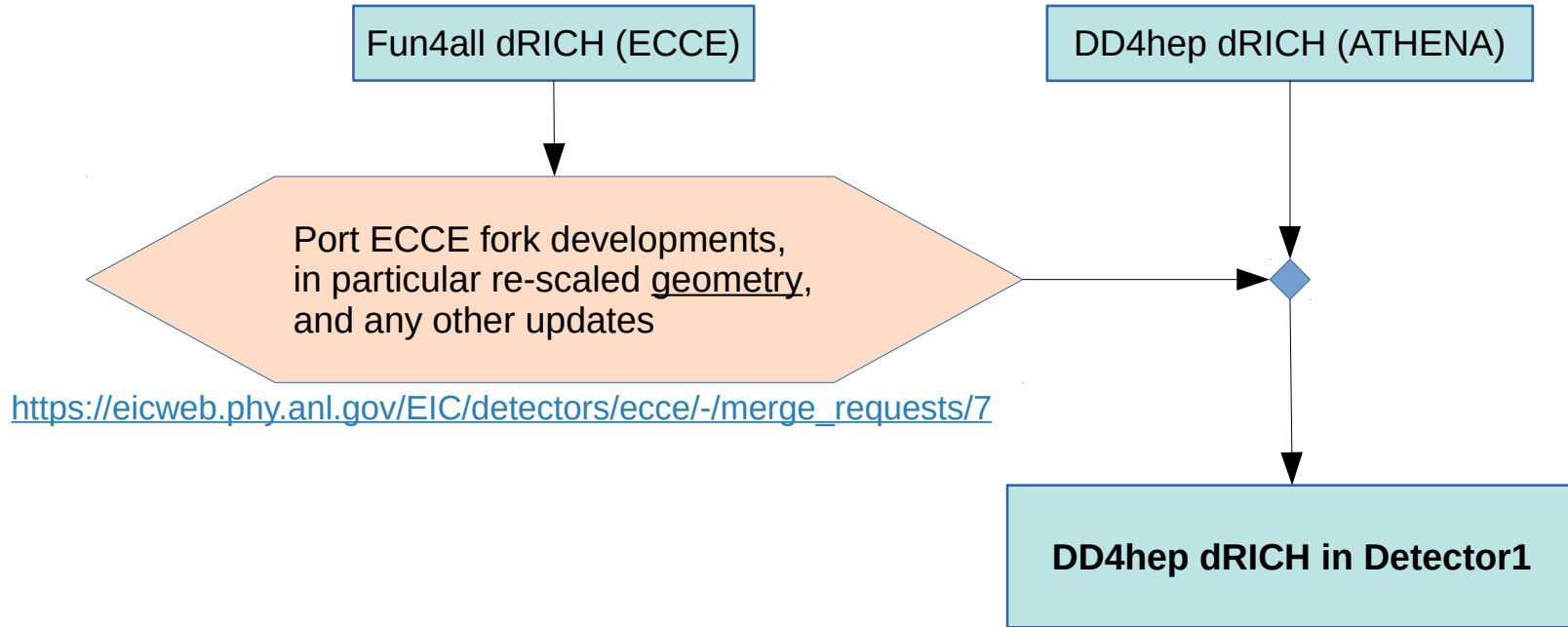
* does not include other versions, such as stand-alone Geant4 versions



dRICH Software Timeline 2022

https://wiki.bnl.gov/eic-project-detector/index.php/EIC_Single_Software_Stack_2022

EIC Single SW Stack proceeding with DD4hep for geometry description and detector interface



dRICH in DD4hep + Juggler + IRT

Software hosted on Gitlab Server

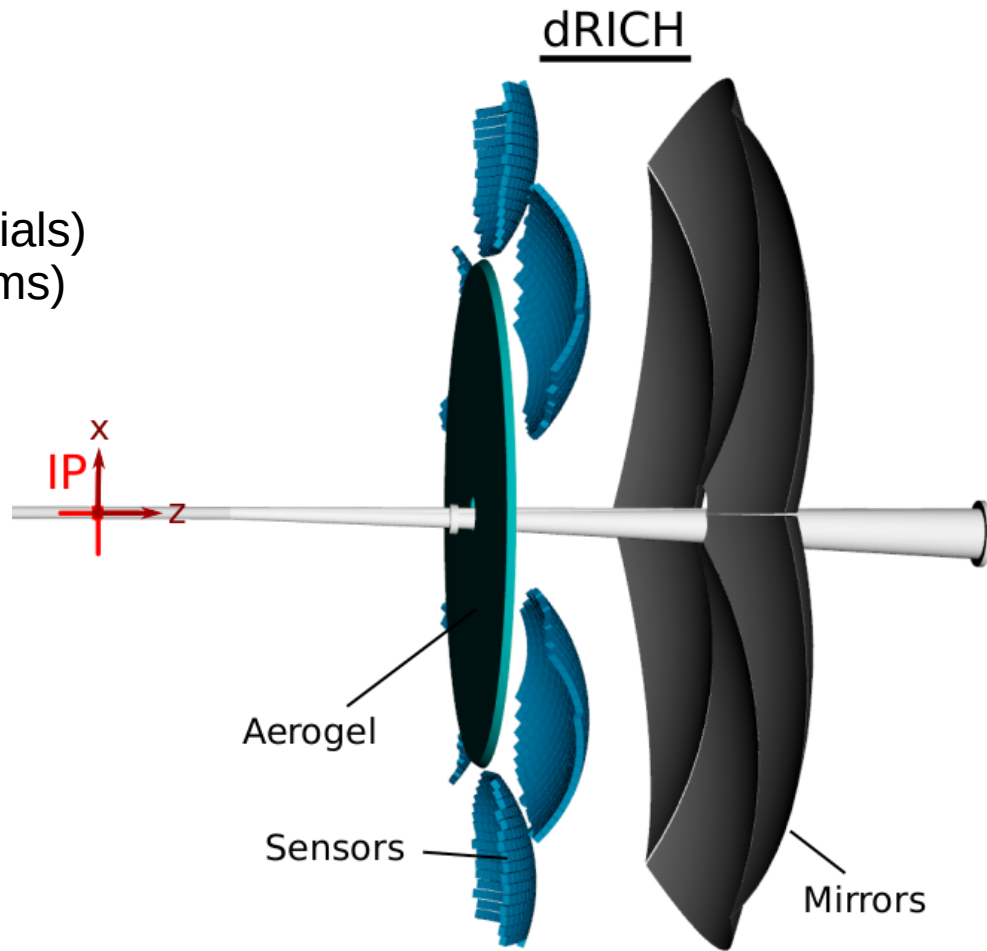
<https://eicweb.phy.anl.gov/EIC>

Relevant repositories:

- **detectors/ecce** (geometry, optics, materials)
- **Project Juggler** (reconstruction algorithms)
- **eicd** (data model)
- **IRT** (indirect ray tracing)

3D Interactive View of ATHENA dRICH (jsROOT)

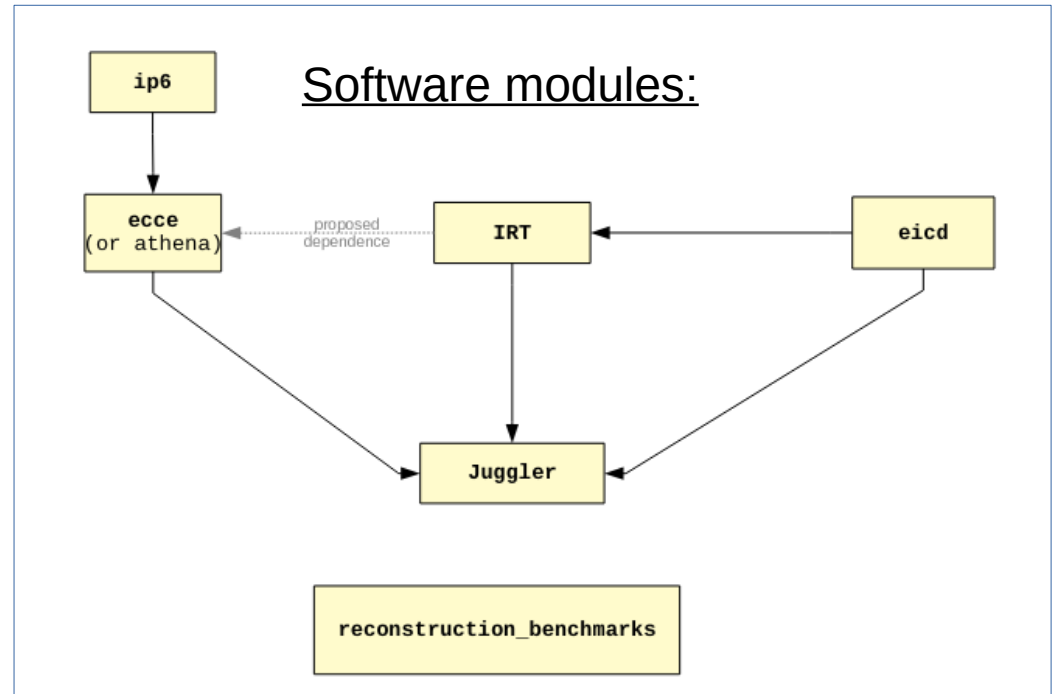
https://eic.phy.anl.gov/geoviewer/index.htm?file=https://eicweb.phy.anl.gov/EIC/detectors/athena/-/jobs/artifacts/master/raw/geo/drich_only_geo.root?job=dump_geometry&item=default;1&opt=clipx;clipy;transp30;zoom75;ROTY290;ROTZ350;tr0;trr0;ctrl;all



dRICH-dev – Repository of development tools

<https://github.com/c-dilks/drich-dev>

- Gateway to dRICH Software Modules
 - Links to available dRICH software and resources
 - Living documentation
- Entry point for new developers
- Development helper scripts



Links to Available dRICH Software and Resources

See this page for the most recent collection of links:

<https://github.com/c-dilks/drich-dev/blob/main/doc/links.md>

Fun4all Standalone: <https://github.com/cisbani/dRICH>

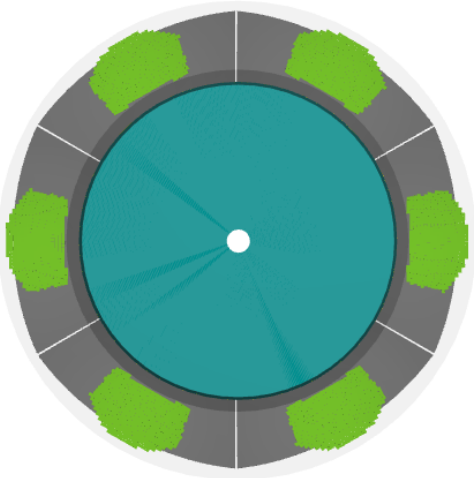
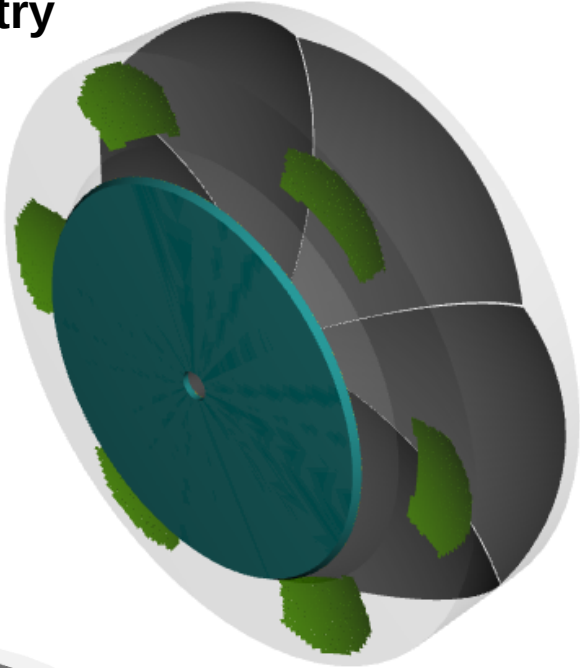
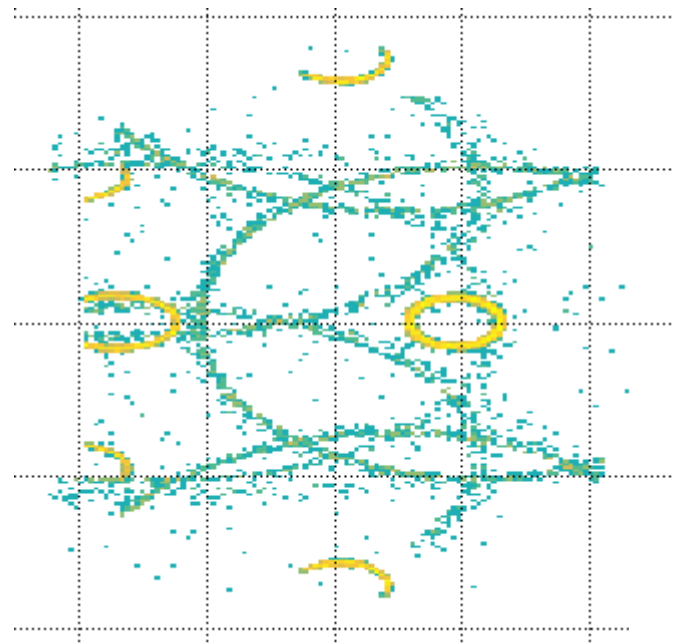
- Geometry G4 text file: <https://github.com/cisbani/dRICH/tree/main/share/config>
 - Updated ECCE Versions: <https://github.com/ECCE-EIC/calibrations/tree/main/dRICH/mapping>
- Optics and Material Properties Generation: <https://github.com/cisbani/dRICH/tree/main/share/source>

ECCE (Detector1) in DD4hep: <https://eicweb.phy.anl.gov/EIC/detectors/ecce>

- Compact XML file (constants): compact/drich.xml
- Placement Algorithms: src/DRICH_geo.cpp
- Optical / Material Property Tables: compact/optical_materials.xml
- GDML Files available in CI artifacts
- IRT, documentation, and analysis: <https://eicweb.phy.anl.gov/EIC/irt>
- Development scripts + more documentation: <https://github.com/c-dilks/drich-dev>

GEMC: https://github.com/EIC-eRD11/dualRICH_inMEIC

Pictures of Cherenkov Rings and Geometry



Initial re-scale to Detector1 Geometry

https://eicweb.phy.anl.gov/EIC/detectors/ecce/-/merge_requests/7

Sebastian's slides:

https://indico.bnl.gov/event/15567/contributions/62935/attachments/40804/68210/dRICH_geometry.pdf

G4 Text file:

https://github.com/ECCE-EIC/calibrations/blob/main/dRICH/mapping/drich-g4model_v5.txt

Assumed Dimensions, from ECCE proposal config

Units are cm, and positions are w.r.t. IP, given for the sector centered on the +x axis

- Occupies z from 180 – 280 **TODO: 30 cm gain?**
- Outer radius = 180 **TODO: Menagerie has larger radius, update this!**
- Snout parameters:
 - Length: 20
 - Radii: projective to back-plane corner **TODO: Menagerie has smaller radii... need to cooperate w/ ECAL**
 - Aerogel thickness = 4
- Mirror parameters:
 - Center (z,x) = (79.19, 125)
 - Radius = 200
- Sensor sphere parameters (extracted from spherical fit)
 - Center (z,x) = (71.93, 124,98)
 - Radius = 140

Snout Radii != menagerie

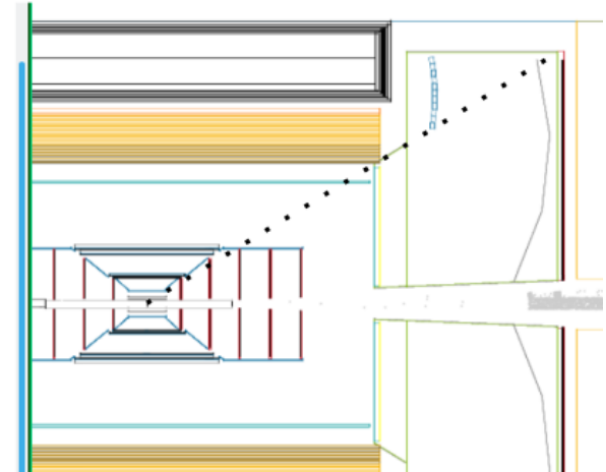
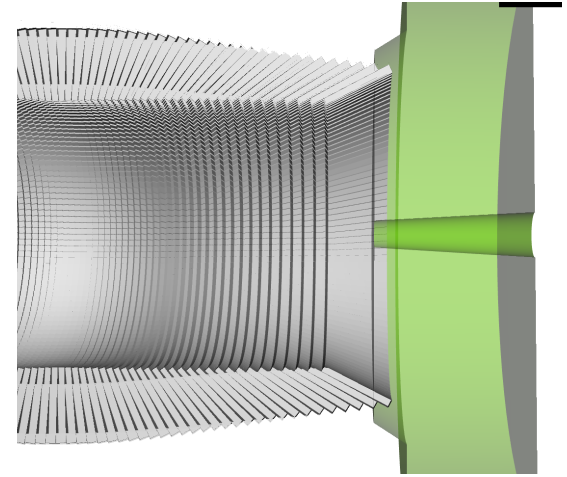
Menagerie:

Sub-Component	WBS	Length (cm)	Inner Radius (cm)	Outer Radius (cm)
	6.10.04	100	10	
<i>Detector Section</i>		<i>80</i>	<i>10</i>	<i>195</i>
<i>Aerogel Section</i>		<i>20</i>	<i>10</i>	<i>110</i>

current radii:

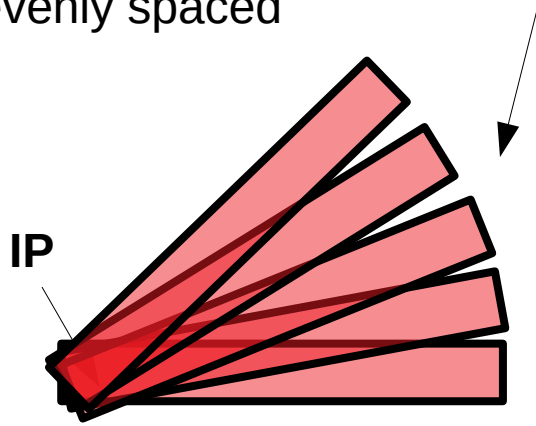
```
DRICH_rmax0 = 115.714 // @ snout frontplane
DRICH_rmax1 = 128.571 // @ snout backplane
DRICH_rmax2 = 180.000 // tank (cylinder) radius

DRICH_rmin0 = 7.837 // bore radius at frontplane
DRICH_rmin1 = 13.628 // bore radius at backplane
```



Optics: Parallel-to-point Focal Regions

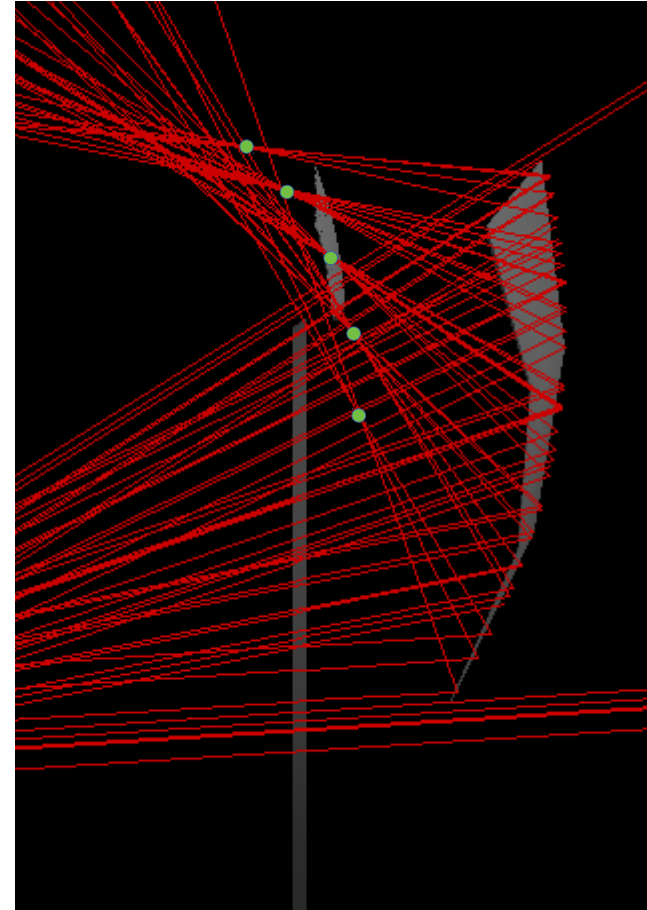
- 5, wide collimated photon beams
 - Emitted from IP
 - Within full dRICH polar acceptance, evenly spaced



TODO:

- Outermost beams are not hitting the sensors, we need to fix this (after envelope updates)
- Determine ideal sensor positions (not a sphere?)

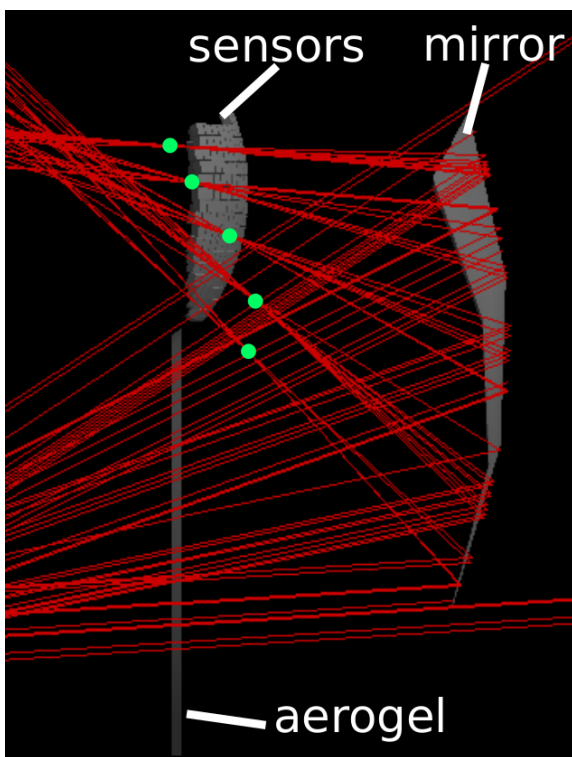
New DD4hep in Detector1 version



Parallel-to-point focii indicated by green dots

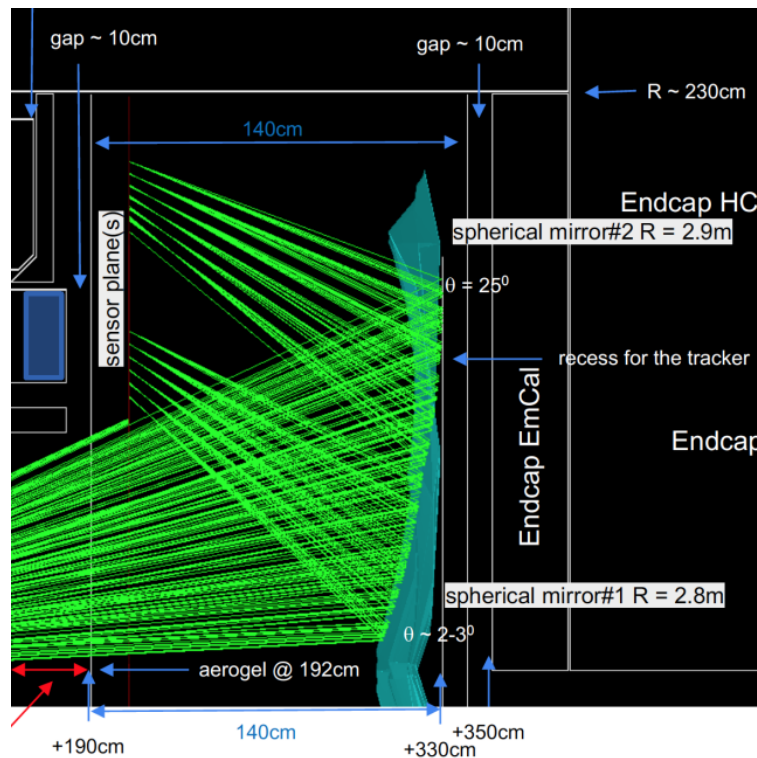
dRICH Dual Mirrors

single-mirror config, 5 collimated photon beams; this was the configuration for the ATHENA proposal performance studies

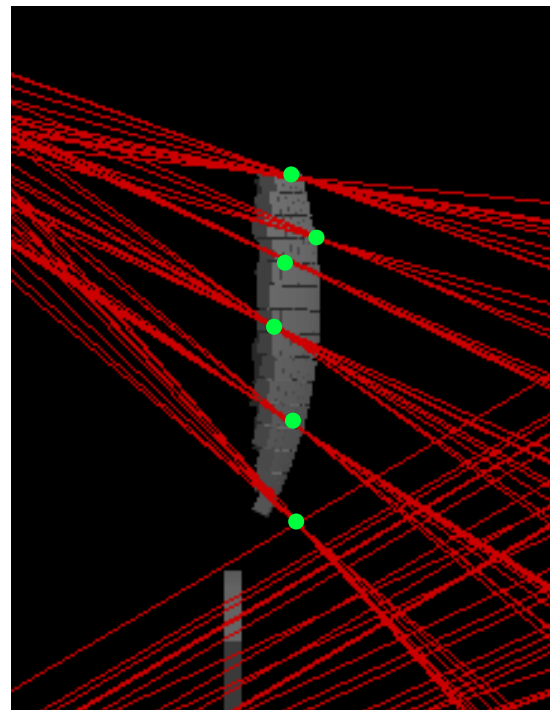


tuned for maximum polar acceptance

Alexander's dual mirror configuration, in standalone Geant4 sandbox



current status of dual mirror configuration in DD4hep:

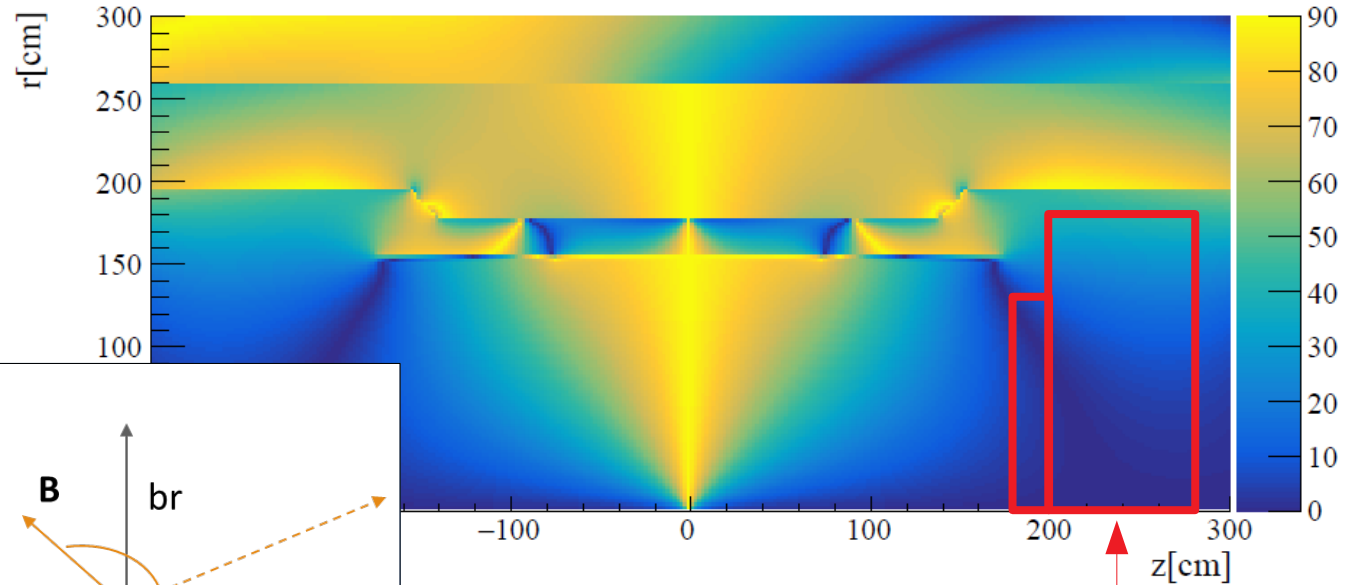


still plenty of room for improvement!!

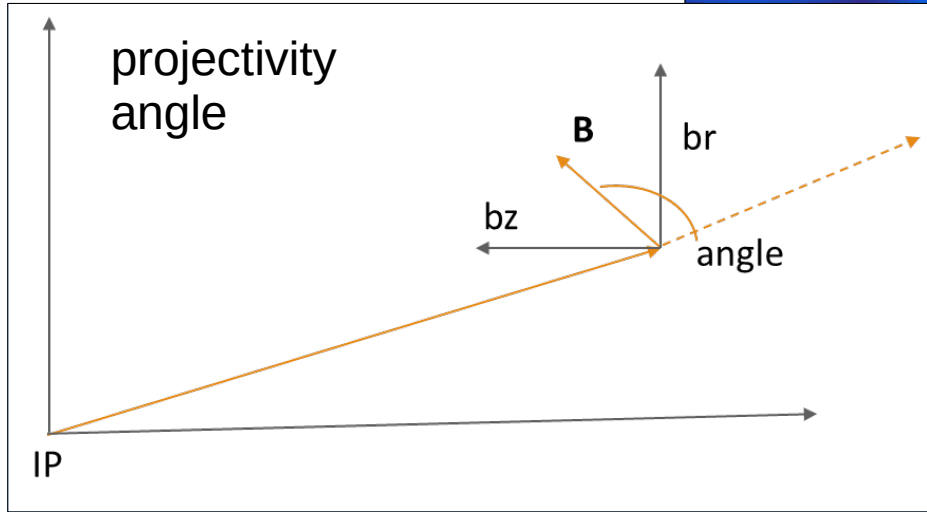
Sensors tiled on a sphere may not be ideal...

Magnetic Field Effects: Ongoing Study

Babar Magnet, dRICH projectivity



approximate current
dRICH position



dRICH Simulation Software Group

- Indico: <https://indico.bnl.gov/category/422/>
- Meet bi-weekly, Wednesdays, 12:30 US/Eastern (next meeting: June 22nd)
- Email: CherenkovPID
- Mattermost: <https://eic.cloud.mattermost.com/main/channels/drich>

Next Steps

- Improve the optics
- Test 30 cm length increase
- Revive IRT and add benchmarks → baseline algorithm
- Add and test additional pattern recognition / PID algorithms → help wanted
- Update sensor materials (<https://eicweb.phy.anl.gov/EIC/detectors/ecce/-/issues/12>)
- Determine what we can do to support machine learning optimization techniques
- Model parallel-to-point focal region, for ideal sensor placement
- Explore Dual / multi-mirror configurations (see https://eicweb.phy.anl.gov/EIC/detectors/athena/-/merge_requests/260)
- Automate generation of material property tables (see <https://github.com/cisbani/dRICH/blob/main/share/source/g4dRICHOptics.hh>)
- Align optics with proton beam?