DRICH Material Properties

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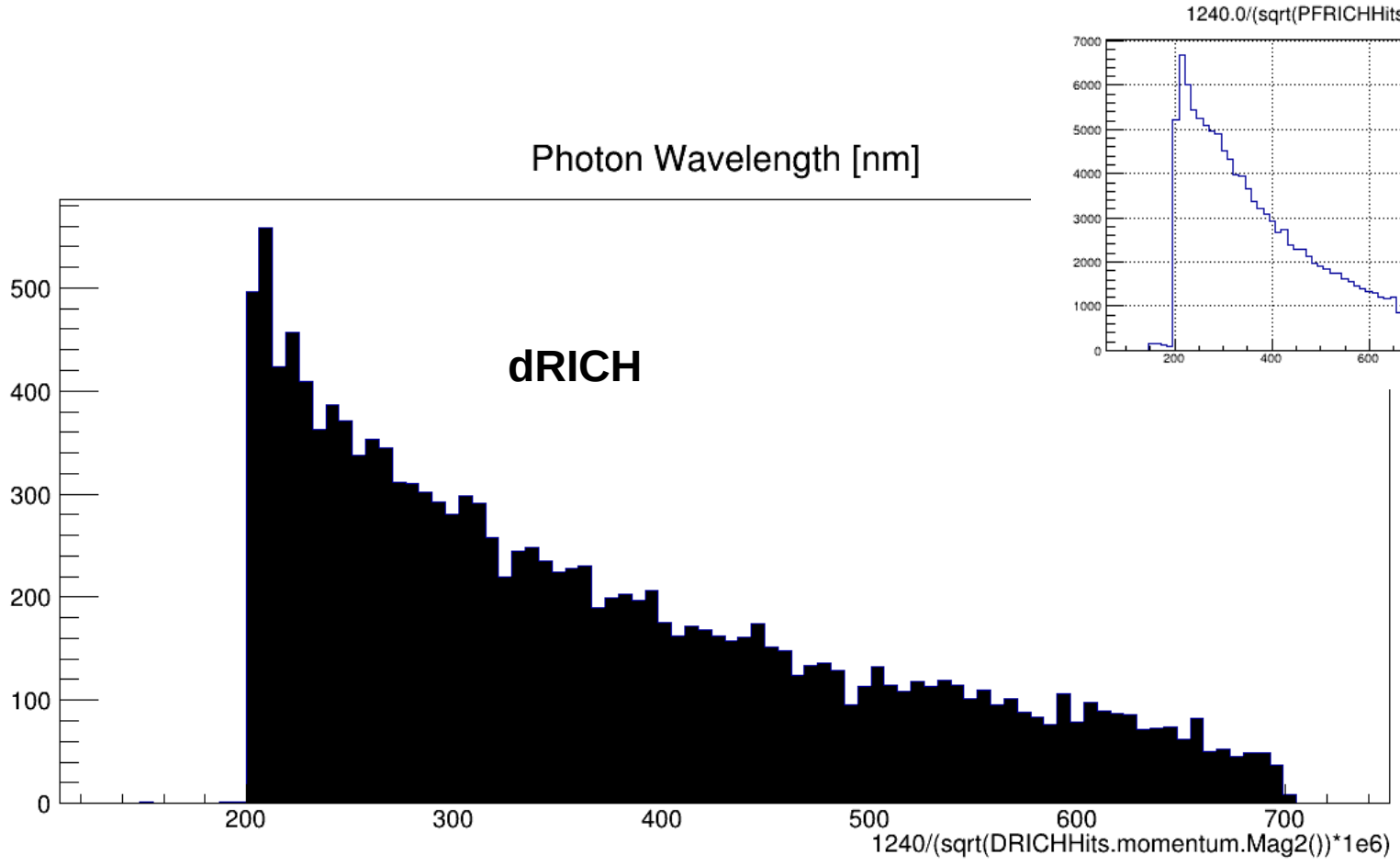
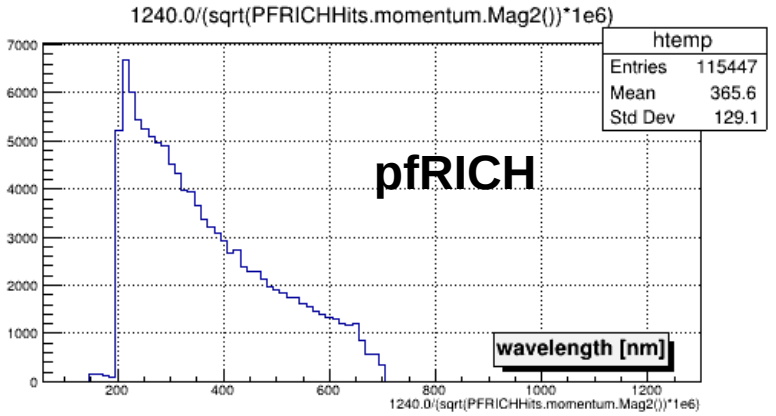
dRICH Meeting
21 September 2022

Wavelength

From Alexander: “A cutoff at ~200nm is present only because the optical properties for C2F6 are defined up to ~6 eV “





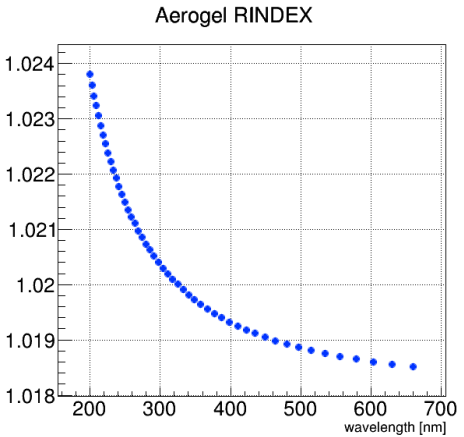
Common Optical Properties Class

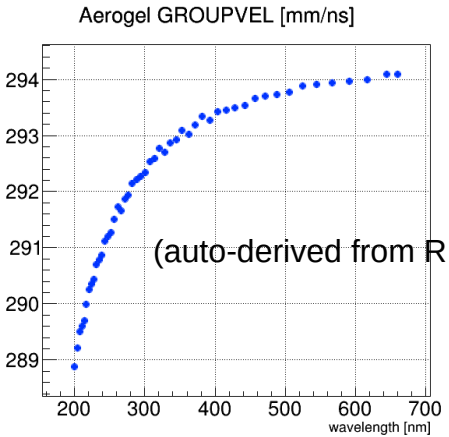
```
/*
 * g4dRIChOptics class hierarchy
 * -----------------------------
 * original authors: E. Cisbani, A. Del Dotto, C. Fanelli
 * source: git@github.com:cisbani/dRICh.git
 * -> adapted for usage in EPIC
 */
```

- Base class g4dRIChOptics with derived classes specific for each dRICH component
- Common class for defining dRICH material properties
  - Used in ATHENA (tables dumps → compact XML files)
  - Used in ECCE (as is)
  - Adapting for EPIC: today's slides
- Contains ***parameterizations*** of material properties, and/or ***experimental data points***
  - There is generally dependence on quantities such as density or threshold
- Today's slides:
  - Cross check EPIC tables with output from g4dRIChOptics
  - Think about extending some tables to lower wavelength

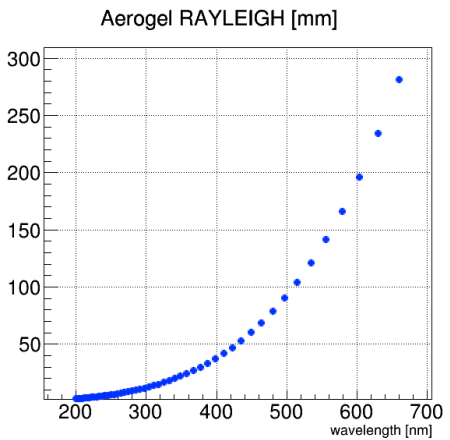
Aerogel

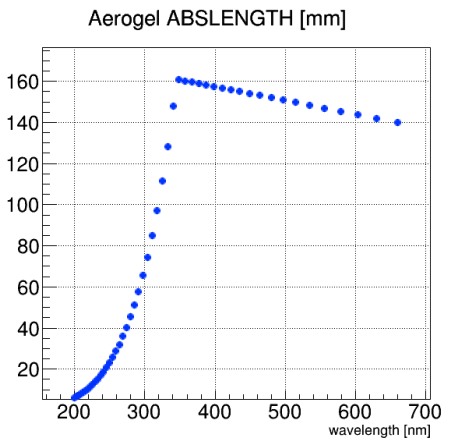
- Change from ATHENA studies: density increased from 0.10 g/cm3 → 0.11 g/cm3
- All material property tables are equivalent to g4dRIChOptics
- Source: experimental data points from CLAS12, rescaled by Alessio/GEMC
  - Alternatives parameterizations available (Vorobiev, Sellmeier)





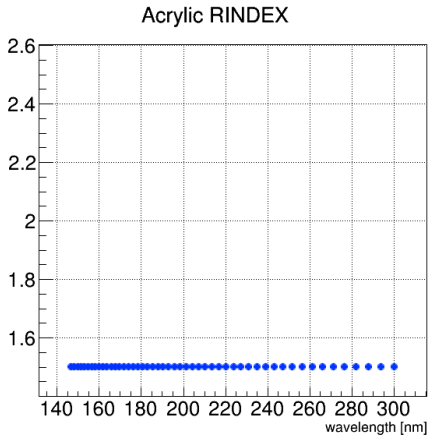
(auto-derived from RINDEX)

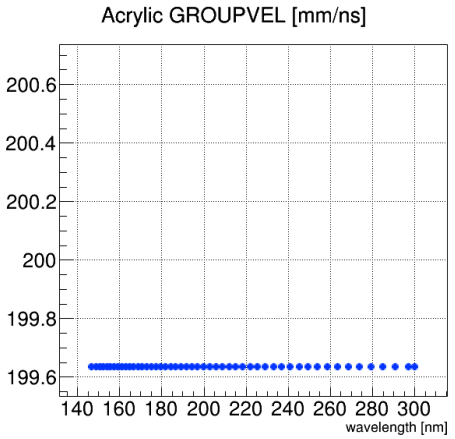


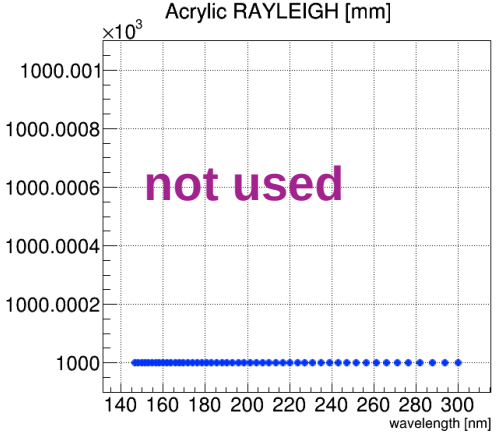


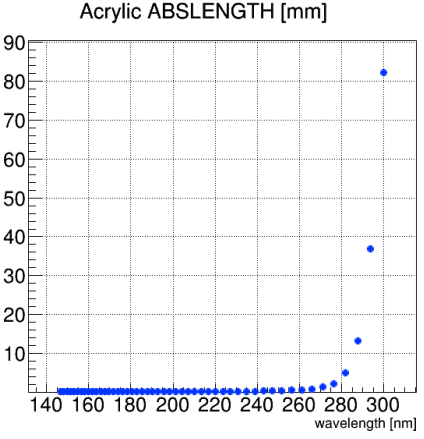
Filter

- All material property tables are equivalent to g4dRIChOptics
- RAYLEIGH not used in EPIC
- Source: not clear in g4dRIChOptics
- Threshold set to 300 nm



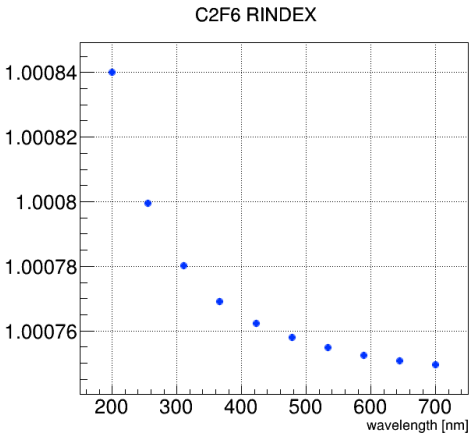


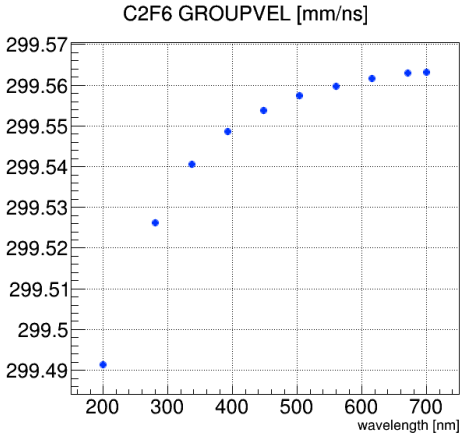


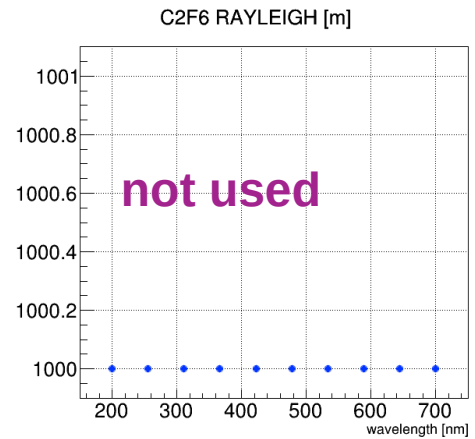


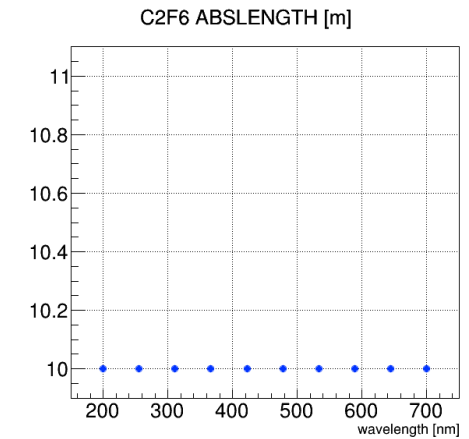
C_2F_6

- All material property tables are equivalent to g4dRIChOptics
- In EPIC we do not use RAYLEIGH table
- Source: Sellmeier formula + density correction (see class for details)
  - Able to extend wavelength range



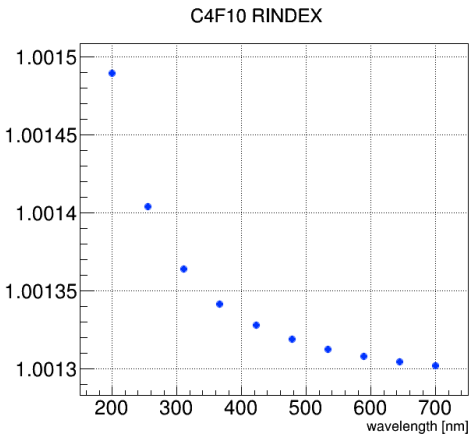


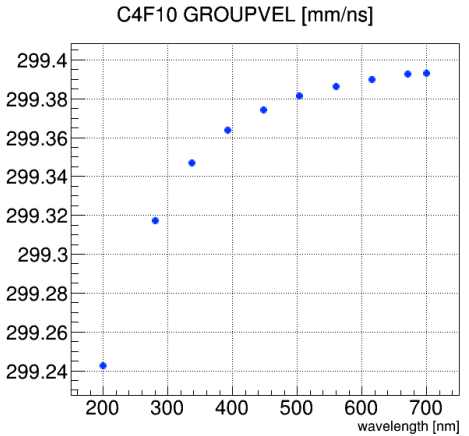


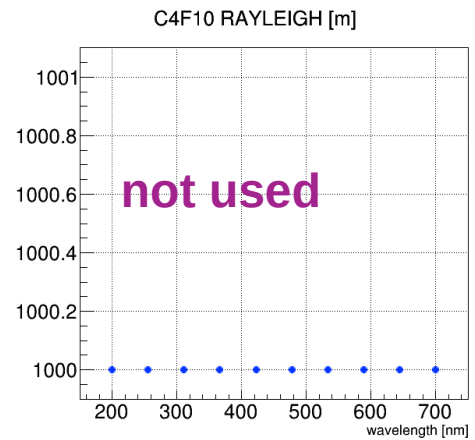


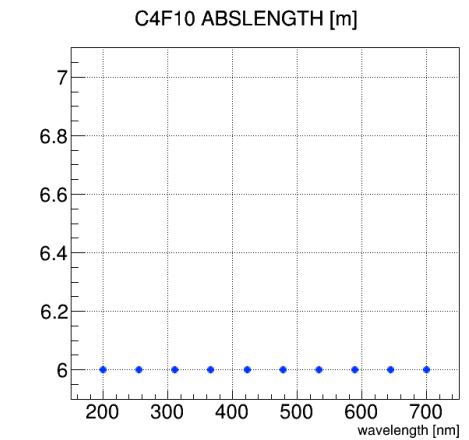
C_4F_{10}

- All material property tables are equivalent to g4dRIChOptics
- In EPIC we do not use RAYLEIGH table
- Source: Sellmeier formula, but no density correction (see class for details)









Mirror Surface

- In EPIC, we use constant REFLECTIVITY = 0.9
- In EPIC, we use different surface finish and type
- g4dRIChOptics uses measured reflectivity (next slide)

In g4dRIChOptics:

```
<opticalsurface name="MirrorSurface_DRICH" model="unified" finish="polishedfrontpainted" type="dielectric_dielectric">
  <property name="REFLECTIVITY" coldim="2" values="
    2.04358*eV   0.867812
    2.06640*eV   0.865156
    2.09046*eV   0.863906
    ...
```

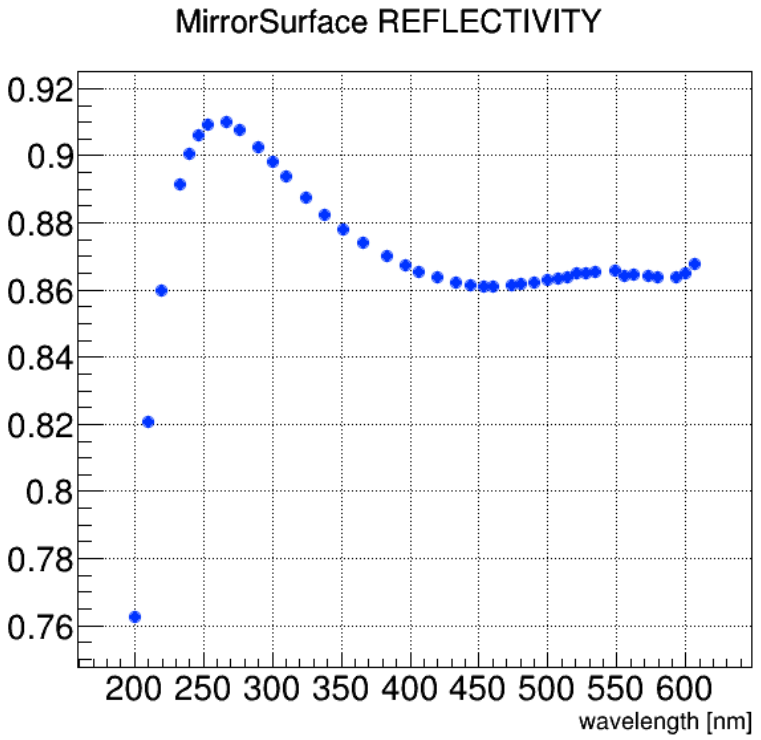
In EPIC:

```
<opticalsurface name="MirrorSurface_DRICH" model="unified" finish="polished" type="dielectric_metal">
  <property name="REFLECTIVITY" coldim="2" values="
    1*eV  0.9
    4*eV  0.9
    7*eV  0.9
    "/>
</opticalsurface>
```

Mirror Surface

- In g4dRIChOptics: Reflectivity of $AlMgF_2$ coated on thermally shaped acrylic sheets, measured by AJRP, 10/01/2012

Reflectivity In g4dRIChOptics:



Sensor Surface

- In EPIC, we use constant EFFICIENCY; Quantum Efficiency is applied downstream, in reconstruction (digitization stage)
  - Ajit has a pull request that adds material properties RINDEX, ABSLENGTH, and fills EFFICIENCY with the Quantum Efficiency
- g4dRIChOptics defines REALRINDEX and IMAGINARYRINDEX, but we have found that we get the wrong number of photons with these defined
- Surface type differs

In g4dRIChOptics:

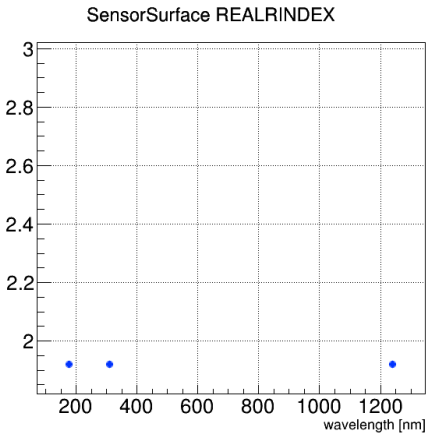
```
<opticalsurface name="SensorSurface_DRICH" model="glisur" finish="polished" type="dielectric_metal">
```

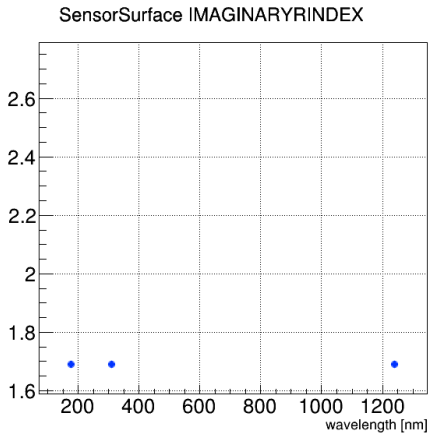
In EPIC:

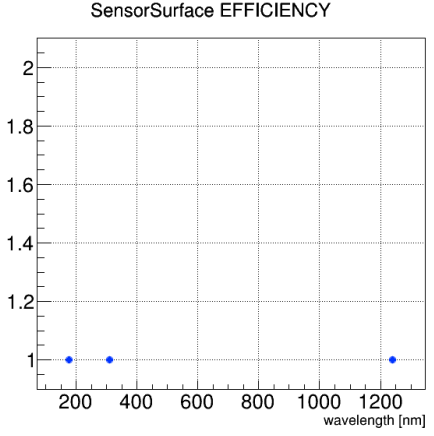
```
<opticalsurface name="SensorSurface_DRICH" model="glisur" finish="polished" type="dielectric_dielectric">
```

Sensor Surface

In g4dRIChOptics:







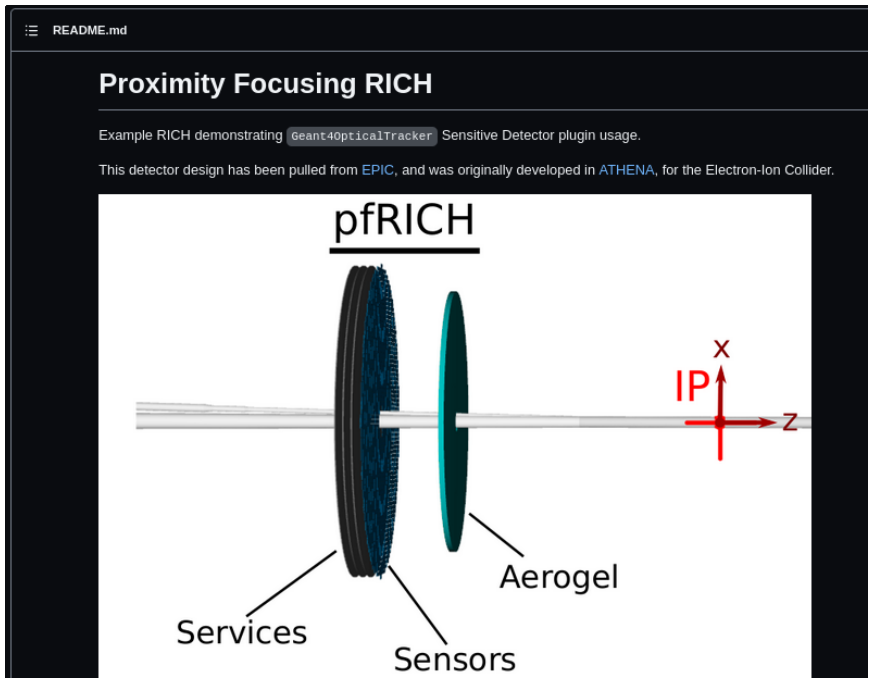
Summary

- Preservation: standalone tool to generate material property tables in XML and plots
- Cross checked with existing tables (from ATHENA)
- Ability to modify tables as needed, e.g., extend to low wavelength
- Investigation of η-dependent Cherenkov angle ongoing….

Other News

ATHENA pfRICH added to DD4hep as an example, and more importantly, a test. This is the first RICH example in DD4hep, and will help ensure support for Cherenkov physics in DD4hep and help stabilize future development

https://github.com/AIDASoft/DD4hep/tree/master/examples/OpticalTracker



2 (simple) tests:

- Throw pions at fixed (η,|p|) and run simulation (basically our npsim)
- Count the average number of hits: results in 230
  - Maybe not ‘realistic’, but this test is good for stability

DD4hep maintainers would likely welcome more tests