pfRICH DSC plans for the upcoming TDR effort

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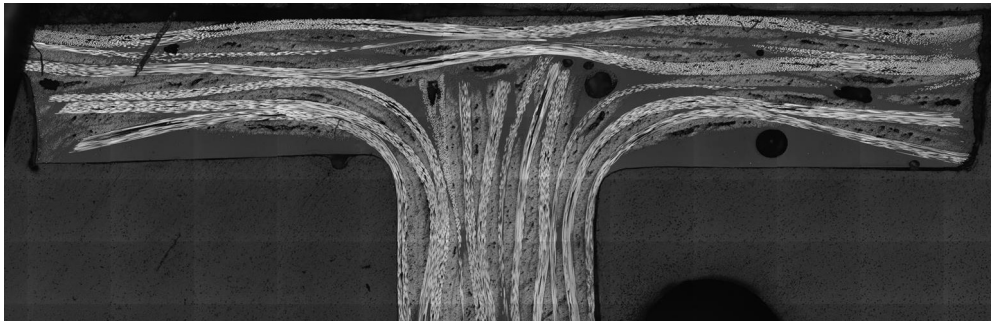
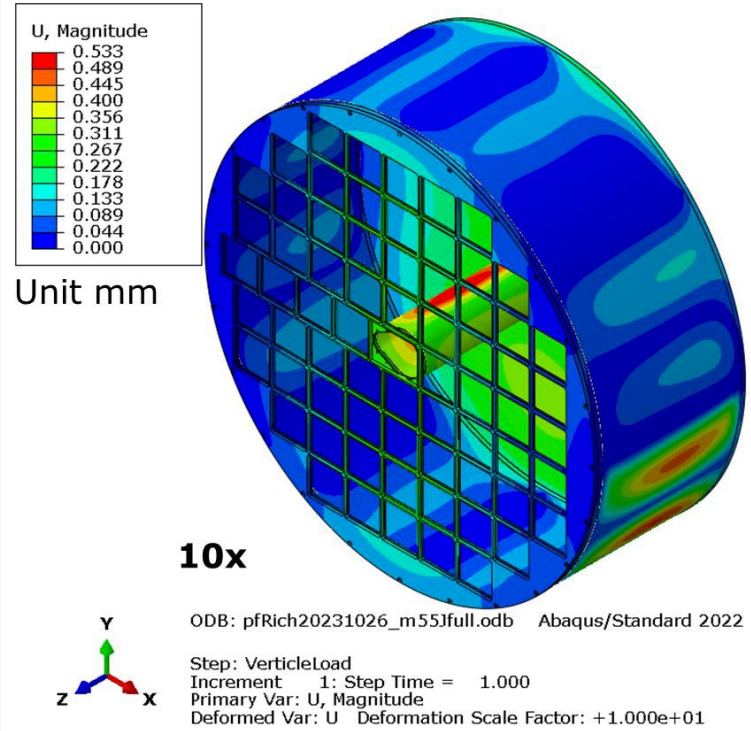
ePIC PID CC WG Meeting, February 23, 2024

Vessel & mechanical design

- Two PED projects
  - Purdue: end rings, front (aerogel) plate and a sensor plane
  - Stony Brook: outer shell of the vessel
- To be concluded by August 2024



Carbon fiber layup of a reinforcement ring

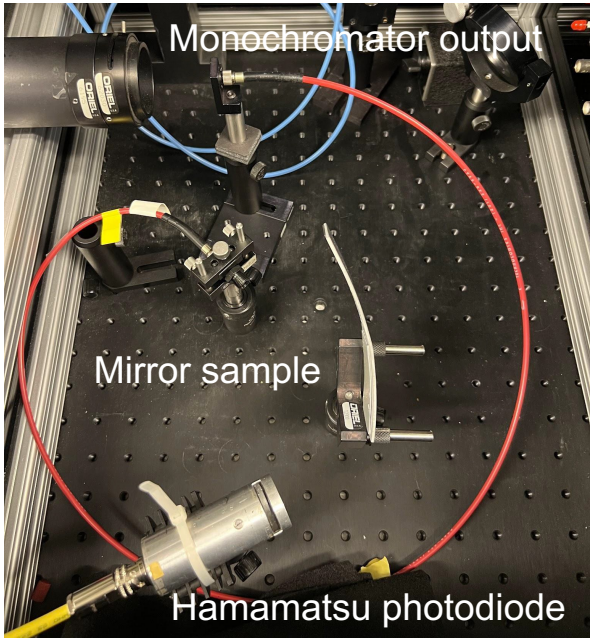


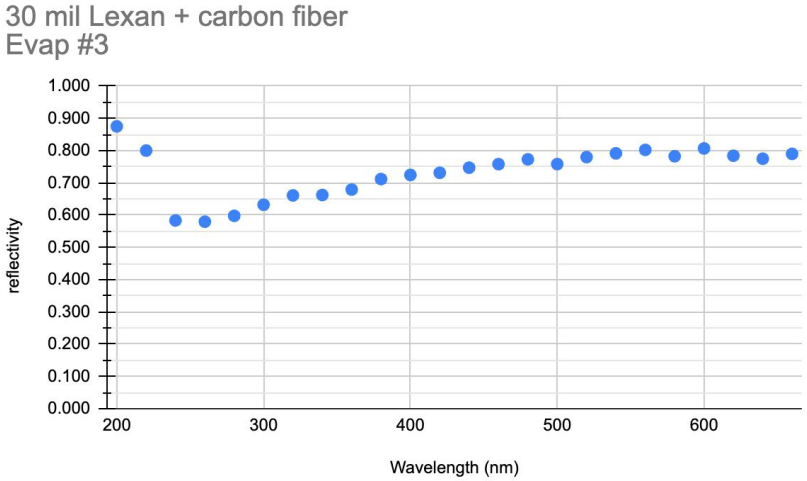
Finite Element Analysis results

Mirrors

- Two PED projects
  - Purdue: substrates
  - Stony Brook: coating
- To be concluded by August 2024

Lexan thickness choice

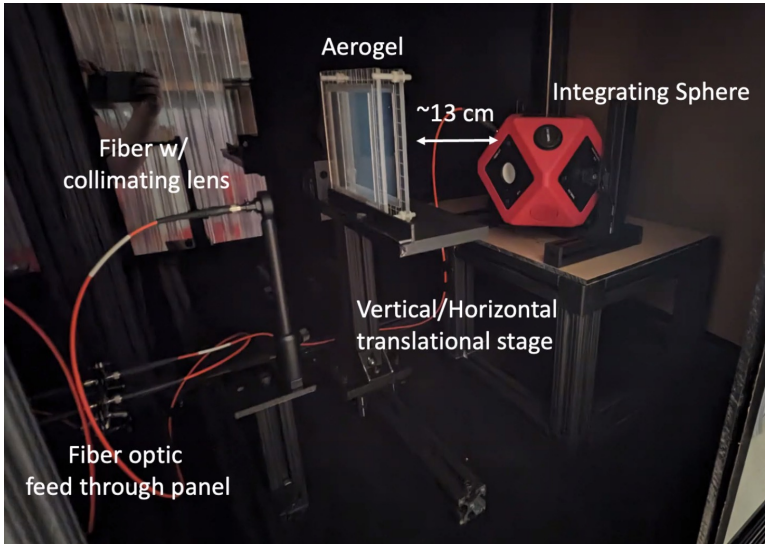




- Evaporator setup at Stony Brook is fully functional
- A basic reflectivity measurement setup at BNL exists
- Present focus on
  - Optimizing the coating process
  - Defining a substrate to Lexan bonding strategy

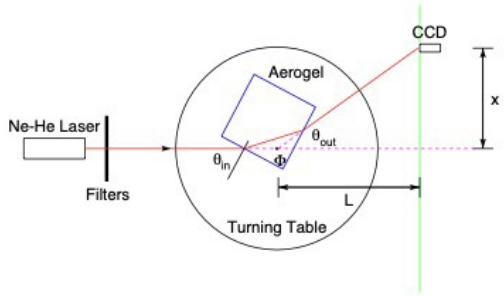
Aerogel

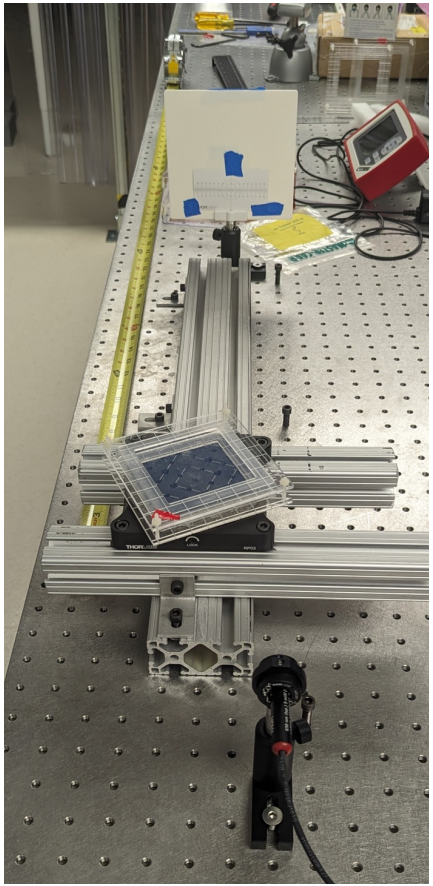
- Received test samples and production ones from Chiba
- Transmission and refractive index measurement setups are in a usable state at Temple & BNL
  - Three production samples will be evaluated in March



Transmission measurement setup

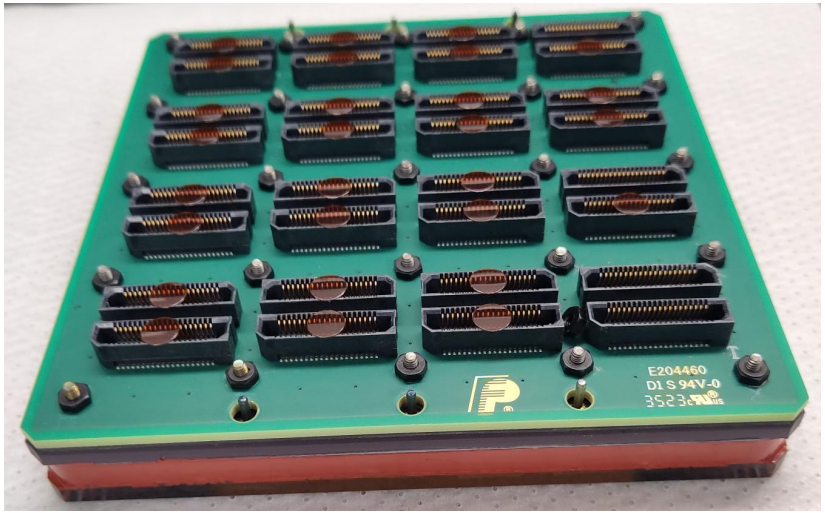
Nucl. Phys. B (Proc. Suppl.)
150 (2006) 281-284

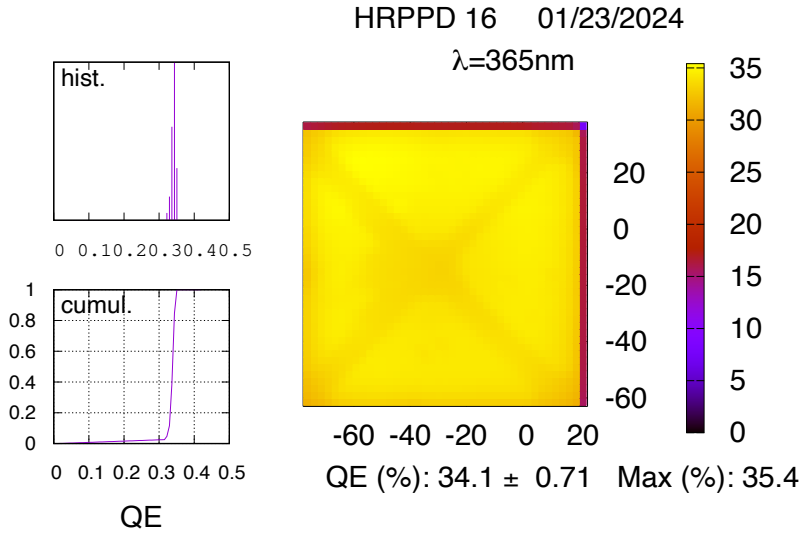




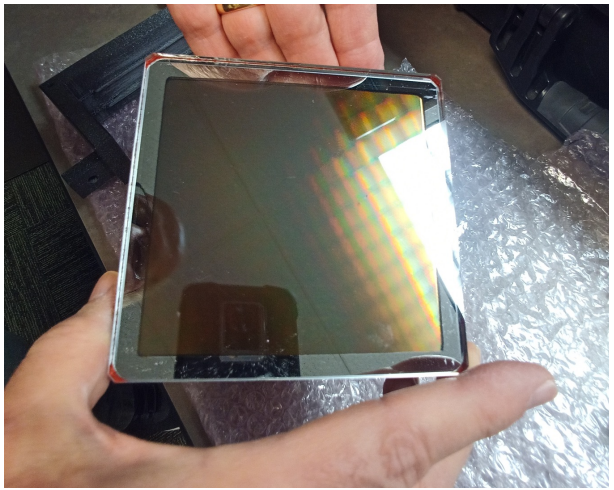
Refractive index measurement setup

HRPPDs





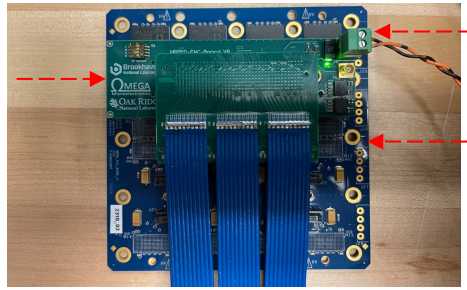
- Three out of five tiles shipped to JLab already
  - Two are on their way back to Incom due to mechanical interface issues
- Results of internal QA process at Incom are promising
- Setups at JLab & BNL to be ready in a few weeks
  - Complete performance evaluation will take months

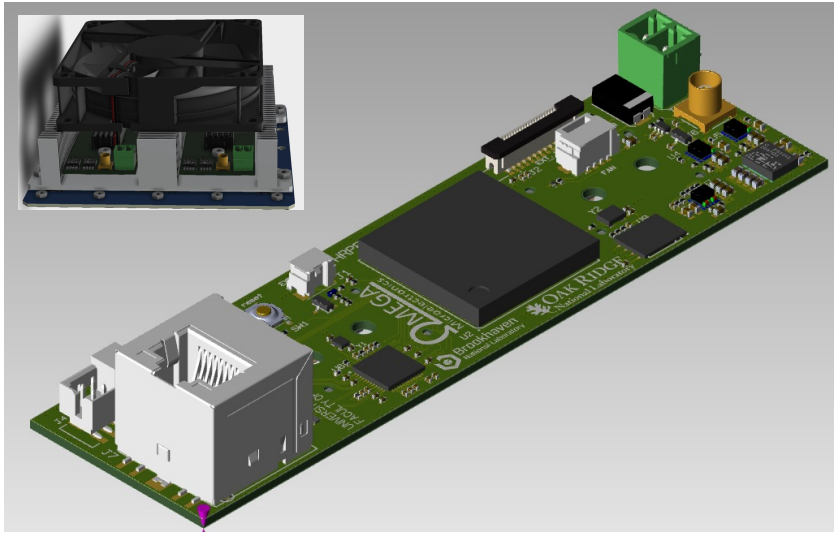


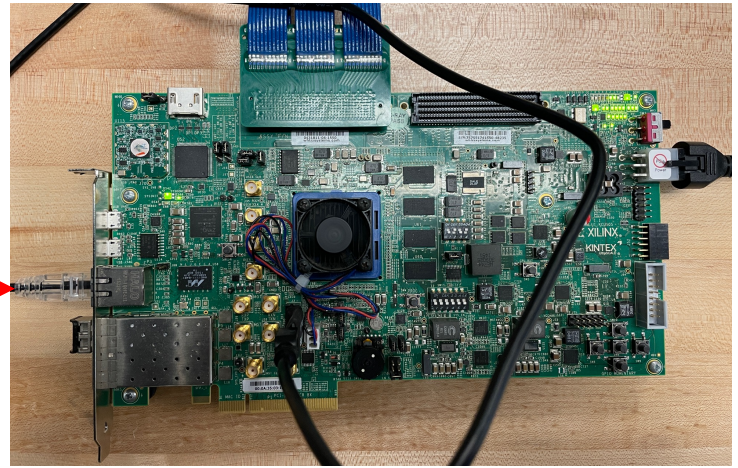
Frontend electronics

- HGCROC3 ASIC backplane (V0) debugging started
  - Not much to say yet, though in this configuration (KCU kit instead of an on-board FPGA interface) we just confirmed that a host DAQ PC does indeed see the ASICs
- FPGA board (V0) expected end of February
- Frontend verification with HRPPD attached: next two months

HRPPD HGCROC3 backplane (V0)



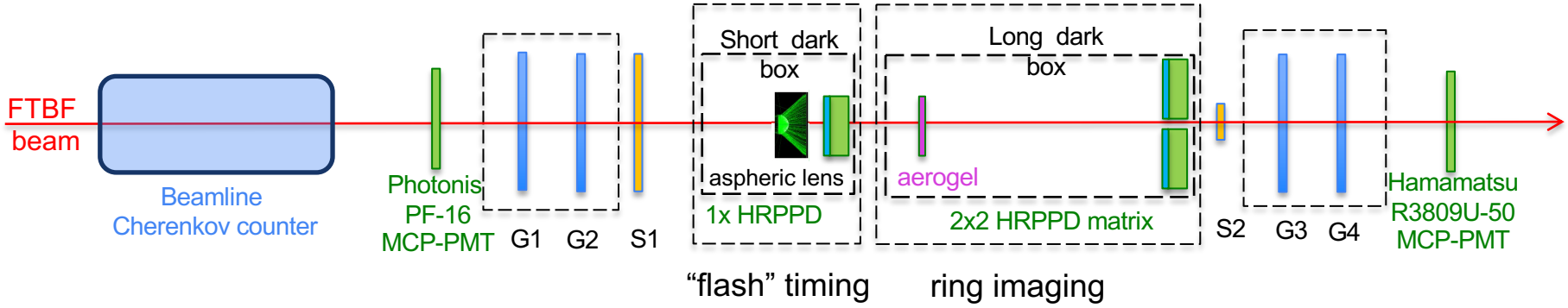


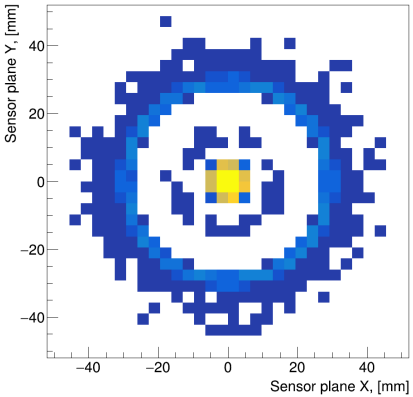


KCU105 Xilinx UltraScale FPGA development kit

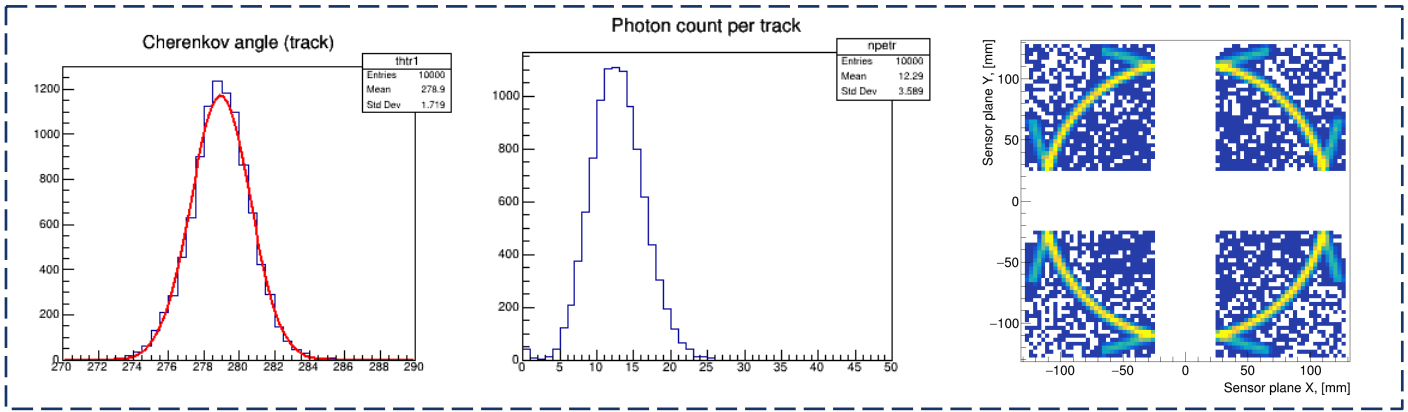
Fermilab beam test plans

Either May this year or 2025+





1x HRPPD



2x2 HRPPD matrix

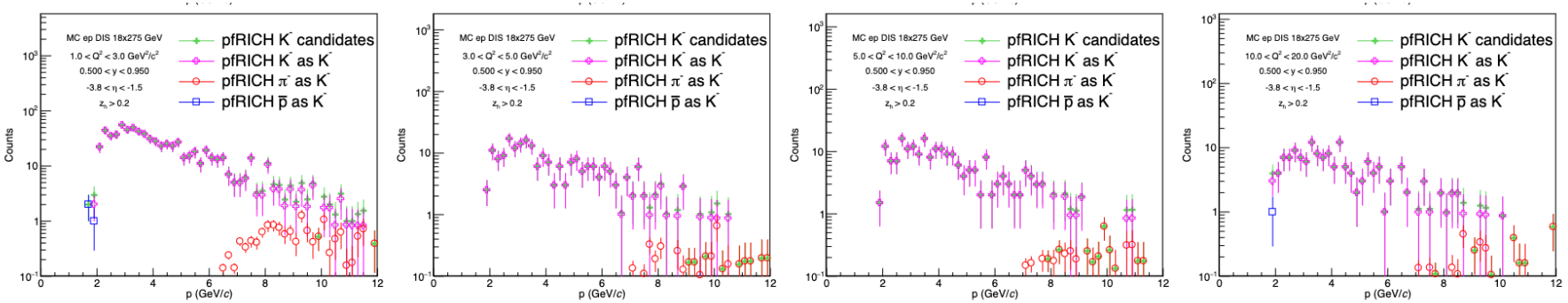
Detector performance modeling

- A standalone GEANT software suite exists
  - A complete implementation of pfRICH geometry
  - Optical photon propagation
  - Event-level reconstruction

- TODO list
  - New aerogel parameterizations (as measured on a test bench)
  - HRPPD QE parameterization (as follows from the evaluation procedure)
  - Other parameter tuning
    - HRPPD PDE & timing resolution
    - Overall geometry (dead area, funneling mirrors, material budget, etc)
    - Mirror reflectivity
    - …

Physics performance evaluation

- A set of plots for TDR is yet to be defined
- Machinery to produce them exists already
  - Delphes and / or custom ROOT format of smearing matrices
  - Software to import them (see slides 17-20 here)



Kaon sample purity plots in Q^2 bins

Drafting effort

- A CDR-style document was produced from scratch by a subset of the present pfRICH DSC groups / members between January and March 2023
  - Along with developing the codes, finalizing the geometry in CAD and GEANT, and running the actual simulations

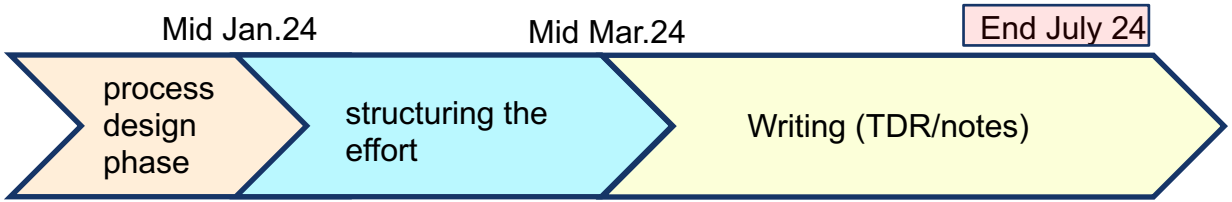
- It is therefore reasonable to believe that we should be able to repeat this exercise between now and August 2024

Other topics & planning

- The lab/testbeam/prototyping needed;
- The further progress needed for the reconstruction software;
- The verification of the implementation of the detector and detector response in simulation and validation using information from lab/testbeam exercises or from literature;
- The studies required to demonstrate the detector performance;
- The required engineering design;
- The needed resources to achieve 60% (CD-2) and 90% (CD-3) design completion;
- The plan should include the time required to draft the text for the pre-TDR (CD-2) and TDR (CD-3).

The plan should present the activities required month by month in order to allow progress to be monitored. The ultimate goal of this exercise should be 90% design completion consistent with the requirements of the TDR and CD-3, indicatively by the end of 2024.

- No detailed planning yet
  - Further clarification on the deadlines may be helpful
  - To some extent will depend on beam / no beam in 2024



Backup

Other subsystems

- Low voltage
- High voltage
- Cooling system
- Gas system

Were developed to quite some extent and costed for the March 2023 and July 2023 review purposes

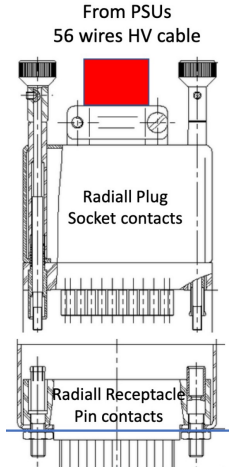
Are not supposed to be a challenge

(Subsequent slides taken from a July 2023 PID Review talk)

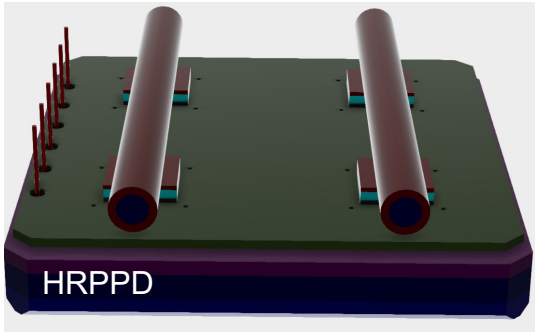
HV system

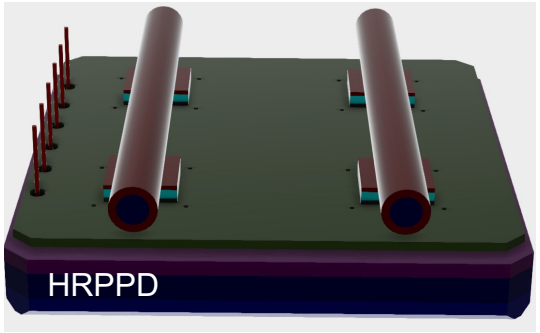
- CAEN HV mainframes and *stackable* HV modules
- CERN-approved Radiall connectors

23x A1515BV's



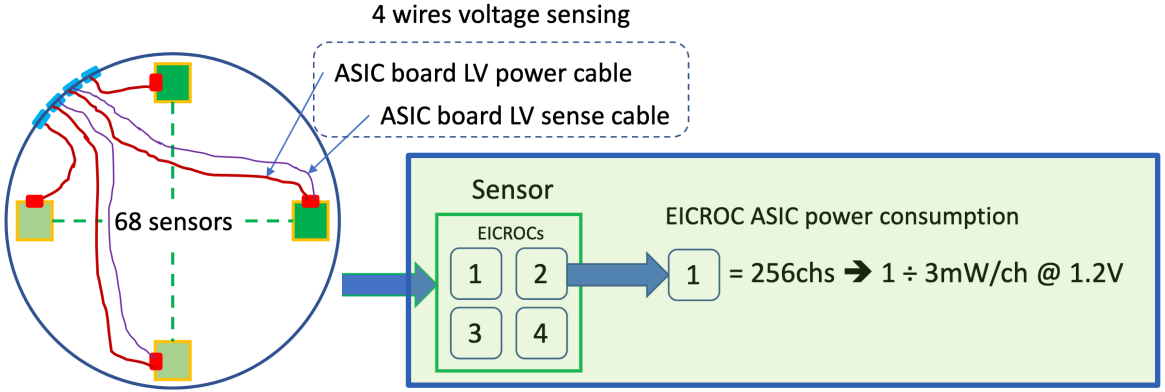
On-detector part





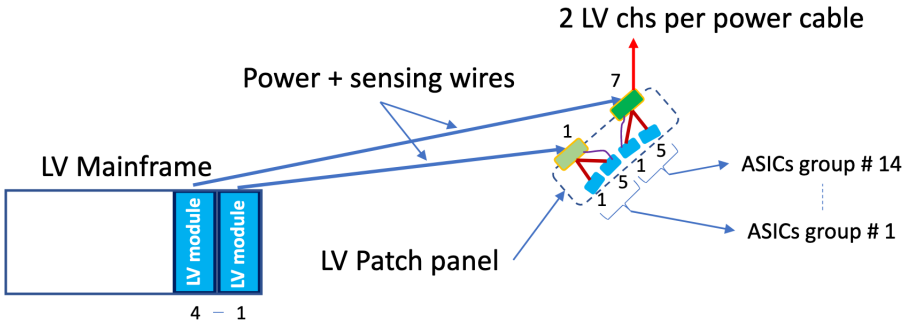
six Teflon coated wires per HRPPD

LV system



Wiener LV mainframe and modules

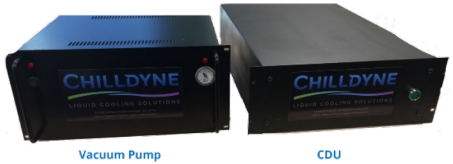
- Each Sensor
  - 4EICROCs x 256chs = 1024chs/sensor ➔ @3mW/ch ➔ ~3W/se
- Whole detector
  - 68sensors x 2.5A ➔ 170A@1.2V ➔ 204W
  - Add 20% extra current for the ancillary electronic components
    - 170A + 20% = 204A@1.2V ➔ 245W
  - Add 20% extra current for safety margin
    - 204A + 20% = **245A@1.2V** ➔ **294W**



Cooling system

Off Detector

- Chilldyne Circulator
  - 8 lpm
  - -10 psi
  - 5°C to 40°C



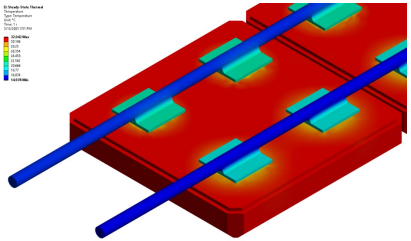
- Polyscience Chiller
  - 9.8 l/min @ 43.4 psi
  - -20°C to 40°C ±0.1°C
  - 800 W @ 10°C

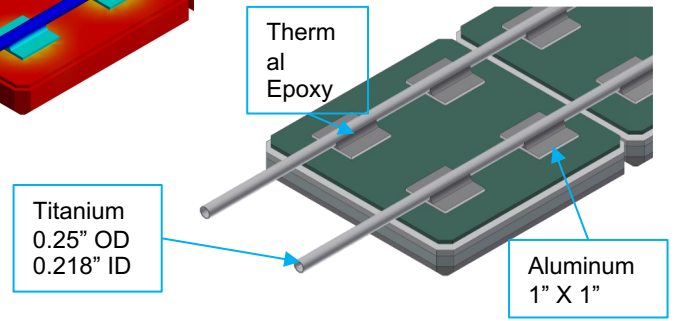
- Distribution Panel
  - Flowmeters
  - Flow Transmitters

On Detector

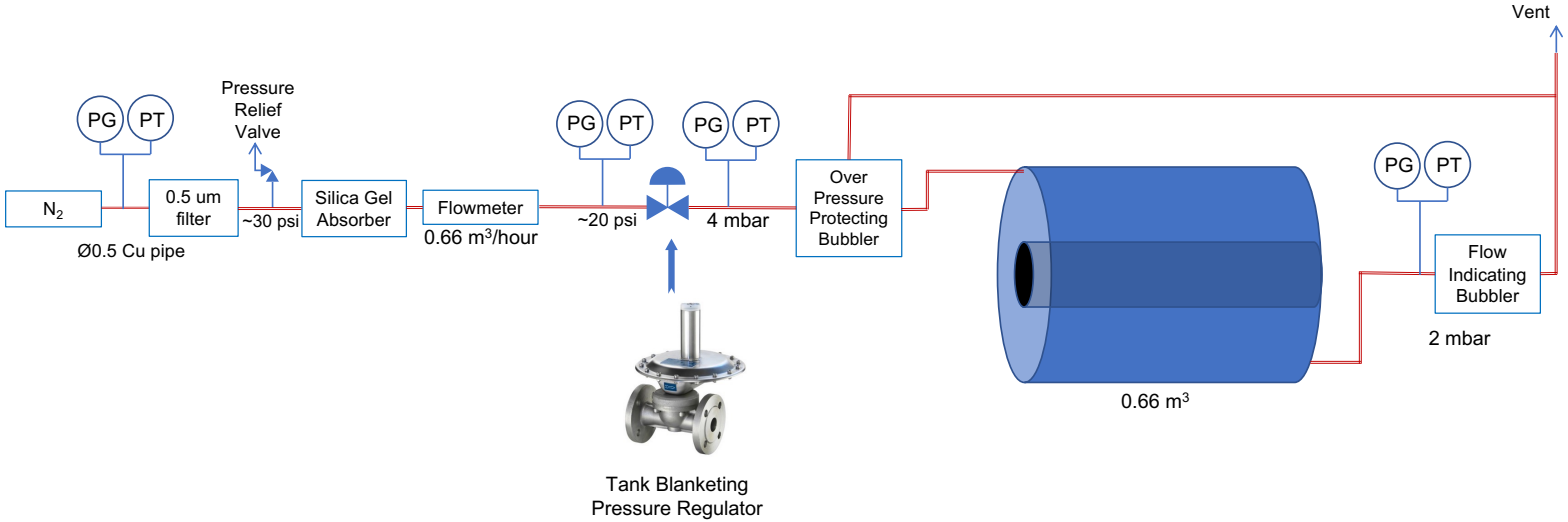
- Heat dissipation: 400W
- Tube @ Δ2°C: ~3 lpm
- ΔP ~0.25 psi

- 9 Modules:
  - ~50W,
  - ~Δ17°C
  - Water ~Δ1.2°C





Gas system



- Assume nitrogen only configuration
- One volume exchange per hour at a pressure 2-4 mbar
- Gas quality (industrial, ultra-pure,…) needs to be finalized