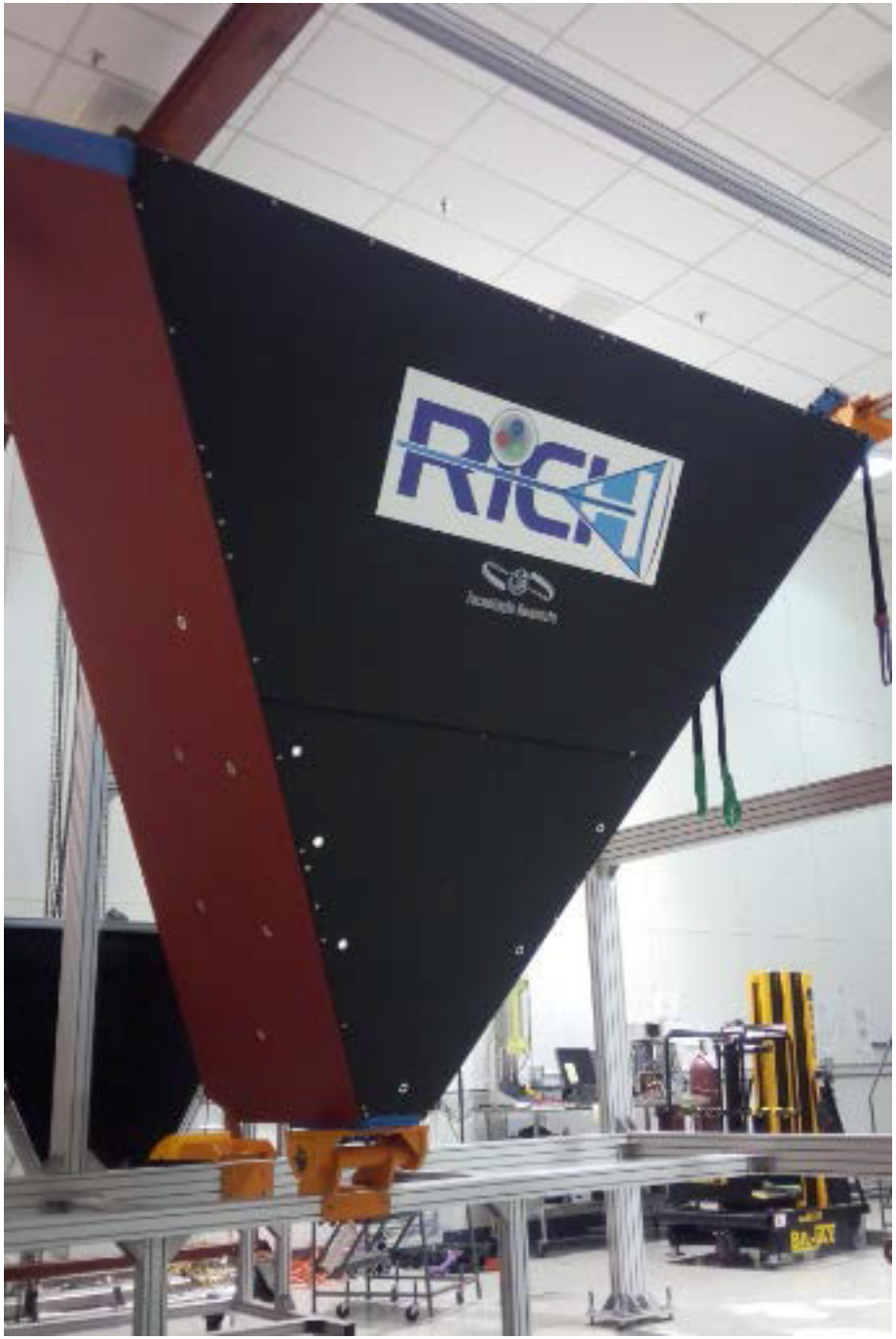


RICH
Detector Status

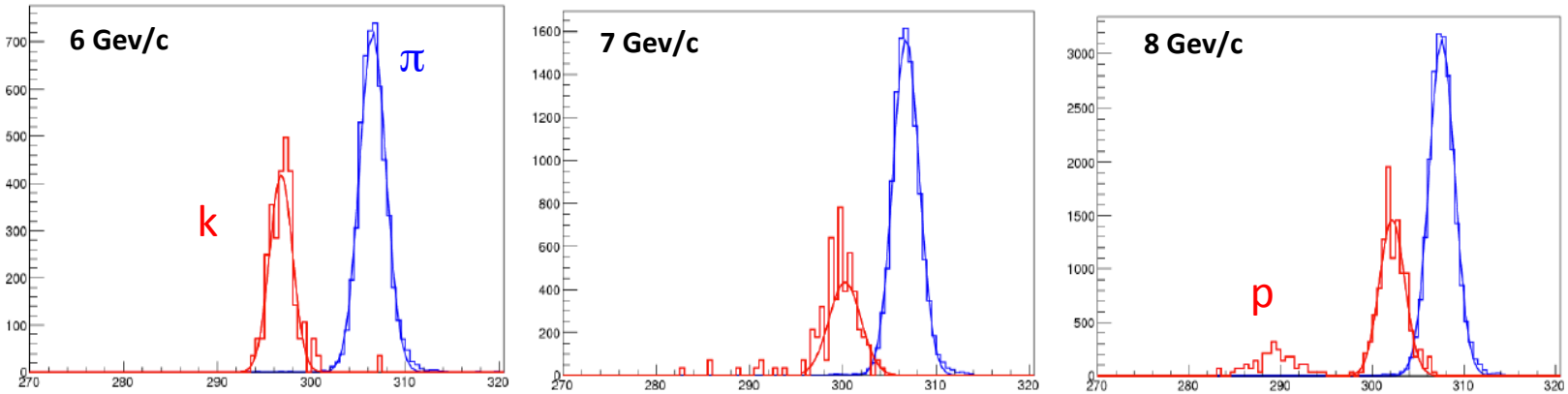
M. Contalbrigo
INFN Ferrara

Hall-B Meeting
11 September 2017

CLAS12 RICH

INSTITUTIONS
INFN (Italy) Bari, Ferrara, Genova, L.Frascati, Roma/ISS
Jefferson Lab (Newport News, USA)
Argonne National Lab (Argonne, USA)
Duquesne University (Pittsburgh, USA)
George Washington University (USA)
Glasgow University (Glasgow, UK)
Kyungpook National University, (Daegu, Korea)
University of Connecticut (Storrs, USA)
UTFSM (Valparaiso, Chile)

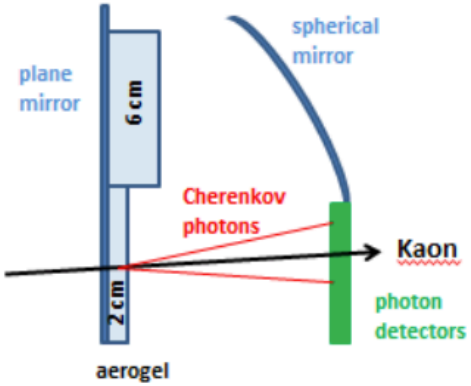
Prototype results:

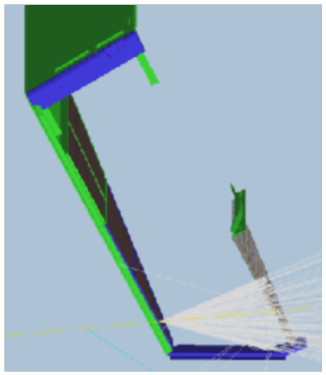


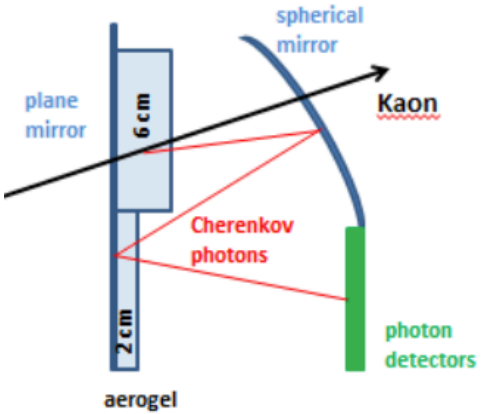
RICH Design

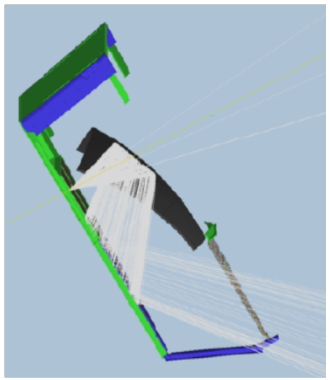
Goal: separate kaons from pions and protons in the momentum range 3-8 GeV/c

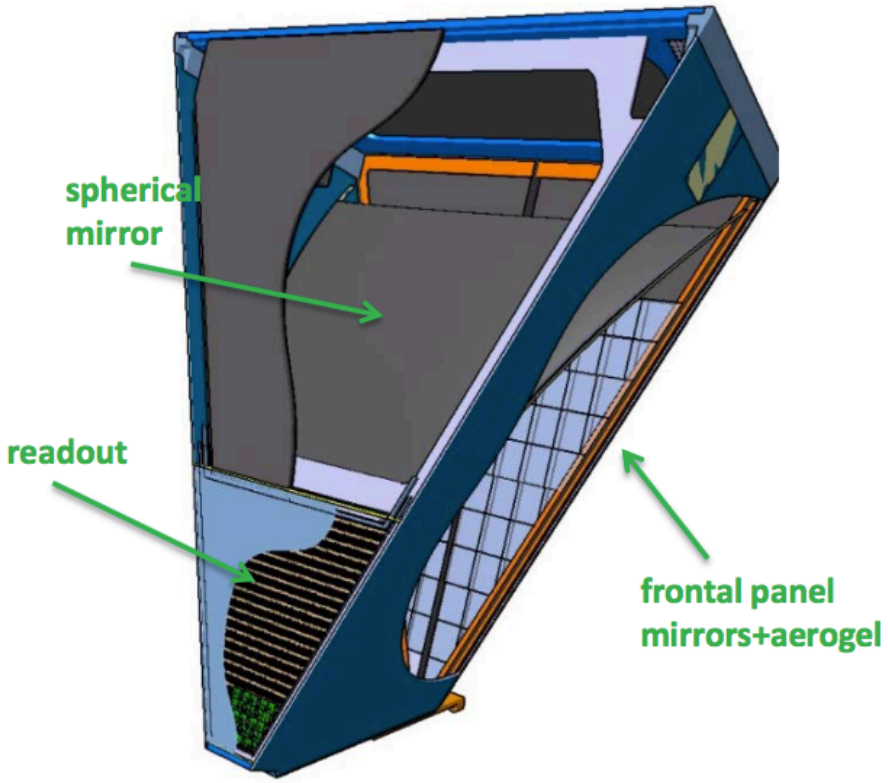
Aerogel radiator to match the momentum
Hybrid-optic to minimize the instrumented area
Working with VIS and near-UV photons (MAPMTs or SiPMs)











Mechanic Assembling

- ✓ External RICH vessel assembled in EEL-124
- ✓ Entrance, exit and electronic panels ready
- ✓ Assembling tools ready

Thanks to DSG group!

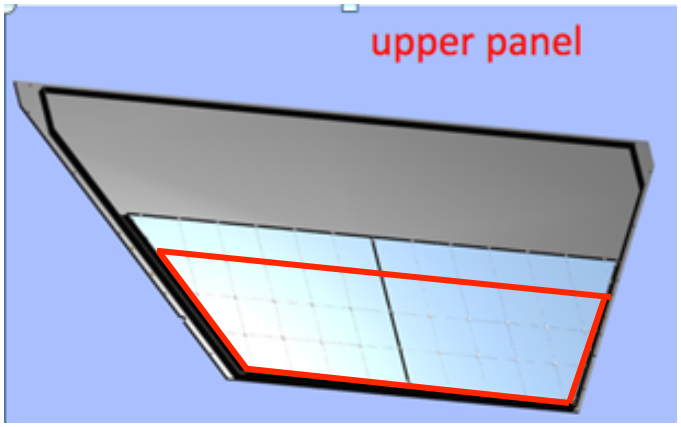
Entrance bottom

Entrance top

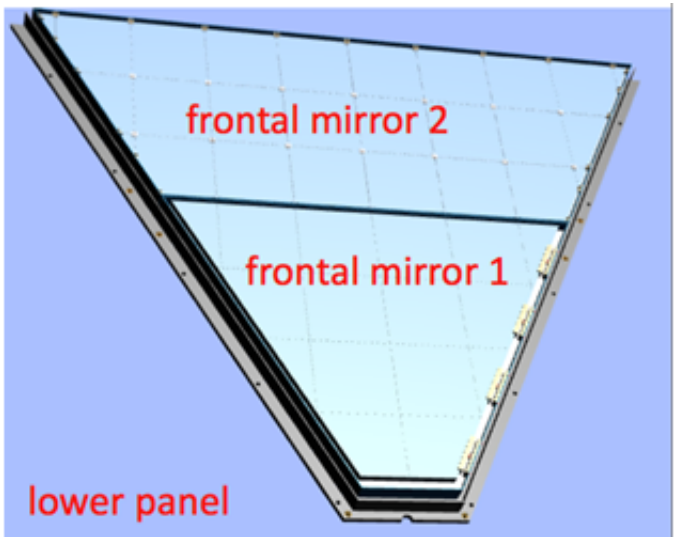
Electronic Panel

Aerogel

✓ 3 cm: minimal quantity @ JLab

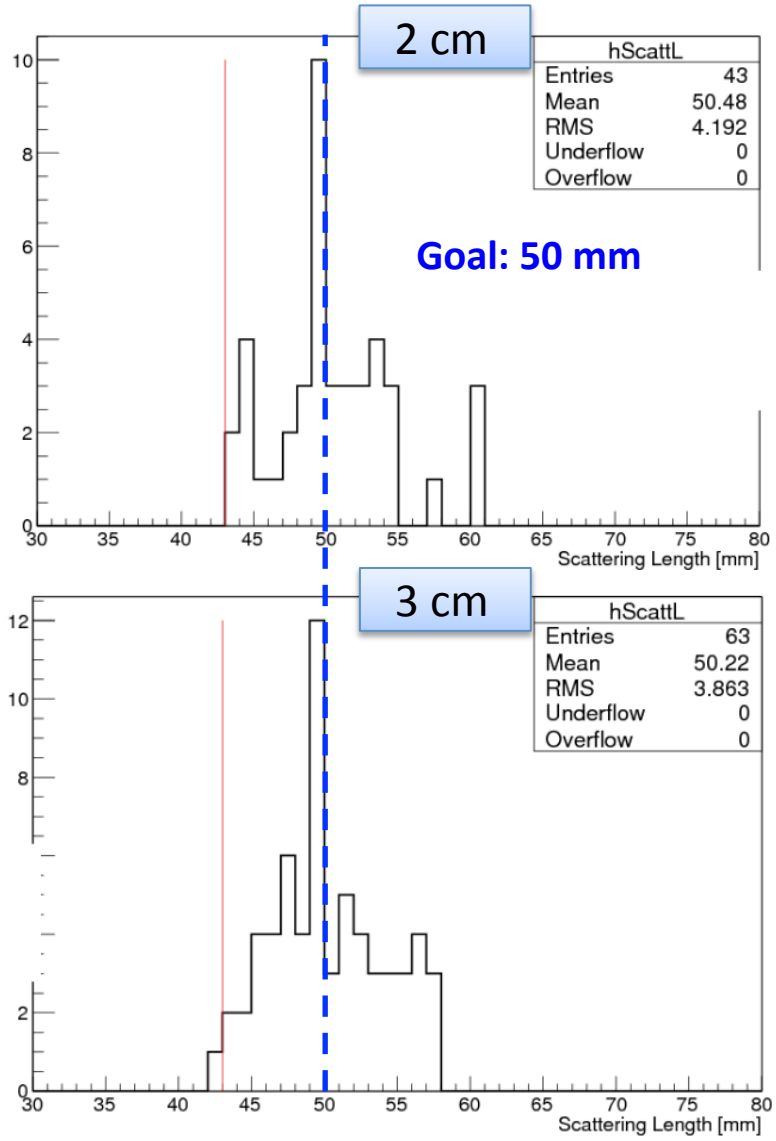


✓ 2 cm: all squared tiles @ JLab
2 cm corner tiles ready for shipment



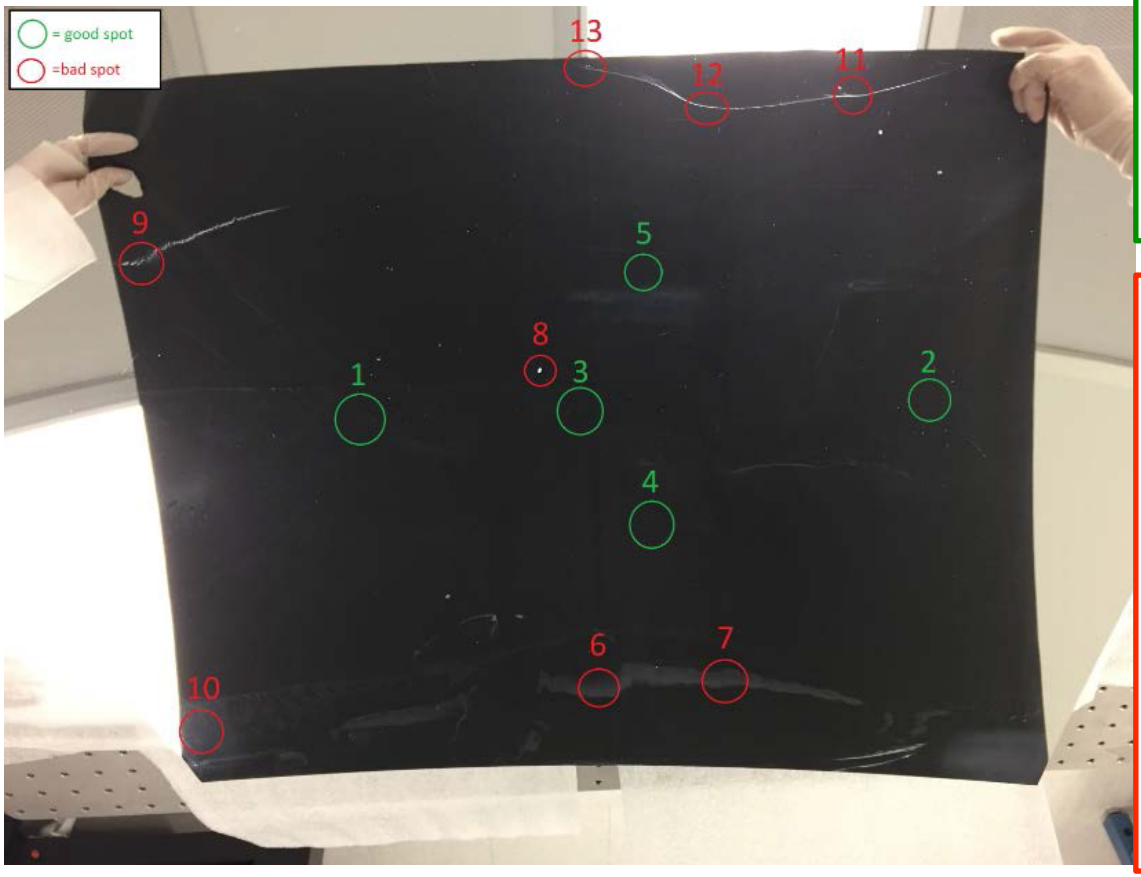
✓ additional spares being produced

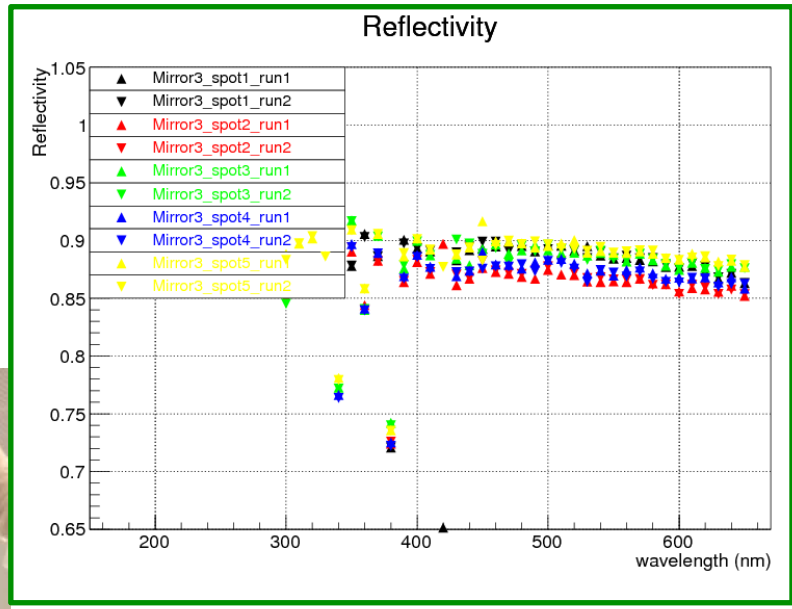
Most critical parameter: scattering length

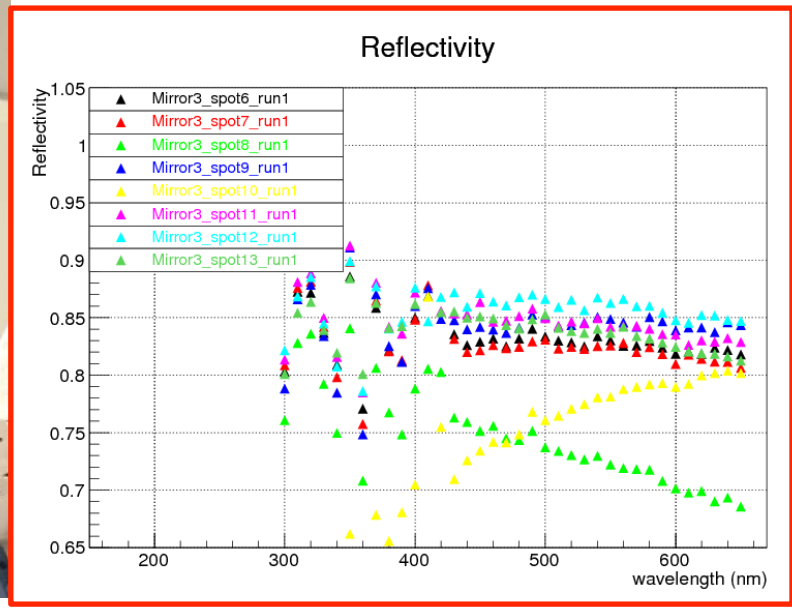


Spherical Mirrors

- ✓ All 10 mirror produced
  30% less areal density vs LHCb
  Shape accuracy better than specifications
- ✓ Coating highlighted defects (chemical residuals)
- ✓ Resurfacing ongoing @ CMA (done this week)



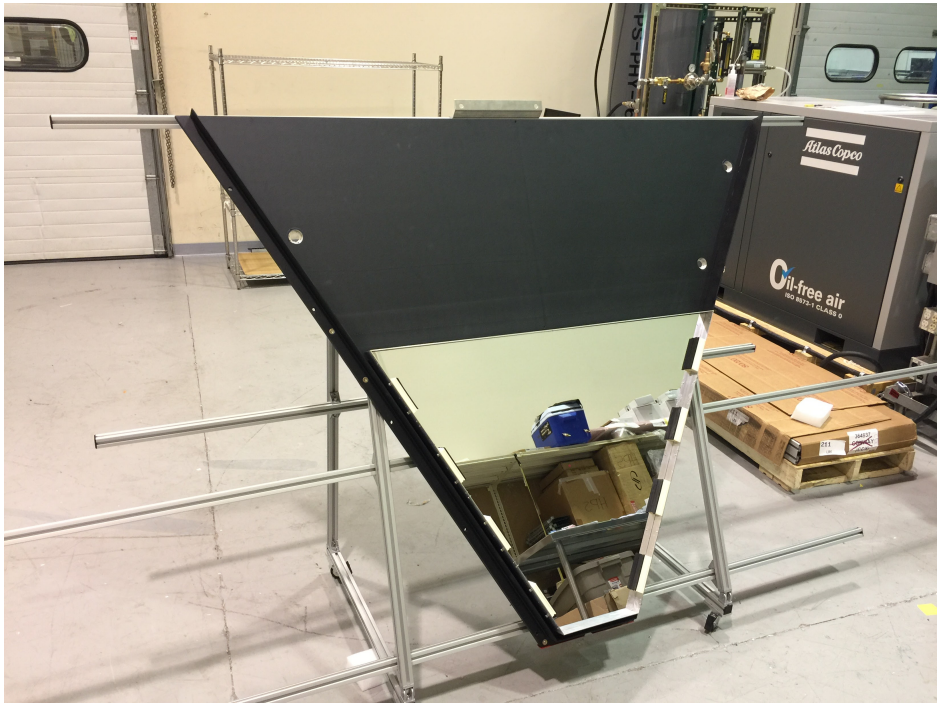




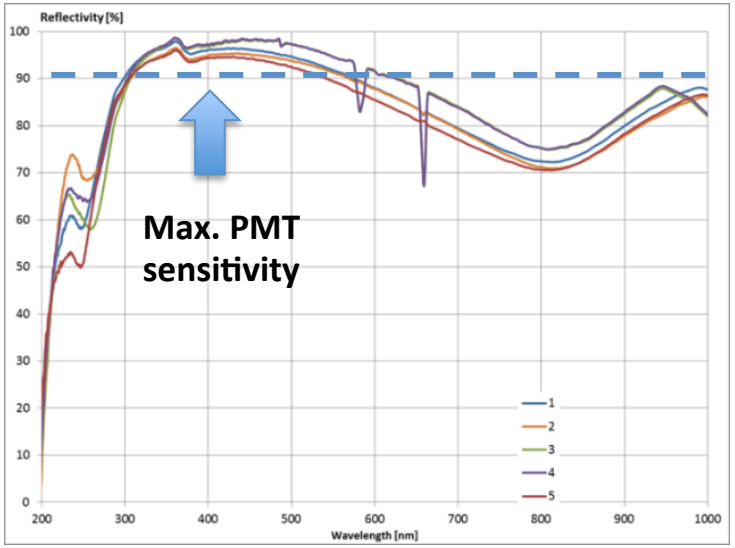
Planar Mirrors

- ✓ Lateral mirror @ JLab
  Material budget comparable to CFRP @ 1/10 cost
- ✓ Assembling validated
- ✓ Surface defects mitigated
- ✓ Front mirror production ongoing (done next week)

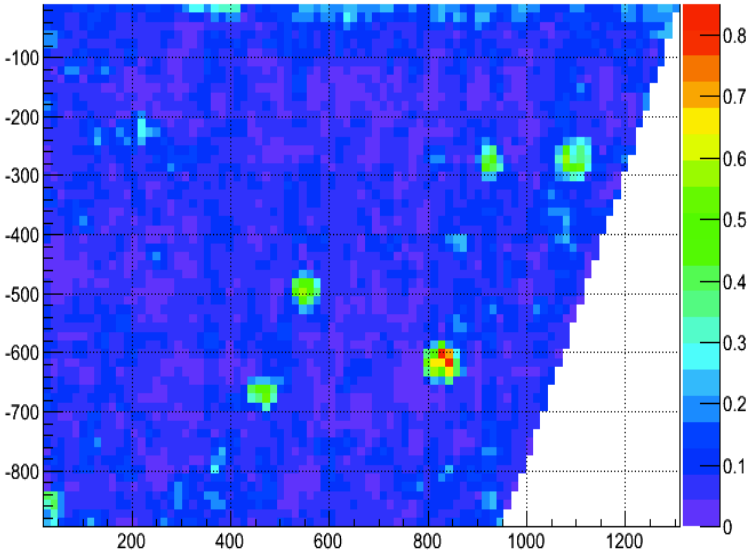
Front panel and mirror assembling test



Reflectivity specs: > 90% at 400 nm



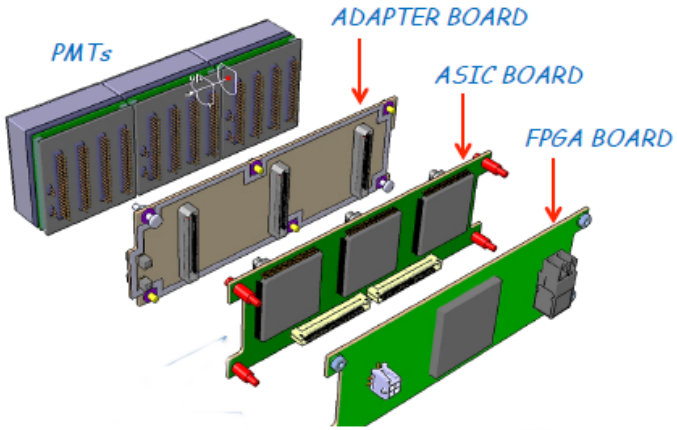
Slope of surface from CMM machine

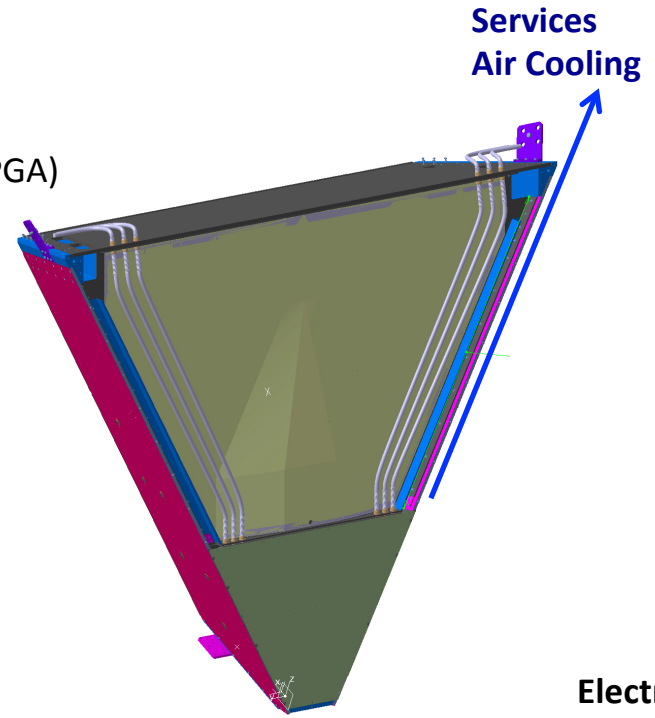


RICH Readout Electronics

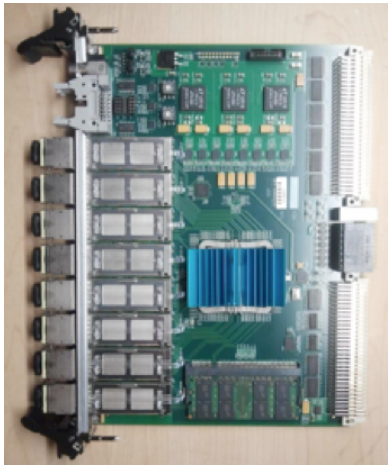
Readout Electronics

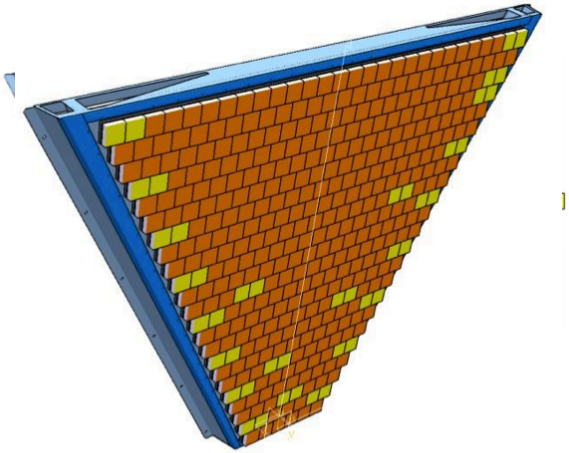
Compact (matches sensor area)
Modular Front-End (Mechanical adapter, ASIC, FPGA)
Scalable fiber optic DAQ (TCP/IP or SSP)
Tessellated (common HV, LV and optical fiber)



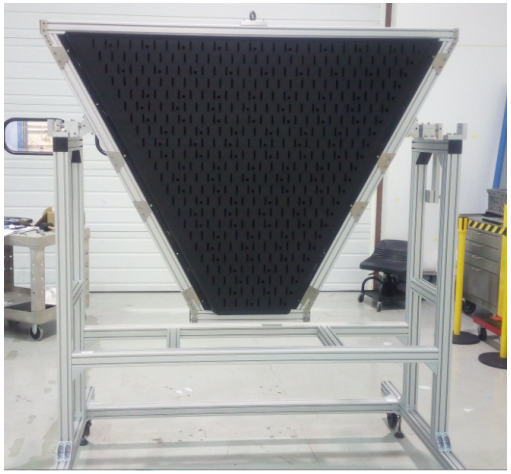


SSP Fiber-Optic DAQ

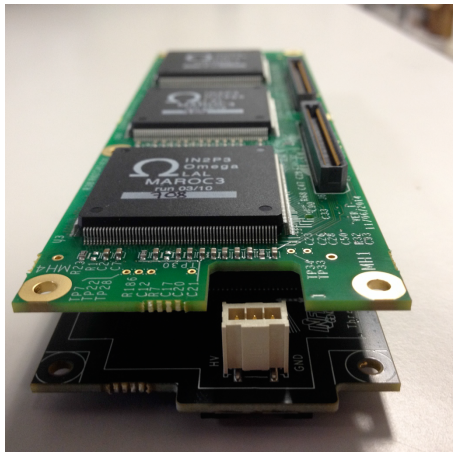


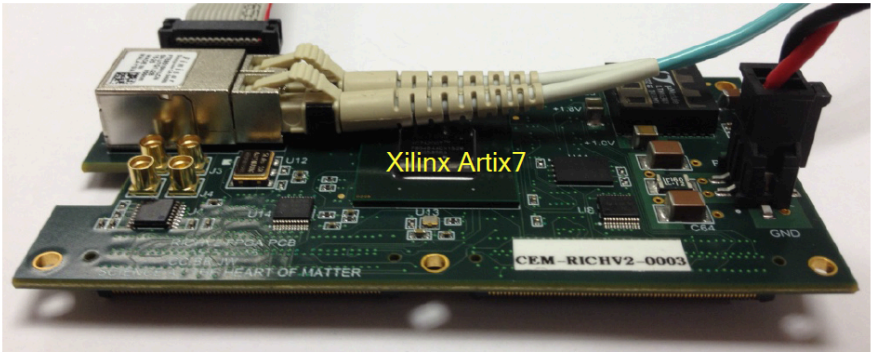


Electronic Panel



RICH Front-End Electronics





example of MAROC signal processing

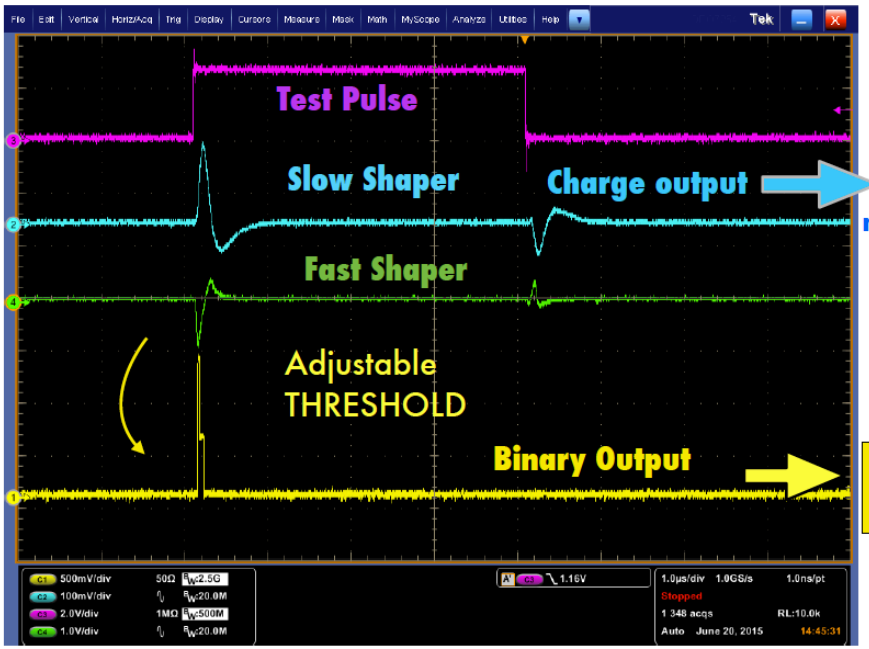
Analog: Charge (1 fC)
Digital: Time (1 ns)

Trigger latency (8 μs)

Optical ethernet (2.5 Gbps)

Trigger: external
internal
self

On-board pulser



ADC
(MAROC)
calibration only
more on backup slide

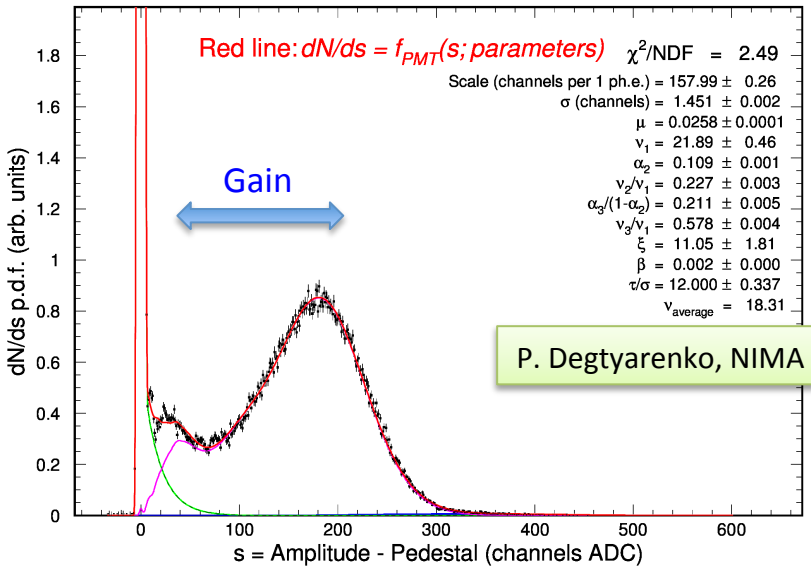
SCALER/TDC
(FPGA)

TDC used for physics runs!

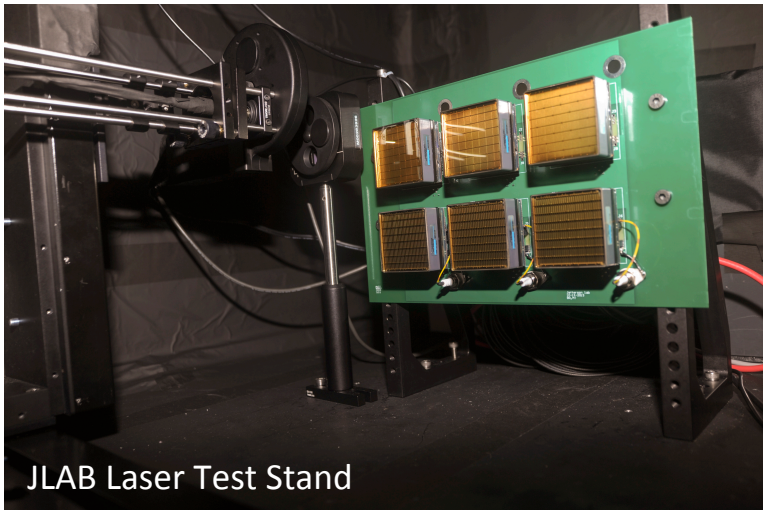
Single channel response, 1 microsecond/div

ADC: Collected Charge

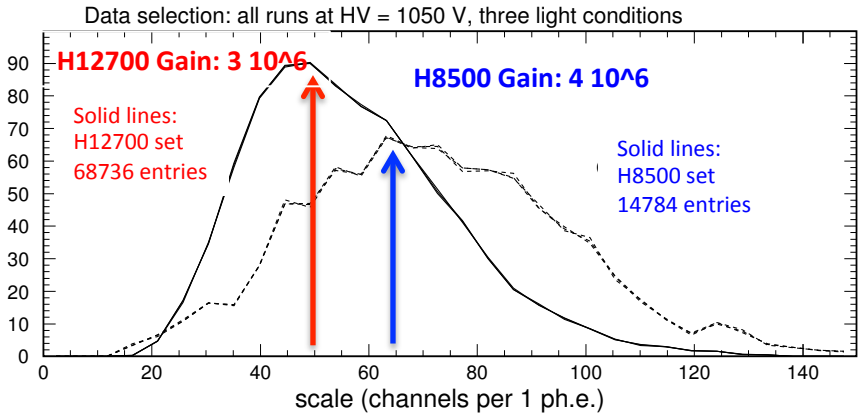
MAPMT model for gain, resolution, SPE efficiency accounting for cross--talk



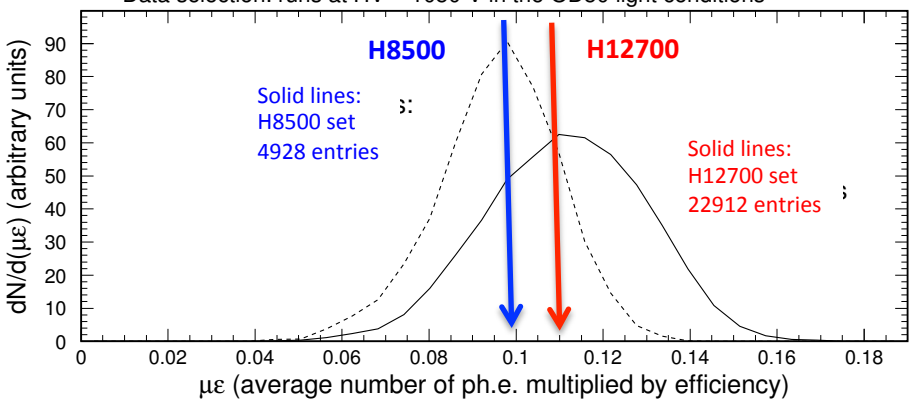
P. Degtyarenko, NIMA 872 (2017)



SPE signal proportional to the MAPMT gain

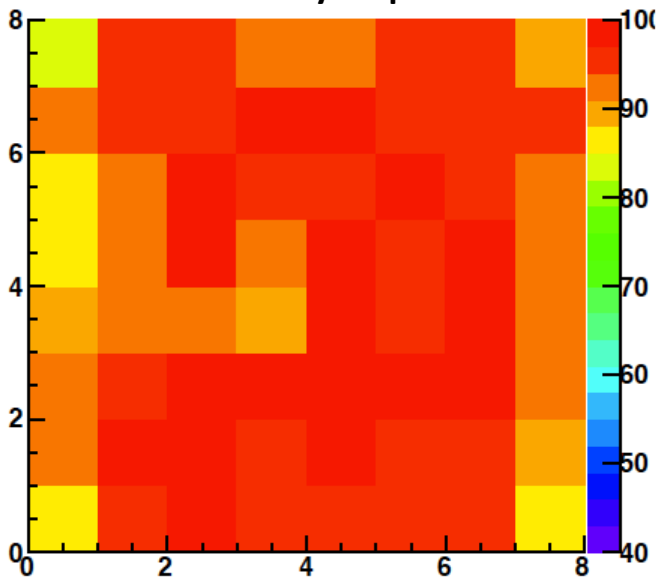


SPE relative efficiency: +20% for H12700

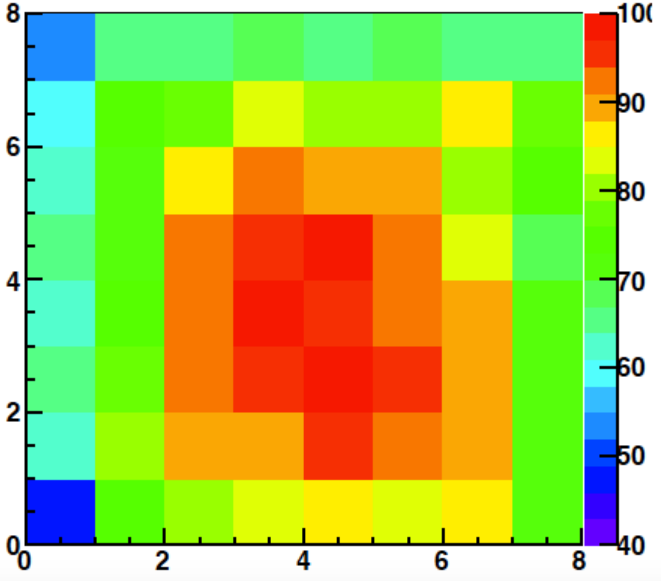


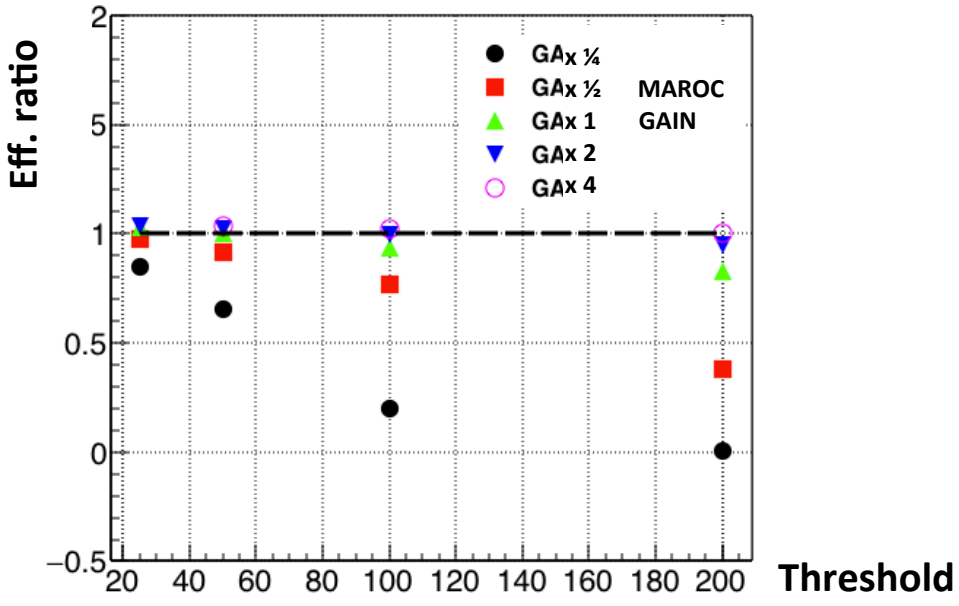
TDC: SPE Discrimination Calibration

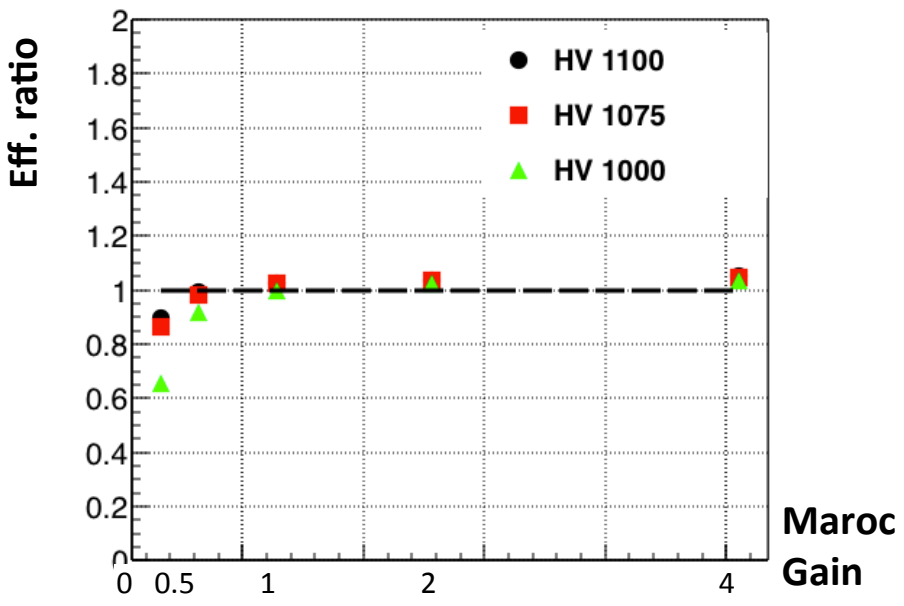
Relative efficiency map



Relative gain map

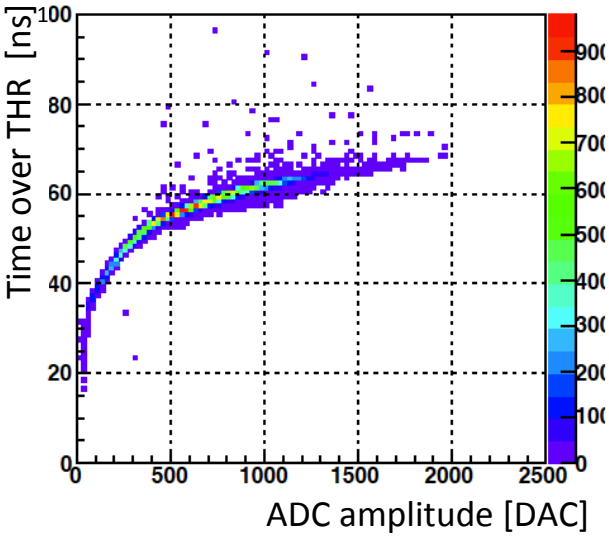




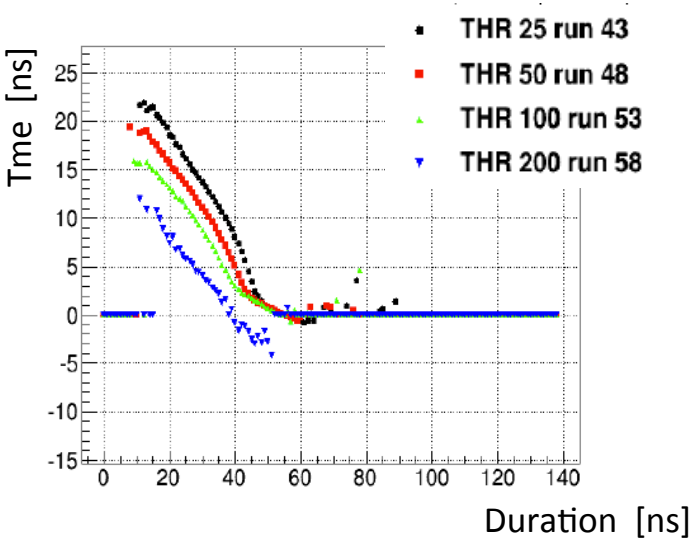


TDC: SPE Timing Calibration

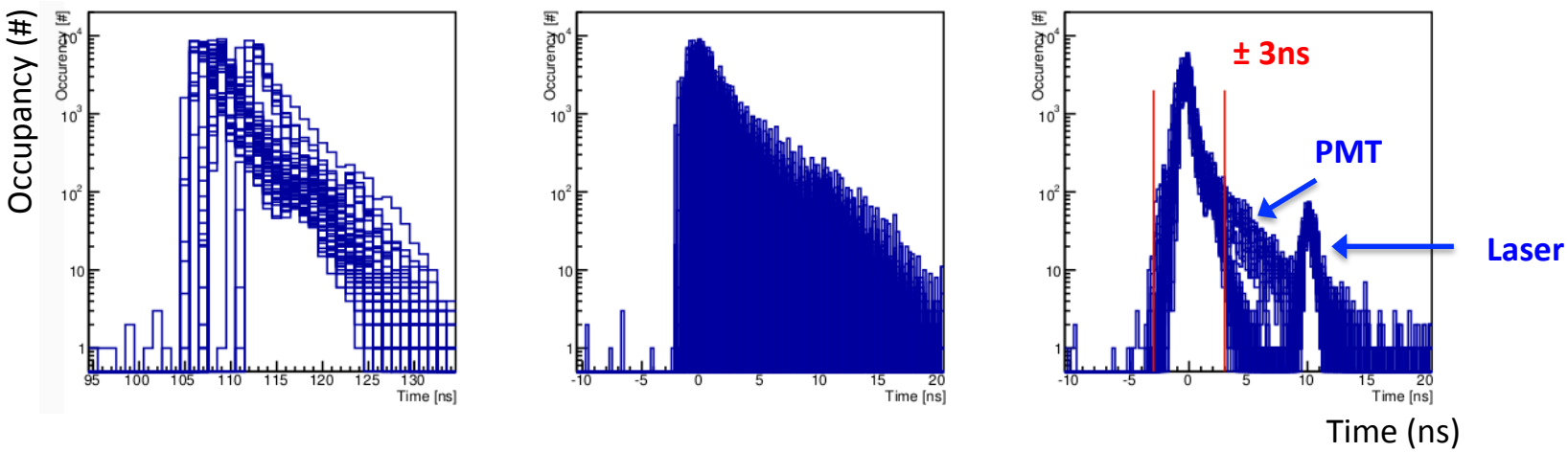
Time over threshold relates to charge



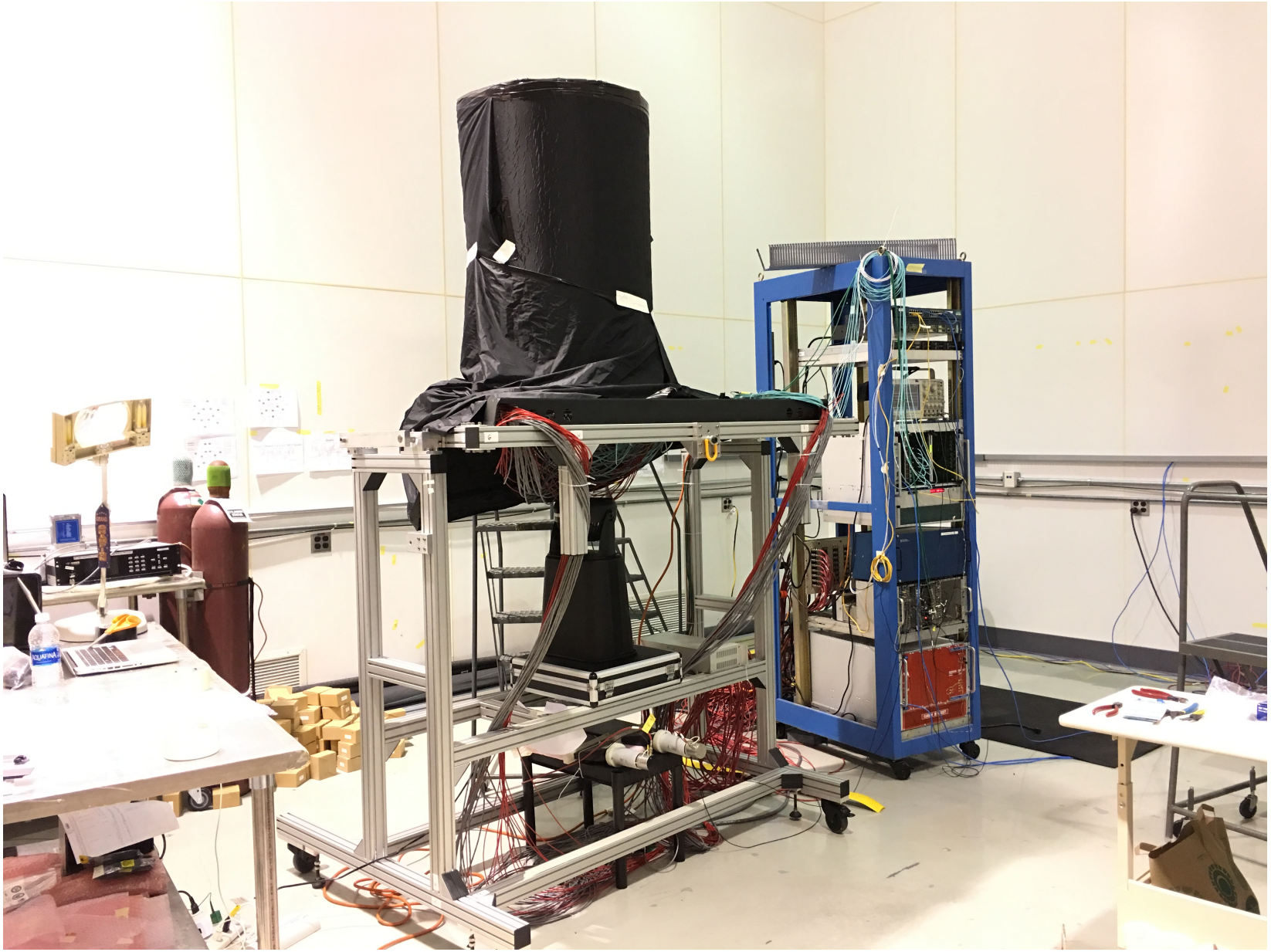
Typical time-walk with charge



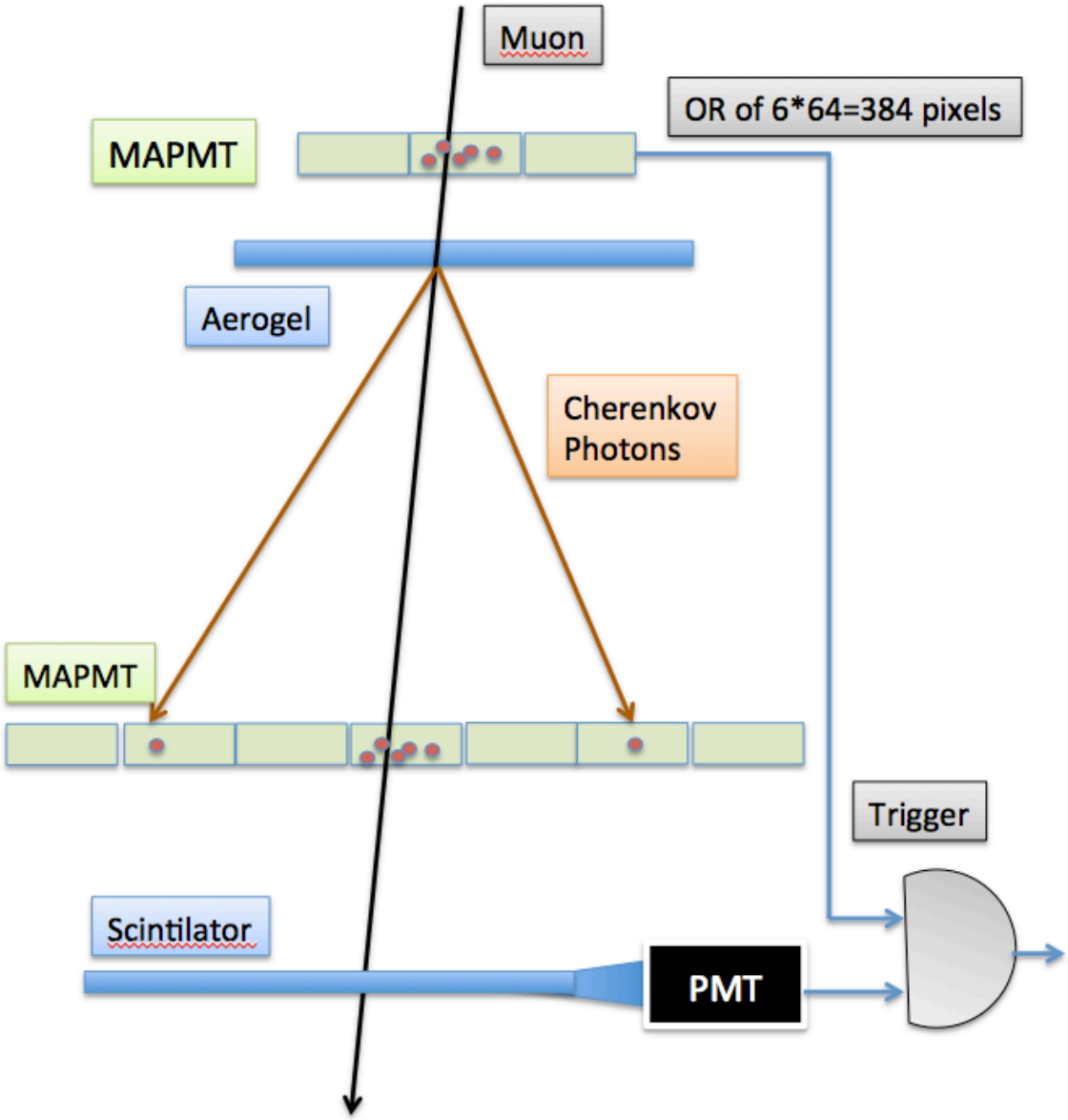
Channel by channel time calibration: **-offsets** **-walk**



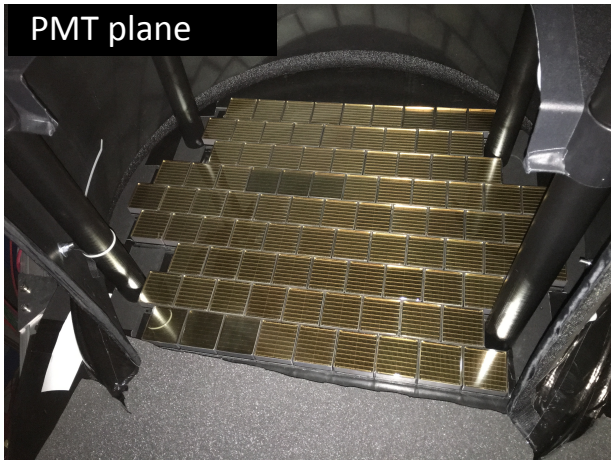
Cosmic Stand

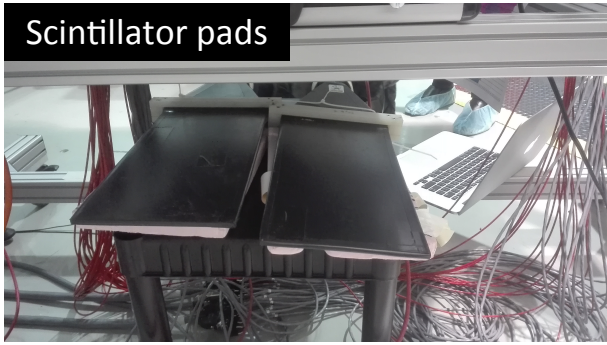


Cosmic Run


Muon
OR of 6*64=384 pixels
MAPMT
Aerogel
Cherenkov
Photons
MAPMT
Trigger
Scintilator
PMT


Trigger and tracking station


PMT plane


Scintillator pads

Power Supply Control

LV voltages

HV Voltages

HVRICH1 - Board #00

Controls

HVRICH1 Board #00

#	Description	Pw	Vmon	Imon	Status	Vset (V)	Iset (uA)
00	HVRICH1_LV_SPARE_Sl00_Ch00	ON	5.19 V	3.07 A	ON	5.200 V	4.0 A
01	HVRICH1_LV_SPARE_Sl00_Ch01	ON	5.20 V	3.10 A	ON	5.200 V	4.0 A
02	HVRICH1_LV_SPARE_Sl00_Ch02	ON	5.20 V	3.12 A	ON	5.200 V	4.0 A
03	HVRICH1_LV_SPARE_Sl00_Ch03	ON	5.20 V	3.13 A	ON	5.200 V	4.0 A
04	HVRICH1_LV_SPARE_Sl00_Ch04	ON	5.20 V	3.11 A	ON	5.200 V	4.0 A
05	HVRICH1_LV_SPARE_Sl00_Ch05	ON	5.20 V	3.10 A	ON	5.200 V	4.0 A
06	HVRICH1_LV_SPARE_Sl00_Ch06	ON	5.20 V	3.12 A	ON	5.200 V	4.0 A
07	HVRICH1_LV_SPARE_Sl00_Ch07	ON	5.20 V	3.10 A	ON	5.200 V	4.0 A

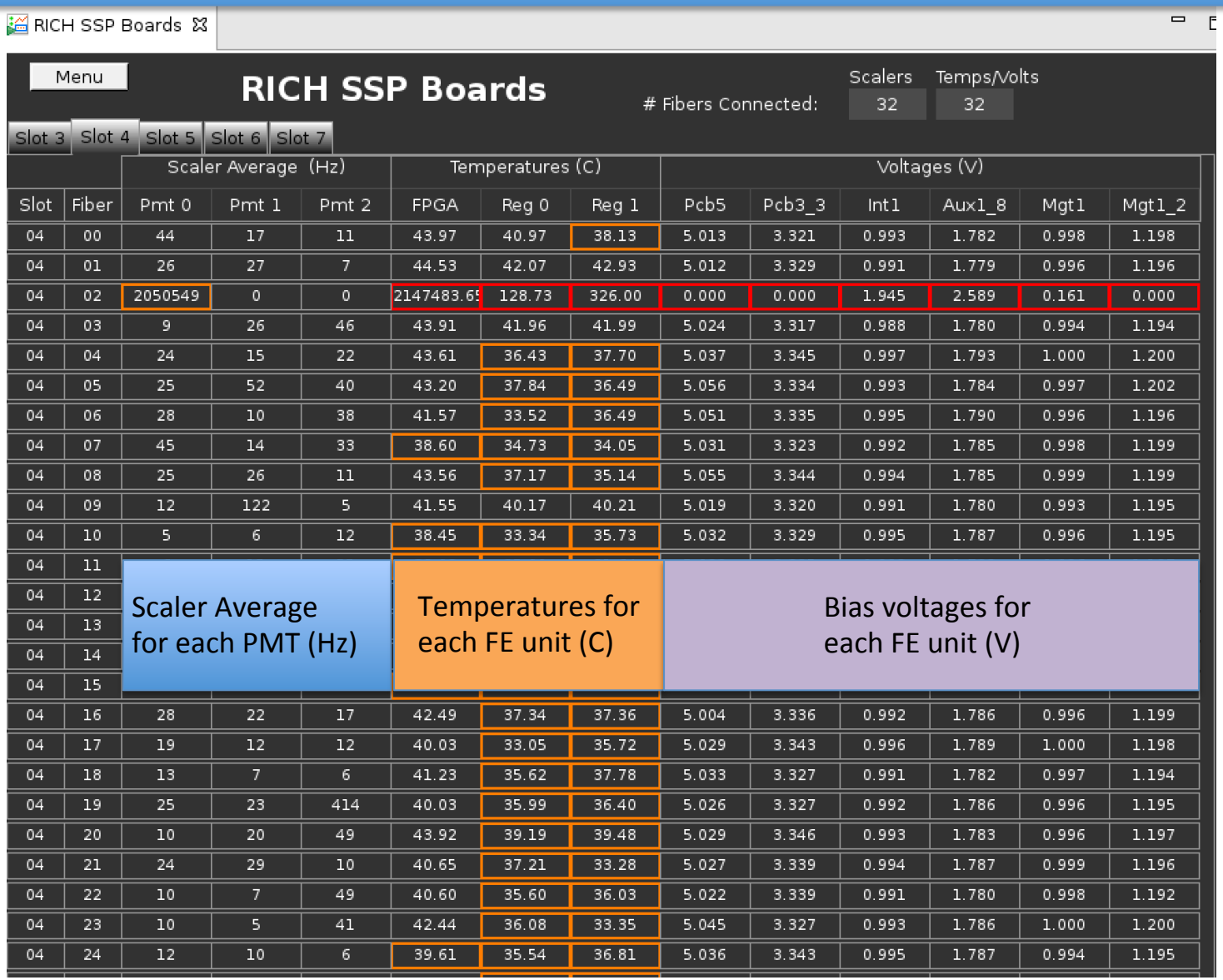
HVRICH1 - Board #11

Controls

HVRICH1 Board #11

#	Description	Pw	Vmon	Imon	Status	Vset (V)	Iset (uA)
00	HVRICH1_HV_SPARE_Sl11_Ch00	OFF	0.00 V	0.00 uA	OFF	0.000 V	100.0 uA
01	HVRICH1_HV_SPARE_Sl11_Ch01	OFF	0.00 V	0.00 uA	OFF	0.000 V	155.0 uA
02	HVRICH1_HV_SPARE_Sl11_Ch02	OFF	0.00 V	0.00 uA	OFF	0.000 V	155.0 uA
03	HVRICH1_HV_SPARE_Sl11_Ch03	OFF	0.00 V	0.00 uA	OFF	0.000 V	155.0 uA
04	HVRICH1_HV_SPARE_Sl11_Ch04	OFF	0.00 V	0.00 uA	OFF	0.000 V	155.0 uA
05	HVRICH1_HV_SPARE_Sl11_Ch05	OFF	0.00 V	0.00 uA	OFF	0.000 V	155.0 uA
06	HVRICH1_HV_SPARE_Sl11_Ch06	OFF	0.00 V	0.00 uA	OFF	0.000 V	155.0 uA
07	HVRICH1_HV_SPARE_Sl11_Ch07	OFF	0.00 V	0.00 uA	OFF	0.000 V	155.0 uA
08	HVRICH1_HV_SPARE_Sl11_Ch08	OFF	0.00 V	0.00 uA	OFF	0.000 V	155.0 uA
09	HVRICH1_HV_SPARE_Sl11_Ch09	OFF	0.00 V	0.00 uA	OFF	0.000 V	155.0 uA
10	HVRICH1_HV_SPARE_Sl11_Ch10	OFF	0.00 V	0.00 uA	OFF	0.000 V	155.0 uA
11	HVRICH1_HV_SPARE_Sl11_Ch11	OFF	0.00 V	0.00 uA	OFF	0.000 V	155.0 uA
12	HVRICH1_HV_SPARE_Sl11_Ch12	OFF	0.00 V	0.00 uA	OFF	0.000 V	155.0 uA
13	HVRICH1_HV_SPARE_Sl11_Ch13	OFF	0.00 V	0.00 uA	OFF	0.000 V	155.0 uA
14	HVRICH1_HV_SPARE_Sl11_Ch14	OFF	0.00 V	0.00 uA	OFF	0.000 V	155.0 uA
15	HVRICH1_HV_SPARE_Sl11_Ch15	OFF	0.00 V	0.00 uA	OFF	0.000 V	155.0 uA
16	HVRICH1_HV_SPARE_Sl11_Ch16	ON	1300.02 V	698.49 uA	ON	1300.000 V	1550.0 uA
17	HVRICH1_HV_SPARE_Sl11_Ch17	ON	1299.98 V	698.47 uA	ON	1300.000 V	1550.0 uA
18	HVRICH1_HV_SPARE_Sl11_Ch18	OFF	0.00 V	0.00 uA	OFF	0.000 V	155.0 uA
19	HVRICH1_HV_SPARE_Sl11_Ch19	OFF	0.00 V	0.00 uA	OFF	0.000 V	155.0 uA
20	HVRICH1_HV_SPARE_Sl11_Ch20	OFF	0.00 V	0.00 uA	OFF	0.000 V	155.0 uA
21	HVRICH1_HV_SPARE_Sl11_Ch21	OFF	0.00 V	0.00 uA	OFF	0.000 V	155.0 uA
22	HVRICH1_HV_SPARE_Sl11_Ch22	OFF	0.00 V	0.00 uA	OFF	0.000 V	155.0 uA
23	HVRICH1_HV_SPARE_Sl11_Ch23	OFF	0.00 V	0.00 uA	OFF	0.000 V	155.0 uA
24	HVRICH1_HV_SPARE_Sl11_Ch24	OFF	0.00 V	0.00 uA	OFF	0.000 V	155.0 uA
25	HVRICH1_HV_SPARE_Sl11_Ch25	OFF	0.00 V	0.00 uA	OFF	0.000 V	155.0 uA
26	HVRICH1_HV_SPARE_Sl11_Ch26	OFF	0.00 V	0.00 uA	OFF	0.000 V	155.0 uA
27	HVRICH1_HV_SPARE_Sl11_Ch27	OFF	0.00 V	0.00 uA	OFF	0.000 V	155.0 uA
28	HVRICH1_HV_SPARE_Sl11_Ch28	OFF	0.00 V	0.00 uA	OFF	0.000 V	155.0 uA
29	HVRICH1_HV_SPARE_Sl11_Ch29	OFF	0.00 V	0.00 uA	OFF	0.000 V	155.0 uA
30	HVRICH1_HV_SPARE_Sl11_Ch30	OFF	0.00 V	0.00 uA	OFF	0.000 V	155.0 uA
31	HVRICH1_HV_SPARE_Sl11_Ch31	OFF	0.00 V	0.00 uA	OFF	0.000 V	155.0 uA

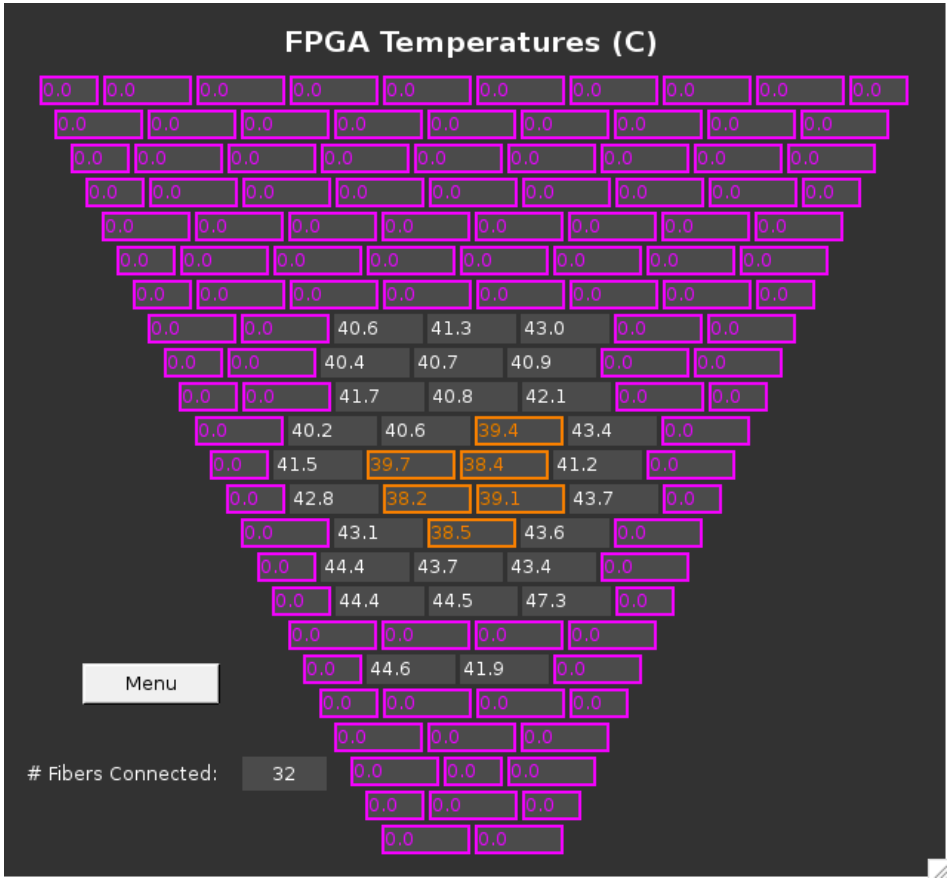
Slow Control

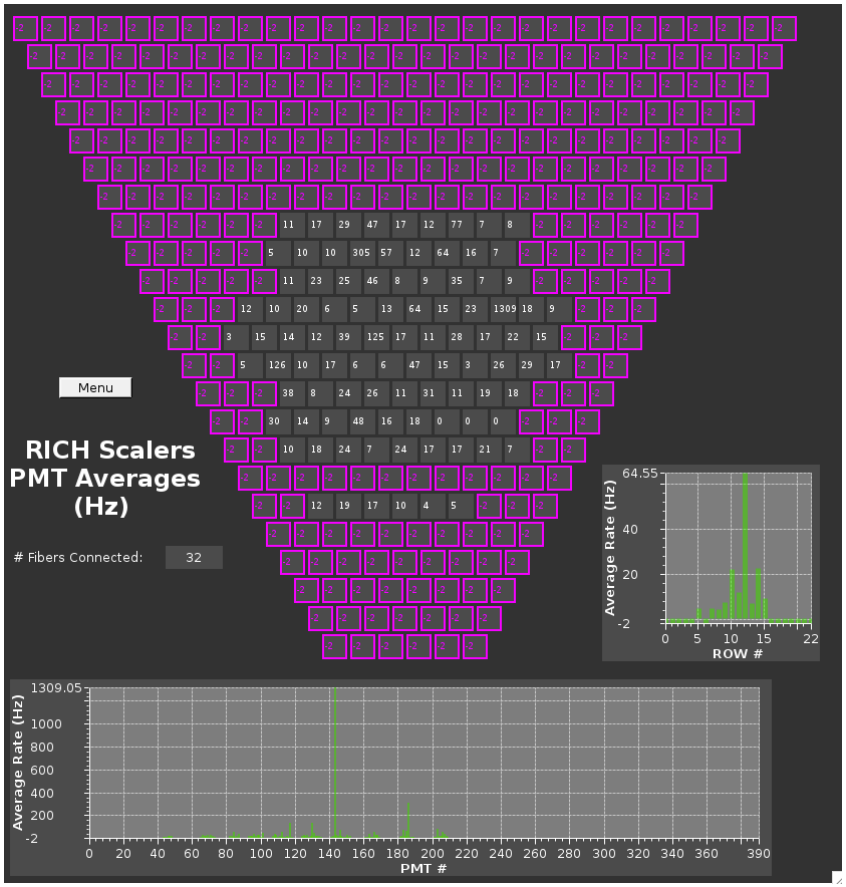


Option: add some of these values to the interlock of the system

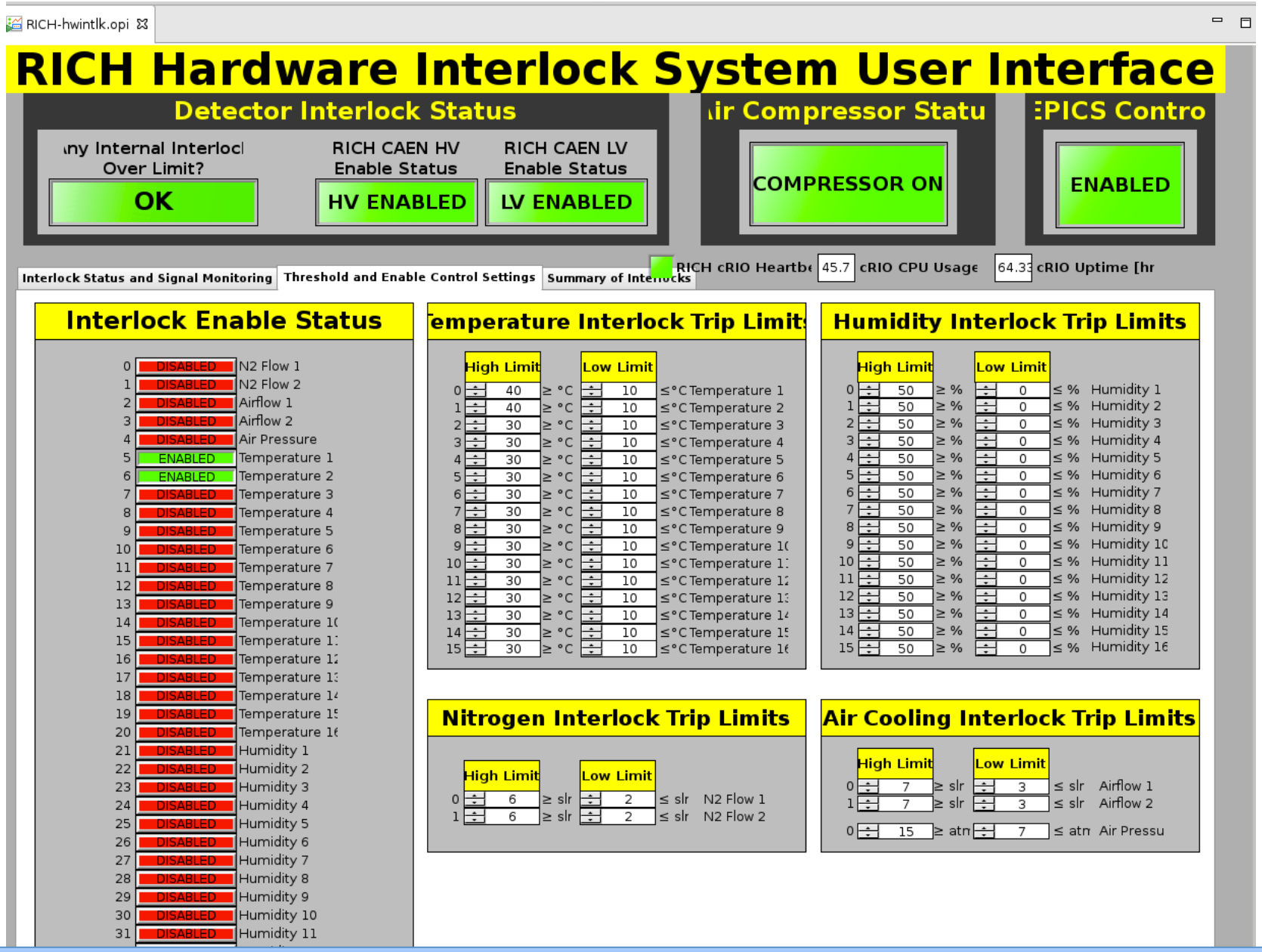
RICH Online Display

Temperatures and Scalers monitored with warning signs



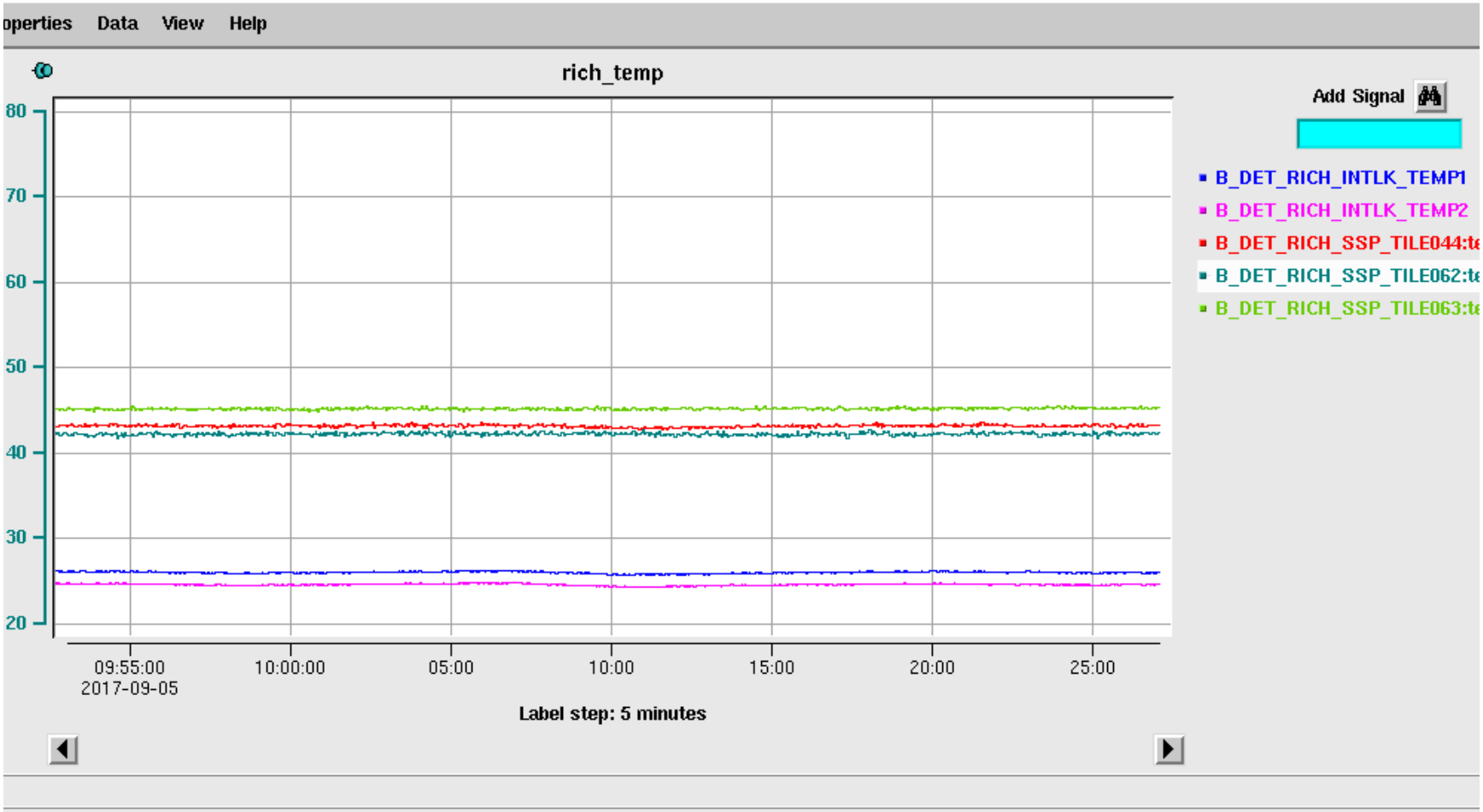


Hardware Interlock



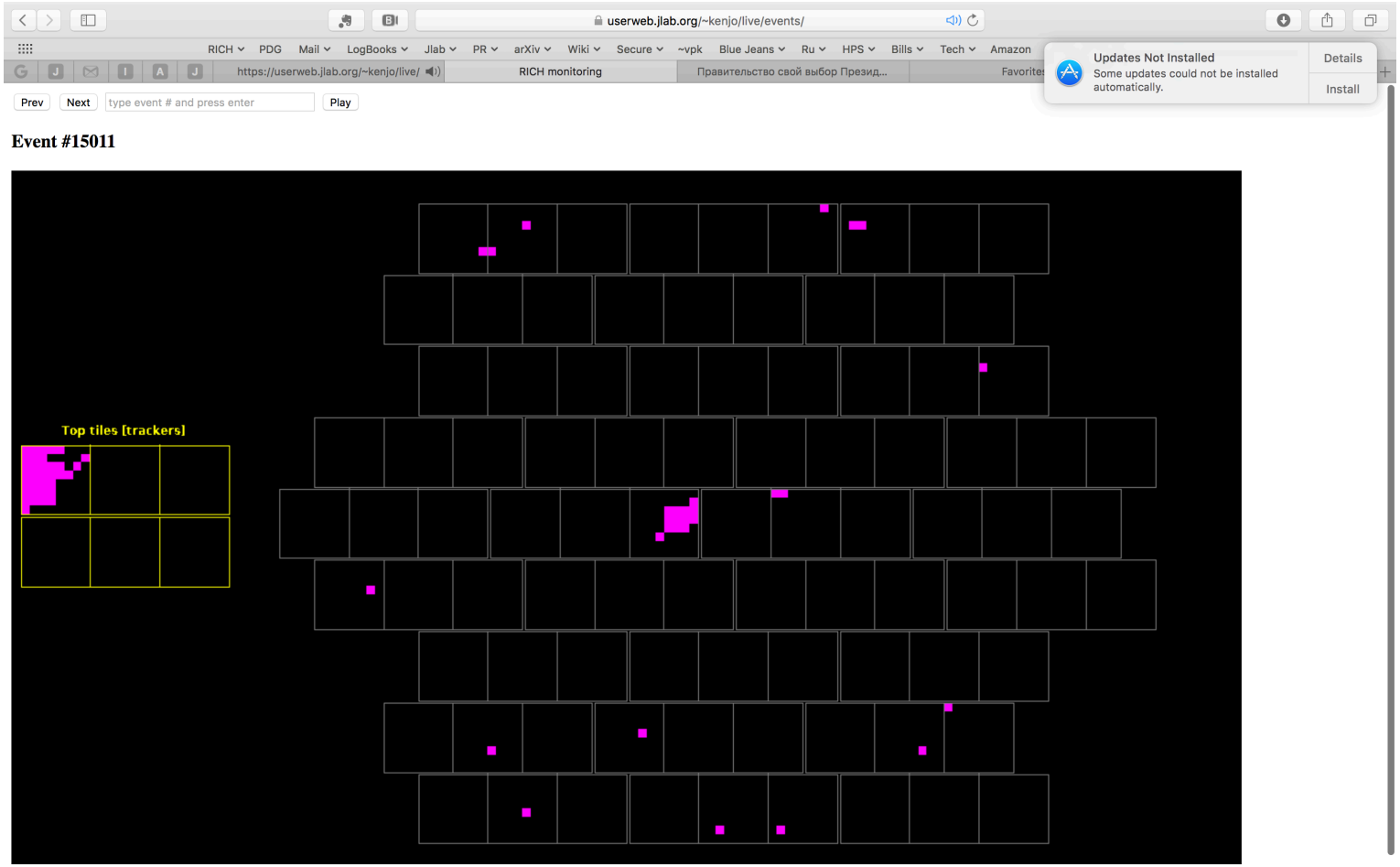
Mya Strip Charts

Cosmic stand worked smoothly during first run (3 days)

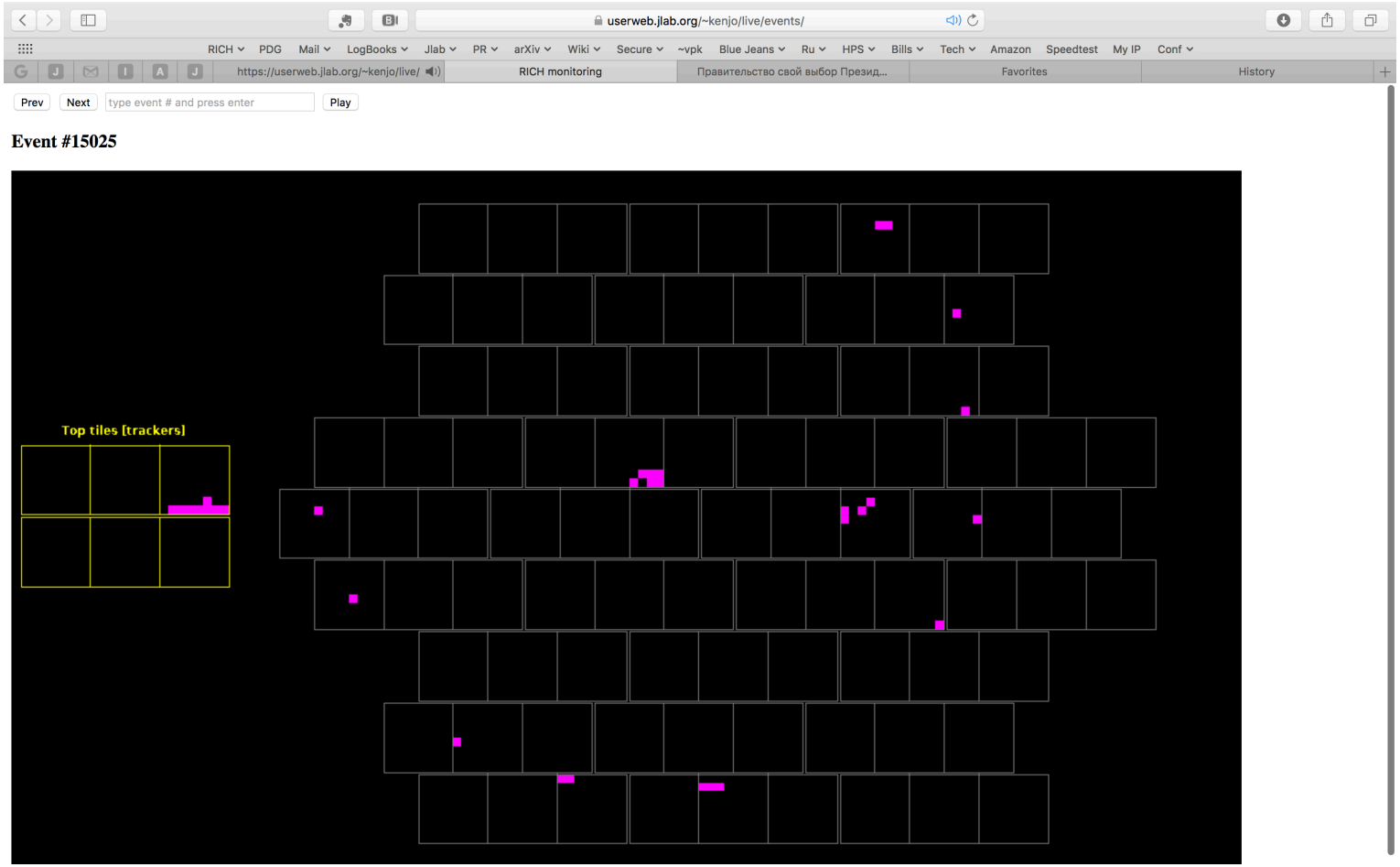


Online Event Display

No background suppression: 1 microsec readout window

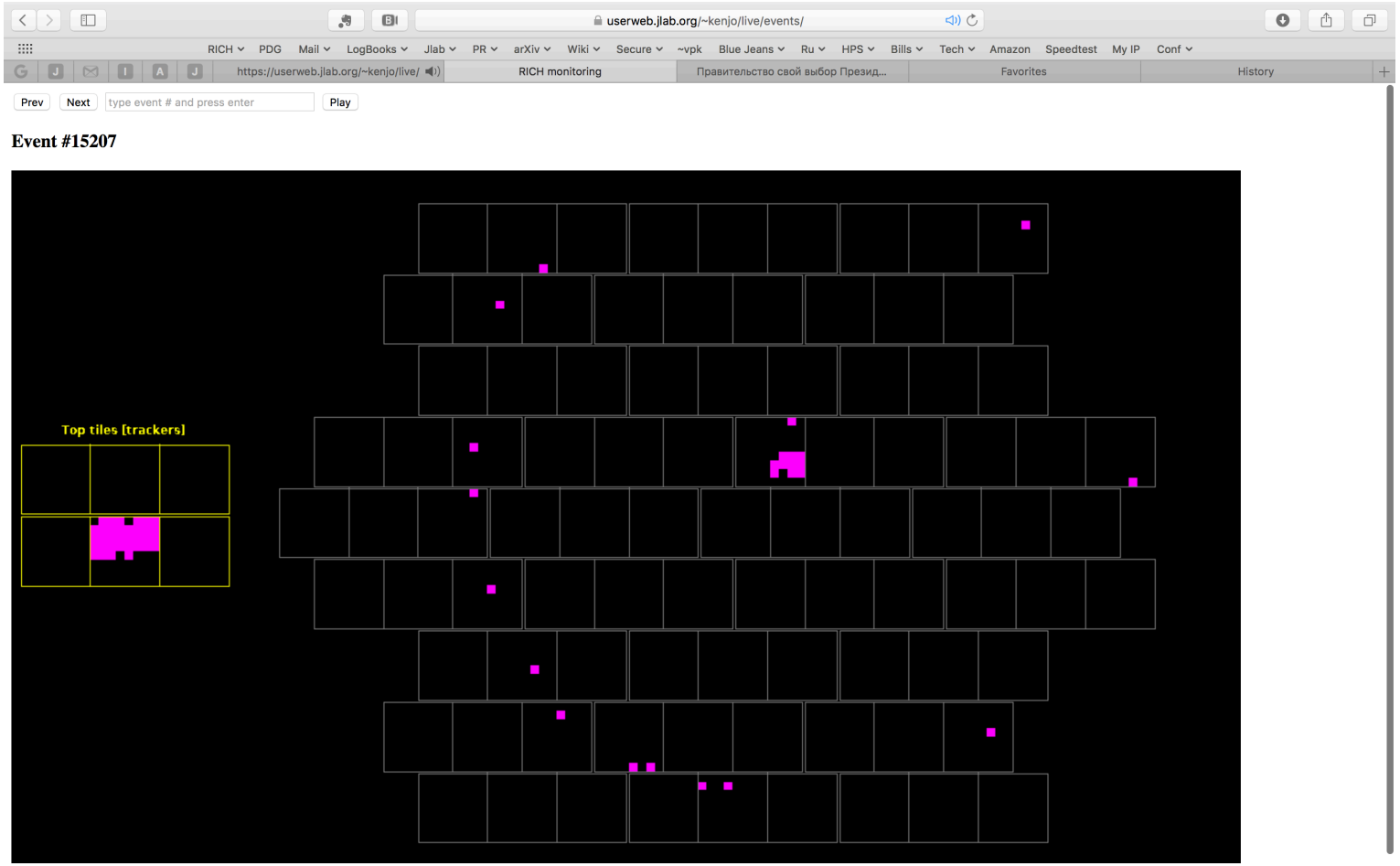


Online Event Display



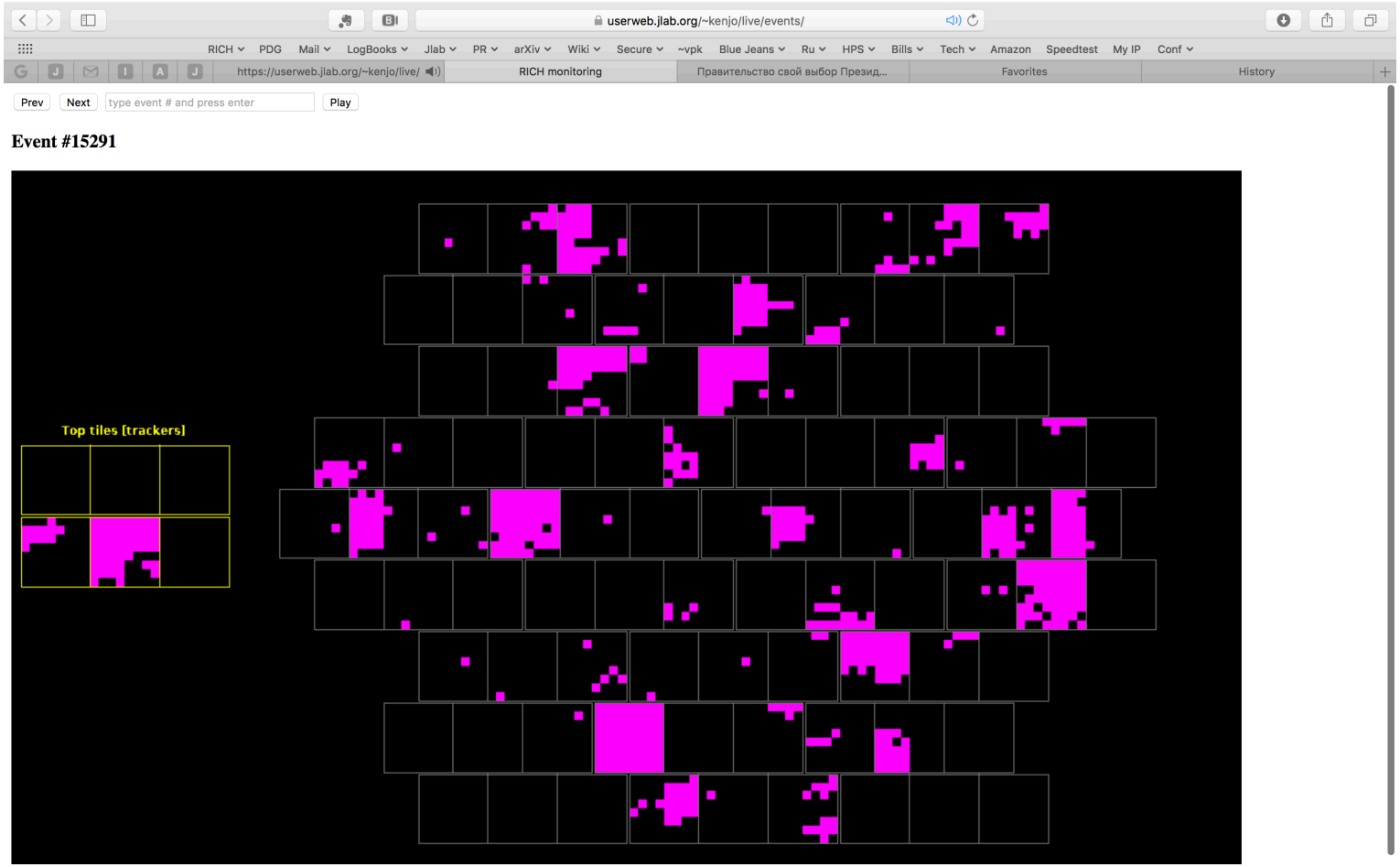
Online Event Display

Online Event Display



Online Event Display

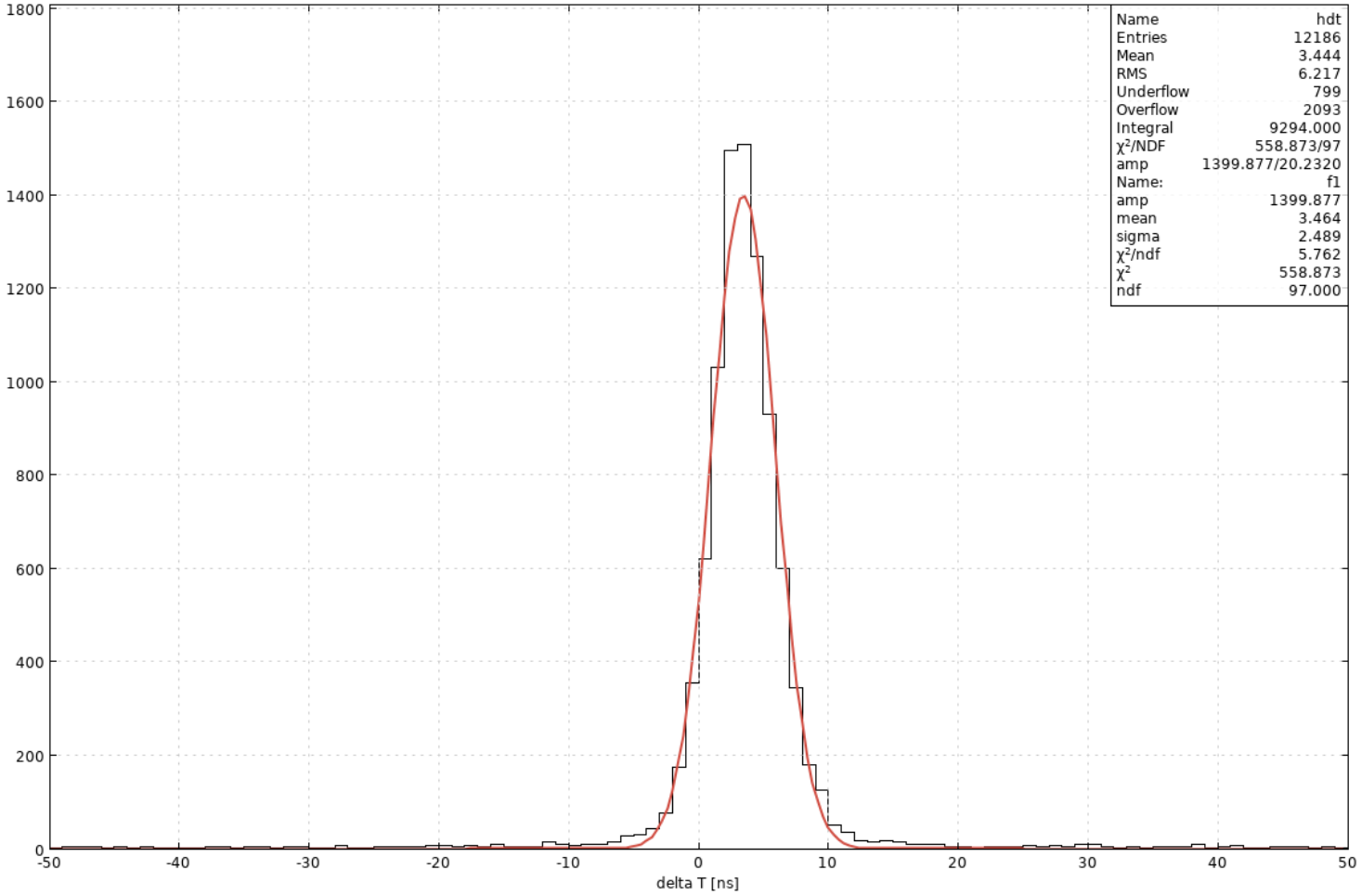
Online Event Display



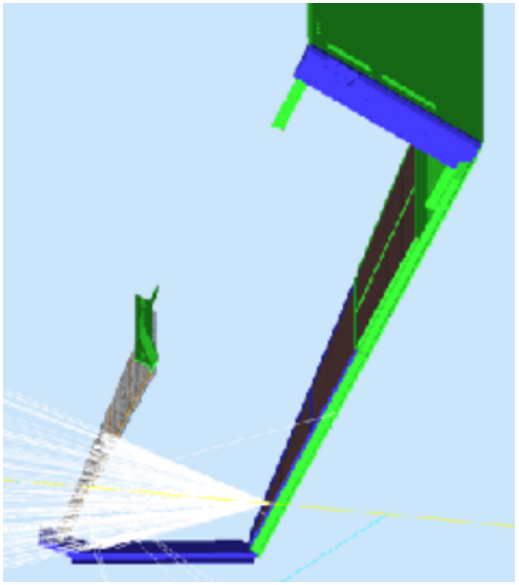
Hit Time Distribution

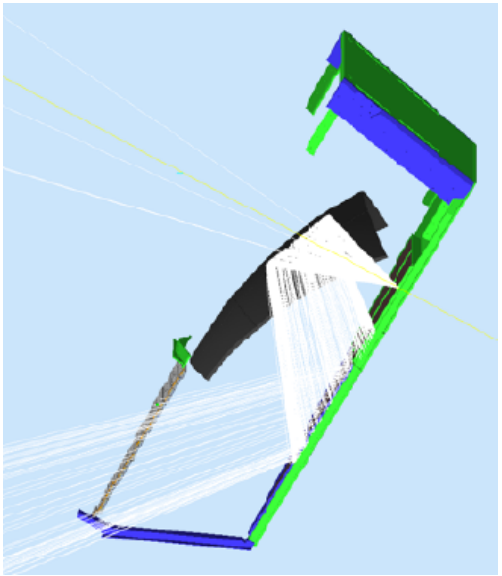
ΔT (BOTTOM plane − TOP Tracking Unit) = 3.4 ns

σ_T without any correction = 2.4 ns



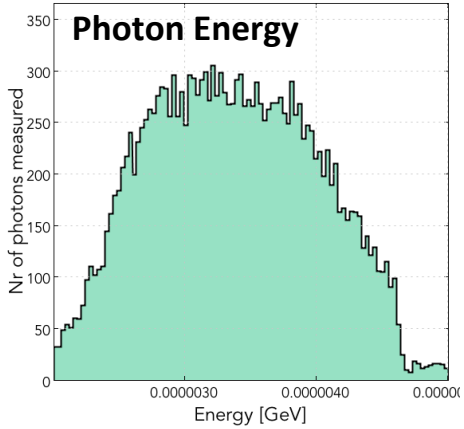
RICH Software





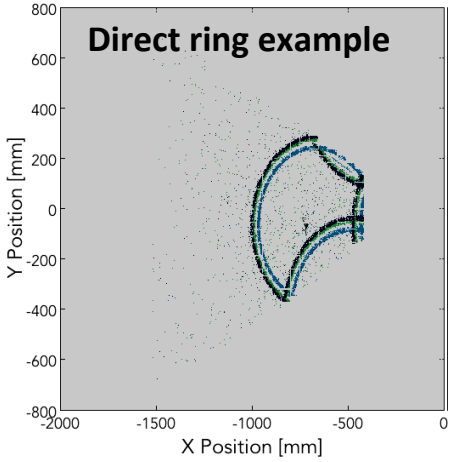
RICH geometry is implemented in the software mostly from CAD through mesh files
- a detailed, consistent and updated description of the detector can be obtained
- simulation and reconstruction shared the same database

Digitization of the MAPMT response:
- calculate the pixel ID
- interface to CCDB
- apply efficiency
- simulated ADC and TDC spectra



Event reconstruction started
- match with DC information in coat-java
- photon tracing algorithm
  (tested with prototype and cosmic runs)
- event display

Strong crew: Matteo, Ilaria, Marco, Giovanni,
Justin, Morgen, Elise, Aram, Andrey, …



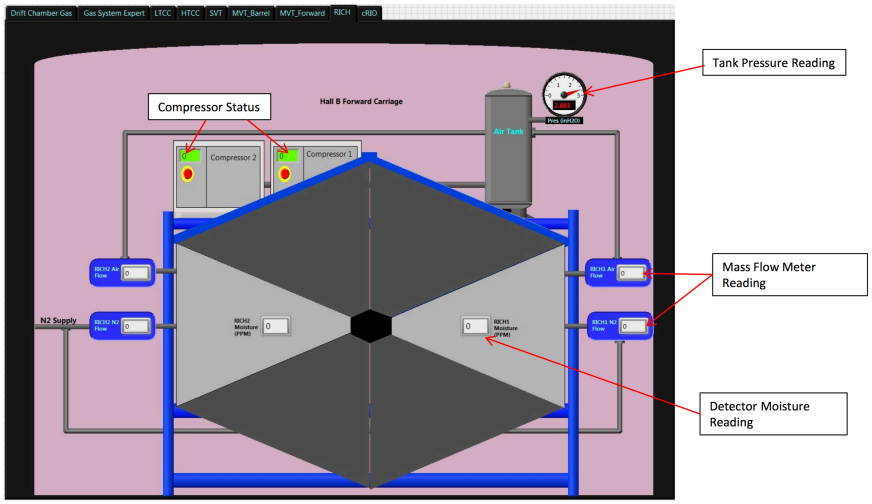
Photon Detector

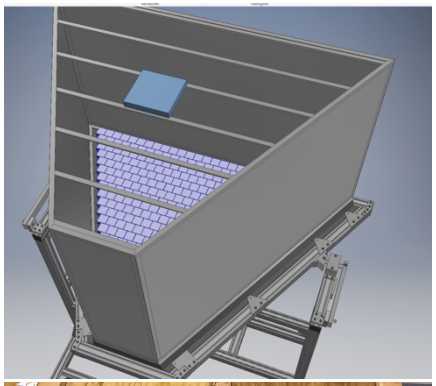
Scale the system up:

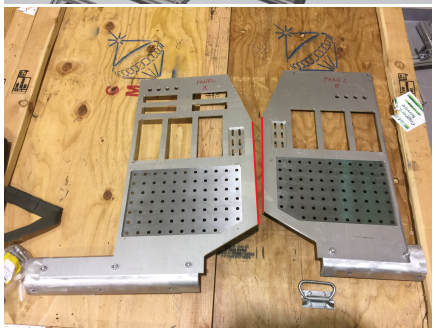
- ✓ Argonne cosmic box
- ✓ Cabling with patch panels
- ✓ Gas system being installed in EEL-124 (DSG)

  Operative test foreseen in October 17
  with fully instrumented electronic panel

Gas System GUI







Air Tank and Gas Line Controls

Clean Air Compressor

Assembling Schedule

activity	WEEK											
	aug 28	sep 4	sep 11	sep 18	sep 25	oct 2	oct 9	oct 16	oct 23	oct 30	nov 6	nov 13
EPanel tests with 32 boards												
Spherical mirror resurfacing and coating												
Aerogel production and delivery												
3D print of the pushers of the 2 cm layer												
Purchase of the wire and spacers												
Construction of the brackets for the load test												
Construction of the brackets for the strong-back												
Construction of the mounts for the trolley												
Setup of the gas slow control and interlocks												
3D print of the cooling distributor (left)												
Setup of the N2 dewar												
3D print of the N2 manyfold												
Cosmics box at JLab												
Production of the patch panels												
Assembly of the frontal panel tools												
Test of the lateral mirror installation												
Test of the prototype mirror B1 installation												
Production of fake tiles												
Setup of the dry area with the Fe cabinet												
Assembly test of the frontal panels												
Preliminary test of the cooling distributor												

September:

Photon Detector Assembling

RICH Components Preparation

activity	WEEK											
	aug 28	sep 4	sep 11	sep 18	sep 25	oct 2	oct 9	oct 16	oct 23	oct 30	nov 6	nov 13
3D print of the cooling distributor (right)												
Drilling holes on the RICH for the N2 distributors												
Fix of the main leaks on the RICH												
Full EPanel assembly												
Test of the spherical mirrors (surface, reflectivity)												
Drilling wire holes on the top frontal panel												
Assembly test of the 3 cm aerogel layers												
Assembly test of the patch panels												
Assembly of the cosmics box on the EPanel												
Stiffening tool load test												
Full EPanel test with cosmics												
Cooling system on the full EPanel												
Assembly test of the brackets of the strong-back												
Cut of the frontal pillar from the trolley												
Assembly test of the mounts on the trolley												
Cleanup of the clean room												
Installation of the spherical mirrors												
Test of the nitrogen system on the cosmics box												
Setup of the N2 system for the RICH transportation												
Installation of the lateral mirrors												
Services in Hall B												

October:

RICH Component Assembling

Photon Detector Commissioning

Steady Cosmic Run

Assembling Schedule

activity	WEEK											
	aug 28	sep 4	sep 11	sep 18	sep 25	oct 2	oct 9	oct 16	oct 23	oct 30	nov 6	nov 13
Installation of the exit panel												
Installation of the stiffening tool												
RICH in vertical position												
Alignment of the spherical mirrors												
Alignment of the lateral mirrors												
Installation of the bottom mirror												
Survey of the RICH												
Installation of the EPanel												
Installation of the patch panels on the RICH												
Installation of the frontal panels												
Test of the N2 system on the RICH												
Light-tightness test												
De-installation of the frontal panels												
Final assembly of the 3 cm aerogel layer												
Final assembly of the 2 cm aerogel layer												
Installation of the frontal panels with the aerogel												
Transportation of the RICH in Hall B												
Installation in CLAS12												

November:

Final Assembling

Validation

Installation

Week of 30 October: RICH Services in the Hall

Week of 13th November: RICH in the Hall