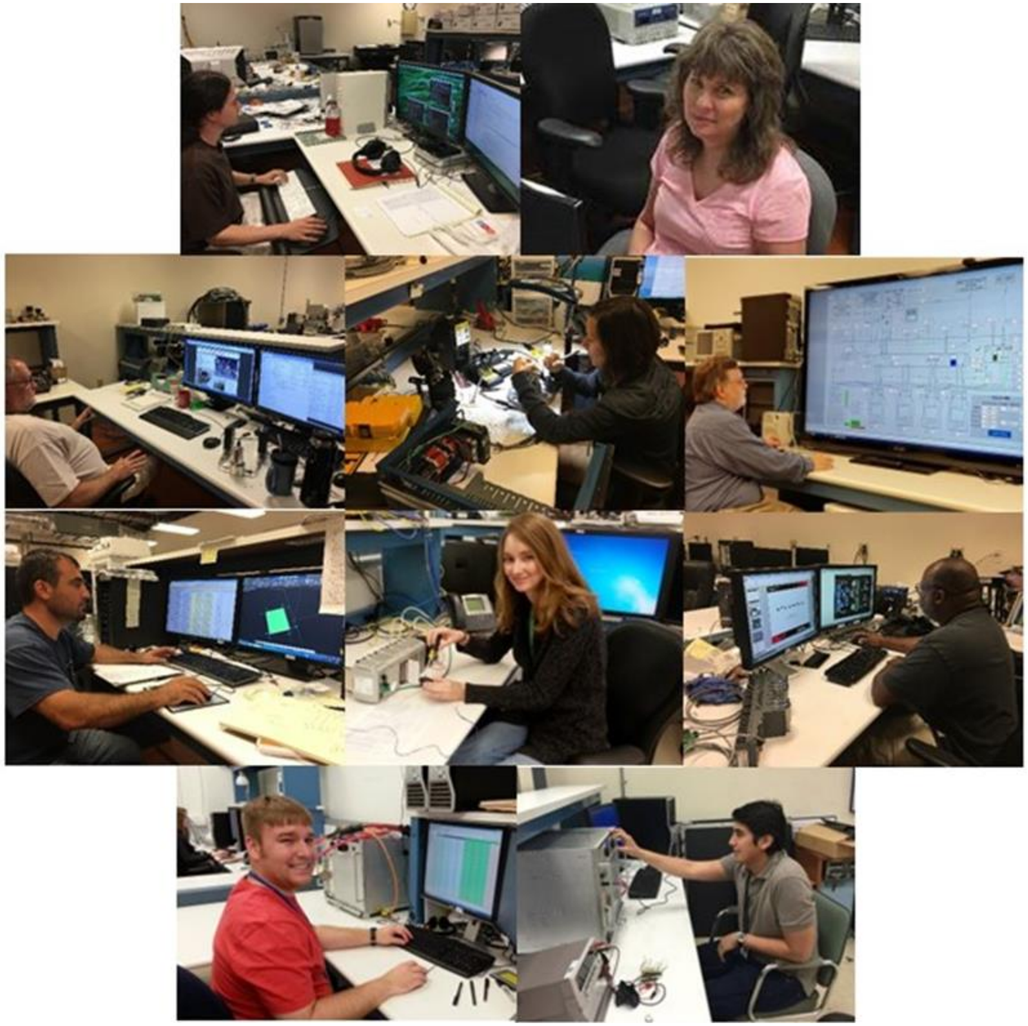
RICH Status Report

Tyler Lemon

Detector Support Group

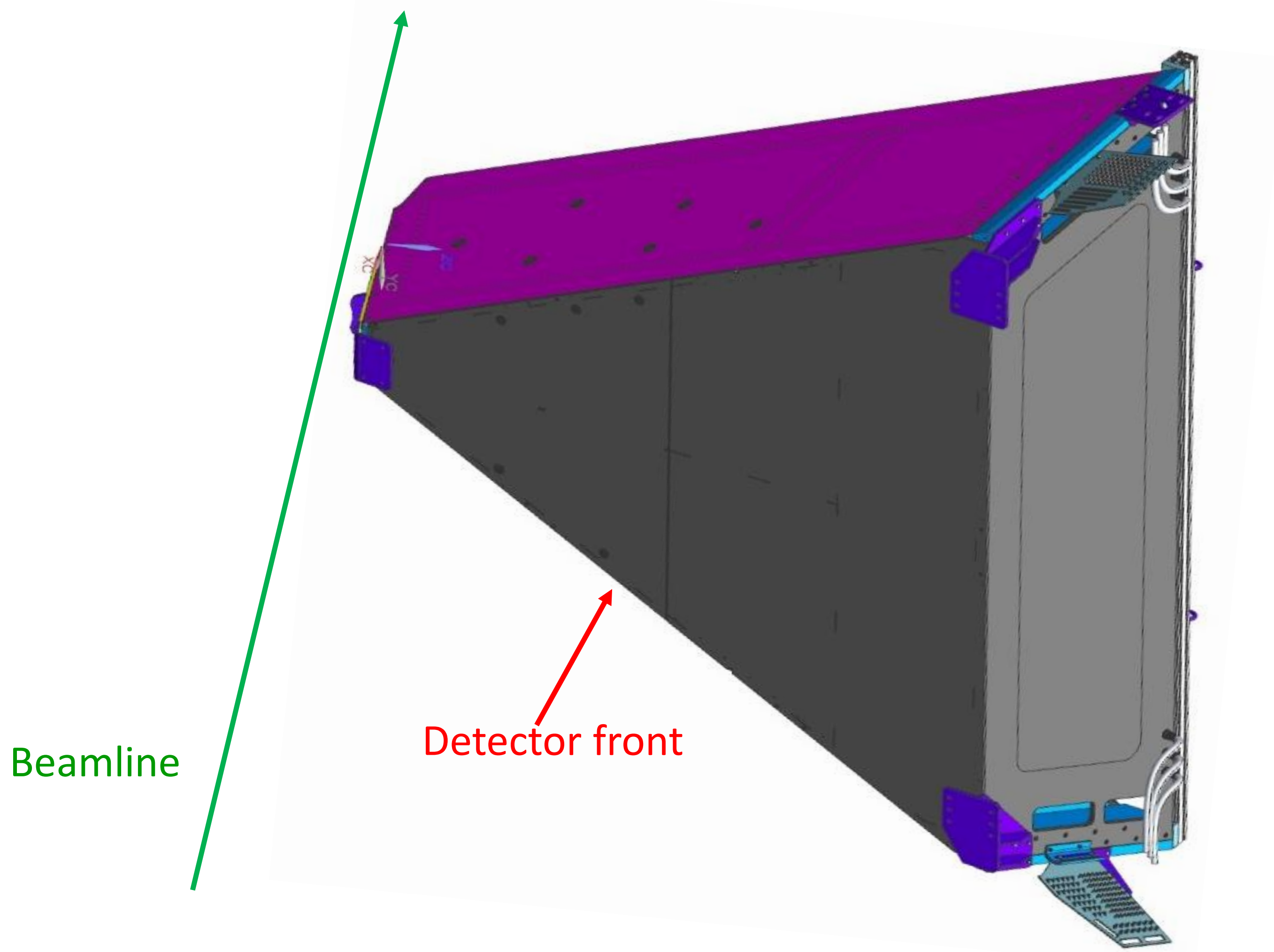
DSG Staff



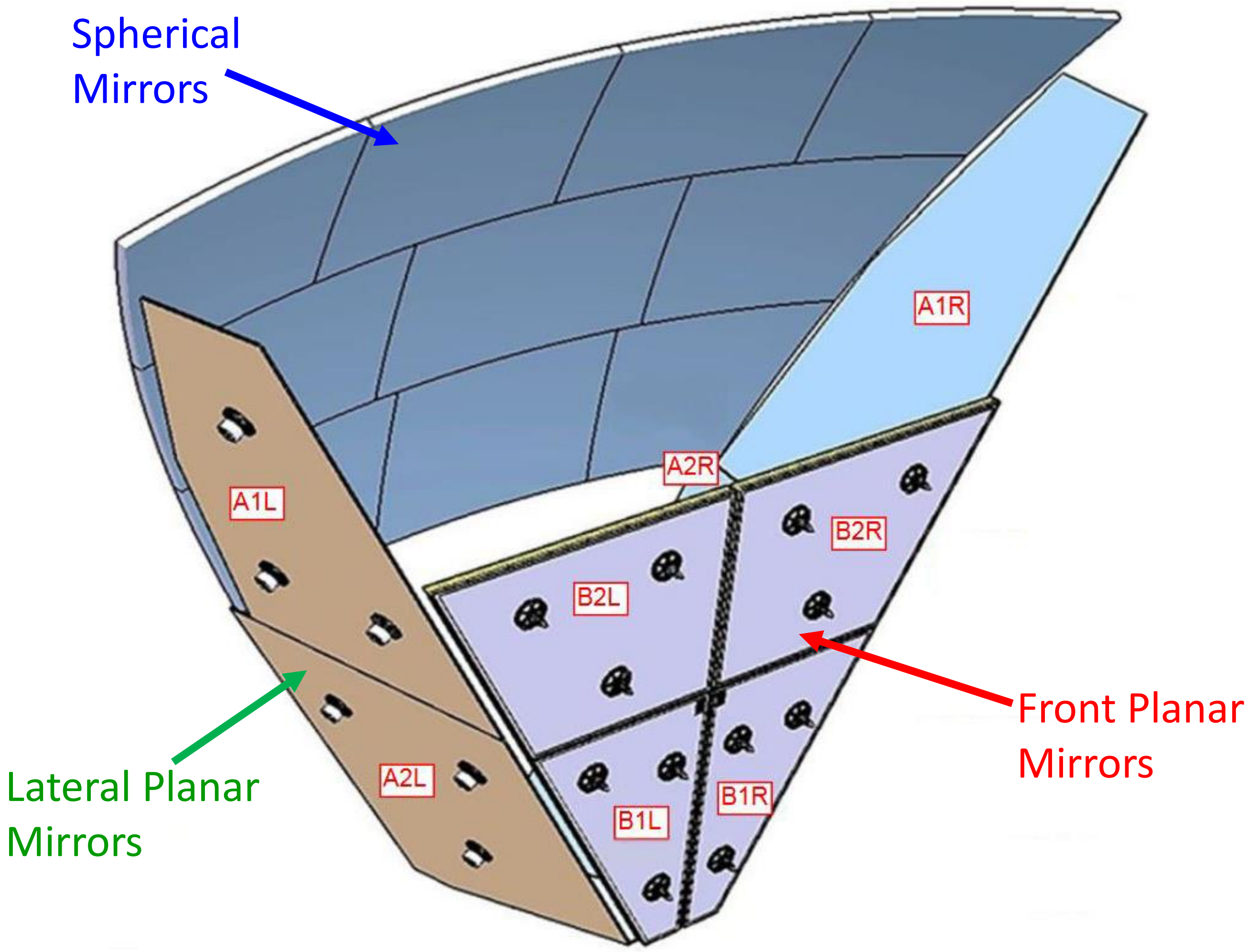
Ring-Imaging Cherenkov Detector

- Contents:
  - Mirrors
  - Aerogel
  - Electronics
  - Interlocks
  - Gas System
  - Assembly structure and detector frame

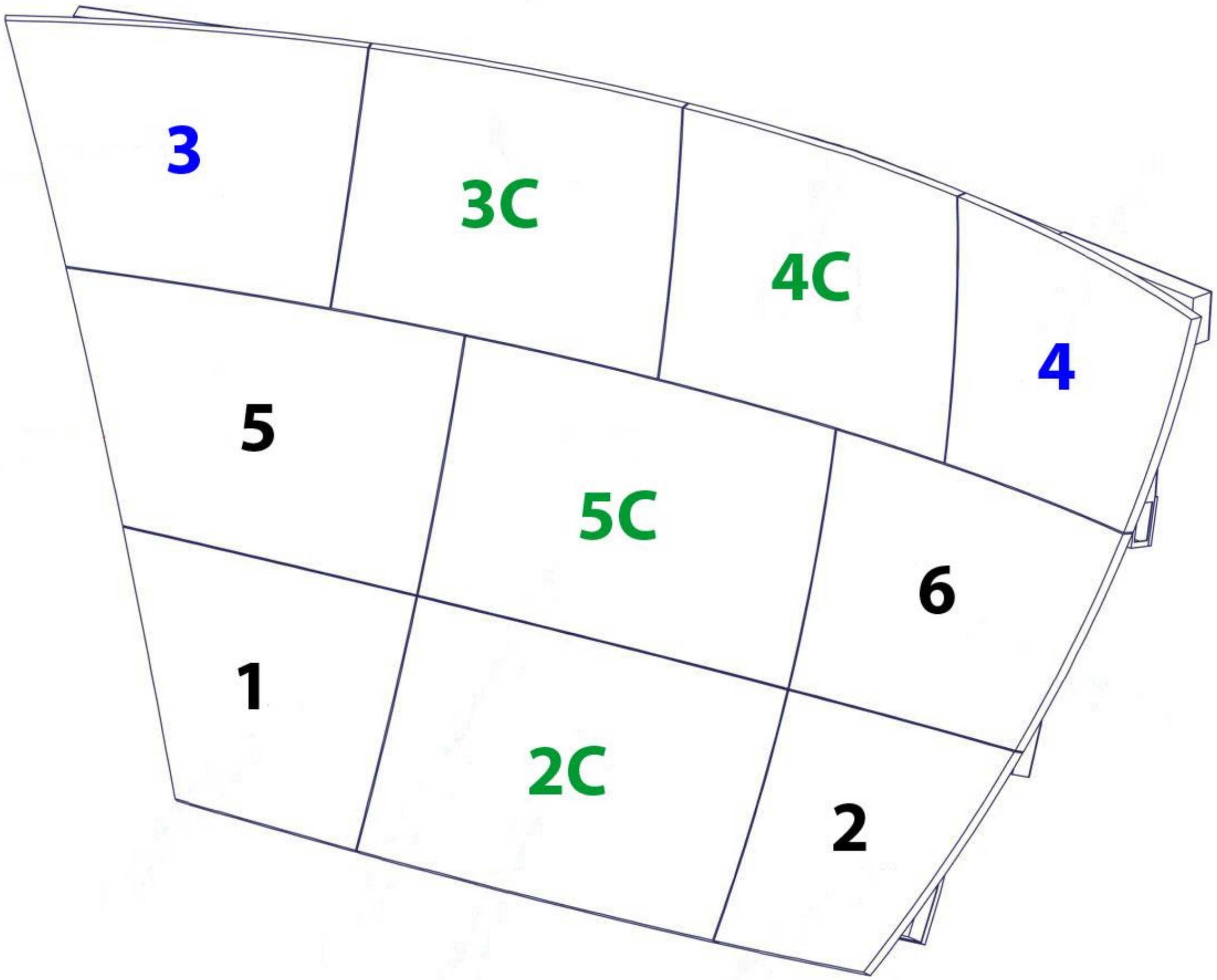
Model of Assembled RICH



Planar Mirrors



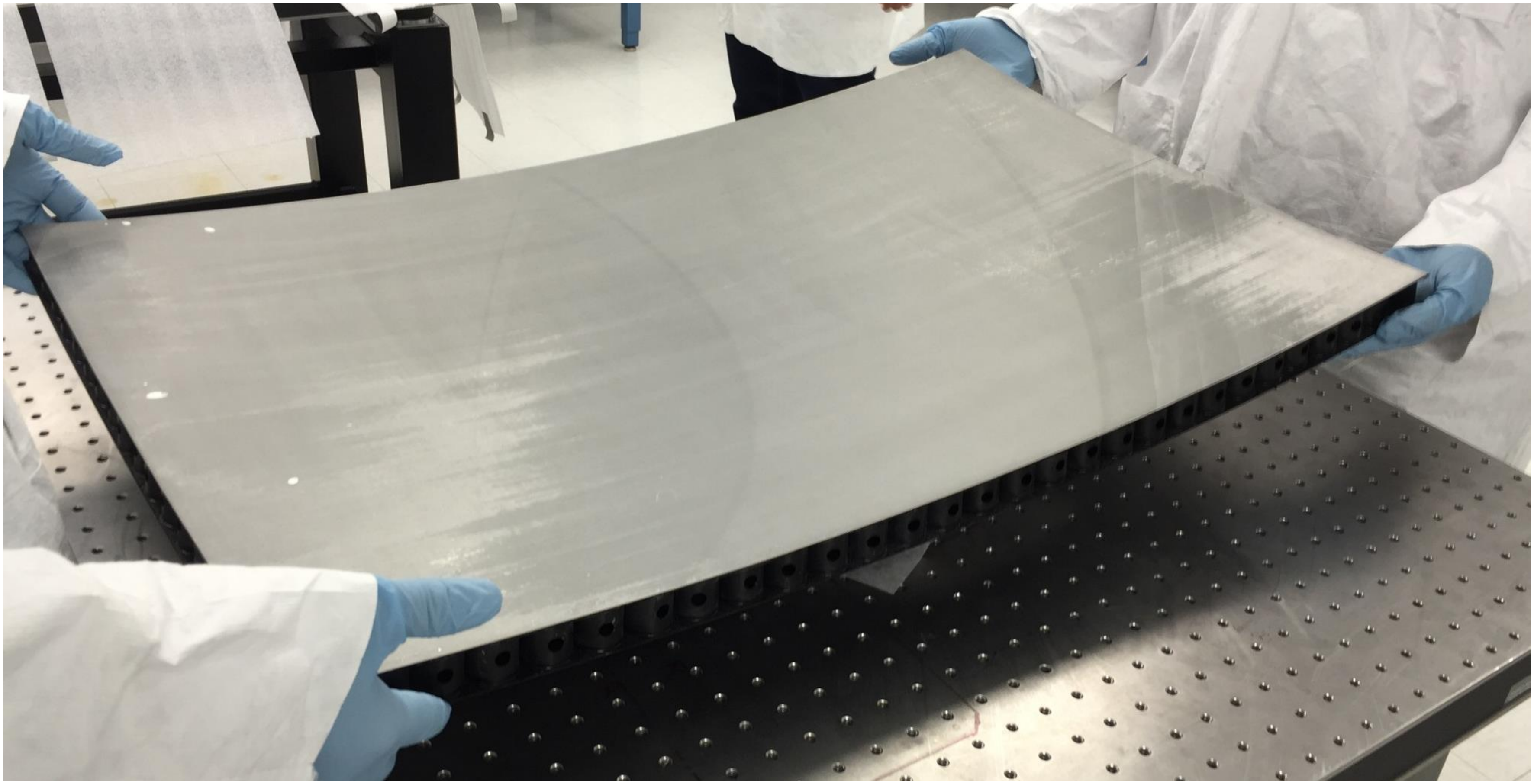
Spherical Mirror Assembly



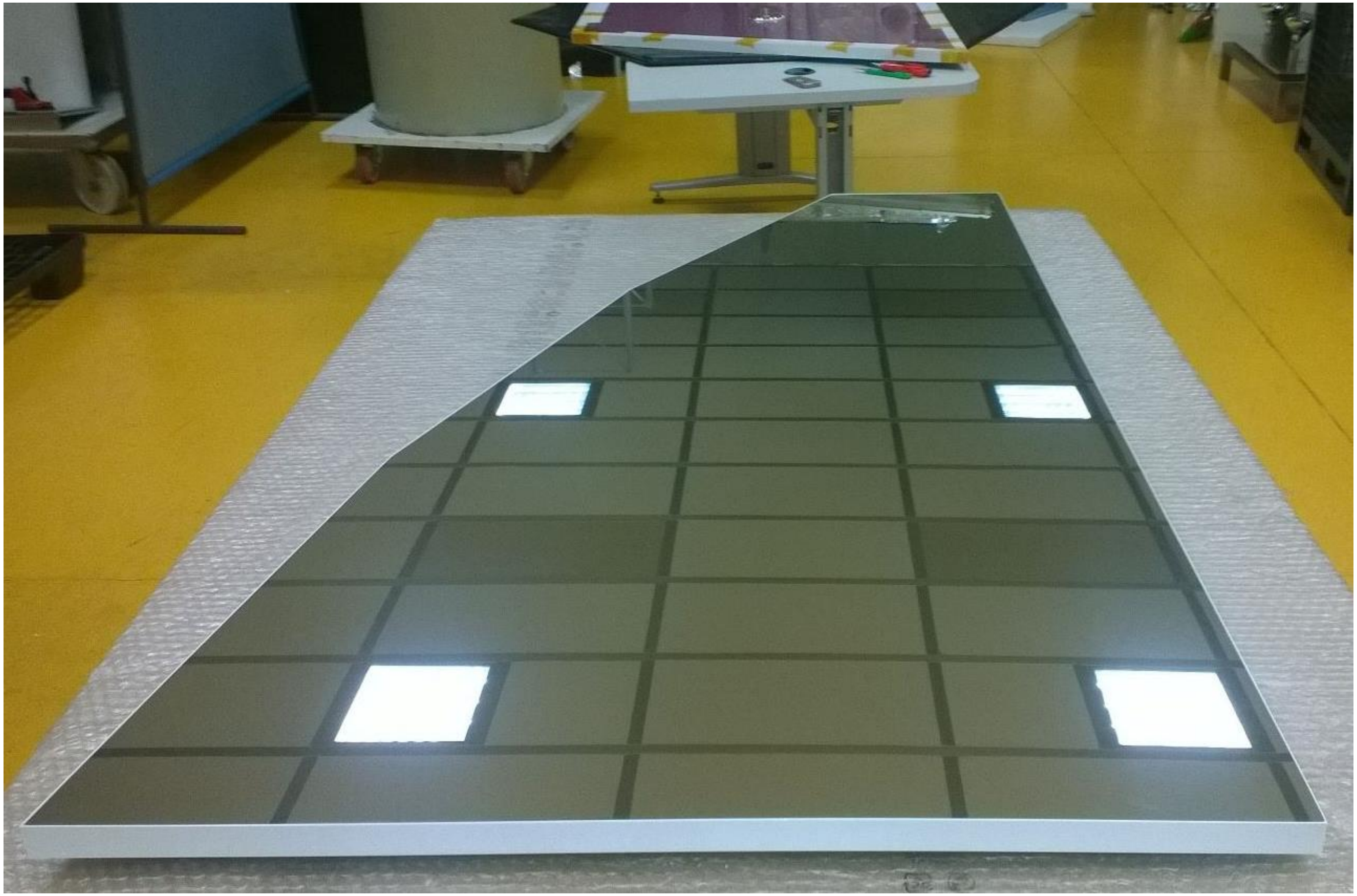
Mirrors

- Ten spherical mirrors
  - Six delivered and stored in clean room
    - 2C, 3C, 4C, 5C, 3, and 4
  - Four to be produced and delivered
    - 1, 2, 5, and 6
- Eight planar mirrors
  - Production started
  - Prototype lateral Mirrors A1R and A2R at Instituto Nazionale di Fisica Nucleare (INFN)

Spherical Mirror 2C



Prototype Planar Mirror A1R



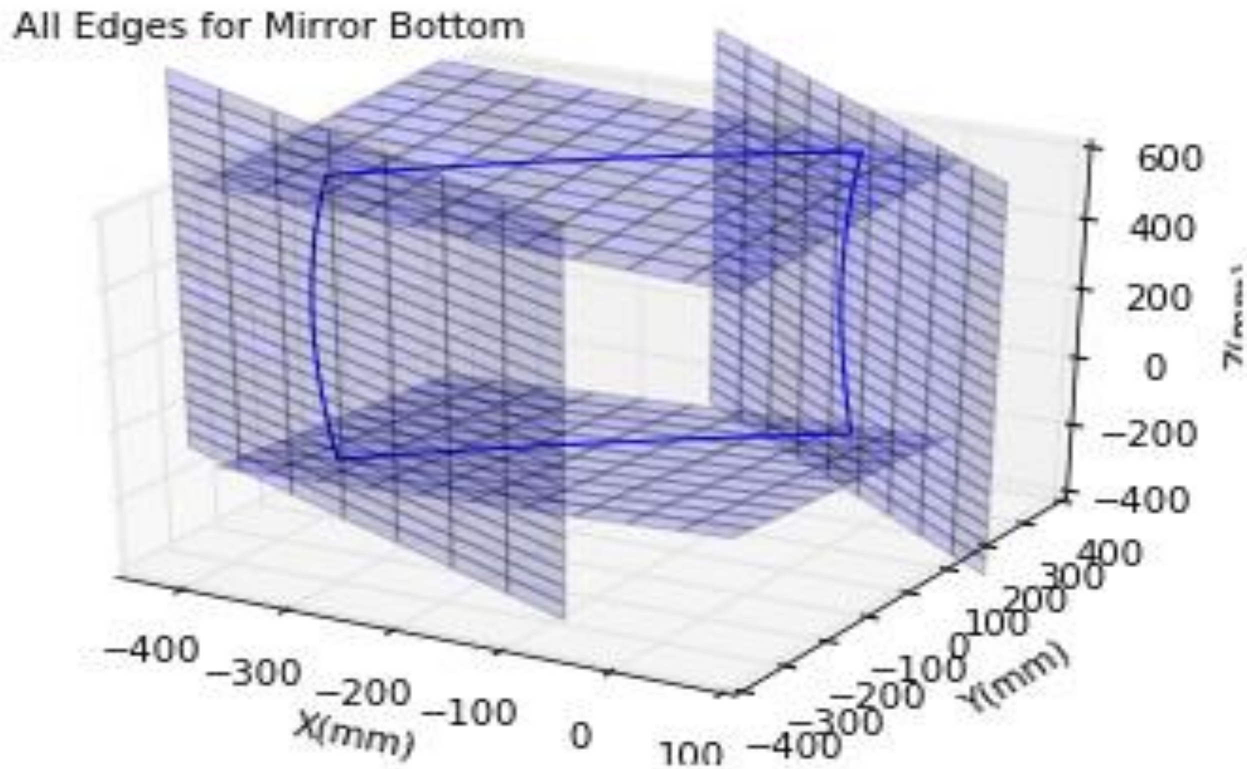
Spherical Mirror Analysis

- Measure edges of mirror surface and back surface with CMM
  - JLab Survey Group, Matt Walker
- Analyze data from CMM in AutoCAD and Python
  - Python
    - Amanda, Brian, Pablo, and Tyler
  - AutoCAD
    - Mary Ann, Pablo, and Sahin
- Calculate.
  - Lengths of sides and diagonals
  - Radius of curvature

Python Analysis

- Calculate radius of sphere for mirrors
  - Using all points for a surface
  - Using combinations of four points
- Project CMM points to best fit plane to calculate length
- Check planarity of sides
- Calculate radius of curvature for each individual side

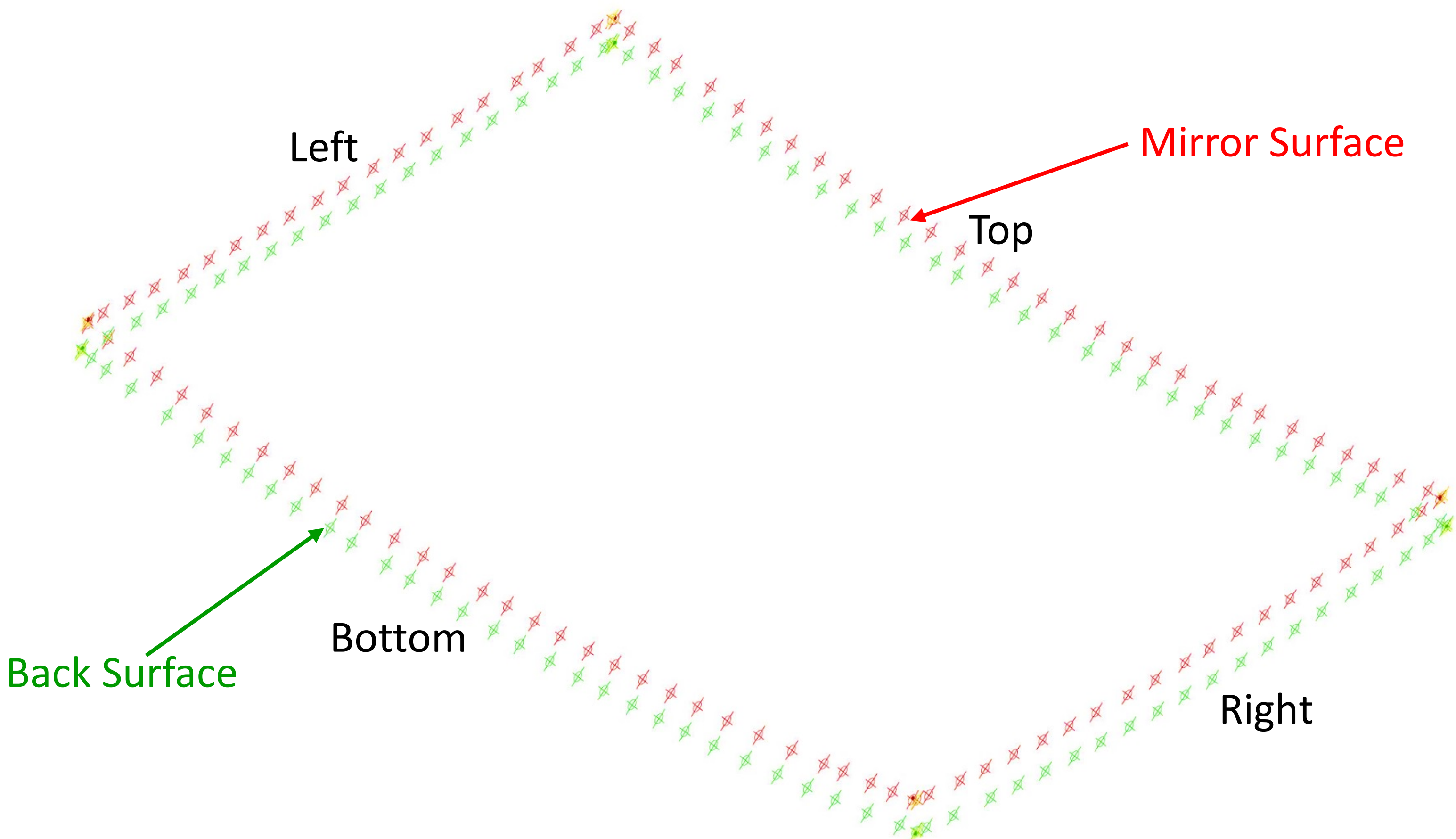
Python Plot for Mirror 5C



AutoCAD Analysis

- Project CMM data to plane created with ideal model
- Measure side and diagonal lengths and thicknesses
- Confirm results from Python algorithms

AutoCAD Plot of Mirror 5C CMM Data



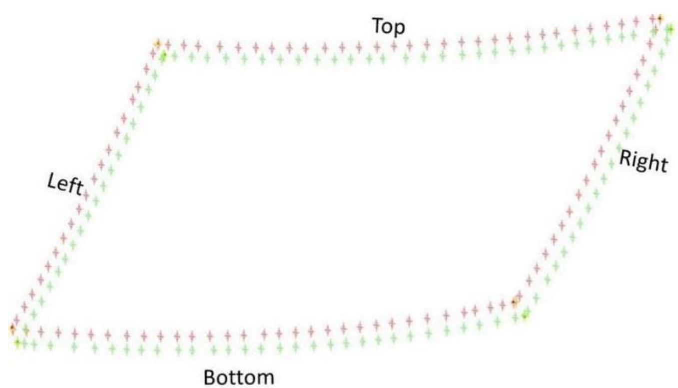
Best Fit Plane Issues

- Noted that all four corners of a surface in ideal model are not coplanar for 3C and 4C
- One corner is out of plane generated by other three corners
  - Caused by how mirrors are shaped and how they are cut from the sphere

Lengths of the Sides of 5C

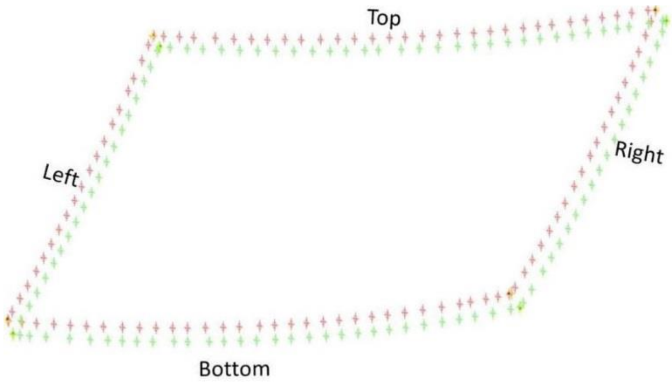
	Mirror Surface			**Back Surface**	
Side	*Python [mm]*	*AutoCAD [mm]*	*Ideal [mm]*	*Python [mm]*	*AutoCAD [mm]*
Right	536.75	535.91	531.48	540.68	535.85
Top	834.36	840.96	837.68	840.39	844.26
Left	536.55	537.32	531.48	540.71	536.35
Bottom	834.51	841.16	837.68	840.83	843.79

Error omitted due to debugging of algorithms



Radius of Sphere for 5C

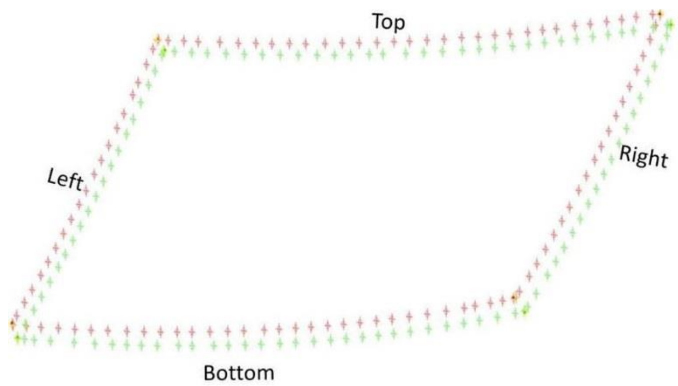
	Mirror Surface		Back Surface
Method	*Python [mm]*	*Ideal [mm]*	*Python [mm]*
All ~100 Points	2696.27 ± 0.07	2700.00	2735.66 ± 0.09
Four Point Combos (100 C 4)	2704.49 ± 36.96	2700.00	2714.77 ± 21.71



Radius of Curvature
Sides of 5C

	Mirror Surface	Back Surface
Side	*Python [mm]*	*Python [mm]*
Right	2700.00	2721.00
Top	2717.00	2740.00
Left	2773.00	2720.00
Bottom	2712.00	2740.00

Error omitted due to debugging of algorithms



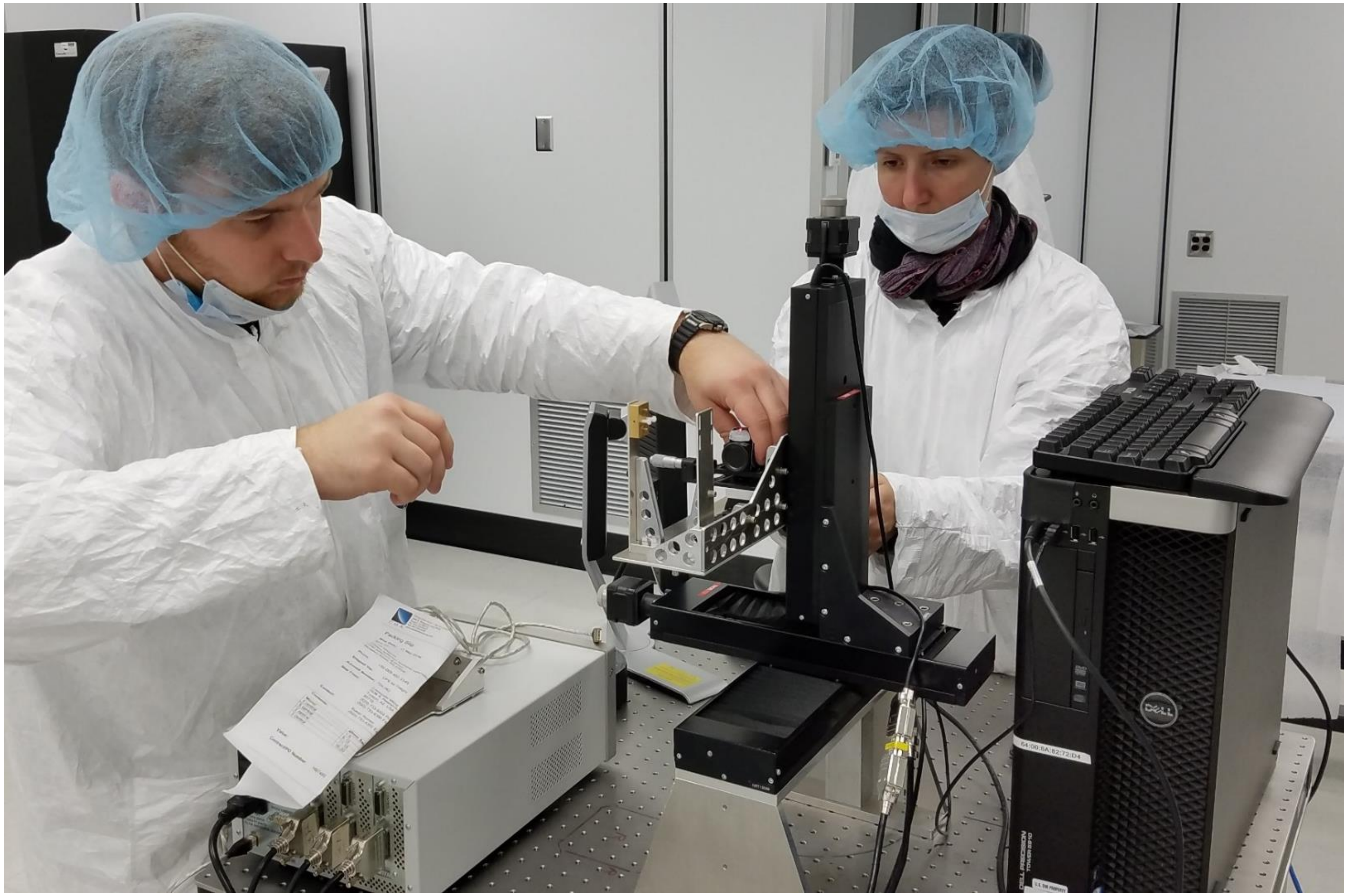
Spot Tests of Spherical Mirrors

- Approximation of mirror surface uniformity and radius of curvature
- Uses CCD and fiber-optic light
  - CCD to view image of reflected fiber-optic light

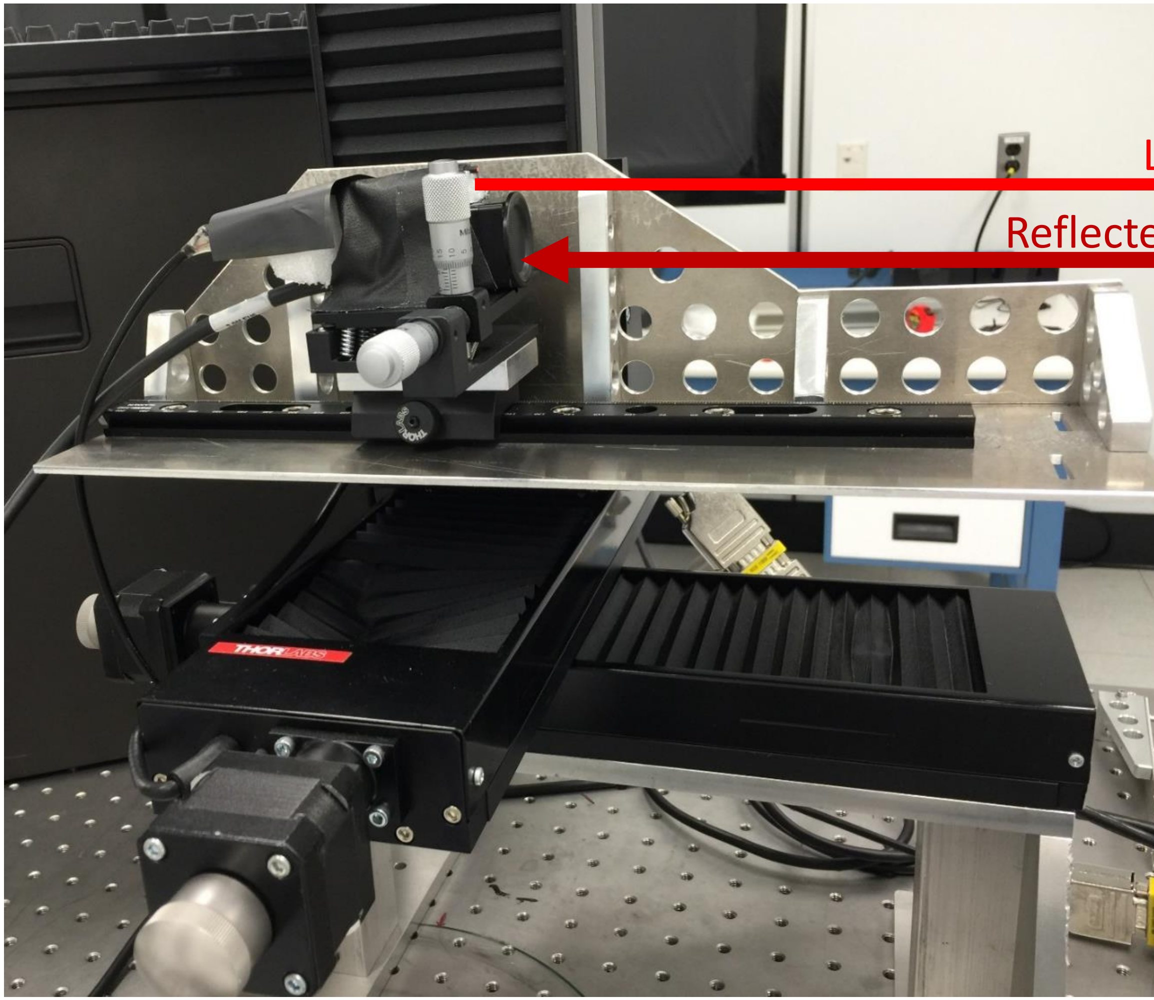
Debian PC for Spot Test

- Researched and installed Debian Linux OS on PC
  - Chief architects
    - Ilaria and Luca (INFN collaborators)
  - Contributors
    - Peter and Tyler on network issues
  - Resolved network issues by using Ilaria's laptop as Wi-Fi network bridge

Placing CCD and Fiber-Optic Light on Mount for Spot Test

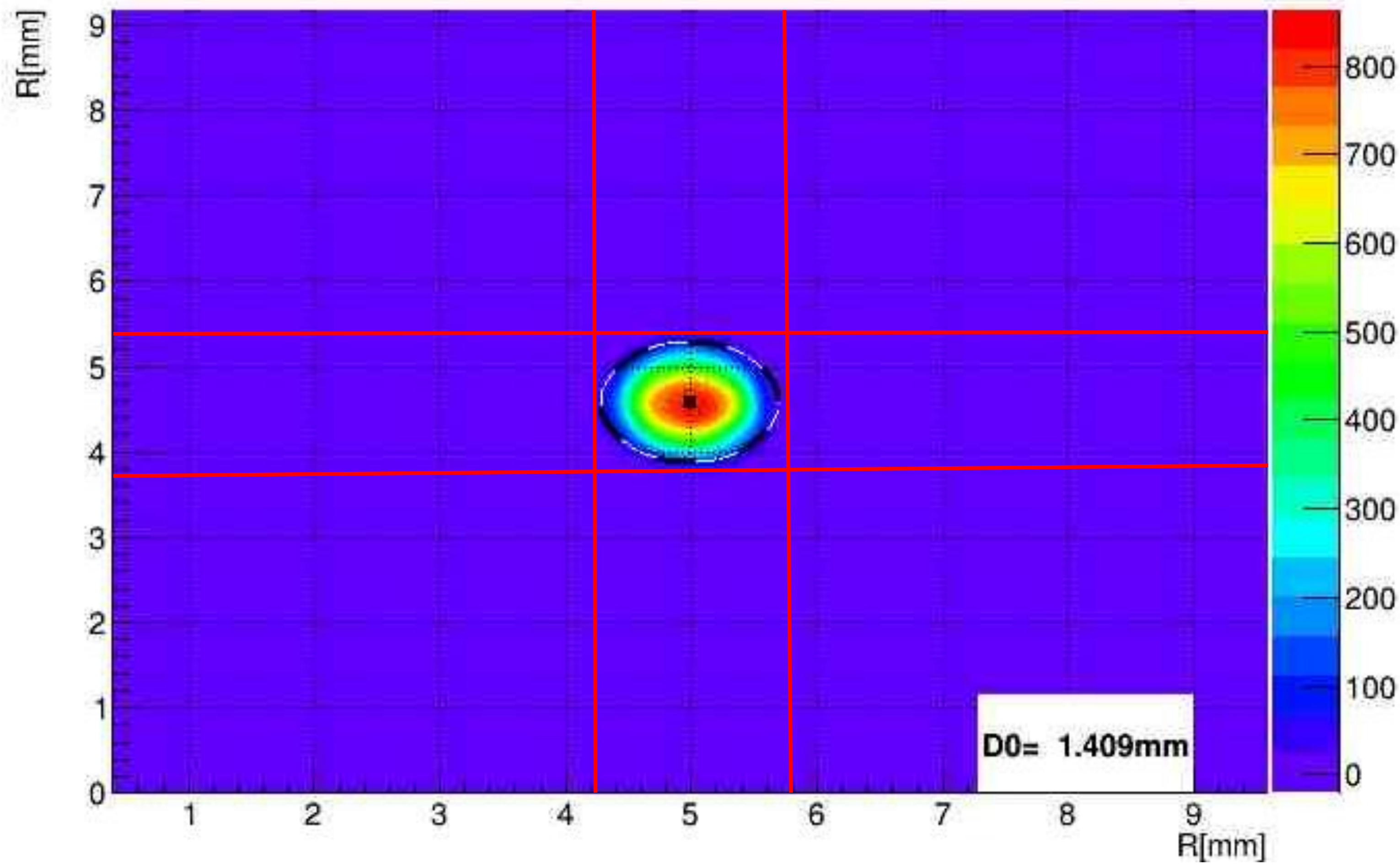


CCD Mount Used for Spot Test



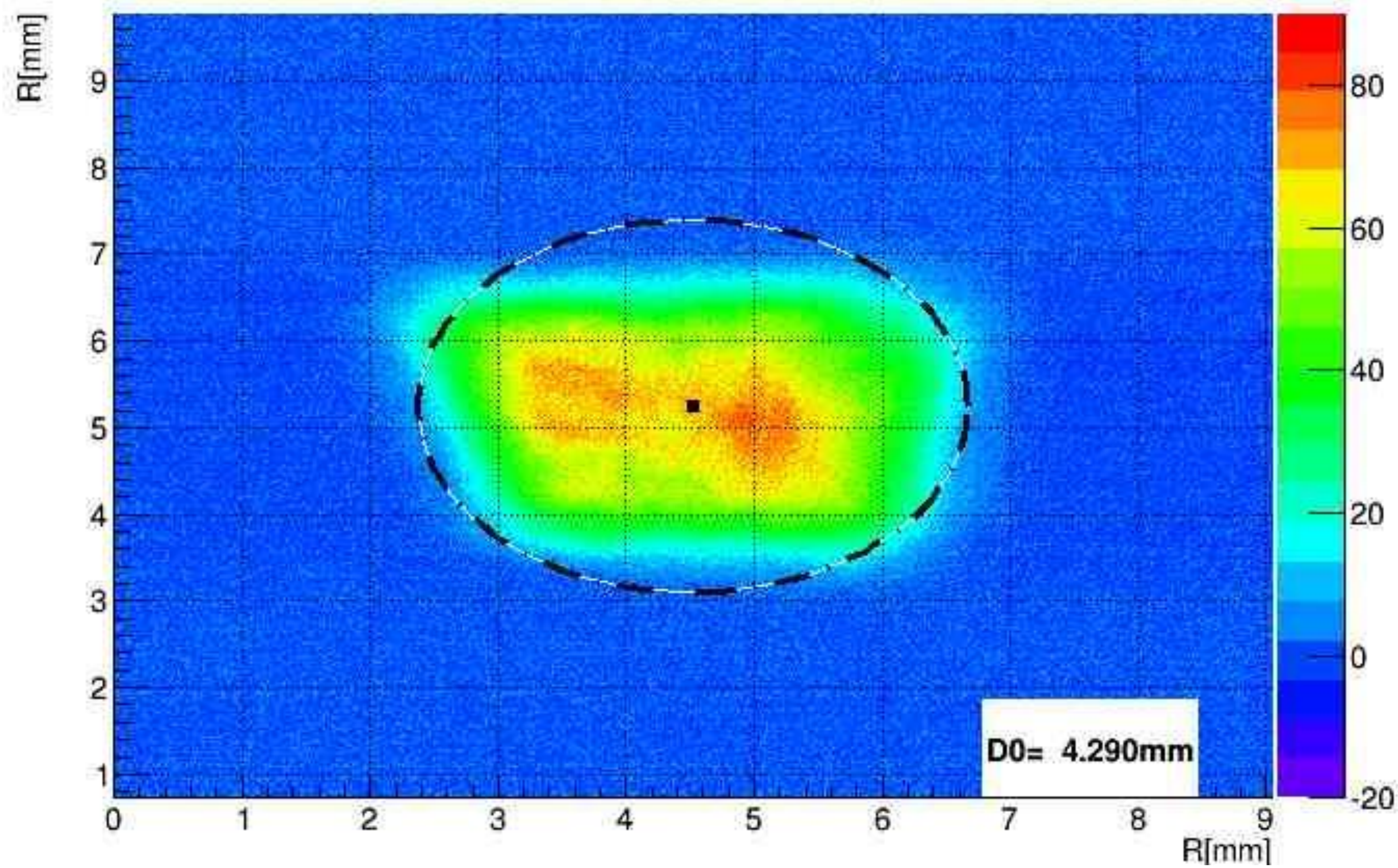
Placing Mirror 3 on Table for Spot Test

Mirror 4
Spot Test Results



Distance Between CCD and Mirror = 2709 mm

Mirror 4
Spot Test with CCD

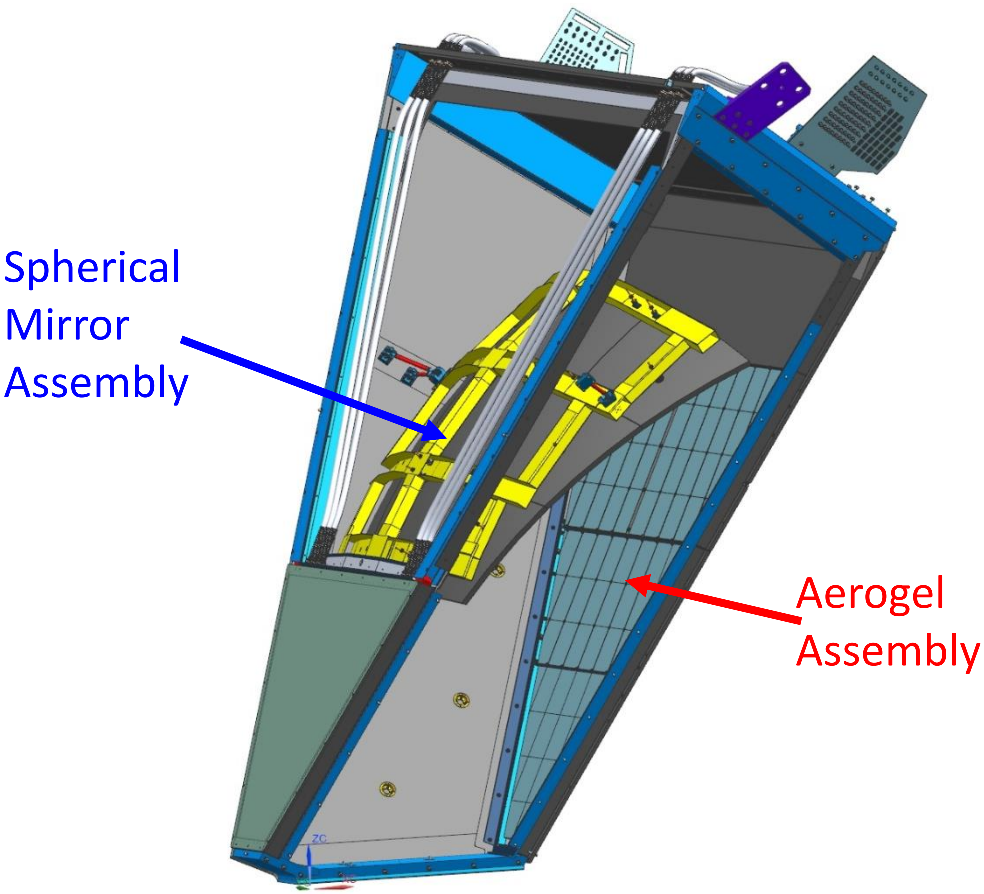


Spot distortion because spot is not at focal plane

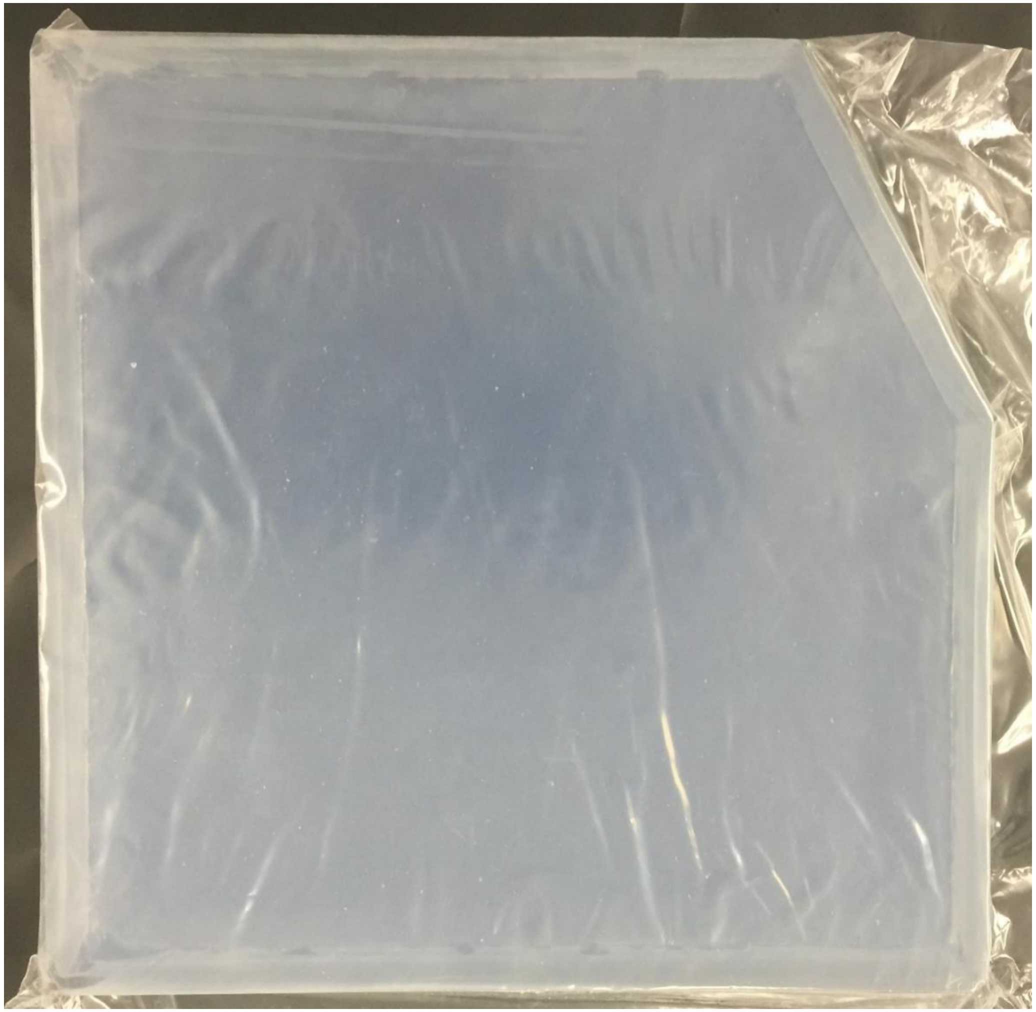
Aerogel

- Received all 3-cm-thick tiles
  - Whole and partial tiles
- Tiles stored in dry-boxes at 0.5% RH
- Visually inspected each tile upon delivery

Model Showing Aerogel in Relation to Spherical Mirrors



Partial Aerogel Tile

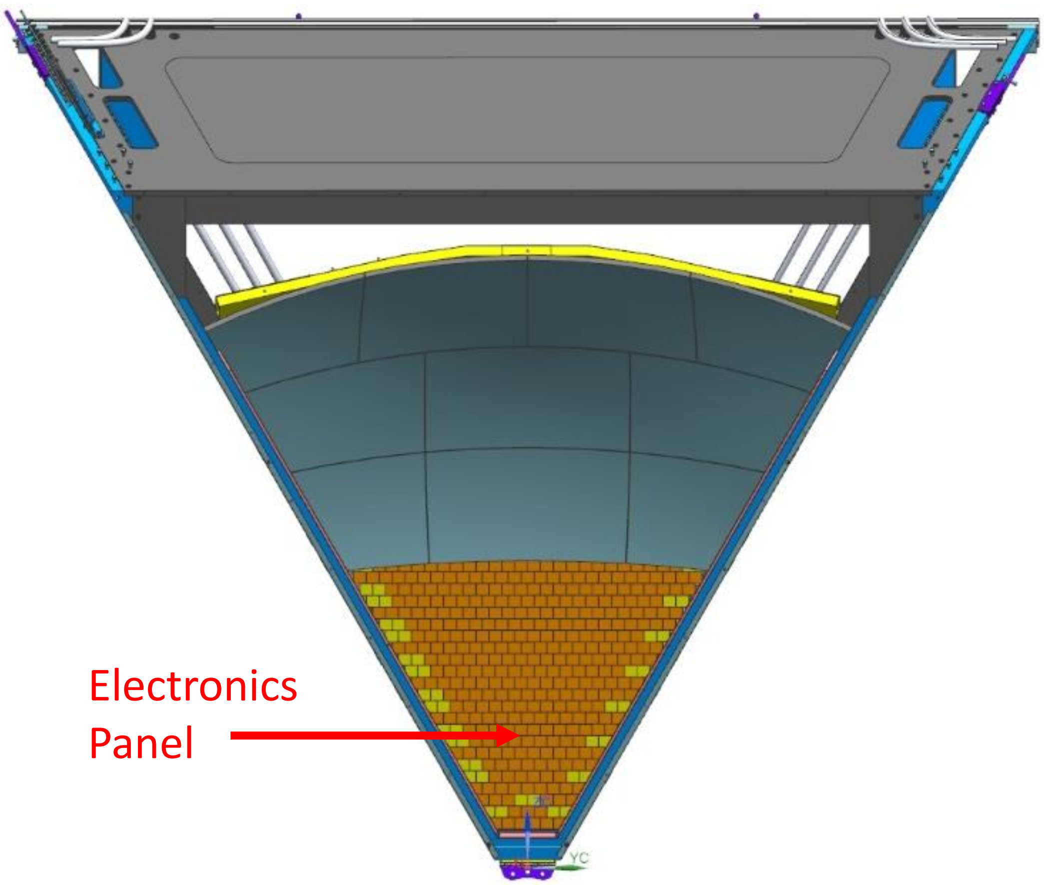


Partial Aerogel Tile

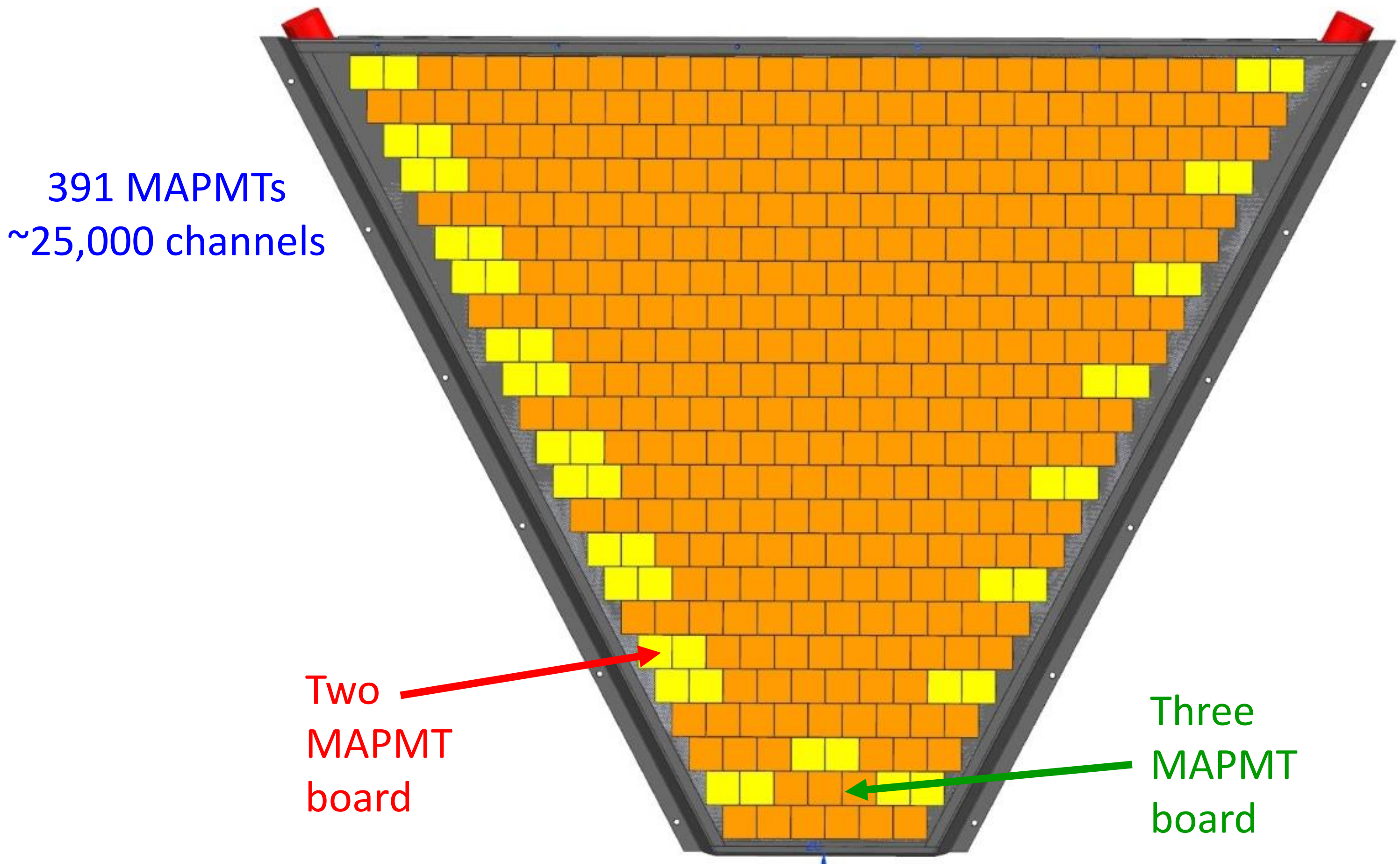
Electronics

- Front End Electronics
  - MAPMTs (64 anodes)
  - MAPMT adapter board
  - ASIC board
  - FPGA board

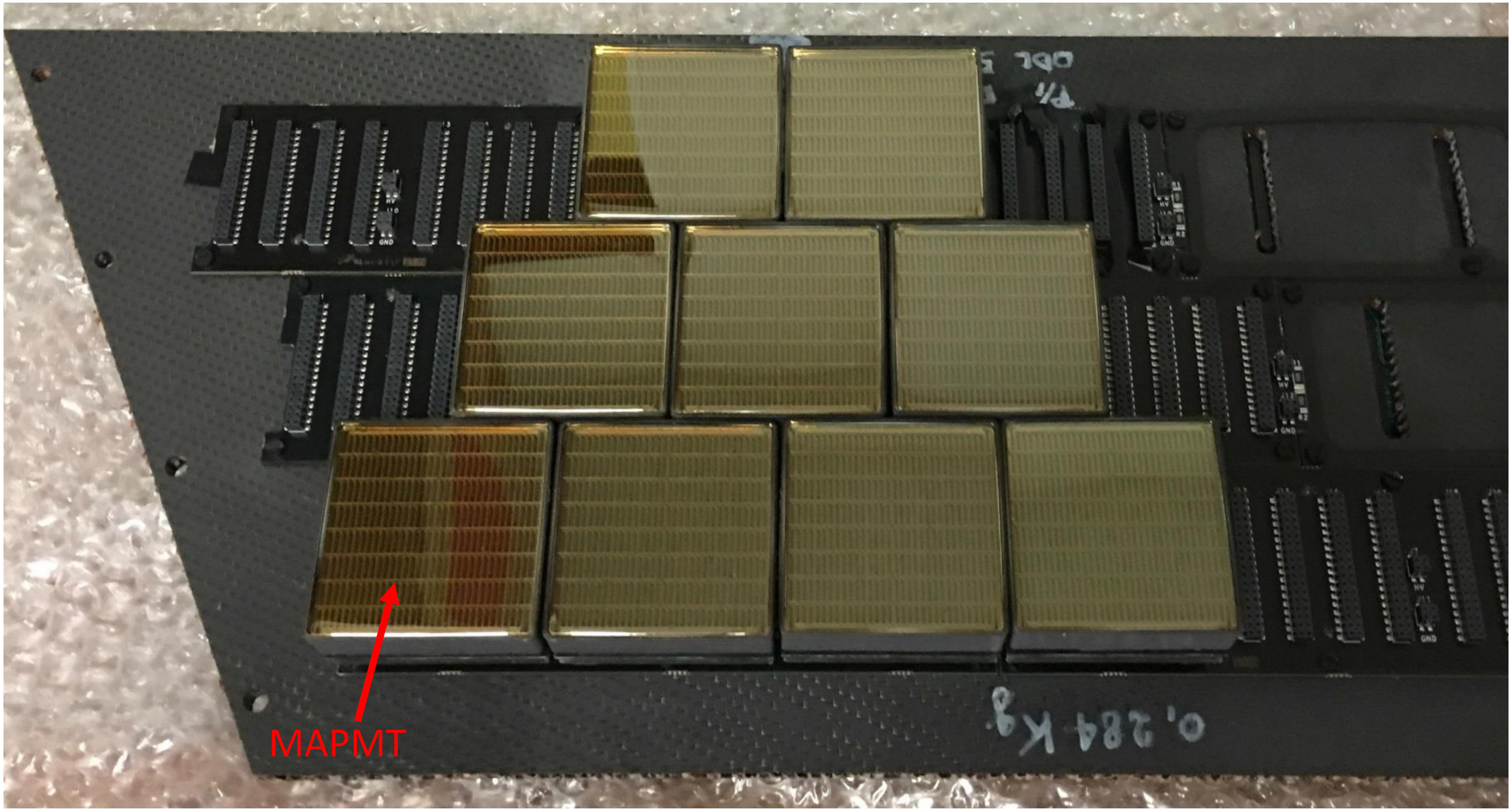
Front View of Model with Front Panel Removed



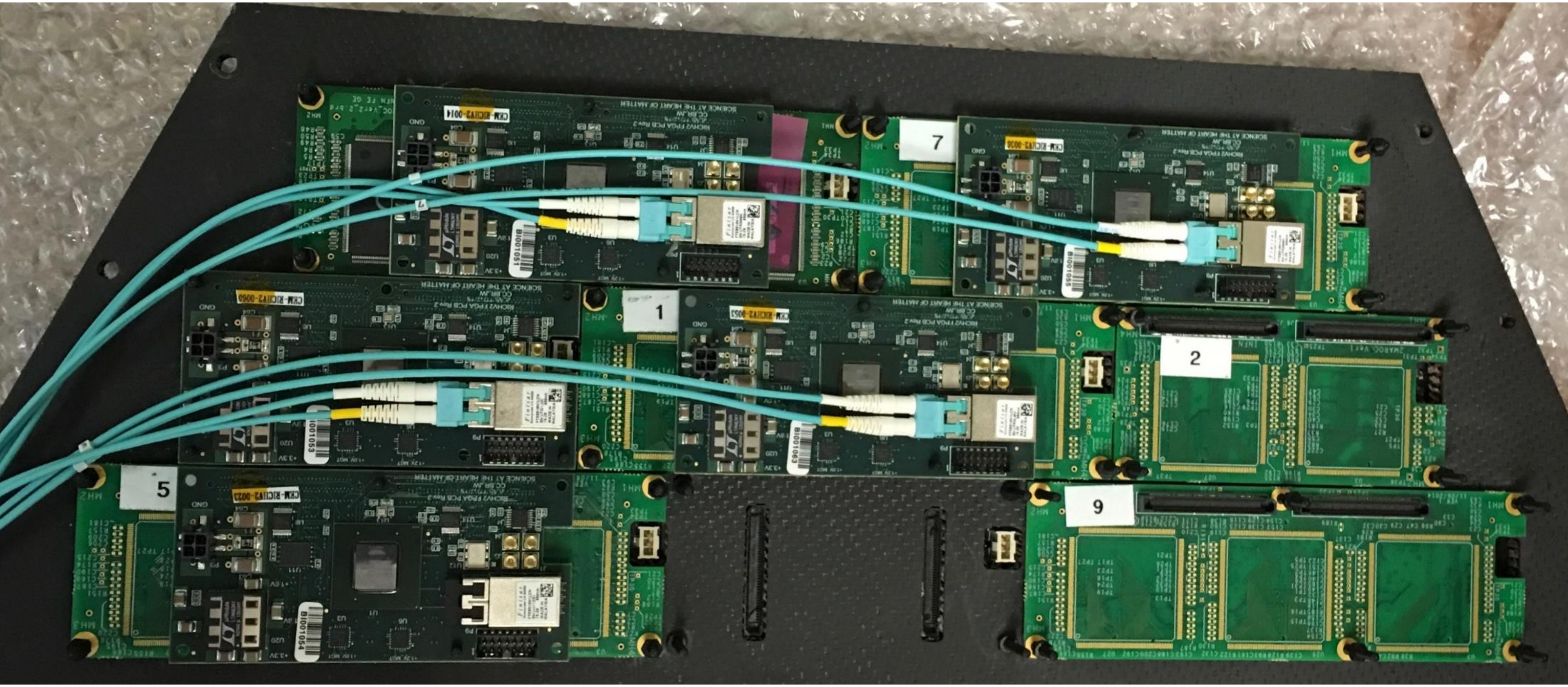
Model of Electronics Panel



Test Setup for Electronics Panel



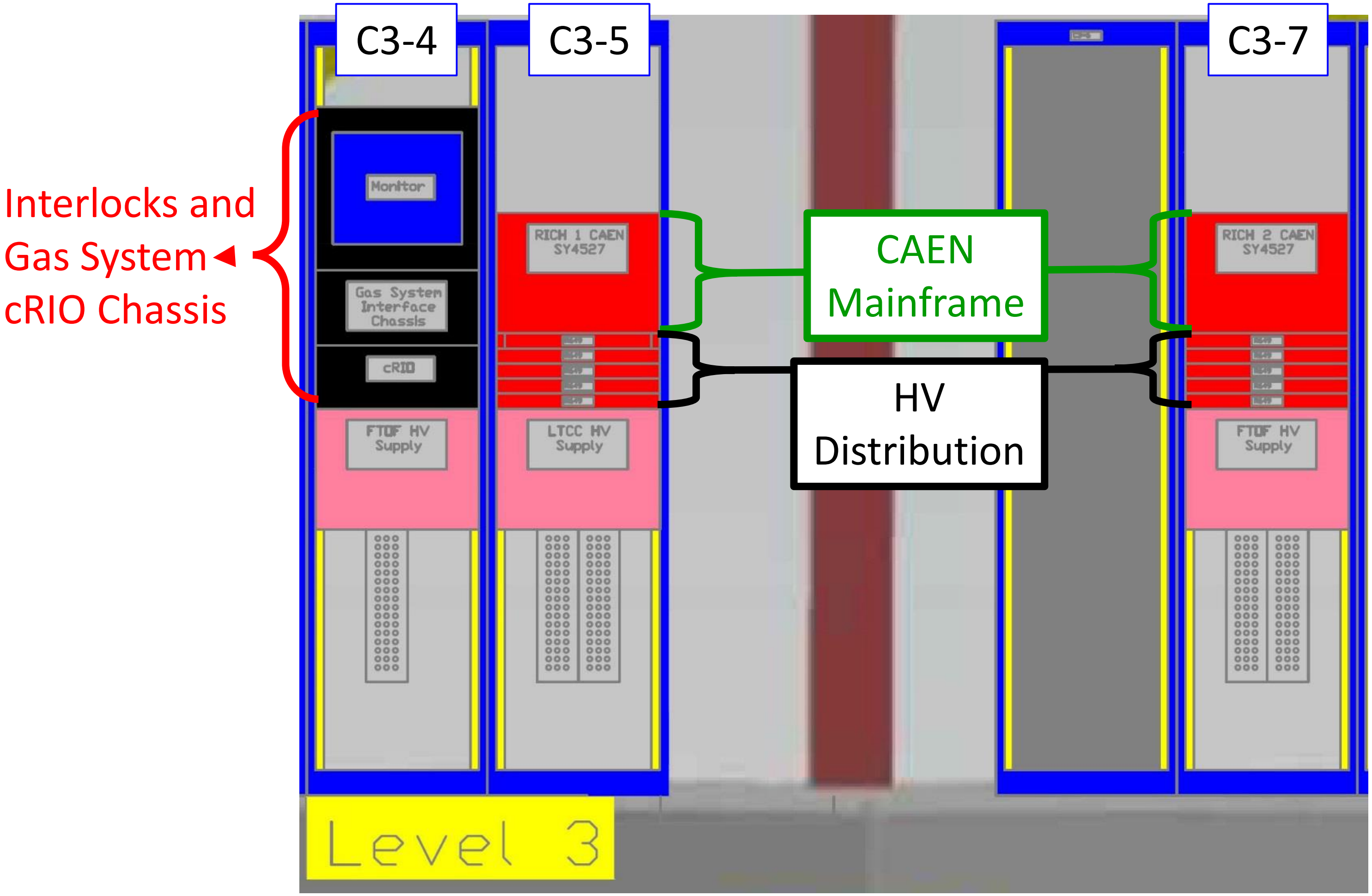
Back Side of Electronics Panel Test Setup



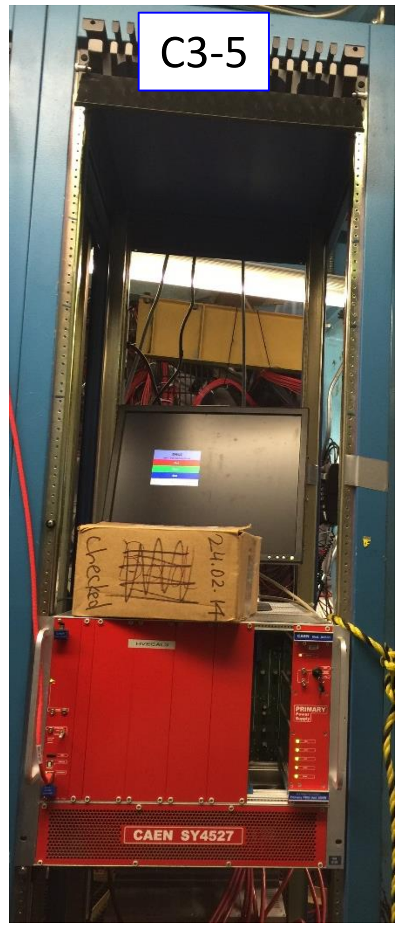
Electronics

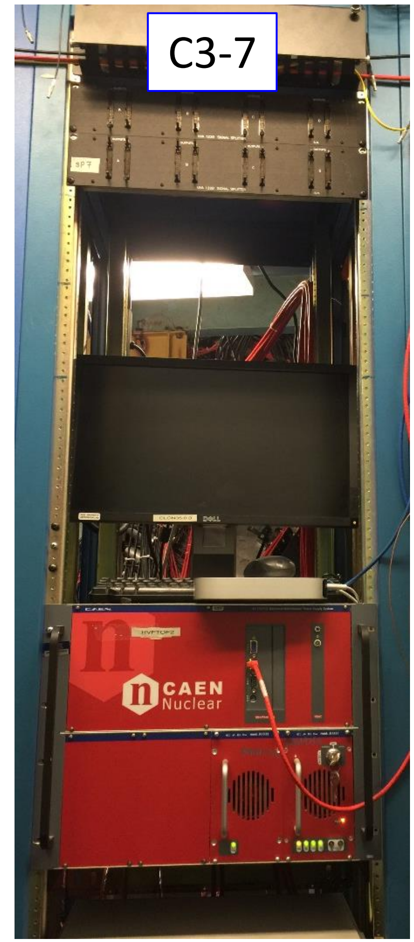
- Back End Electronics
  - CAEN SY4527 mainframe (8 U)
  - CAEN R649 HV distribution (5 U)
  - LV distribution at patch panel
  - Fiber Distribution Panel (4 U)
  - VXS crate with SSP cards (11 U)

Electronics Racks
Forward Carriage Level 3

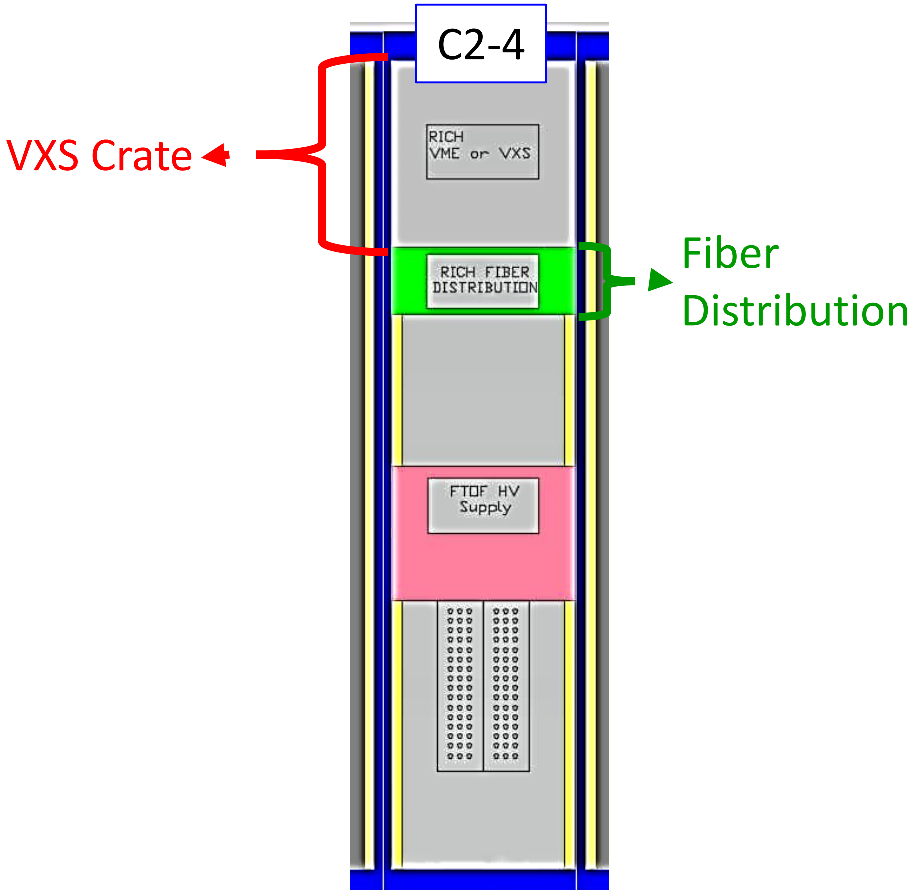


Racks C3-4, C3-5, C3-7
Forward Carriage Level 3





Electronics Rack
Forward Carriage Level 2

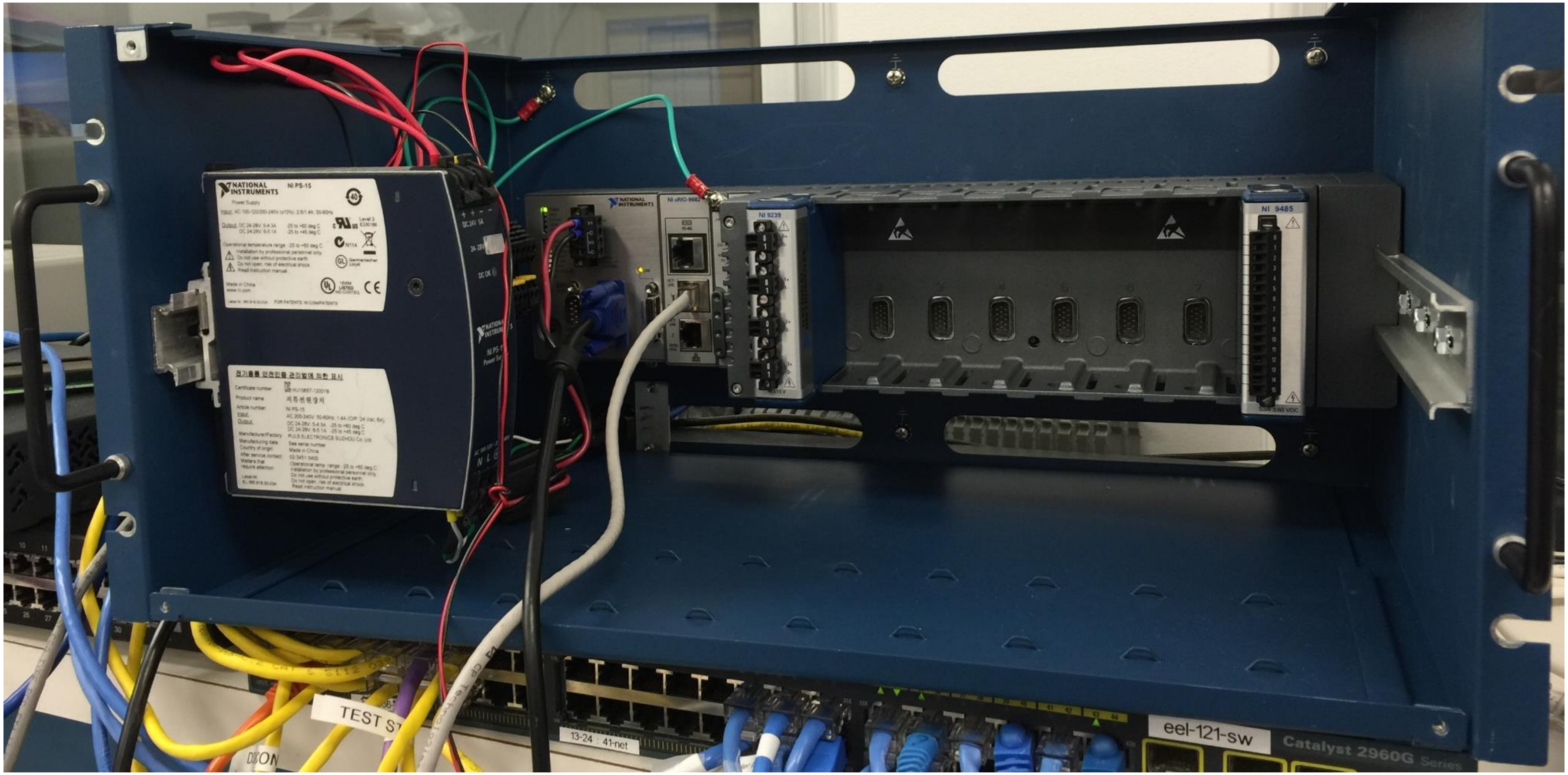


Rack C2-4
Forward Carriage Level 2

Interlocks

- Developing cRIO-based interlock system
  - Mindy, Marc, George, Brian, Peter
  - Monitor
    - Internal temperature
    - Humidity
    - Air cooling status
- All PRs submitted
- All cRIO modules and rack mounts received
  - Controller to be delivered

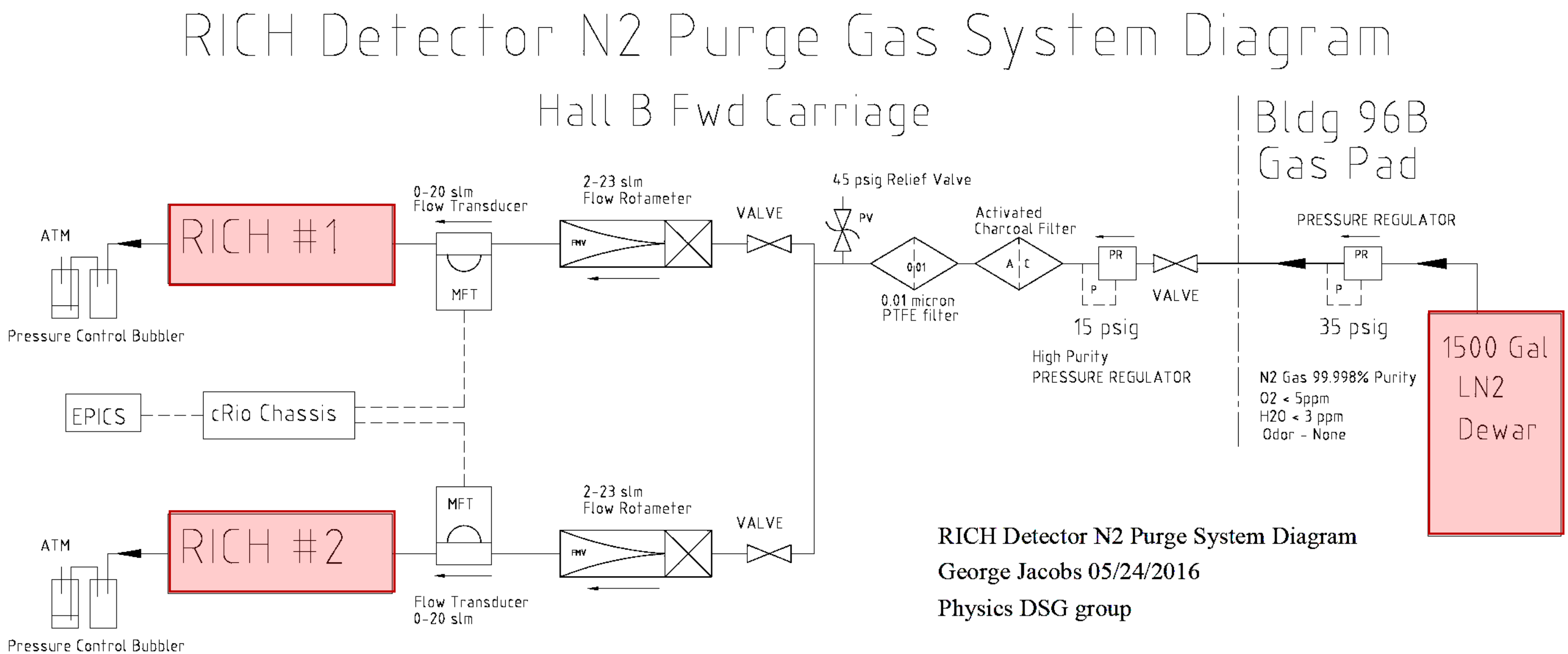
cRIO Chassis and Controller



Gas System

- Developing gas system
  - George, Brian, Marc, Mindy, Sahin
- Nitrogen purge system
  - Maintain low internal humidity for aerogel
- Air cooling system
  - Prevent electronics overheating
  - <100°F to prevent FTOF damage

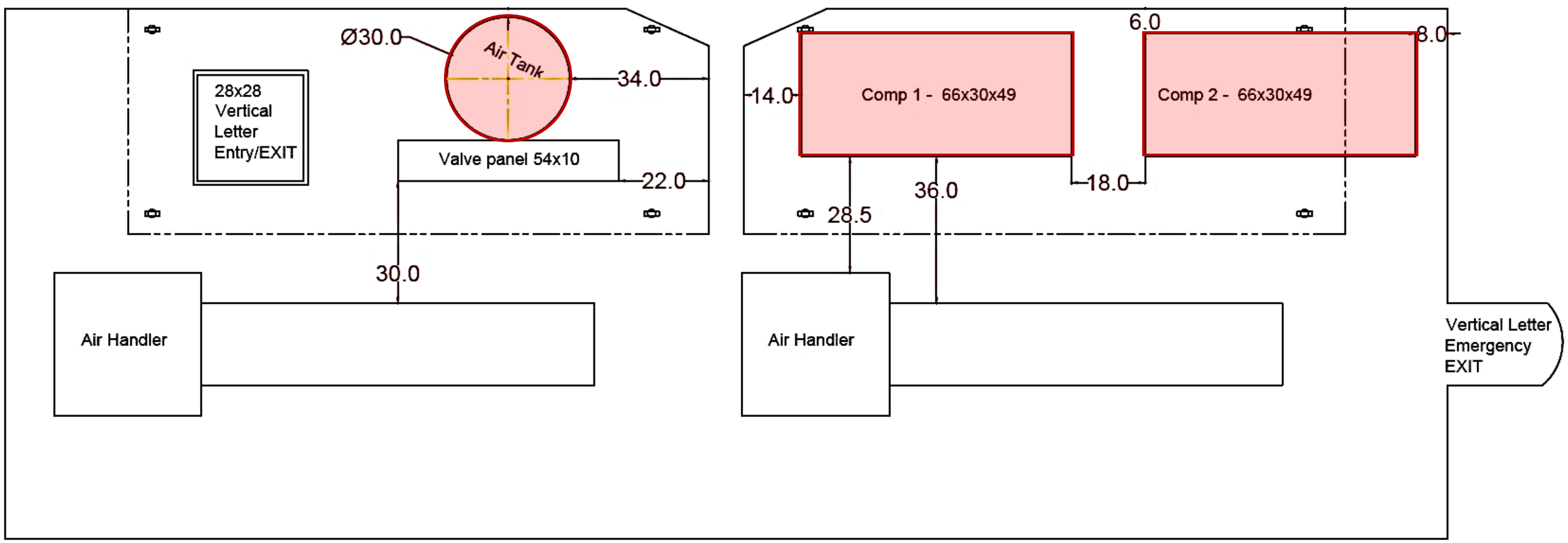
Nitrogen Purge System Diagram



Air Cooling System

- Two Atlas Copco compressors
- Air cooling system located on top deck of Forward Carriage

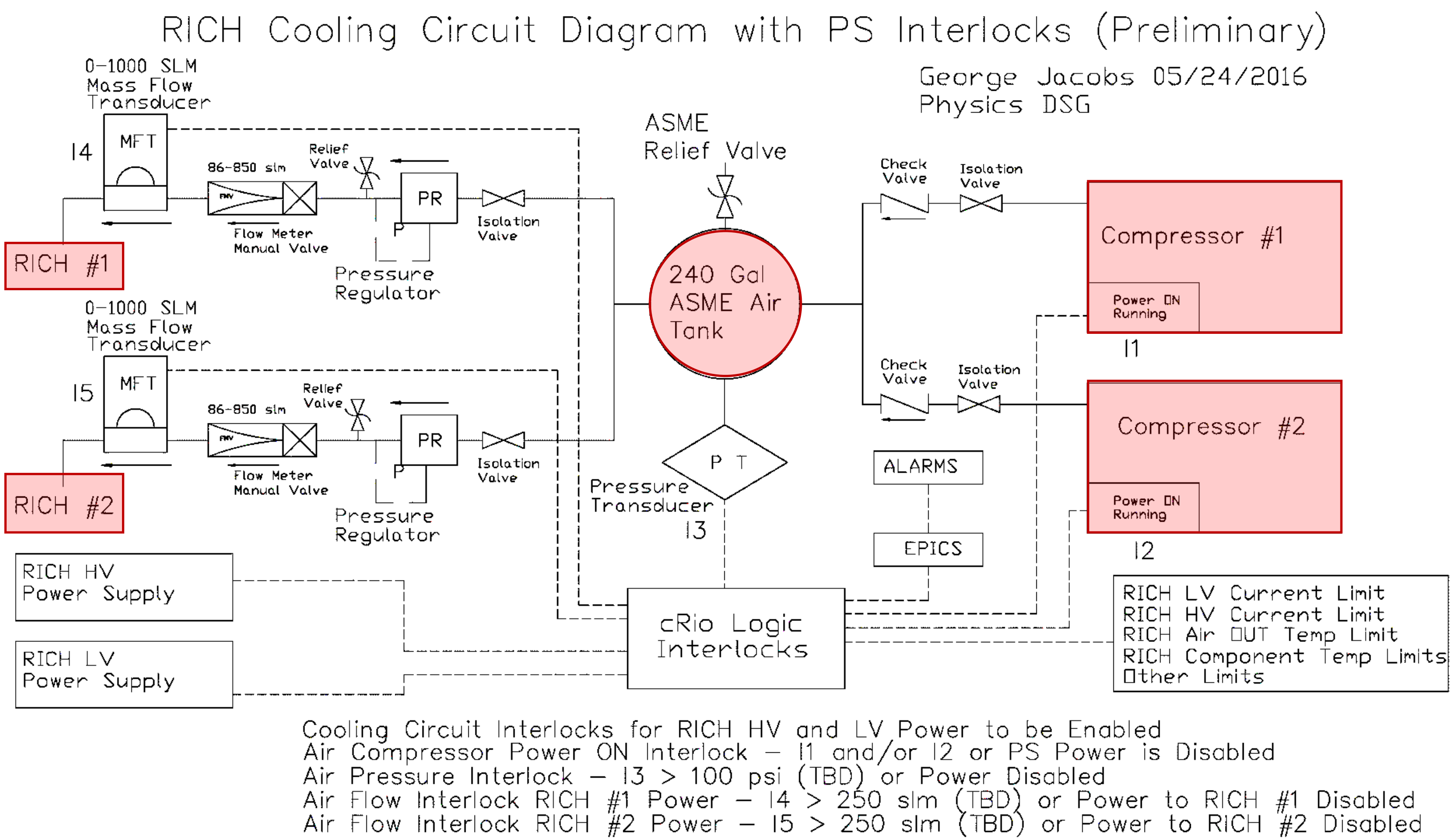
Air Cooling System Location



Sahin Arslan

Detector Support Group

Air Cooling System Diagram



Assembly Structure and External Frame

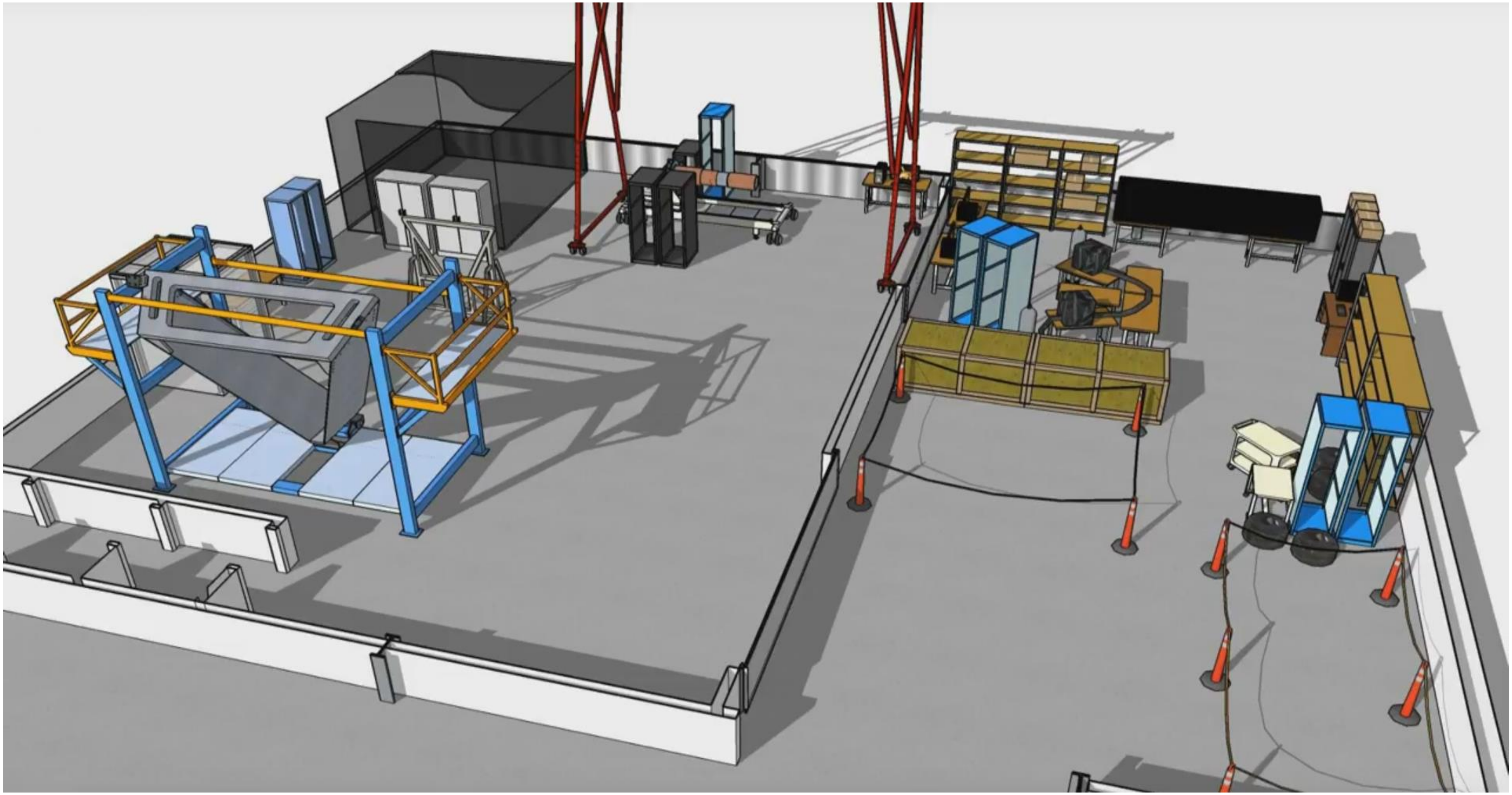
- Assembly test in progress at INFN facility in Italy

Assembly Tests at INFN

Assembly at JLab

- Detector assembled in EEL 124
- Assembly structure will be bolted to cleanroom floor
  - Bolt size will be determined by INFN collaborators
- Start as soon as possible
  - Depends on space in clean room

EEL 124 Layout



Upcoming Events

- Deliveries
  - August 2016
    - Last spherical mirrors
    - Aerogel (2-cm-thick)
  - September 2016
    - Electronics boards
  - October 2016
    - Assembly structure
    - External frame

Upcoming Events

- Assembly
  - <u>October 2016</u>
    - Spherical mirror mounting and coating
    - Electronic panel
  - <u>November 2016</u>
    - Assembly structure
    - Detector structure

Upcoming Events

- Testing
  - <u>August 2016</u>
    - Pre-production electronic boards
  - <u>November 2016</u>
    - Electronic panel
- Installation
  - <u>**September 2017**</u>

Conclusion

- Contributions by *all* DSG members
  - Measurements
    - CMM-based
  - Analysis using Python and AutoCAD
    - Mirror dimensions
  - Research and Design
    - Interlocks
    - Gas system
  - Procurement
    - Interlocks
    - Gas system
  - Safety
    - THA and OSP

Conclusion

- Delivery of components underway
- Performing acceptance tests
  - Mirrors
  - Aerogel
  - Electronics
- Finalized location and layout for assembly and testing

THANK YOU

Backup Slides

Air Cooling Compressor Specs

Model: SF 11-100 AFF Multi (Includes 3 x SF4 modules)

	100 psi	Unit
Inlet conditions		
1. Barometric pressure	14.5	psi(g)
2. Ambient air temperature	68	°F
3. Relative humidity	0	%
Performance		
1. Maximum discharge pressure[1]	112	psi(g)
2. Operating pressure[1]	100	
3. Capacity delivered[1]	43	cfm
4. Shaft power input - loaded	11.1	bhp
5. Shaft power cooling fan	2.0	bhp
6. Drive Arrangement	Belt Drive	
7. Dryer - FF only	.7	bhp
8. Package power input - Loaded	12	kW
9. Sound level[2]	60	dB(A)
10. Pressure dew-point	37	°F
11. Minimum ambient temperature	32	°F
12. Maximum allowable inlet temperature	104	°F
Cooling data		
1. Cooling air flow – Unit canopy total cfm with dryer included	1363	cfm
2. Cooling air flow – Dryer only	106	cfm
3. Discharge air temperature (Ambient +)	TBD	°F
Electrical data		
1. Motor	3 x 4 / 3 x 5	kW / Hp
2. Motor type	Induction	
3. Enclosure	TEFC	
4. Service Factor	1.15	
5. Efficiency	88.5	%
6. Speed	3505	rpm
7. Insulation	F w/B rise	
8. Bearing	Antifriction	
9. Starter type	Press Switch - Stop/Start	
Physical data		
1. Dimensions L x W x H		
- Floor Mount	66 x 30 x 48	inches
2. Weight		
- Floor Mount	1136	lbs
3. Air discharge	1/2	inch NPT
4. Condensate drain – manual / auto	1/8 / 1/4	Ø inches NPT