



# Preparation for FST Installation

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# Pre-Installation Goals



Final Goal: identify 36 sets of good FST module & purple cable & gray cable and mount modules & purple cables to the support structure.

- Check routing and length of purple cable and soft cooling tube.
- Check possible leakage of cooling system especially on the joint of the cooling tube.
- Decide mounting order based on the dummy module practice.
- Finalize slow control and online monitoring.
- RO test of all FST modules.

# Pre-Installation Plan



Task	Start Date	End Date	Personel	Status
Purple Cable Routing Check	04/12/2021	04/23/2021	Rahul, Felix, Mike, Flemming, Yu, Prithwish, Xu	Done
Cooling Line Check	04/12/2021	04/23/2021	Rahul, Felix, Mike, Bill, Flemming, Yu, Prithwish, Xu	Done
Cooling Slow Control Update	04/12/2021	05/09/2021	Yu, Prithwish, Xu	In Progress
Setup RO System	04/19/2021	04/23/2021	Xu, Mike, Yu, Prithwish	Done
Mounting Practice with Dummy Modules*	04/12/2021	05/09/2021	Xu, Yu, Prithwish	In Progress
Support Structure Test**	04/26/2021	05/09/2021	Rahul, Bob, Mike, Xu	Next Up
Mount One Module and RO Test	05/10/2021	05/16/2021	Xu, Yu, Prithwish	Not Started
Mount Six Modules and RO Test	05/17/2021	05/23/2021	Xu, Yu, Prithwish	Not Started
Run Cooling System with Modules	05/24/2021	07/19/2021	Xu, Zhenyu, Gavin, Yu, Prithwish, Bill	Not Started
Mount Remaining Modules and RO Test	06/01/2021	07/19/2021	Xu, Zhenyu, Gavin, Yu, Prithwish	Not Started
RO Test Backup Modules and Cables	07/20/2021	08/30/2021	Xu, Zhenyu, Gavin, Yu, Prithwish	Not Started

\* Decide mounting orders.

\*\* See Rahul's Talk.

# Required Equipments



- Setup RO System: 1 MPOD Crate (✓) + 3ISEG (✓) + 1ARC (✓) + 3ARM(✓) + 3ABC(✓)
- Mount 1 FST Module and RO Test: 1 FST Module (✓) + 1 purple cable (✓) + 1 PPB (✓) + 1 gray cable(✓) + light cover (✗)
- Mount 6 FST Modules and RO Test: 6 FST Module (✓) + 6 purple cable (3) + 6 PPB (✓) + 6 gray cable(✓) + light cover (✗)
- Run Cooling System with FST Modules: Cooling System(✓) + Soft Cooling Tube (✗)
- Mount 36 FST Modules and RO Test: 36 FST Module(30) + 36 purple cable(3) + 36 PPB(✓) + 36 gray cable(✓) + light cover (✗)
- Test Backup FST Modules: dark box (✓) + backup FST modules (✗) + backup purple cables (✗) + backup PPBs (✓) + backup gray cables (✓)

# Man Power



- UIC
  - Xu (04/08/2021-FST is ready)
  - Gavin (05/24/2021-08/14/2021)
  - Zhenyu (06/01/2021-08/20/2021)
- BNL
  - Rahul
  - Mike
  - Bob
  - Bill
  - Flemming
  - Prithwish
  - Yu

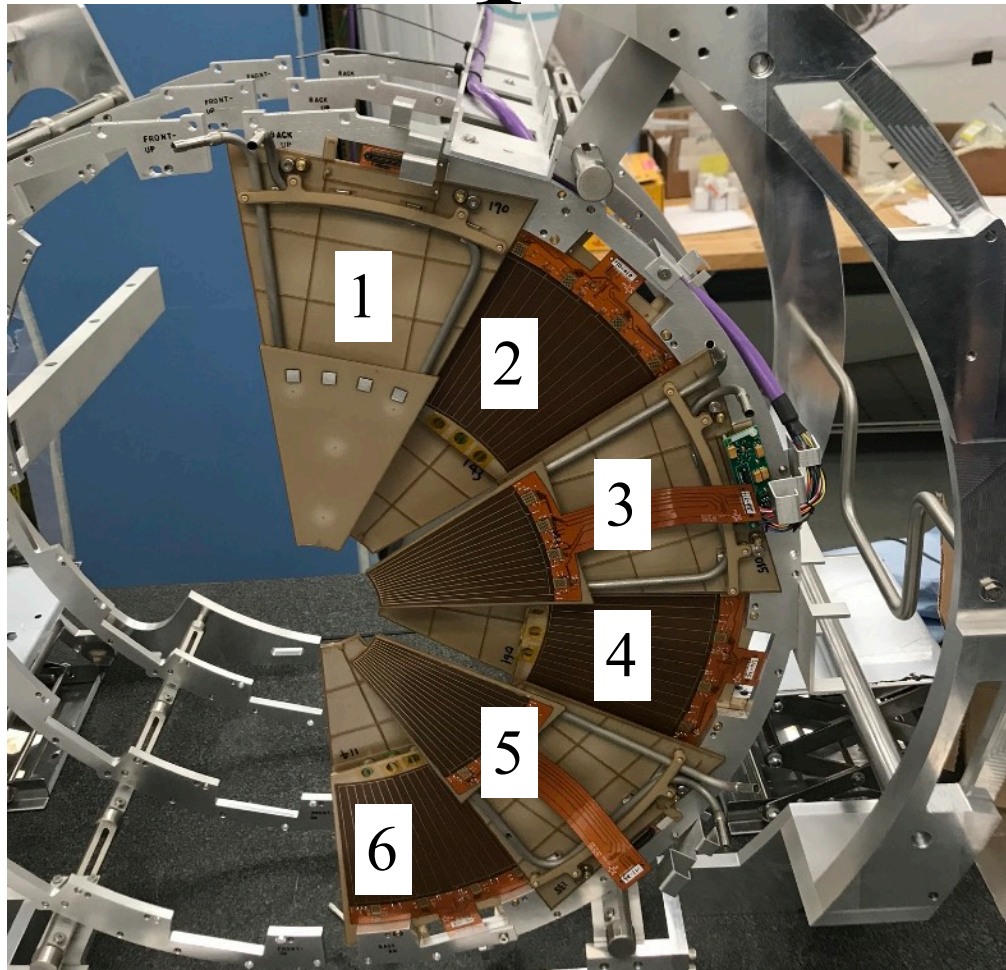


# Clean Room Overview

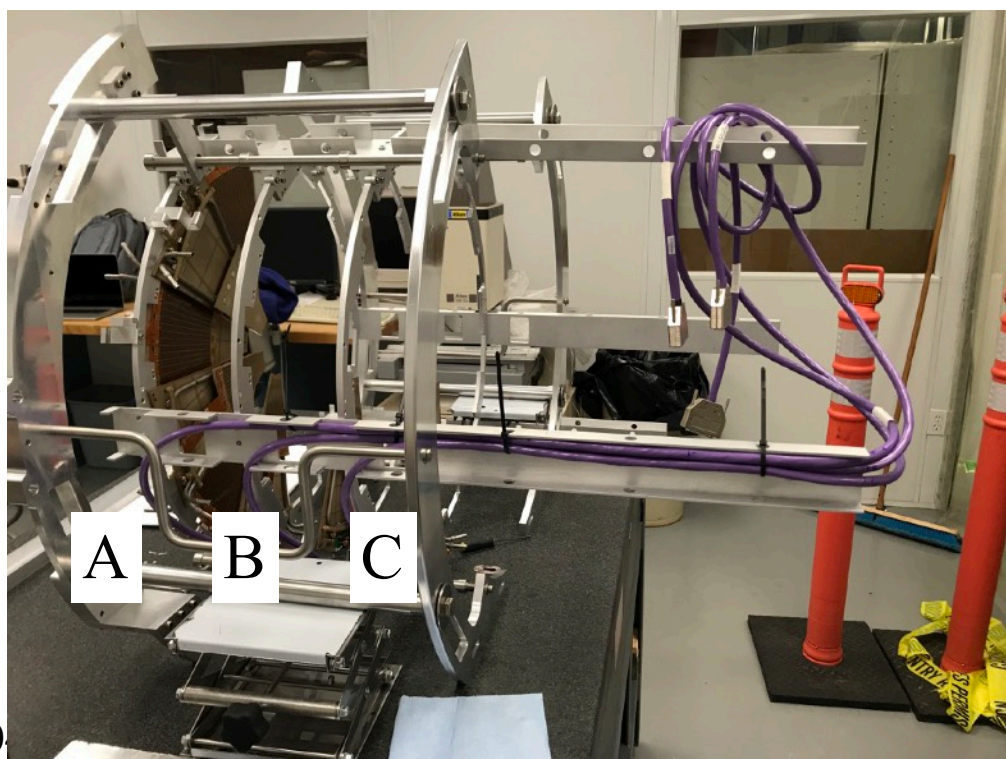




# Purple Cable Length Check



- Purple Cable Length: measured from T-board to the end of cable tray:
  - 1:  $38.5 + 5.5$  in
  - 2:  $36.5 + 5.5$  in
  - 3:  $45.5 + 5.5$  in
  - 4:  $34.0 + 5.5$  in
  - 5:  $45.5 + 5.5$  in
  - 6:  $52.5 + 5.5$  in



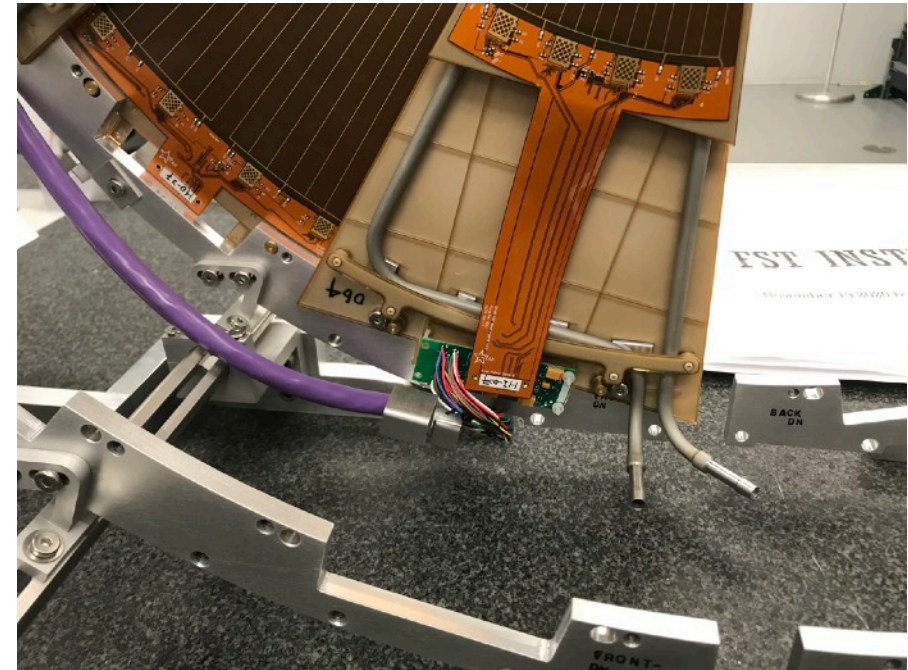
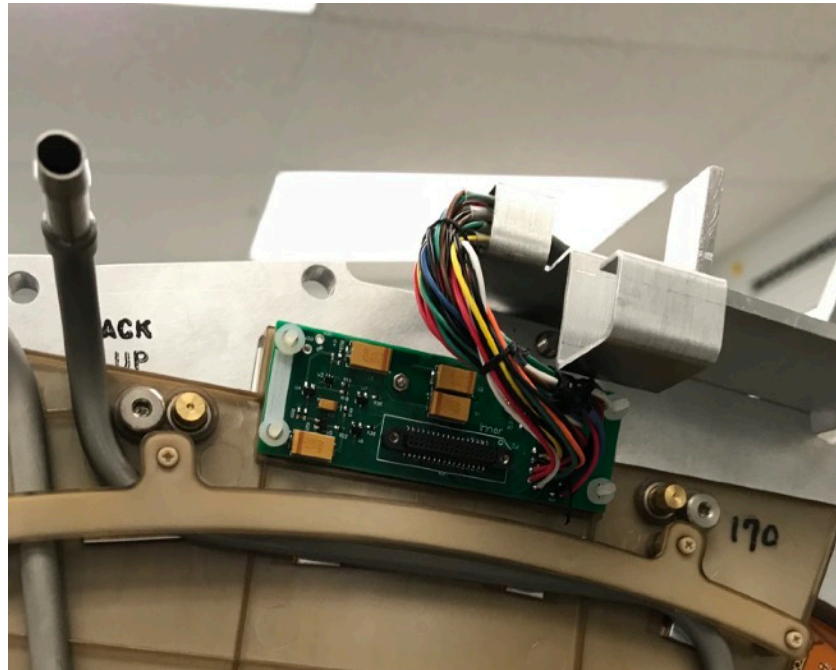
- Purple Cables are mounted on the bottom module (6 in previous slide & longest cable) on three disks.
- Cable length:
  - A:  $52.5 + 5.5$  in
  - B:  $47.5 + 5.5$  in
  - C:  $42.5 + 5.5$  in
- The distance between disks is 5 in (measured) and consistent with the difference on cable length.



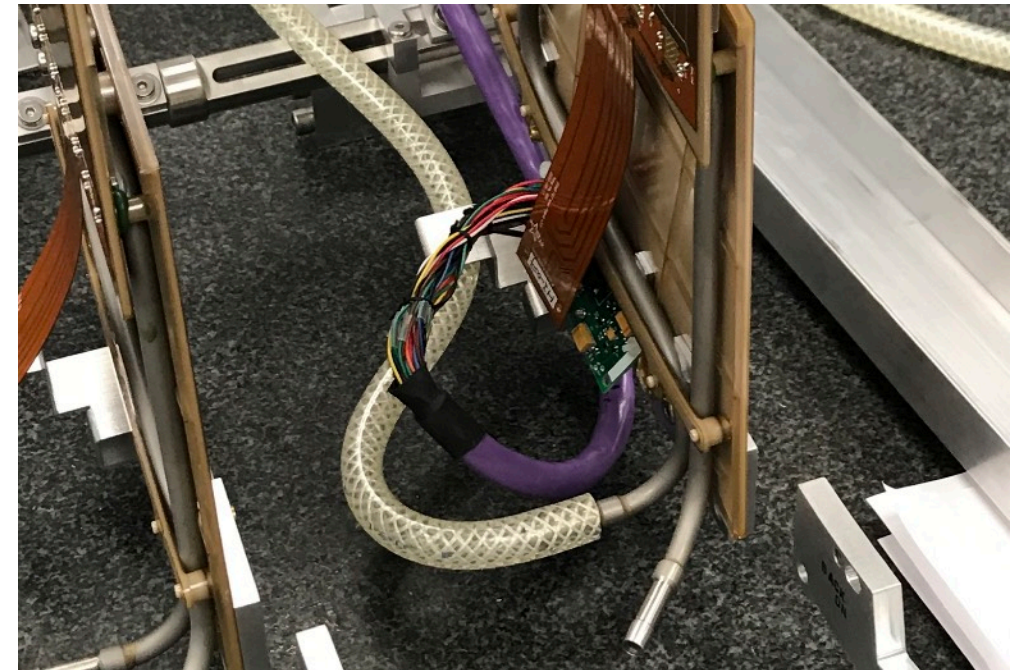
# New Purple Cable Routing



Old Routing



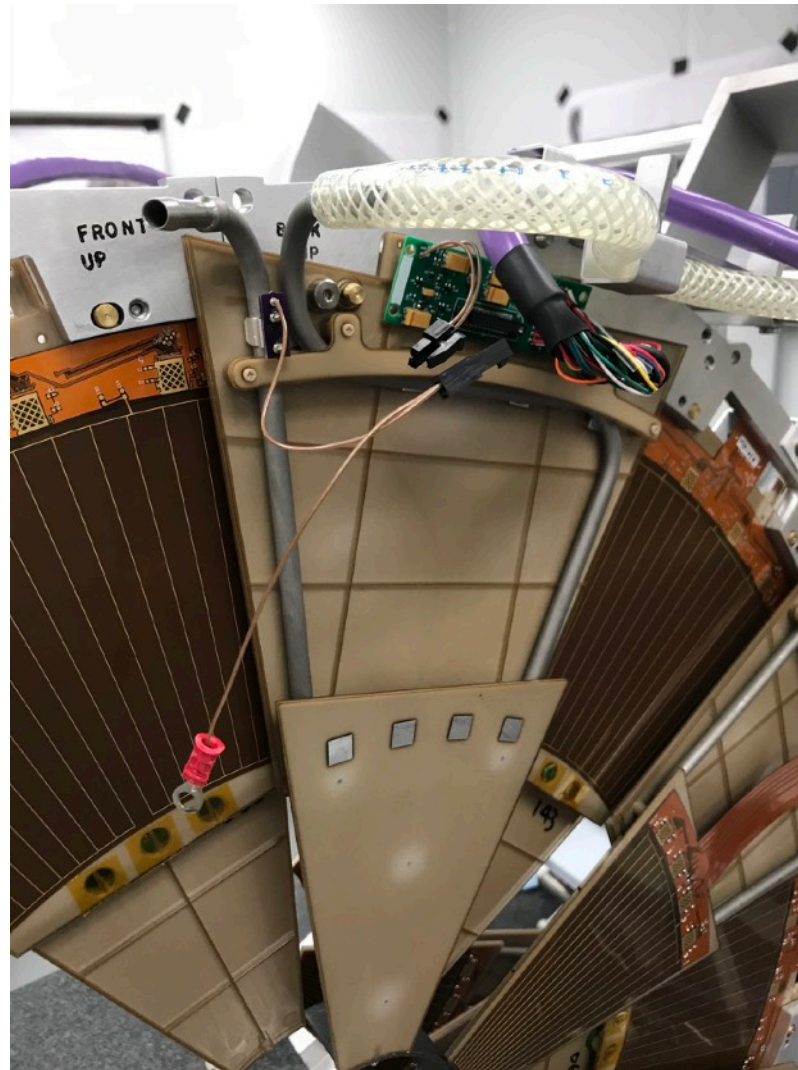
New Routing



- New routing removes the force from cable but introduce 5.5 in longer purple cable.



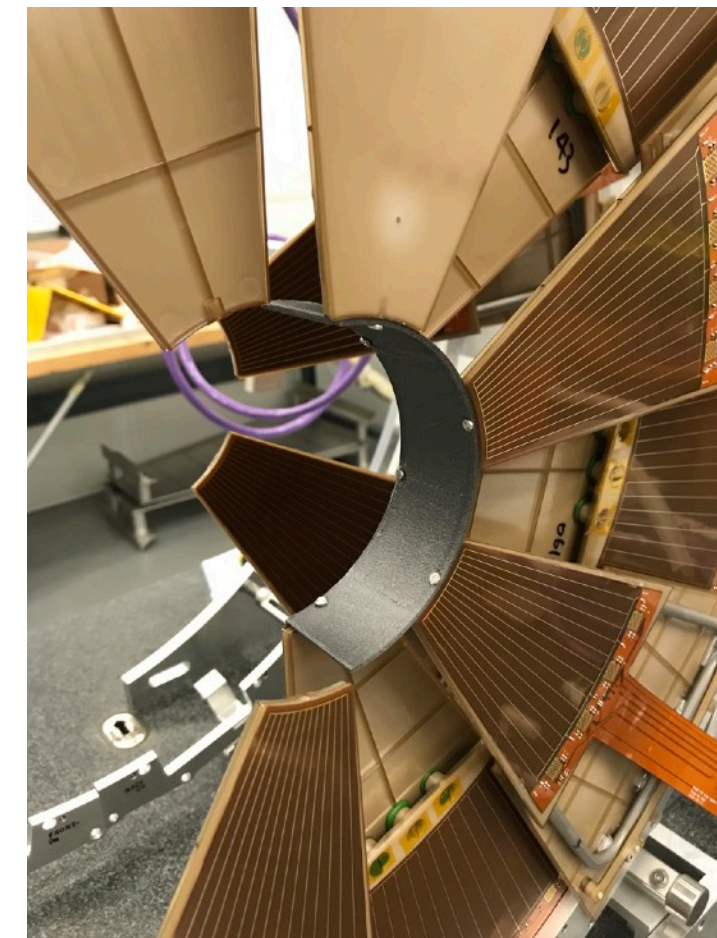
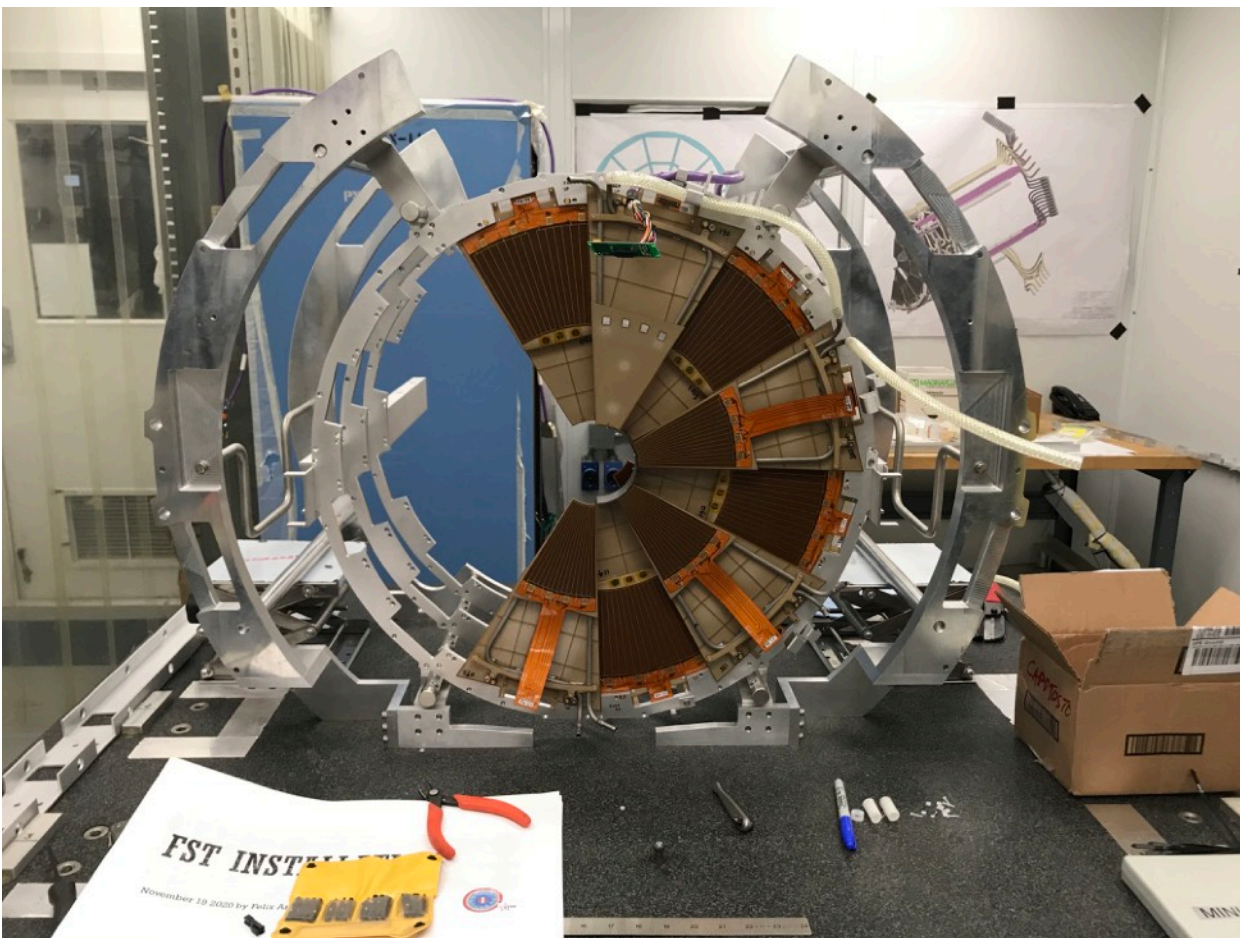
# Cooling Tube Status



- Soft cooling tube length: 41.5 cm.
- Soft cooling tube do NOT conflict with other part of detector under current assembly.
- Cooling tube (Stainless Steel) is grounded to the T-Board and Support Structure.



# Dummy Module Mount



## Issues:

- Screws on support structure are not tighten => causing the movement of module while plugging the soft cooling tube.
- Screws on the fixture of module are not tighten => causing the cooling tube detached from from the heat sink while plugging the soft cooling tube.
- Small deflection still exists while plugging the soft cooling tube.



# Readout System



- Test stand setup in the clean room: 1 MPOD Crate + 3ISEG + 1ARC+ 3ARM + 3ABC
- DAQ software is working properly.
- MPOD crate is online and can be controlled by the slow control.

# MPOD Crates Slow Control — Expert



**Clean Room**  
Main Switch for Crate 1

**MPOD02**  
Main Switch for Crate 2

Main Switch for crate 3

Diagram showing the overall control interface for MPOD02, including main switches for three crates and various bias and ramp control modules. A red box highlights the 'Status Overview c2' and 'Ramp Controls' sections for Crate 2.

**iseg.adl**

u-EHS 8 060n  
fstmpod02

Main Switch  
80 main0n(0)

MONITOR

Table of output channels (u0 to u7) with parameters: VOLTAGE (V), CURRENT (A), TRIP DELAY (ms), and Ramp Rate (V/s). A 'Fix Trip Setup' button is visible.

**hv\_status\_overview.adl**

fstmpod02

Main Switch  
80 main0n(0)

PHYSICS MONITOR

Module temp (C)	RAMP RATE (V/s)	VOLTAGE (V)	CURRENT (A)
23	5	70,000	10,000e-06
23	5	70,003	0,000000e+00
23	5	140,000	10,000e-06
23	5	140,003	0,000000e+00
23	5	70,000	10,000e-06
23	5	70,003	0,000000e+00
23	5	140,000	10,000e-06
23	5	140,004	0,000000e+00
23	5	70,000	10,000e-06
23	5	70,001	0,000000e+00
23	5	140,000	10,000e-06
23	5	140,006	0,000000e+00
23	5	70,000	10,000e-06
23	5	70,001	1,000000e-06
23	5	140,000	10,000e-06
23	5	140,003	0,000000e+00

Ramping

Module temp (C)	RAMP RATE (V/s)	VOLTAGE (V)	CURRENT (A)
-999	5	70,000	10,000e-06
-999	5	70,003	1,000000e-06
-999	5	140,000	10,000e-06
-999	5	140,006	0,000000e+00
-999	5	70,000	10,000e-06
-999	5	70,004	0,000000e+00
-999	5	140,000	10,000e-06
-999	5	140,006	0,000000e+00
-999	5	70,000	10,000e-06
-999	5	70,004	0,000000e+00
-999	5	140,000	10,000e-06
-999	5	140,006	0,000000e+00
-999	5	70,000	10,000e-06
-999	5	70,003	0,000000e+00
-999	5	140,000	10,000e-06
-999	5	140,002	1,000000e-06
-999	5	70,000	10,000e-06
-999	5	70,003	0,000000e+00
-999	5	140,000	10,000e-06
-999	5	140,002	1,000000e-06

**iseg\_ramp\_controls.adl**

Main Switch  
80 main0n(0)

ENABLE RAMP

Channel	PHYSICS V	STANDBY V	V Step
u0	70	0	70
u1	140	0	140
u2	70	0	70
u3	140	0	140
u4	70	0	70
u5	140	0	140
u6	70	0	70
u7	140	0	140

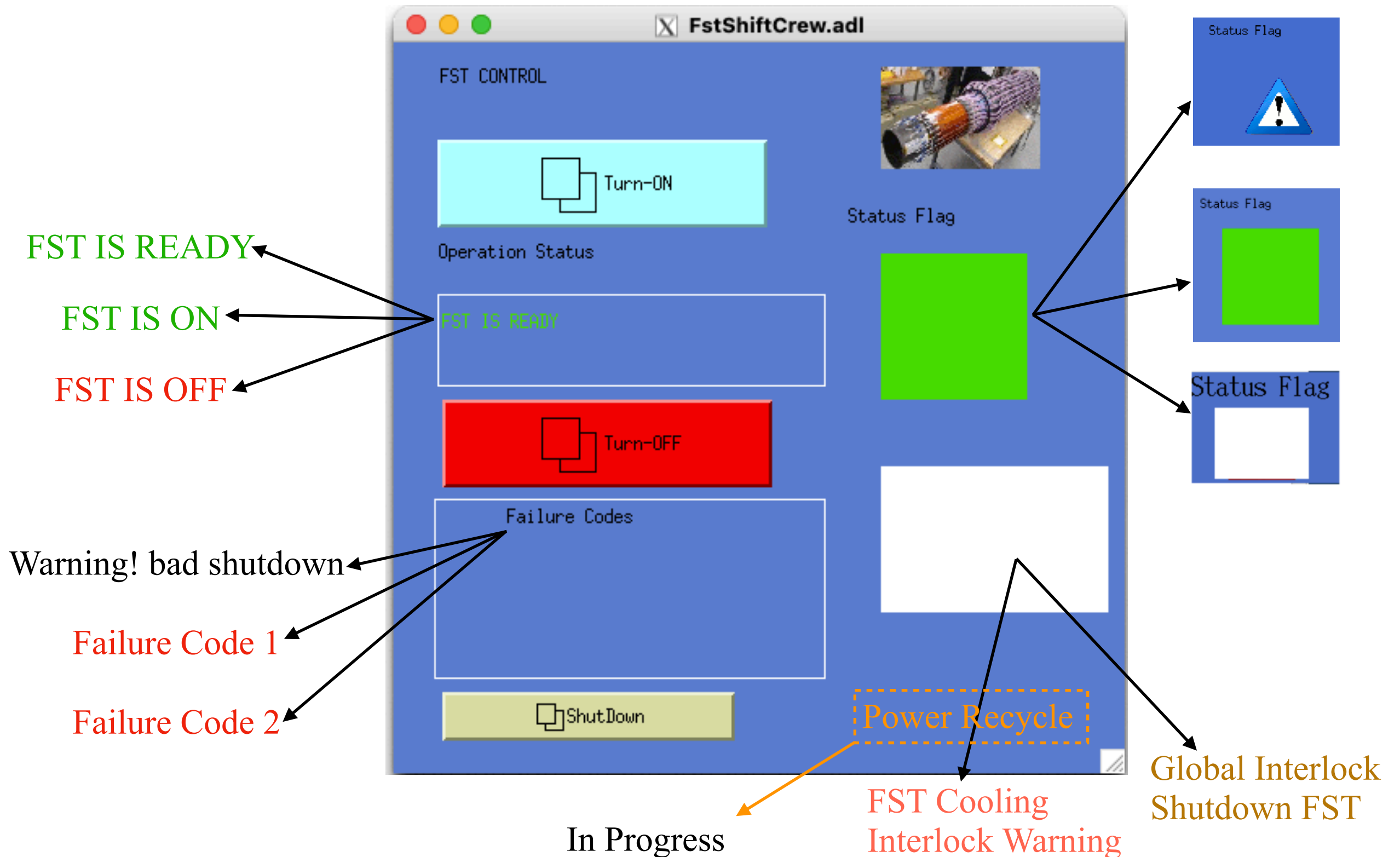
SlowRamp V/s: 5, FastRamp V/s: 5, Delay (s): 0

Buttons: Load Config, Save Config

Path: /home/sysuser/iocTop/FST/HW/mpod02/def



# MPOD Crates Slow Control — Shift Crew



# FST Cooling Slow Control



## EPICS Interface

The EPICS interface consists of several windows:

- IST.adl (IST Cooling System):** Displays Chiller (Setpoint 19.0 degC, Outlet Temp 19.2 degC, Inlet Temp 19.6 degC, Power 240.3 %, Heat Load 30.0 Watts), Interlocks, Reservoir (Temp 20.6 degC, Humidity 100.0 %, Pressure 14.6 psia), Pressure (psig) gauges, and Flow (l/min) gauges. Buttons for 'Control', 'Alarms', and 'Expert Settings' are visible.
- IST\_Chiller\_Control.adl (IST Chiller Control):** Features 'Chiller Power' (OFF/ON), 'Startup Mode' (ENGAGE), 'Sensor Reset' (RESET), 'Pump Start' (START), and 'Pump Stop' (STOP).
- IST\_expert.adl (IST EXPERT SETTINGS):** Shows PID parameters (Prop. BH 4.4, Deriv. Gain 0.00, Integ. Gain 0.09), Setpoint Limits (High 60, Low 16 degC), Alarm 1 and 2 settings, Coolant Fluid (Water), and 'Special Options'.
- IST\_Alarms.adl (IST COOLING ALARMS):** Displays Alarm 1 and 2 High/Low status, Cont. Sensor, Sec. Sensor, and Keypad Used, with an 'ALARM LATCH CLEAR' button.

Red arrows indicate the flow of information and control between these windows. A green box highlights a list of 10 numbered notes explaining the control logic.

1. Main Setpoint – only controls primary chillers. Aux chiller setpoint must be set locally
2. Power sent to primary chillers, as a fraction of 1500 W.
3. Very approximate heat load from detector – calculated using flowrate and temp. rise. Low precision (+/- 75 W).
4. Main Chiller enable. Local switch must be set to "Remote" for this to have any effect.
5. Temporarily turns off ADCs and sensors, forcing them to reset
6. Primary chiller PID parameters
7. Low temp alarm – should be set above maximum expected dewpoint in the hall
8. Fluid medium used in calculation of (3.)
9. Additional TC-48-20 options for experts only
10. Alarm status from TE-48-20. If latching is enabled (not expected), these can be reset here

- Re-use of old IST cooling slow control.
  - FST use the same cooling system as IST => a natural choice to re-use old IST cooling slow control system.
- GUI for Expert
  - Operation, monitor and alarm are all based on sequencer.
  - Need to modify old IST sequencer for FST setup => adjust flow speed limits.
  - Need to modify old IST GUI for FST => adjust naming and pictures.
- Updates will start after the cooling system back online.

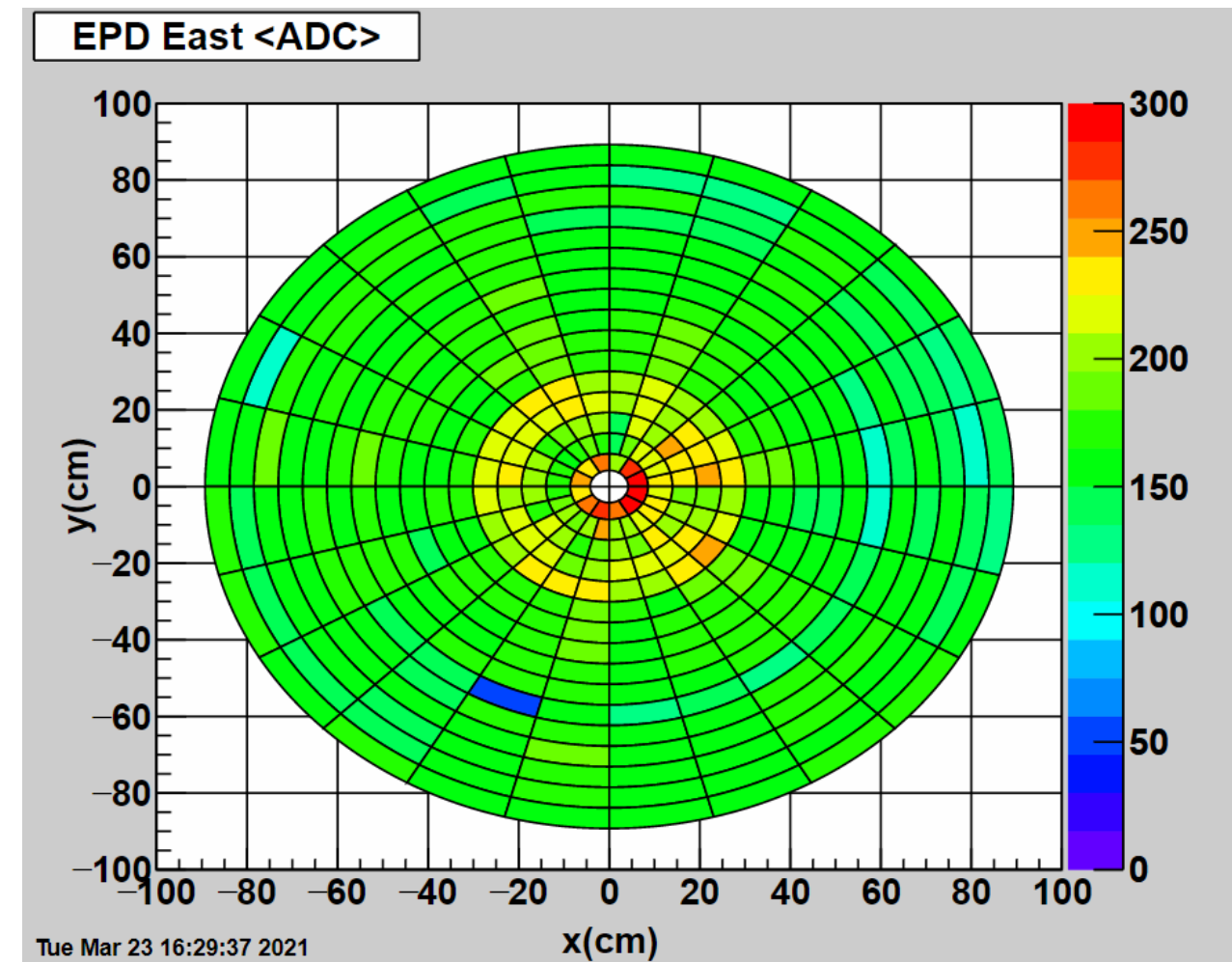
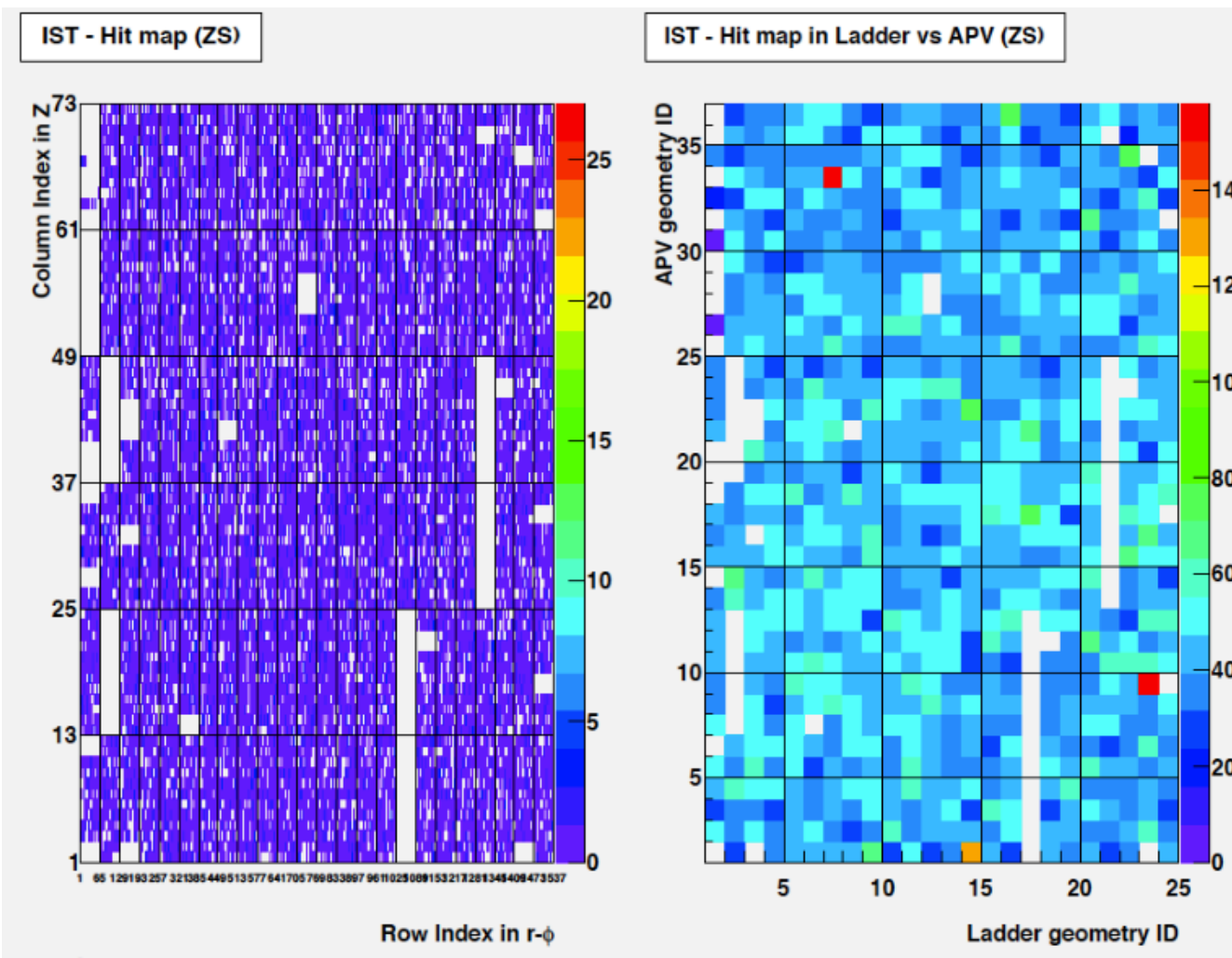


# Online Monitoring



IST

EPD -> FST



- Re-use the old IST online QA plots with modification for FST.
- Able to check out and compile old IST code.
- Need to update to FST geometry.
- Will test with the data collected in the DAQ integration test, then send to Jeff for implementation.
- Plan to use similar style as EPD.

# Online Zero-Suppression—Noise



Chip's output signal  $PH_i^k$  (channel k of i-th event) can be described as a sum of following components:

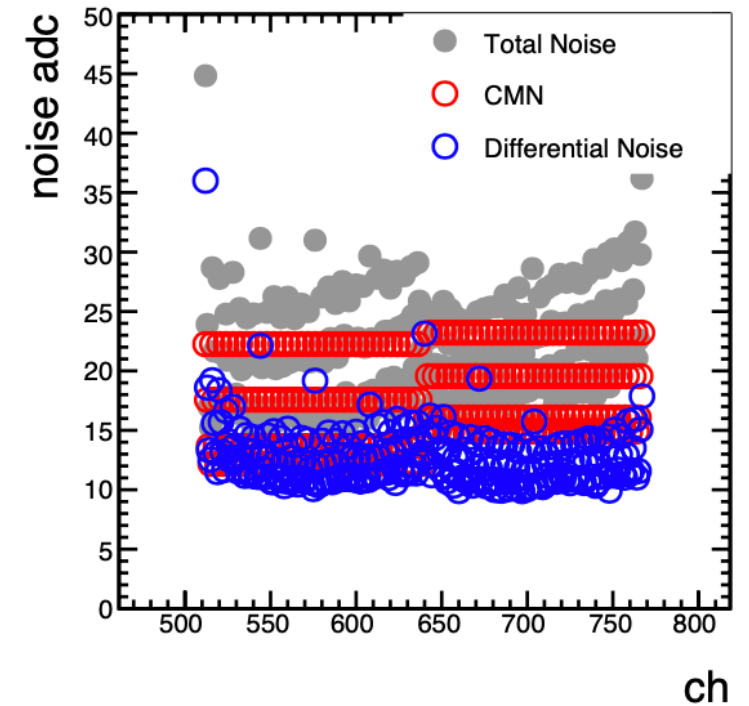
$$PH_i^k = S_i^k + P^k + N_i^k + C_i$$

- $S_i^k$  is the chip response to the injected charge
- $P^k$  is the pedestal level
- $N_i^k$  is the random noise
- $C_i$  is common mode noise

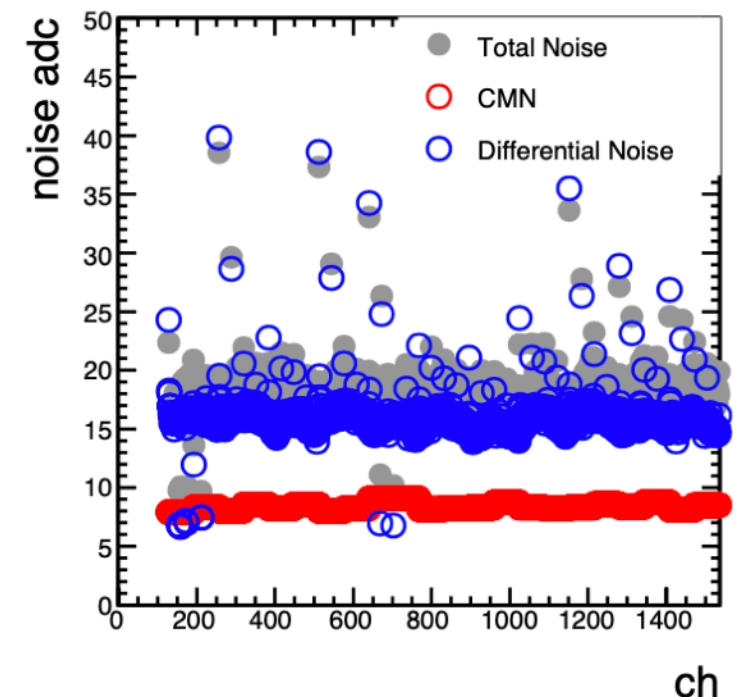
$$C_i = \frac{1}{N_{channel}} \sum_{k=1}^{N_{channel}} (PH_i^k - P^k)$$

- $N_{channel}$  is all channels within the same group without signal (hit) => in our analysis we average all channels in same APV and same R-Strip into one group (32 channels in each group)
- Comment Mode Noise (CMN) has significant contribution to the total FST noise (different to IST), therefore, needs to be subtracted in Zero-Suppression DAQ.

FST Noise



IST Noise

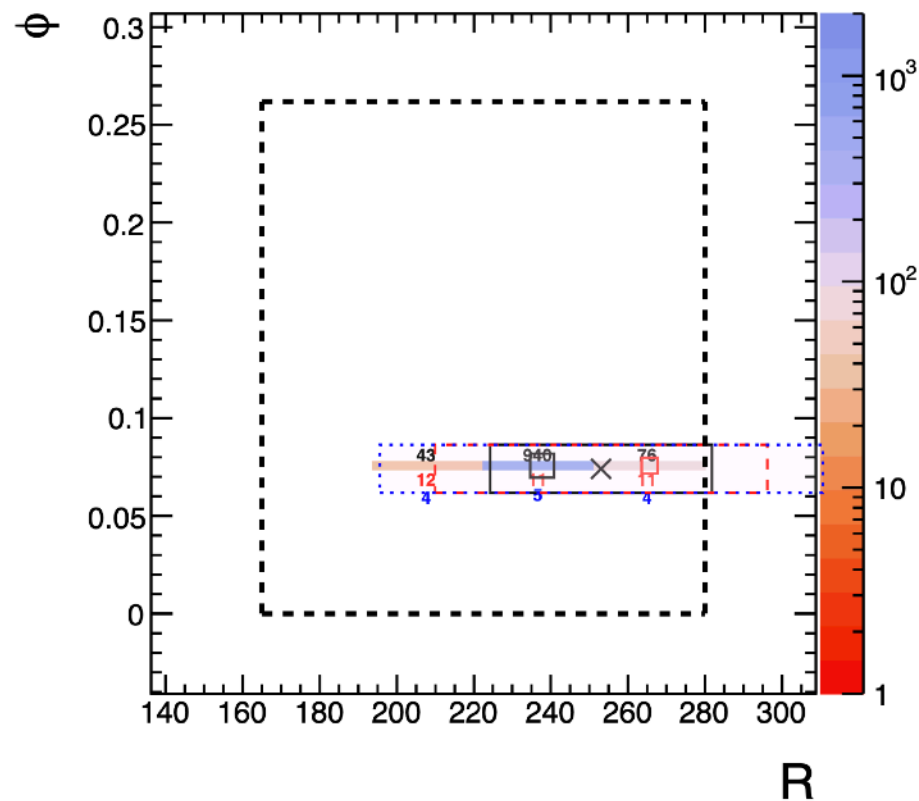




# Online Zero-Suppression—Signal

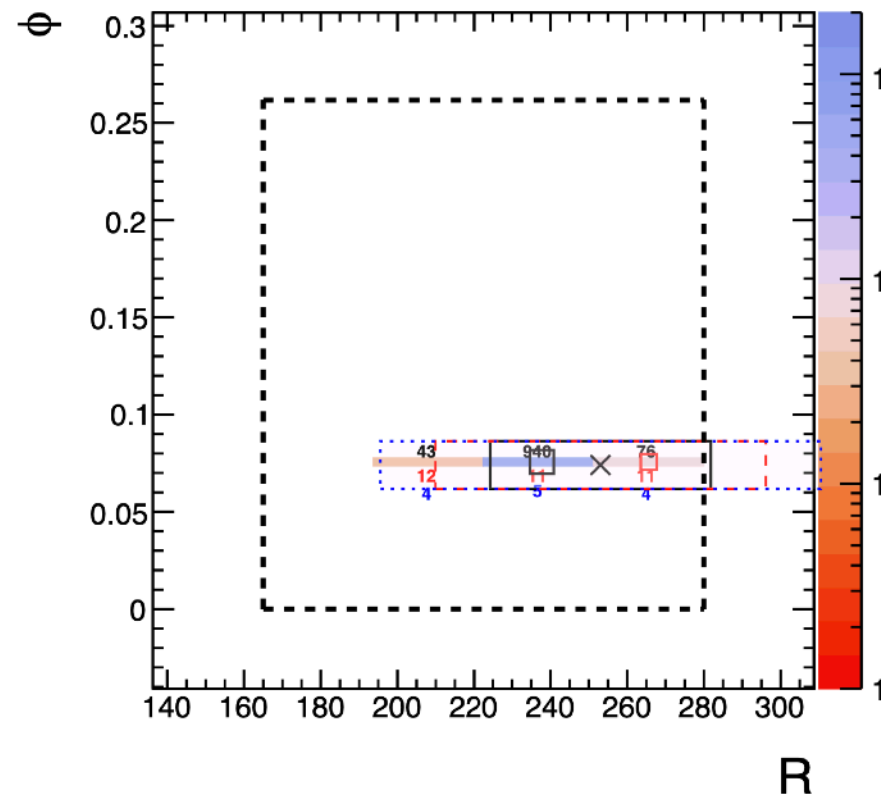
Time Bin 2

Event 1561 (Threshold: 2.5)

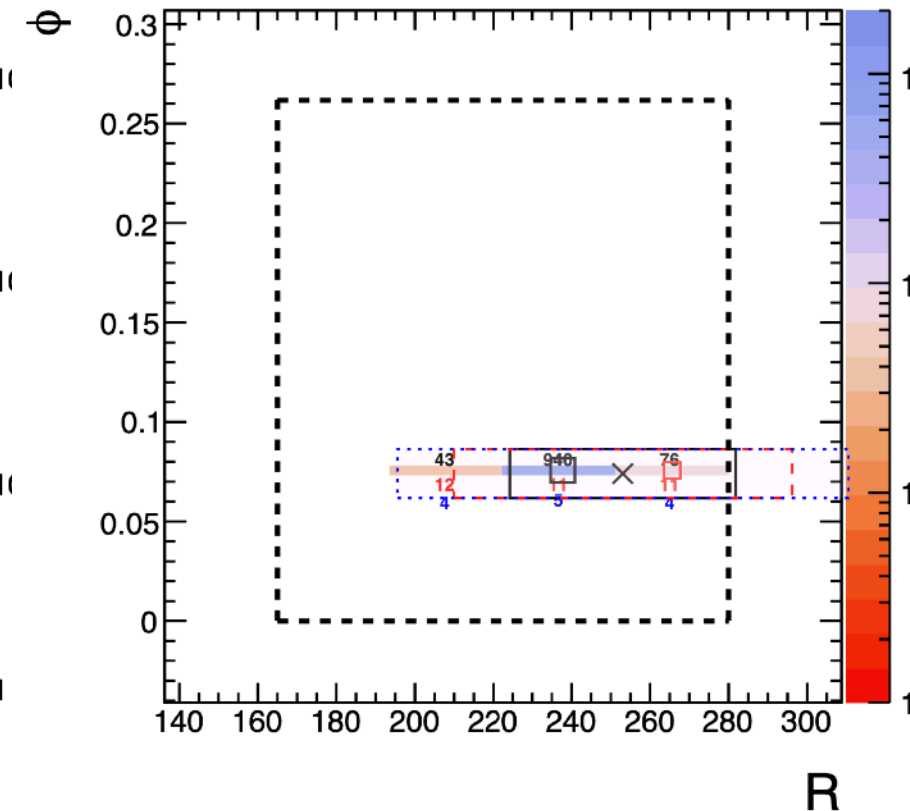


Time Bin 1

Event 1561 (Threshold: 3.5)



Event 1561 (Threshold (TB2): 2.5 & Threshold (TB1): 3.5)



- Requiring a seed with Threshold larger than 4.0 and 2 Time bin.
- Hit threshold 2.5 with 2 Time Bin requirement can reject non-cluster noise very well.
- Hit threshold 3.5 with 1 Time Bin requirement has the similar effect on non-cluster noise after we did a threshold scan.
- The final cluster will include hits with hit threshold 2.5 & 2 time bin or hit threshold 3.5 & 1 time bin when a seed is found.

# Summary and Outlook



- Checked purple cable routing and cooling tube routing.
- Setup DAQ and RO system.
- HV Crate slow control is ready.
- Need to update cooling slow control and online plots.
- Will start real module mounting once the support structure is ready.