Summary of the test beam at DESY 2019 for SiW-ECAL

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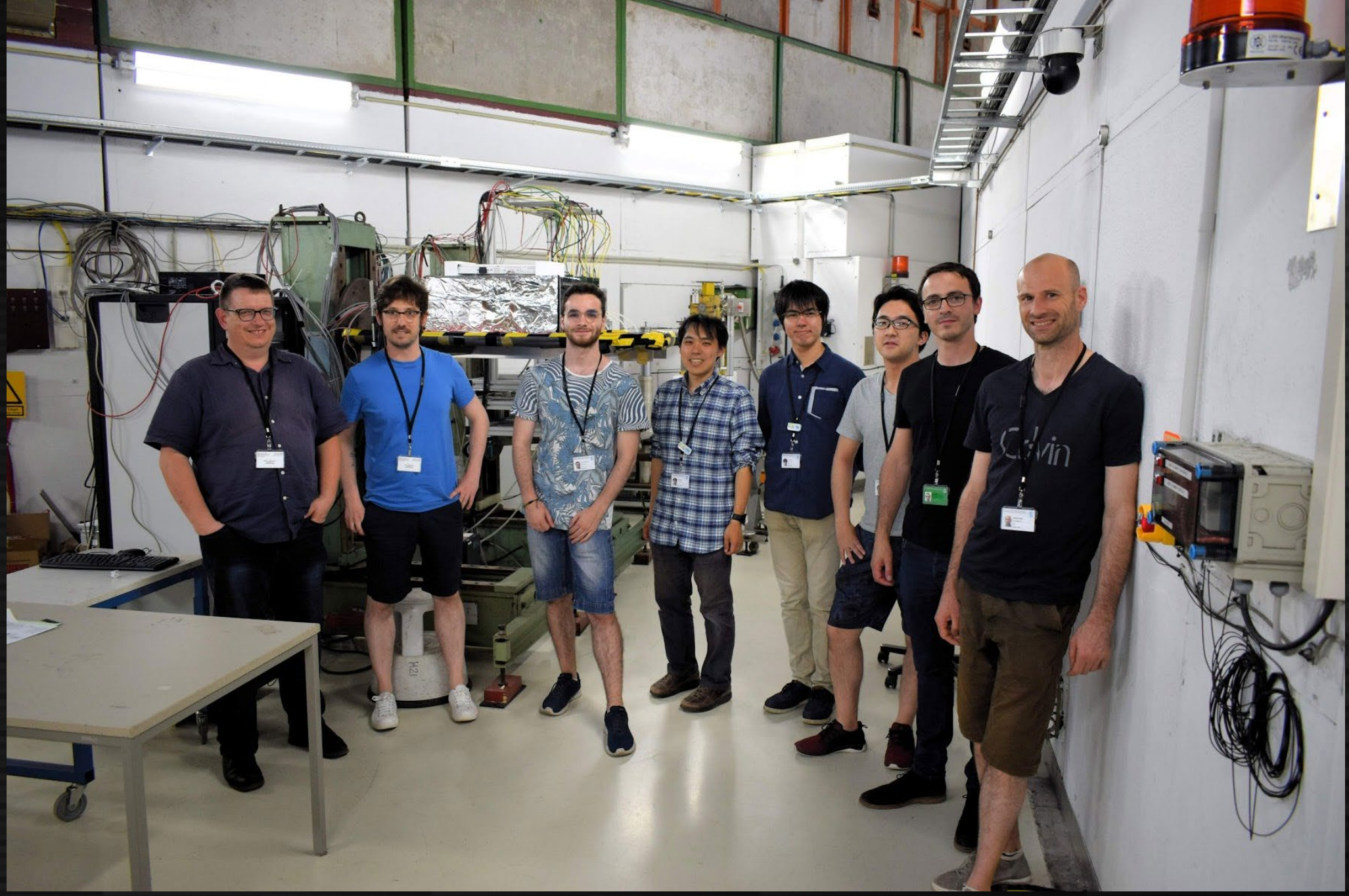
on behalf of SiW-ECAL group

Test beam: overview

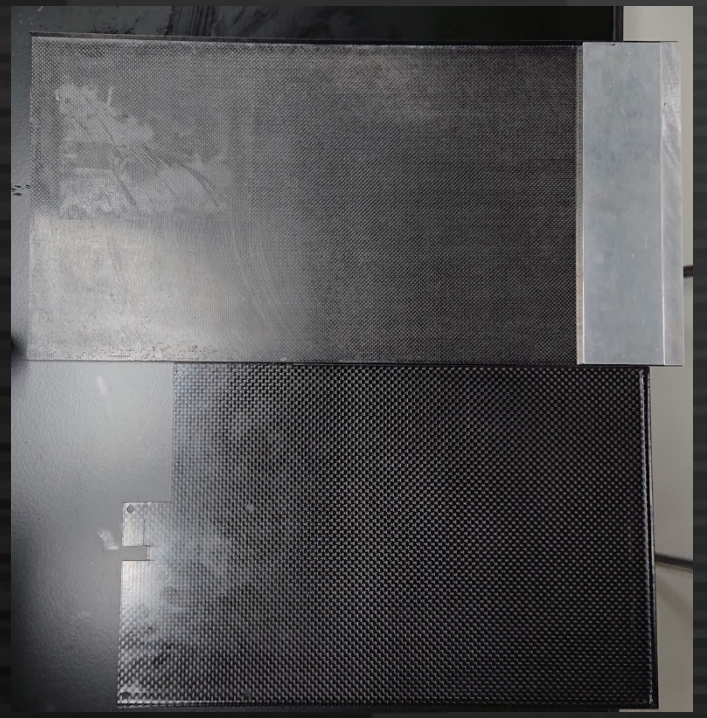
- 24 June – 6 July, TB24 at DESY
- 9 layers
  - 5 x FEV13 from Kyushu, 2 x FEV12BGA + 2 x COB from LAL
  - This talk only covers FEV13 part
- 3 GeV for MIP, 1-5 GeV for shower
- 3 from Japan (Y. Kato (Tokyo), K. Goto (Kyushu) and TS)



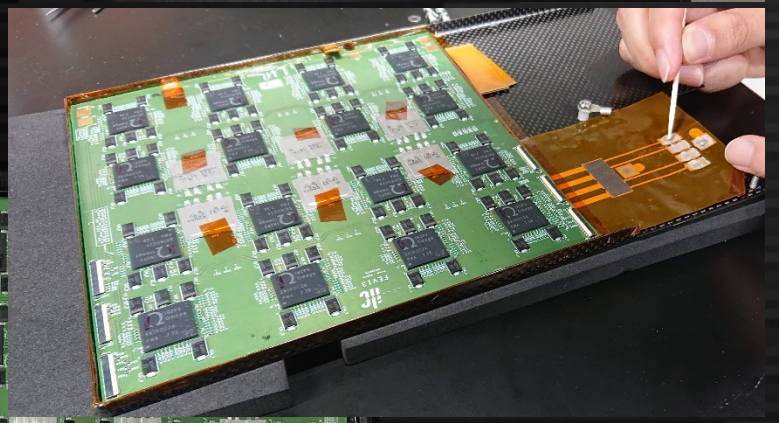
FEV13 layers

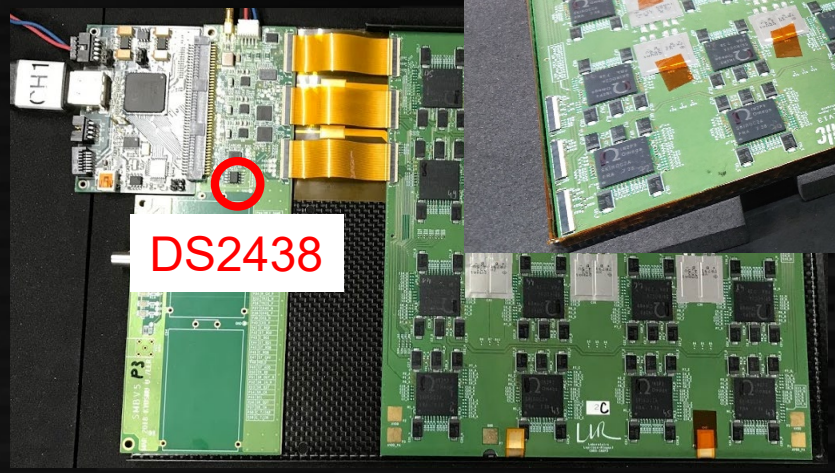
- Modification/improvement from previous TB @ CERN
  - Replace the backing plate / cover
    - Newly made carbon sheets
      - No problem on HV connection any more (except for the fragile MMCX connector)
  - Temperature monitoring on SMB
    - Implemented last year but not used
    - Separate script to acquire the temperature every 1 min
  - 5 MHz clock (with new firmware)
    - Power-pulsing delay tuned (not done in the previous TB)

Old
(reused from FEV8)

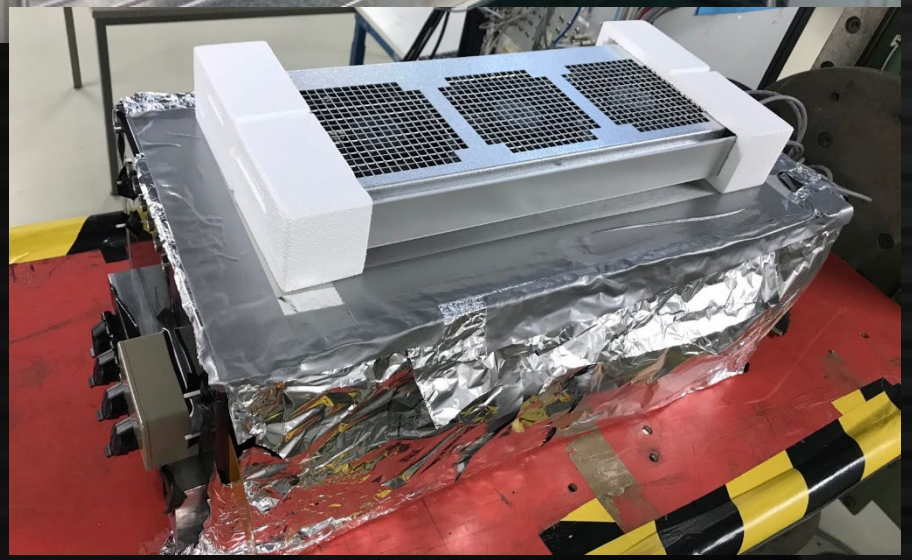


new





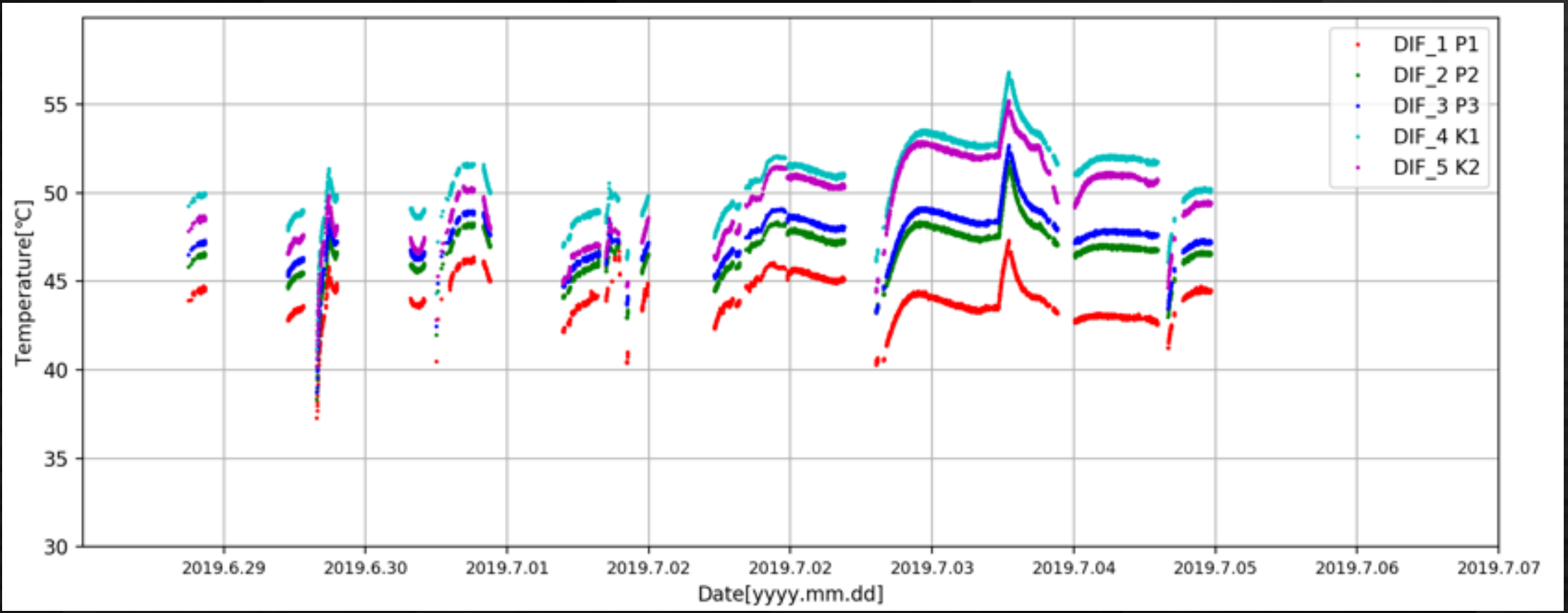
Assembly to the LAL box



Technical issues

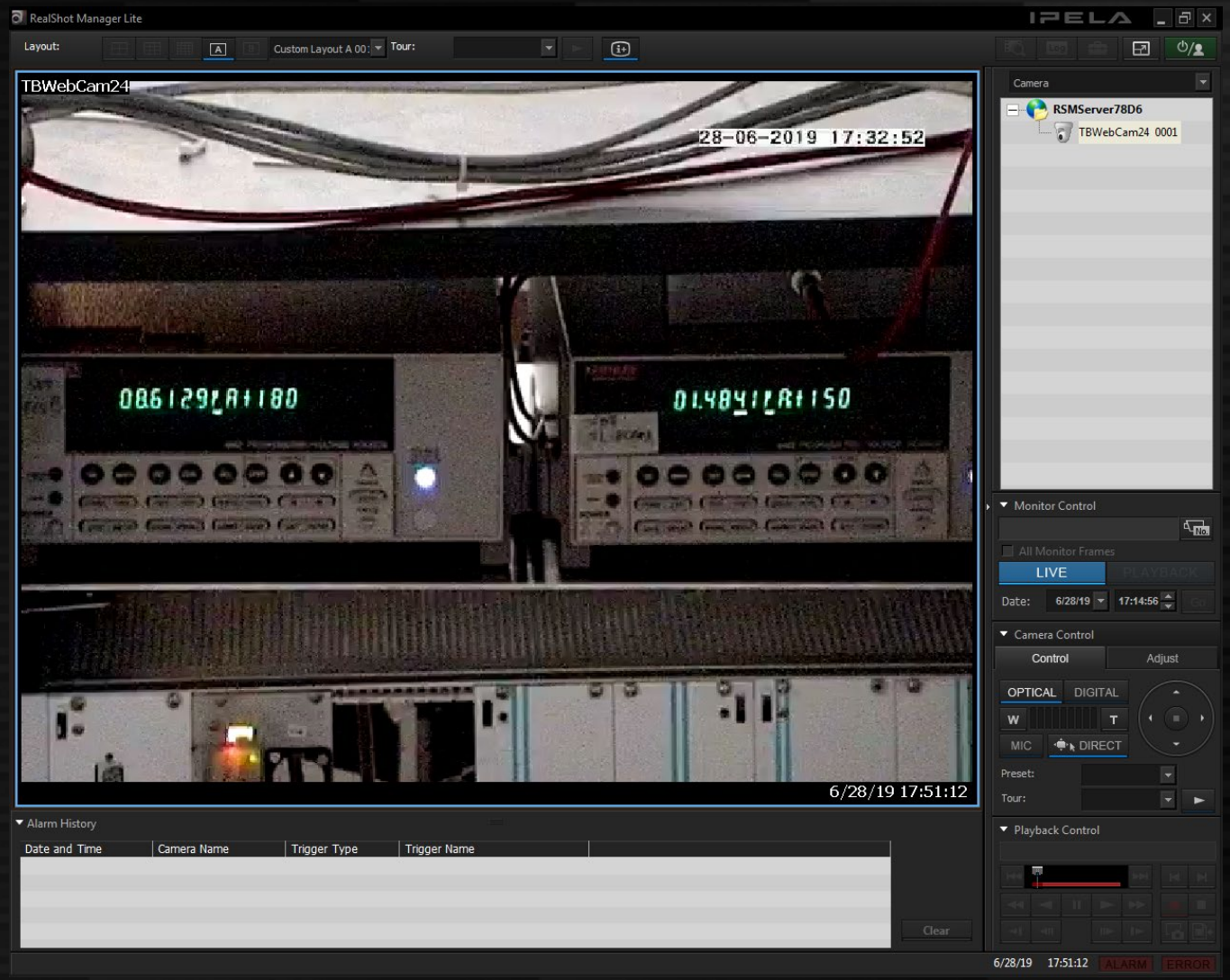
- HDMI connection
  - Data loss or corruption sometimes occurs
  - Once: replace DIF to a spare (thanks to a stock from LAL)
  - Need to support the heavy cables (partially done with cable ties)
- HV connector (MMCX) easily broken at SMB
  - Needed to re-solder several times
  - Should be replaced in the next design
- Imperfect insulation of new carbon frame (HV: 180/150 V)
- Cable connection complicated
  - 1 HV + 1 SMB + 1 DIF (loose) + HDMI / layer

Temperature



Quite high at center of the box – no air flow (fan is placed outside)
Kyushu layers are power-pulsed: LAL layers are not
Leakage current increase also seen (but not 100% correlated)

Leakage current



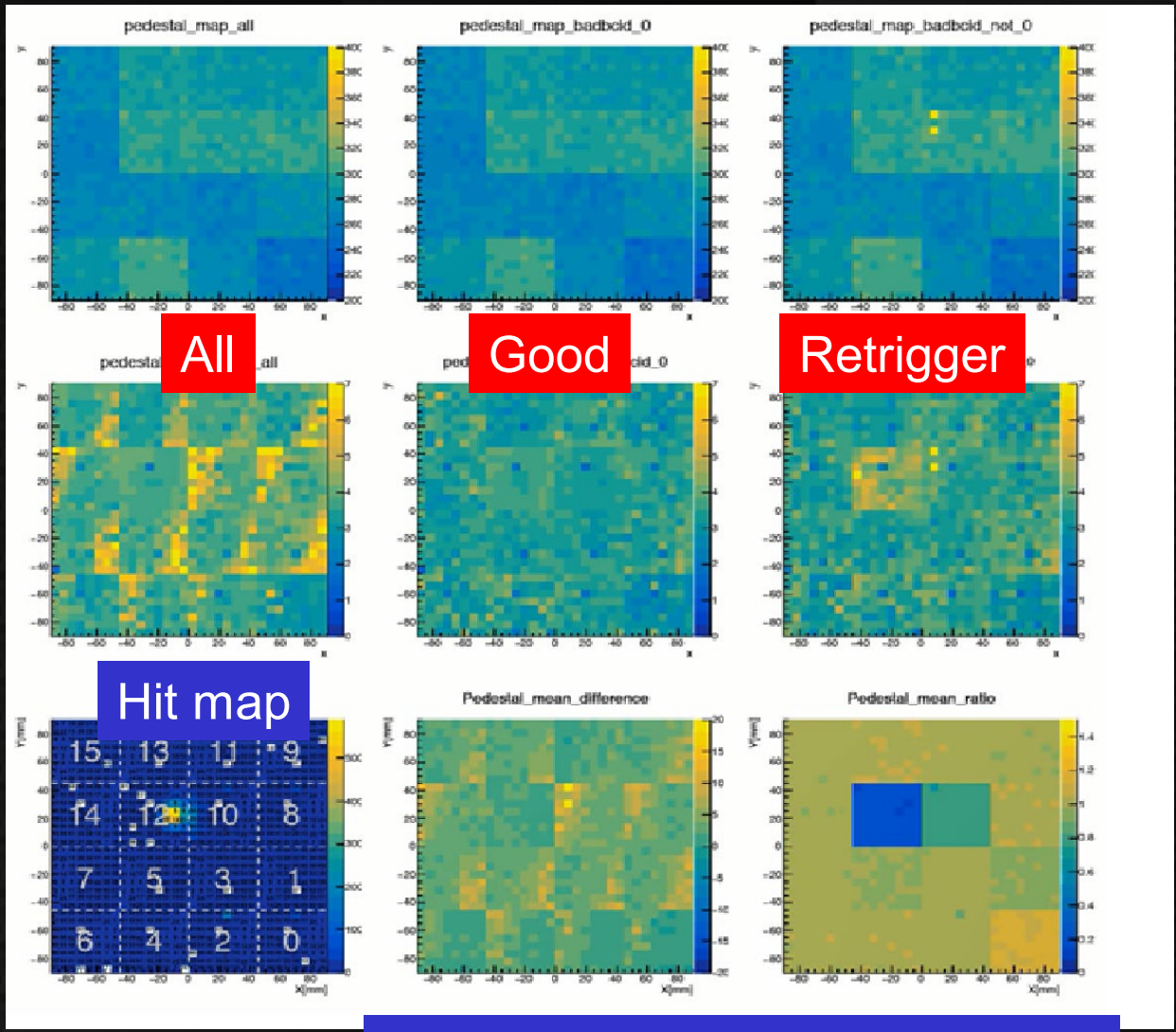
Program

- MIP programs
  - Position scan
  - S-curve
  - Angle beam (to calculate active thickness)
  - TDC
  - Retriggering / double pedestal
- Shower program
  - TDC / autogain
  - Retriggering
  - Edge effect

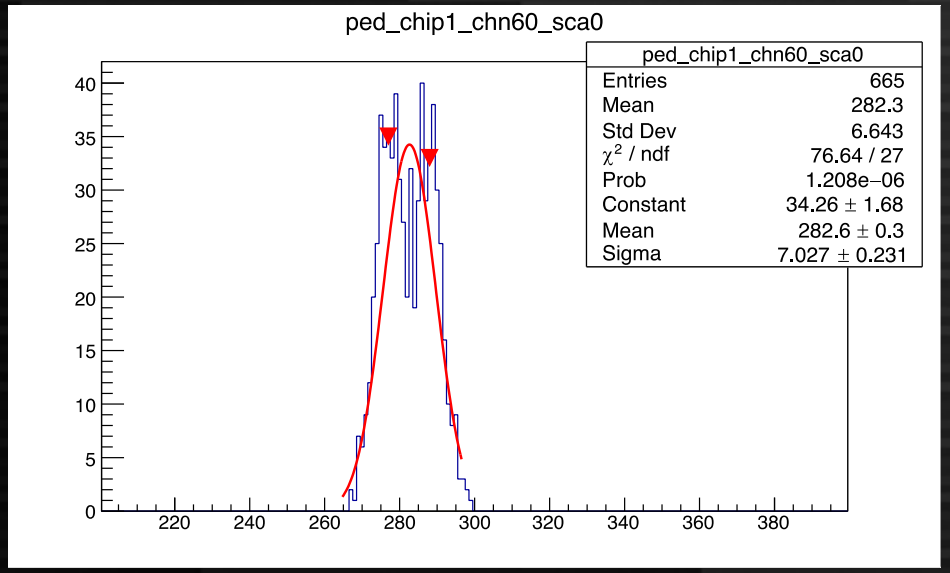
Quick view: pedestal

Pedestal mean

Pedestal width

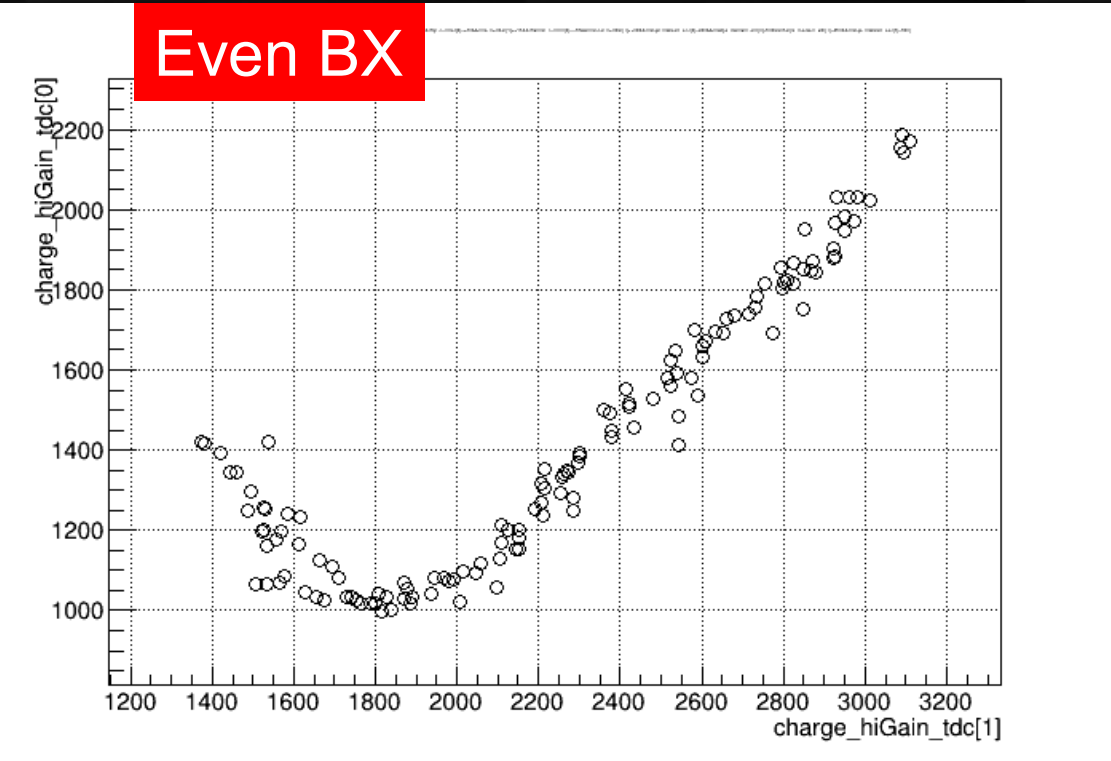


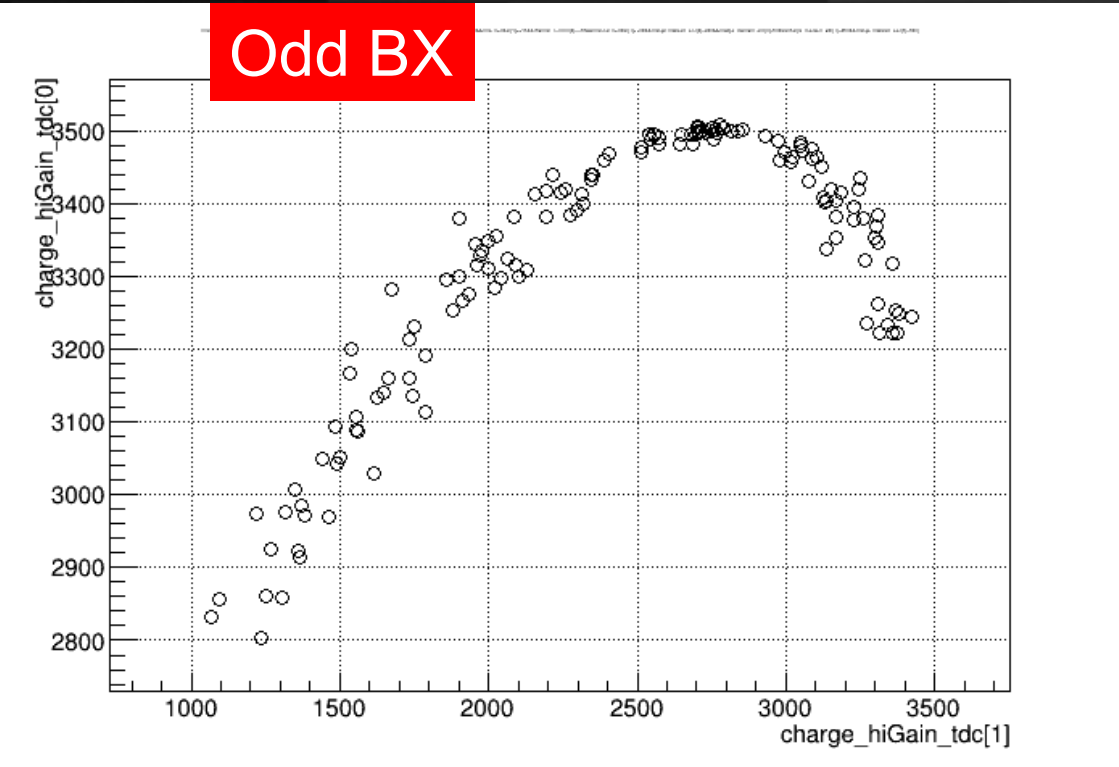
Double pedestal difference/ratio



Double pedestal

Quick view: TDC with MIP





- Correlation of TDC between slab 1 and 2
- Select 1 ch (at the center of the beam), 450 < ADC < 500 (to avoid timewalk)
- ~10 / 1 ns at the normal slope: timing resolution ~ a few ns?

To do for analysis

- Target: analysis will be completed by end of this year
  - Common event display for Kyushu+LAL layers
  - MIP analysis
    - Tracking: efficiency
    - Effect of threshold and retriggering
    - Gain variation
    - TDC: timing resolution and calibration
    - Effective thickness
  - Shower analysis
    - TDC: timing resolution vs signal height and sensor thickness
    - Energy resolution with comparison to simulation
    - Edge effect

- Summarize chip/PCB issues for the next production
- Shower analysis for paper

To do for hardware

- Optimize HV connection (and consider slab-slab HV connection)
- Optimize power-pulsing structure
  - Minimum delay time (and minimum power-on for A/D/DAC/ADC)
- 8-inch wafers (2020)
  - Including some modification on PCB design
- Connection to SL-board (after linux-based DAQ prepared)
  - Temperature measurement?
  - Connection needs to be modified
- Power-pulsing capacitor (current one already discontinued)