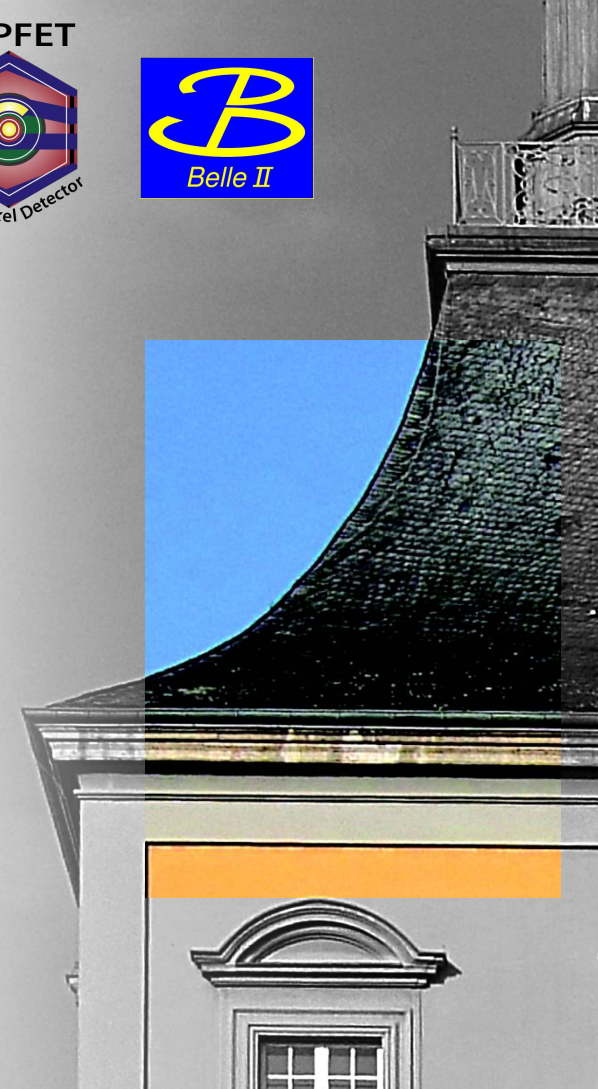
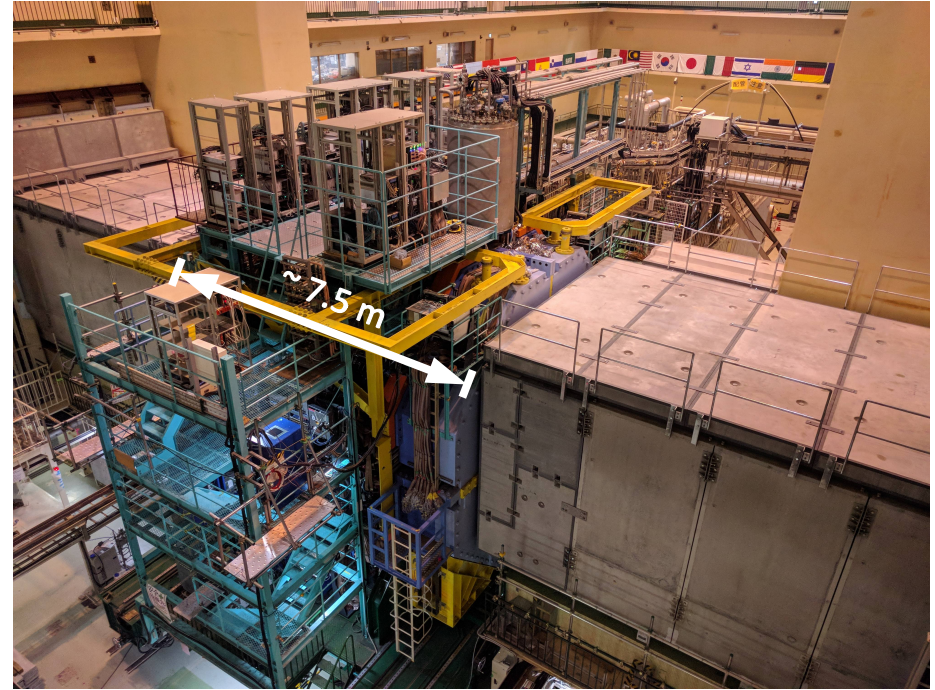
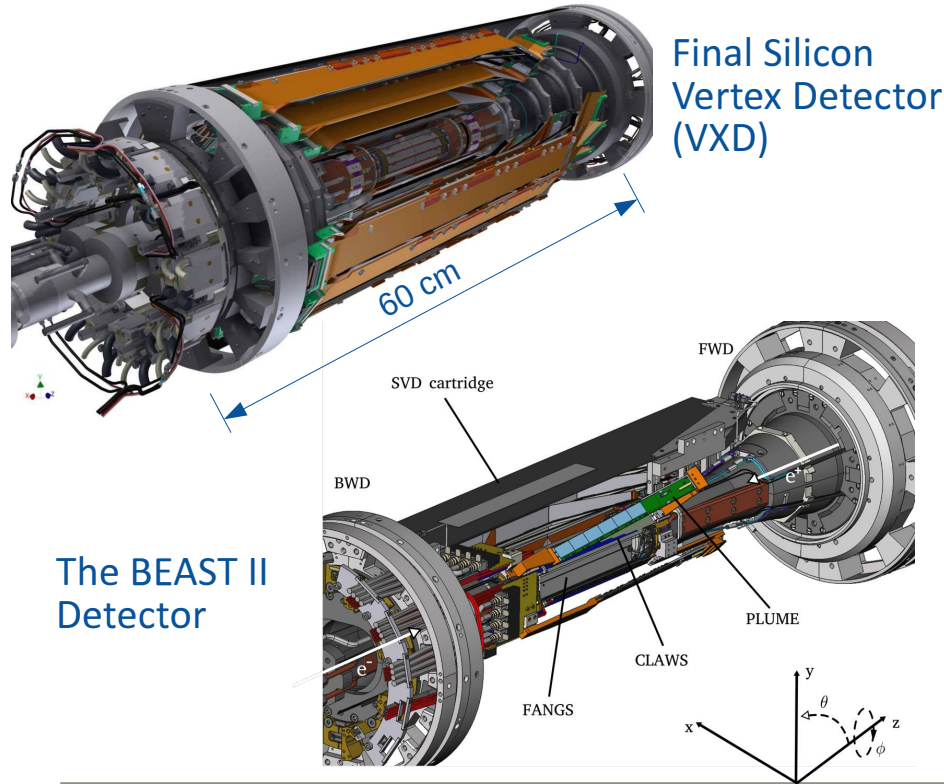


BOTHO PASCHEN FOR THE DEPFET COLLABORATION

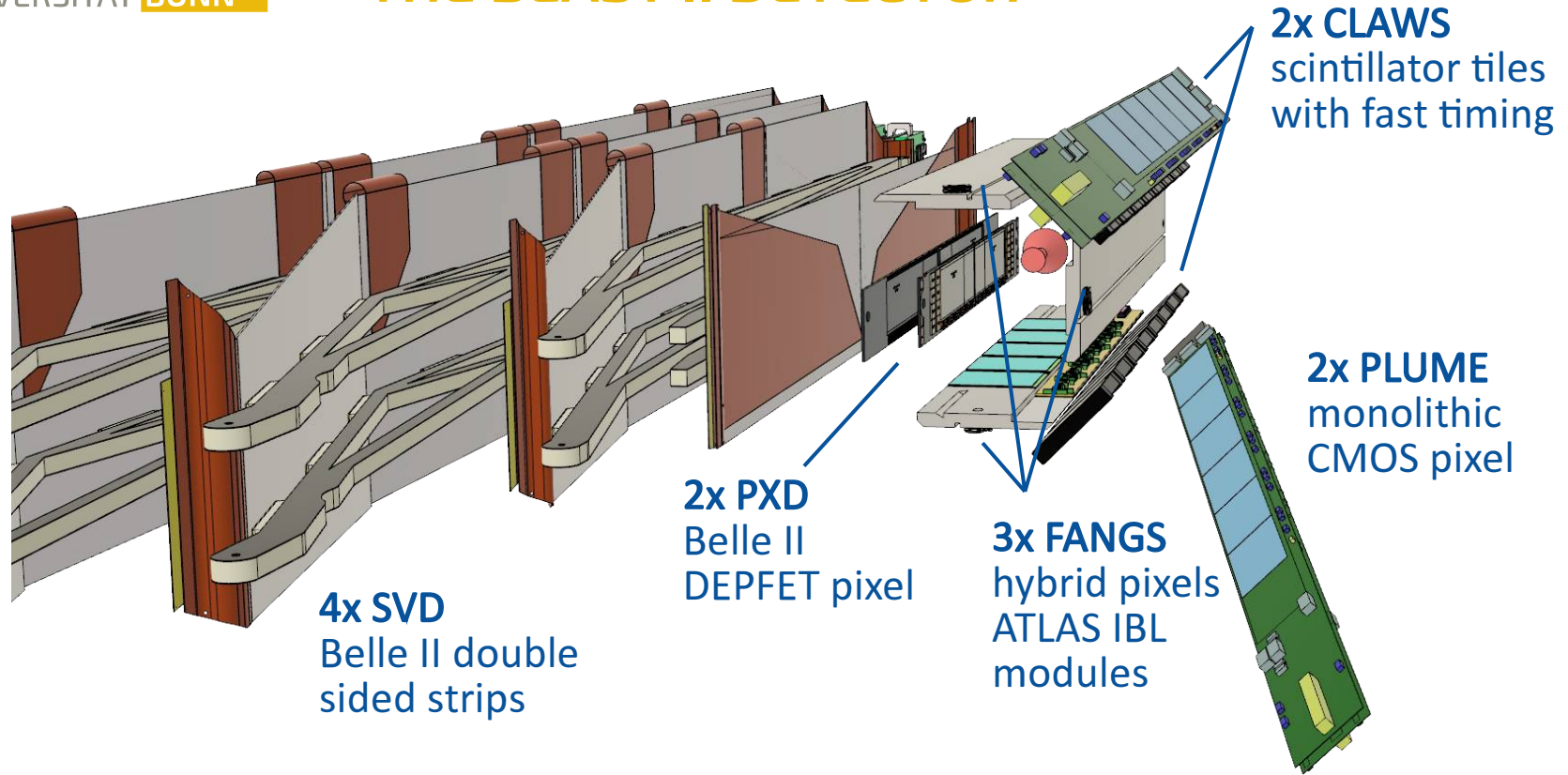
STATUS PHASE 2 PXD MODULES



PHASE 2 SUPERKEKB/BELLE II COMMISSIONING



PHASE 2 THE BEAST II DETECTOR



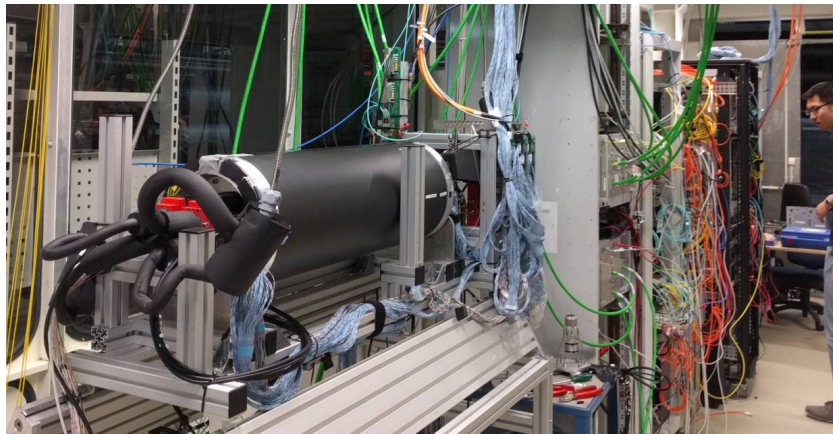
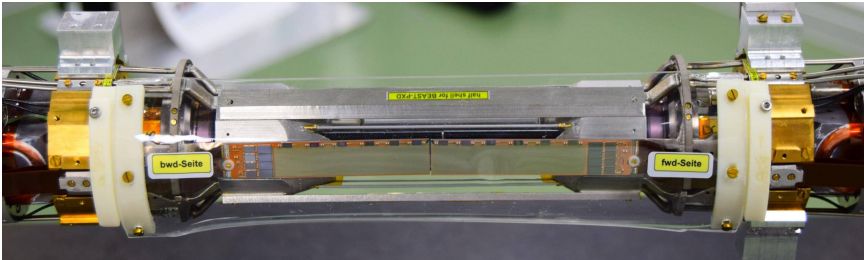
PHASE 2 PXD

- Modules partially tested in Germany in summer 2017
- Sent to KEK September 2017
- Attached to the beam pipe and integrated with the rest of the BEAST detectors Sep – Nov 17
- Insertion into Belle II mid November 17

2 layers of DEPFET pixels
4 modules
 $r = 1.4 \text{ cm}, 2.2 \text{ cm}$

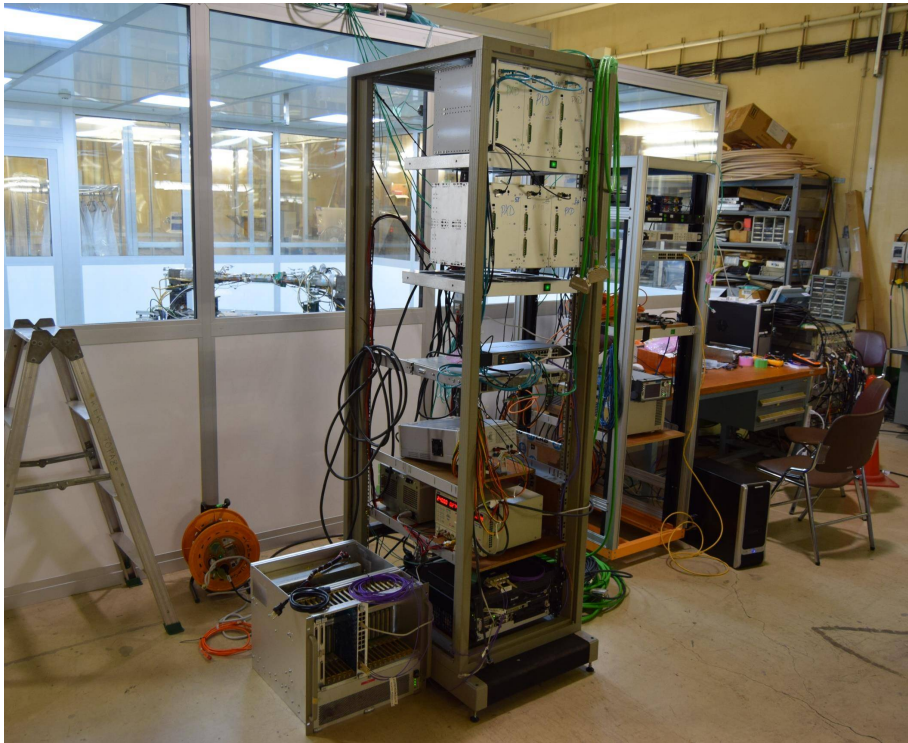


PHASE 2 PXD DETECTOR TESTS IN GERMANY



- W37_OB1
 - Tested in Bonn
 - No ADC optimization
- W37_OF1
 - Tested in Göttingen
 - No ADC optimization
- W46_IB
 - Tested at MPP/HLL
 - No ADC optimization
 - No source scans
- W37_IF
 - Untested after Kapton assembly
 - Untested at DESY
- Final tests at DESY (PERSY setup), August 2017
 - Foreseen as full system test before shipping
 - Not all components ready, some ready but missing (e.g. local DAQ computer, cables, breakout boards)
 - Finally 3 out of 4 modules tested close to final system conditions

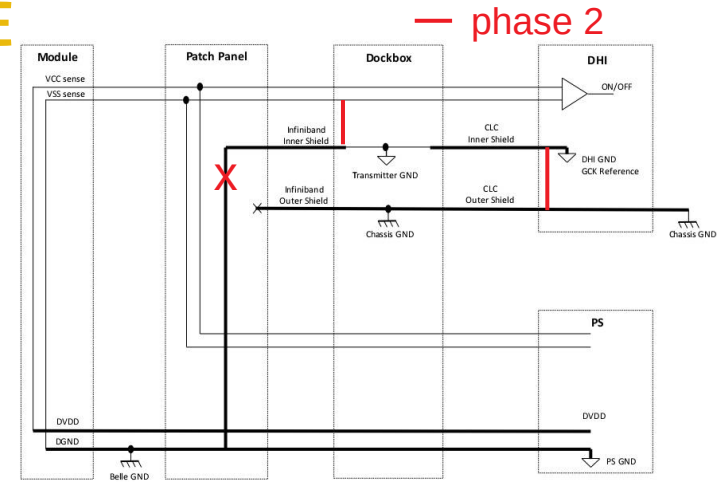
PHASE 2 PXD DETECTOR COMMISSIONING IN B4 CR



- Very limited space, setup plan made on the go
- Hardware arriving late, lots of manhours wasted implementing temporary solutions
- No dedicated PXD workspace (single small table shared by three systems)
- Insufficient tools and materials (e.g. soldering iron, cables, computers missing)
→ survived by borrowing from other systems and even using leftover Belle 1 storage content
- No mechanical solutions for rack assembly in place
- What worked: brute force effort by PXD experts on location
→ This has to be changed for phase 3 (more than 10-fold increase of system size)
→ Many lessons learned and measures already in preparation

PXD MODULE PERFORMANCE DIGITAL SENSING ISSUE

- Short between DGND sense and shield introduced for phase 2
→ Digital voltage sensing broken
- Set voltages guessed from module behavior
e.g. DHP temperature measurement,
DCD→DHP data transmission



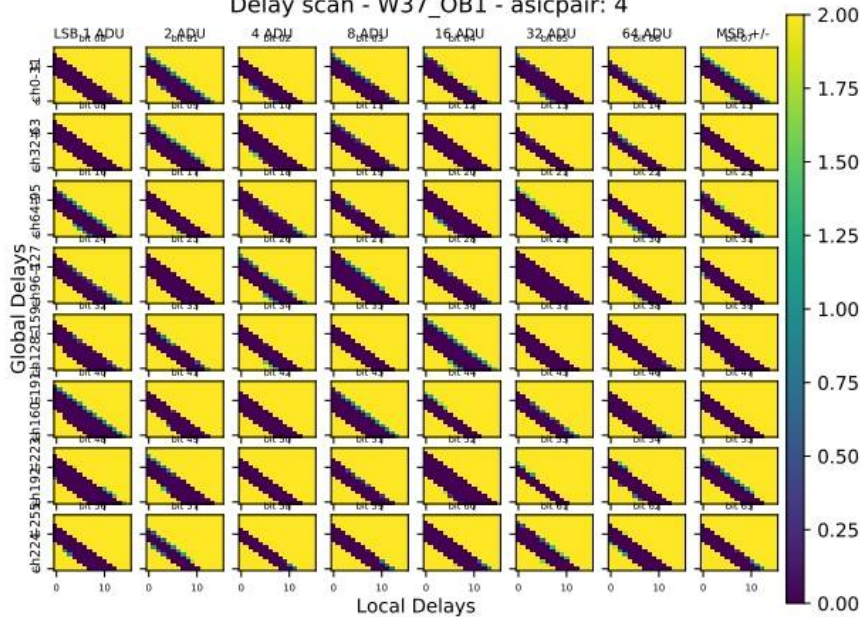
	nominal	W37_OF1	W37_OB1	W46_IB	W37_IF
DHP-core [V]	1.2	1.5	1.4	1.15	1.4
DHP-IO [V]	1.8	1.9	2.0	1.7	1.9
DCD-DVDD [V]	1.8	1.9	2.0	1.7	1.9
SW-DVDD [V]	1.8	1.9	1.8	1.7	1.8
Senseline resistance [Ω]	-	31	38	60	31

config DB
commit ID 55

PXD MODULE PERFORMANCE

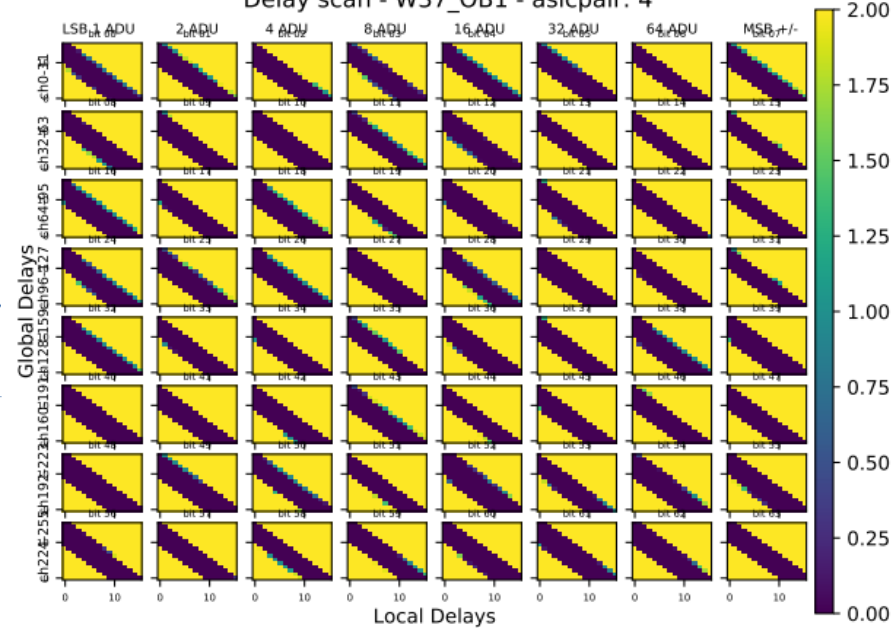
DIGITAL SENSING ISSUE: DCD DATA TRANSM.

Delay scan - W37_OB1 - asicpair: 4



- DHP-IO = DCD-DVDD = 1.8 V
(setting)

Delay scan - W37_OB1 - asicpair: 4



- DHP-IO = DCD-DVDD = 2.0 V
(setting)

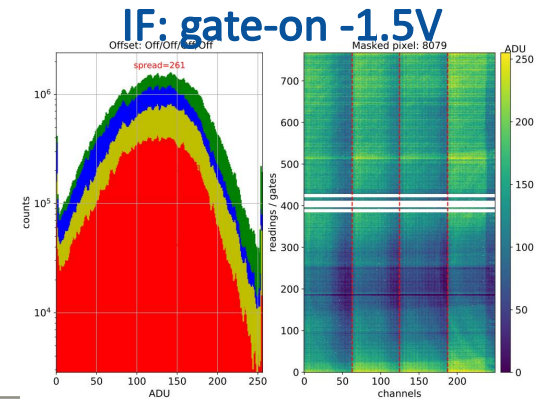
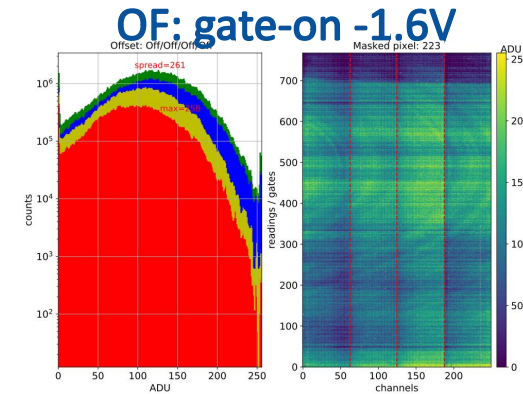
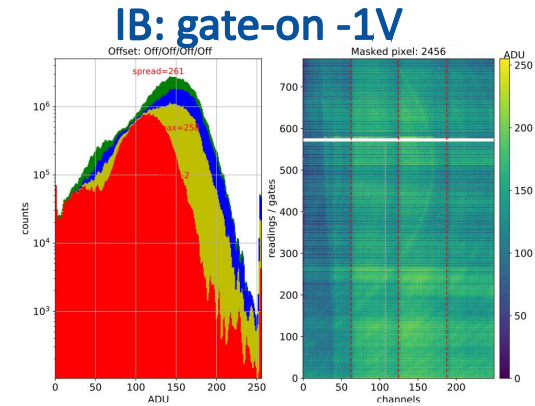
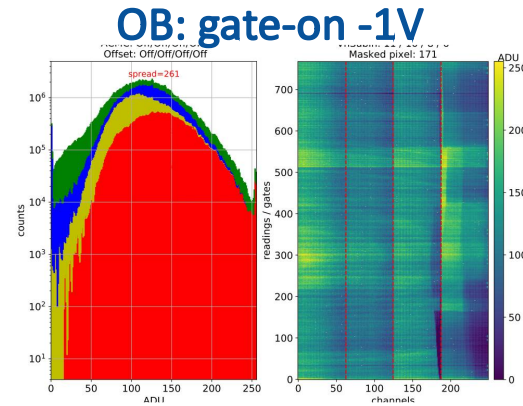
PXD MODULE PERFORMANCE

DIGITAL SENSING ISSUE: DCD DATA TRANSM.

- Other affected parameters:
 - `row2_sync_dcd_clk_dly = 2`
(laboratory value = 3)
 - `offset_des_dly = 7`
(laboratory value = 8)

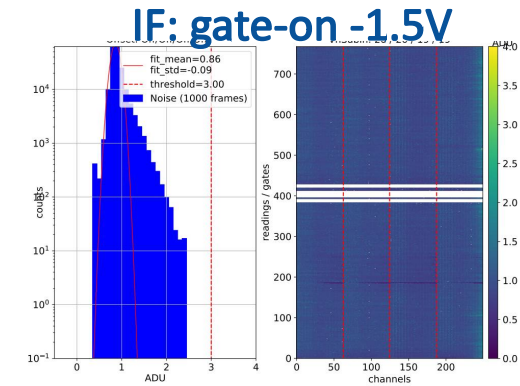
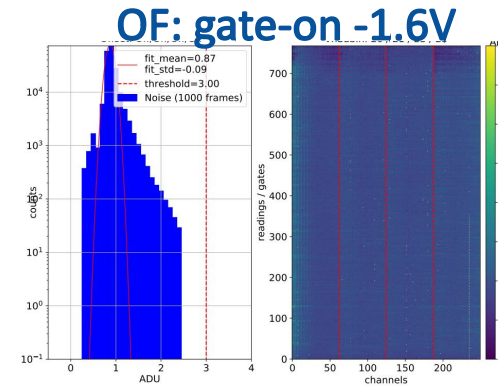
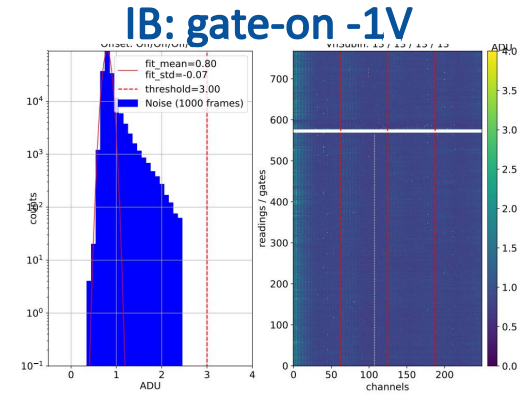
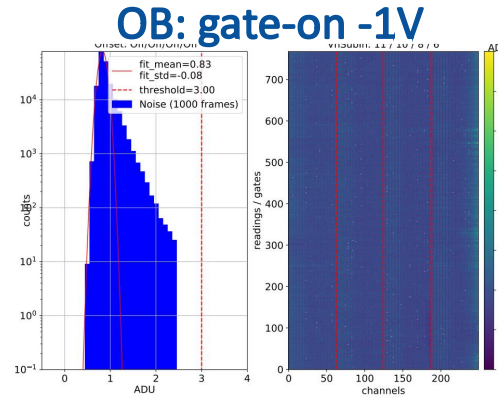
PXD MODULE PERFORMANCE PEDESTALS

- 2 modules well behaved pedestals
- 2 modules with problematic gates
- Pedestal distributions appeared stable before beam
- Since February ~700 GB pedestal data waiting for analysis
 - Long term evolution
 - Temperature dependence
 - Power cycle behavior



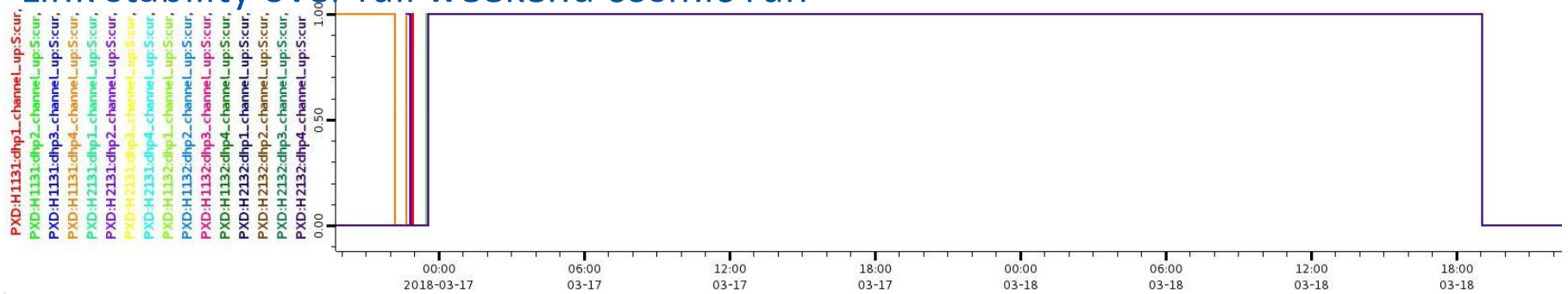
PXD MODULE PERFORMANCE PEDESTALS

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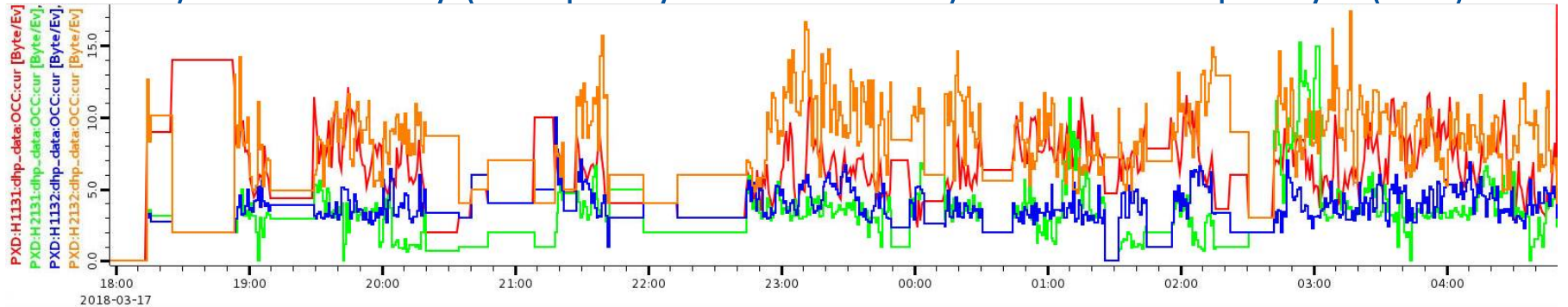


PXD MODULE PERFORMANCE STABILITY

– Link stability over full weekend cosmic run

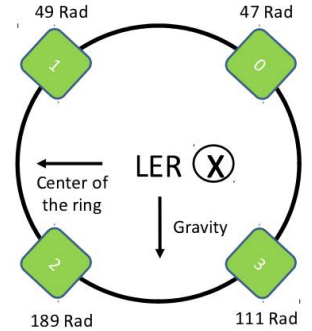
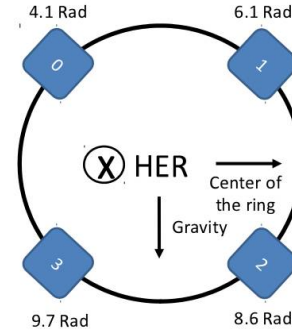
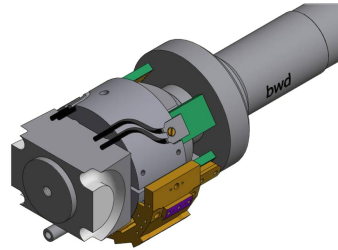


– Pedestal/noise stability (occupancy measurement) → Noise occupancy $O(10^{-5})$

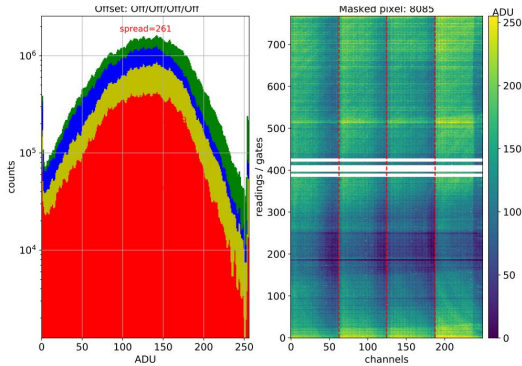


PXD MODULE PERFORMANCE AFTER FIRST BEAMS

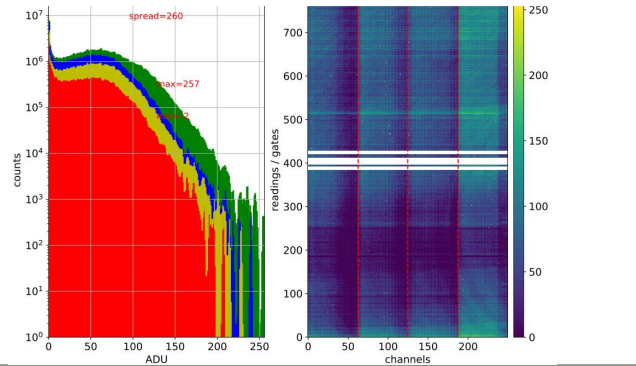
- Radiation dose
- Uncertain from diamonds
- Obvious damage in PXD after 03. April (around 100 mV gate-on)



IF, 19.03: gate-on -1.5 V



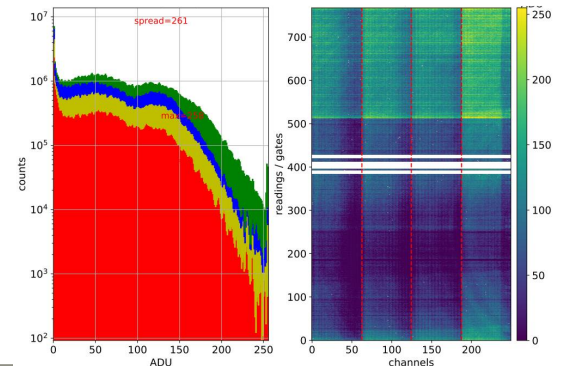
IF, 03.04: gate-on -1.5 V



19 – 24 March

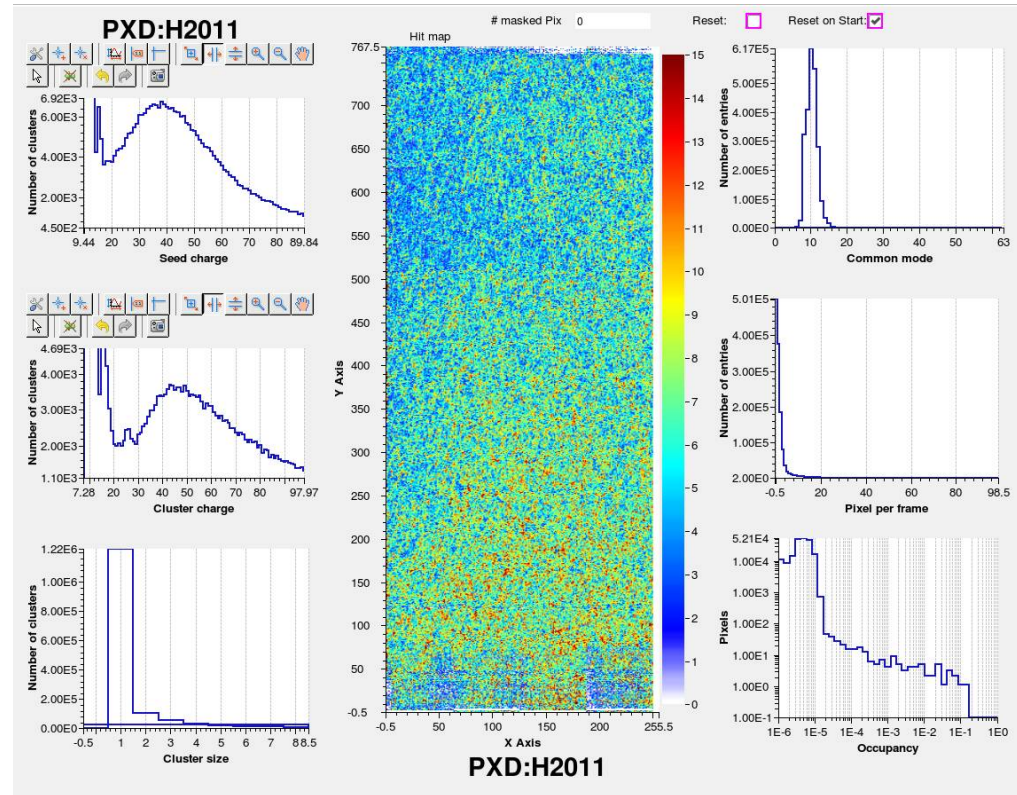
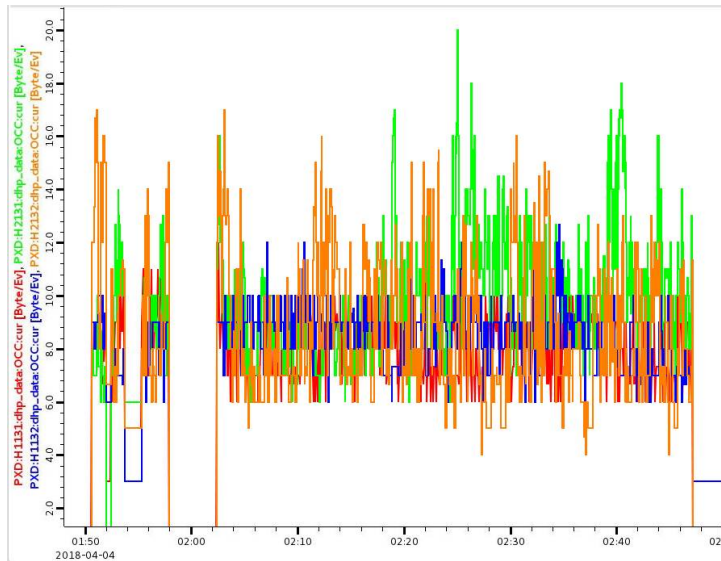
24 March – 4 April

IF, 03.04: gate-on3 -1.6 V



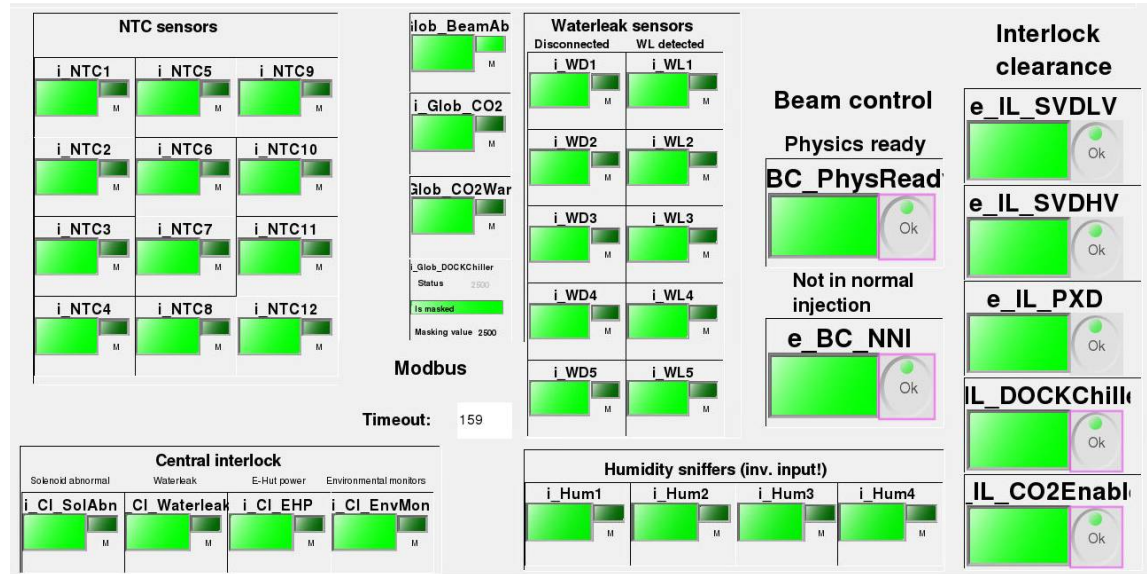
PXD MODULE PERFORMANCE DURING FIRST STABLE BEAMS

- 1 h run on 4.4.
- 25 mA beam stored in HER



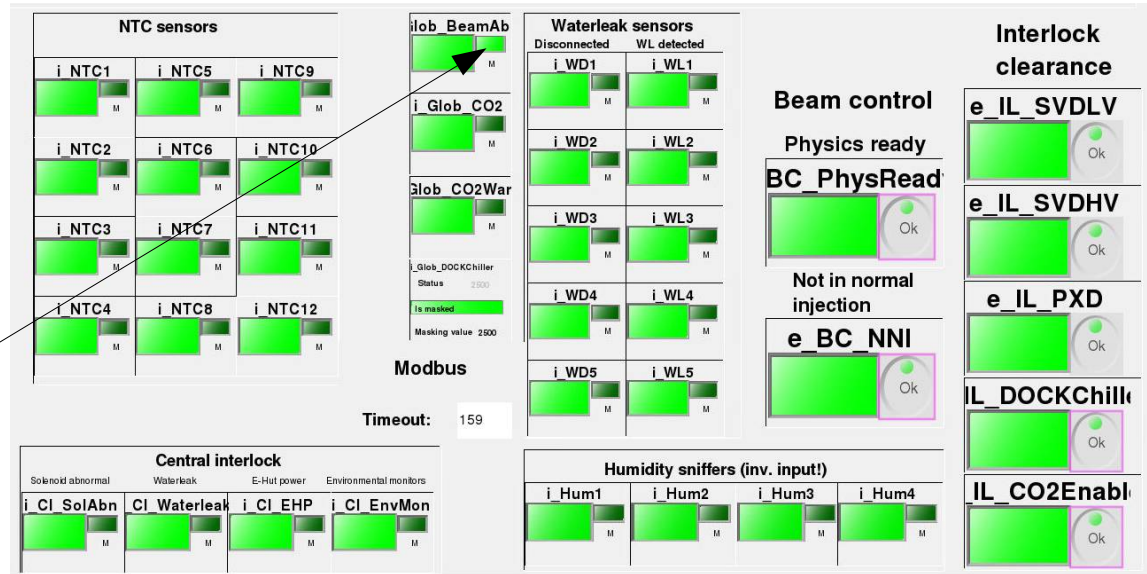
VXD LOCAL HARDWIRED INTERLOCK (VLHI)

- Common PXD/SVD system
- All important environment conditions
 - Beam
 - Magnet
 - Humidity
 - cooling
- Currently dangerous mode of operation



VXD LOCAL HARDWIRED INTERLOCK (VLHI)

- Common PXD/SVD system
- All important environment conditions
 - Beam
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 - Humidity
 - cooling
- Currently dangerous mode of operation



ROADMAP FROM FEBRUARY B2GM

Time during February

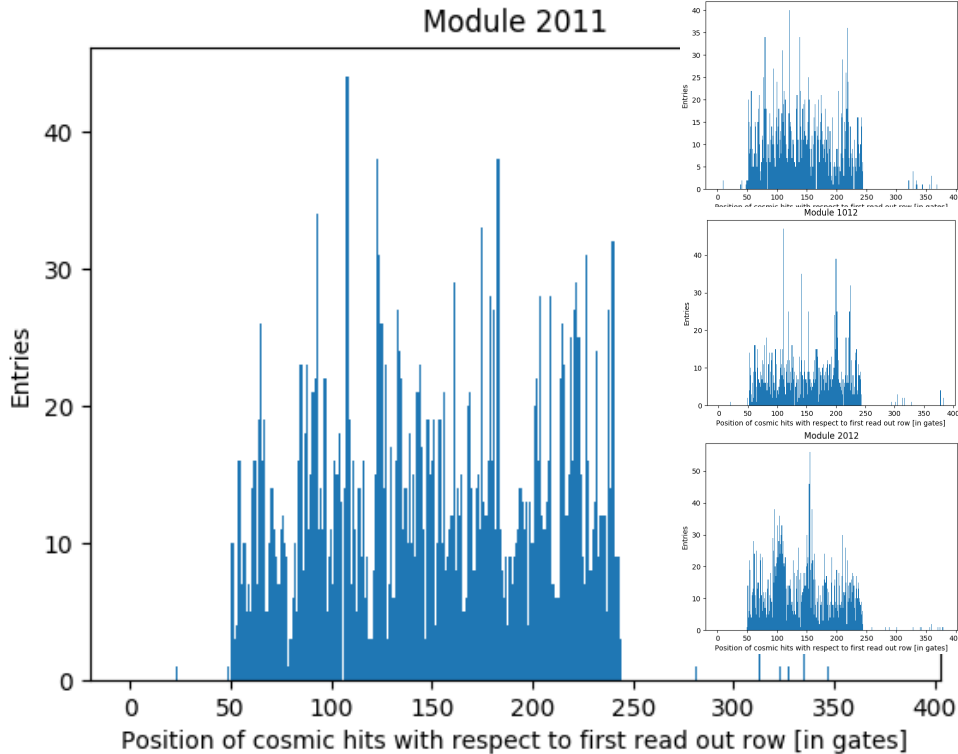


- 24/7 shifter system to be in place until 5th of March (first expected beam)
 - GUIs, live DQM **X**
- During February:
 - 8 hours per day module optimization (ADCs, delays, matrix) **X**
 - Automated data taking during the rest of the time
 - Currently ca. 30 minutes local run needed for pedestal taking (once a day)
 - Usually no module interaction necessary during runtime
 - Concurrent development of GUI and scripts **(ok, but)**

ok

- No shifter GUI available yet
- Limited live DQM (CSS occupancy plots, online monitor)
- Part of scripts developed:
 - Delays (data, offsets)
 - Pedestals
- Local DAQ development (dhh_daq, pydepfreader, phase 2 server not set up yet)
- A lot of time taken by standard operation (switching on/off, calibrating)
- A lot of time spent on DAQ tests

TRIGGER LATENCY



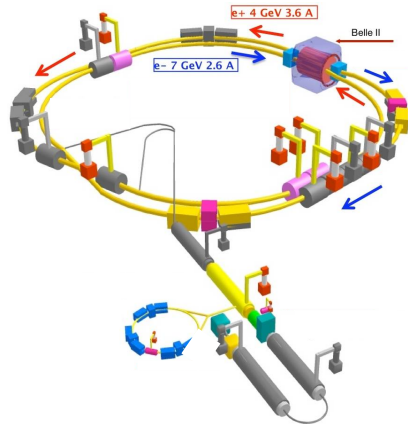
- Runs 719-745
Night 22/23.02.2018 global cosmic run
 - DHE trigger delay = 0
 - DHE trigger width
= 2*192 gates (2 frames)
 - DHP latency = 100 (gates)
 - Analysis:
 - disregard pixels with more than 10 hits per file
 - ADC value ≥ 12
- 193-194 gates of real hits for trigger
 → ~50 gates trigger latency compatible with 5 us latency observed by other detectors

Thank you

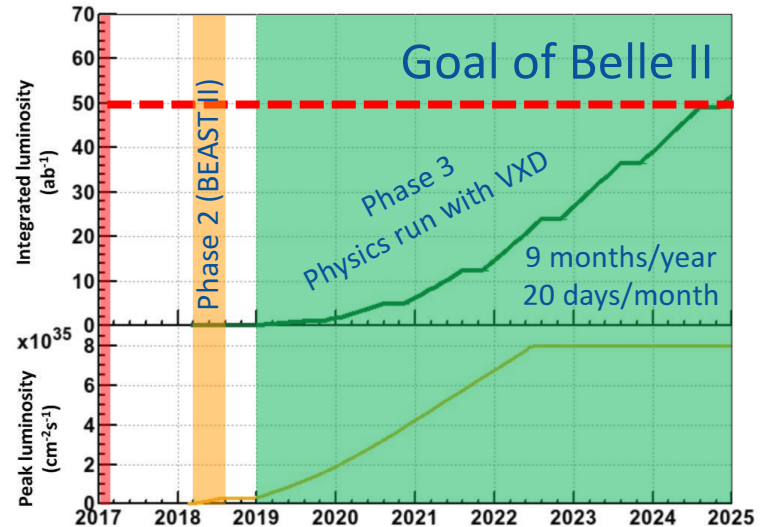
Lots of work left to do

SUPERKEKB SCHEDULE

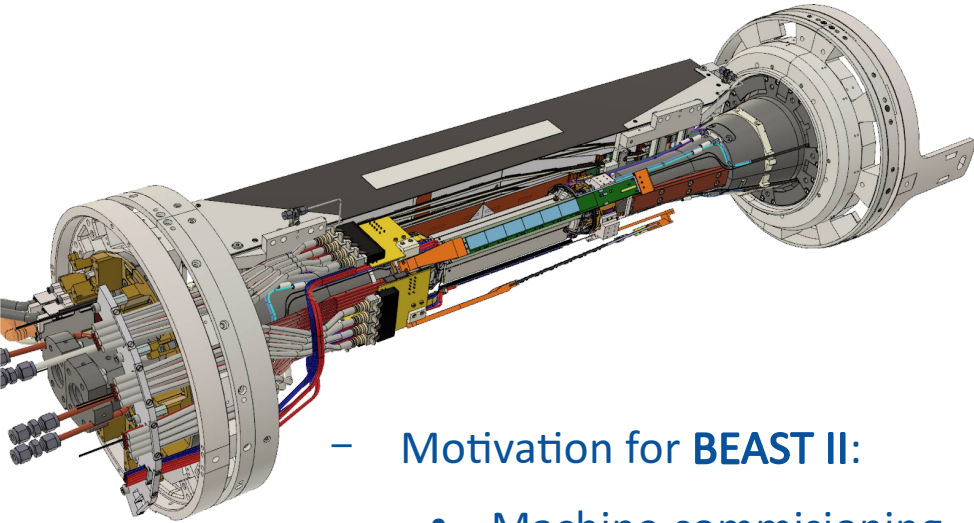
- Careful commissioning strategy in three phases
- Dedicated detectors for beam backgrounds



- Phase 1: Accelerator commissioning
- Phase 2: BEAST and partial Belle II commissioning
- Phase 3: Full Belle II detector



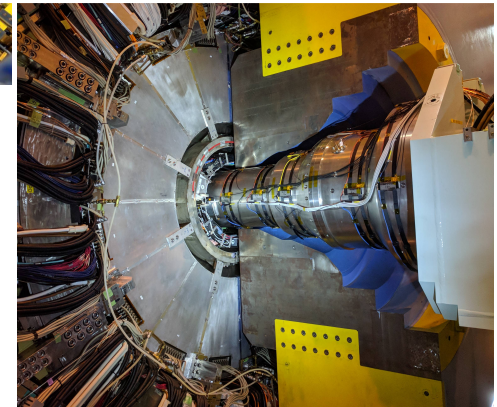
PHASE 2 VERTEX VOLUME SET UP



- Motivation for **BEAST II**:
 - Machine commissioning
 - Radiation safe environment for the VXD
- DAQ integration of Belle II pixel and strip detectors

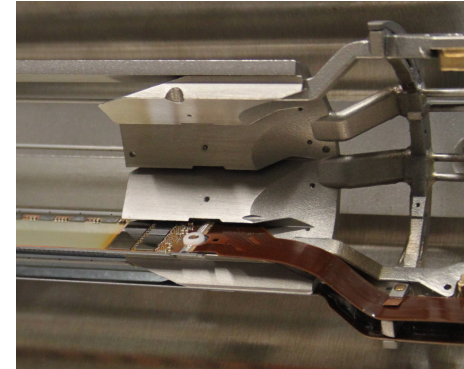
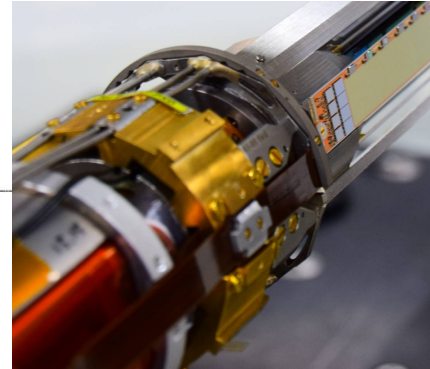
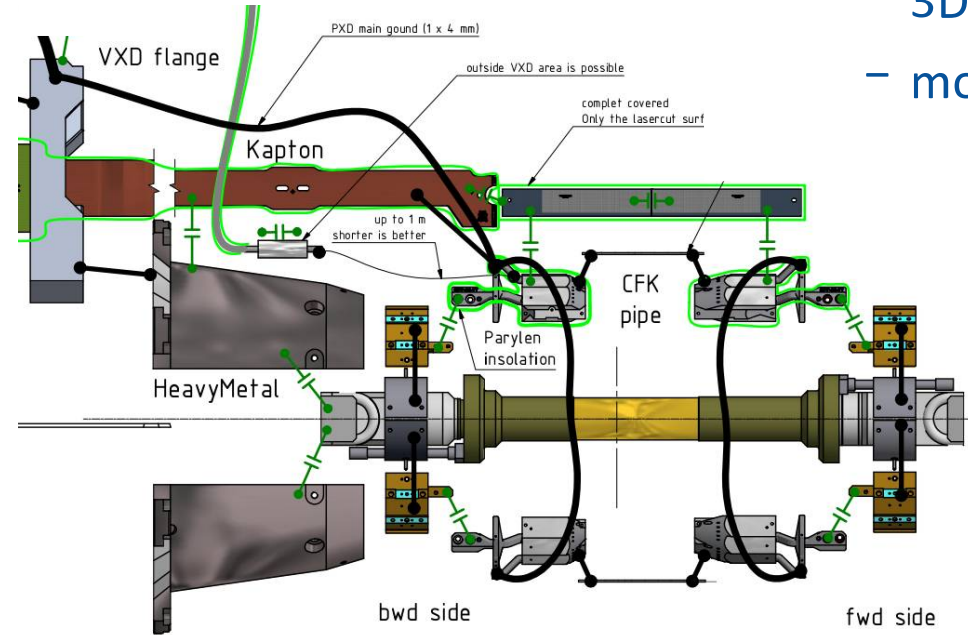


Final machine parts:
final focus magnets

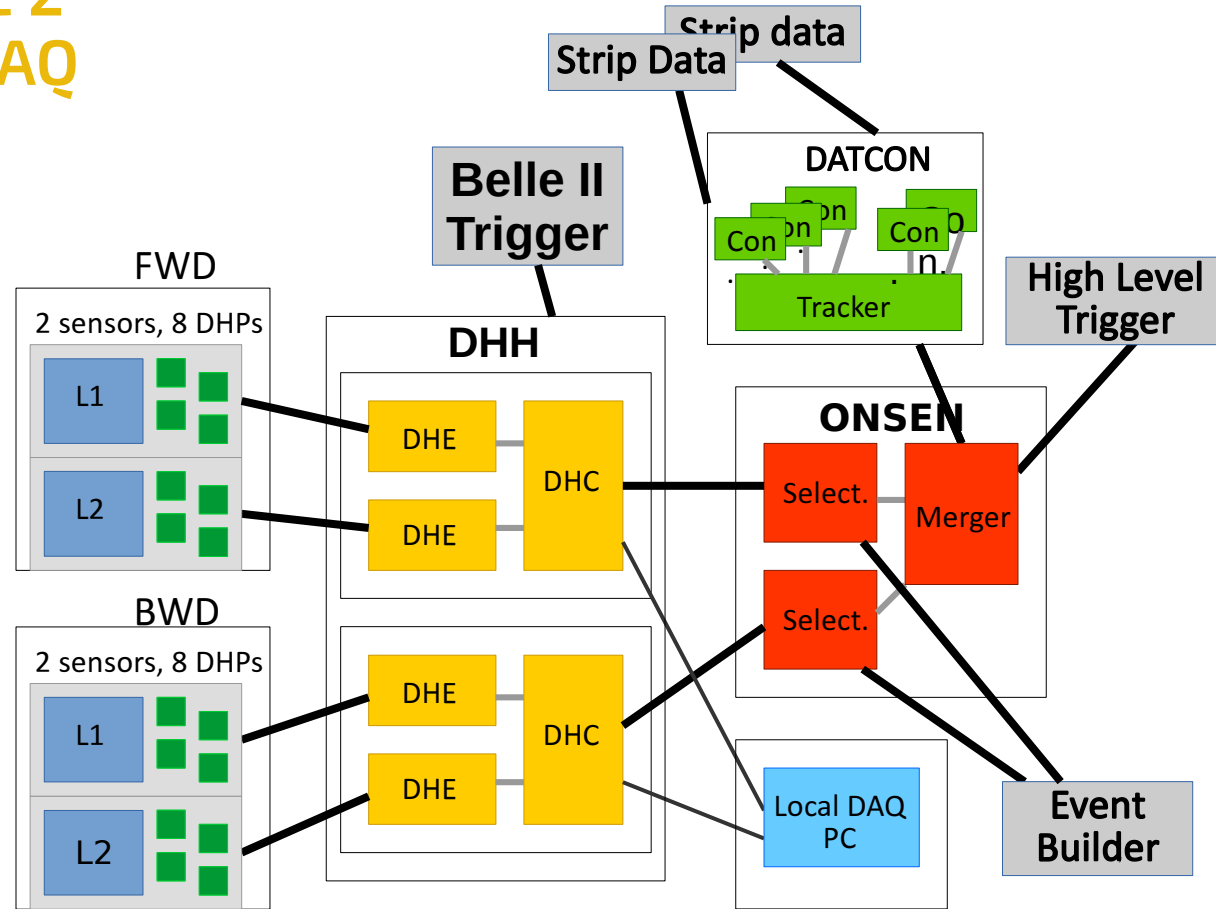


PHASE 2 PXD MECHANICAL INTEGRATION

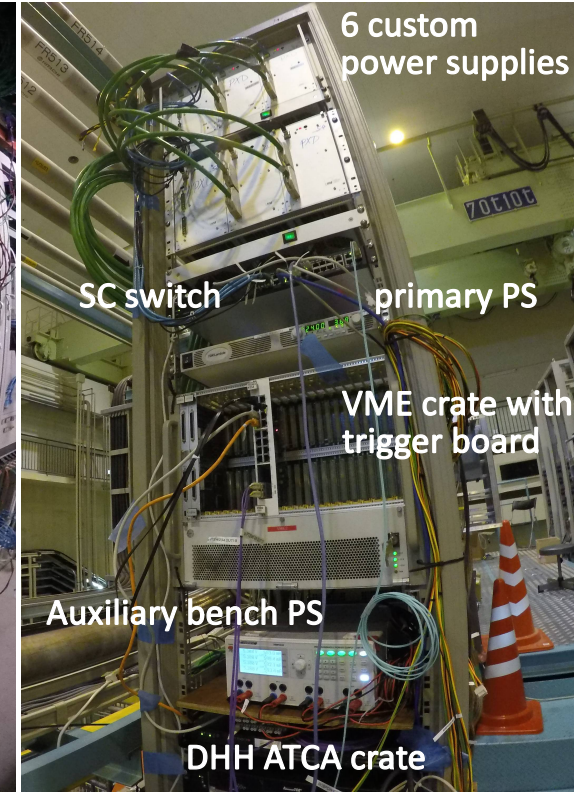
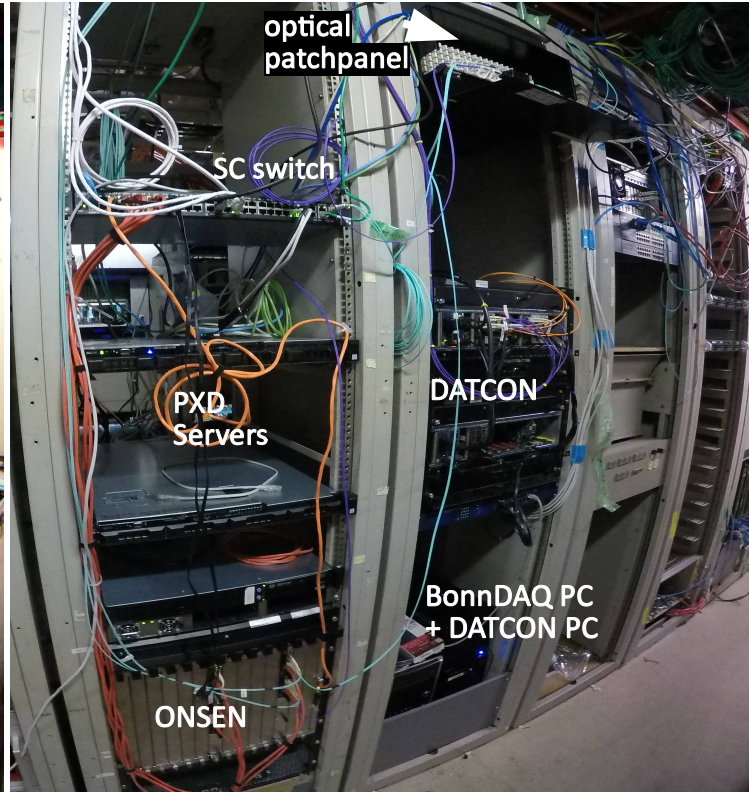
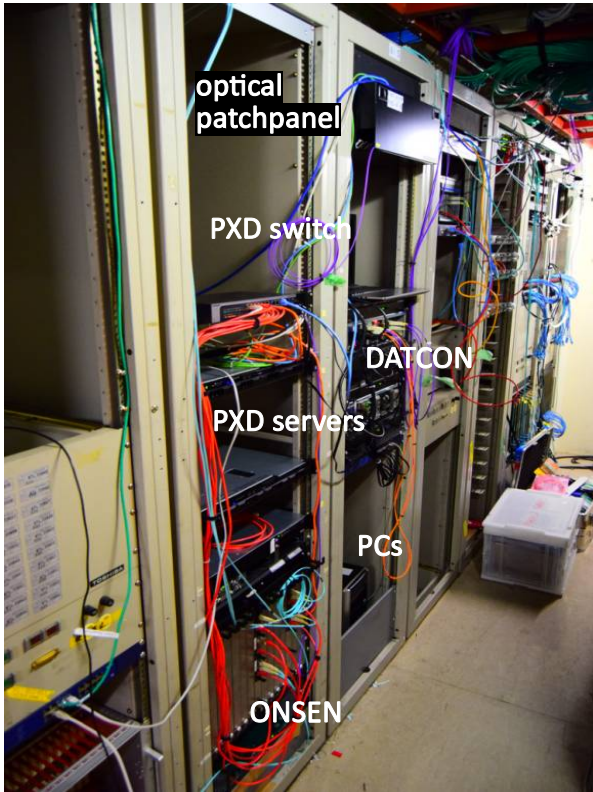
- 3D printed metal support cooling blocks (SCB)
- mounted directly on the beam pipe



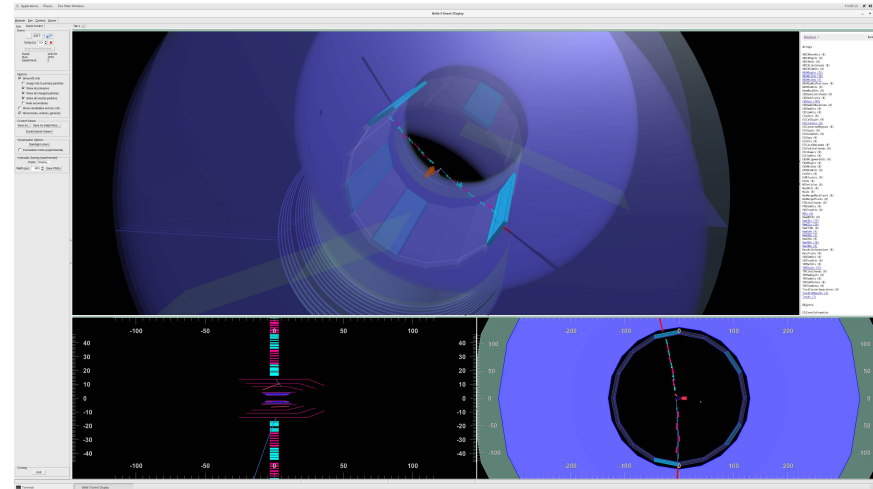
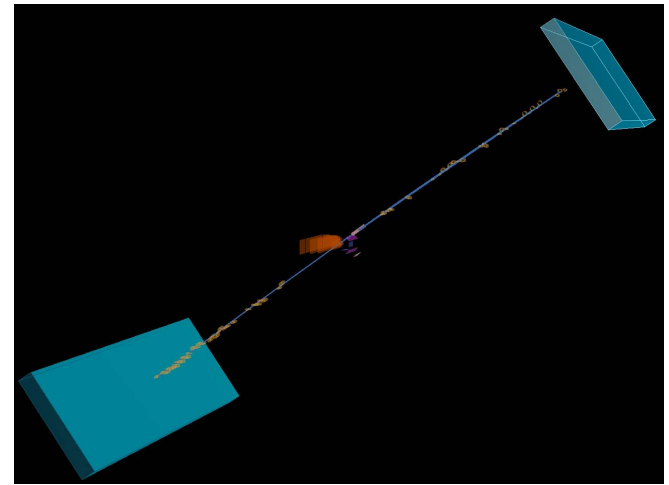
- PXD DAQ is a chain of several FPGA boards
- Full integration into Belle DAQ
- Online data reduction with live ROIs from hardware and high level software trigger



PHASE 2 PXD HARDWARE

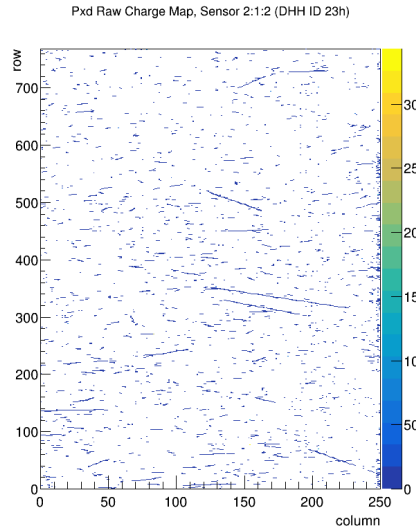


- Run going on since 14.02.
- Startup of High Energy Ring (HER) this monday
- Phase 2 continues with accelerator commissioning and eventually collisions and luminosity tuning und mid July

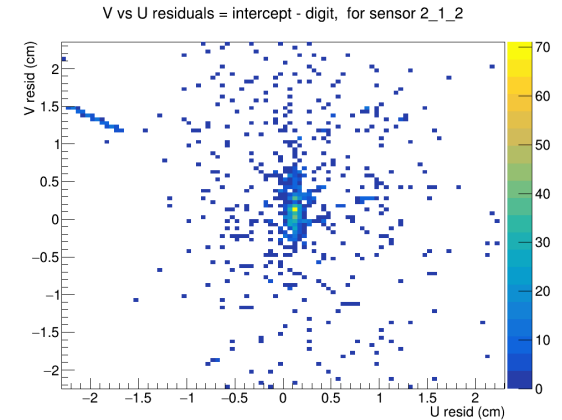
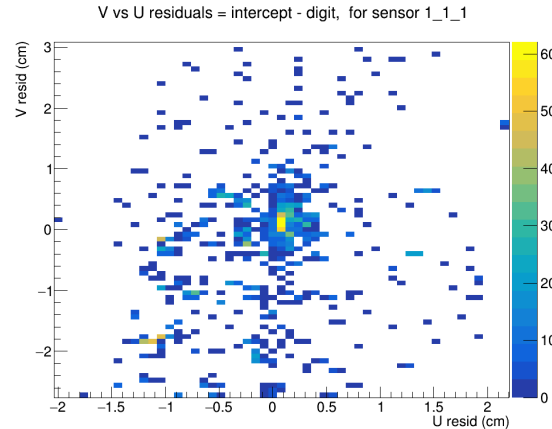


PXD MODULE/DAQ PERFORMANCE

- Cosmic runs of 8 hrs with stable data taking without problems



- ROI mechanism working in HLT simulation on recorded data



- Phase 2 indeed very helpful for VXD operation and DAQ