

PXD2 Operation (in 2023/4) Vision and Requirements

22.5.2023

Björn Spruck

Looking Into The Crystal Ball



Lets Ask Some “Expert” Review From Outside

Question:

How would the pixel detector shifts at Belle II be organized in the future?

ChatGPT:

As an AI language model, I don't have real-time information or insights beyond my knowledge cutoff in September 2021. Therefore, I cannot provide specific details on how the pixel detector shifts at Belle II would be organized in the future, as it depends on the latest developments and **decisions made by the Belle II experiment collaboration.**

However, I can provide you with some general information about the organization of pixel detector shifts in high-energy physics experiments like Belle II. Typically, the operation and maintenance of a pixel detector **involve a dedicated team of scientists, engineers, and technicians who work in shifts to ensure continuous data taking and detector performance.**

The shift organization generally follows a 24/7 schedule to cover all operational hours. The shifts are typically divided into several categories, such as day shifts, evening shifts, and night shifts, with a specific duration for each shift, such as 8 or 12 hours. The exact shift schedule and duration can vary depending on the experiment and the specific requirements.

During a shift, **the team members are responsible for monitoring the detector's performance, data acquisition, and troubleshooting any issues that may arise.** They collaborate closely with experts from different subsystems of the experiment, such as the data acquisition system, trigger system, and detector control system, to ensure smooth operation.

- Not too bad, points taken

Envision the pixel detector operation and monitoring shifts at Belle II after the long shutdown.

ChatGPT:

Envisioning the pixel detector operation and monitoring shifts at Belle II after a long shutdown, we can expect several considerations and improvements based on the experience and advancements gained during the shutdown period. Here's a hypothetical scenario:

Enhanced detector performance: After the long shutdown, the pixel detector would likely undergo maintenance and upgrades to improve its performance. This could include upgrades to the readout electronics, cooling systems, or sensor technologies. The shifts would focus on **monitoring and optimizing the new detector setup.**

Advanced data acquisition system: ...

Improved calibration and alignment procedures: The shutdown period would have allowed for **improvements in calibration and alignment techniques.** Shifts would involve regular monitoring of calibration data, checking the alignment of the detector elements, and making adjustments as needed.

Shift flexibility and remote monitoring: **Advancements in technology may enable more flexibility in shift organization. Remote monitoring capabilities might be enhanced,** allowing shifts to be conducted partially or fully remotely. This could provide opportunities for collaboration with experts and scientists who may not be physically present at the experiment site.

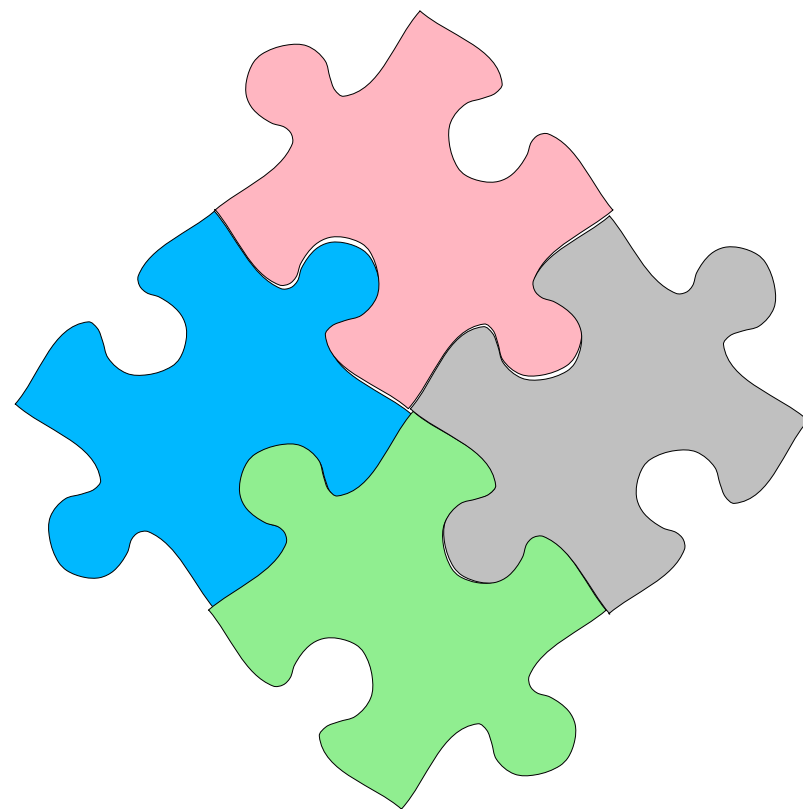
Automated monitoring and alarm systems: Developments in automation and machine learning algorithms could enable the implementation of advanced monitoring and alarm systems. These systems would continuously analyze detector performance data and raise alarms in case of anomalies or deviations from expected behavior. **Shift personnel would be responsible for promptly responding to alarms and taking appropriate actions.**

Shift rotation and training: Shift personnel would continue to work in rotation to ensure 24/7 coverage. They would receive regular training on the updated detector setup, data acquisition system, and monitoring procedures. Training sessions would cover various operational scenarios, emergency procedures, and potential issues that could arise during the shifts.

Collaboration and communication: Shift personnel would maintain close collaboration with experts and other shift teams within the Belle II collaboration. Regular meetings and communication channels would facilitate the exchange of information, troubleshooting, and sharing of best practices.

It's important to note that the specifics of the post-shutdown pixel detector operation and monitoring shifts at Belle II would depend on the specific upgrades and developments implemented during the shutdown period. **The collaboration's decisions, priorities, and available resources would also influence the shift organization.** Therefore, it's best to refer to the official Belle II experiment sources for accurate and up-to-date information on the actual implementation.

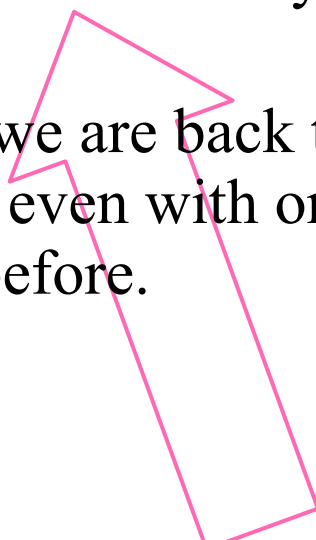
- In-beam commissioning
- Shifting: Evolution of Tasks
- Person Power
- Documentation / Manual
- Durable Operations (Hardware, Risks)
- Monitoring
- (Technical) Changes



In-Beam Commissioning Challenges

Cannot foretell the future, but can make best guesses

- Commissioning (after installation with cosmics) should already give us enough experience with the full system to iron out most operational issues, thus be in a state where we do not have any “infrastructure” problems
- Initial few week with beam may be intense, as modules may not work reliable due to changed properties due to radiation, re-calibration, working point adjustments etc. We may assume that constant baby-sitting is required by shifters and experts
- Assume that afterwards (February???) we are back to the stable situation which we had before the shutdown, hopefully even with on-call shifting. Strongly depends on what we find in the phase before.



What happens here will be most likely surprising us
→ **hard to make reasonable plans**

Reminder: PXD Shifting 2022 (mostly same as 2021)

**Report from PXD
Meeting Oct. 2022**

- Since 2020 we made the on-call expert an official task
 - Normal shifter (8h, 4h+4h, 8h, in presence)
 - On-call expert (24h) for emergency cases → works nicely!
 - Shifts are rather uneventful, issuing new pedestals now and due to high occupancy
- COVID effects
 - Coverage problem for DAY shifts as all but one PXD member located in European time zone → unpleasant local times for shifters
 - Stay at home effect now vanished! Harder to get WE filled, esp long week-ends
- PXD shifter contacted by Control Room mainly for
 - excess of noise in PXD common mode DQM plots
 - efficiency warning
 - run start problems due to pedestals upload issues
- Few calls to on-call expert
 - Issues around DHP/DCD SEUs

Pedestal taking!
The main reason we could not switch to a relaxed on-call scheme for pxd shifts

- Where do we stand (in 2022)?

Planned Changes in Shifting

Report from PXD
Meeting Oct. 2022

- Goal for us:
 - PXD shifter → on call only + DQM / quality flagging at end of shift
 - Any relevant error on PXD side must be visible for CR shifter
 - It is in Kibana, but that is not helpful for CR shifter
 - → messages to rocket chat (“call pxd shifter”)
 - Have given CR shifter more influence on PXD, clearer instruction, flowchart, etc; e.g. power cycle without first asking PXD shifter
 - Problem: How to properly detect and handle new issues e.g. DHP/DCD SEU
 - We were close, but some issues are still not fully solved, e.g. some alarm messages for CR shifter
 - New shifters have (and need) less deep-knowledge on PXD → this will be an issue for PXD2
- If at all. We should rely on CR shifter (purpose of DQM plots)
- Belle II common alarm system (work in progress)

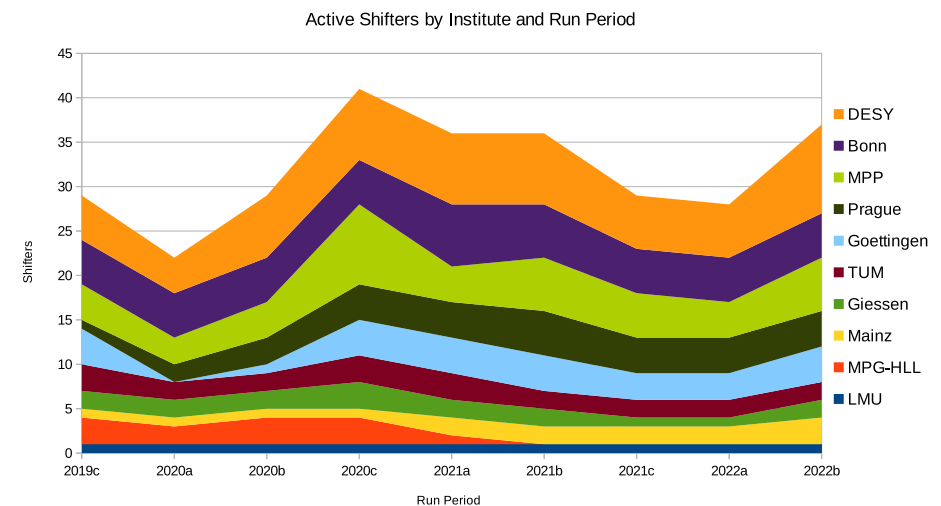
Discussion:

(slides from 08.05.2018)

- Whom to train? For now: shifter training is time consuming → train only people where its foreseen that they can/will do lot of shifts.
- System will advance to more automatisation (“on click actions”). Less shifter knowledge required? Is this good or bad?
- Shifter will not learn much in a “normal” shift if nothing goes wrong.

Reminder - Phase3 Operation

- Towards the end (2021/22):
 - Rather large number of shifters for 24/7 coverage
 - Several (6, with decreasing tendency) on-call experts for 24/7 coverage
 - 1-2 persons at KEK
 - Few system specific experts (not on-call, not reachable immediately)
- Few issues which needed attention by shifter
 - Mainly pedestals (occupancy, noise)
 - Pedestal issue due to SEU in ASIC (new!)
 - Nearly an on-call shifter
- On-call expert for new/unknown issues



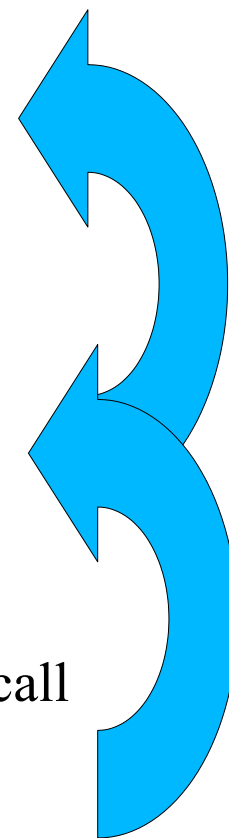
Shifter Scheme

- Assume we will keep the old scheme until at least February
 - Shifters
 - (On-call) experts
 - Mandatory presence at KEK
- Experience will tell us if we can relax it
 - → would transition PXD shifter → PXD expert shifter again
- Note: Independent of shifter, we need mandatory presence at KEK (someone with experience)

**Long-term long-standing problem:
Person power with PXD experience**

Re(de)fine Shifter Tasks

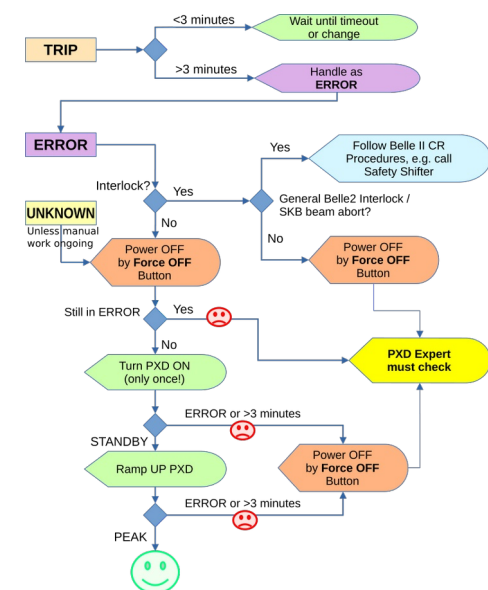
- What is the **new** task list for the PXD shifter
 - What can the (non expert) shifter still do? What cannot be done by CR shifter? What cannot be done automatically?
 - What can the CR shifter do, what is he supposed to do?
 - → Abort/Restart Run
 - → DQM checks
 - → Alarms
 - → Power Cycle PXD (“HV control” → the modules, not the electronics)
 - What is left:
 - Pedestals (mostly automatically, but could be issued by CR, too)
 - Shift reports (mostly automatically)
 - DQM (redundant of what CR is doing)
 - Recovering SEU in DCD (automatic? Discussion!)
 - Anything more severe which requires in-depth knowledge/debugging left to on-call
 - → Would need step-by-step manual to hand it to normal shifter



To be decided

Documentation, Manuals

- Two fold:
 - Documentation of the (yet to be installed) system
 - Operation manual
- Both is needed!
- Information is now even more scattered
 - Confluence “Phase3”, “B4”, “PXD2” + other left-overs
 - GitLab issues which contain documentation
 - Repositories (stash and GitLab)
 - Need to condense into one place “Phase4”?
 - **Rework & cleanup needed, now!**
- Operation manual need flow-charts/step-by-step instructions
 - For finding issues
 - For solving issues
 - Including hardware interventions!



- Still missing:
 - Full vanilla on procedures (cold start), as flow chart and/or script
 - → including check of running IOCs
- Procedures for most sub-systems missing
 - Most “should” boot up to working condition after power is restored, but not well documented how to solve if it stops in-between
 - Manual actions needed for some systems
 - DHH need “clock program, reset” (which could in principle be automated)
- → room for improvement

Reaction Times For Troubles

- Belle II and SKB operation is expensive
 - Limit downtime is a must!
- For (hardware) troubles → we need to know **beforehand** what need to be done and how!
 - → think about possible failures and document how to solve
 - Step-by-step list needed which can be followed by non-experts.
 - → exercise and check it before operation restarts
 - We need to know: **where are spares**, what tools we need, howto exchange etc.
 - Document inventory in hephyDB and keep up to date!
- A “call the corresponding expert and wait for his instructions” is not a valid procedure
 - What if expert not reachable due to weekend holiday etc? Switch PXD/Belle2 off for a week?
 - Does the expert has a step-by-step checklist in mind? Why not write it down?
- Reminder: Risk assessment requested from Technical Coordination!
 - → helps **us** to find weak points in our system
- Exchange procedures not well written yet
 - <https://confluence.desy.de/display/BI/PXD+-+Risk+Assessment>
 - <https://confluence.desy.de/pages/viewpage.action?pageId=98091216>

Redundancy (And Lack of it)

- We have redundancy for most important systems.
- pxdgw1/2, pxdarch1/2, pxdbonndaq2/3
 - But: documentation missing or sparse
 - Is there automatic or manual hand-over. Who can do it? How?
- Exercise worst case!

- Redundancy missing for pxdioc4!
 - Still need to decide what to do with dhh IOCs which have huge load.

Monitoring Remarks

- Alarm system:
 - More alarms have been added, but “actions” mostly missing or not detailed → need work (config file identical for CSS and Phoebus, smooth transition)
 - → Add more items to alarm system!
 - Alarms vs not-so-urgent-issues (e.g. redundancy lost, can be taken care later)
 - Transition to common Belle2 alarm system? (→ future)
- Other monitoring:
 - PCs, load, services (IOC) monitored by zabbix on pxdmonitor1 → shifter interface?
 - Better documentation to make it more useful
- Data Quality Monitoring
 - Belle 2 wide improvement and changes for DQM on the way
 - → Minor change for PXD, as we already used proper in-run monitoring, alarm limits (colorize) and output to EPICS for archiving and alarming the shifter in rocket.chat

- Hardware has limited life times
 - Our COTS hardware was running for >3 years now
 - → Rate of failures may start to increase
 - → Need to prepare for failures
- Clear responsibilities needed for each piece of hardware!
 - Who orders from which budget?
- Decide what to buy on stock
 - Weight price of hardware vs price for experiment downtime!
- (Regular) Maintenance:
 - What need to be checked?
 - Example: need filters to be cleaned (dust)? Aging of filter fleece?
 - How often: Check once per year?

Example: hard drives

Backblaze Hard Drives Annualized Failure Rates for Q1 2023
Reporting period: 1/1/2023 through 3/31/2023 for drive models active as of 3/31/2023

MFG	Model	Drive Size	Drive Count	Avg. Age (months)	Drive Days	Drive Failures	AFR
HGST	HMS5C4040ALE640	4TB	3,722	80.0	334,847	1	0.11%
HGST	HMS5C4040BLE640	4TB	12,728	77.0	1,145,343	12	0.38%
HGST	HUH728080ALE600	8TB	1,116	59.4	99,522	2	1.83%
HGST	HUH728080ALE604	8TB	93	68.3	8,434	4	4.33%
HGST	HUH721212ALE600	12TB	2,606	41.8	232,402	0	0.16%
HGST	HUH721212ALE604	12TB	13,151	24.2	1,178,671	2	0.71%
HGST	HUH721212ALN604	12TB	10,690	47.7	959,203	77	2.93%
Seagate	ST4000DM000	4TB	18,070	88.9	1,633,962	170	3.80%
Seagate	ST6000DX000	6TB	884	95.4	79,651	4	0.02%
Seagate	ST8000DM002	8TB	9,467	77.6	855,217	29	2.09%
Seagate	ST8000NM000A	8TB	96	14.3	7,456	0	0.00%
Seagate	ST8000NM0055	8TB	14,331	65.8	1,296,710	132	3.72%
Seagate	ST10000NM0086	10TB	1,159	63.5	105,443	14	4.85%
Seagate	ST12000NM0007	12TB	1,239	40.6	112,607	23	7.46%
Seagate	ST12000NM0008	12TB	19,749	35.9	1,774,769	120	2.47%
Seagate	ST12000NM001G	12TB	12,805	27.4	1,137,007	26	0.83%
Seagate	ST14000NM001G	14TB	10,760	25.7	962,379	35	1.33%
Seagate	ST14000NM0138	14TB	1,497	27.8	134,818	23	6.23%
Seagate	ST16000NM001G	16TB	21,910	15.6	1,897,163	31	0.60%
Seagate	ST16000NM002J	16TB	310	9.5	27,590	0	0.00%
Toshiba	MD04ABA400V	4TB	94	94.3	8,460	0	0.00%
Toshiba	HDWF180	8TB	60	17.5	2,186	0	0.00%
Toshiba	MG07ACA14TA	14TB	38,156	28.9	3,421,785	109	1.16%
Toshiba	MG07ACA14TEY	14TB	577	22.7	50,665	3	2.16%
Toshiba	MG08ACA16TA	16TB	5,194	10.7	440,772	4	0.33%
Toshiba	MG08ACA16TE	16TB	5,932	17.7	529,316	9	0.62%
Toshiba	MG08ACA16TEY	16TB	5,288	15.8	470,414	1	0.08%
WDC	WUH721414ALE6L4	14TB	8,412	27.7	754,296	10	0.48%
WDC	WUH721816ALE6L0	16TB	2,699	17.8	240,256	2	0.30%
WDC	WUH721816ALE6L4	16TB	14,098	6.3	1,128,989	6	0.19%
Totals			236,893		21,030,333	889	1.54%

(Technical) Changes – Transition to Phoebus

- GUI: Old CSS eol → Phoebus
 - Transition of opi and testing going in parallel to commissioning
 - → packages and gui available similar to old CSS within pxd network
 - Nsm2 plugin ported
 - Elastic Search (message) plugin done
 - Alarm system differs (tested in parallel, works)
 - Several minor issues (missing, incompatible, unusable gui elements)
 - Biggest issue: clashes with “window mode” of X2GO (java fx library), and that is what shifters were used to :-(
 - **No show stopper**, but need a workaround for X2GO
 - → Replace instruction in confluence
 - **TODO** → decide when to make a full transition or delay (=wait for improvements) and keep running with CSS 4.6 until then
 - → OPI/BOB need to be in sync for long time ← want to avoid to support both
- Independent of that:
 - Changes in GUIs for 20→40 modules
 - Think about revamp of overview panel