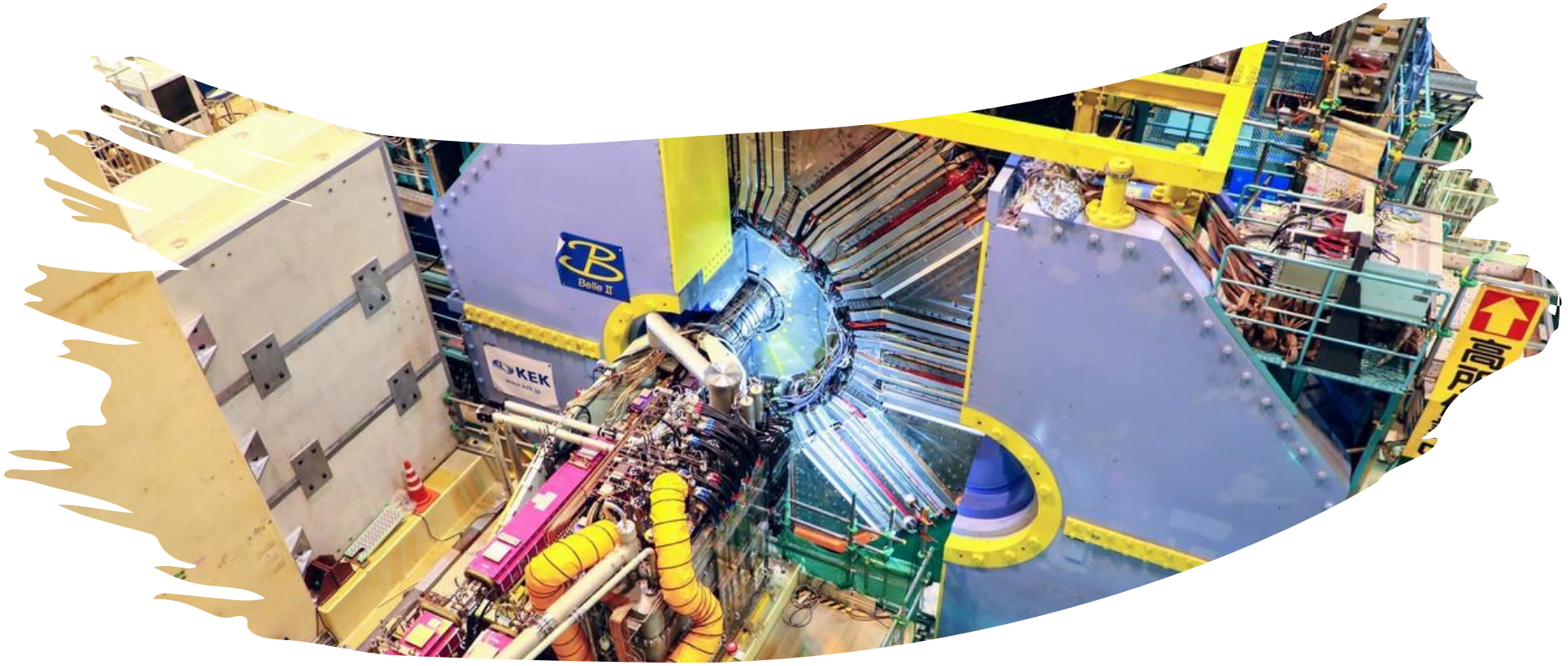

Calibration Data Flow and Performance at Belle II

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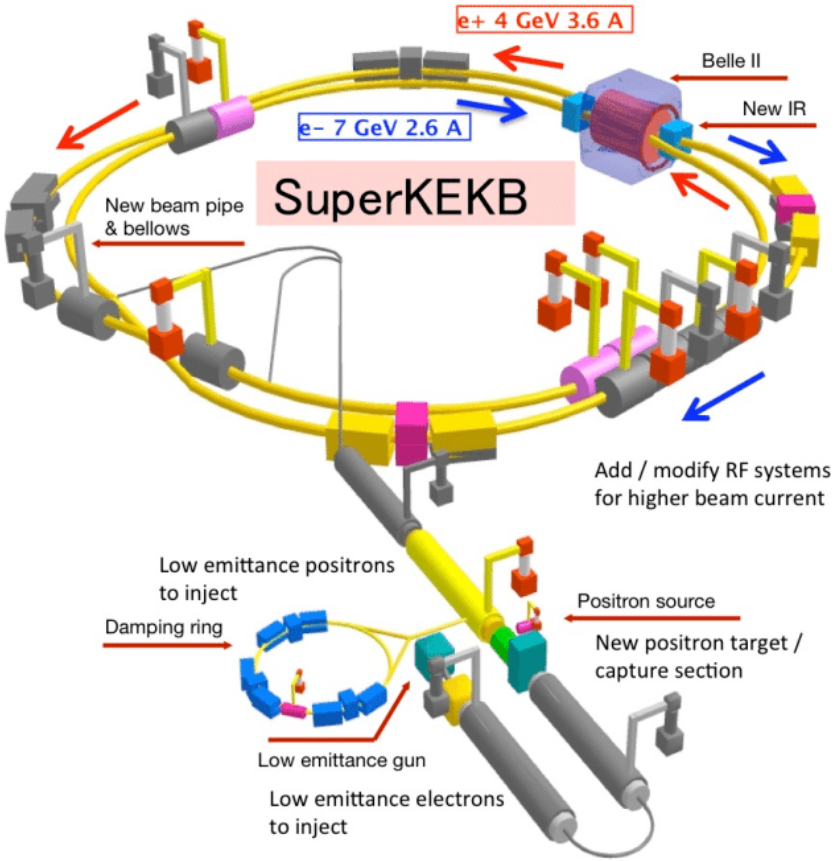
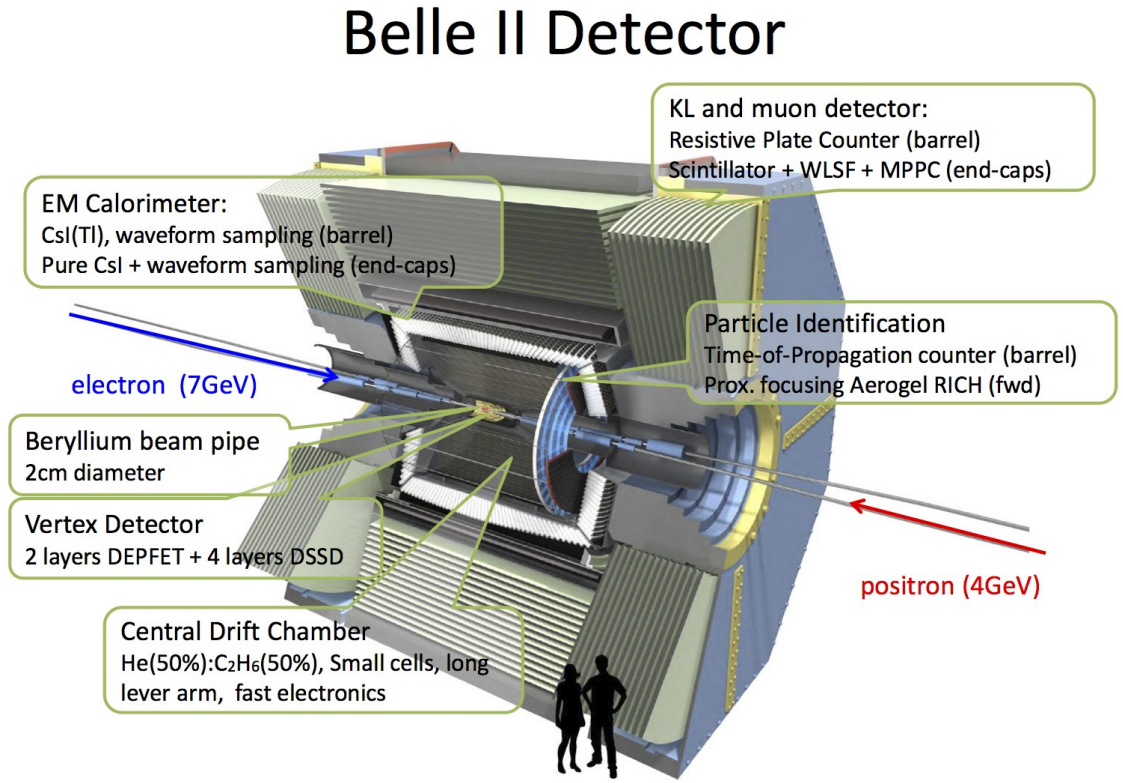
Bundesministerium
für Bildung
und Forschung

UNIVERSITÄT BONN

From e^+e^- collisions to raw data

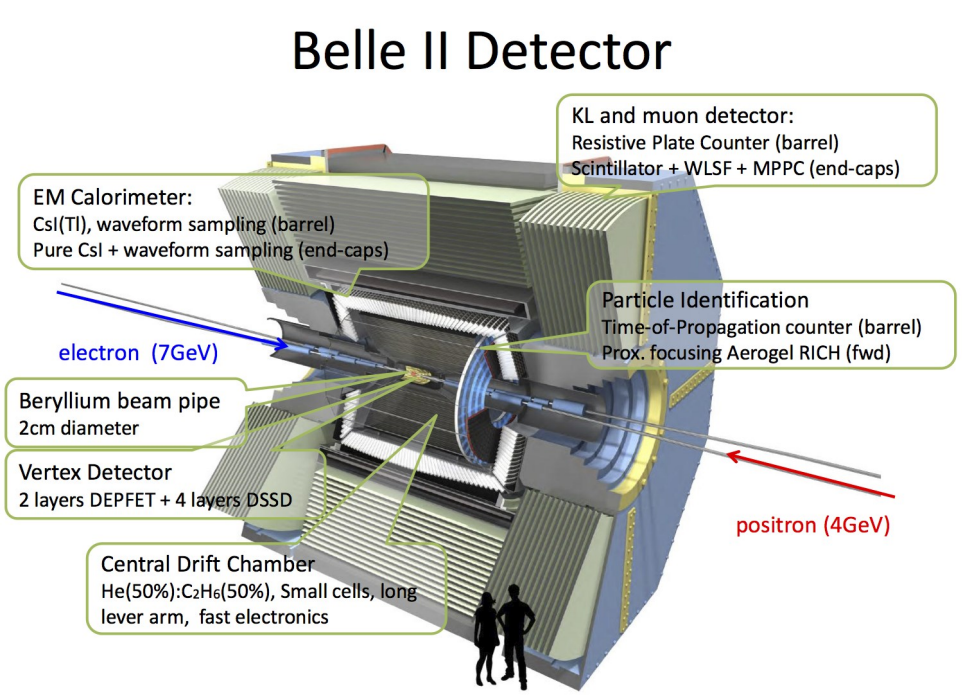


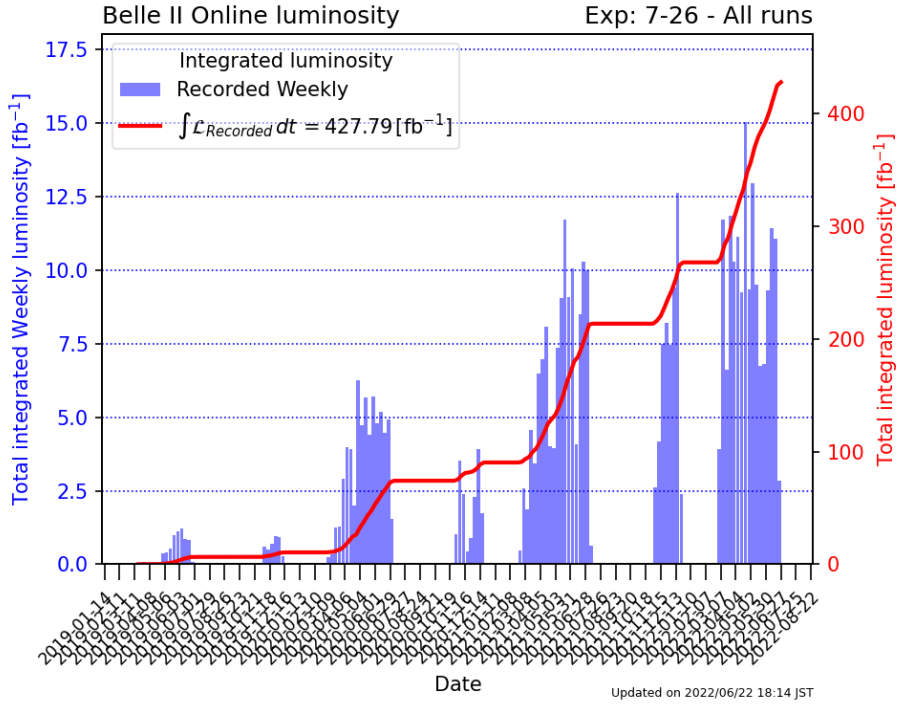
Asymmetric e^+e^- collider
@ and around the $Y(4S)$ resonance



General purpose
4π detector

From e^+e^- collisions to raw data

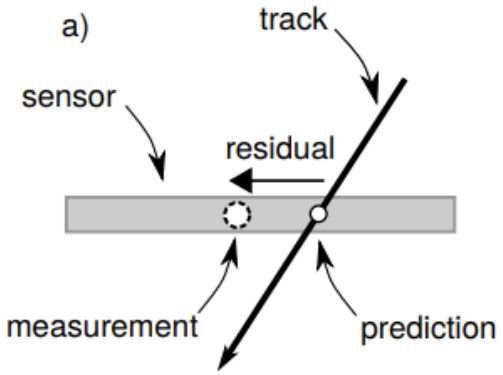


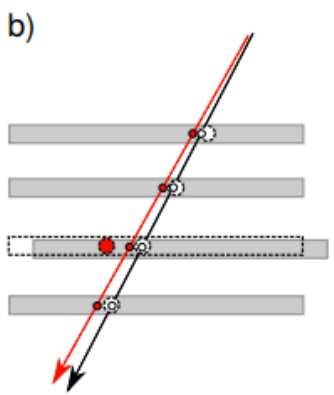


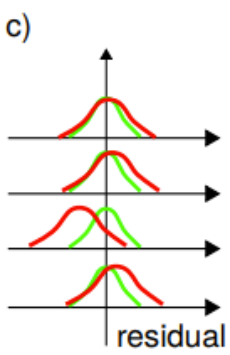
General purpose
4π detector

Total integrated luminosity
$\mathcal{L} = 424\ \mathrm{fb}^{-1}$

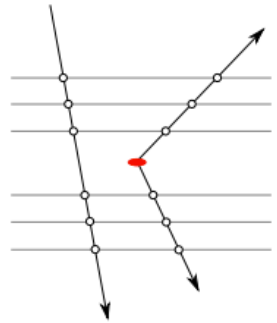
Alignment – A brief introduction

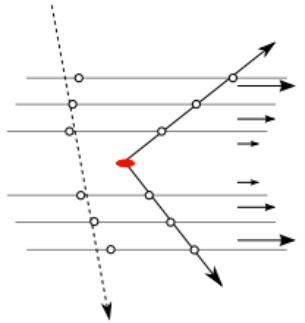


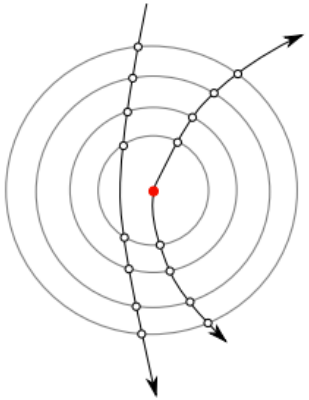


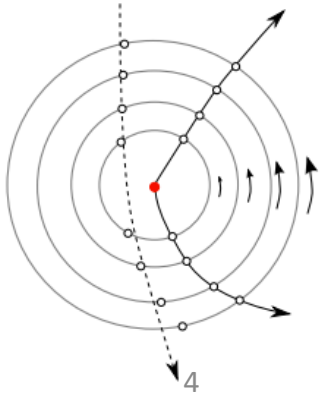


Challenges:
Weak modes due to lack of absolute reference
→ Complementary data samples



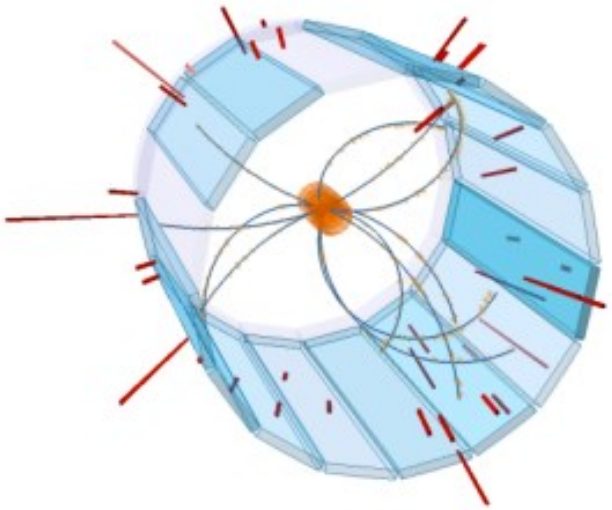




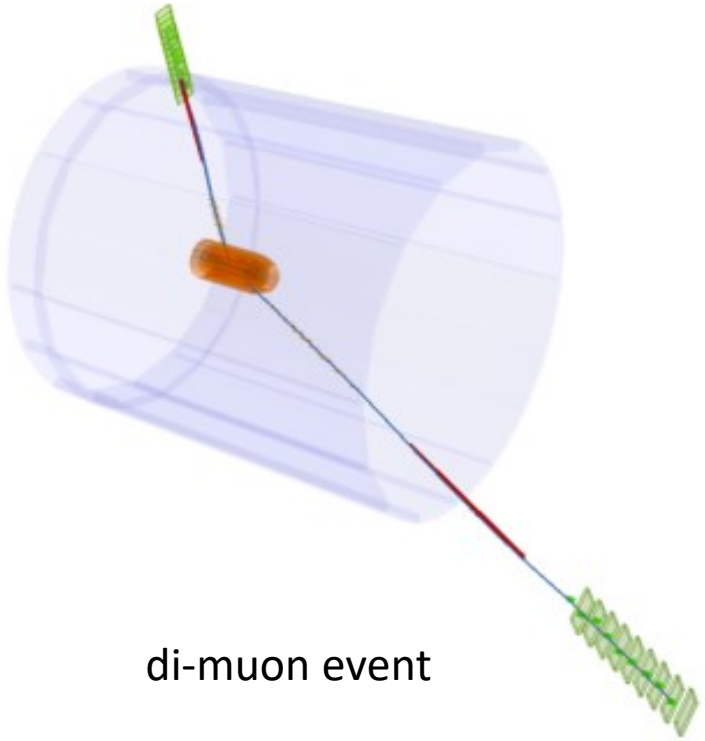


Belle II: Global Alignment with Millepede II

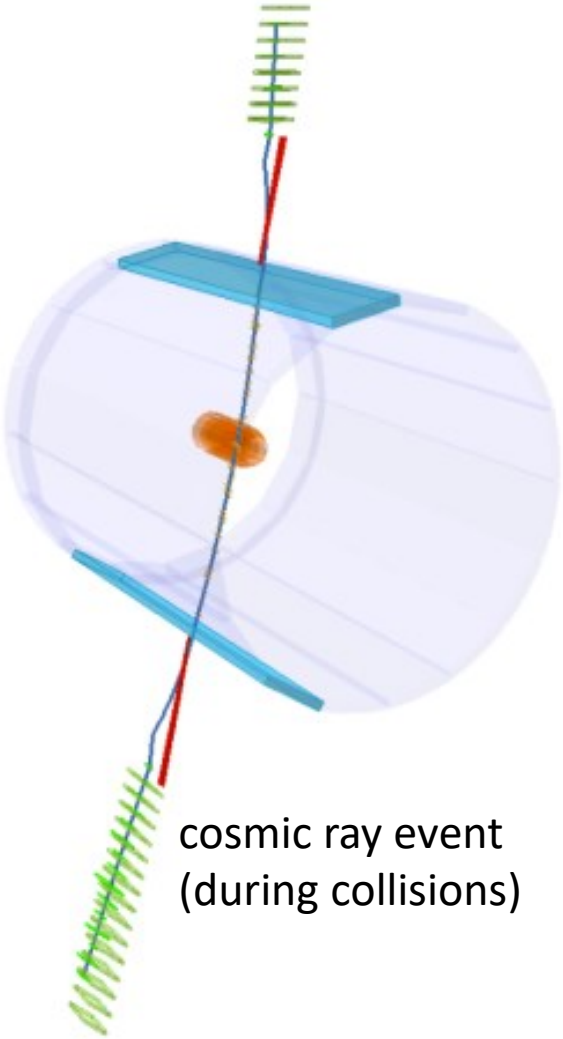
Alignment – data samples



hadron event

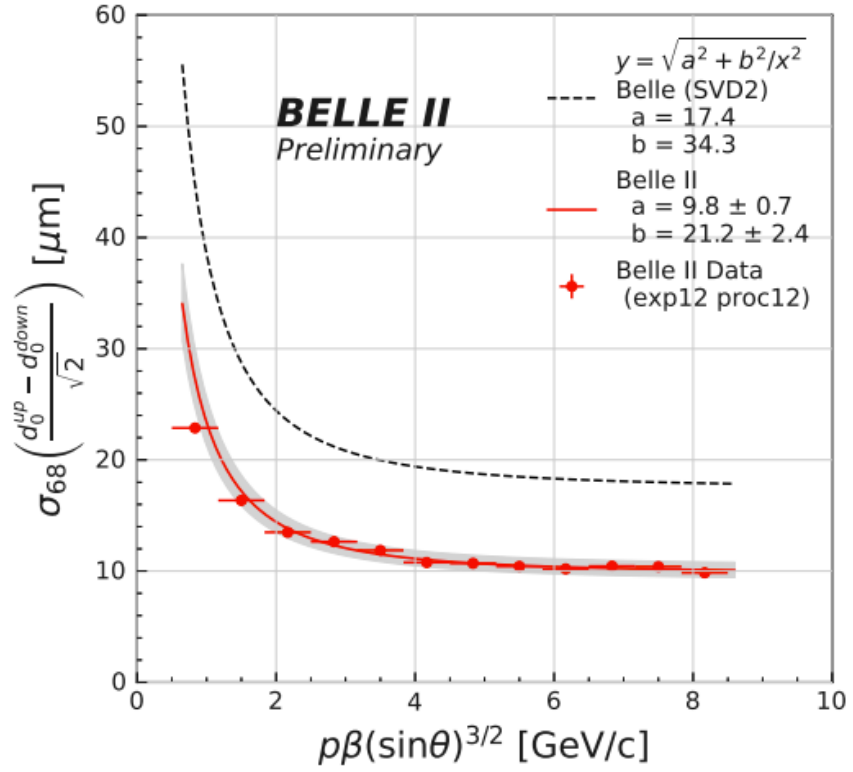


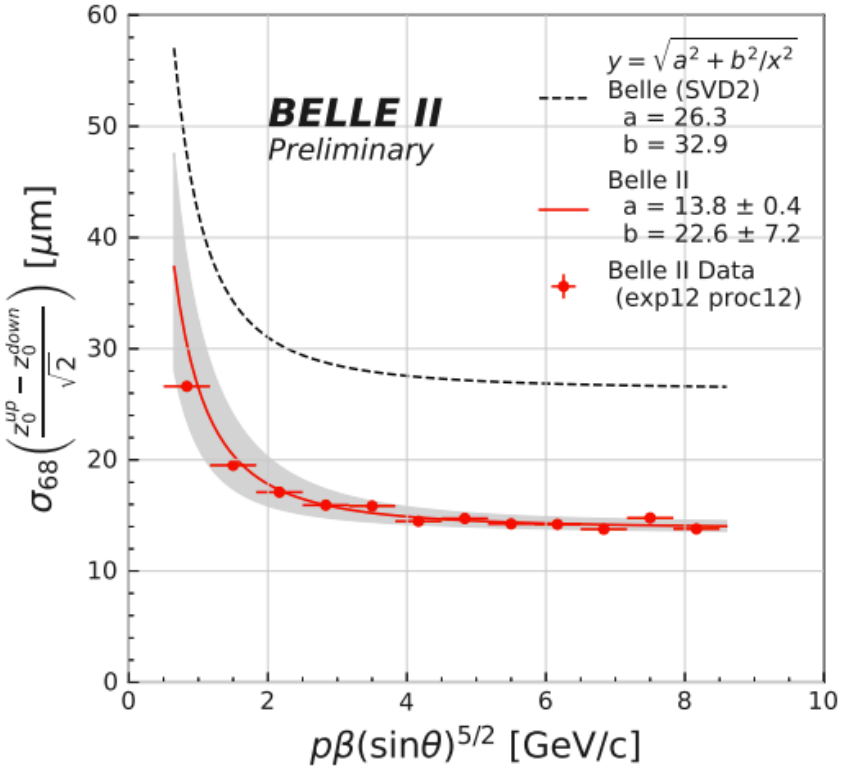
di-muon event



cosmic ray event
(during collisions)

Alignment – Resolution of track parameters





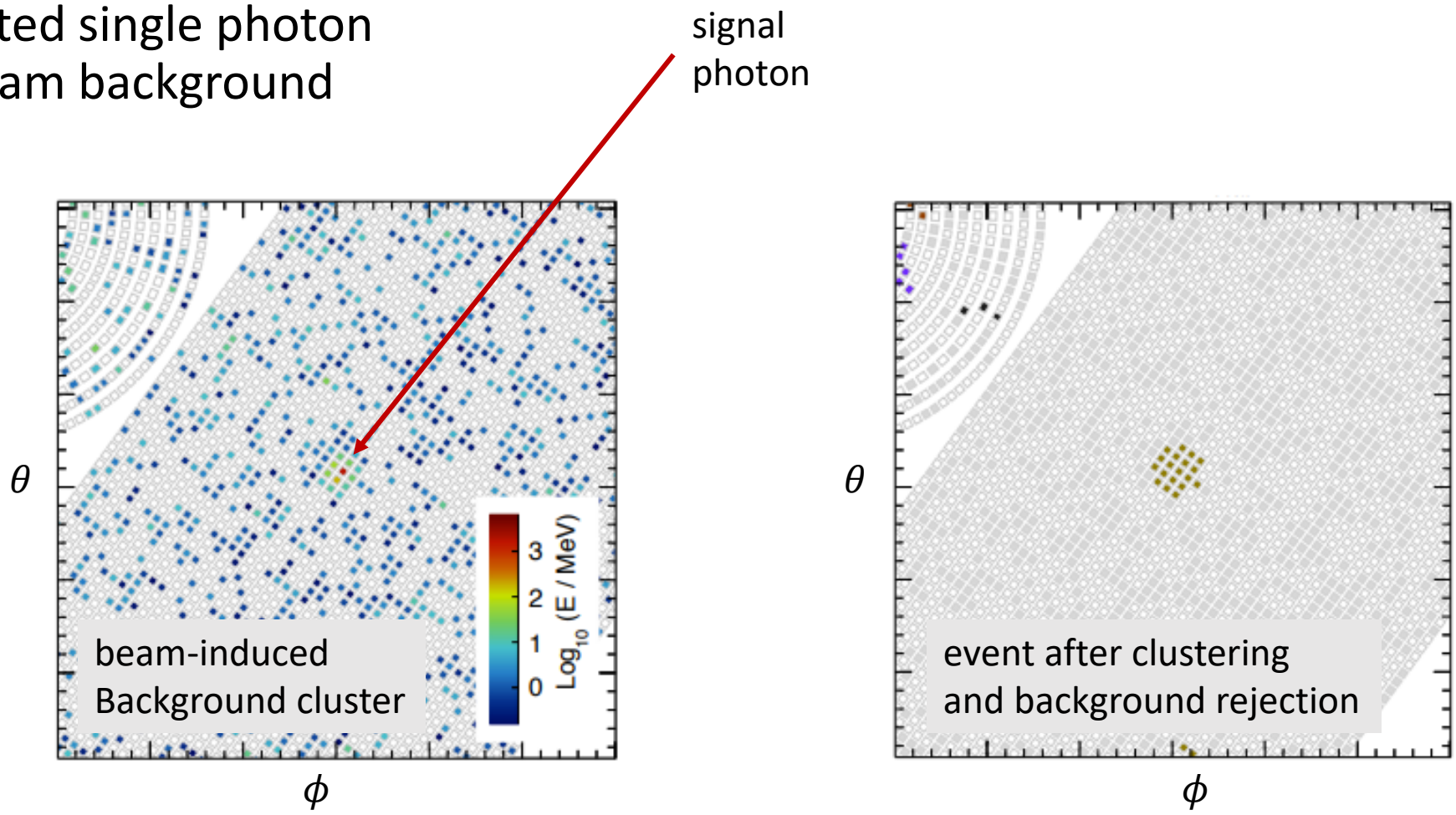
$$\sigma^2(\tilde{p}) = a^2 + \frac{b^2}{\tilde{p}^2}$$

$$\tilde{p}_{d_0} = p\beta\sin(\theta)^{3/2}$$
$$\tilde{p}_{z_0} = p\beta\sin(\theta)^{5/2}$$

a: detector resolution
b: material budget affecting multiple scattering
$\tilde{p}$: pseudo-momentum

ECL reconstruction

Simulated single photon
and beam background



ECL calibration

ECL leakage

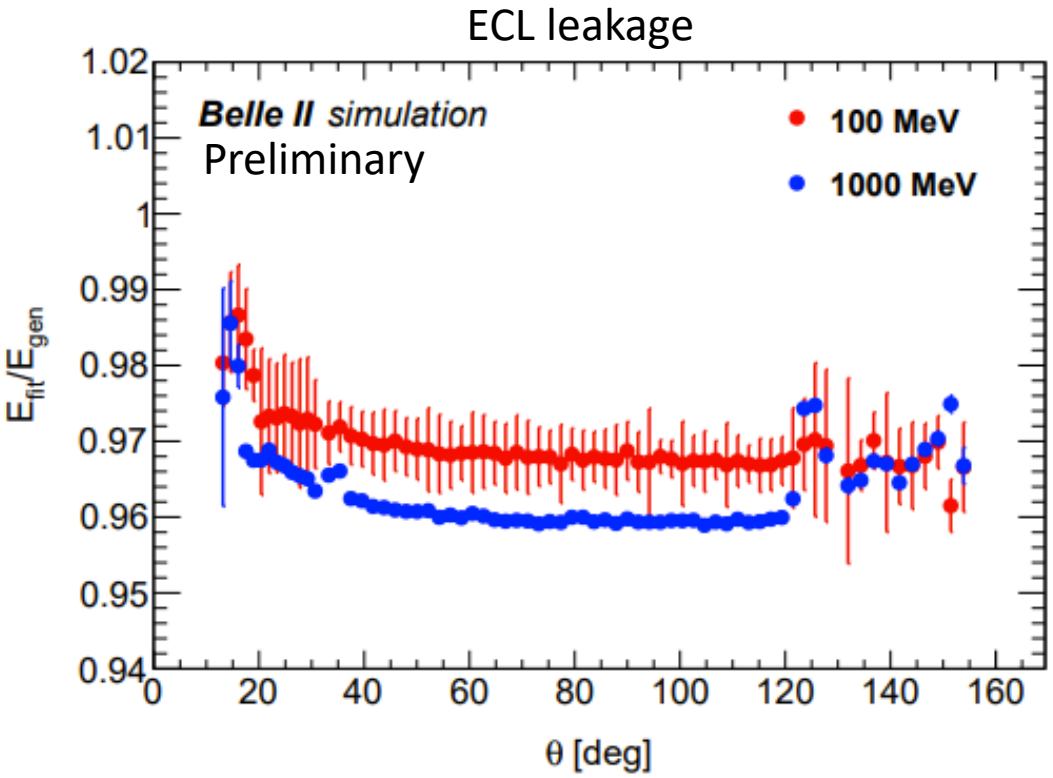
- Reconstructed energy smaller than true energy through leakage
- Derived from simulated single photon + beam background

Absolute energy

- $ee \rightarrow \gamma\gamma$ or cosmic ray events

Final photon energy

- symmetric π^0 and η candidates



Calibration setup

- Small background rates allow for loose trigger lines
- The high-level trigger does not require precise calibrations

→Offline calibrations feasible

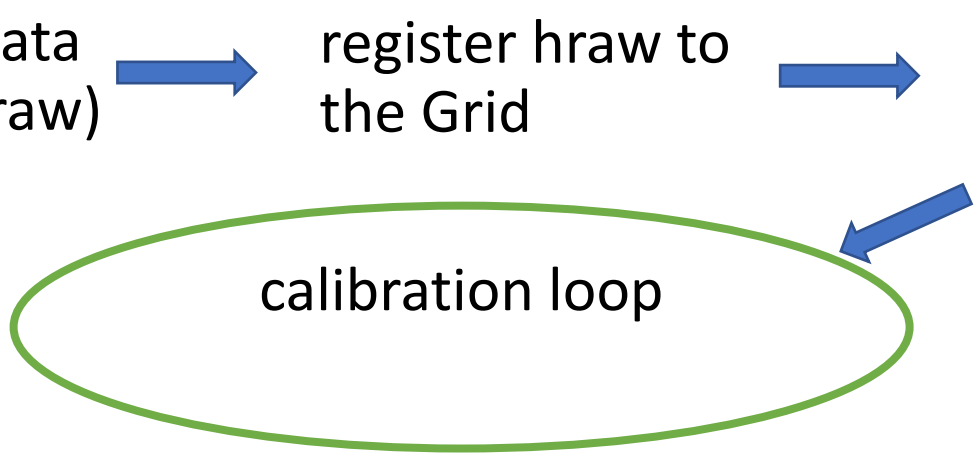
Advantage:
Calibration of the bucket with the current bucket data instead of the previous bucket data

Disadvantage:
Data “lagging” behind, but prompt calibration done within weeks of data taking

Data Flow

HLT-skimmed raw data produced at KEK (hraw)

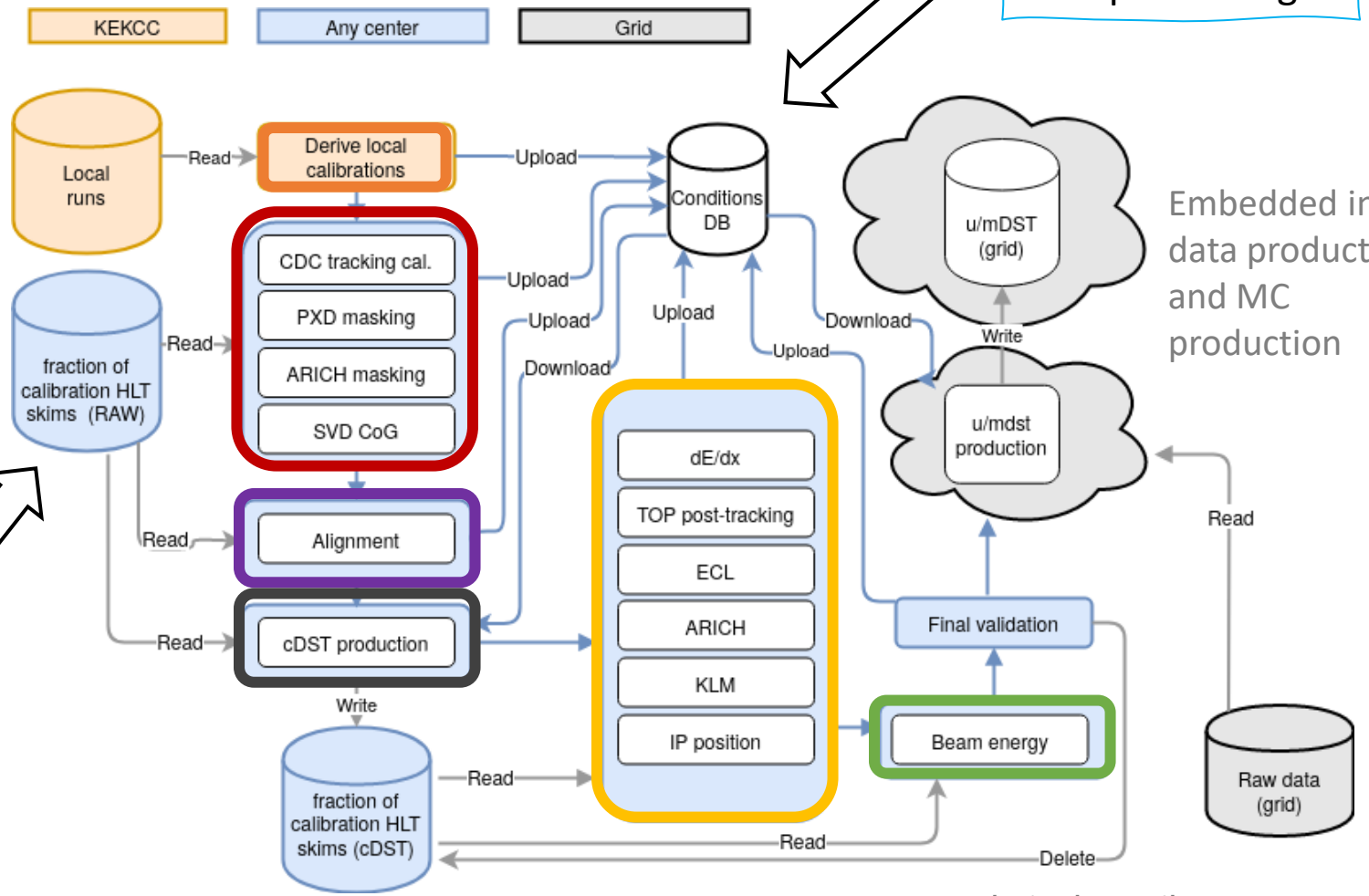
~17 TB per loop



The calibration loop

1. Local calibrations
2. Pre-tracking/raw-data based calibrations
3. Alignment
4. cDST production
5. Post-tracking/data based calibration
6. Analysis-based calibrations

Calibration results as payloads for data processing



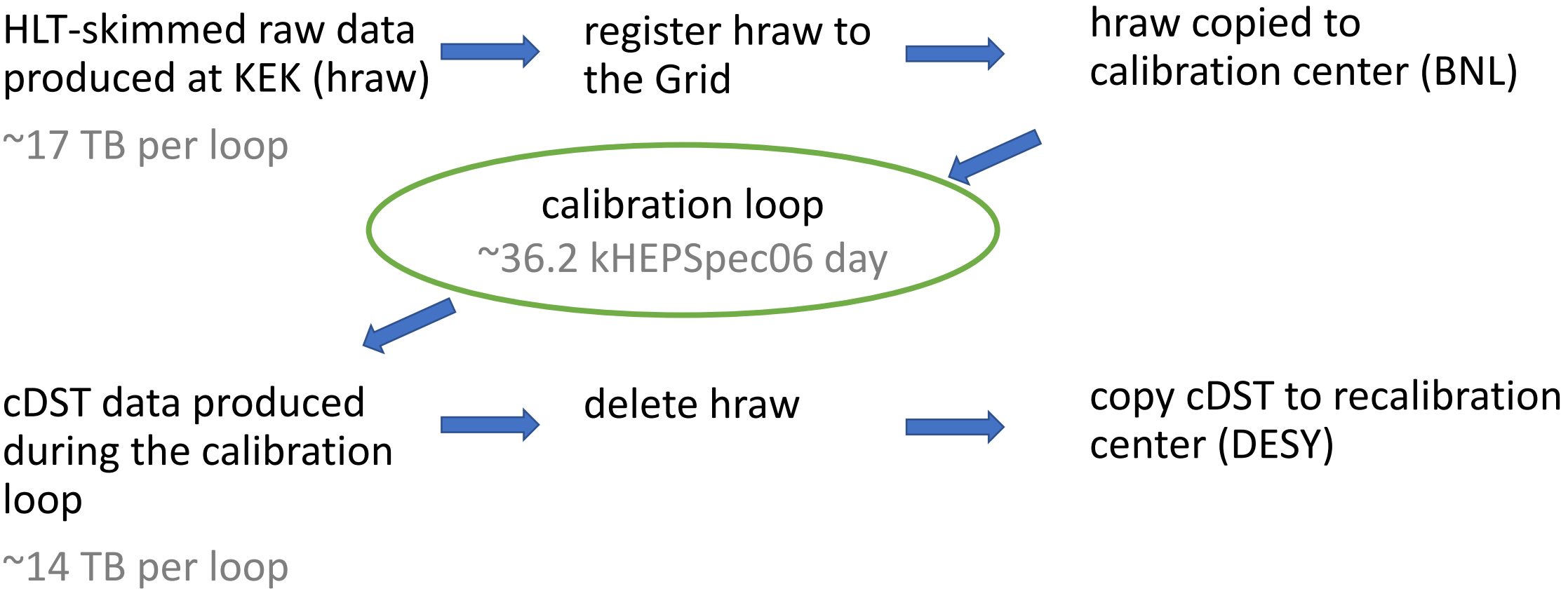
Embedded into data production and MC production

Calibration skims [hraw] (adaptive prescaling to $9\ \mathrm{fb}^{-1}$)

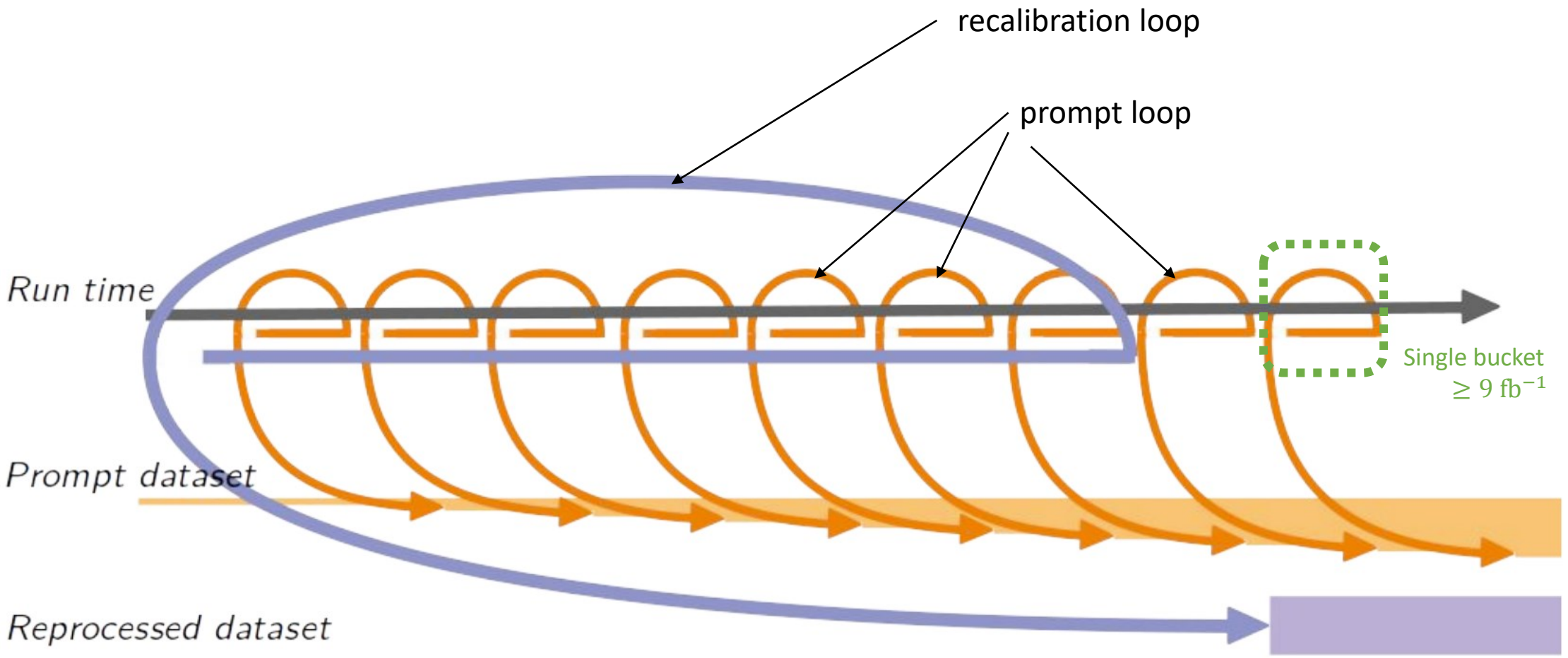
The calibration loop is fully automated and provides physics data within ~2 weeks of data taking

Technical Details:
Talk by David Dosset
11.05.2023, 14:45

Data Flow


HLT-skimmed raw data produced at KEK (hraw)
~17 TB per loop
register hraw to the Grid
hraw copied to calibration center (BNL)
calibration loop
~36.2 kHEPSpec06 day
cDST data produced during the calibration loop
~14 TB per loop
delete hraw
copy cDST to recalibration center (DESY)

The Belle II calibration procedure



The Belle II calibration procedure

Promptly after data taking:

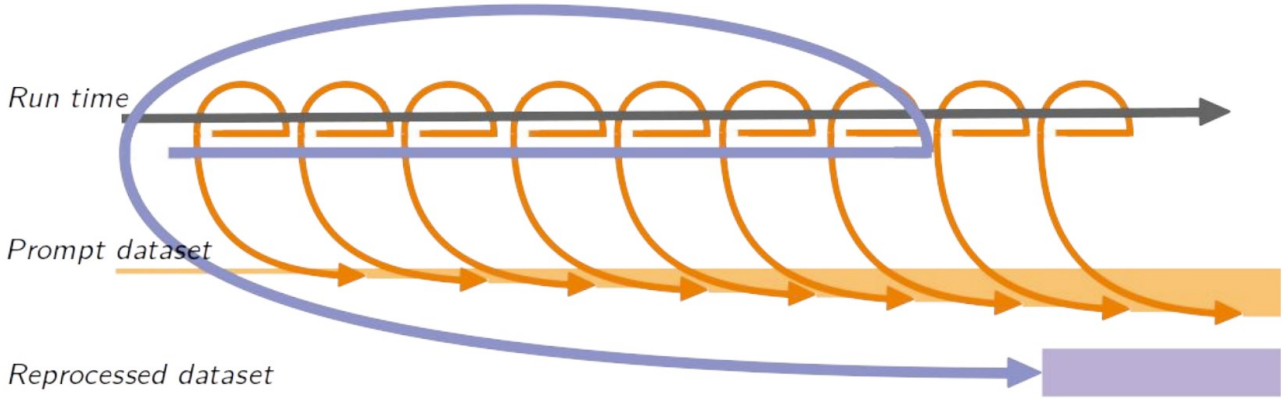
prompt calibration @ BNL

- Minimum luminosity (*) per prompt calibration "bucket": $9\ \mathrm{fb}^{-1}$
- All calibrations included
- Uses hraw as input
- ~one bucket every 2 weeks of data taking
- Ideally already the final calibration

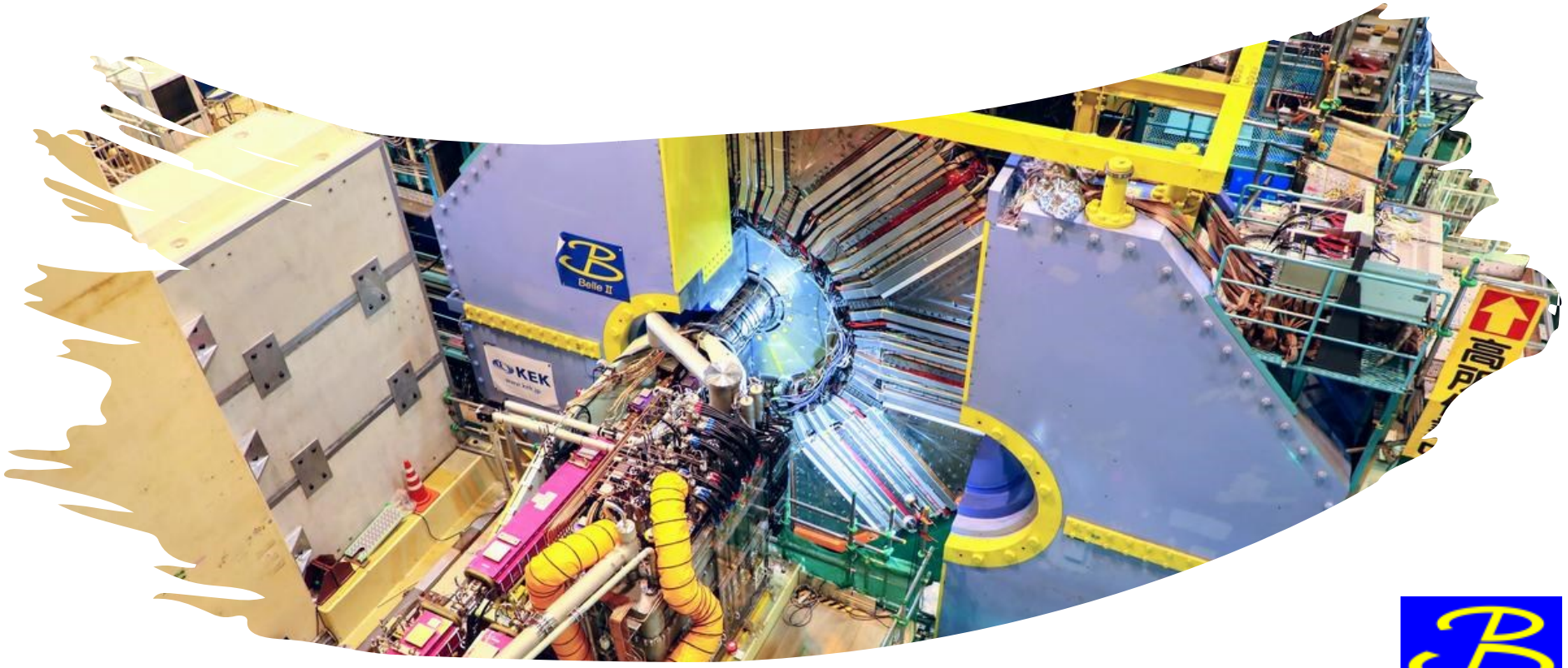
Before data reprocessing:

recalibration @ DESY

- To update older data with the latest reconstruction software
- Only calibrations with expected improvement
- Uses cDST as input
- ~once/year until 2025, every other year starting from 2025



(*) Data of each individual bucket is adaptively prescaled to correspond to $9\ \mathrm{fb}^{-1}$



Summary

- Automation of the Belle II calibration
- Calibrations ready for high precision physics