BRIL & Luminosity

Responsibilities, activities:

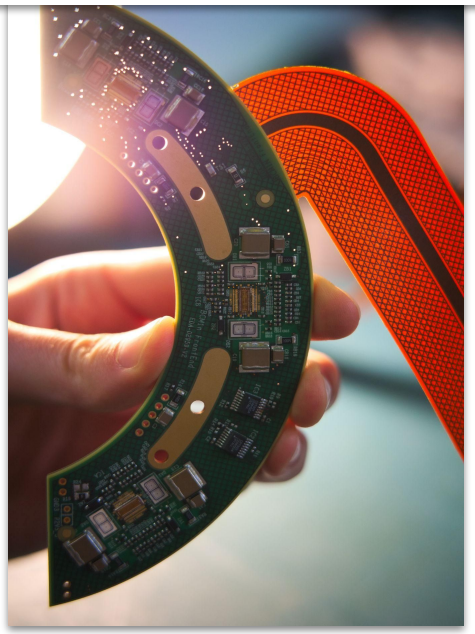
- People: 6 Ph.D students, 1 Postdoc, 3 staff, 1 emeritus
- DESY activities (~30 months of institutional responsibility and EPR)
  - BRIL IB chair: W. Lohmann (DESY) succeeded by S.Spanier (Tennessee)
  - Detector operations: (~15 months)
    - Online luminosity measurement with the fast beam condition monitor (BCM1F) L3 convener: Jonas Rübenach (-> completing thesis)
    - Maintenance and operation of the Beam Pickup Timing Device (BPTX)
  - Luminosity analysis (Run-2 and Run-3, ~15 months):
    - High-precision measurement of the integrated luminosity (->several students leaving in the next 6-9 months)
    - Z-boson counting: D.Walter (-> now CERN fellow)

Luminosity Measurement

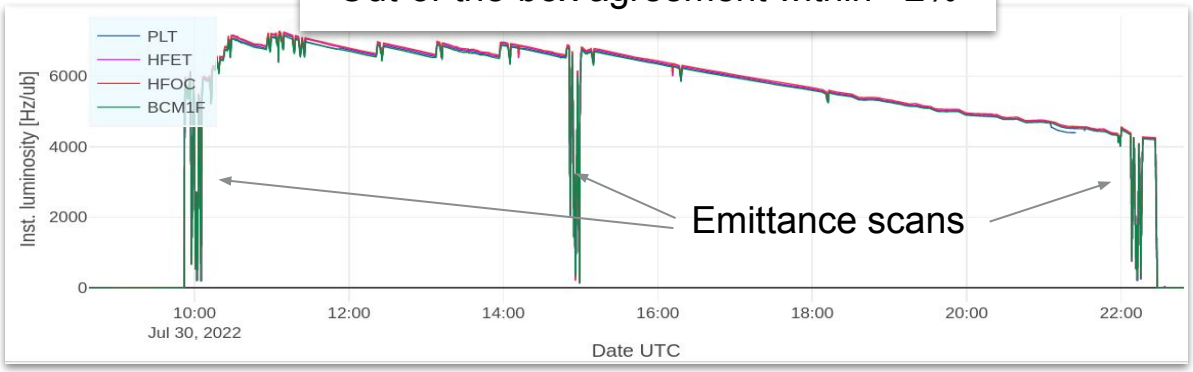
Fast Beam Condition Monitor BCM1F

- Rebuilt for Run-3, Phase-2 Tracker Si-sensors, 48 channels
- Measure bunch-by-bunch online luminosity and background
- One of four online luminometers
- BCM1F assigned “bestlumi” for most of Run-3 so far.

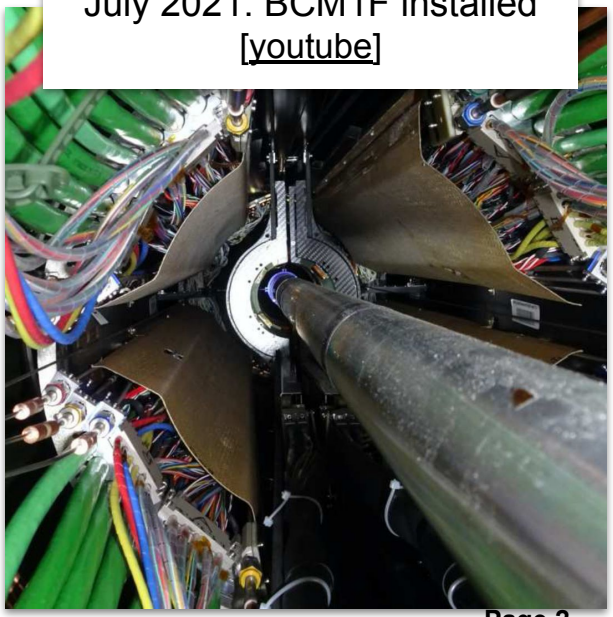
BCM1F “C-shape”



Out-of-the-box agreement within ~2%



July 2021: BCM1F installed [youtube]

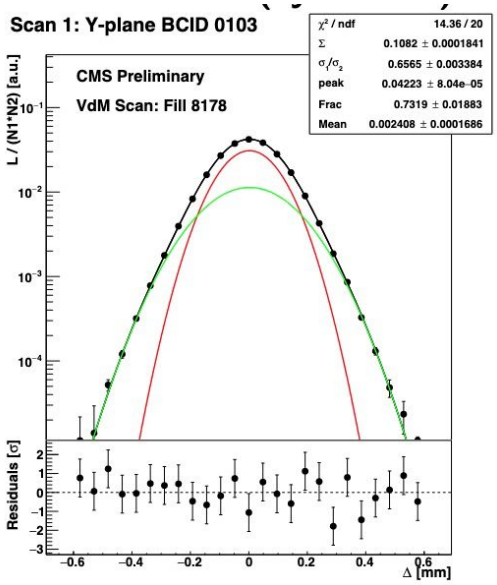


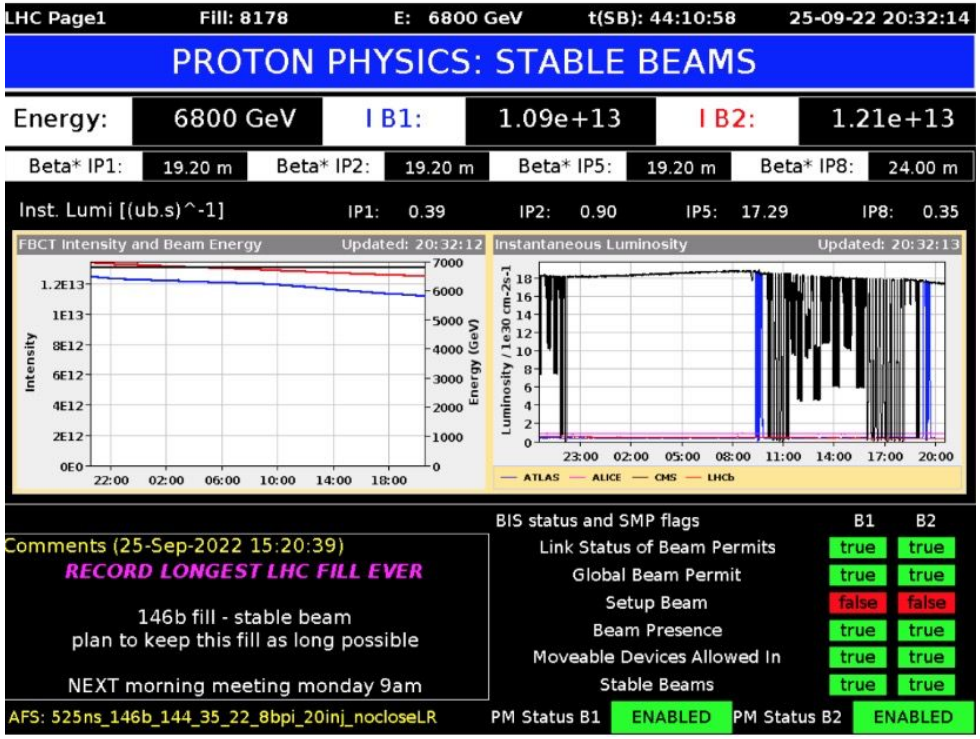
- Delivered integrated luminosity for Early Run-3 Analysis
  - 1.2 fb^{-1} recorded 27 Jul – 2 Aug 22
  - Agrees with Z-boson counting
- Uncertainty estimate: ~6%
  - beam-beam interactions (~5%)
  - xy non-factorization (~2%)
  - beam-position calibration (~2%)
- Systematics to be studied using full vdM scans
  - 1st VdM scan took place 24-25 Sept, during LHCf run
  - VdM scan scheduled for Nov 9-11

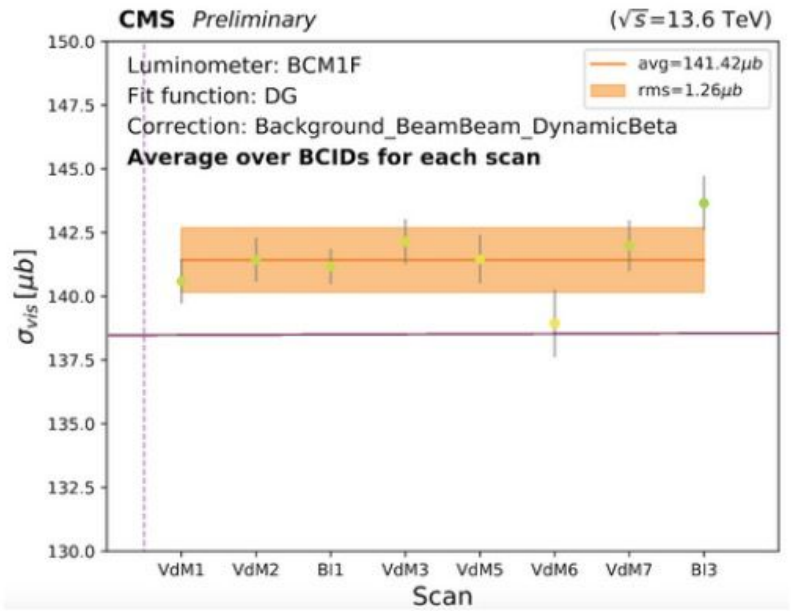
VdM Scan during LHCf run

24-26 Sept

- Longest and most advanced VdM scan data
- Expect another leap in precision
- Lots of interesting analysis opportunities
- Initial results available => uncertainty reduction from 6 to 4%





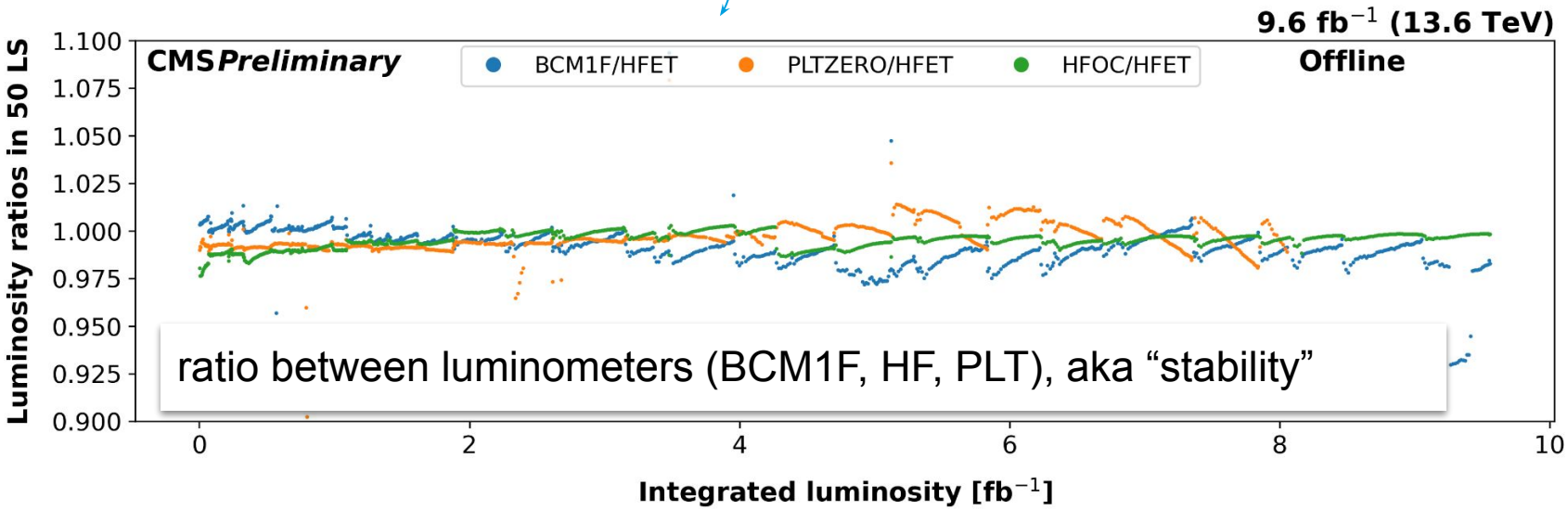


Luminosity Analysis

Final word on Run-2 and initial calibration for Run-3

DESY contributions:

- Stability and linearity (emittance scan analysis - slide 5)
- Transverse factorizability (beam imagining scan analysis - slide 6)
- Cross-detector comparisons



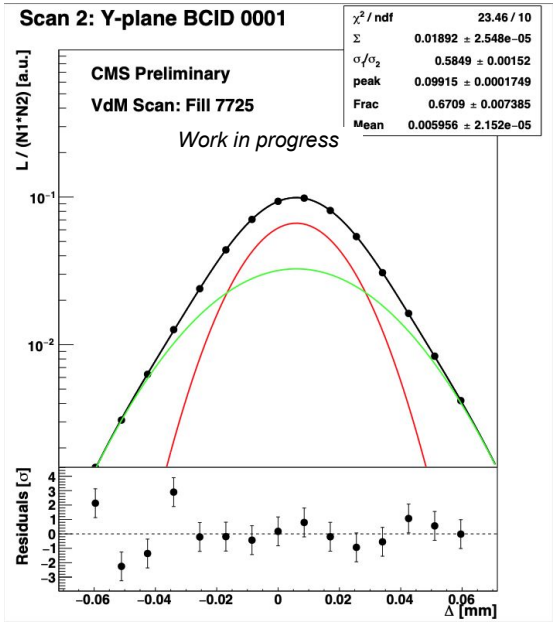
Run-2: paper still underway

Run-3: prelim. result for Moriond 2023

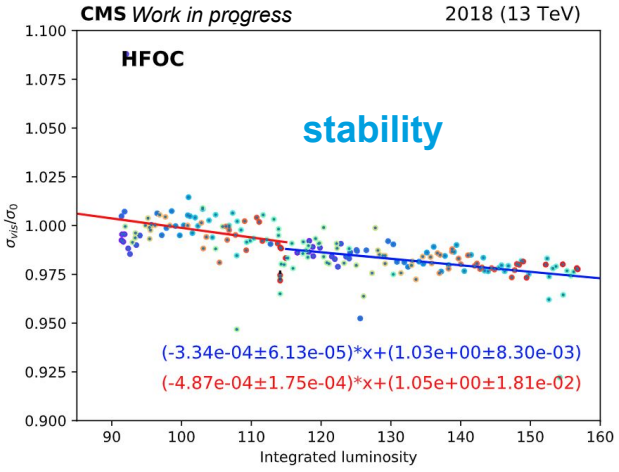
Emittance scan analysis

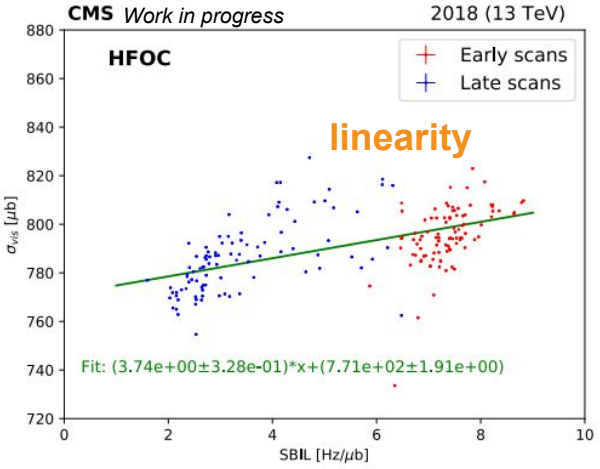
Study linearity and stability of luminometers wrt time and inst. luminosity

- Finalise Run2 and perform Run3 analysis
- **Run2:** derive final corrections and luminosity uncertainties (for 17/18 lumi paper)
- **Run3:** improve estimations for online luminosity calibration



- Emittance scans at beginning and end of most physics fills
- Main tasks:
  - study best fit functions
  - apply beam-beam, dynamic beta and background correction
  - assess stability and linearity



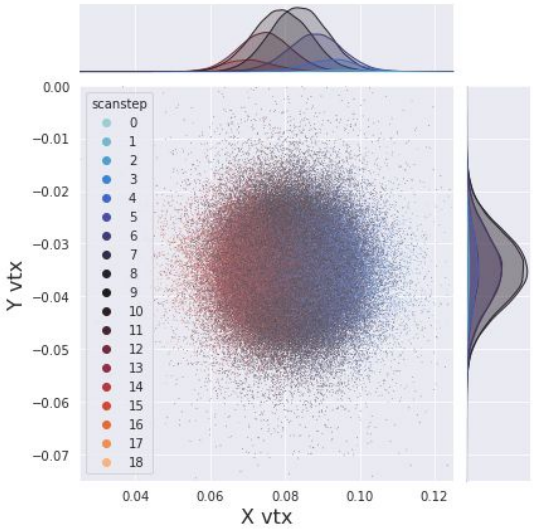


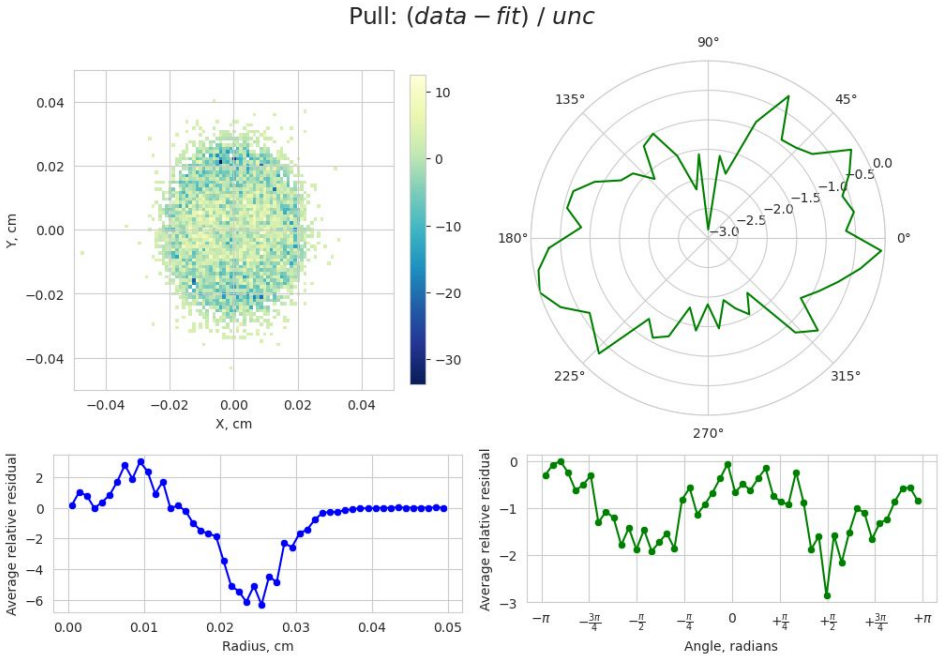
Luminosity Analysis

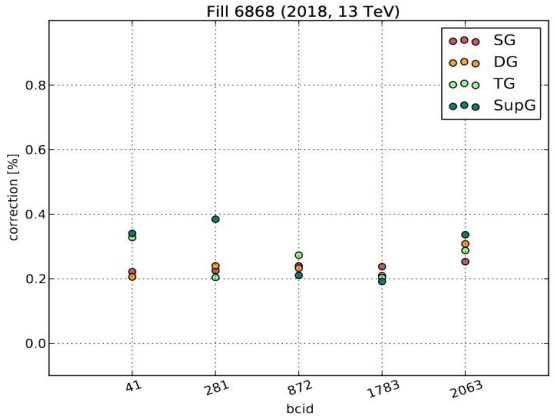
Factorisation bias estimation via Beam-Imaging method

- Non-factorizable beam shapes are observed at LHC
- Beam Imaging method: one beam is at nominal position, while the other one is moved
- BI data is fit with 5 models in order to get correlation parameters: Single Gaussian, Double Gaussian, Triple Gaussian, Super Gaussian, Super Double Gaussian
- Currently WIP preparing TensorFlow based software for fitting **Run3** data.

Beam-Imagine scans shape



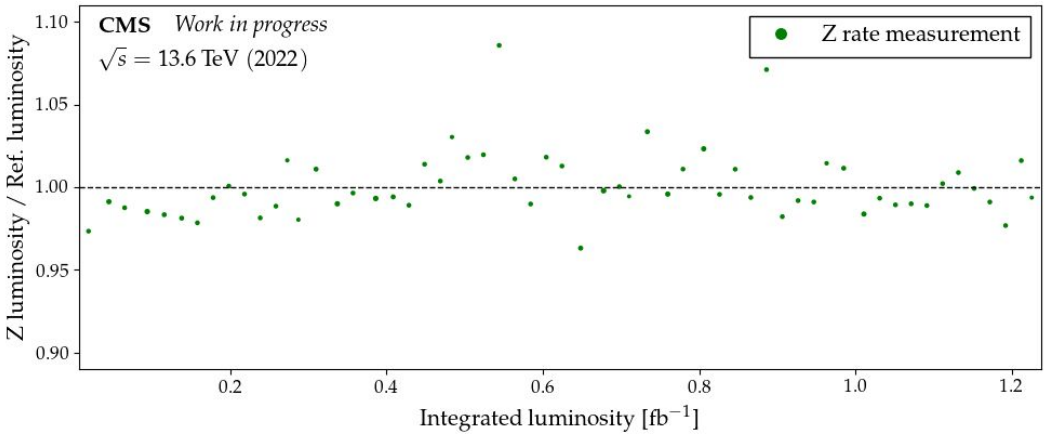


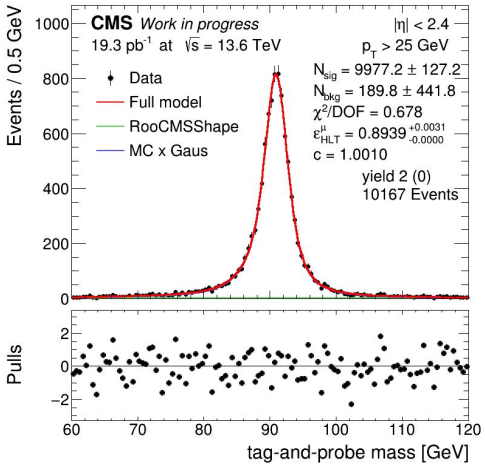


Z-Boson Counting

Luminosity measurement with independent systematics and in-situ efficiency

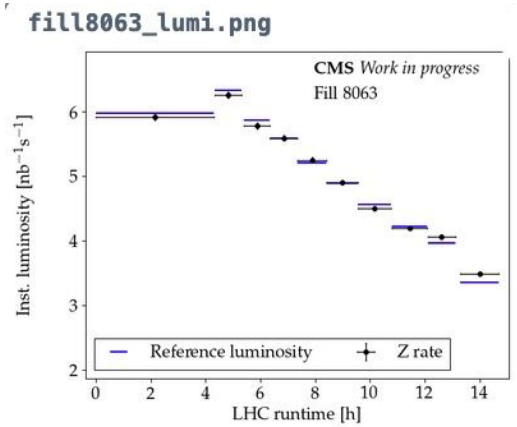
- count number of reconstructed Z->mumu (in bins of 20pb^{-1})
- correct for trigger and reco efficiency (using T&P)





- compare with reference luminosity (for stability)
- normalize to theory prediction (NNLO+N3LL):

  Int. lum.: 1.15 fb^{-1} +/- 5%, in good agreement with BRIL value



Run-2 analysis: paper draft moving towards approval

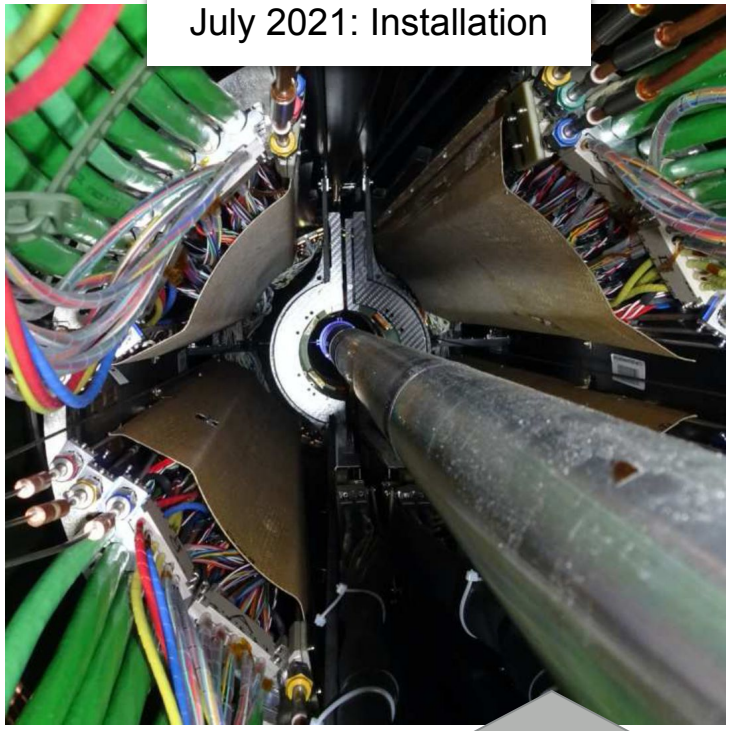
Run-3 analysis: cross check of luminosity normalization, and comparison with ATLAS

Backup

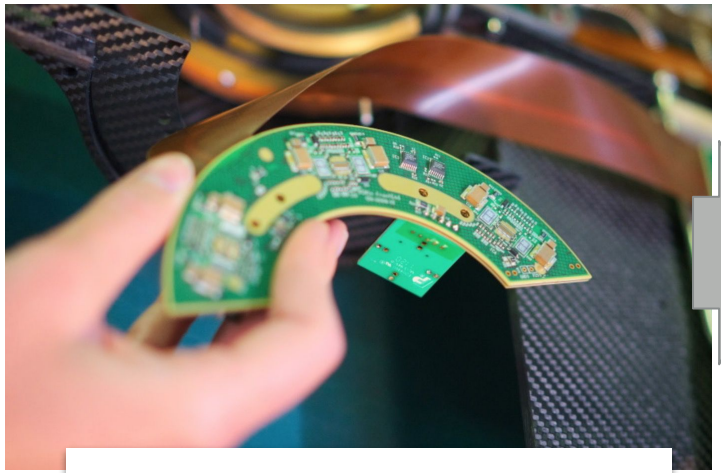
Luminosity Detectors

Fast Beam Condition Monitor (BCM1F)

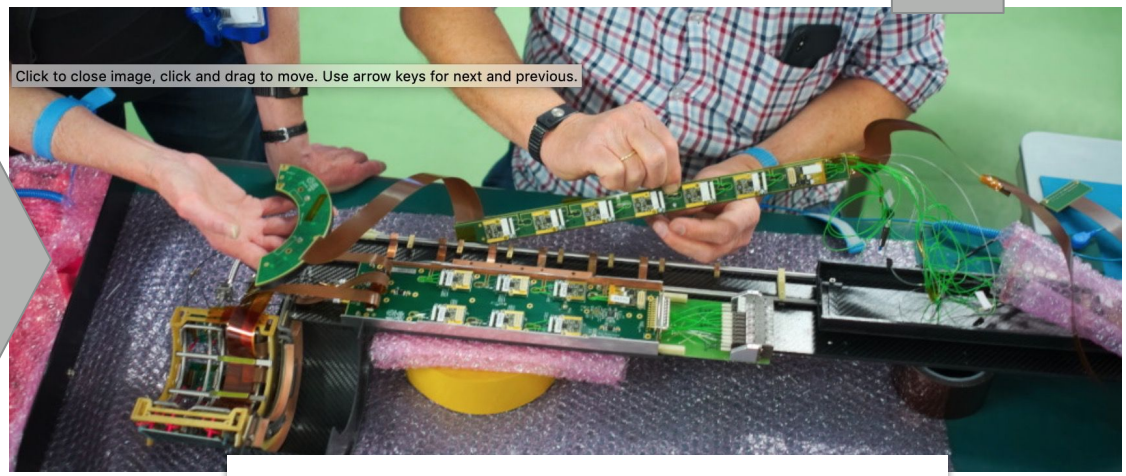
- Rebuilt for Run 3, using cooled Si-sensors
- Successfully installed in July 2021
  [CERN Bulletin] [youtube]
- Proven to work immediately and stably during test beams 18-31 October
  [Last PRC report]
- Restart last week, a few splash events so far



July 2021: Installation



BCM1F “C-shape”
Assembly and testing at DESY



May/June 2021: Integration with Pixel Luminosity Telescope (at CERN)