

BCM1F and Luminosity

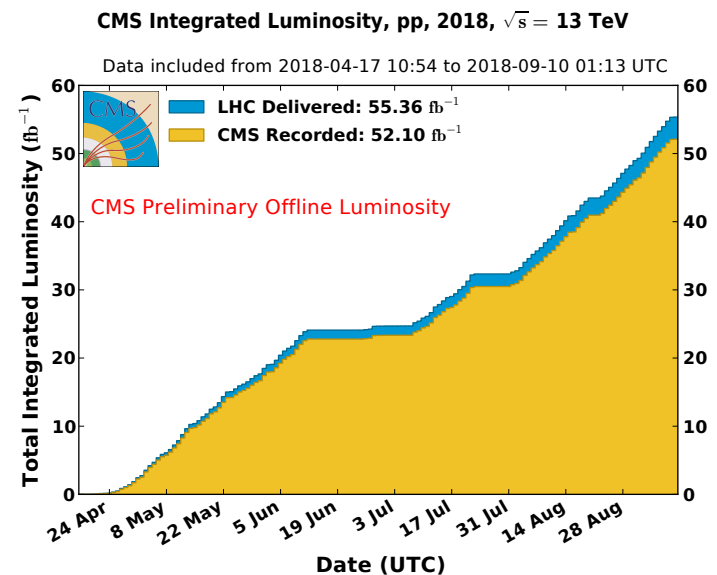
PRC October 2018

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Beam Monitoring and Luminosity Measurement

Overview of DESY Engagements

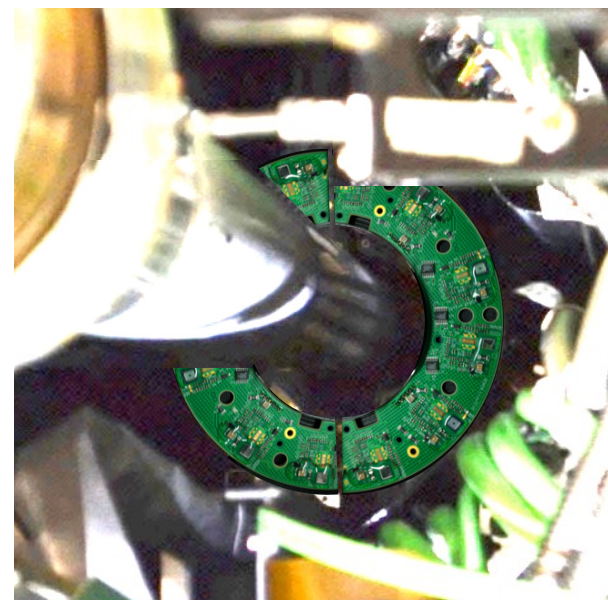
- **Precision measurement of integrated luminosity (analysis of VdM scan data)**
 - x-y correlation (assumption of beam density factorisation between x and y coordinates)
 - Length scale determination (residual between nominal and actual beam positions)
 - Orbit drift (time dependence of actual beam positions)
 - Final publication of 2015/16 luminosity
- **Operation, calibration and maintenance of BCM1F**
 - Software development and operations
 - Online calibration for 2018
 - Study of 2017
- **Refurbishment of BCM1F for Run-3**
 - Sensor design and characterisation
 - C-shape assembly and testing



BCM1F 2018

Detector Performance Overview

- **Poly-crystal diamonds**
 - Like in 2017, very robust and consistent performance, 100% duty cycle
 - Online corrections for non-linearities and number-of-bunch dependency applied
- **Silicon sensors**
 - Very good stability and linearity
 - Summer 2018: After a total of 80 fb^{-1} leakage currents started to saturate the electronics (DC-coupled r/o)
- **Single crystal diamonds (sCVD)**
 - Severe radiation damage: no measurement since $\sim 10 \text{ fb}^{-1}$ in early 2017
 - same as early 2016 (before previous refurbishment)

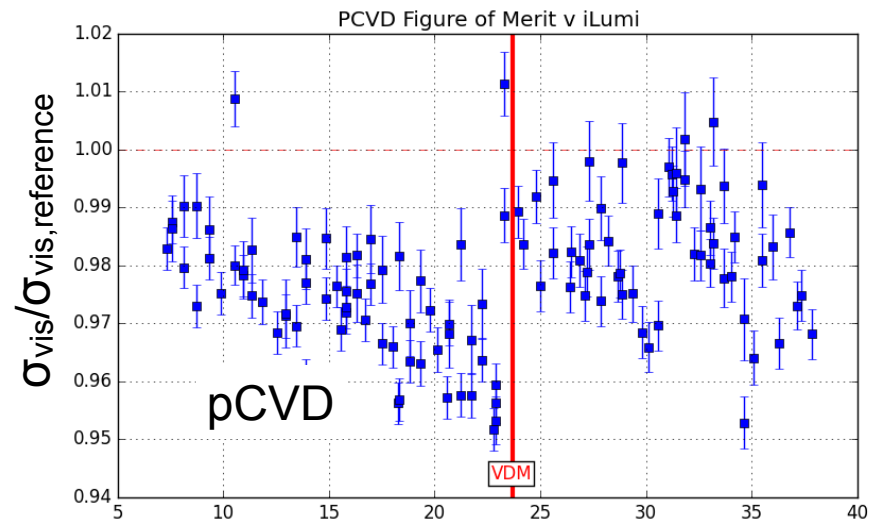


artistic view

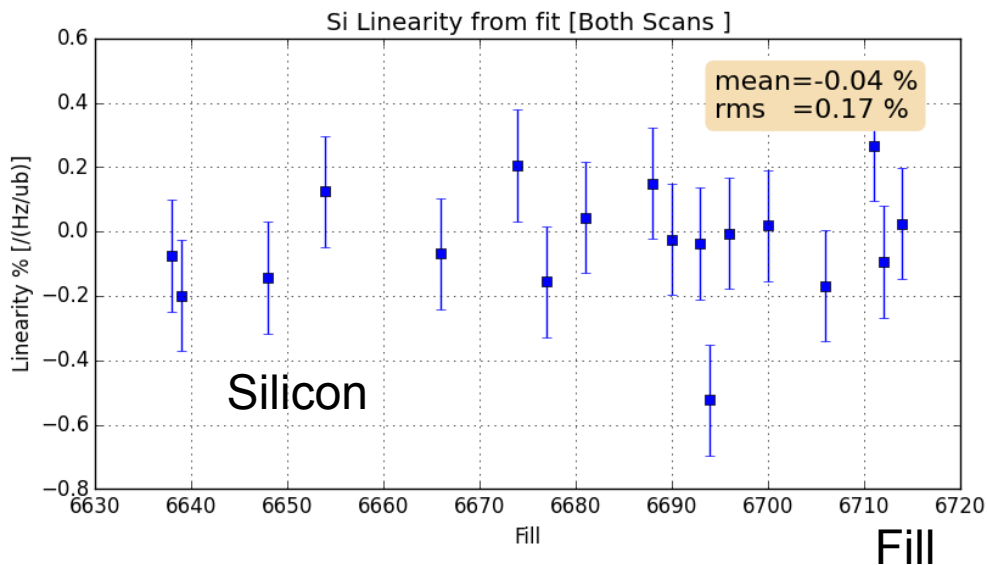
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pCVD and Silicon

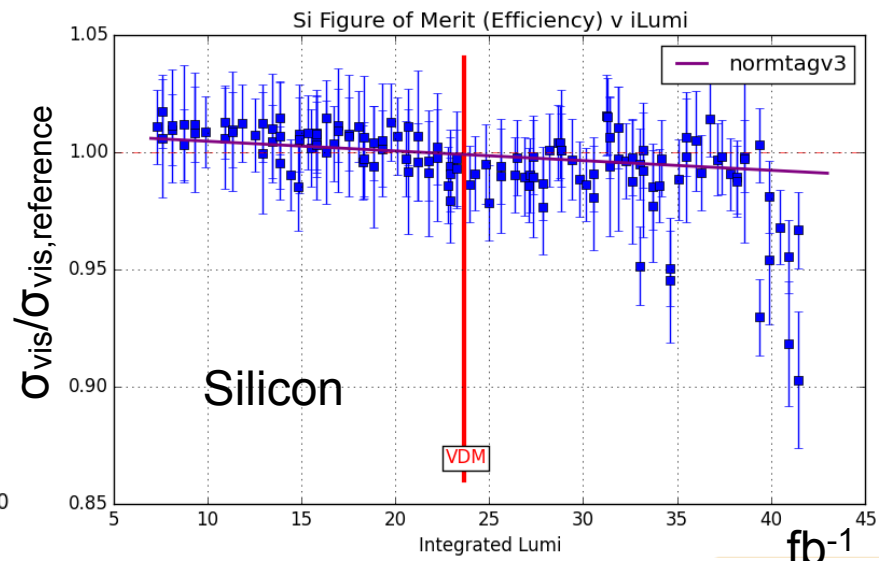
- Emittance scans: short vdM scans to monitor:
 - normalisation
 - non-linearity



Good long-term stability, some steps due to annealing (of AOH) during breaks



Very good linearity: 0.04% / Hz/ μ b

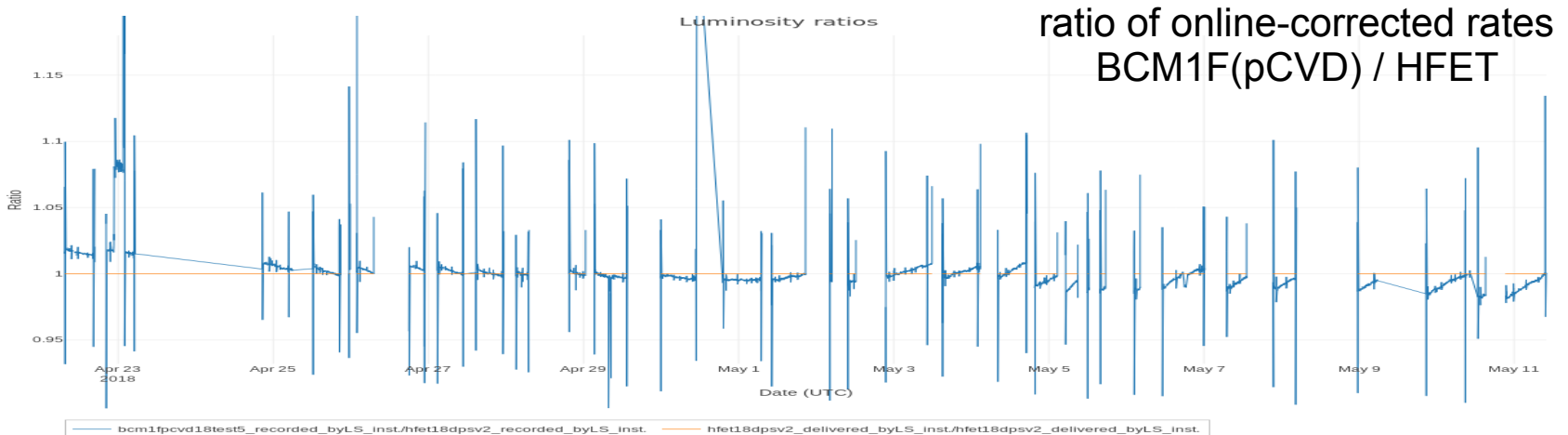
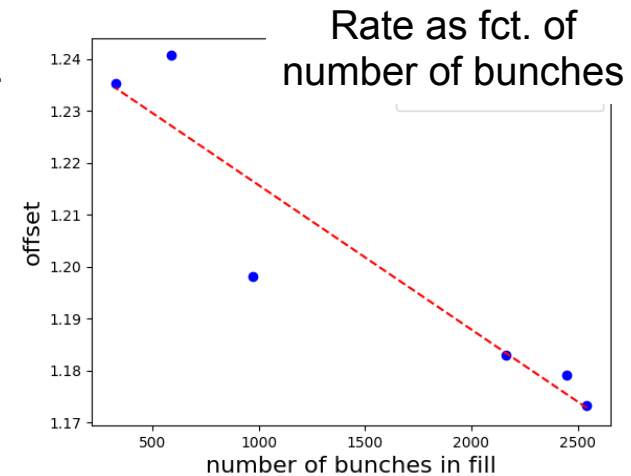
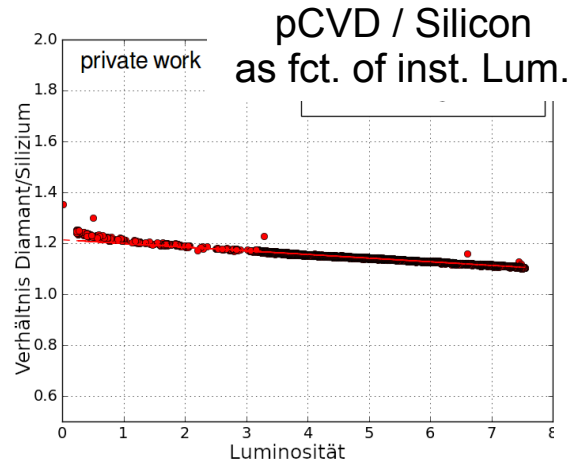


Very good long-term stability. At 40 fb^{-1} : leakage currents saturate electronics

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pCVD Calibration

- Determine online corrections
 - non-linearity
 - dependency on number of bunches



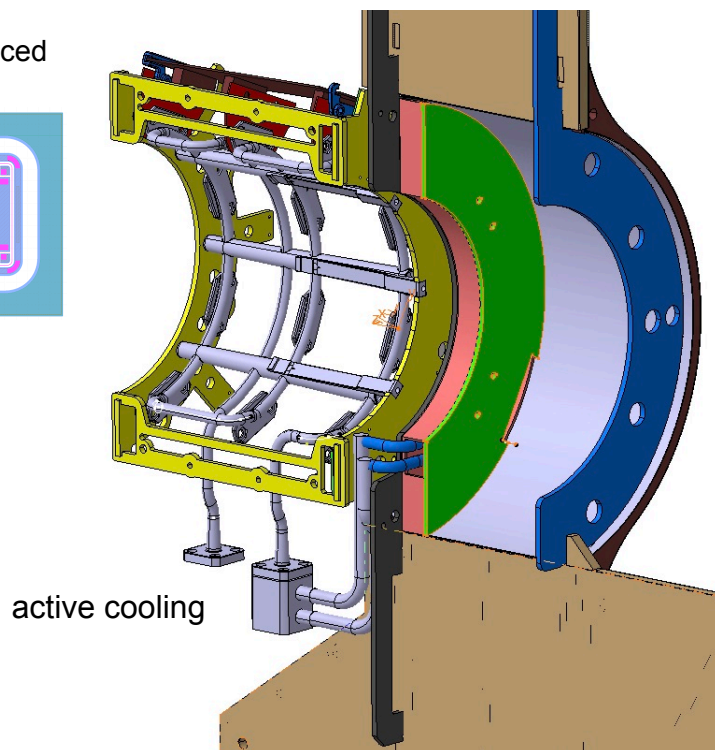
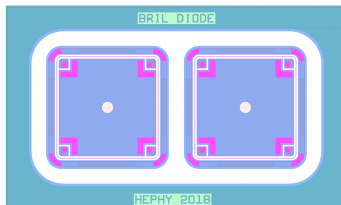
with online corrections: good linearity and stability

BCM1F for Run3

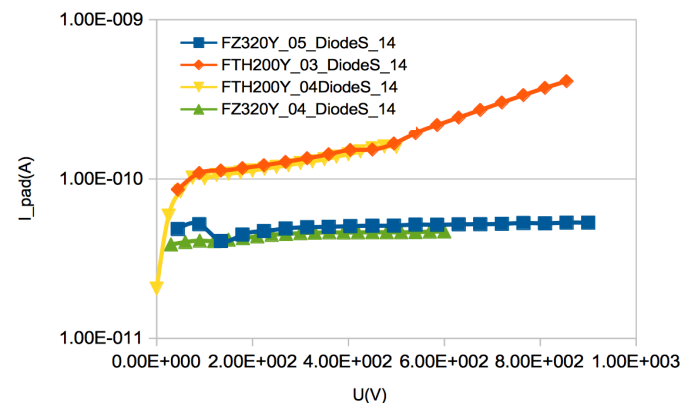
Rebuild with improvements

- Silicon Sensors
 - A/C coupling to prevent electronics saturation due to leakage currents.
 - Sensors being manufactured as part of phase-2 HGCal sensor production.
- Updated C-shape design with cooling (-20°C)
- Timeline
 - 2018: Prototype design and production
 - 2019: Testing and final design
 - Summer 2020: Installation
- DESY contributions:
 - Sensor design, characterization and selection (probe station, sensor dicing, test board operation)
 - PCB (C-shape) assembly and testing (includes SMD and r/o): in preparation
 - Possible test beam studies in 2019

sensors being produced
(with HGCal)

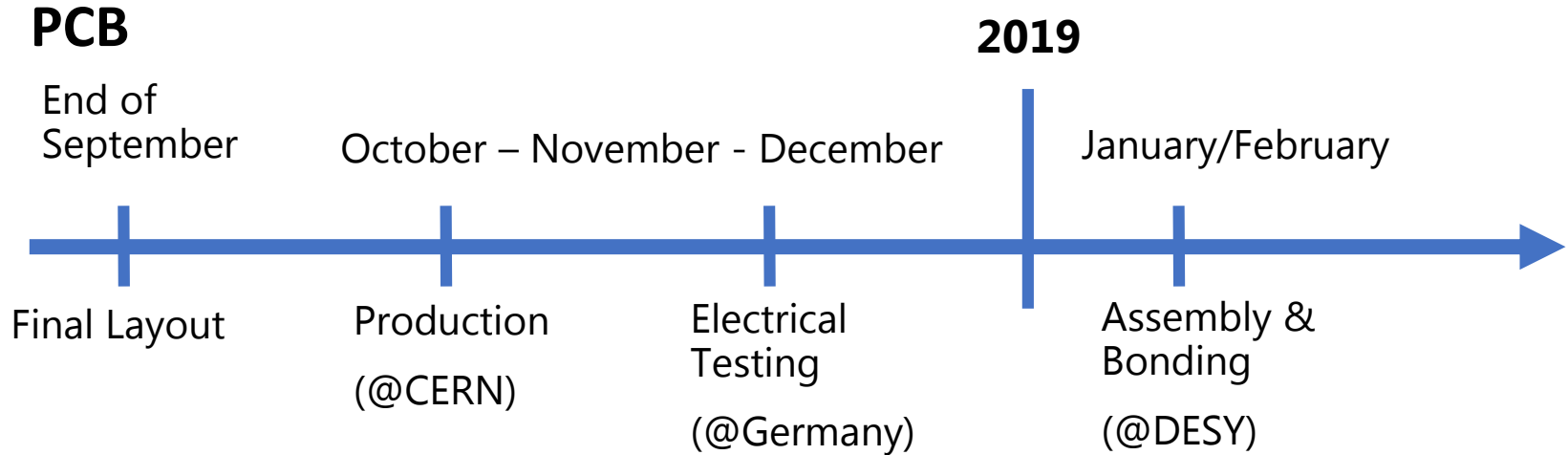


probe station IV scan
(tested in Hamburg)

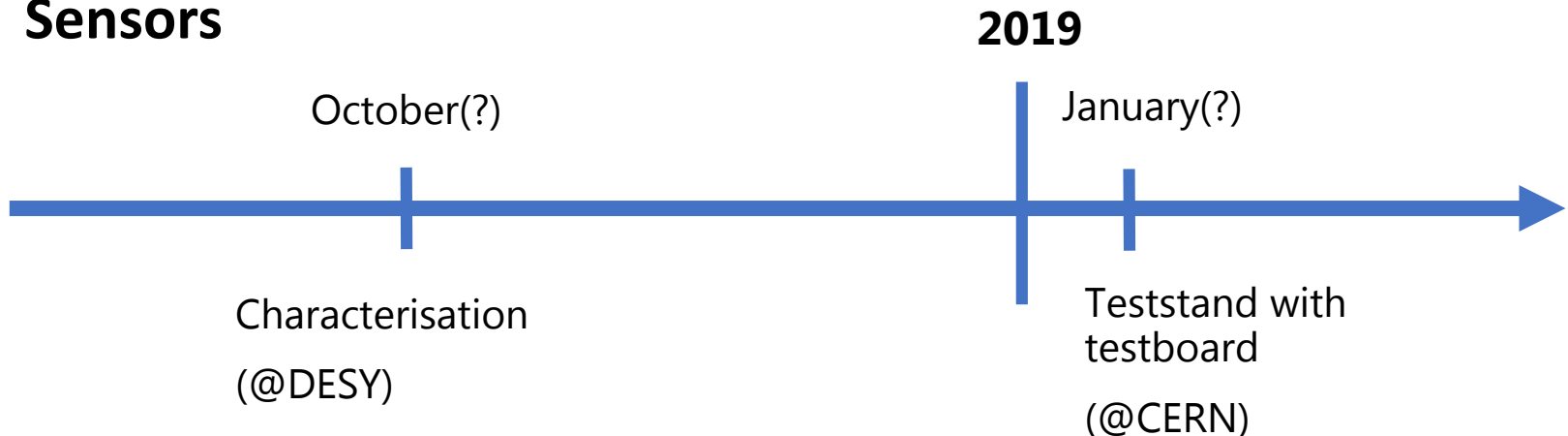


BCM1F for Run3

Timeline for design, construction and testing



Sensors



Precision Measurement of Integrated Luminosity

Analysis of VdM scan data

- Determination of precision corrections and uncertainties of 2018 vdM analysis

- length scale

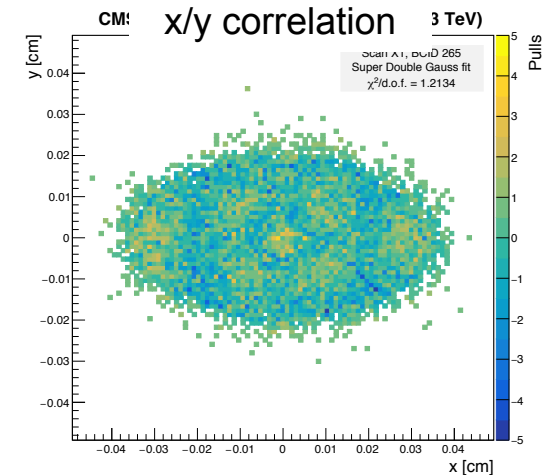
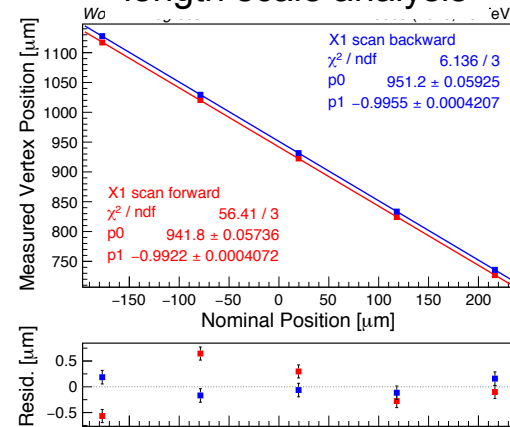
- x/y correlation
 - X1_Y1
 - BIX1_Y1
 - BIX3_Y3
 - X5_Y5
 - X6_Y6

- Complete vdM analysis for 5 TeV pp run in 2017 (underway)

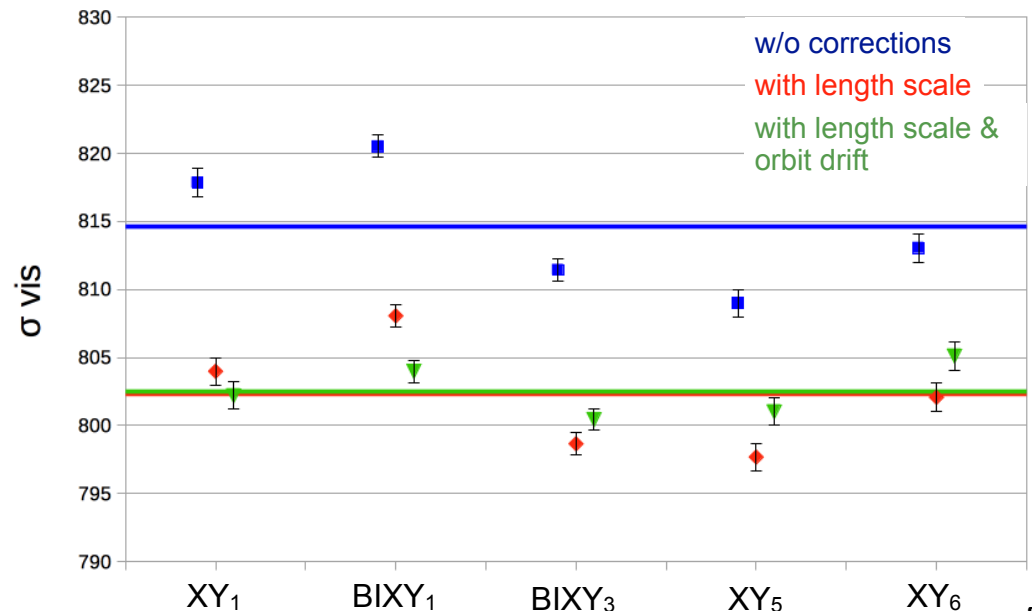
- Luminosity measurements for 2015-2017

- CMS-PAS-LUM-15-001 (pp 2015)
- CMS-PAS-LUM-17-001 (pp 2016)
- CMS-PAS-LUM-17-002 (pPb 2016)
- CMS-PAS-LUM-17-004 (pp 2017)

X Scar length scale analysis



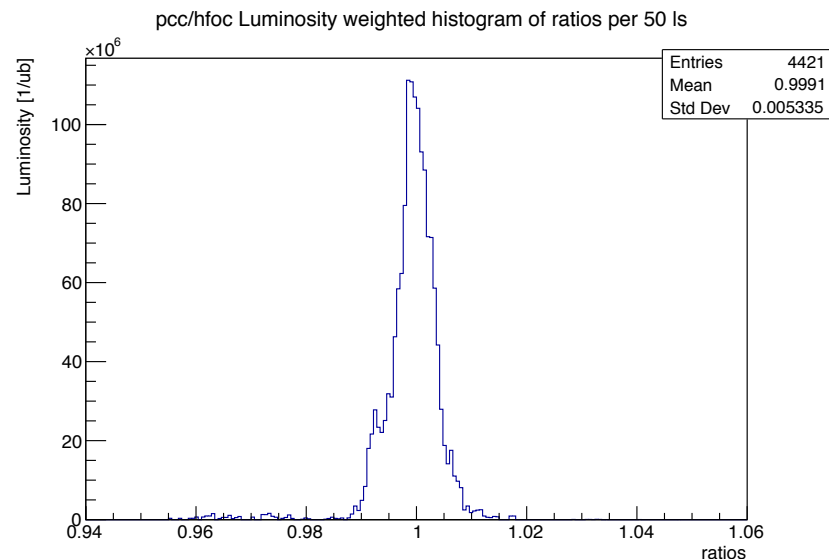
Visible cross sections (for HF)



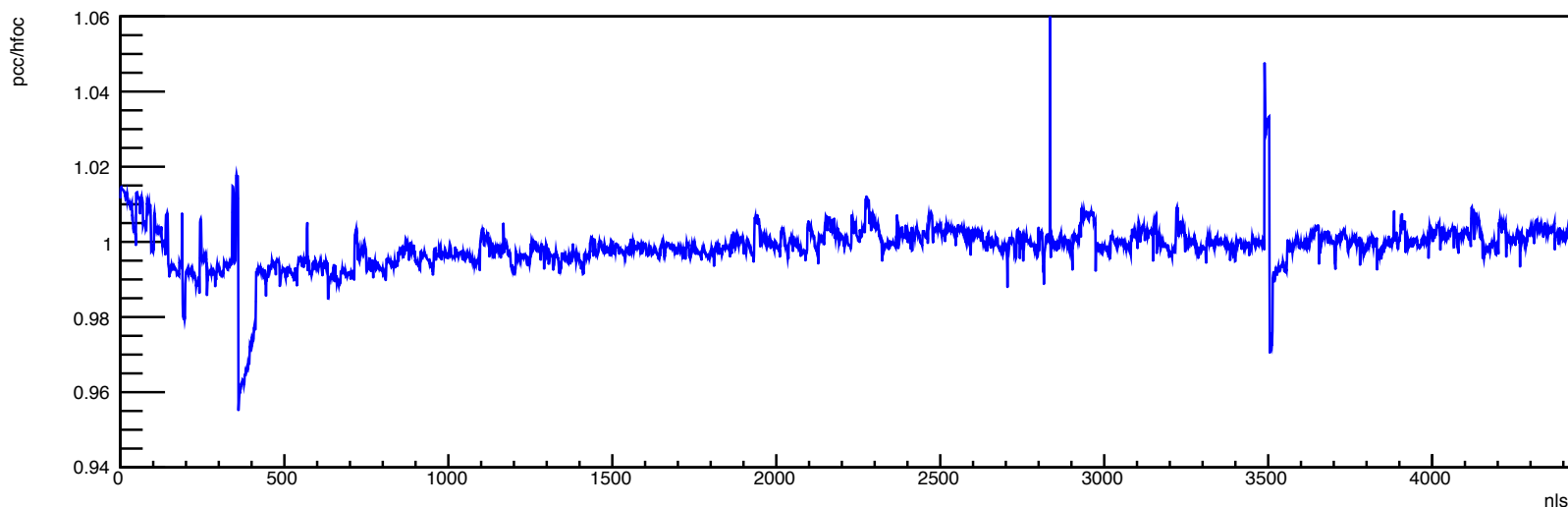
Re-Analysis of 2015/2016

For final publication

- Plan first-ever luminosity publication
- Improved vdM analysis results already available
- Last step before publication: investigate long-term stability and extrapolation from vdM scan



pcc/hfoc Int. Lumi Ratio by 50 LS



Expect total uncertainty to be reduced from 2.5% to 2.0% → paper

Summary

Cooling

- BCM1F 2017/2018:
 - successful operation for the last two years (100% duty cycle)
 - pCVD: online calibration to correct for non-linearities,
 - Silicon: very good linearity, (DC-coupled) r/o saturated after 100 fb^{-1}
- BCM1F refurbishment for Run3:
 - Technology: Silicon sensors, AC-coupled with active cooling,
 - PCB and sensor design being updated based on lessons learned
 - Plan: Expect prototype PCB and sensors in Q4 of 2018, assembly in Q1 of 2019
- vdM analysis:
 - 2018: contributing to vdM analysis (like previous years)
 - 2015/16: plan final publication with improved total uncertainty (2.5% \rightarrow 2.0%)

Backup