

# BRIL/Luminosity

## Review of 2016 and Look Forward to 2017

Jessica Leonard  
CMS RunCoord and DPG Meeting  
25 January 2017



# Outline



EYETS hardware activities

Post-EYETS commissioning

Luminosity status for 2016

Outlook for 2017

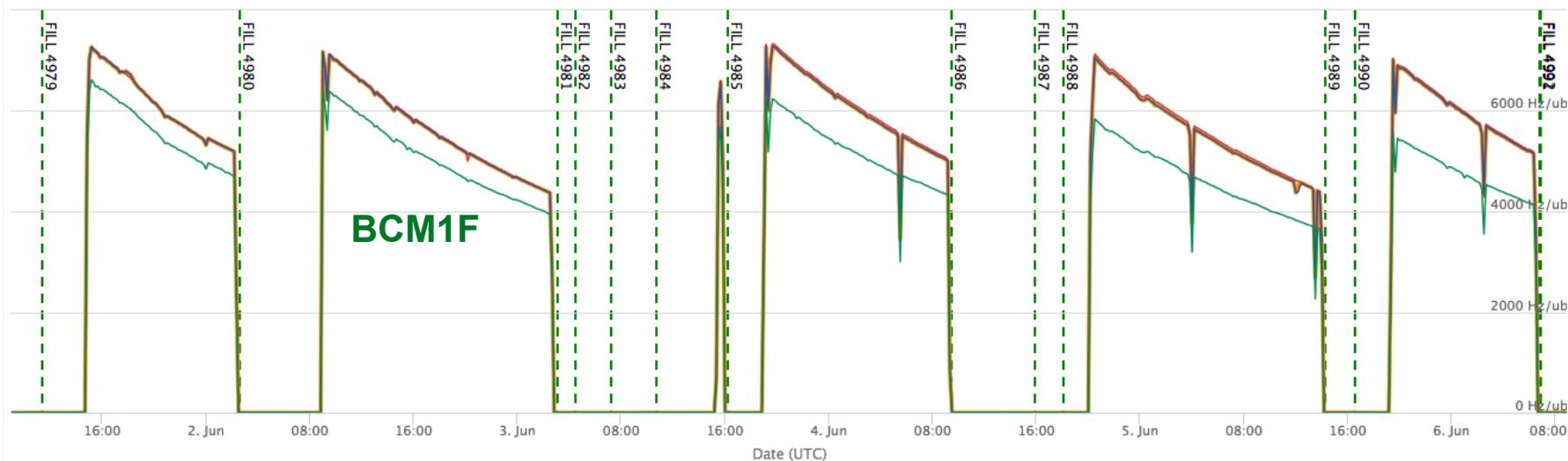
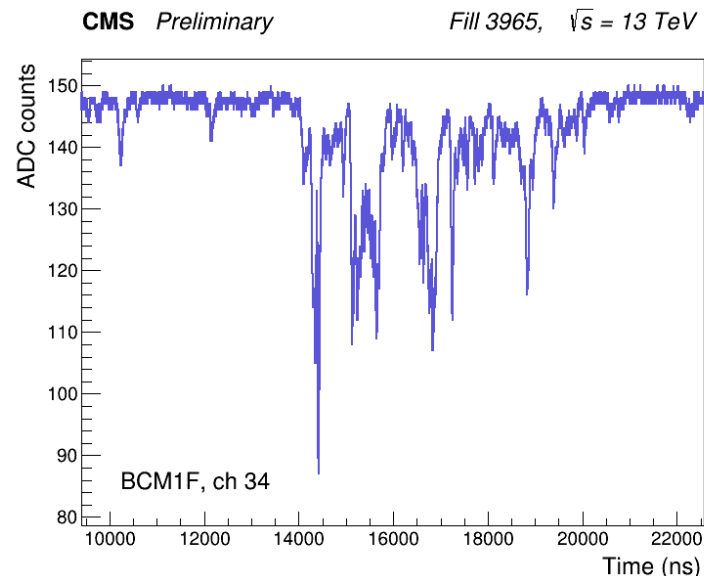


# New BCM1F Detector



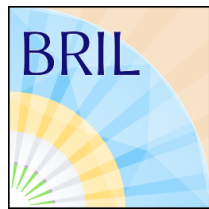
## BCM1F issues over previous year

- Single-crystal diamond sensors performed well during Run I, problems in Run II
- Erratic current → could not run at foreseen high voltage
- Low voltage → efficiency lost at significant rate with increasing radiation damage





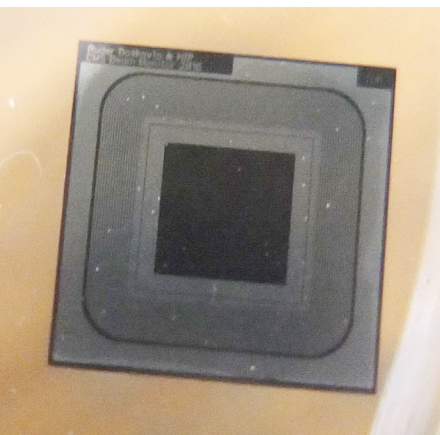
# BCM1F Run II v.2



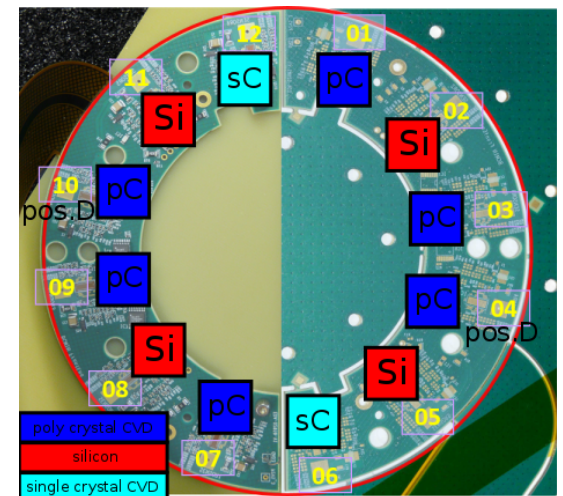
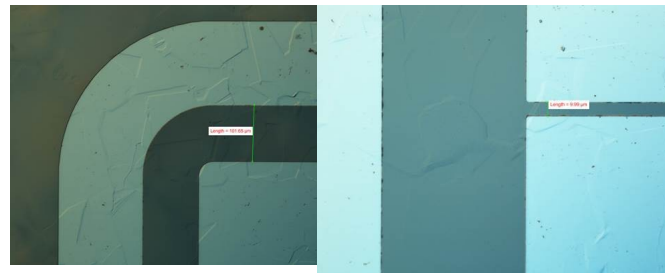
Sensors: use a combination of poly-crystal diamond, single-crystal diamond, silicon

- Silicon: very well understood technology; low ambient temperature (within tracker cooling volume)
- Poly-crystal diamond: so far have had good behavior in CMS (BCML detector) with magnetic field (suppresses erratic behavior)
- Single-crystal diamond: possibility exists that problem was due to something external. Single-crystals work okay before radiation damage. Spares: no cost

Silicon diode

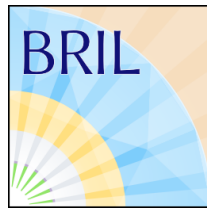


pCVD metallization





# BCM1F Run II v.2



“C-shape” PCBs: 6 new PCBs manufactured (4 + 2 spare, CERN)

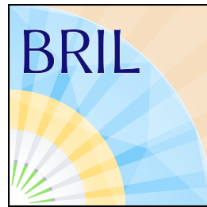
- Same design as previously
- 4/6 problematic, new production in progress
- Install: 2 new, 2 spares from old production

Spares from old production

- Components already assembled
- Old sensors must be removed, new sensors must be mounted
- Spare PCBs require some modification: reduce size of HV pad



# BCM1F Run II v.2



## Current status

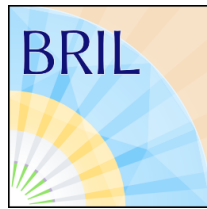
- Full BCM/PLT carriages have been removed
- 2 new-production C-shape PCBs have been tested, had components assembled, sensors mounted (DESY-Zeuthen), will undergo further testing
- 1 spare old-production at DESY, will undergo same process
- 1 spare old-production being shipped from CERN to DESY

## Near future

- Finish assembling C-shape PCBs at DESY
- As each is ready, ship to CERN for final integration testing
- Install: ~March 9



# PLT Work During EYETS



Primary problem: 2/16 channels dead

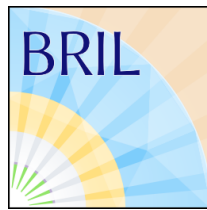
- Suspect: single port card
- EYETS effort: replace port card
- PLT removed from CMS. Two cards are ready, will be replaced when expert is available

Smaller problem: 2 channels read out luminosity data but missing pixel data (used for efficiency studies)

- Diagnosis ongoing, solution will depend on what investigation reveals
- If intervention too risky for functionality of channels, will live with these two channels channels as-is
  - One channel lost pixel data at beginning of year, excluded from luminosity
  - Other channel lost pixel data in middle of year, use previous pixel data for corrections (not much variation in general)



# 2017 Commissioning



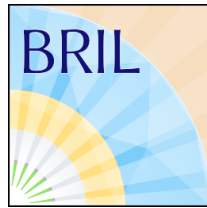
## Recommission BCM1F and PLT

- BCM1F will have to undergo complete new commissioning
  - Understand behaviors of different sensor types
    - Single-crystal can be used as initial reference for poly-crystal, silicon
  - Channel-by-channel stability, efficiency studies/continuous monitoring
    - Single-crystal and poly-crystal efficiencies expected to change at different rates
  - Discriminator threshold scan: optimize threshold relative to signal size and noise
  - Backend electronics has not been touched
- PLT: verify behavior of working channels, understand behavior of two (hopefully fixed) channels
  - Ideally: System with channels masked in 2016 identical before/after EYETS





# Luminosity Analysis: 2016



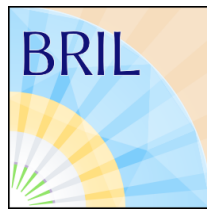
Currently using 2015 calibration for 2015 and 2016 run periods

- Significant difference between 2015/2016 calibrations (systematic: multiple luminometers)
- No obvious physical reason for difference
- Complicating factor: Significant difference between ATLAS/CMS measured luminosity
- While no distinction between 2015/2016 calibrations: use 2015 calibration for both years (consistency)

*But...*

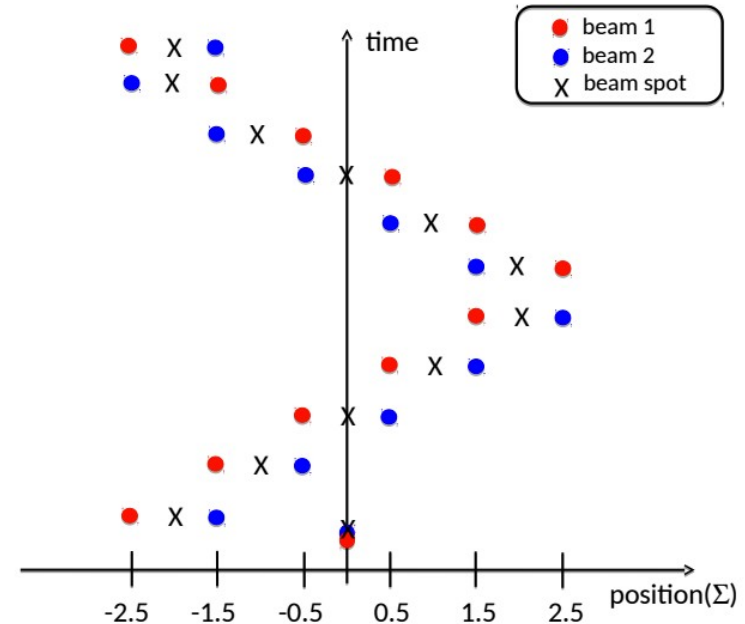


# Luminosity Analysis: Length Scale Scan



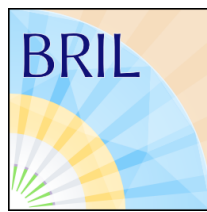
Recent development: indication that Length Scale Calibration correction (3.2%) from 2015 analysis is not correct

- Length Scale Calibration scan: both beams scanned in same direction, remain head-on throughout scan
- Point: Verify that when LHC says “we moved beams X distance,” CMS sees beams (i.e. beamspot) move X distance
- Beam positions: LHC magnet settings, DOROS beam position monitors
- Issue: Missed discrepancy in naming of datasets → beamspot was not reconstructed in dataset used for LSC scan analysis. Instead, previous run’s beamspot was used as fixed value
  - Side note: now that we know the issue, BRIL/LUMI dataset contact will ensure proper action taken for special runs incl. VdM scans





# Luminosity Analysis: Current Status



Action: 2015 luminosity analysis will be updated to use a Length Scale Calibration correction determined from a new re-reco with reconstructed beamspot (still to be made)

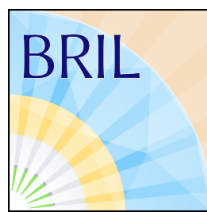
- Thorough length scale analysis still underway
- LUMI POG in contact with appropriate people for re-reco
- → 2015 luminosity value  $\sim 2.5\%$  closer to 2016 value

2016 luminosity analysis being finalized for Moriond

- Then understand any remaining differences relative to 2015: check stability (PCC, Z counting)

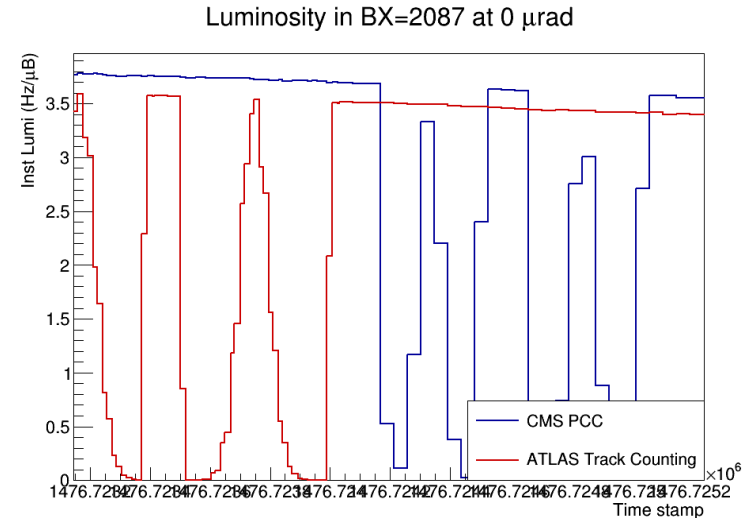
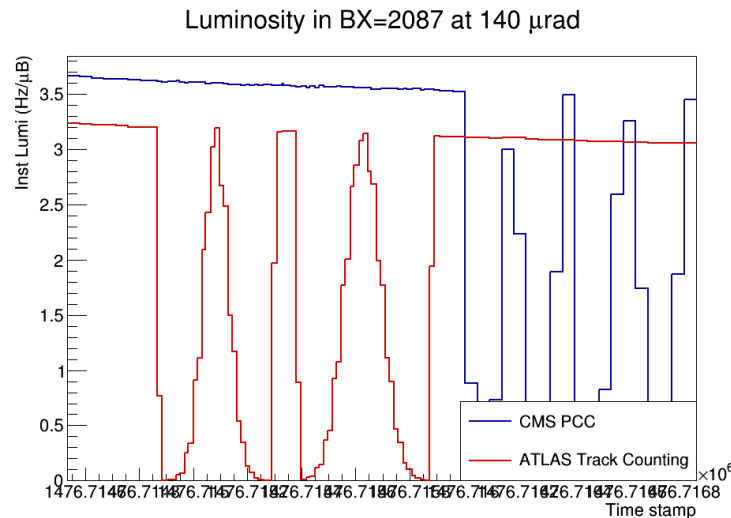


# Luminosity Analysis: Crossing Angle Scan



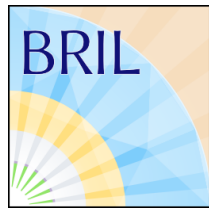
ATLAS/CMS difference: at least partly physical

- 2016 crossing angle scan: scan colliding beams from 140  $\mu\text{rad}$  to 0  $\mu\text{rad}$  angle
- Idea: Beam emittances different in H/V directions. ATLAS, CMS have perpendicular crossing planes. As crossing angle  $\rightarrow$  0  $\mu\text{rad}$ , any emittance-based differences disappear
- Initial analysis supports hypothesis: CMS gets  $\sim$ 4-8% more lumi than ATLAS at nominal crossing angle than at 0  $\mu\text{rad}$ . Ratio varies with instantaneous bunch luminosity, probably related to emittance
- $\rightarrow$  Difference during high-PU fill being studied, emittance still to be factored in





# 2017 Outlook



Van der Meer scan ASAP after new subdetectors commissioned (pixel, BCM1F)

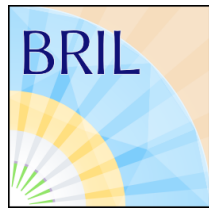
- More specific planning at Chamonix workshop...
- Before/after-EYETS luminosity comparison
  - BCM1F, Pixel (PCC) undergoing changes
  - PLT and HF *should* be comparable (but not strictly guaranteed)
  - No big interventions on DT, could be used as stability reference

Luminosity workshop foreseen March 30, 14:00-17:30

- Sessions: BRIL hardware, BRIL DPG, LUMI POG



# BRIL/Lumi Operations



## Shift operations

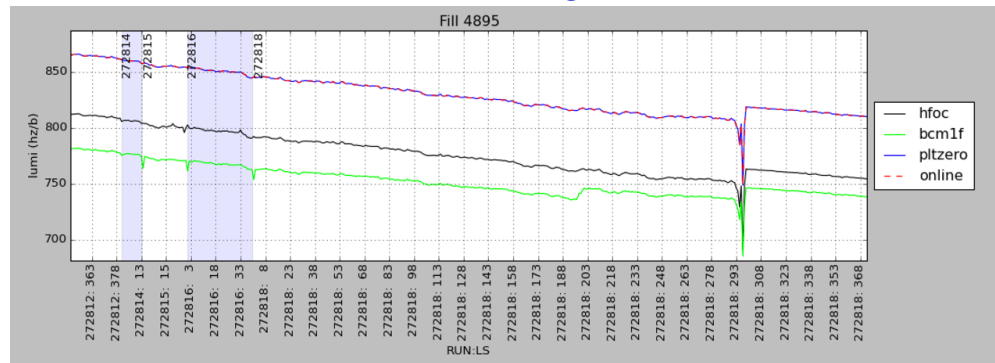
- DOC + daytime desk shifter (mostly – desk duties subsumed by DOC for some runs)

## BRIL normtag production (semi-online)

- Person runs lumi comparison script ~daily, selects best online luminometer for all LS
- Person edits common BRIL normtag file
- Under consideration: make this part of shifter or DOC duty

## Lumi data validation (offline)

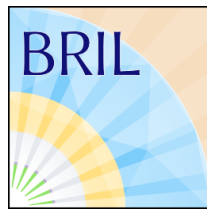
- Pixel cluster luminosity only available offline
- Person runs script ~weekly, now validates lumi data for all runs and selects best luminosity (including pixel cluster luminosity)
- Person edits common “certified” normtag file



Online  
luminometer  
comparison



# “Massi Files”



So-called “Massi” files: Bunch-by-bunch luminosity measured over time during every fill

- Used by LHC etc. for comparisons between experiments (all experiments provide these files in common format)

Discussion planned among LHC/experiments on how to improve production process

- Supposed to reflect currently best-known luminosity values (including all calibrations, corrections as they are developed)
- But so far no versioning or other tracking system agreed/implemented → will be addressed
- Caused some issues during 2016 lumi comparisons

Massi files currently stored in publicly-accessible AFS area

- Need to be accessible by people from LHC, ATLAS, etc.
- → CMS-only EOS area won't work... other options?



# Conclusions



Current BRIL effort focused on hardware interventions during EYETS

Commissioning effort will follow

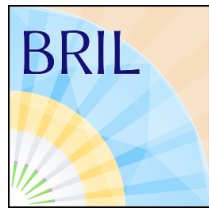
Luminosity analysis for 2015-2016 close to being finalized

- More insight into 2015/2016, ATLAS/CMS differences
- 2016 analysis being prepared for Moriond

(\*)Additional requests from yesterday's talks have been noted

- BPTX data easily accessible for analysis
- Provide Z counting semi-online per fill







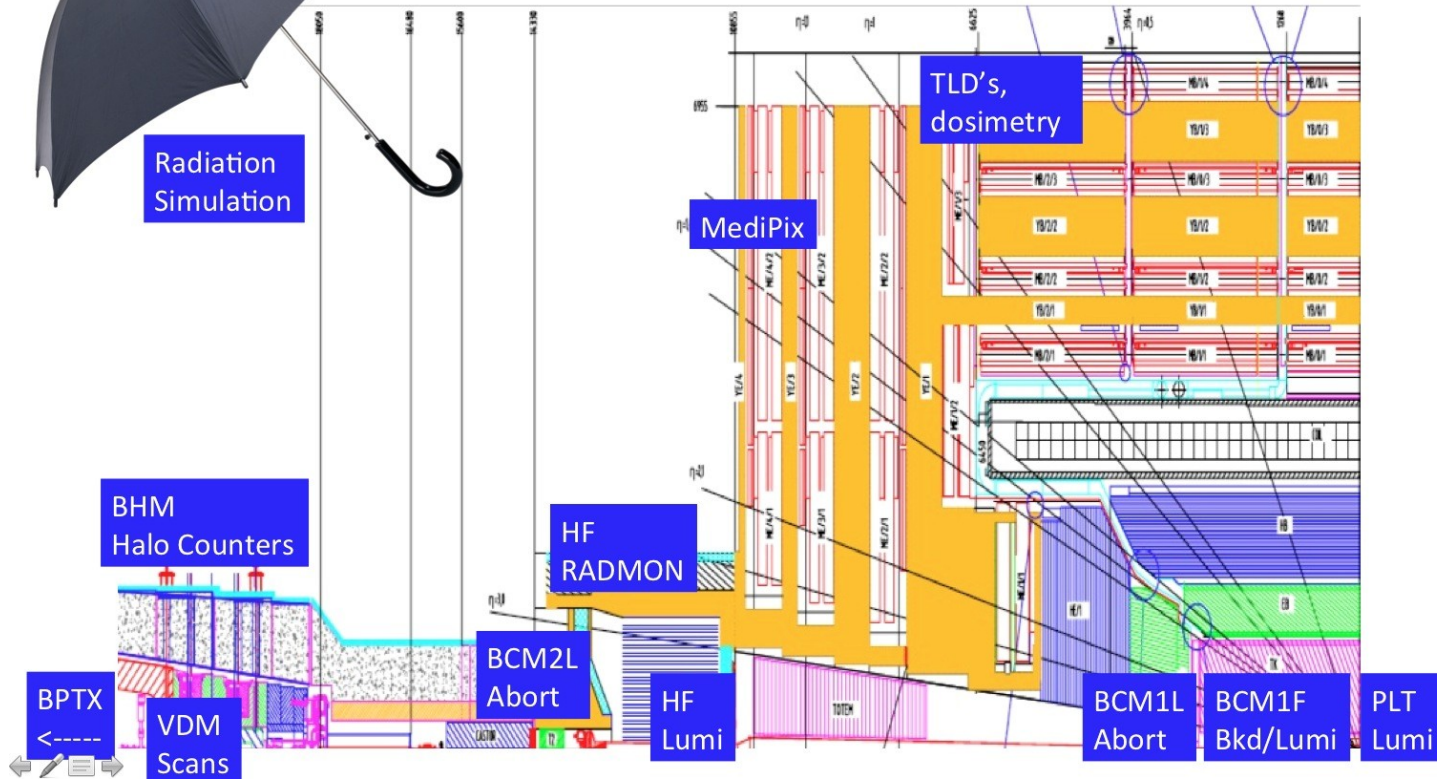
# Backup



Radiation Simulation

## CMS BRIL Project

- ➔ LHC
- ➔ CMS TC
- ➔ CMS RC
- ➔ CMS POGs



### Readout independent of CMS DAQ