



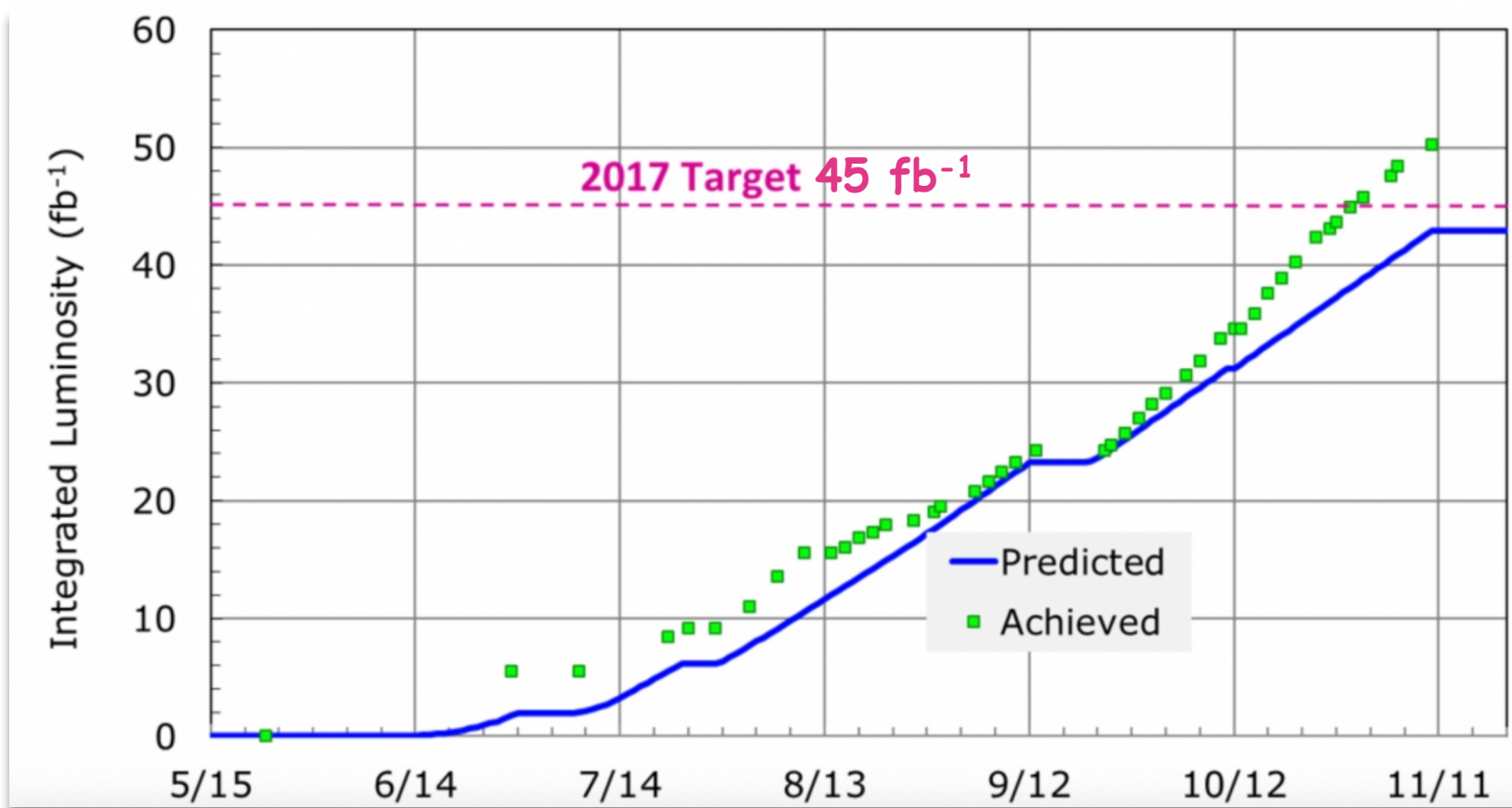
Статус ускорителя ЛНС



О. Л. Федин Ученый совет ОФВЭ
26 декабря 2017 года



LHC Performance 2017





Planned 2017 scenarios



| LHC injectors | Nominal | BCMS | BCMS+ |
|---|----------------------|----------------------|----------------------|
| Beta* (1/5) [cm] | 40 | 40 | 33 |
| Half crossing angle [urad] | 185 | 150 | 170 |
| No. of colliding bunches | 2748 | 2544 | 2544 |
| Proton per bunch | 1.1e11 | 1.2e11 | 1.2e11 |
| Emittance into SB [μm] | ~ 3.2 | ~ 2.3 | ~ 2.3 |
| Bunch length [ns] | 1.05 | 1.05 | 1.05 |
| Peak luminosity [$\text{cm}^{-2}\text{s}^{-1}$] | $\sim 1.1\text{e}34$ | $\sim 1.7\text{e}34$ | $\sim 1.8\text{e}34$ |
| Peak pile-up | ~ 28 | ~ 48 | ~ 52 |
| Luminosity lifetime [h] | ~ 24 | ~ 15 | ~ 14 |

- ❑ **NO change of beam energy in 2017 and 2018**
- ❑ *Goal is to prepare the LHC to run at 14 TeV during Run 3.*
- ❑ *Preference to make the change in energy in a single step.*
- ❑ *Keep pushing performance and availability (~50%)*
- ❑ **BCMS (Batch Compression Makes Sense) beams** (Smaller emittance though cycle; lower electron cloud heat load; faster intensity ramp-up; lower total beam current; lower losses; better for R2E... pile-up ?)
=> **maximize integrated luminosity**



Filling scheme



{spacing}_{bunches}_{IP1/5}_{IP2}_{IP8}_{trainlength}_{injections}_{special info}

bunch spacing - number of bunches per beam - number of collisions in ATLAS/CMS - ALICE - LHCb - the maximal length of a train - number of injections per beam

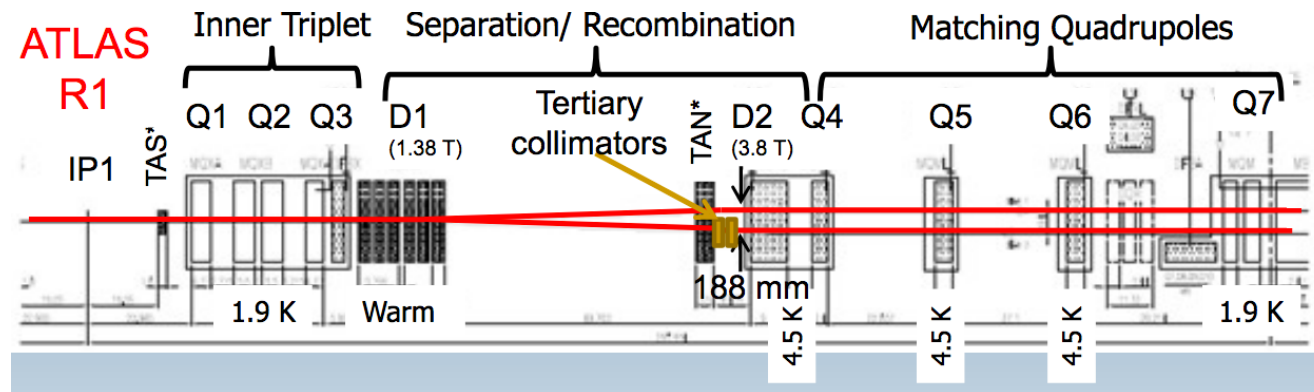
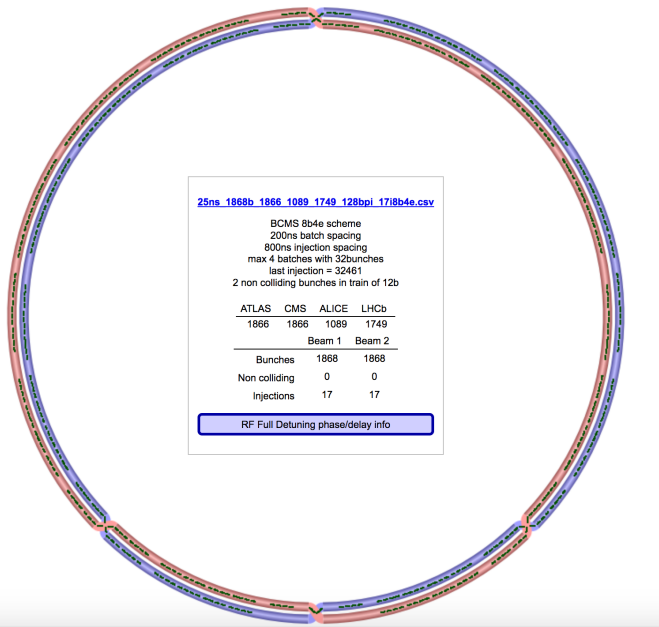
http://lpc.web.cern.ch/cgi-bin/filling_schemes.py

- Initial period with very good luminosity production

25ns 2556b 2544 2215 2332 144bpi 20inj

- Then period with frequent dumps due to fast losses, correlated with losses in cell 16 left of IR2 (Interaction Region - Collimator, RF, dump system, experiments)

25ns 1868b 1866 1089 1749 128bpi 17i8b4e

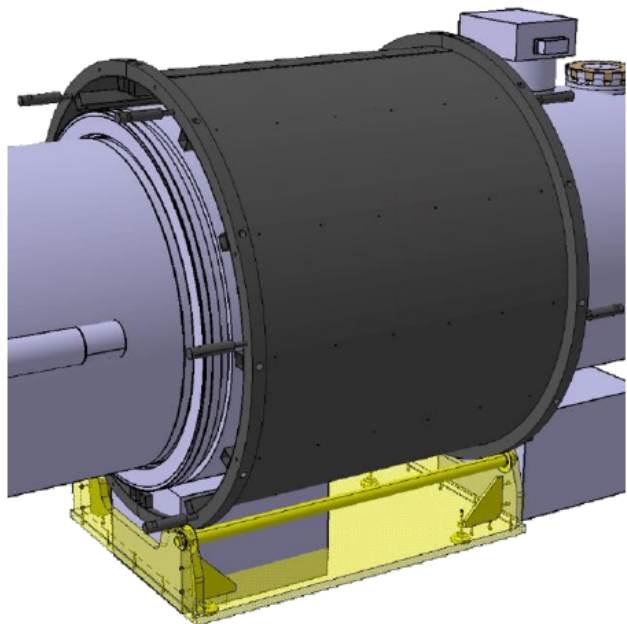




Mitigation of 16L2 loss issue



- ❑ Improvement observed with 8b+4e scheme => **electron could play a role**
- ❑ Exploring other ways of mitigating electron cloud: **solenoidal field**
- ❑ Crash program over only about 2 weeks to prepare and install a solenoid in 16L2 in TS2





TI – Major Breakdowns

61 Major Events – Only 19 Electrical Perturbations !



Linac 4
Water leaks



BA81
Magnet leak

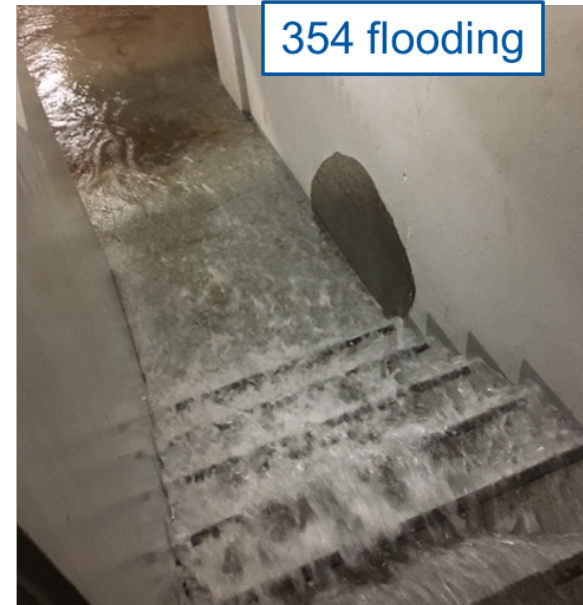
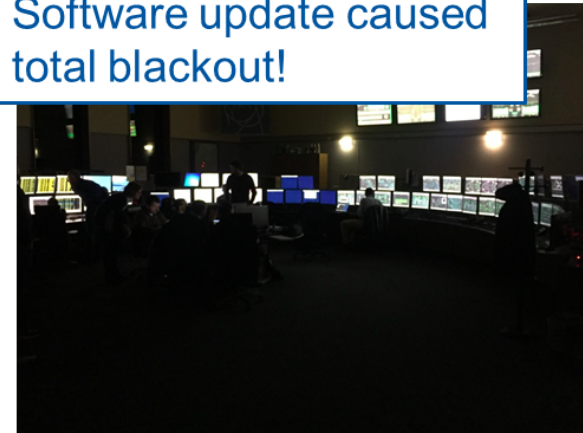


US45 & US85
Transformers



UW25 pump
Bearing failure

Software update caused
total blackout!



354 flooding

Courtesy J. Nielsen

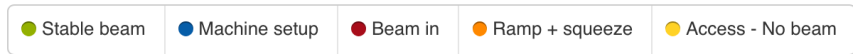
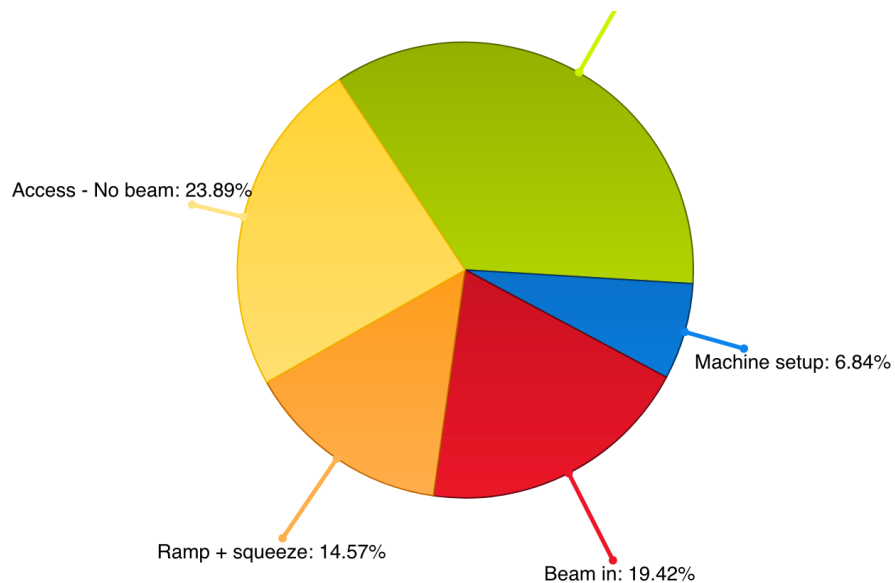


Accelerator Performance and Statistics



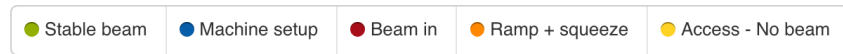
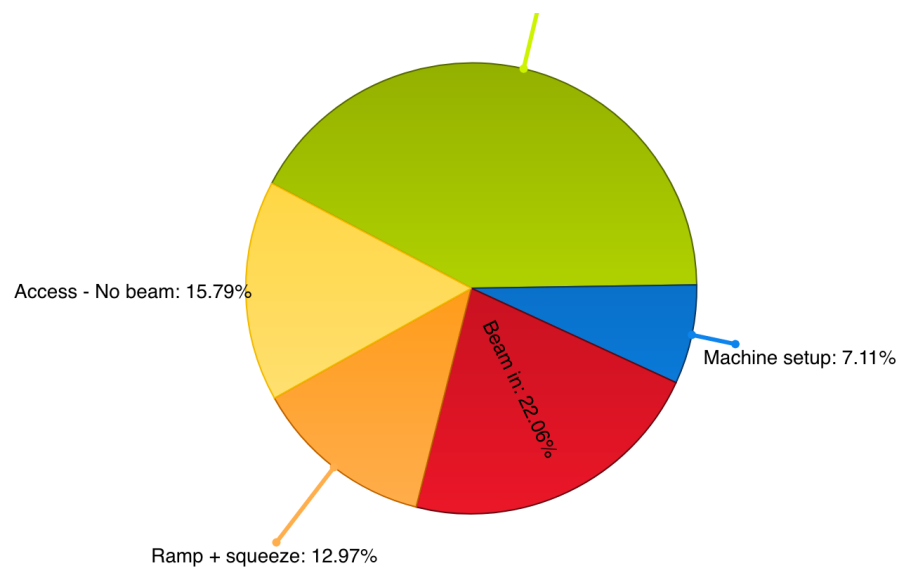
2016

Stable beam 35,29%



2017

Stable beam 42,06%





Mode Breakdown

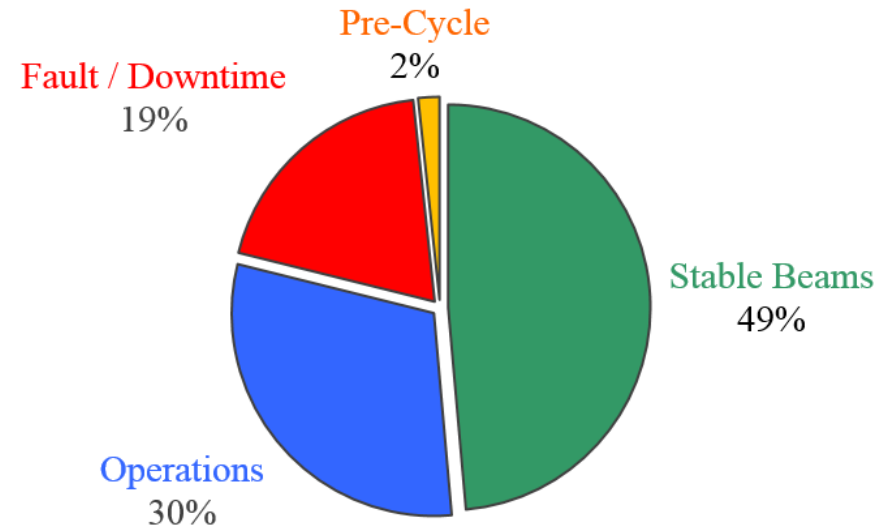
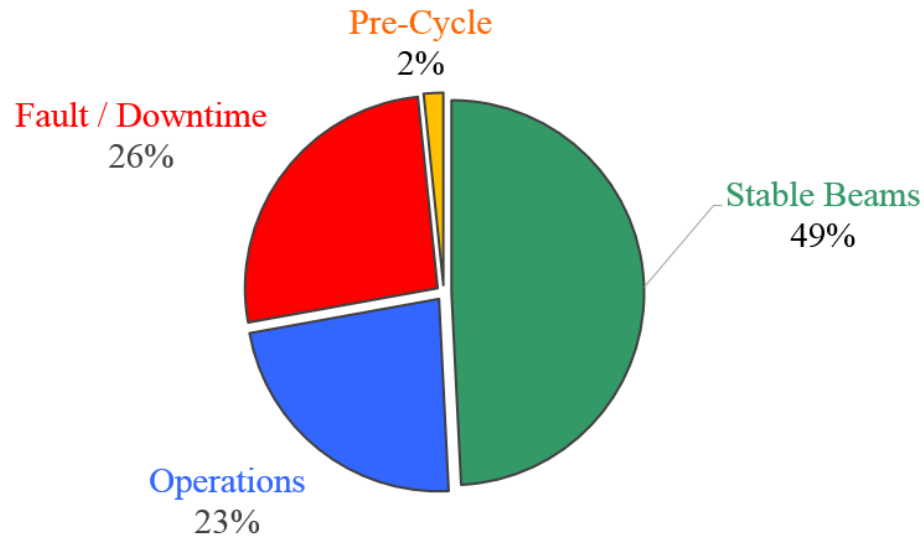


2016

7% less time in fault
7% more time in operations

2017

140 $\frac{1}{2}$ days physics \approx 3362.1 hours



| | Duration [h] |
|----------------|--------------|
| Stable Beams | 1633.9 |
| Operations | 1018.1 |
| Fault/Downtime | 652.9 |
| Pre-Cycle | 57.2 |
| | = 3362.1 |



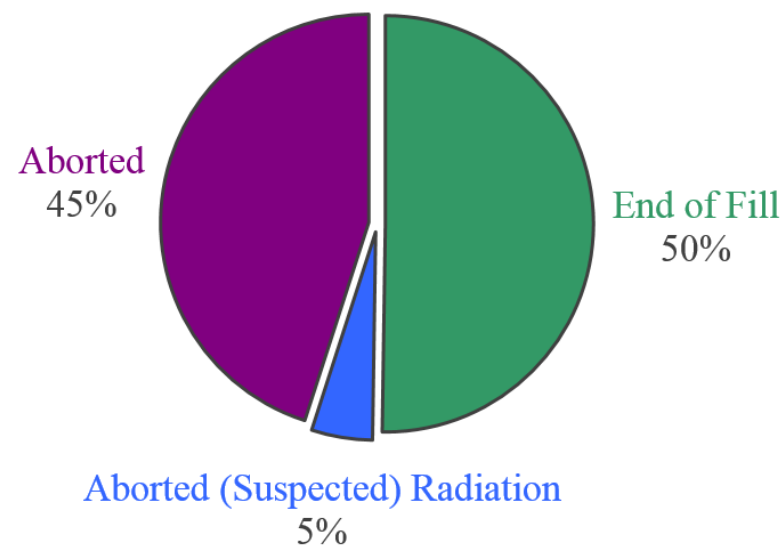
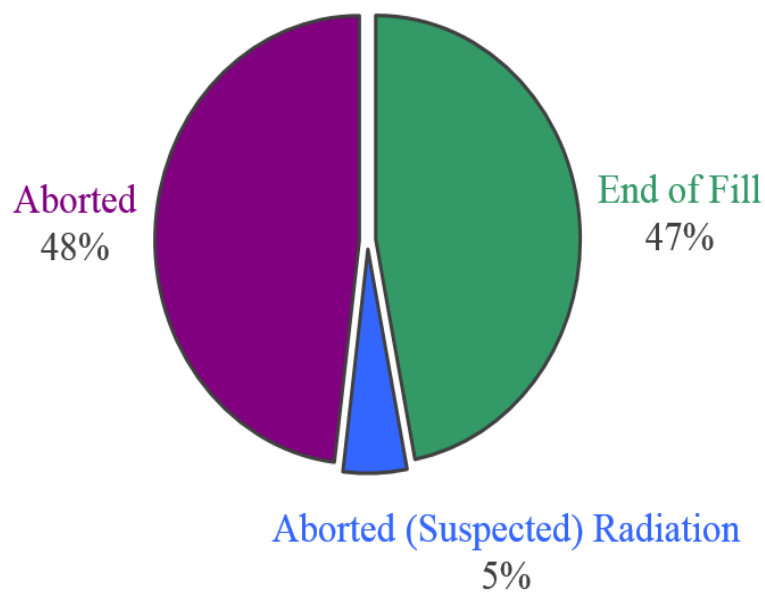
2016 vs 2017 Physics Beam Aborts



2016

3% more reach end of fill

2017

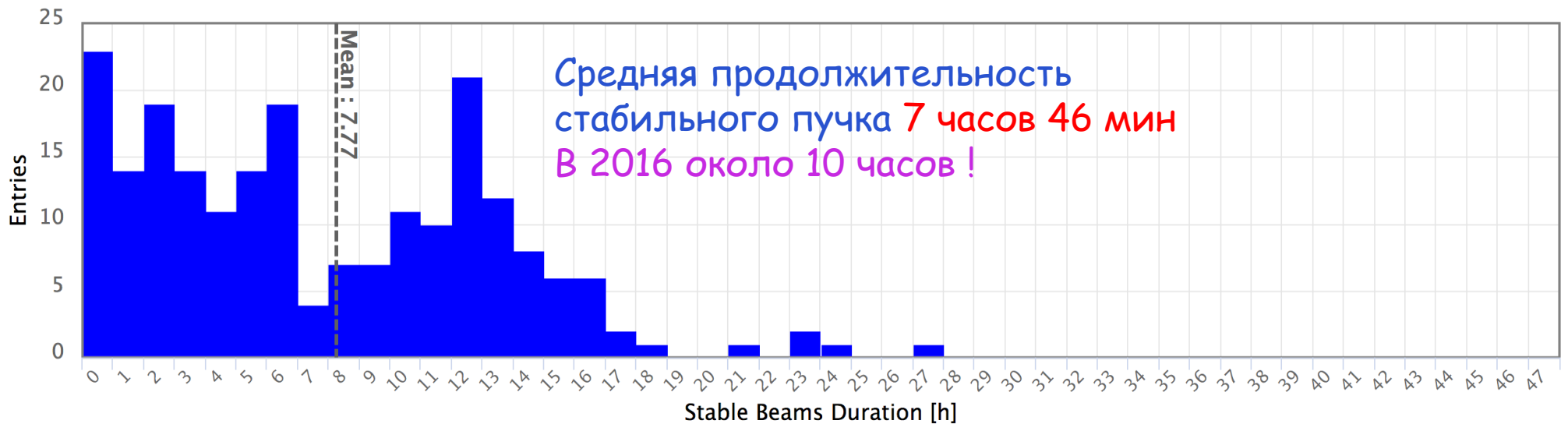
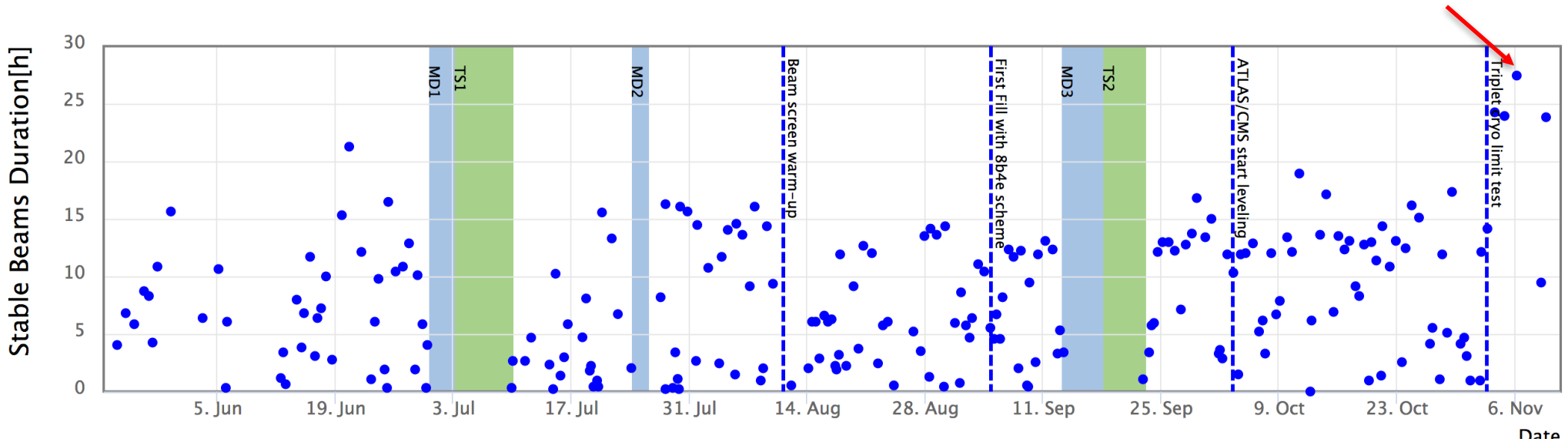




Stable beam duration

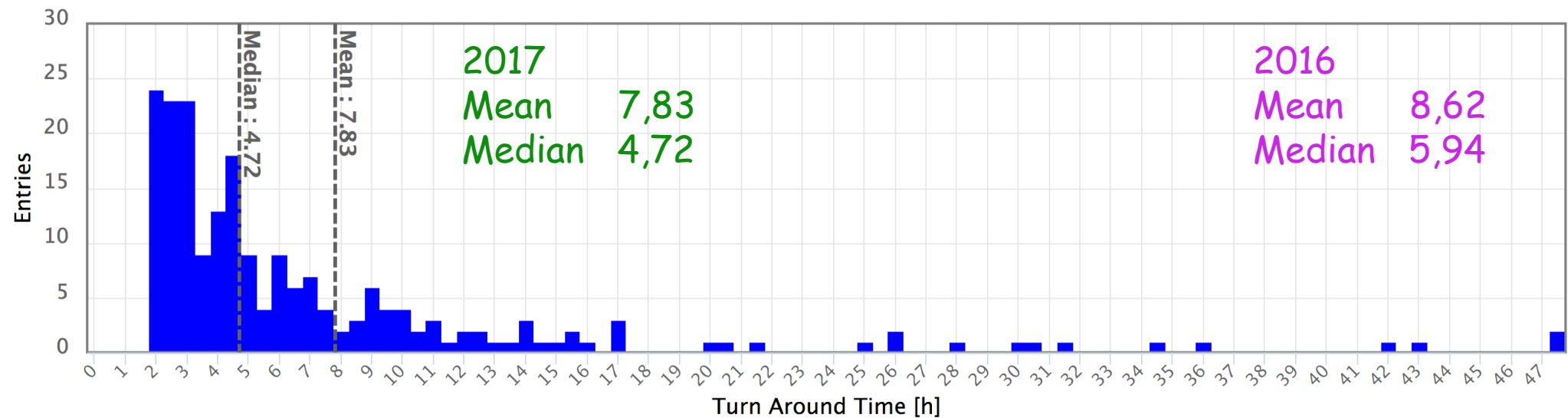
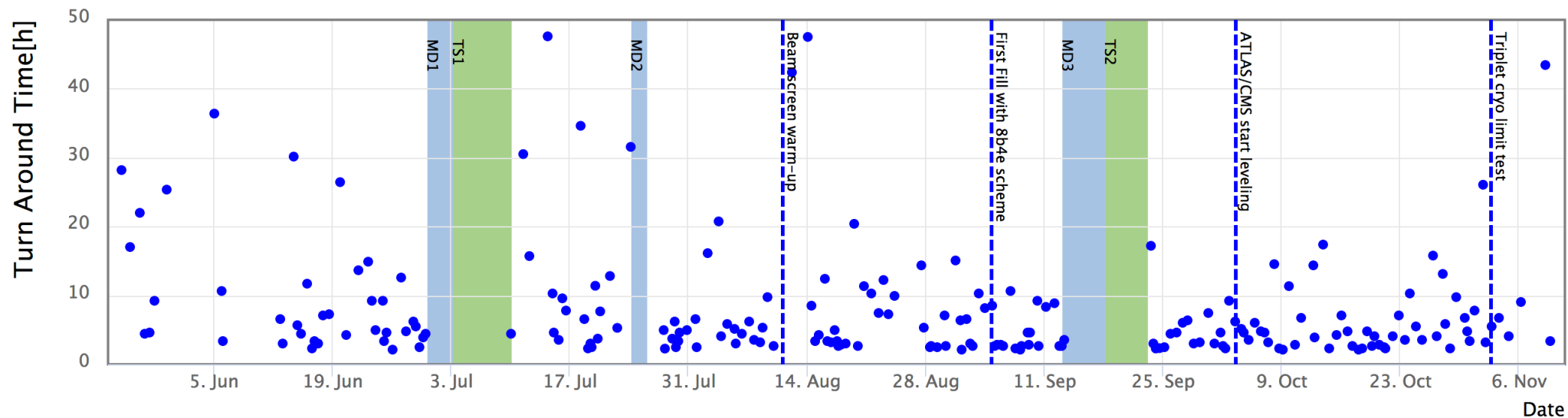


Рекордная продолжительность стабильного пучка в 2017: **1 день, 3 часа, 24 мин**



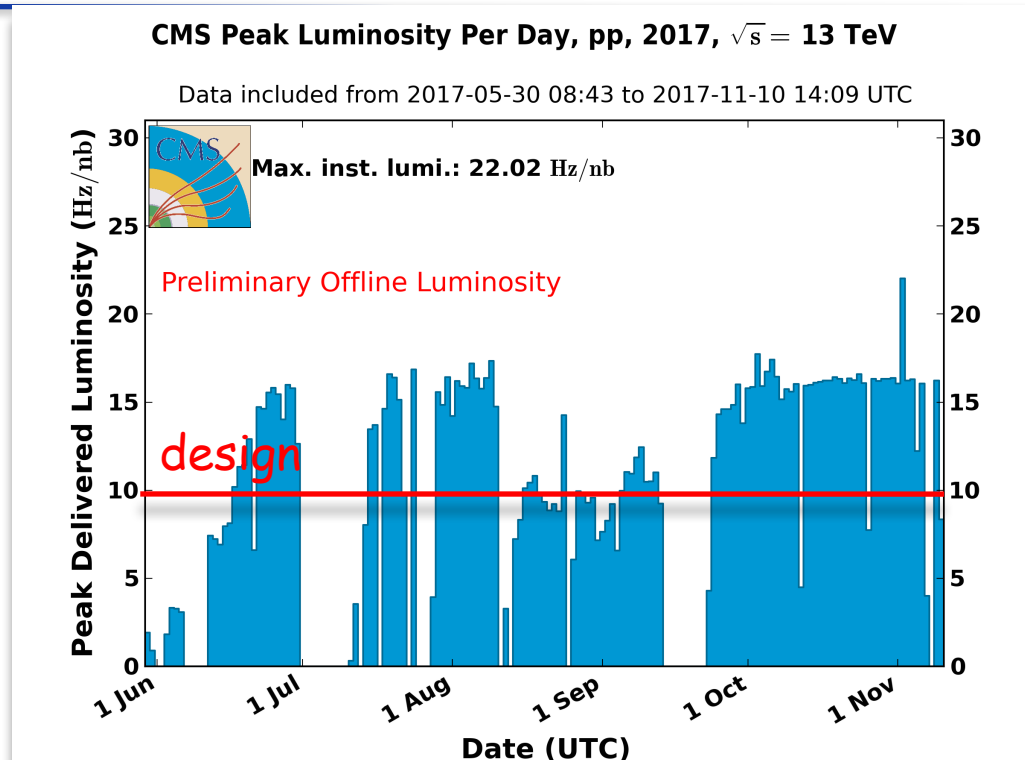
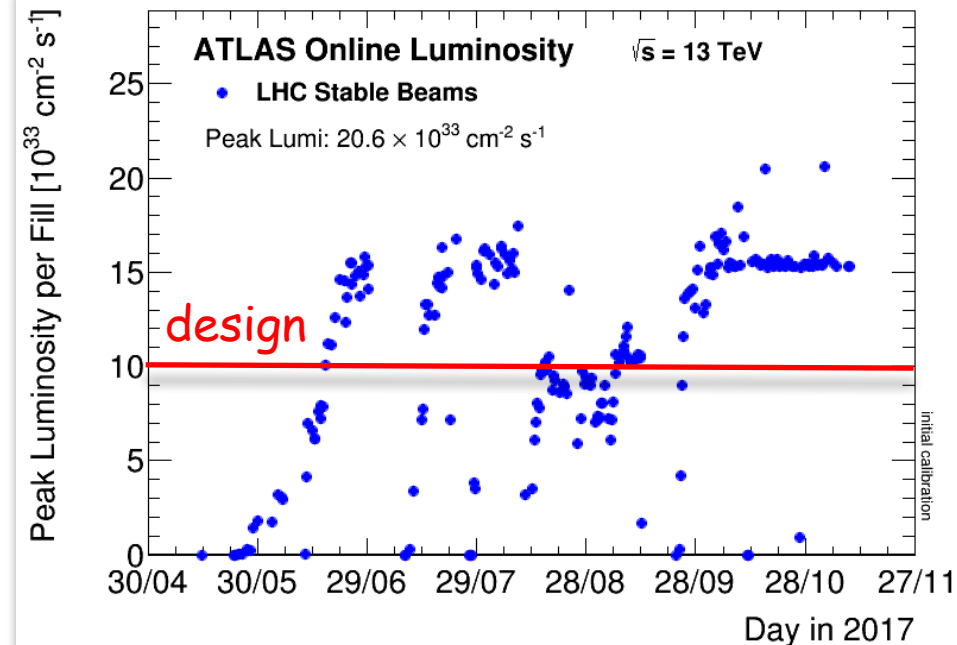


Turn around time





Peak luminosity ATLAS vs CMS



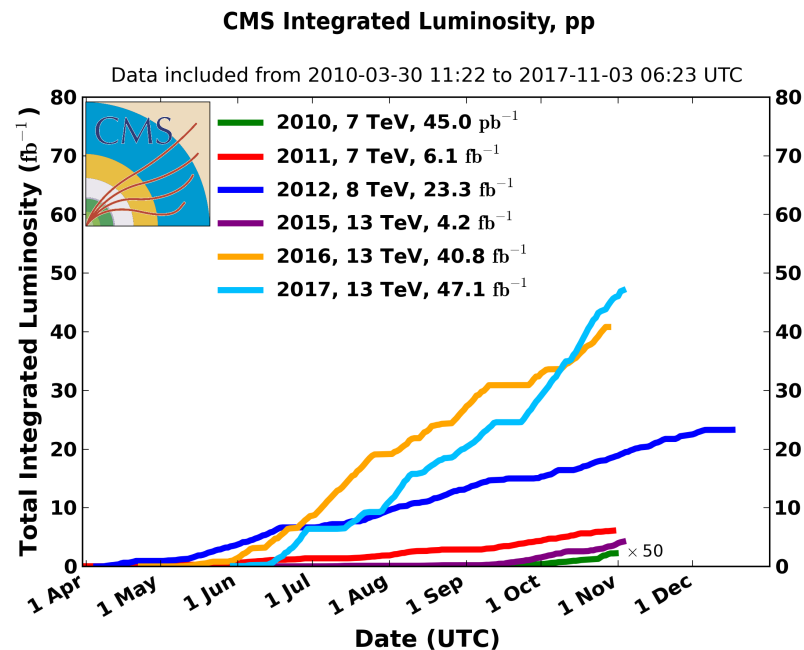
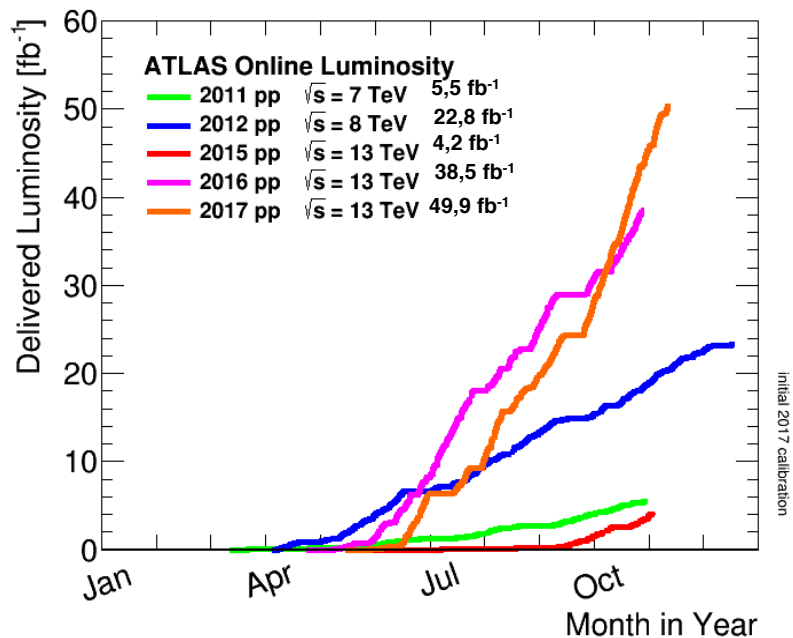
Пиковая светимость в 2017 году составила:

□ ATLAS $20,6 \times 10^{33} \text{ cm}^{-2} \text{ c}^{-1}$

□ CMS $22 \times 10^{33} \text{ cm}^{-2} \text{ c}^{-1}$

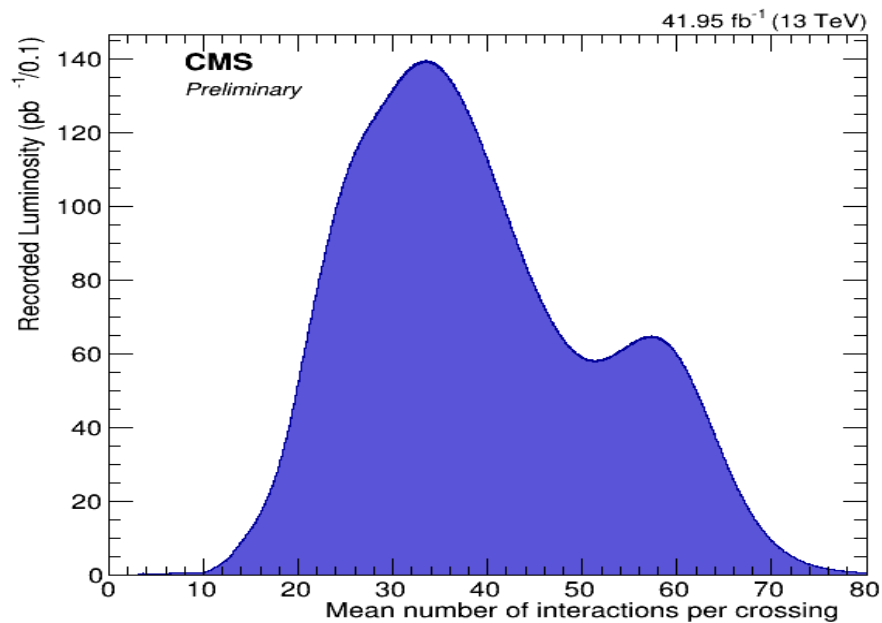
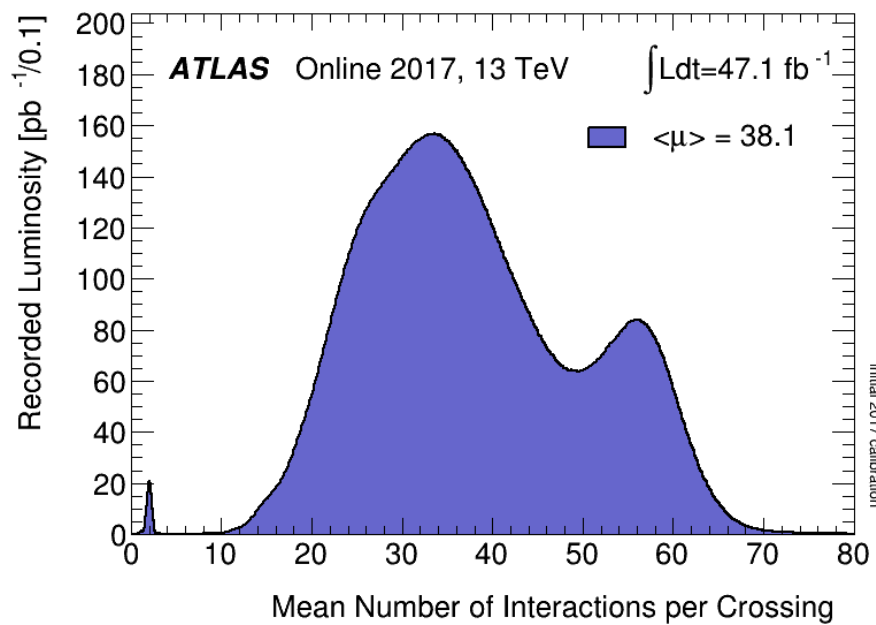


Integrated luminosity ATLAS vs CMS





Pileup





СПАСИБО ЗА ВНИМАНИЕ