Prospects for PPS detectors in Run 3

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Outline

• Roman Pots
• Tracking Detectors
• Timing Detectors
• Precision Clock
• Daq
• Trigger
Roman Pots

• Horizontal Pots
  – 2 tracking stations per arm
    • Pixel detectors
  – 2 timing stations per arm
    • Double diamonds & UFSD

• Vertical Pots (Alignment using elastic events)
  – 4 tracking stations per arm
    • 2 top
    • 2 bottom
Roman Pots
Tracking

- Pixel detectors
  - Good resolution
  - Best acceptance on the farthest pots (beam smaller)
  - Little modification on mechanics (motorize packages)
  - Radiation damage on electronics
    - Study of new FEE from phase 2 upgrades
    - Make more spares packages
    - Automatic movement of detectors inside the pots
    - Displacement of the pots during tech stops
    - Swapping of the detectors on both arms
Pixels damage

SEC45 220F Efficiency map - 0.6 fb$^{-1}$ after TS2

Damage before TS2

SEC45 220F Efficiency map - 4.0 fb$^{-1}$ after TS2

SEC45 220F Efficiency map - 8.0 fb$^{-1}$ after TS2

SEC45 220F Efficiency map - 11.7 fb$^{-1}$ after TS2

New damaged spot
Timing

- **Strategy**
  - Increase the number of layers of timing detectors
  - 2 stations per arm, one cylindrical and one box
  - Each station with separated cooling
  - Possibility to evolve from pure diamond detectors to UFSD in the three year period with mixed solutions (one pot diamonds and one UFSD)
  - 8 layers with < 50ps resolution per layer ~ 17.5 ps overall or better

- **Diamonds**
  - Double diamonds (on test this year)

- **UFSD**
  - New generation more tolerant to radiation
  - Cooled to -25°C
• Double diamond technology
  – Two crystals on top of each other
  – Same preamplifier with lower impedance
  – Double signal to noise ratio
  – Almost double resolution (50ps)
• Four layer per package
  – 25ps resolution overall
  – Possible improvements with standard electronics
  – Start studying a FEE chip with broadband amplifiers (better S/N)
UFSD

• Tested in 2017 in the real environment
  – CNM production
  – Warm mode (~20°C)
  – Early production
  – Low radiation resistance

• New detectors for special run in 2018
  – FBK production
  – No radiation damage foreseen in low lumi environment
  – 4 layers per package (30-100ps res per plane)
- Lower temperature (-25°C)
- New FEE readout chip (TOFEE)
  - Preamp + discrimination
- Need more channels per surface
  - Resolution degrade rapidly with capacitance
- Larger radiation tolerance tested on new detectors (~$10^{15}$ protons eq)
**Precision Clock**

- **Clock source**
  - RF differential clock (tested now)
    - Phase shift every Run Start (to be upgraded with special PLL)
  - Optical clock distribution
    - Implemented now on PPS
    - Expandable up to 128 endpoint
    - Jitter < 2ps at the RP stations
    - PLL’s with fixed phase.
**DAQ electronics for Timing**

- Digitizer board
  - 2 mezzanine
    - HPTDC
    - Sampic (low bandwidth)
- Based on Microsemi Smartfusion FPGA (rad tolerant)
- Upgrade to latest CMS DAQ protocols
- Looking forward for new ps TDC from CERN, eventually design a new mezzanine with the latest hardware.
Proton trigger

• Low Level Trigger (L1)
  – Proton tag on Timing pots (at least one proton on single and on both arms)
    • Source from timing detectors.
  – Coincidence with other L1 algos (calorimetry, muons etc…)

• High Level Trigger (HLT)
  – Proton object in HLT algos.
Conclusions

• PPS is preparing for RUNIII operations
• We foresee a consolidation program with the present technology.
• Tracking stations upgraded with new FEE ASICs, if available, and internal motors for remote displacement respect to the beam
• Timing stations doubled with resolutions <18ps
  – Double diamonds
  – UFSD
• Proton trigger at L1 and HLT