PHOS calibration

- Energy calibration is essential for all calorimeters, especially for PHOS with its high energy resolution and fine granularity.
- PHOS was not pre-calibrated by monochromatic electron beams, thus calibration has to be found in-situ.
- Initial step: equalize gains of photodetectors (APD).
- PHOS LED monitoring system is highly configurable device allowing one to study per-channel performance.
- APD gain dependence on applied bias voltage was measured for all channels using LED system at fixed amplitude and varied bias voltage.

PHOS readout upgrade for Run2

- One FEE card reads signals from 32 detection channels.
- FEE cards processes analog summation of signals from 2x2 detection channels for fast triggering.
- All FEE cards (~430) were upgraded during LS1:
  - DTC mezzanines were installed.
  - New firmware was programmed.
  - New F/W provides low gain suppression to reduce event size for redundant information.
  - FEE cards were commissioned in the lab during LS1, now run in PHOS within ALICE.

PHOS trigger upgrade for Run2

- New readout system is 10 times faster than in Run1:
  - Readout rate can achieve 8 kHz in pp collisions.
  - Readout system is ready for Run3: after firmware upgrade and trigger format, readout rate will achieve 40 kHz.

- Summary trigger unit (STU) reads data from 28 TRU

PHOS Trigger Region Unit

- STU generates L0 trigger by OR of all TRUs.
- STU generates L1 trigger by OR of all TRUs.
- STU generates L1 triggers on high-energy clusters with different thresholds.
- PHOS STU ships data to DCAL STU for processing the common jet trigger.

Upgraded PHOS for Run2

- PHOS is a high-resolution electromagnetic calorimeter consisting of 12544 detecting elements: cells of PbWO4 scintillating crystals.
- The physics goal of PHOS is to measure neutral meson and direct photon spectra in pp, p-A and AA collisions and to study properties of deconfined quark-gluon matter at extreme energy density.
- PHOS is equipped by the Charged Particle veto detector (CPV) to suppress signals from charged tracks.

During LHC long shutdown 2013-2014, PHOS performed major upgrade:
- Expanded acceptance by half module → new azimuth coverage 250°-<φ<320°.
- One CPV module installed in front of one PHOS module at 260°-<φ<280°.
- Completely changed readout system to point-to-point readout with 10 times higher performance and improved reliability.
- Completely changed trigger system with more advanced L0 and L1 trigger algorithms.

PHOS Trigger Summary Unit

- Further calibration improvement is possible by a physical gauge.
- m2 mass is the most feasible gauge for PHOS energy calibration due to the m2 large production cross section and easy identification in pp collisions.
- Energy calibration parameters are found from equalization of the measured m2 mass reconstructed from two photons, one of which hits a channel to be calibrated.
- PHOS calibration is found from recorded 670 million events of pp collisions with minimum bias triggers.

CPV performance

CPV takes part in physics runs with cosmic rays and pp collisions at 13 TeV since the beginning of 2015.

- Shape of the induced-charge cluster.
- Number of pads in clusters.
- Signal amplitude spectrum.