Current EM calorimeter PHOS uses PbWO₄ (PWO) crystals, rectangular parallelepiped 22 x 22 x 180 mm³, photodetector - the Hamamatsu S8148 (S8664-55) type APD, active area of 5×5 mm² and low noise CSP. To increase the light yield of the PWO crystal (by a factor of 3) and to reduce the electronic noise, the PWO crystals, APD and CSP are cooled down to -25°C (stability ~0.2°C)

In total 12 544 channels

**PHOS upgrade program (Run 4):**

**Upgrade of photodetectors APD → SiPM**
- Improved time resolution for particle ID
- Improved energy resolution
- Strong non-linearity at high energy

**Upgrade of FEE**
- Chips for current FEE version out of market
- Additional timing channel provides a precise time measurement

**Upgrade of mechanics**
- Provide access to FEE during data taking
Main goals of the test PHOS T9 test in 2022 are:

1) measurements (at momenta from minimum available on T9 up to max possible) energy resolution curve and the time resolution crystals at temperatures t=+16°C and t=−25°C

2) test of the new prototype of the 32-channels PHOS readout card (FEC32).

PbWO4 arrays of 3×3

APD from current PHOS

Sensitive area 3x3 mm2, 40k pixels (S14160-3015PS).
Possible array of 4 SiPM per crystal. Signal – serial, voltage – in parallel

6x6 mm2, 160k pixels (S14160-6015PS )

Two SiPMs – with different pixel size, one for low energy, one for high energy

Photodetectors

Current PHOS
S14160-3015PS
S14160-6015PS

PHOS crystal with photodetector
New PHOS FEE parameters

- **E channel**: Dynamic range: from 1 MeV to 130 GeV. Digitization – 12 bit, 40 Msps, 2 channels → effectively 17 bits
  Two gains. max HG – 4 GeV (1 MeV/ADC_ch) max LG – 130 GeV (32 MeV/ADC_ch)
- **T channel**: TOF with Start-Stop method; Time bin size – 0.1ns or less HPTDC(in future picoTDC)
- **Readout – E and T codes**
- **Analog Trigger L0** (2x2) – 8 analog trigger signals
- **Readout method** – 10G Ethernet, P2P (SRU) IT RU (ALICE O2).
- **Voltages and dimensions are the same as present PHOS FEC.**
**PHOS in 2022**

- **PHOS**
  - Dimensions: 880(L)x810(W)x810(H) 150 KG

- **Standard table**
  - Dimensions: 2100(L)x1000(W)x1900(H) 150 KG

- **Cooling system**
  - Dimensions: 1500(L)x900(W)x1900(H) 150 KG

- **Gas Cherenkov’s**

**DESY table**
- Dimensions: ~2.5m (along beam) x 4m space

**Analog signal from gas Cherenkov**
- S1 – scintillator 100 x 100 x 5
- S3S4-start counter 80x20x20 (from ALICE/TOF)

**Trigger:** electron=C x S3 x S4 x S1

**Nitrogen purging line**

**Beam:**
- Electron beam (target), max allowed number of spills, beam size ~1-2 cm
- Beam intensity ~ 1000 p/spill
- Momentum – from min to 15 GeV/c