ALICE ITS upgrade for LHC Run 3
Commissioning in the laboratory

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ALICE in Run 3 and ITS 2

ALICE in Run 3

Physics motivations

High precision measurements of **rare probes over broad p_T range**

- Heavy-flavour mesons and baryons down to very low p_T
- Charmonium and Bottomonium states
- Dileptons and low-mass mesons
- Light (anti-)nuclei and hypernuclei

Data taking strategy

- **Very low S/B ratio** prevents selection with hardware trigger
- Large minimum bias data sample through **continous readout**
- Improve **tracking efficiency and resolution at low p_T**
- Preserve Particle Identification (PID)

Upgrade strategy

- New silicon trackers: **ITS 2 (midrapidity)**, MFT (forward rapidity)
- New TPC readout chambers (GEMs) and electronics
- New Fast Interaction Trigger (FIT) detector
- Fast readpout for other detectors (TOF, TRD, Muon spectrometers, ZDC, ...)
- New Online plus Offline system (O^2 project)

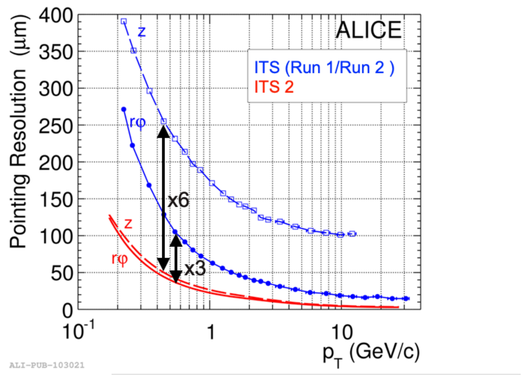
ITS 2 project

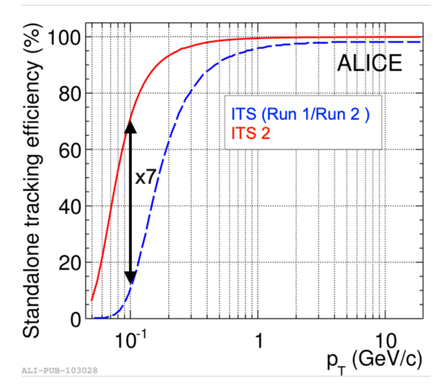
Main targets

- Primary and secondary vertex reconstruction
- Access low p_T tracking

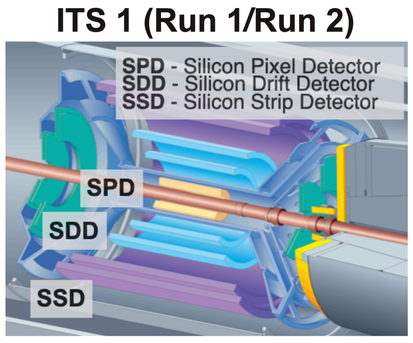
Detector requirements

- Improve impact parameter resolution
  - Reduce distance from IP to first layer → new beam pipe
  - Reduce material budget and pixel size
- Improve tracking efficiency and p_T resolution at low p_T
  - Increase granularity → from 6 to 7 layers all pixels
- Increase readout capabilities

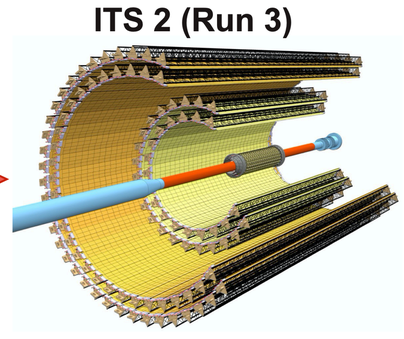




ITS 1 (Run 1/Run 2)



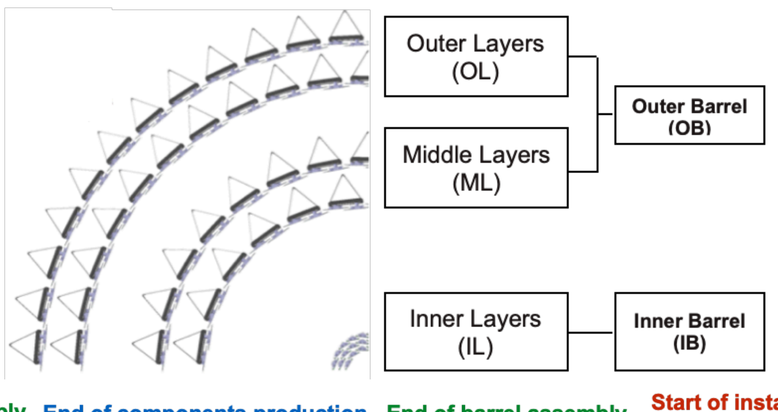
ITS 2 (Run 3)



Detector components and status

7-layer barrel geometry based on ALPIDE chips

- Inner Barrel (IB) : 3 layers
- Outer Barrel (OB) : 4 layers
- r coverage: (min) 22 – (max) 394 mm
- η coverage: (min) 1.3 – (max) 2.5
- 12.6 Gigapixels
- Total active area ~ 10 m^2

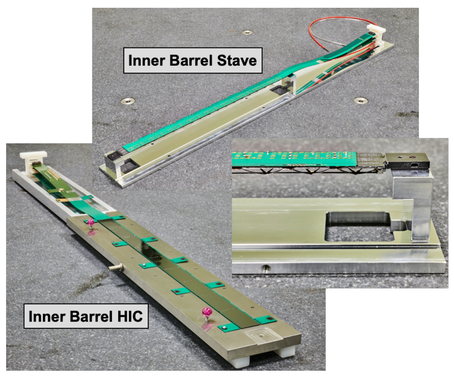


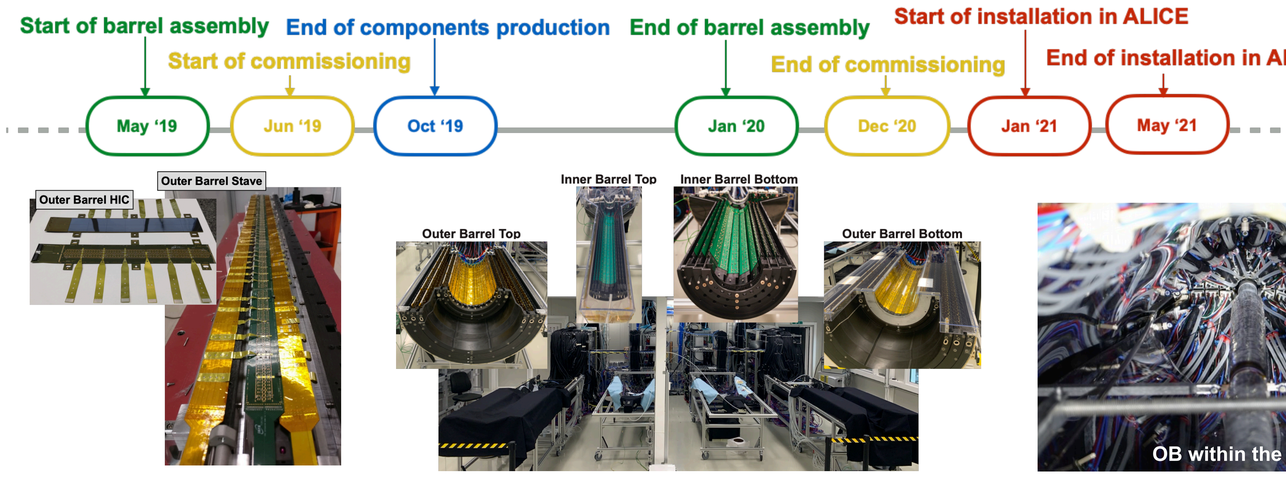
Inner Barrel

- 48 staves
- 9 ALPIDE chips on 1 row per stave
- chip thickness: 50 μm
- stave length: 290 mm
- distance from IP: (min) 22 – (max) 42 mm

Outer Barrel

- 54 staves in ML + 90 staves in OL
- ML: 56 ALPIDE chips on 2 rows per stave
- OL: 98 ALPIDE chips on 2 rows per stave
- chip thickness: 100 μm
- stave length: 843 – 1473 mm
- distance from IP: (min) 194 – (max) 394 mm



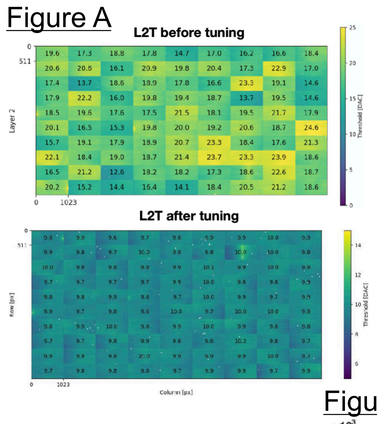


Commissioning in Laboratory

Commissioning organization

- Fully equipped clean-room at CERN (Bld. 167) for layer assembly and commissioning → **Same backend system that will be used in the experiment (Cooling plant, Power and Readout racks, Trigger and DAQ system)**
- Commissioning of the detector in laboratory completed in December 2020
- Verification of detector performance and long stability of parameters before installation inside the cavern
- Commissioning shifts 24/7 started in July 2019 → 3 daily teams with 2 shifters + 1 shift leader

Figure A



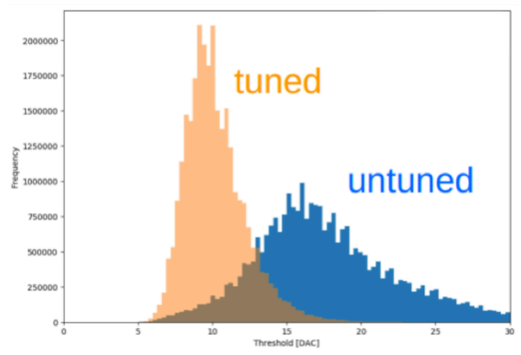
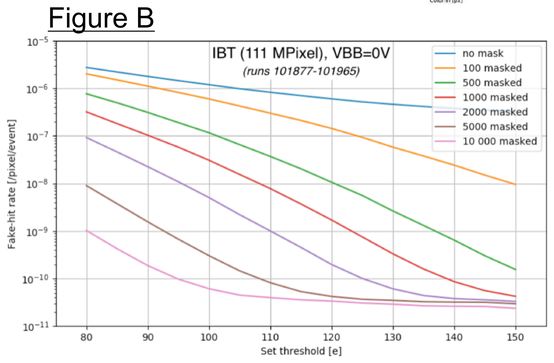
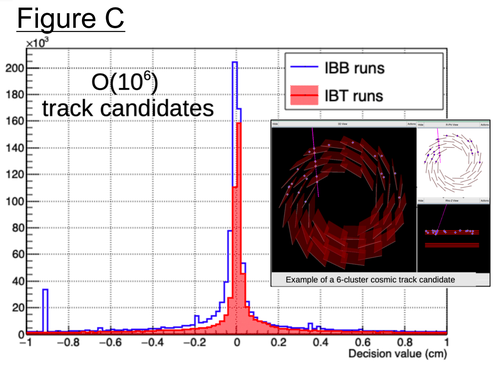


Figure C

Figure B





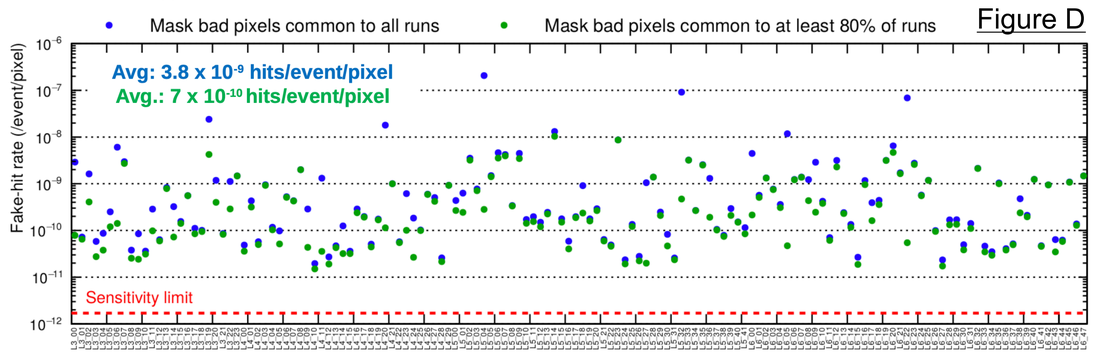
Inner Barrel

- Threshold Tuning (Figure A): Adjustment of frontend parameters to equilibrate the charge threshold archiving uniform detector responce; threshold stability over time → **Really good threshold uniformity**
- Fake-hit rate (Figure B): threshold is a trade-off between detector efficiency and fake-hit rate → measured fake-hit rate below 10^{-10} hits/pixel/event → **Extremely quiet detector**
- Alignment study (Figure C): correlation in the three layers of the clusters produced by cosmic tracks

Outer Barrel

- Stability test (Figure D):
  - Slight variations in the voltage applied to the chips require multiple runs (5-10) to detect all hot pixels → Room for powering procedure improving
  - **Noise performance very good**
  - Negligible threshold variations over time → **Detector stable over time**

Figure D



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