Mexico and the ALICE Experiment

F Antinori

24 March 2017

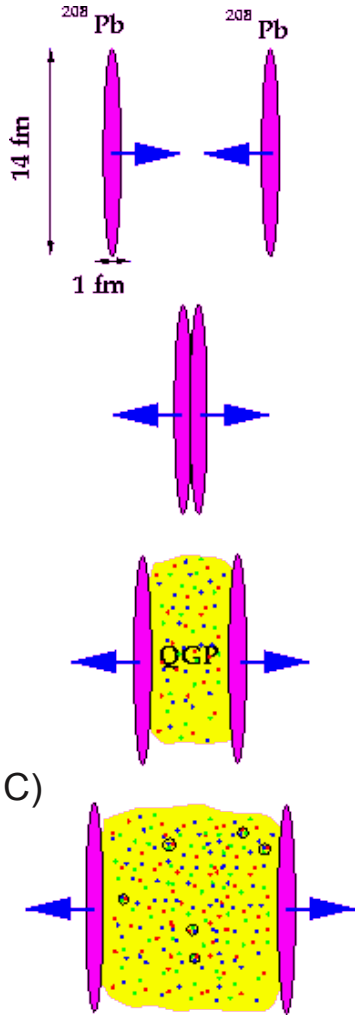
Ultrarelativistic Nuclear Collisions

basic idea: compress large amount of energy in small volume

→ produce a “fireball” of hot matter:

temperature O(10^{12} K)

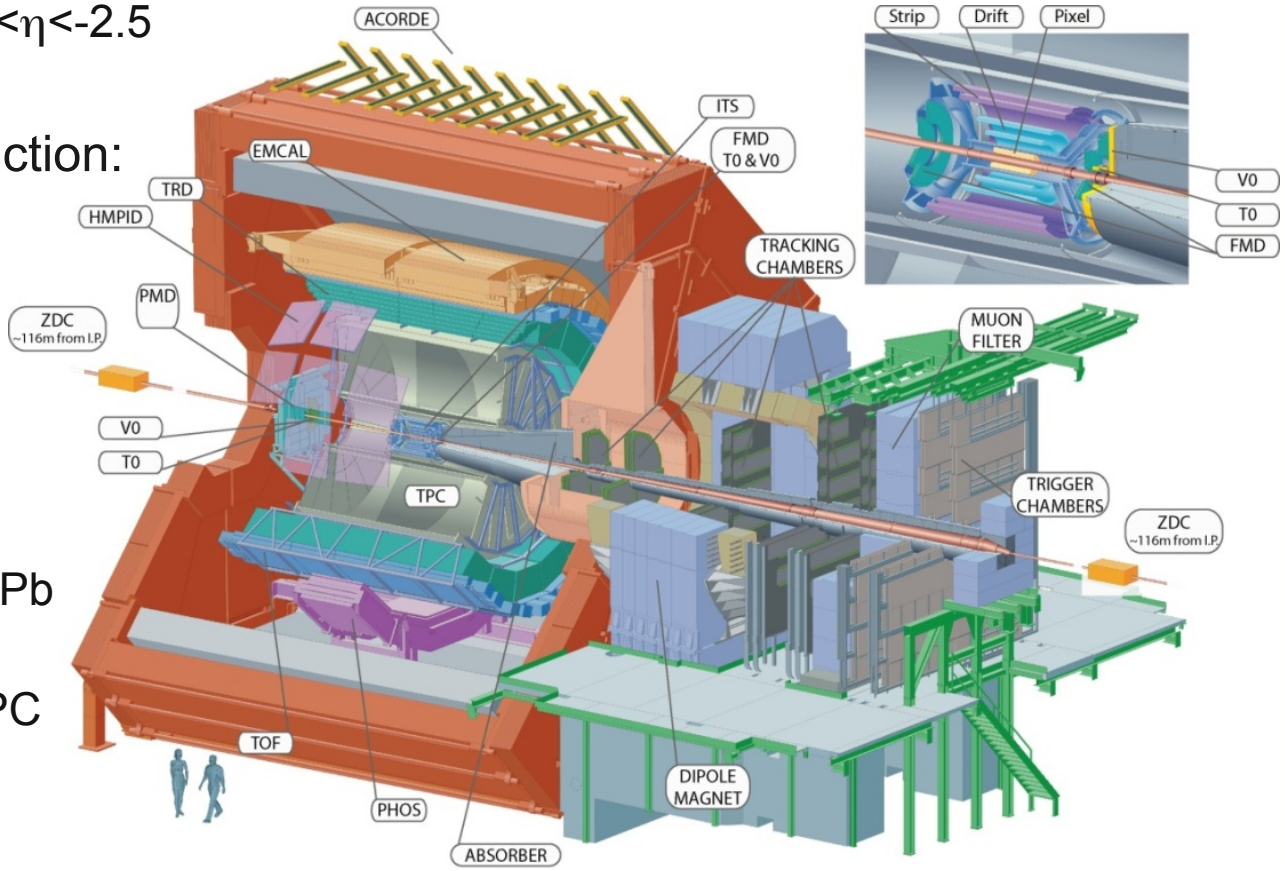
- ~ 10^5 x T at centre of Sun
- ~ T of universe @ ~ 10 μs after Big Bang



- extreme conditions: how does matter behave?
  - → study the fireball properties
  - deconfined QCD medium(Quark-Gluon Plasma, QGP)
    - predicted by QCD
    - evidence for QGP already at lower energy (CERN-SPS, BNL-RHIC)
  - LHC: high statistics and controlled probes
    - → quantitative study of properties of QCD medium
      - viscosity, opacity, transport, diffusion, …

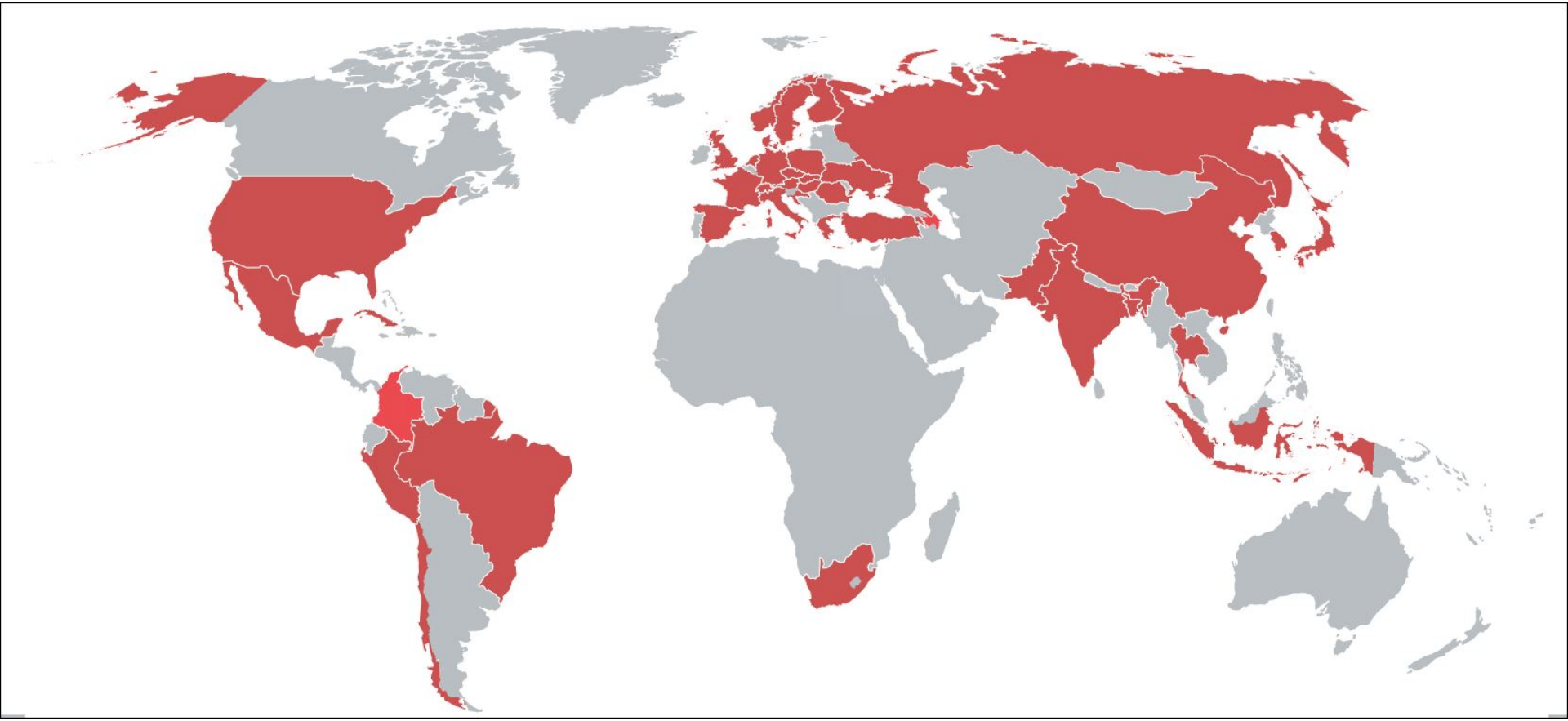
The ALICE Experiment

- Two main parts:
  - barrel ($|\eta|<0.9$), B = 0.5 Tesla
  - muon spectrometer, $-4<\eta<-2.5$
- High precision reconstruction:
  - low material tracking
  - high res. vertexing
  - hadron and lepton ID
- Triggers:
  - minimum-bias (MB)
    - or centrality, in Pb-Pb
  - single and di-muon
  - EMCAL, high-mult., UPC
  - TRD
- Collisions systems (so far) : Pb-Pb, pp, p-Pb, Pb-p



THE ALICE Collaboration

42 Countries – 174 Institutes – 162'518 KCHF capital cost



THE ALICE COLLABORATION

History of the ALICE Experiment:

1990-1996 Design

1992-2002 R&D

2000-2010 Construction

2002-2007 Installation

2008 -> Commissioning

4 TP addenda along the way:

- 1996 Muon spectrometer
- 1999 TRD
- 2006 EMCAL
- 2007 DCAL

2012 LoI for the Upgrade

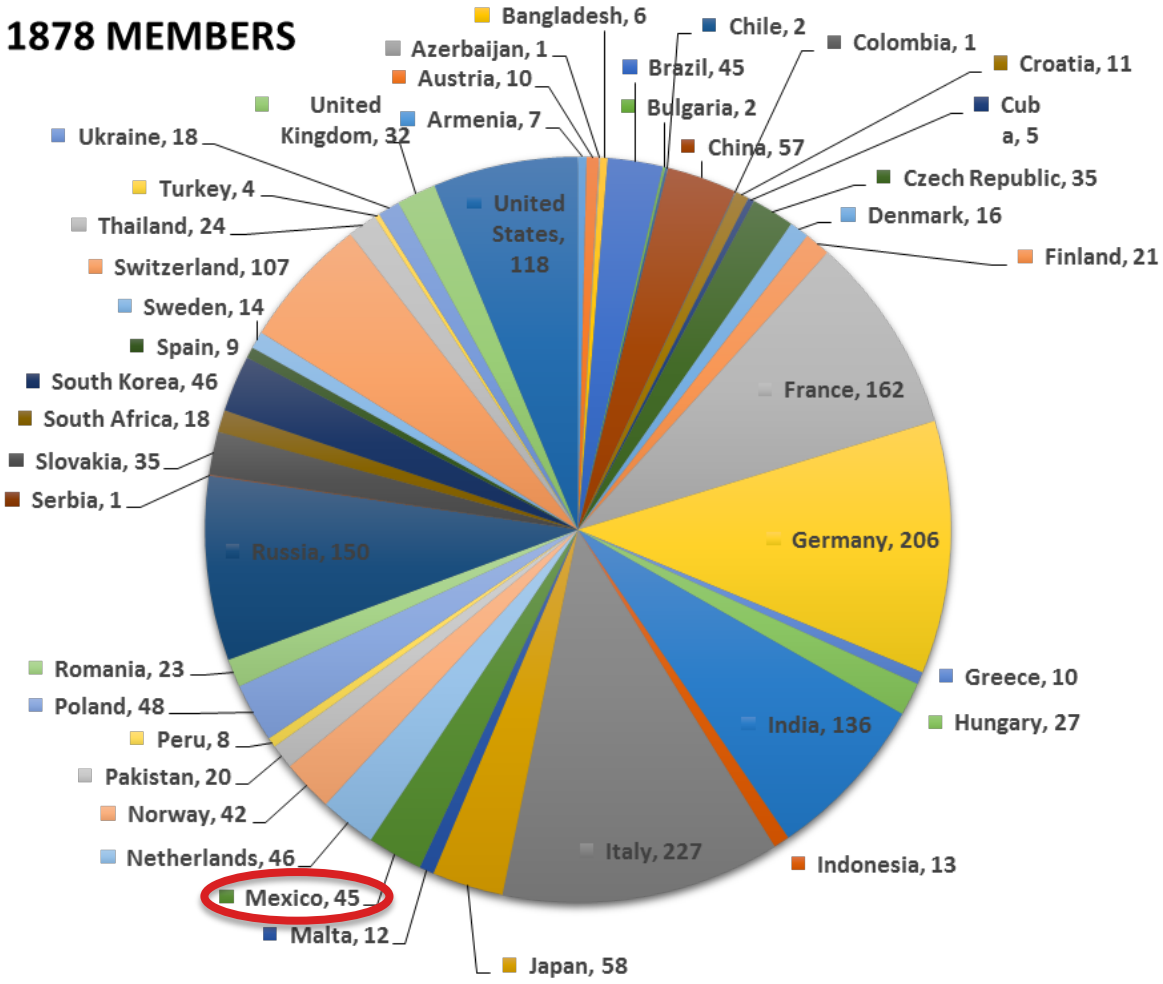
2012-2014 R&D

2014-2016 Procurement/Fabrication

2016-2017 Integration, pre-commissioning

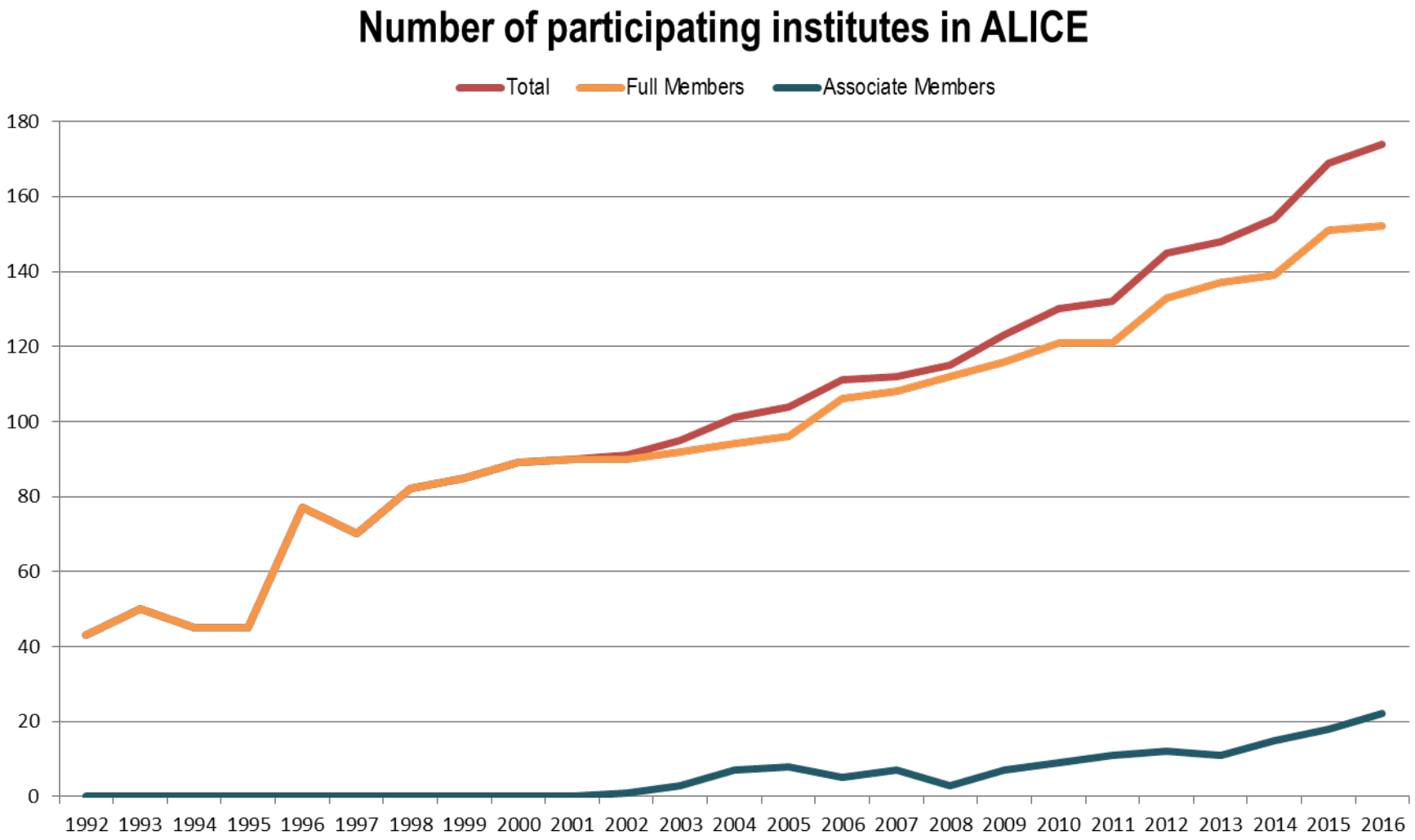
2018-2019 Installation, commissioning

2019-2020 Full deployment of DAQ/HLT



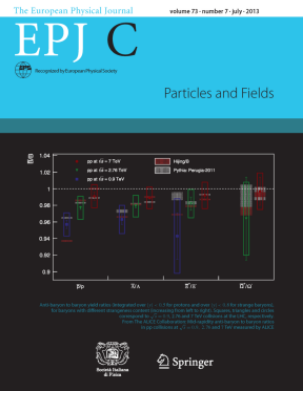
Source: Alice Collaboration data base, June 2016

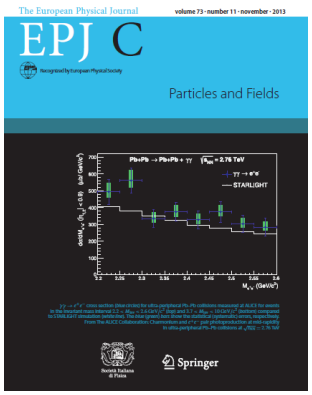
PARTICIPATING INSTITUTES (1992-2016)

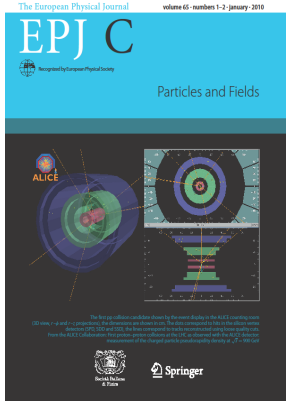


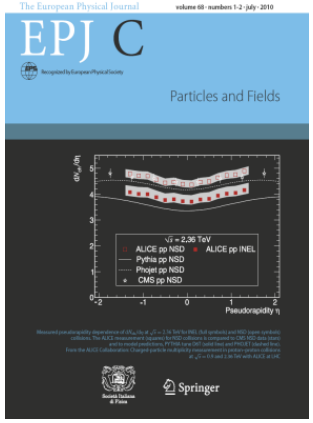
High scientific impact

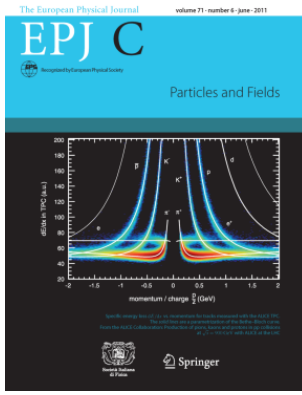
- major scientific output
  - **177 ALICE papers on arXiv**
  - **high-impact papers (***average of ~80 citations per paper***) :** the top cited papers at the LHC after the Higgs discovery ones are HI physics papers (source: ISI).
  - **several hundred** presentations at international conferences *each year*





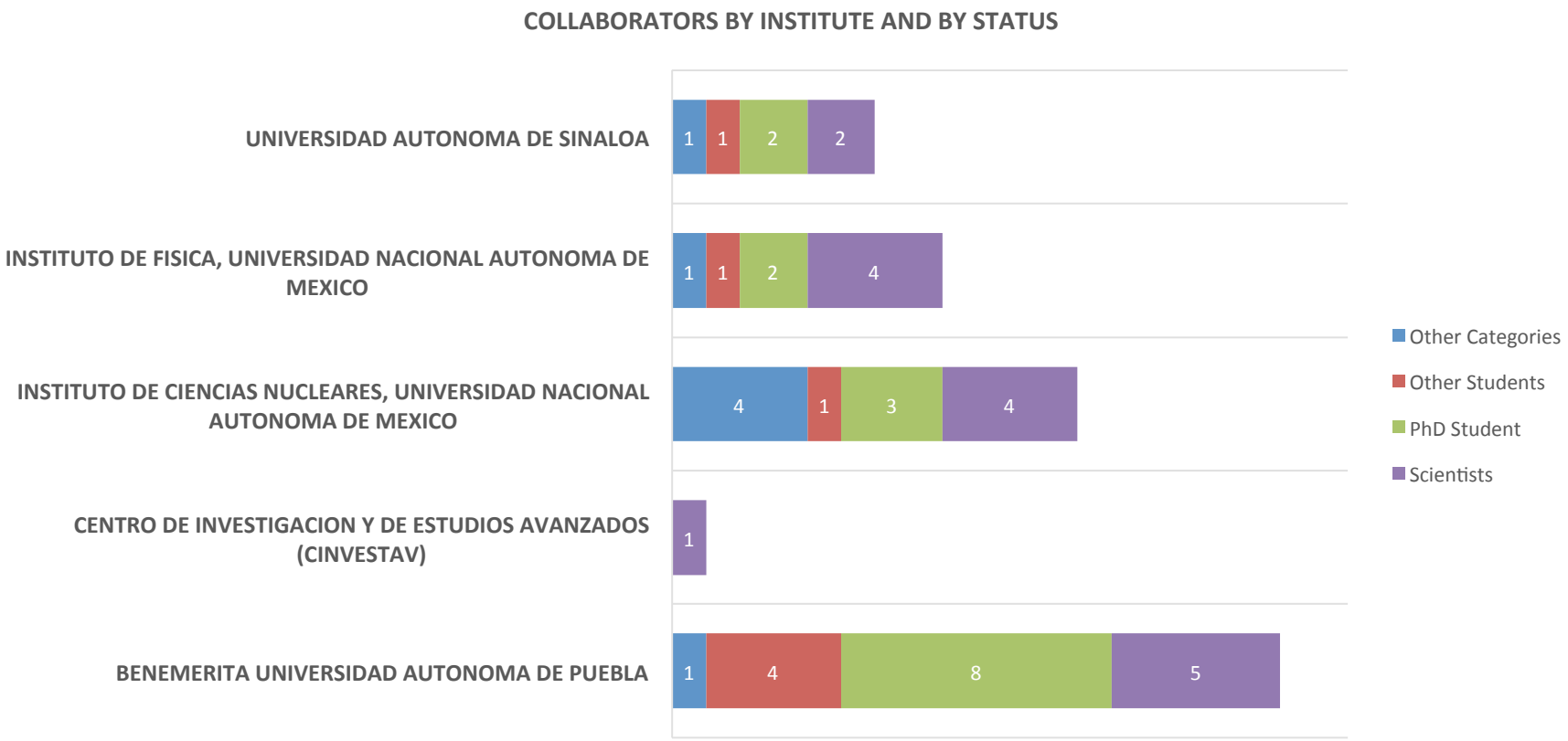






MEXICO MEMBERS (source: ALICE Collaboration database, March 2017)

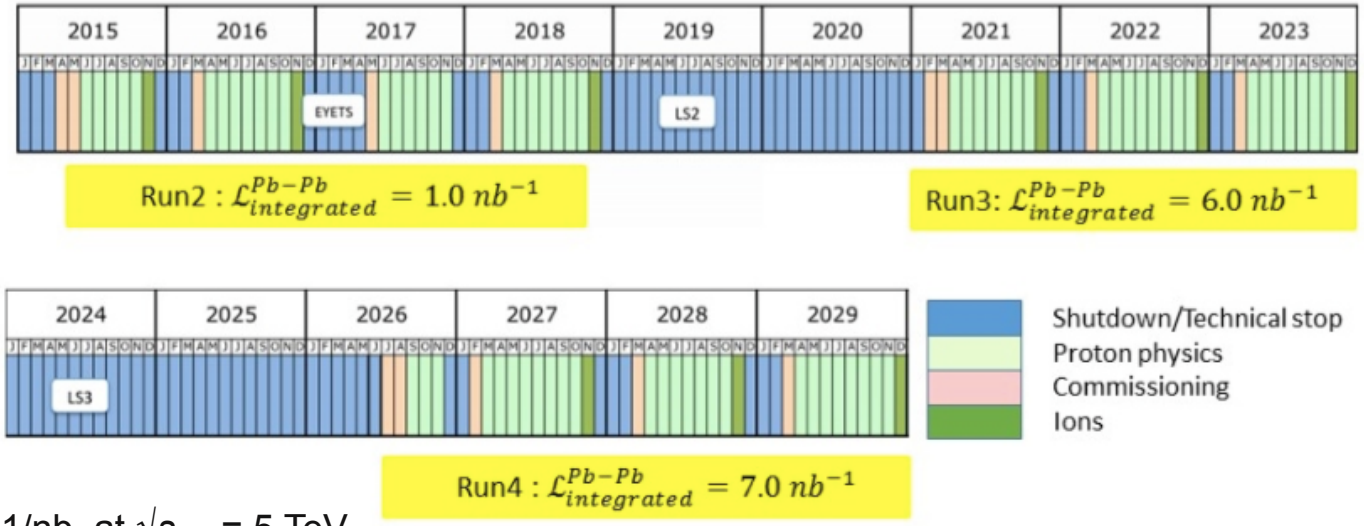
45 COLLABORATORS INCLUDING 15 PHD STUDENTS



Main Mexican Contributions

- V0 and AD (CINVESTAV, UNAM, UAS)
  - forward scintillator arrays
  - trigger, luminosity, centrality, event plane
- ACORDE (A COsmic Ray DEtector) (BUAP, CINVESTAV, ICN, UAS)
  - calibration triggers
  - multi-muon trigger for cosmic-ray physics (muon bundles)
- Computing (UNAM, DGTIC)
  - Tier 2 (1024 cores, 570 TB), Tier 1 in preparation
  - pioneered GRID computing in Mexico, ICN now leading the computing for HAWC
- Data Analysis (all)
  - coordination of Physics Analysis Groups
    - A Ortiz (UNAM): LF-Spectra; A Fernández (BUAP): UD-Cosmics
  - Editorial Board (G Paic)
  - identified particle production (up to nuclei)
  - fluctuations
  - ultraperipheral collisions
  - high multiplicity, event shape in pp
  - cosmic rays

LHC Heavy Ion Timeline



- Run 2:
  - Pb-Pb: 1/nb, at $\sqrt{s}_{NN}$ = 5 TeV
  - p-Pb at 5 and 8 TeV (increased luminosity)
  - pp reference at Pb-Pb energy (5 TeV)
- LS2:
  - LHC injector upgrades; bunch spacing (likely) reduced to 25 ns
    - Pb-Pb interaction rate may exceed 50 kHz (now <10 kHz)
  - Experiments upgrades (LS2 and LS3)
- Runs 3+4:
  - Experiments request for **Pb-Pb: >10/nb** (ALICE: 10/nb at 0.5T + 3/nb at 0.2T)
  - In line with latest projections by the machine group (Chamonix 2016, 2017)

ALICE upgrade programme

- Run 1 + Run 2 (ongoing)
  - wide-band exploration of QGP features
    - comprehensive study of identified particle production, correlations, jets, …
  - first measurement of mass-dependence of in-medium energy loss
  - discovery of new regime for charmonium production (→ regeneration)
  - discovery of collective effects in p-Pb, pp collisions
  - + diffractive and cosmic physics
- Run 3 + Run 4 (plans)
  - understand dynamics of quark interaction with medium
    - energy loss, hadronisation with “calibrated” probes

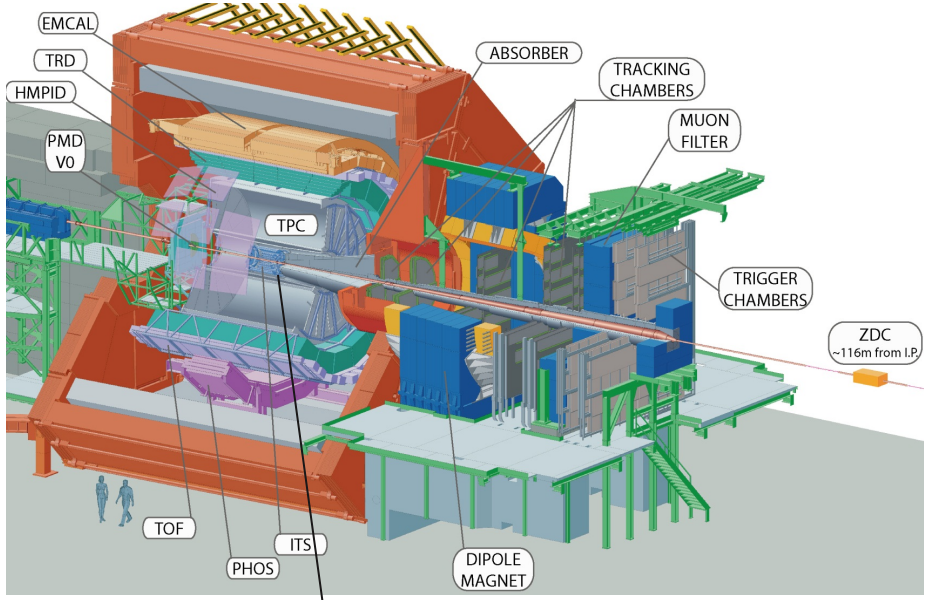
    → high statistics charm and beauty studies at low p_T
  - high statistics study of suppression and regeneration of quarkonia

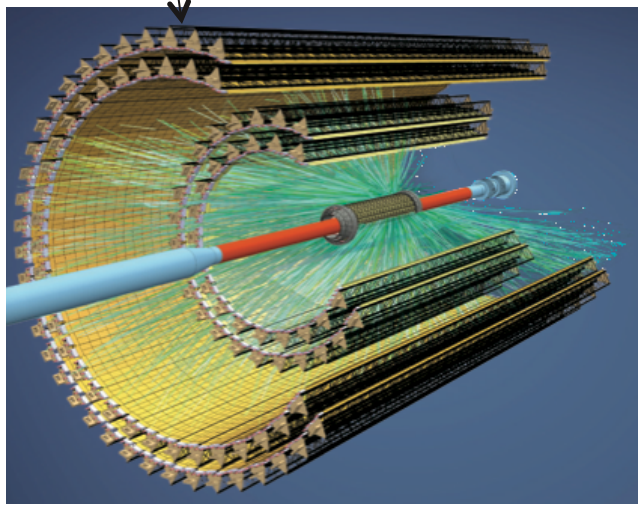
    → high statistics charmonia down to zero p_T
  - study of QGP radiation, thermal evolution of the medium

    → thermal dileptons

ALICE Upgrades

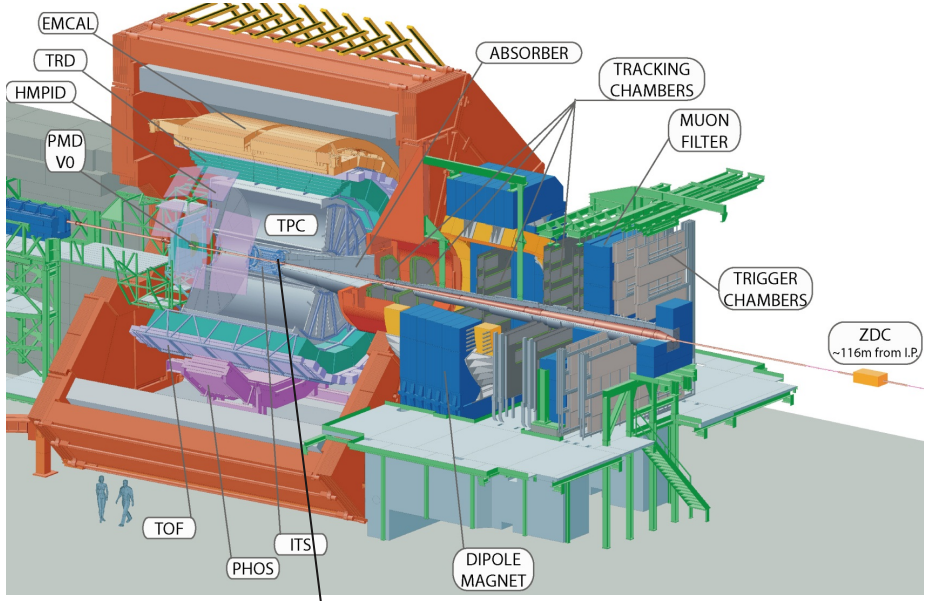
- New Inner Tracking System (ITS)
  - Improved resolution, less material, faster readout

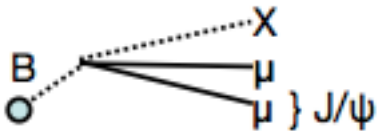


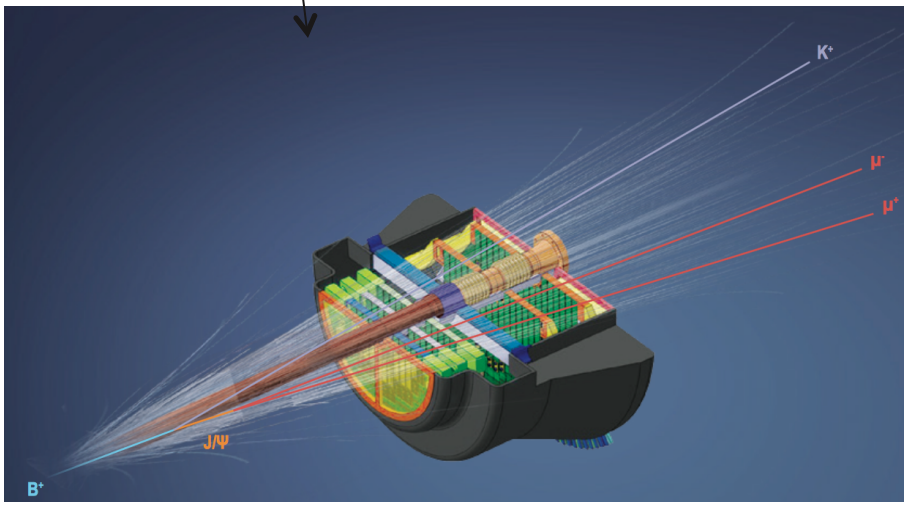


ALICE Upgrades

- New Inner Tracking System (ITS)
  - Improved resolution, less material, faster readout
- New Forward Muon Tracker (MFT)
  - HF vertices also at forward rapidity

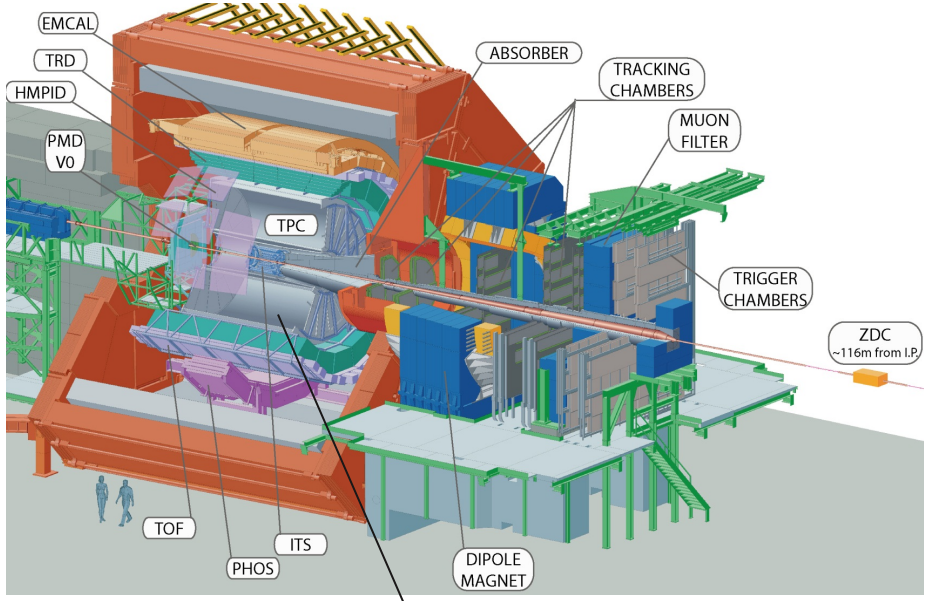


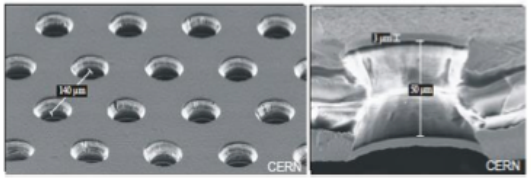




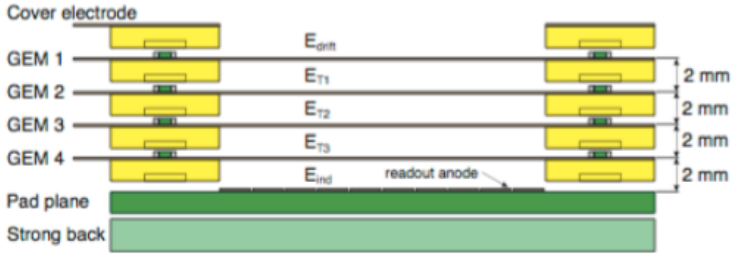
ALICE Upgrades

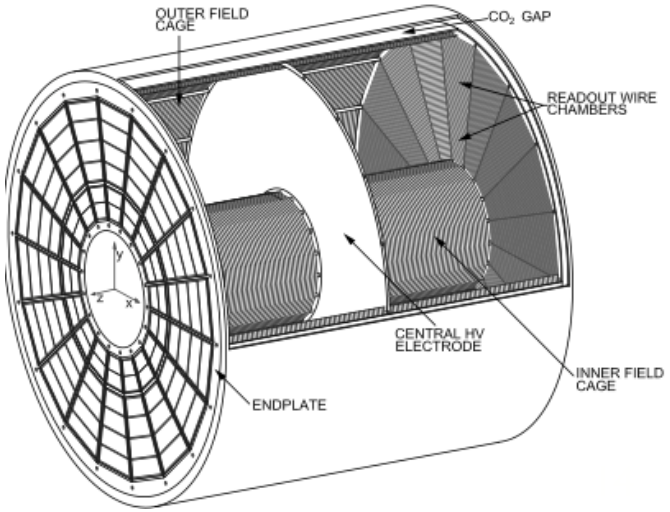
- New Inner Tracking System (ITS)
  - Improved resolution, less material, faster readout
- New Forward Muon Tracker (MFT)
  - HF vertices also at forward rapidity
- New TPC Readout Chambers
  - 4-GEM detectors





Electron microscope photograph of a GEM foil

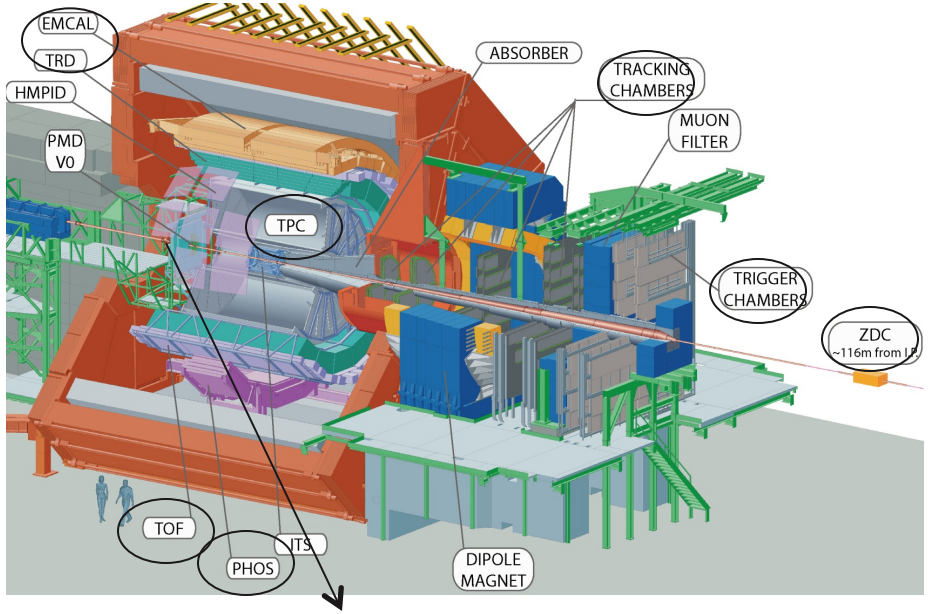


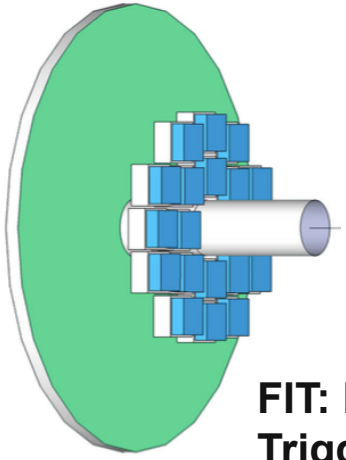


ALICE

ALICE Upgrades

- New Inner Tracking System (ITS)
  - Improved resolution, less material, faster readout
- New Forward Muon Tracker (MFT)
  - HF vertices also at forward rapidity
- New TPC Readout Chambers
  - 4-GEM detectors
- New trigger detectors (FIT, AD)
  - + centrality, event plane



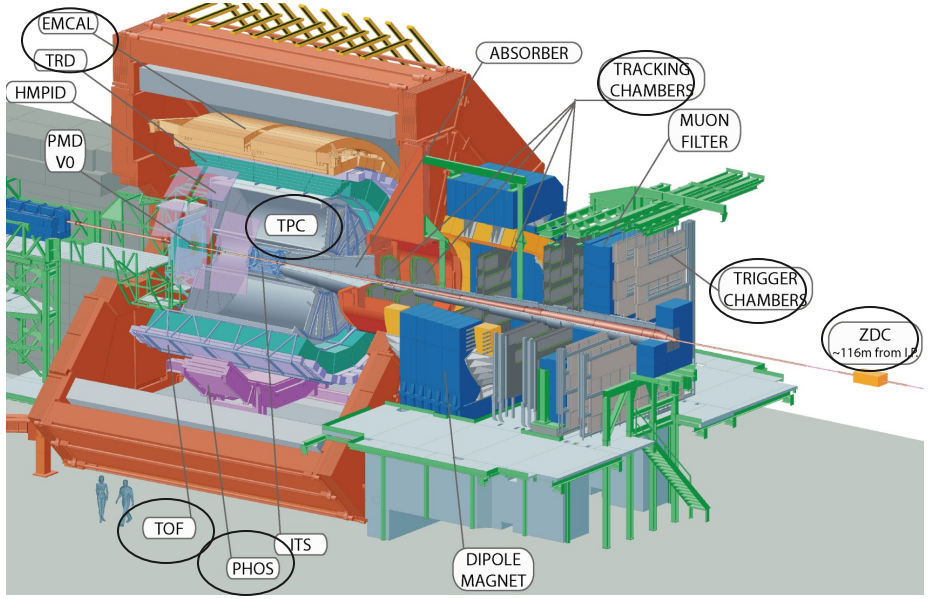


FIT: Fast Interaction Trigger

ALICE

ALICE Upgrades

- New Inner Tracking System (ITS)
  - improved resolution, less material, faster readout
- New Forward Muon Tracker (MFT)
  - HF vertices also at forward rapidity
- New TPC Readout Chambers
  - 4-GEM detectors
- New trigger detectors (FIT, AD)
  - + centrality, event plane
- Upgraded read-out for TOF, TRD, MUON, ZDC, EMCal, PHOS, integrated Online-Offline system (O^2)
  - record minimum-bias Pb-Pb data at 50 kHz (currently <1 kHz)



Mexico and the ALICE Upgrades

- CINVESTAV (G Herrera, I León)
  - AD detector
- ICN-UNAM (G Paic, M Enrique)
  - TPC upgrade (currents monitoring)
- IF-UNAM (A Menchaca, V Grabski, R Alfaro, A Sandoval)
  - V0+ detector (FIT)
- BUAP (A Fernández, M Rodríguez, M Martínez, G Tejeda, A Vargas, S Vergara, R Camacho)
  - TPC upgrade (currents monitoring)
  - AD detector
  - Central Trigger Processor

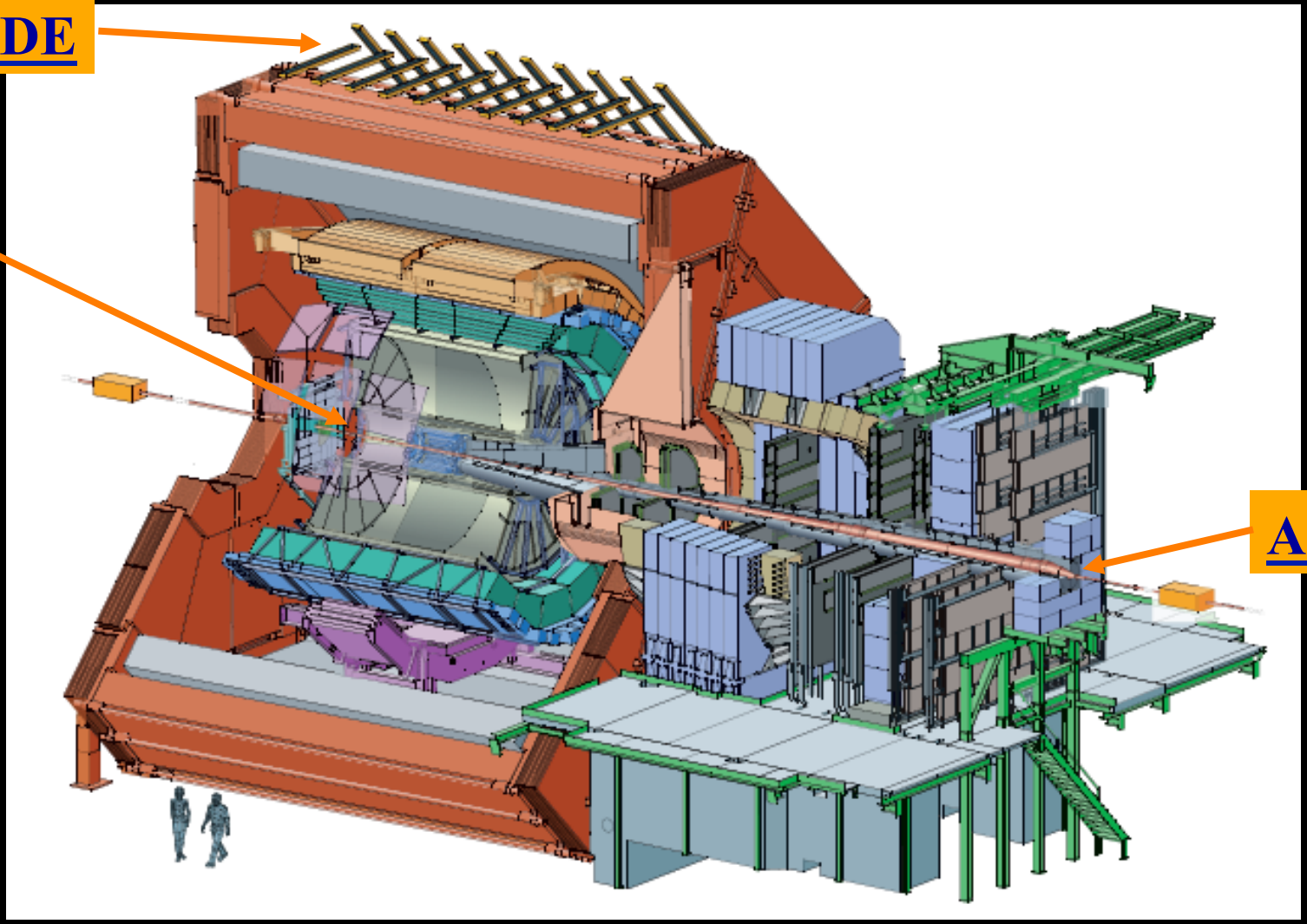
actividades del equipo mexicano

ACORDE

V0A

TPC

V0+



AD

Análisis de datos

2017