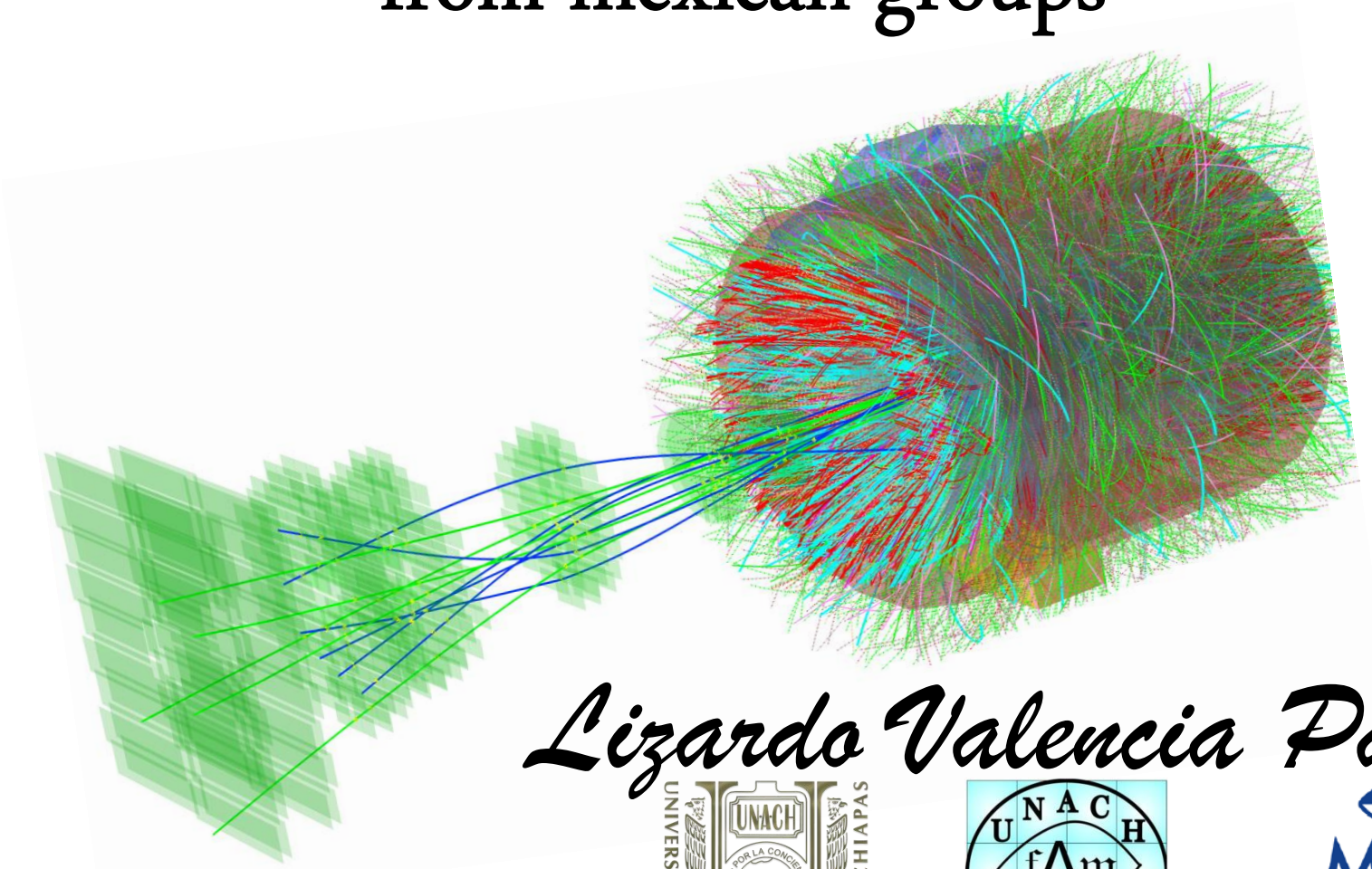
The ALICE experiment upgrades for LHC Run 3 and beyond: contributions from mexican groups



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UNACH FÍSICA Y MATEMÁTICAS

MCTP Mesoamerican Centre for Theoretical Physics

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Motivations

The ALICE experiment upgrades

Contributions from mexican groups:

- FIT
- AD
- ACORDE
- TPC

Summary

MOTIVATIONS

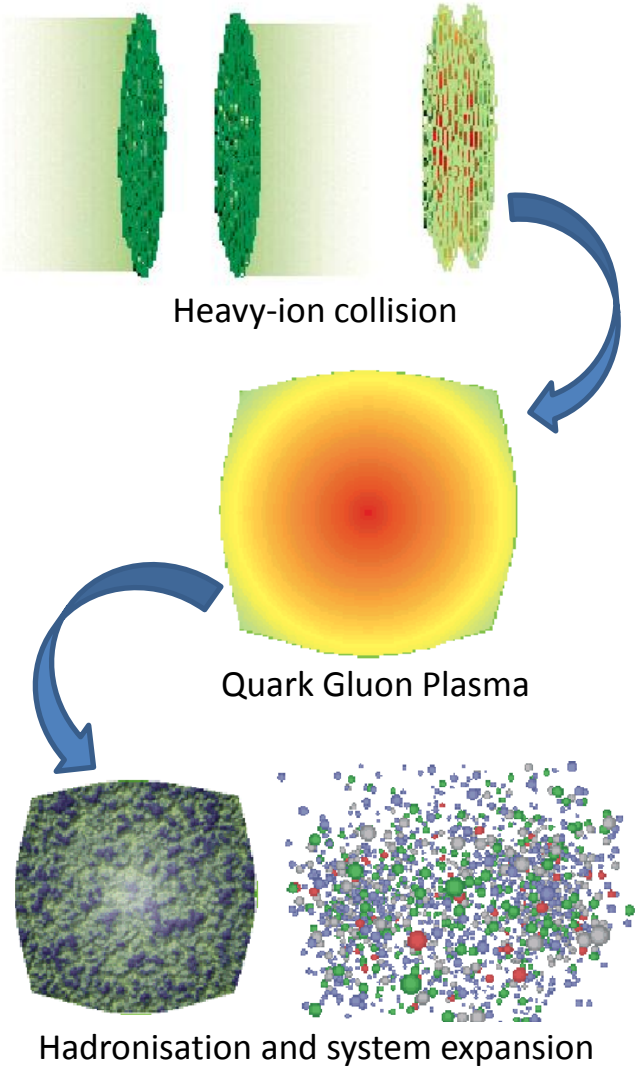
The Quark Gluon Plasma

The Quark Gluon Plasma (QGP) is a deconfined stated of quarks and gluons created in heavy-ion collisions with the following properties:

- Energy density larger than 10 GeV/fm^3.
- Very low viscosity (nearly a perfect fluid).
- Strong energy loss for hard partons.
- Very short mean free path.

In order to characterize the QGP at the LHC we need measurements in a wide range of observables, from bulk particle production to specific probes.

However, some probes have not been fully exploited due to insufficient statistics or large combinatorial background (open heavy flavours, quarkonium, dileptons, …).



Open questions

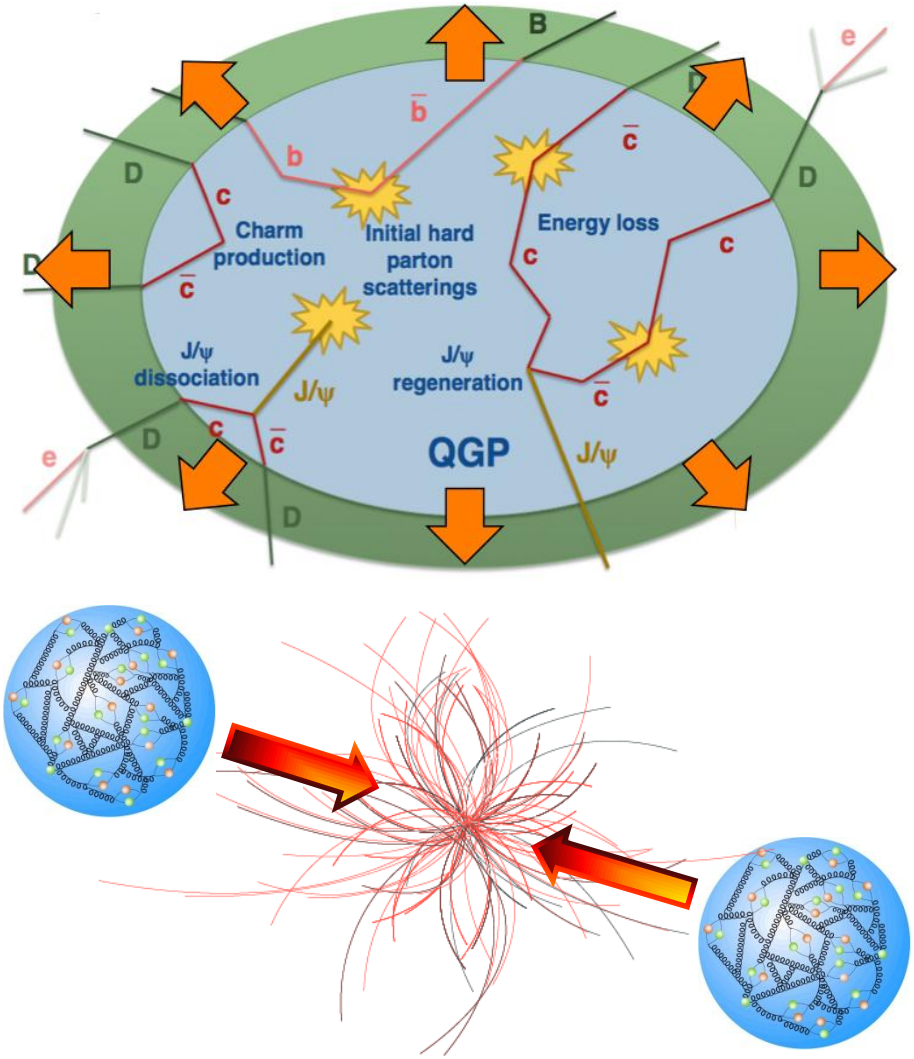
Besides that, there are still many physics questions to be addressed:

- How is quarkonium suppression (dissociation and regeneration) related to deconfinement and QGP temperature?
  ➔ Study charmonium down to zero p_T.

- What are the mechanisms of quark-medium (QGP) interaction?
  ➔ Understand heavy quark dynamics and hadronization at low-p_T.

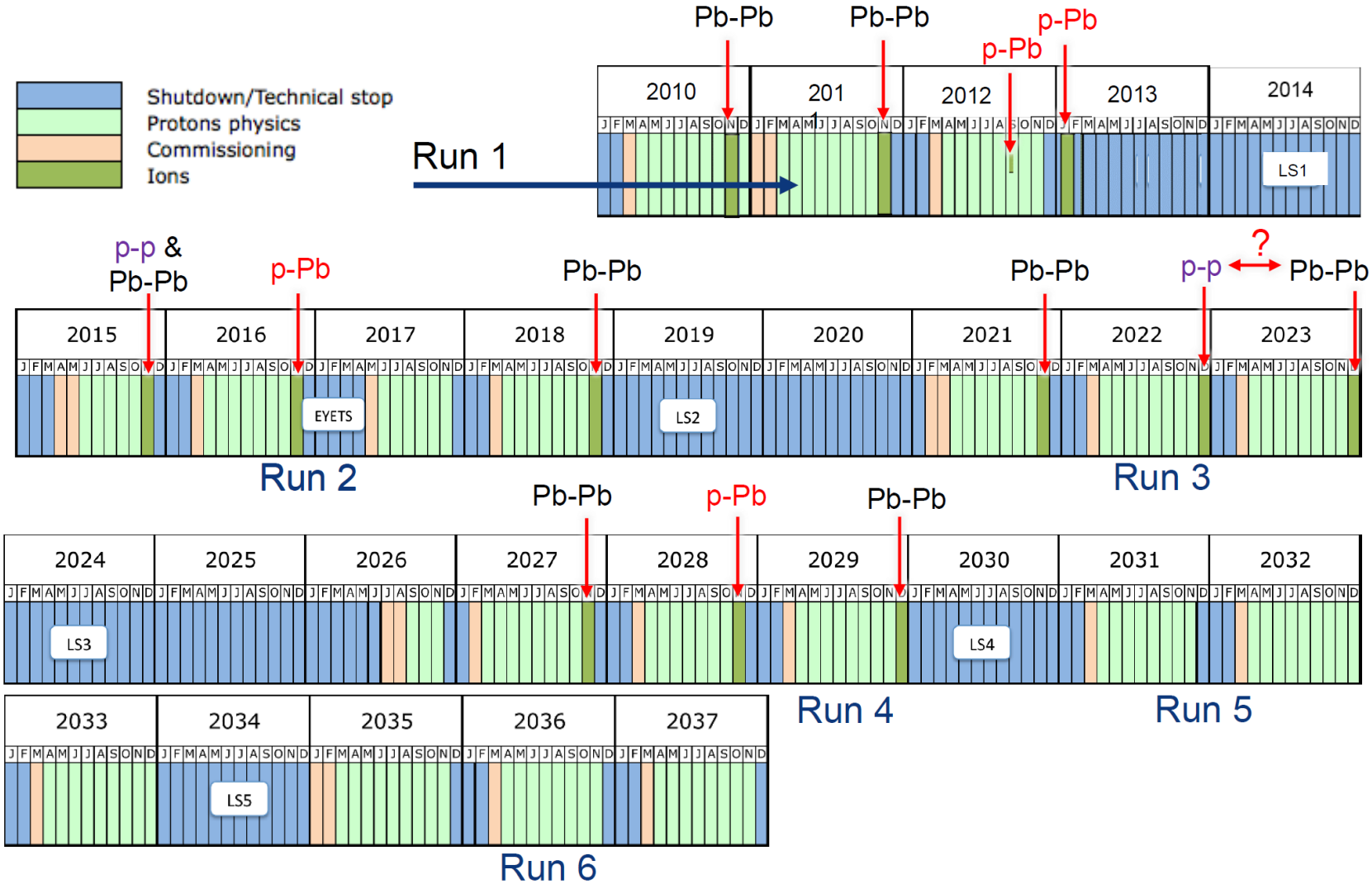
- How is collectivity developed? Is it possible to recreate the QGP in small systems?
  ➔ In-depth study of pp and pA collisions.

We need more data to analyse!



THE ALICE EXPERIMENT UPGRADES

LHC: past, present and future



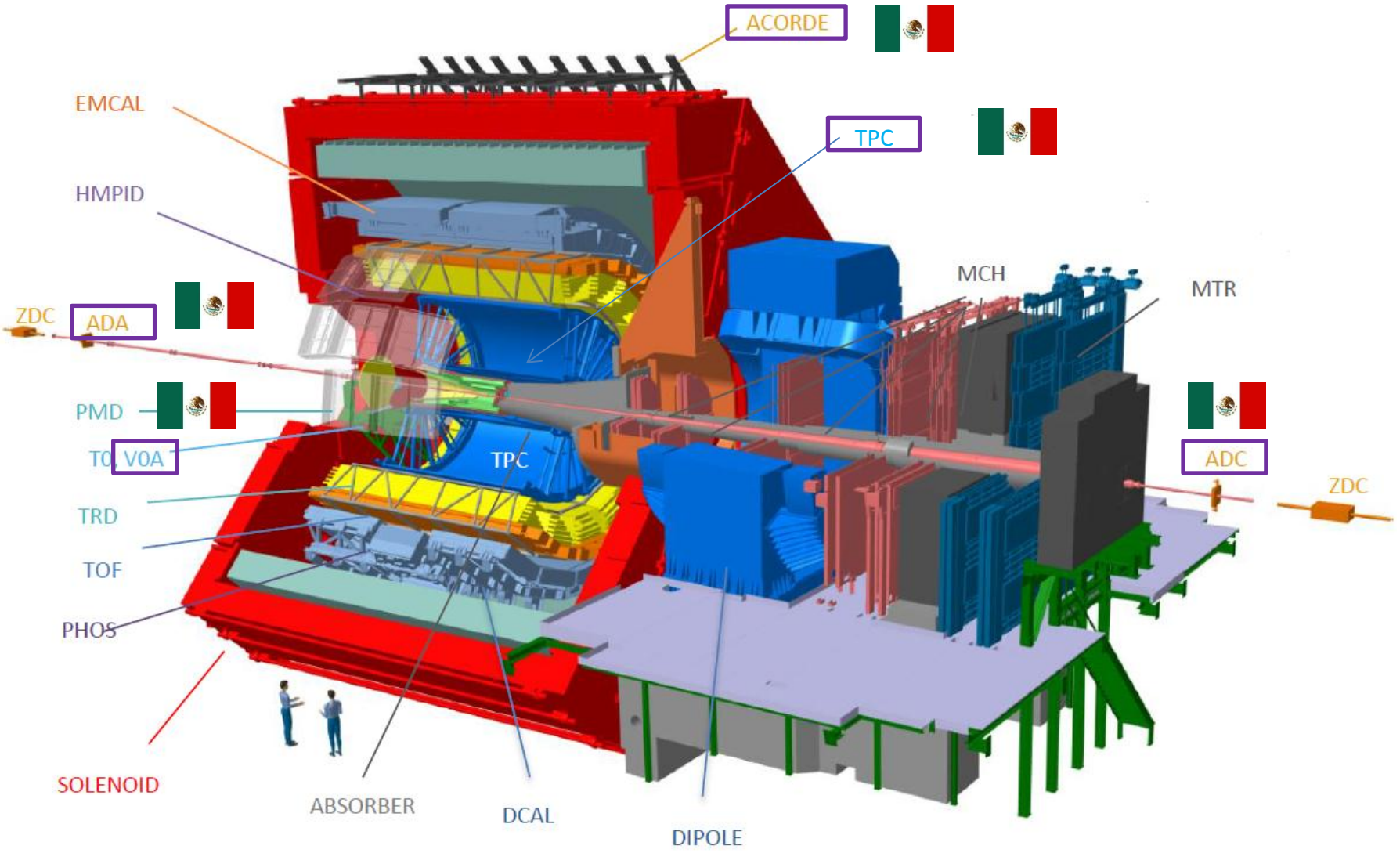
Plans for the ALICE experiment

In LHC Run 2 ALICE will collect an integrated luminosity of 1 nb^{-1} in Pb-Pb collisions. For LHC Run 3 and 4, ALICE will collect more than 10 nb^{-1} of Pb-Pb collisions at an interaction rate of 50 kHz: 100x the interaction rate during LHC Run 1 (2009 - 2013).

In order to achieve these goals, the ALICE experiment will have to:

- Increase the read out capabilities in order to record all Pb-Pb interactions (each collision will be shipped to the online systems).
- Improve track reconstruction performance (in particular for low-p_T particles).
- Enhance particle identification capabilities.

The ALICE experiment



The ALICE experiment upgrades

New Inner Tracking System (ITS)
- improved pointing precision
- less material -> thinnest tracker at the LHC

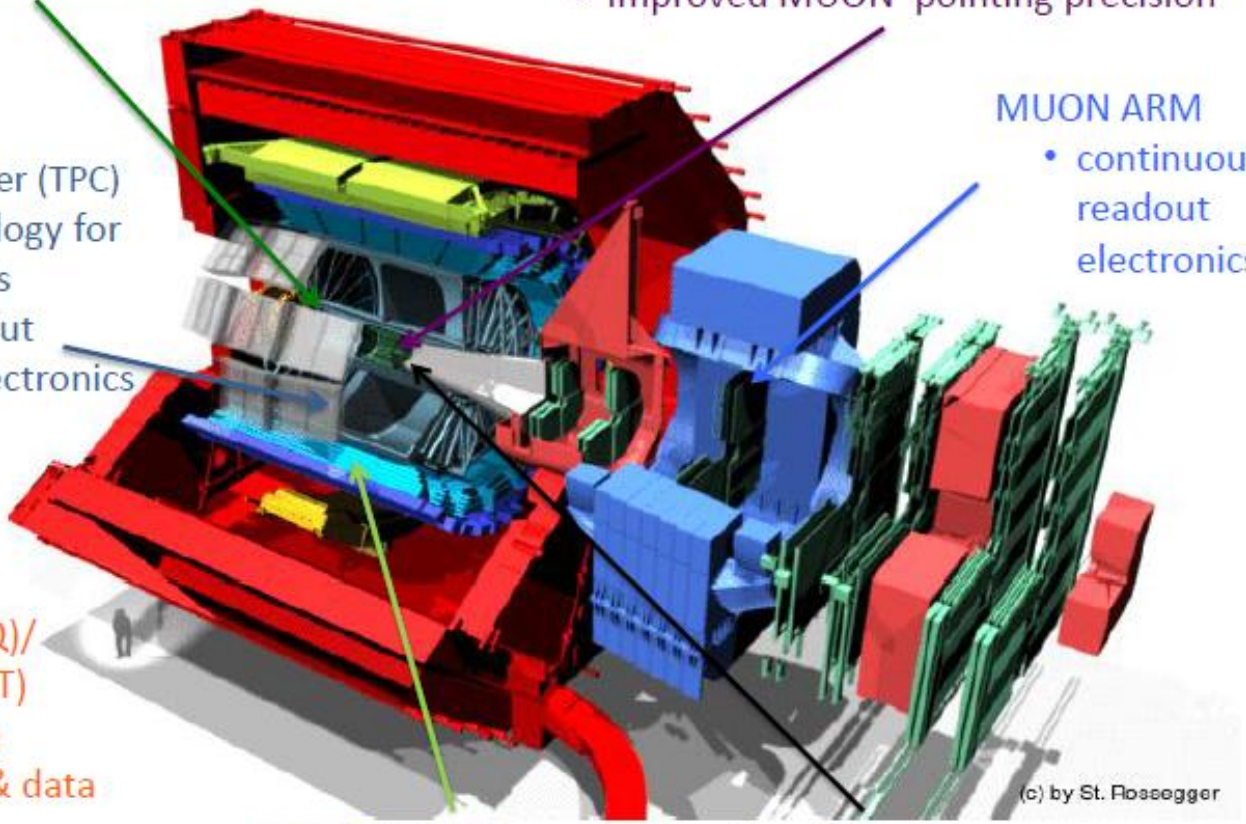
Muon Forward Tracker (MFT)
- new Si tracker
- Improved MUON pointing precision

MUON ARM
- continuous readout electronics

Time Projection Chamber (TPC)
- new GEM technology for readout chambers
- continuous readout
- faster readout electronics

New Central Trigger Processor

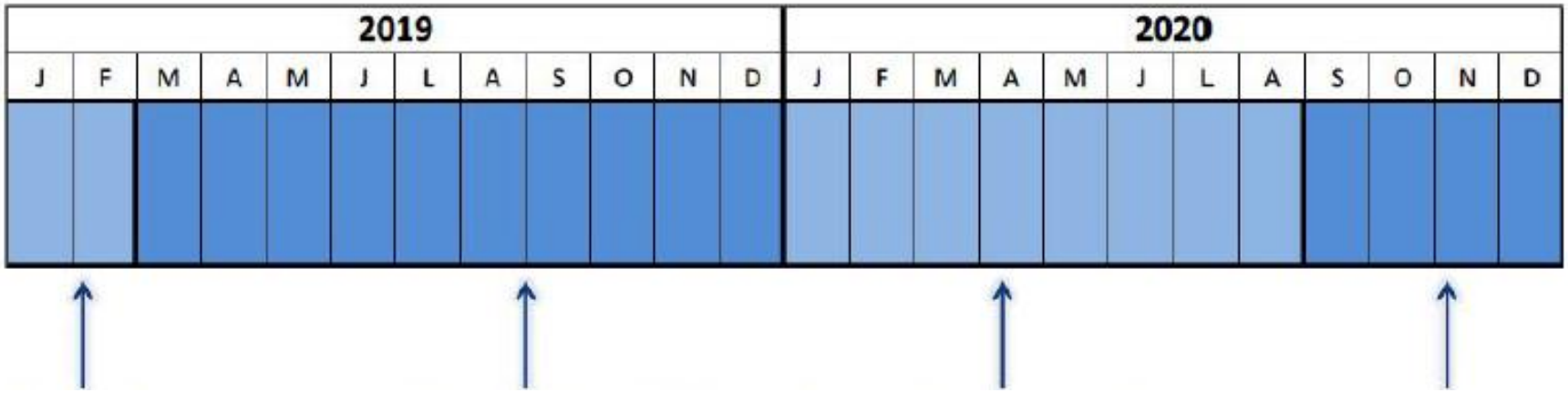
Data Acquisition (DAQ)/ High Level Trigger (HLT)
- new architecture
- on line tracking & data compression
- 50kHz Pbb event rate



TOF, TRD, ZDC
- Faster readout

New Trigger Detectors (FIT)

Long Shutdown II

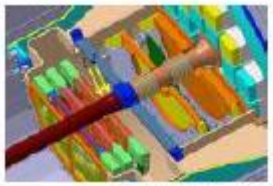


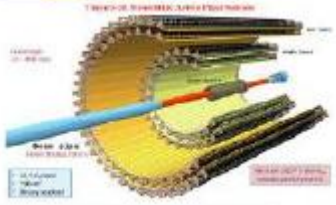
2 months: opening experiment and remove TPC/ITS/beam pipe

10 months: TPC upgrade in cleanroom

8 months: reinstall TPC/ITS/MFT/FIT/beam pipe and close experiment

4 months: commissioning





CONTRIBUTIONS FROM MEXICAN GROUPS

Fast Interaction Trigger (FIT)

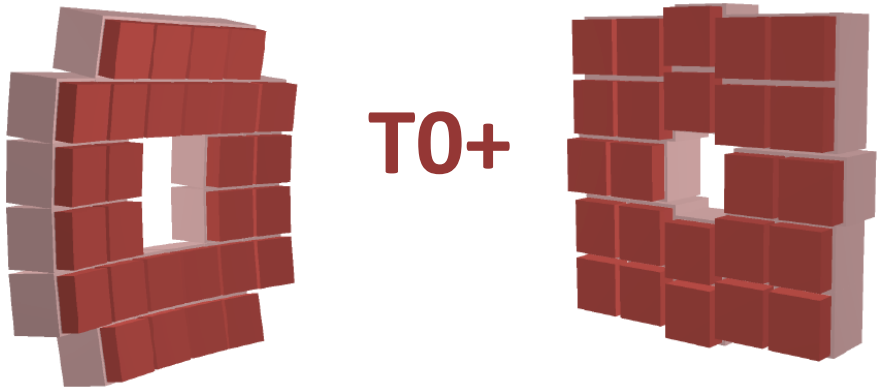
The FIT system will consist of two detectors: T0+ and V0+, upgrades of the actual T0 and V0.

FIT will be used for different purposes:

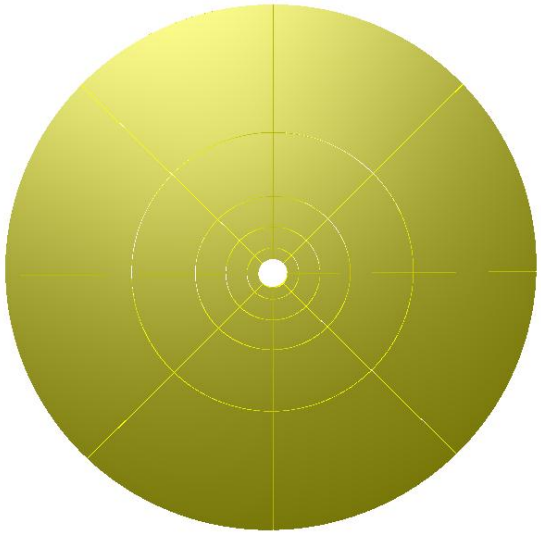
- Luminosity monitoring and beam tuning.
- Multiplicity ➔ event plane and centrality.
- Reject beam-gas and beam-halo events.
- Minimum bias trigger.

Mexican groups are in charge of design and construction of V0+. This new detector will have a faster plastic scintillator, larger acceptance, time resolution of about 200 ps and 25% more readout channels.

The event plane is determined by the z axis and the impact parameter.



V0+



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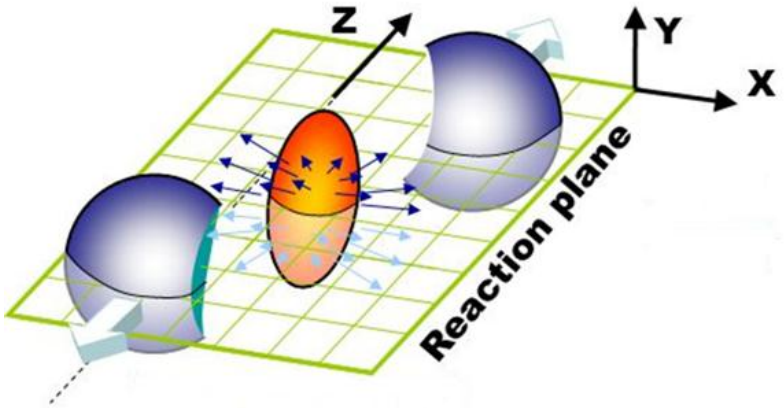

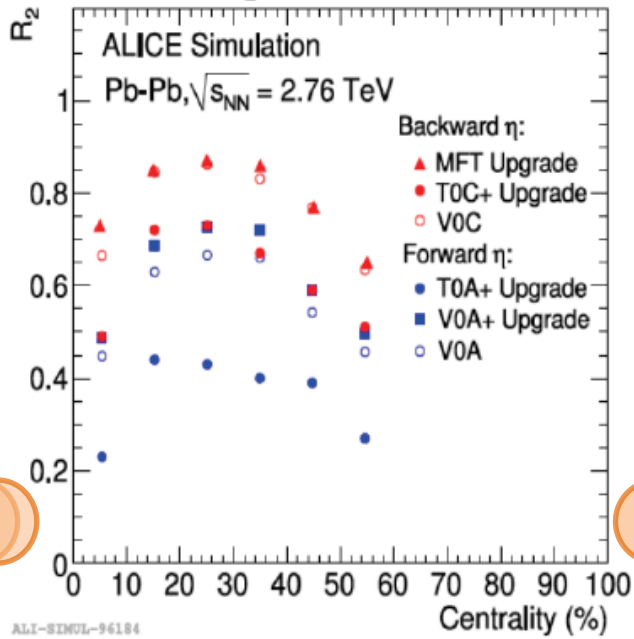

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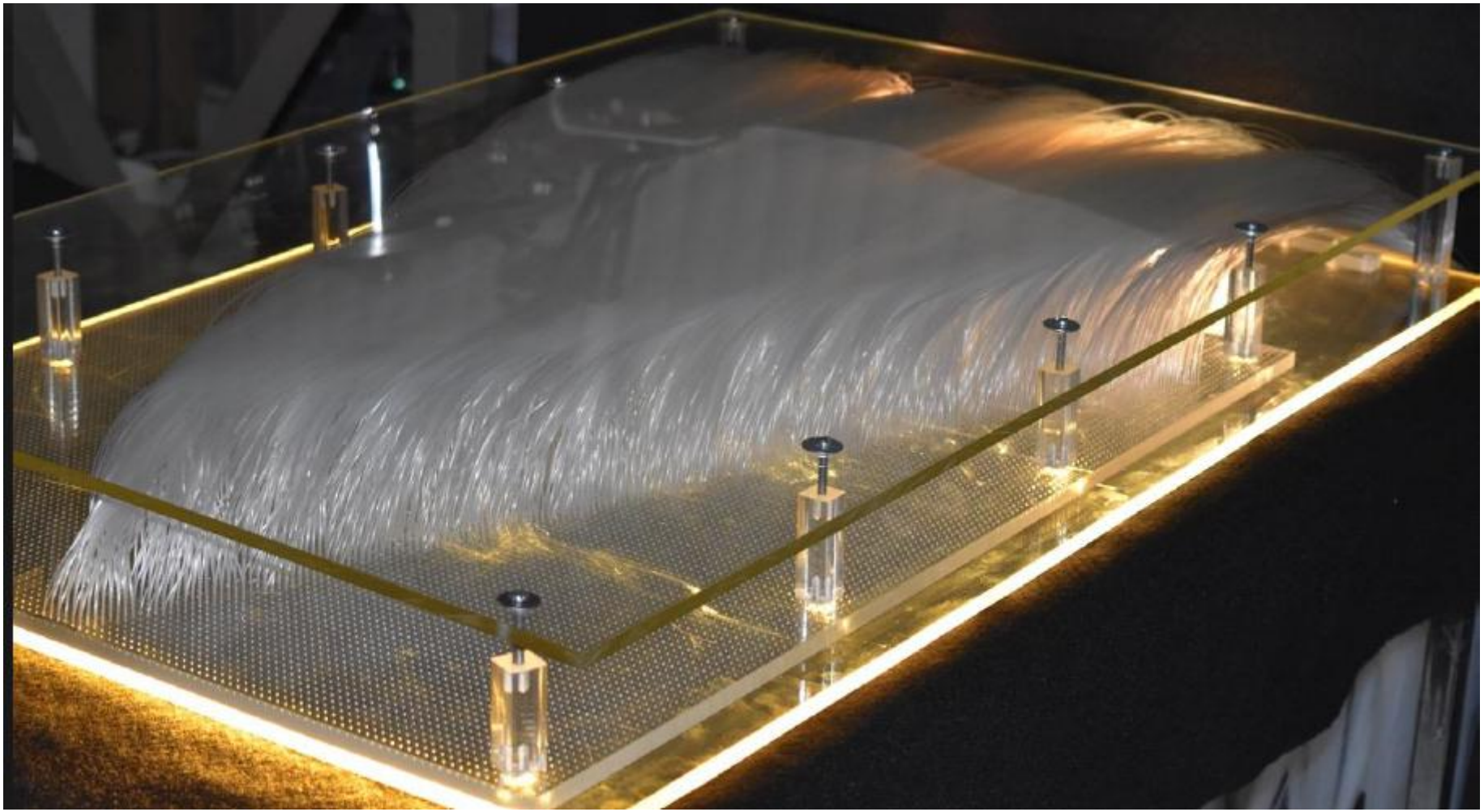

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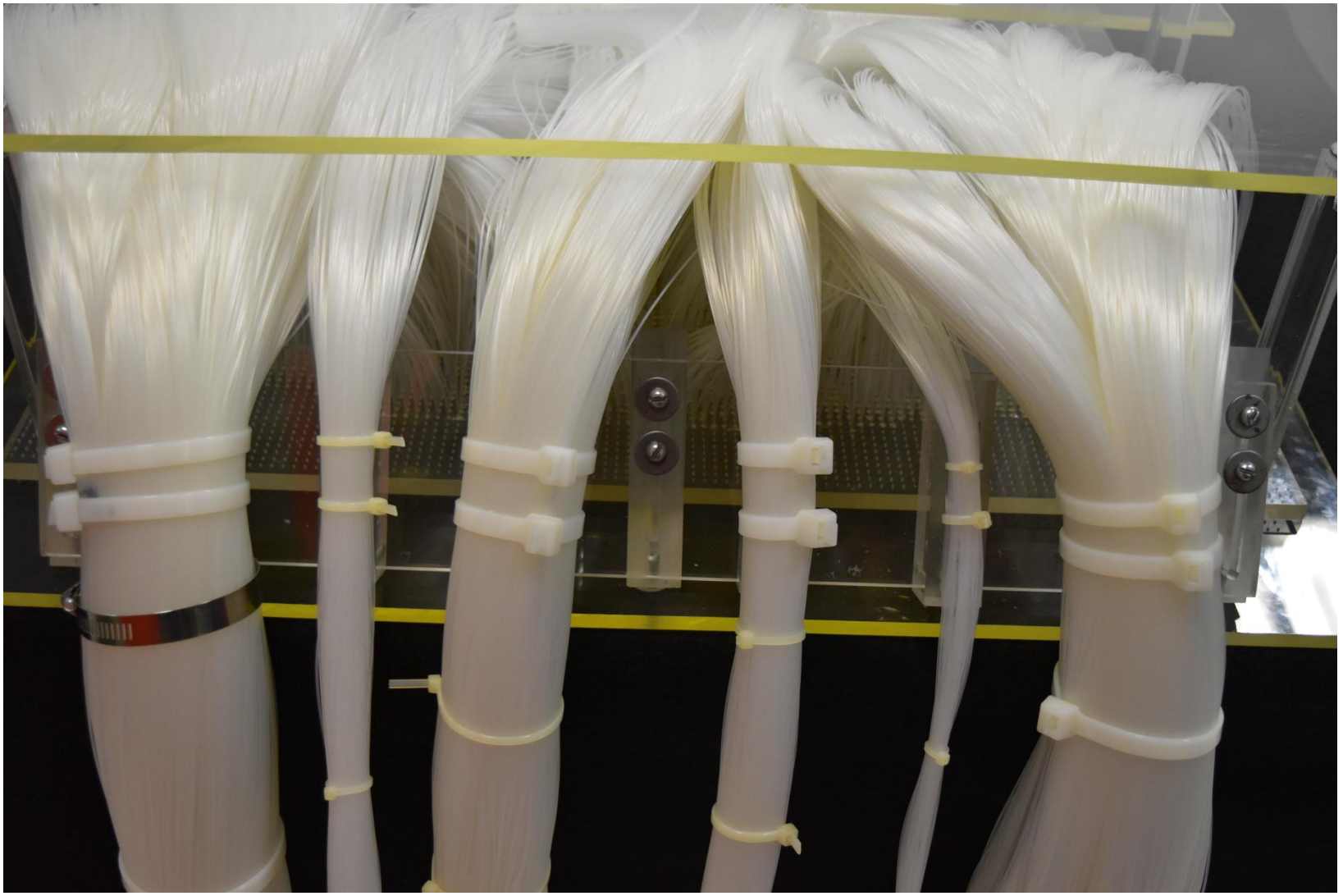

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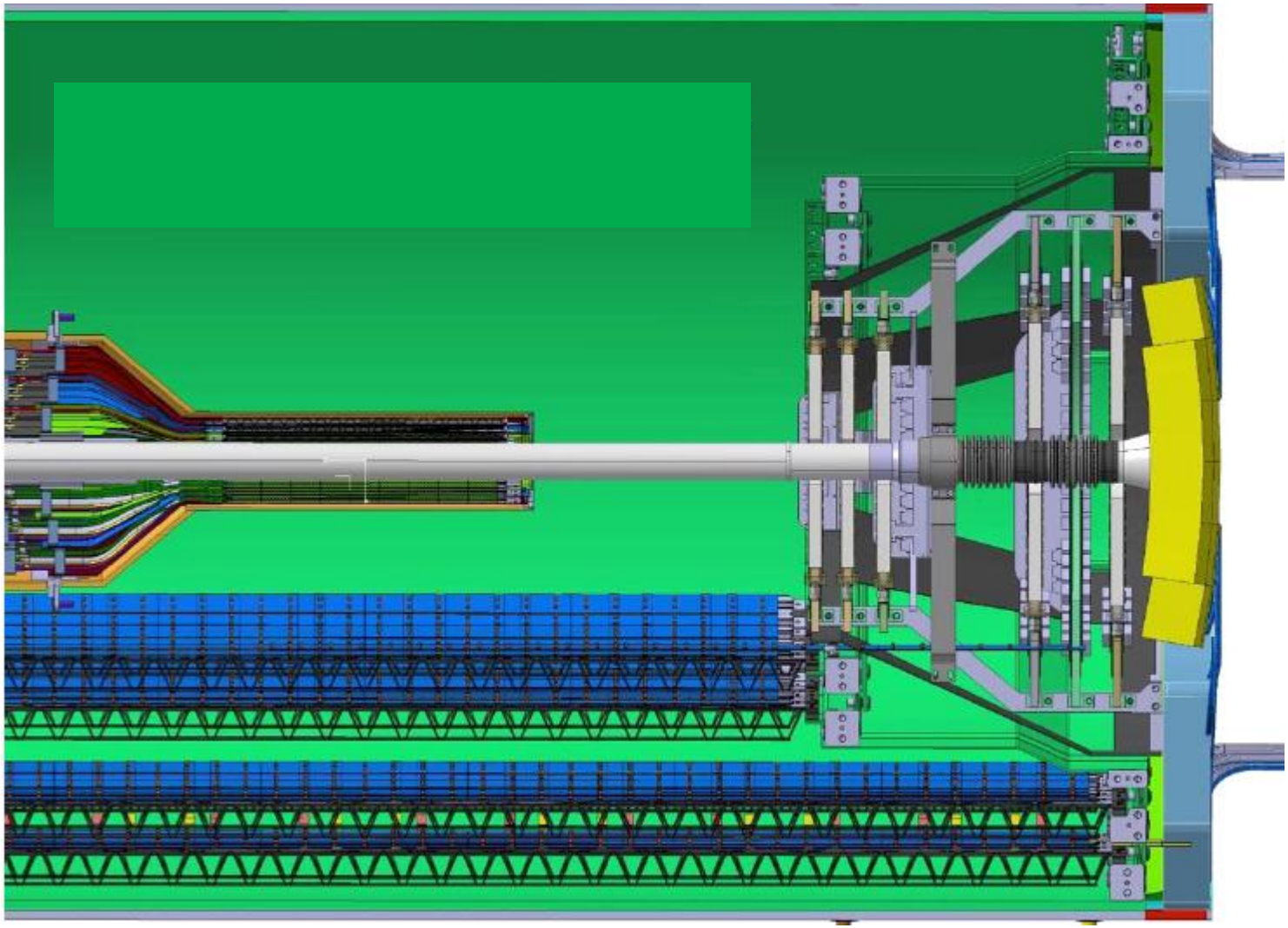

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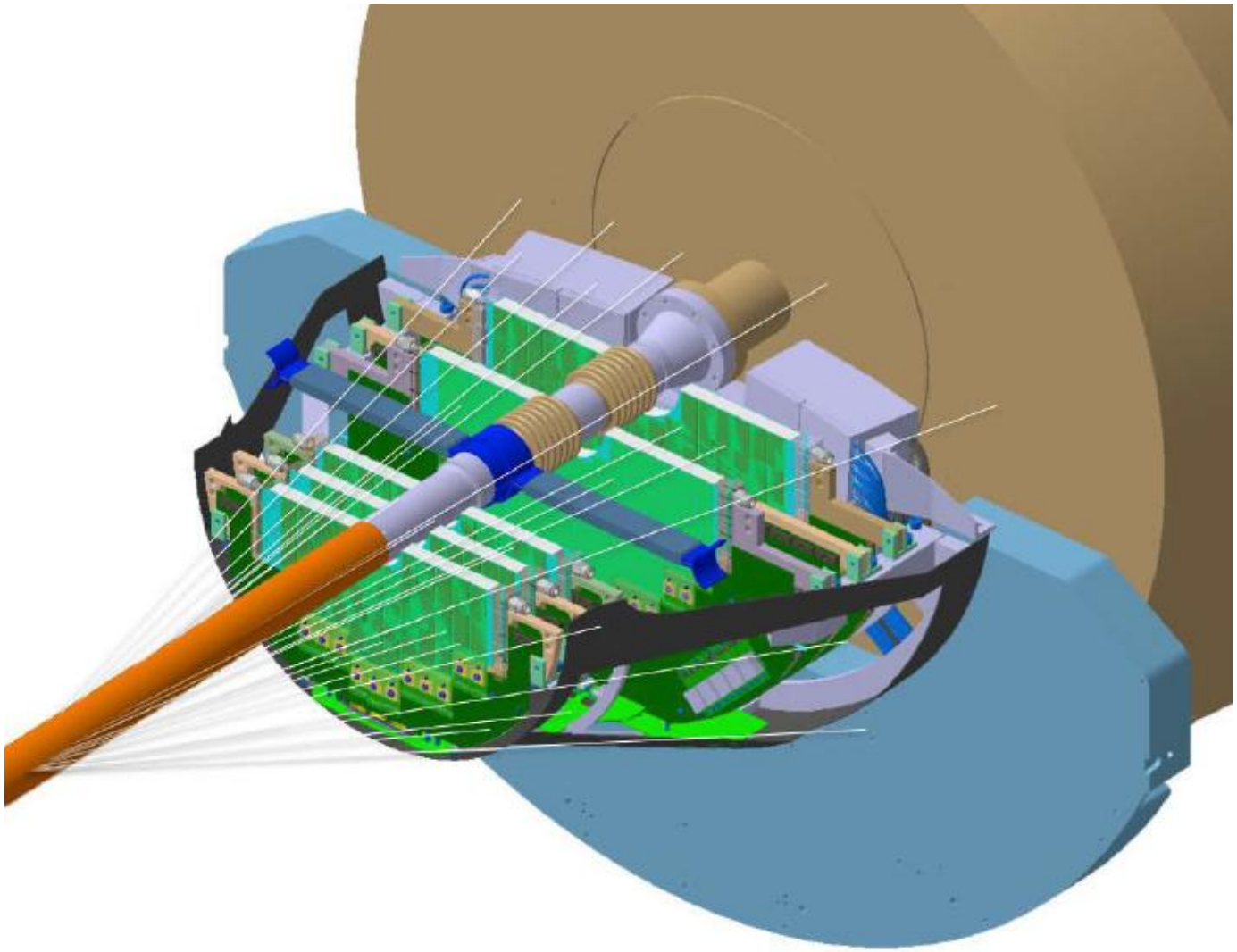

ALICE Diffractive

For proton-proton collisions, the total cross section:

$$\sigma_{Tot} = \sigma_{Elastic} + \sigma_{ND} + \sigma_{SD} + \sigma_{DD} + \sigma_{CD}$$

AD detector started operations in the LHC Run 2 in order to improve the physics diffractive capabilities of the ALICE experiment.

AD is composed of two stations, each one consisting of 2 layers with 4 scintillator pads each.

The scintillators are coupled to a PMT through a wave lenght shifting bar and an array of clear optic fibers.

Upgrade foreseen: more stations along the beam pipe to increase acceptance.

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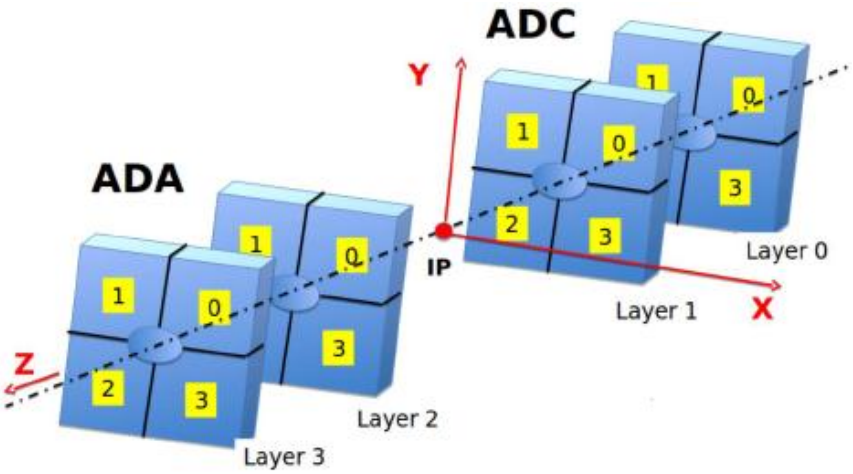
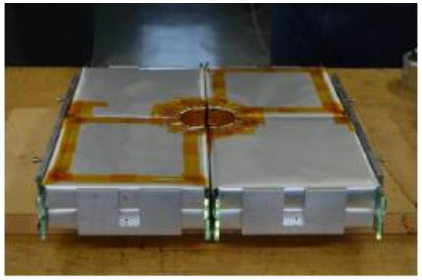
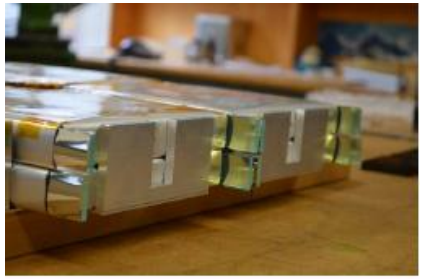
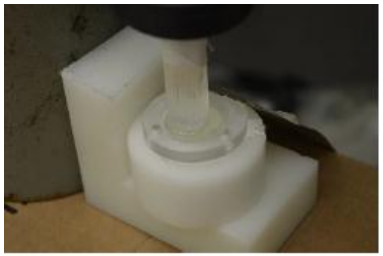
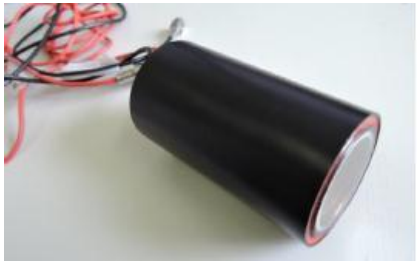










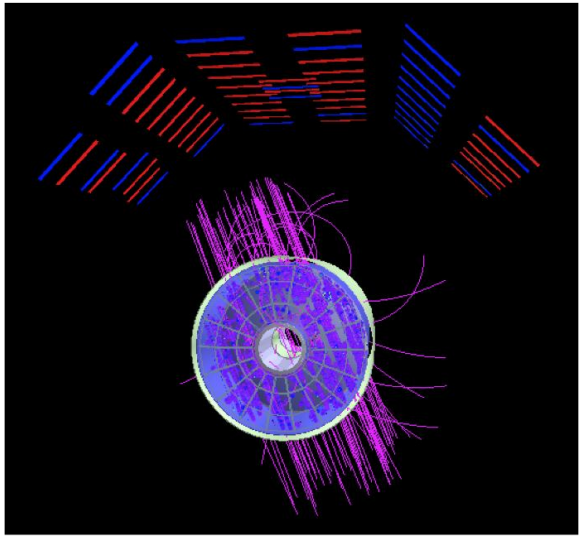
ACORDE & TPC

ACORDE is an assemble of 60 scintillator modules located on top of the L3 magnet. Designed for cosmic ray physics.

Upgrade foreseen: replace scintillators with RPCs.

TPC: charged particles ionize the gas so the e's drfit to the end plates (MWPC). Here, the ions produced are prevented from getting to the main drift volume by means of a gating grid.

This mechanism limits the RO rate of the TPC to 3.5 kHz, well below the desired 50 kHz RO in Pb-Pb.



New TPC: eliminate the gating grid by exploiting the low Ion Back Flow (IBF) of Gas Electron Multipliers (GEM). R&D: 4 GEM chambers stack with different GEM whole patterns on each GEM helps to block the IBF.

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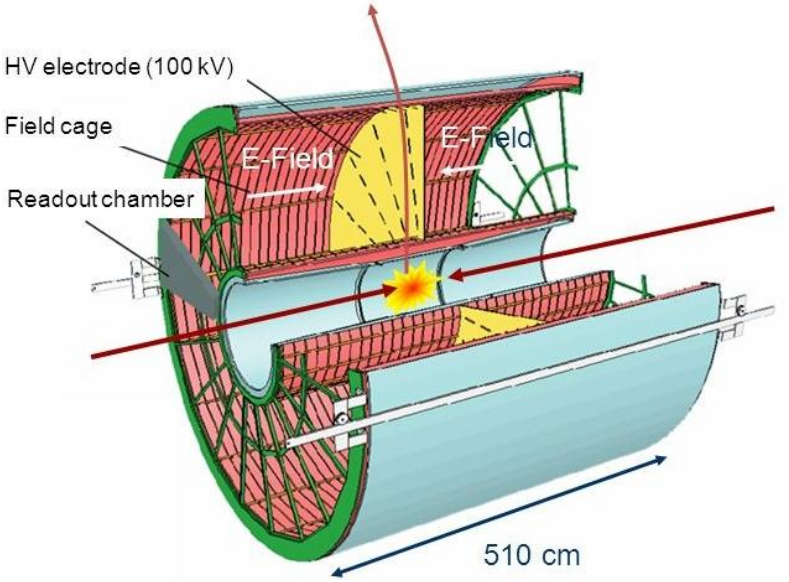

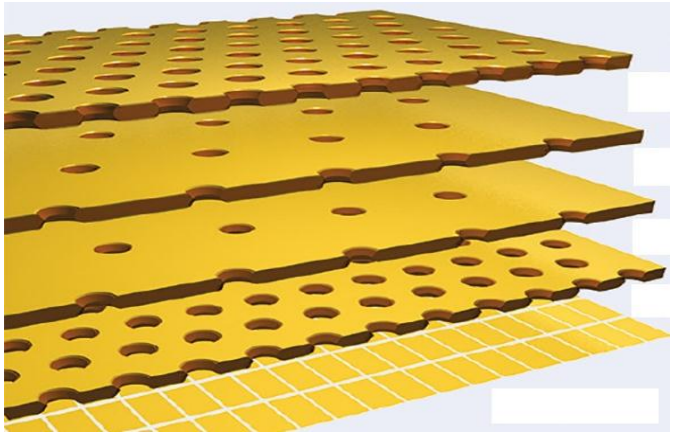

SUMMARY

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There are still many physics questions related to the QGP waiting for an answer. More data from heavy-ion collisions is needed.

The strategy of the ALICE Collaboration is to fully exploit the LHC and HL-HLC potential.

A major upgrade of the ALICE experiment is planned for the long shutdown 2 (2019-2020).

The goal is to collect more than 10 nb^{-1} of Pb-Pb collisions during Run 3 and 4 (2021-2023 and 2026-2029) at an interaction rate of 50 kHz.

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Thanks for your attention

References

CERN-LHCC-2013-024

CERN-LHCC-2012-012

CERN-LHCC-2015-021

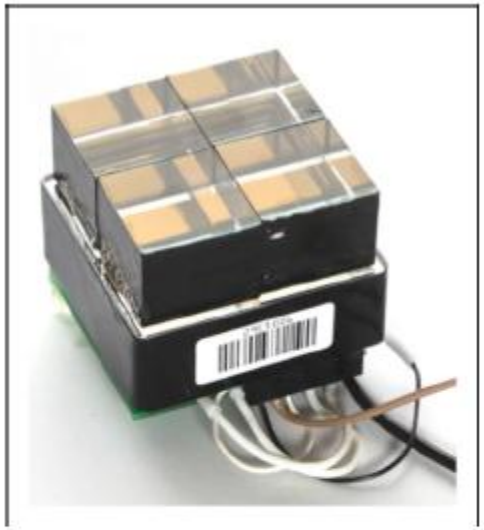
CERN-LHCC-2013-019

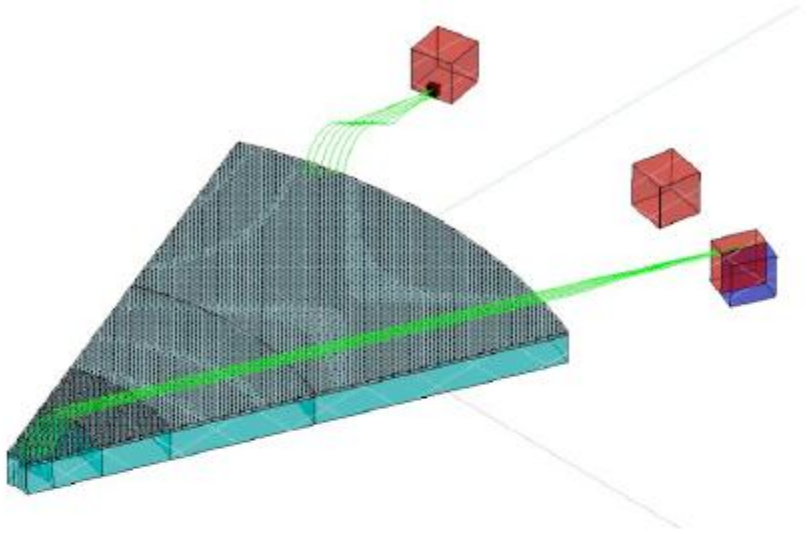
CERN-LHCC-2015-006

CERN-LHCC-2012-12

BACKUP

Fast Interaction Trigger





T0+ modules

- Improved T0
- Rectangular quartz radiators
- New sensors MCP-PMT
- Larger acceptance
- More channels
- Upgraded electronics and readout

V0+ sectors

- Improved V0
- Faster plastic scintillator
- Monolithic structure
- Reduced fiber length
- New sensor (SiPM or MCP-PMT)
- New electronics and readout