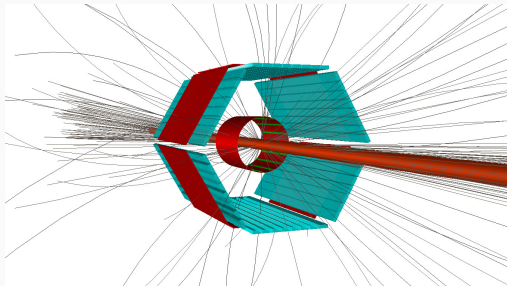# Phase Zero for the MPD at NICA

MexNICA + NICA-PL

V Collaboration Meeting of MPD@NICA, Apr. 24, 2020

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for the MexNICA+NICA-PL joint task force

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## Phase Zero for MPD-NICA

### Main goals are to provide

- feedback to NICA
  - $\rightarrow$ time scale: a few weeks during beam commissioning
  - $\rightarrow$ *real* collisions vs background (beam-gas, cosmics)
  - $\rightarrow$ beam lumi
- physics data for NICA
  - $\rightarrow$ total event multiplicity vs centrality
  - $\rightarrow$ total event energy vs centrality

- callibration test for MPD + NICA
  - $\rightarrow$ trigger/recon tests
  - $\rightarrow$ data aquisition tests
  - $\rightarrow$ MPD $\leftrightarrow$ NICA inter-connection tests
  - $\rightarrow$ slow control tests
  - $\rightarrow$ on-line/off-line data storage & processing tests
  - $\rightarrow$ safety systems tests

## How can we achieve this?

☑ MEXNICA + NICA-PL joint task force:
detectors, mechanics, electronics and simulations

☑ MPD Phase Zero, CDR in progress

☑ MPD Phase Zero preparations completly aligned with
those of MPD Phase-1: person-power, integration,
transference

<span style="color:red">MPD Phase Zero should tie seamlessly to
the natural progression towards MPD Phase-1</span>
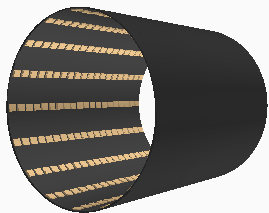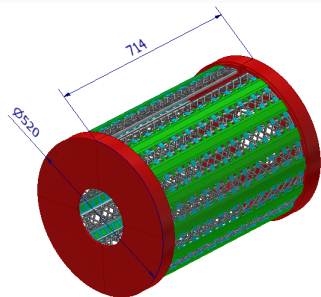
# MPD Phase Zero detector geometry
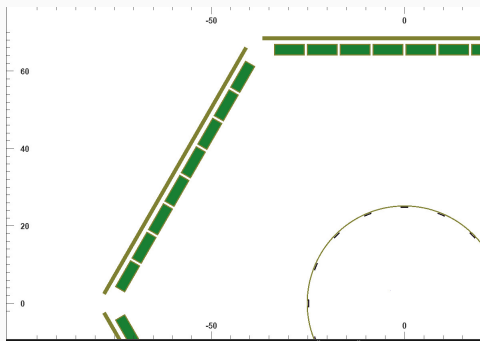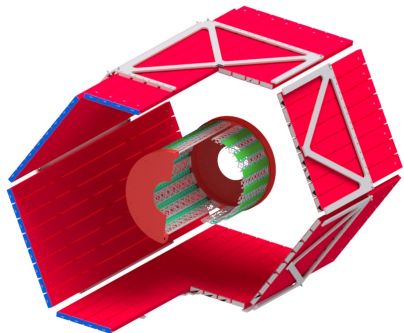


Inner detector → miniBeBe cylinder [71.4 cm length, 52 cm diameter]

Outer detector → 6 hexagonal MCORD sections [174 cm length, 65 cm distance (nearest surface)]

currently testing slight variations on this geometry

# MPD Phase Zero detector geometry - miniBeBe





**miniBeBe**

- external structure:
  520 mm external diameter
  714 mm external length

- sensitive section:
  16 strips 600 mm in length
  20 plastic scintillator
  $20 \times 20 \times 3$ mm$^3$ per strip
  4 SiPM coupled per cell
  Total: 320 cells, 1280 SiPM

- sensitive area of 128,000 mm$^2$

- total weight $\sim 4$ kg

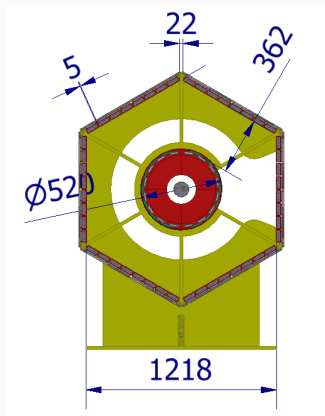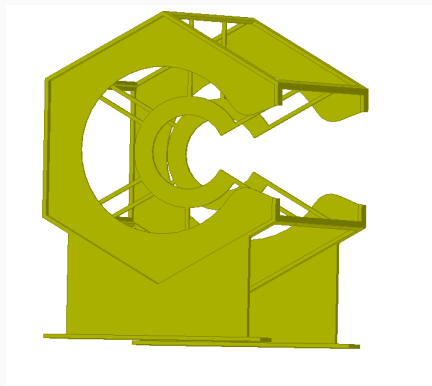# MPD Phase Zero detector geometry - MCORD
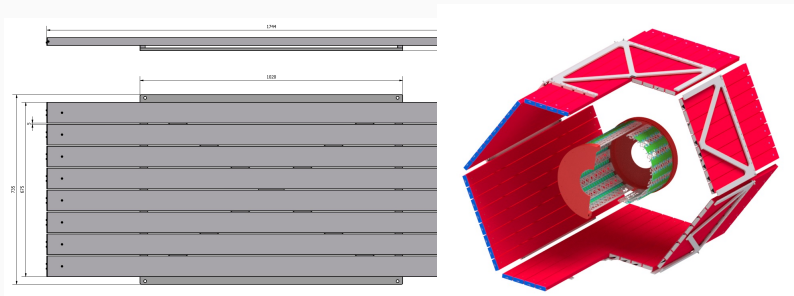


## MCORD

- 6 sections w/frame, each section 8 long slabs w/double-sided 3 mm SiPMs, 1 mm diameter WLS light-fiber for readout
- $1620 \times 74 \times 24$ mm$^3$ plastic scintillator per slab w/ $1744 \times 80 \times 30$ mm$^3$ aluminum cover
- each section has aluminum frame $1020 \times 735 \times 10$ mm$^3$
- one section weight $\sim 45$ kg

# MPD Phase Zero detector mechanical frame

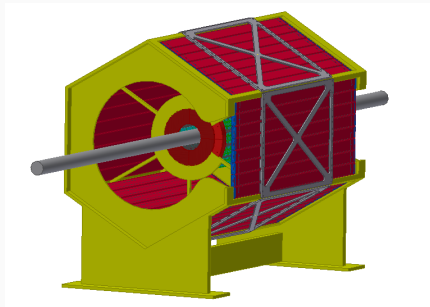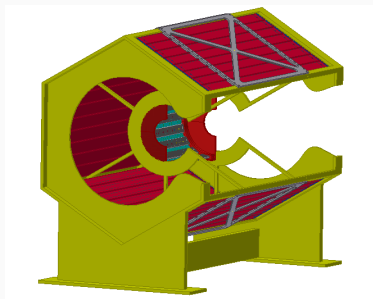**Currently testing mechanical set-ups, with general features:**

$\rightarrow$ minimally invasive and away from beam

$\rightarrow$ easiness in instalation and access

# MPD Phase Zero detector mechanical frame

Currently testing mechanical set-ups, with general features:

$\rightarrow$ minimally invasive and away from beam

$\rightarrow$ easiness in instalation, access and transfers

$\rightarrow$ one frame supports 5 MCORD sections and half miniBeBe
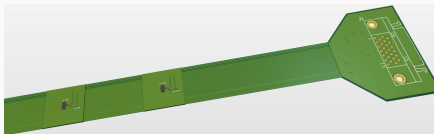
# MPD Phase Zero detector mechanical frame

Currently testing mechanical set-ups, with general features:

$\rightarrow$ minimally invasive and away from beam

$\rightarrow$ easiness in instalation, access and transfers

$\rightarrow$ easiness in removal and transference for Phase-1
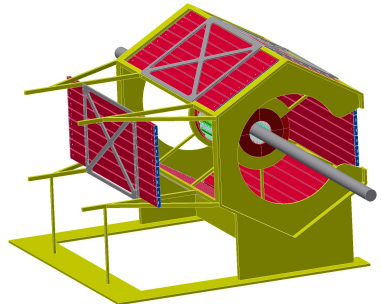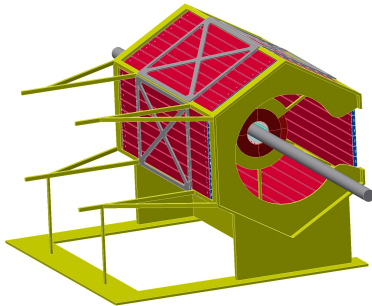
# MPD Phase Zero detector FEE - miniBeBe
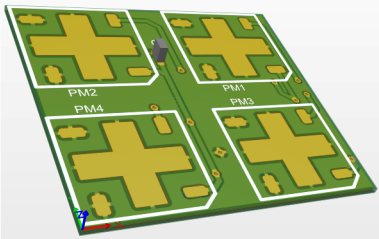




- 16 strips, 320 BC404+SiPM+circuit board (SFED)
  - → ribbon card 600 mm length
  - → designed to support up to 10 SFED
- area covered by the SFED card is 256,000 mm$^2$, 15 % of the total cylinder area.
- trigger signals collected with TRB3 FPGA card

Please see next presentations by
Eduardo Moreno on miniBeBe status

# MPD Phase Zero detector FEE - MCORD

- dedicated AFE assembly per 2 SiPM detectors
- CAN (protocol 2.0A) network connectivity with unique ID chip as CAN address
- low cost LDO instead of SMPS power supply
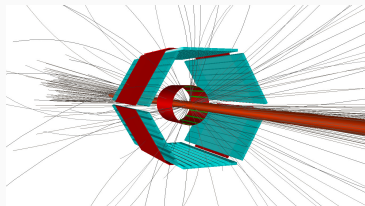- access to all settings and data from HUB via CAN-bus interface.
- protection for AFE
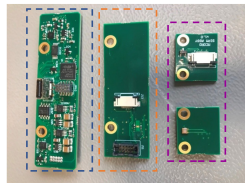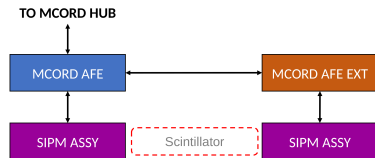
Please see next presentation by

Marcin Bielewicz on MCORD status

**Analog Front End**

# MPD Phase Zero - simulations

Simulate physical interaction of the particles produced in heavy-ion collisions at NICA energies with the sensitive volumes of miniBeBe and MCORD.                  [Au+Au @ 11 GeV, Bi+Bi @ 9 GeV]
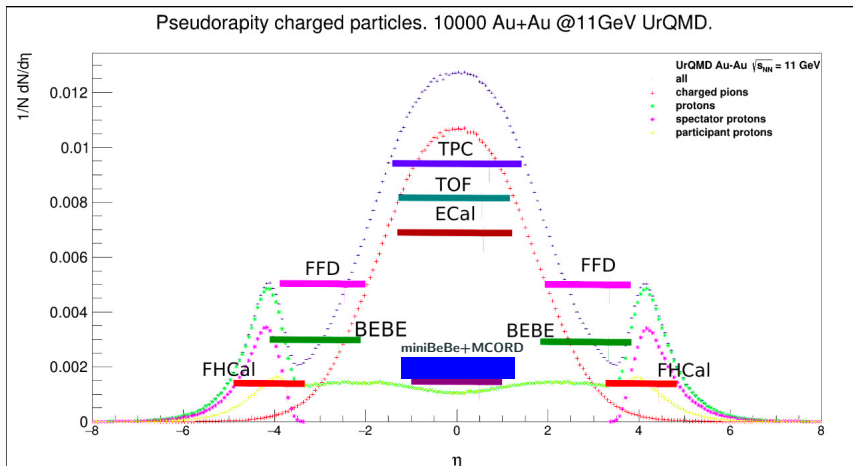


- hit in miniBeBe or MCORD: MC track enters active sensitive volume without any deposited energy restriction → $\eta$ coverage, hits & eloss

- simplest info: # hits/event → raw multiplicity vs centrality

- study different trigger options: beam-beam vs beam-gas

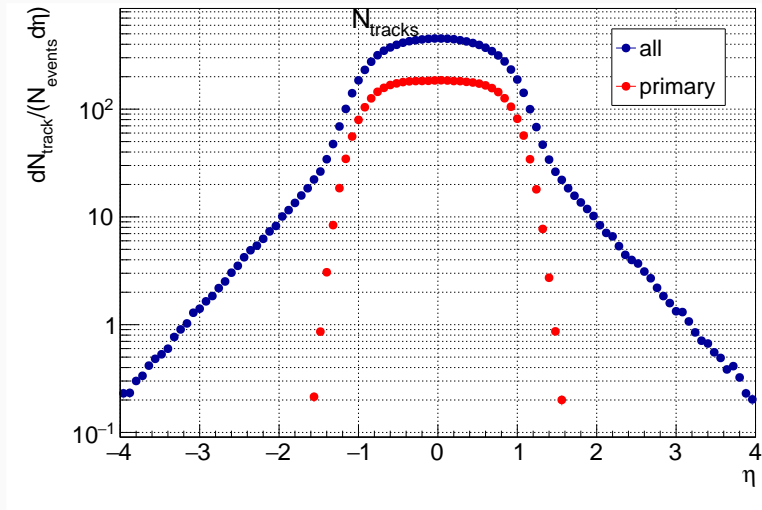Phase Zero MPD: miniBeBe+MCORD $\sim -1.1 < \eta < 1.1$



Pseudorapity charged particles. 10000 Au+Au @11GeV UrQMD.

# MPD Phase Zero detector $\eta$ distribution

miniBeBe + MCORD (hit), 6K 0-5% Bi-Bi @ 9 GeV
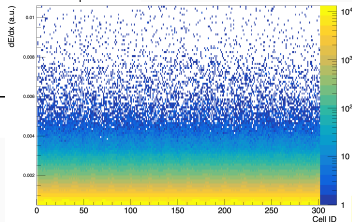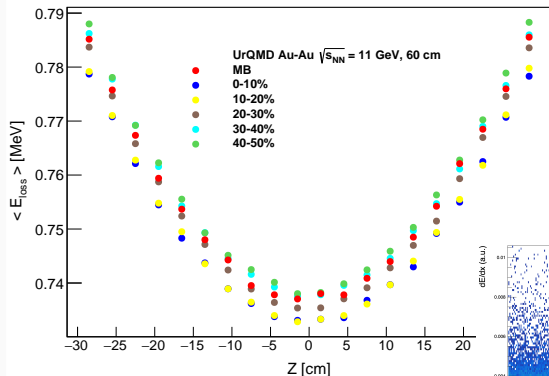
miniBeBe + MCORD (hit), 6K 0-5% Bi-Bi @ 9 GeV - no vx smearing

E-loss dist per track scaled by number of events/bin width
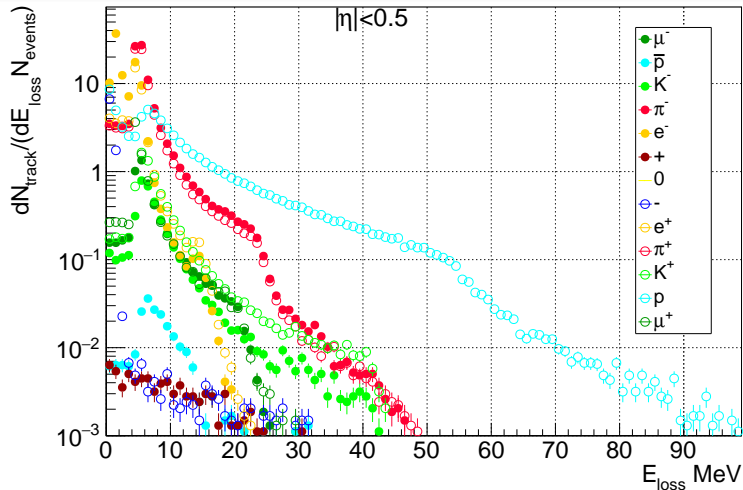
# MPD Phase Zero detector - $\langle$Hits$\rangle$, $\langle$E$_{loss}$$\rangle$, $\langle$ToF$\rangle$ /strip/cell

miniBeBe (hit) 1M 0-50% Au-Au @ 11 GeV $\qquad$ $\langle$E$_{loss}$$\rangle \sim 0.7 - 0.8$ MeV /hit
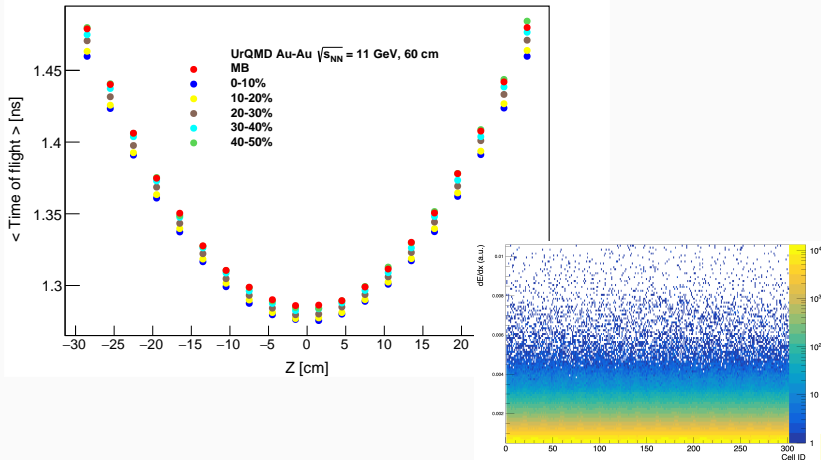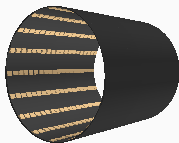
miniBeBe (hit) 1M 0-50% Au-Au @ 11 GeV          $\langle$ToF$\rangle \sim 1.3 - 1.5$ ns /hit
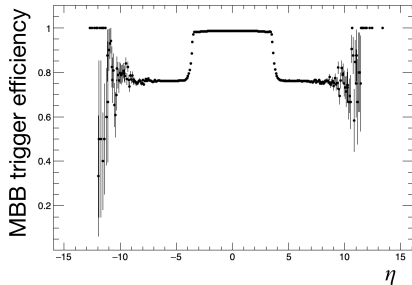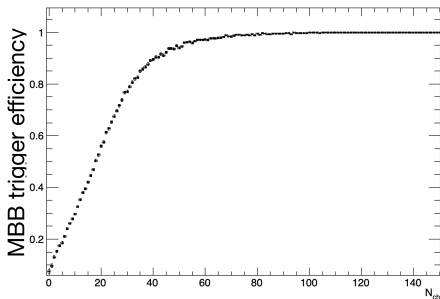
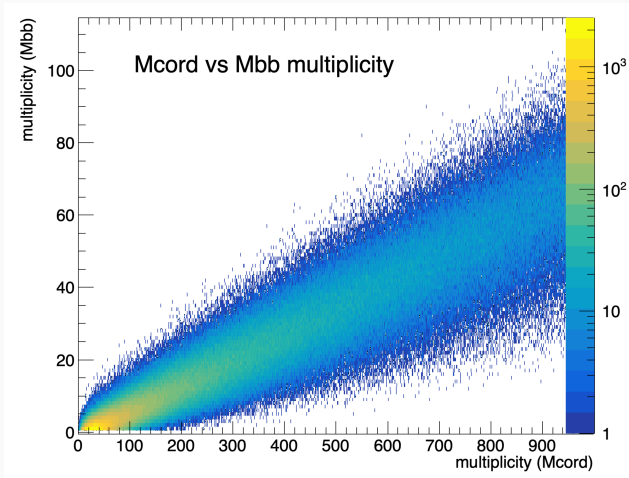# MPD Phase Zero detector - miniBeBe trigger efficiency



→ trigger definition: at least one hit in miniBeBe (like minimum bias)

miniBeBe is 100% efficient within its acceptance

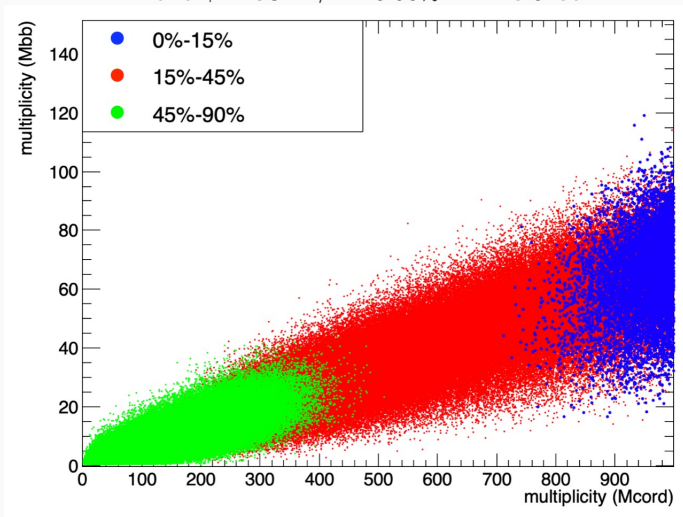# MPD Phase Zero detector simulations - multiplicity

miniBeBe + MCORD, 1M 0-90% Bi-Bi @ 9 GeV



Linear relation # hits miniBeBe vs MCORD → on-line centrality trigger?

# MPD Phase Zero detector - centrality
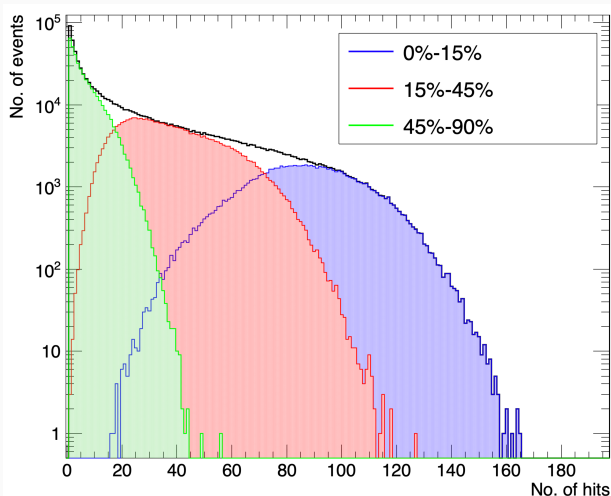


miniBeBe + MCORD, 1M 0-90% Bi-Bi @ 9 GeV

Centrality ranges: correlate the number of hits in miniBeBe and MCORD

# MPD Phase Zero detector simulations - centrality

Possible to construct an on-line centrality trigger for at least 3 centrality classes? → overlap corrected off-line during data analysis or data recon

miniBeBe + MCORD, 1M 0-90% Bi-Bi @ 9 GeV

# Final remarks

MPD Phase Zero: miniBeBe + MCORD

- ☑ **provide feedback, physics data to NICA and callibration tests for MPD+NICA**
- ☑ **MexNICA + NICA-PL joint task force: detectors, mechanics, electronics and simulations**
- ☑ **MPD Phase Zero CDR in progress**
- ☑ **MPD Phase Zero preparations completly aligned with those of MPD Phase-1: person-power, integration, transference**

## MexNICA & NICA-PL joint task force

☑ geometry and simulations, physics performance
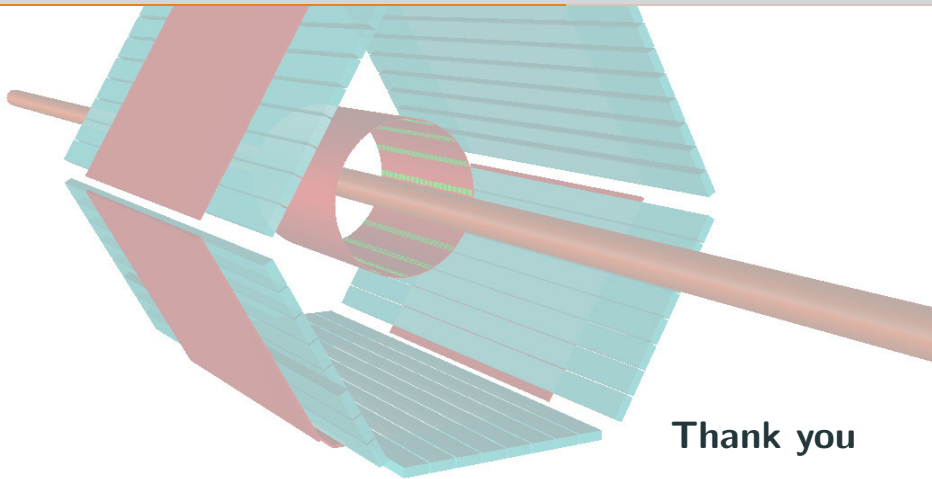
☑ mechanical support and front-end electronics

Alejandro Ayala, Eduardo Moreno
Mario Rodriguez, Maria Elena Tejeda
Lucio Rebolledo, Mauricio Alvarado
Luis Montaño, Enrique Patiño
Ramon Acevedo, Guillermo Tejeda
Isabel Dominguez, Pedro Nieto
Luis Valenzuela

Adam Kisiel, Marcin Bielewicz
Daniel Wielanek, Piotr Kolasinskipi
Lukasz Swiderski, Krystian Grodzicki
Grzegorz Kasprowicz

Please see next presentations by

Marcin Bielewicz on MCORD status

Eduardo Moreno on miniBeBe status

**Thank you**