Design and test-beam results from the FoCal-H demonstrator prototype

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on behalf of ALICE Collaboration
Outline

• FoCal detector for ALICE Upgrade
• 2021 FoCal-H prototype
  – Design and performance
• Preliminary results and MC studies
• Summary and conclusions
ALICE Upgrade - FoCal

**FoCal-E**: high-granularity Si-W sampling sandwich calorimeter for photons and $\pi^0$.

**FoCal-H**: conventional metal-scintillator sampling calorimeter for photon isolation and jets.

$3.4 < \eta < 5.8$
ALICE Upgrade - FoCal

Explore the small-x structure of nucleons inside nuclei down to Bjorken-x of $\sim 10^{-6}$

Observables in $3.4 < \eta < 5.8$
- $\pi^0$ and other neutral mesons
- Isolated (direct) photons
- Jets
- $J/\psi$ and other quarkonia correlations
- UPC Physics
**FoCal-H 2021 Prototype**

- **Spaghetti-type calorimeter**
  - capillary tubes concept by the IDEA collaboration

- **Quadrangular prism**
  - Copper tubes OD – 2.5mm, ID - 1.2mm
  - Scintillator fiber - diameter 1.0 mm
  - 95 x 95 x 550 mm$^3$
  - 36 x 40 = 1440 scintillating fibers

- **2021 Readout system**
  - Onsemi MICROFC-60035-SMT-TR1 SiPMs with 35 µm cell
  - Two CAEN A1702 boards used
  - 32 channels each
    - 48 active during TestBeam
  - 12 bit ADC, measures only the total charge per channel
    - 1 ADC for all channels
  - DATA transfer via Ethernet
  - Root based software for DAQ
  - Focus on readout of central 32 channels
FoCal-H 2021
Prototype TestBeam

SPS H6 Beamline
EHN1 (building 887, Preveissin site), CERN

- up to ~120 GeV
- 4 different systems
- various different configurations tested in 13 days
Focal-H 2021 Prototype Preliminary Results

- Particles traversing along the scintillating fiber - result as peak in the total energy distribution
- Change incident angle to reduce effect
- Reproduced in MC

- Charge reconstruction
- Beam energy dependence follow qualitatively expected trend
Monte-Carlo studies

- **GEANT4 based simulation**
  - Geometry and materials description
  - Physics list: FFTP_BERT (also QGSP_BERT checked)
  - Signal: energy deposit in the plastic scintillator fibers
  - Scintillation, light propagation, SiPM response, digitization - considered in an effective manner

- **Main goals**
  - Precise data analysis
  - Total charge studies
  - Saturation estimation
  - Beam decomposition

- **Tests for future prototype designs**
FoCal-H 2021 Prototype
Final results

- Electrons peak position in MC matches the DATA
- DATA total charge distribution described by a weighted sum of simulated $e$, $\pi$, $\mu$, $p$
- Consistency between MC and DATA
Prospects

- **PS TestBeam, 8 - 16 June 2022**
  - Readout studies
  - Work with additional detector system

- **SPS TestBeam, Autumn 2022**
  - 9 modules, 3x3 construction
    - Each module – 6.5 x 5.8 x 110 cm³
    - Capillary tubes, inner diameter 1.1mm, 596 * 1mm scintillating fiber
      - Shower containment
      - Energy resolution
      - Beam energy scanning
Conclusions

- The FoCal-H demonstrator prototype was assembled
- Stable operation and performance achieved during a test run in 2021
- Channeling verified and its effect is being evaluated
- MC description consistent with DATA
- Next prototype preparations are ongoing