



ALICE

CARLSBERG FOUNDATION<sup>†</sup>

UNIVERSITY OF  
COPENHAGEN



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

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on behalf of ALICE Collaboration

<sup>†</sup> CF21-0606, Hadronic  
Calorimeter for Forward  
Physics

CALOR 2020 – 19th International Conference on Calorimetry  
in Particle Physics  
University of Sussex, UK, 16-20 May, 2022



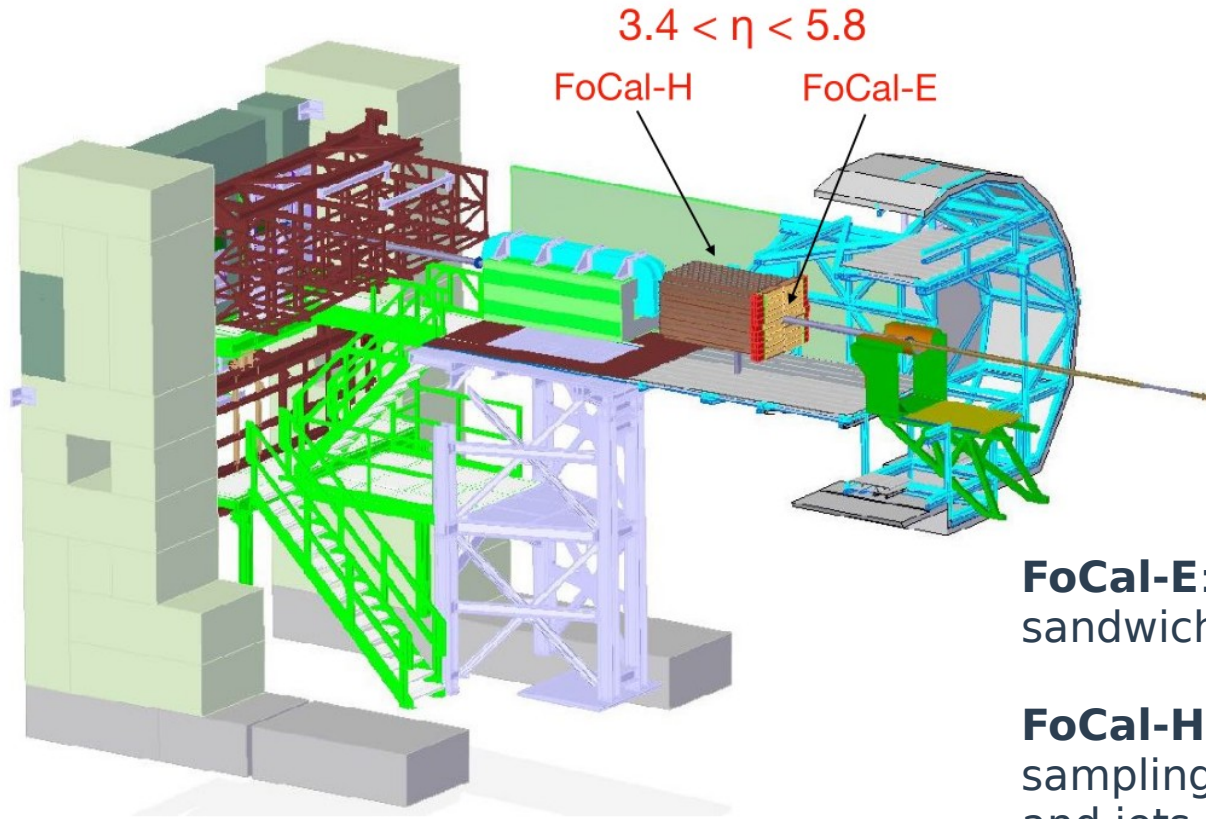
РЕПУБЛИКА БЪЛГАРИЯ  
МИНИСТЕРСТВО НА ОБРАЗОВАНИЕТО  
И НАУКАТА

\* partially supported by  
National Roadmap for Research  
Infrastructures – CERN  
D01-374/18.12.2020 г.

# Outline

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

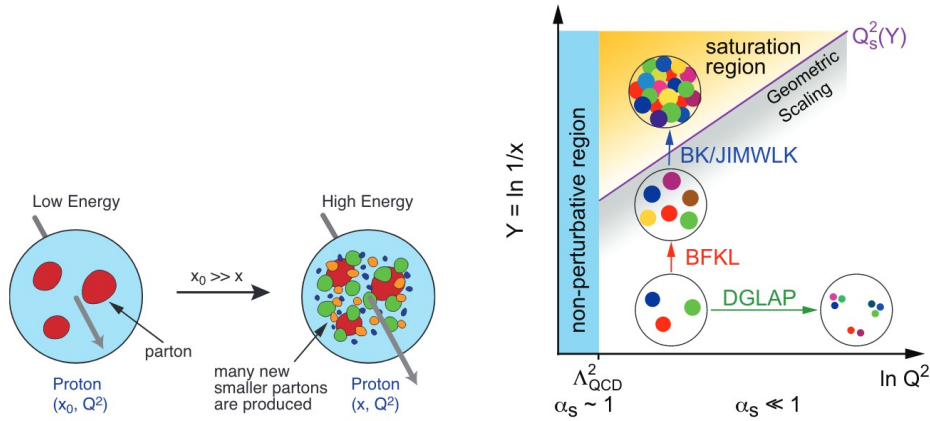
# ALICE Upgrade - FoCal



**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

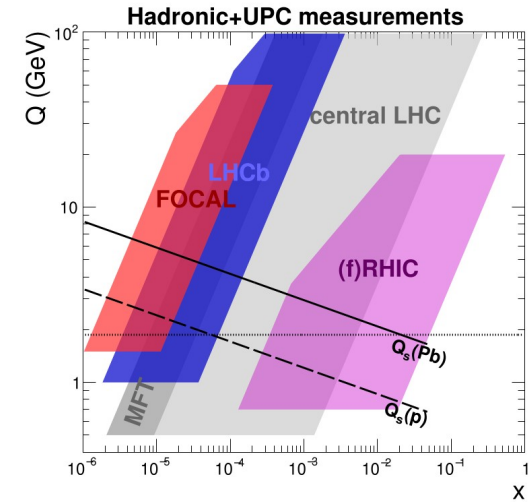
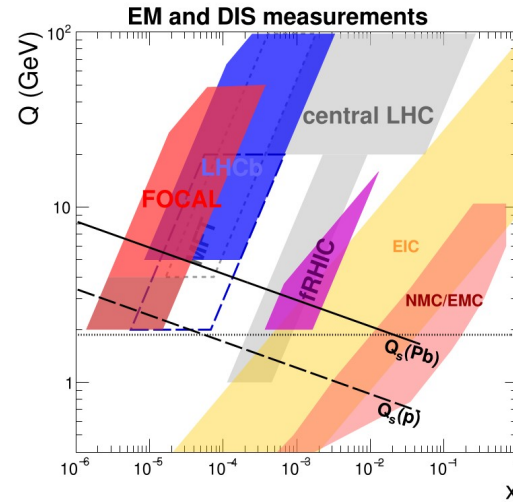
# ALICE Upgrade - FoCal



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

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



# FoCal-H 2021 Prototype

- Spaghetti-type calorimeter**

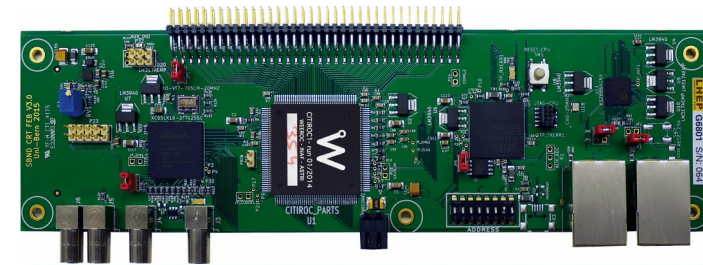
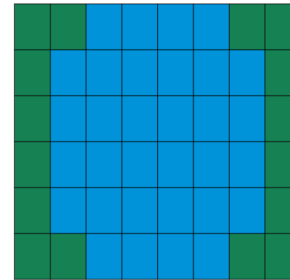
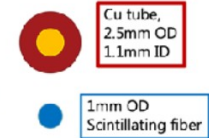
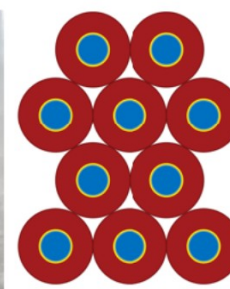
- capillary tubes concept by the IDEA collaboration

- Quadrangular prism**

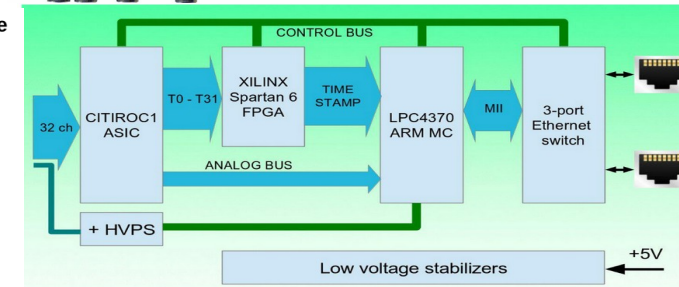
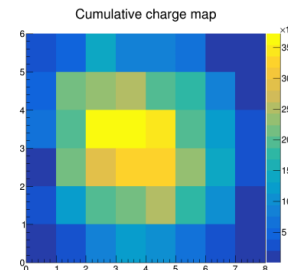
- Copper tubes OD - 2.5mm, ID - 1.2mm
- Scintillator fiber - diameter 1.0 mm
- 95 x 95 x 550 mm<sup>3</sup>
- 36 x 40 = 1440 scintillating fibers

- 2021 Readout system**

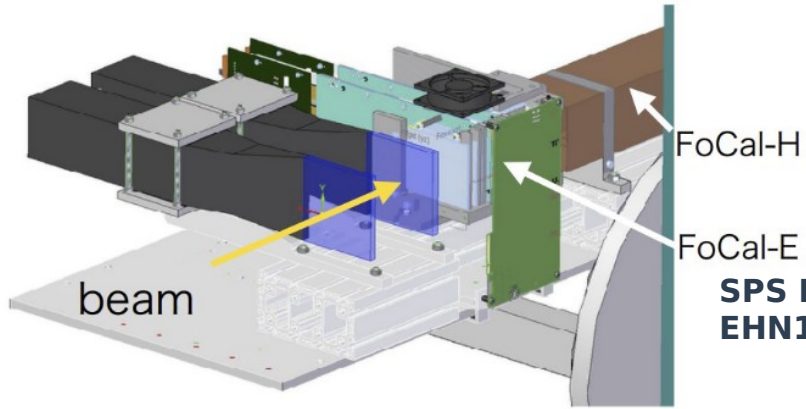
- Onsemi MICROFC-60035-SMT-TR1 SiPMs with 35 μm cell
- Two CAEN A1702 boards used
- 32 channels each
- 48 active during TestBeam
- 12 bit ADC, measures only the total charge per channel
  - 1 ADC for all channels
- DATA transfer via Ethernet
- Root based software for DAQ
- Focus on readout of central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



Run 2021\_10\_04\_13\_27\_35: 40 GeV, negative

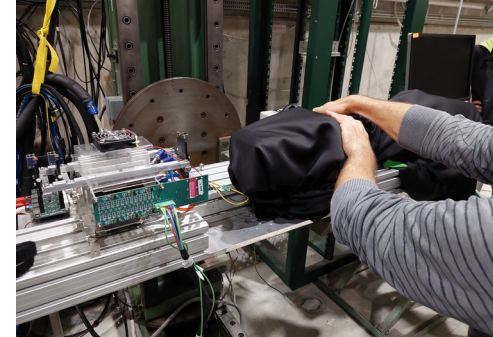
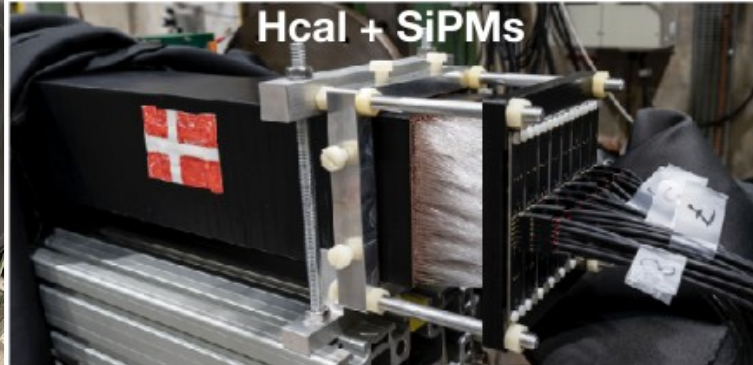
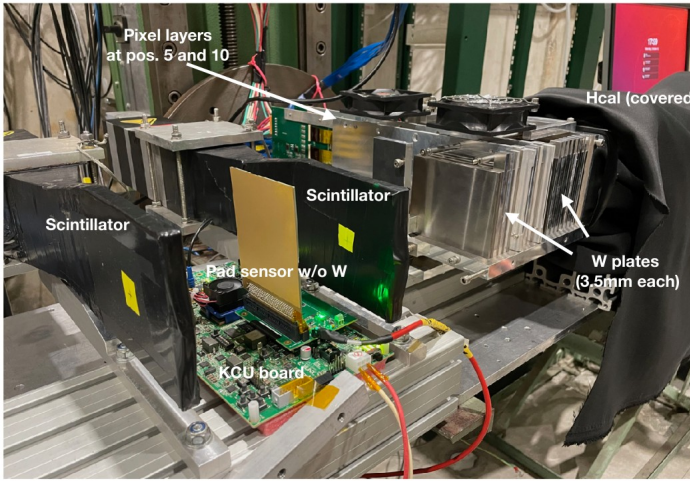


# FoCal-H 2021 Prototype TestBeam



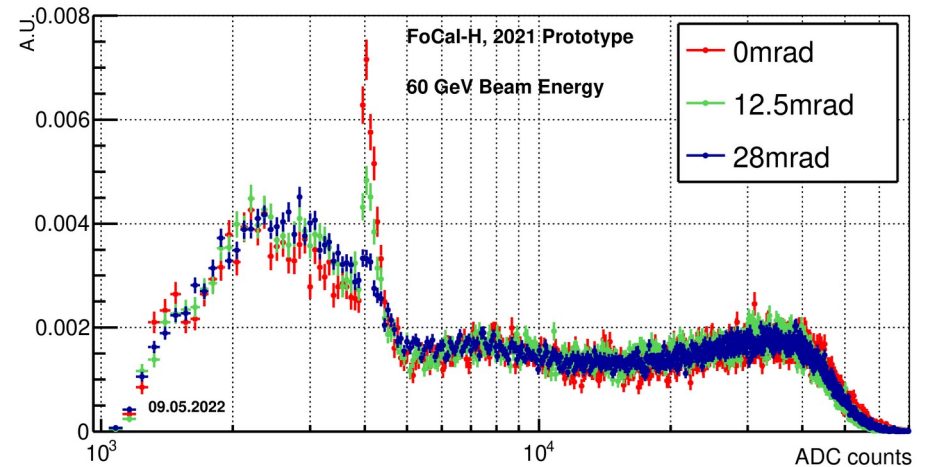
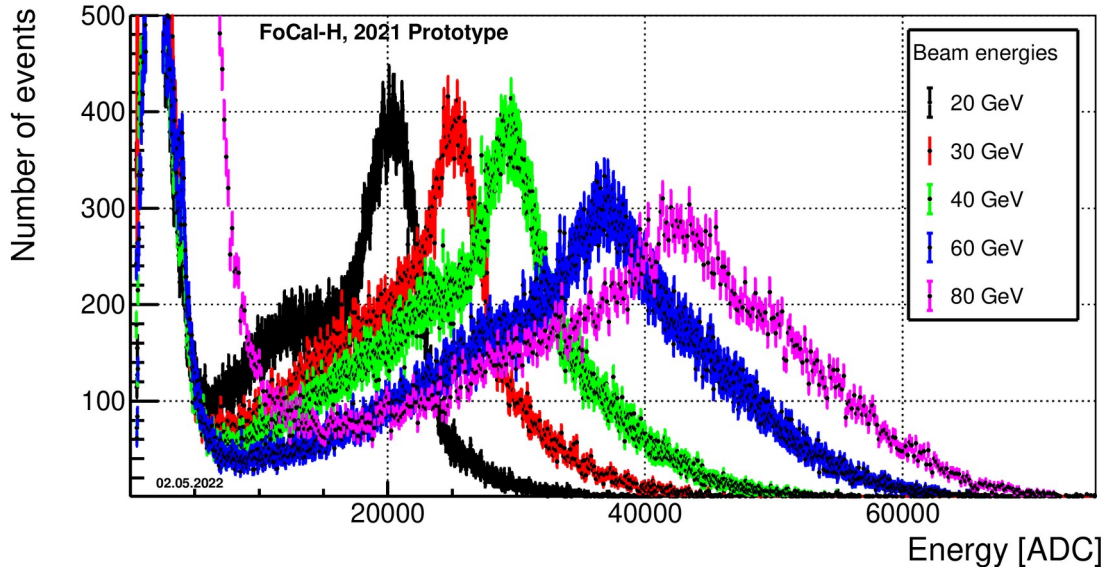
## SPS H6 Beamline EHN1 (building 887, Preveessin site), CERN

- up to  $\sim 120$  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

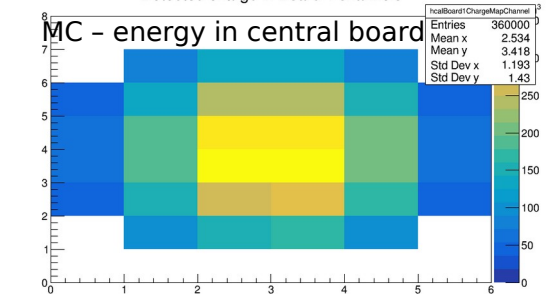
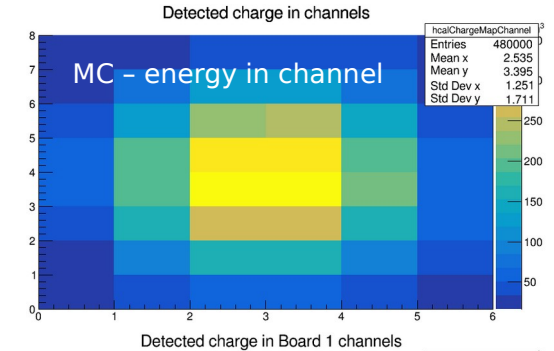
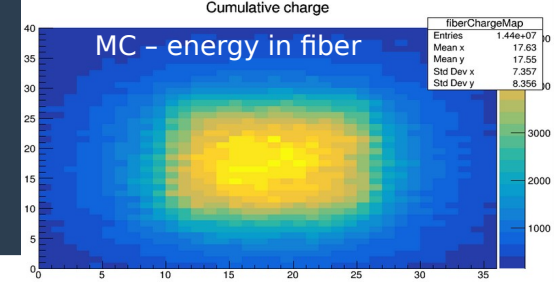
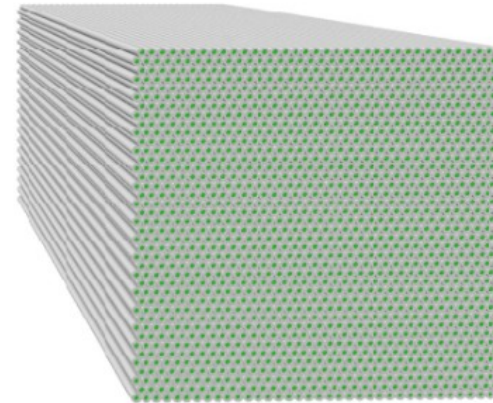
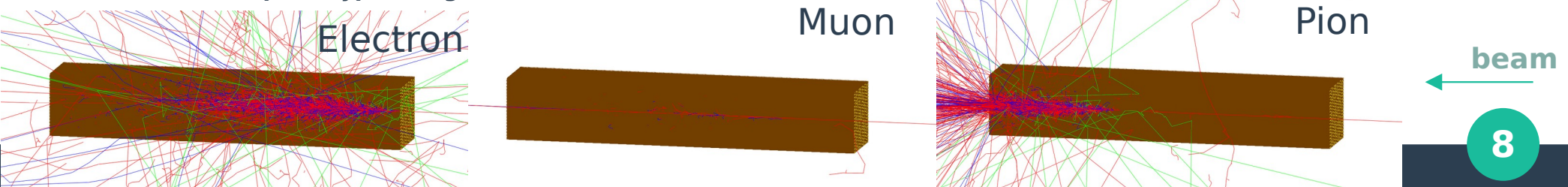
## • GEANT4 based simulation

- 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

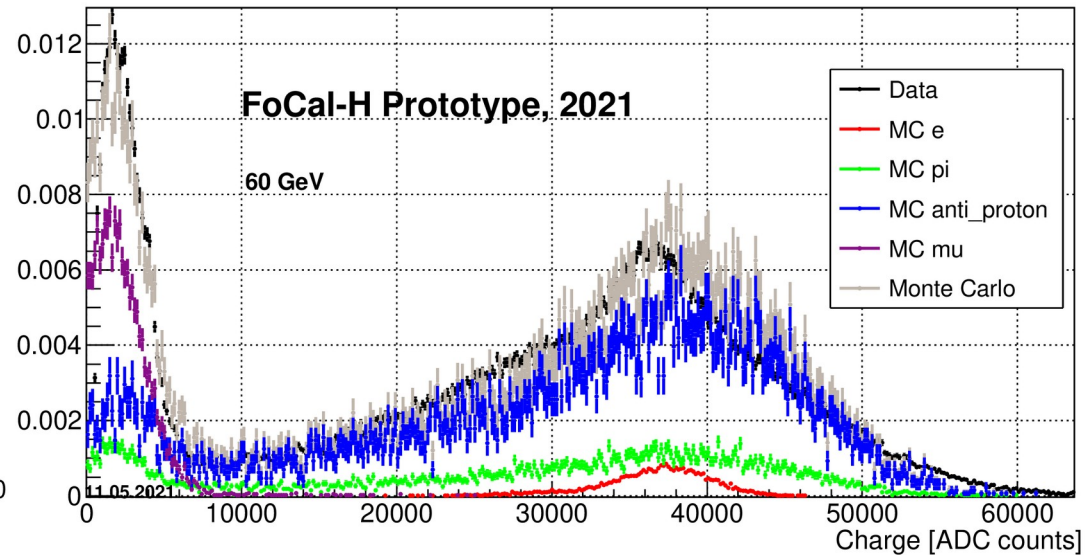
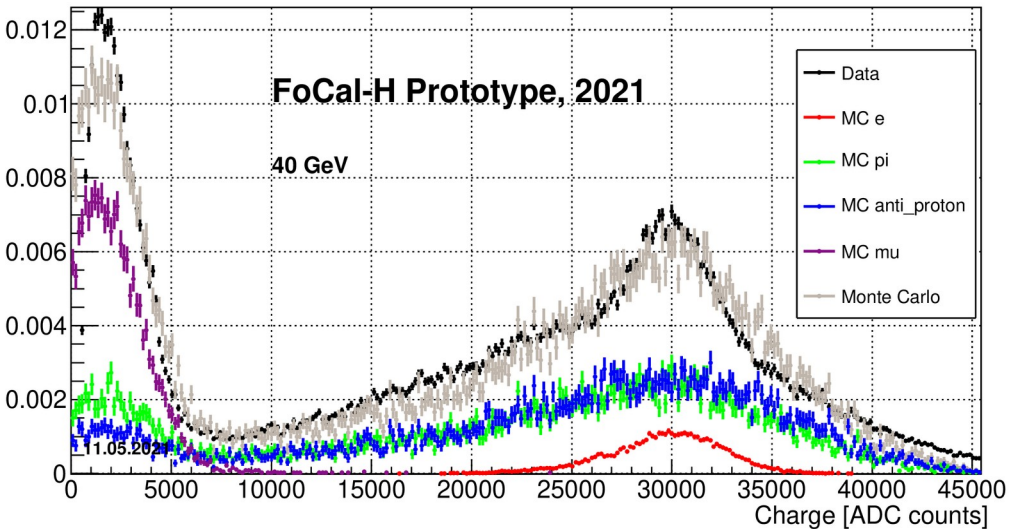
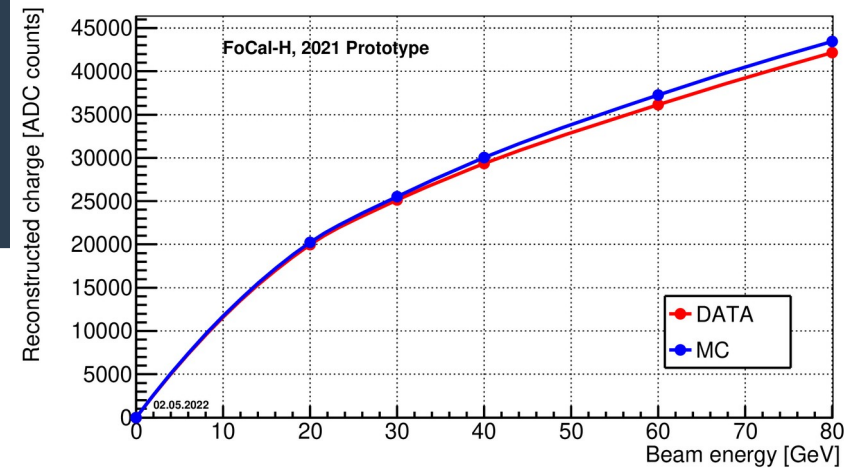
- precise data analysis
- total charge studies
- saturation estimation
- beam decomposition

## • 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

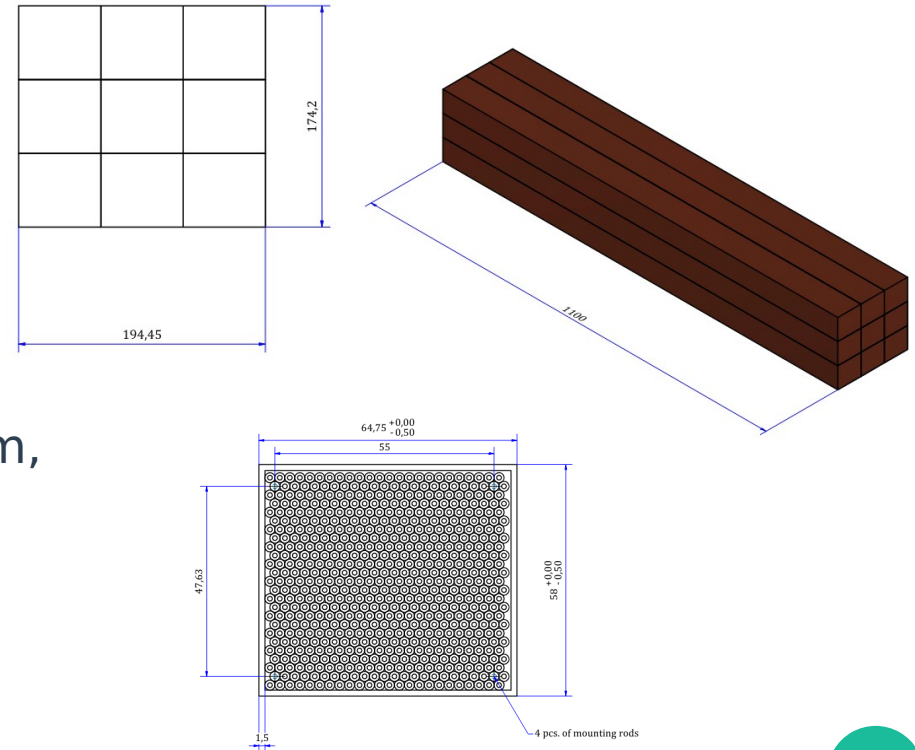
- **PS TestBeam, 8 - 16 June 2022**

- Readout studies
- Work with additional detector system

- **SPS TestBeam, Autumn 2022**

- **9 modules, 3x3 construction**

- Each module -  $6,5 \times 5,8 \times 110 \text{ cm}^3$
- 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**