SQM 2022

The ALICE FoCal

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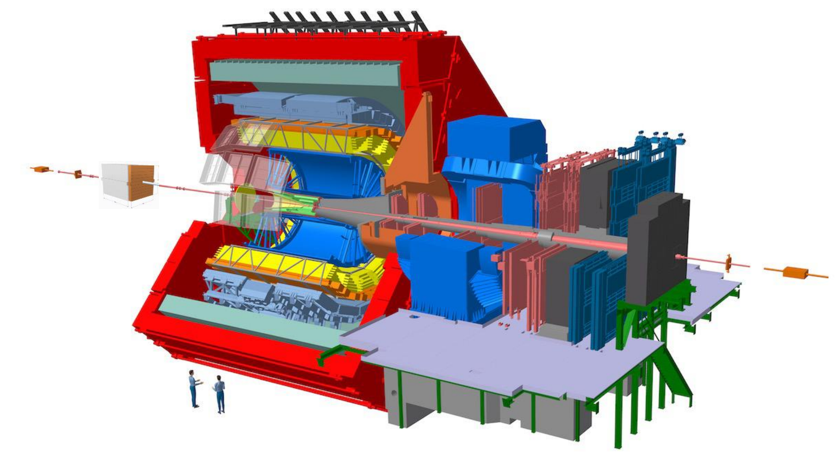
On behalf of the ALICE FoCal Project

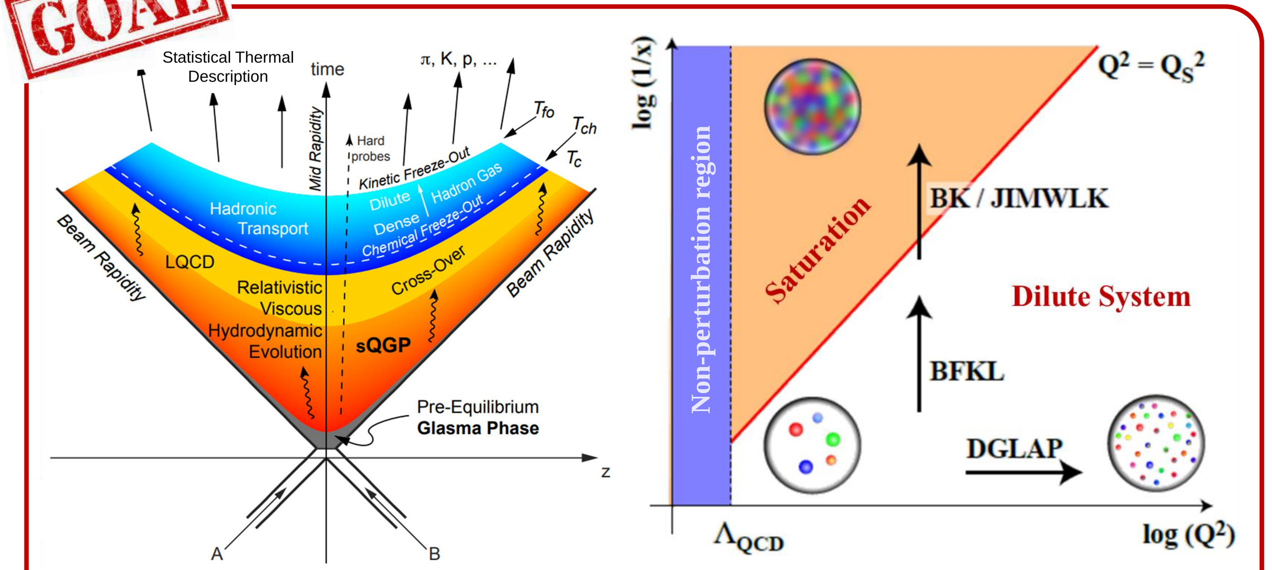


CERN ALICE

Physics Program

GOAL

CERN-LHCC-2020-009



NEED

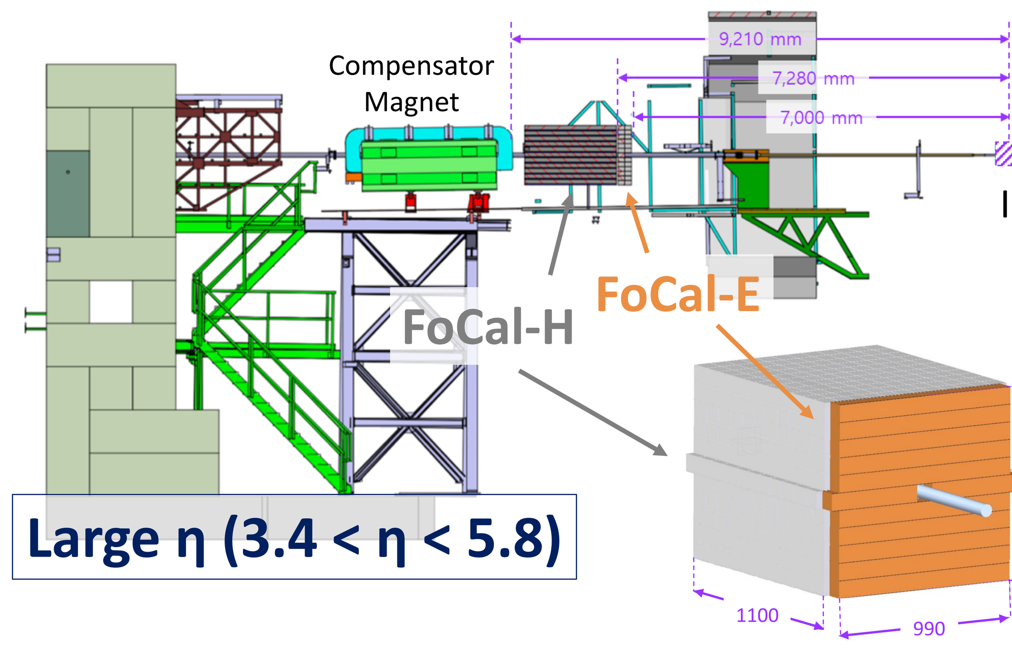
Explore small-x structure of nucleons down to 10^{-6}

(Observable) Main: direct photons

Complementary: π^0, Jets, Quarkonia, Z^0, $W^{\pm}$

FoCal uniquely placed to explore low-x physics over a broad range in Q^2 (Higher energy & Large η)

FoCal Detector Upgrade



Electromagnetic: FoCal-E

High-granularity & Compact Si-W sampling sandwich calorimeter

20 layers, each including

- 3.5 mm Tungsten (~ 1 X_0)
- Silicon Sensors

Hadronic: FoCal-H

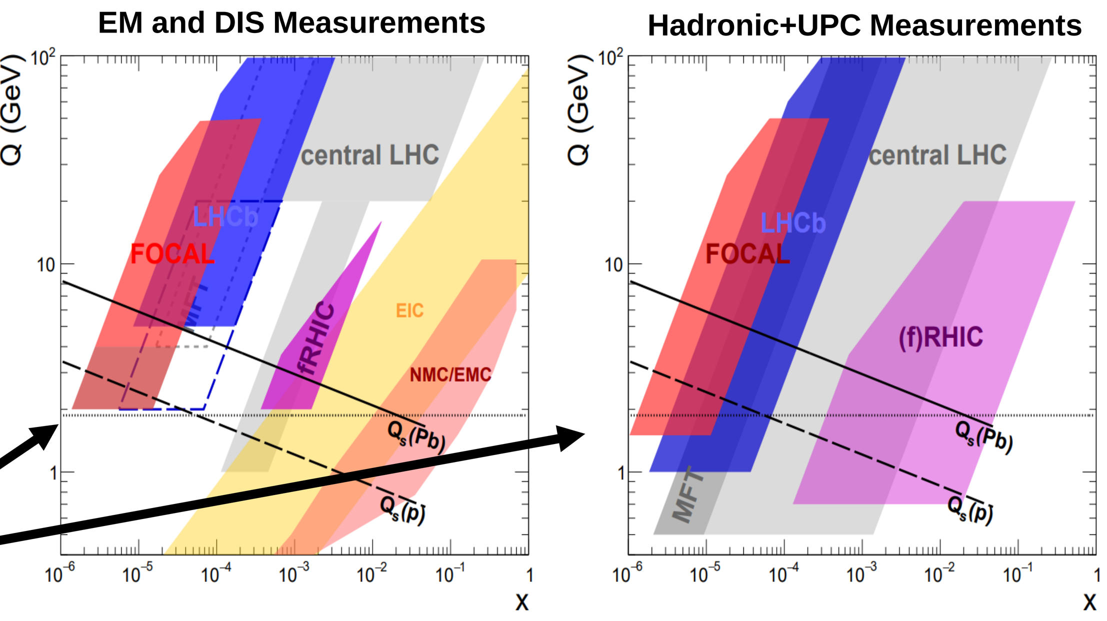
Conventional metal-scintillator sampling Calorimeter

CHALLENGE

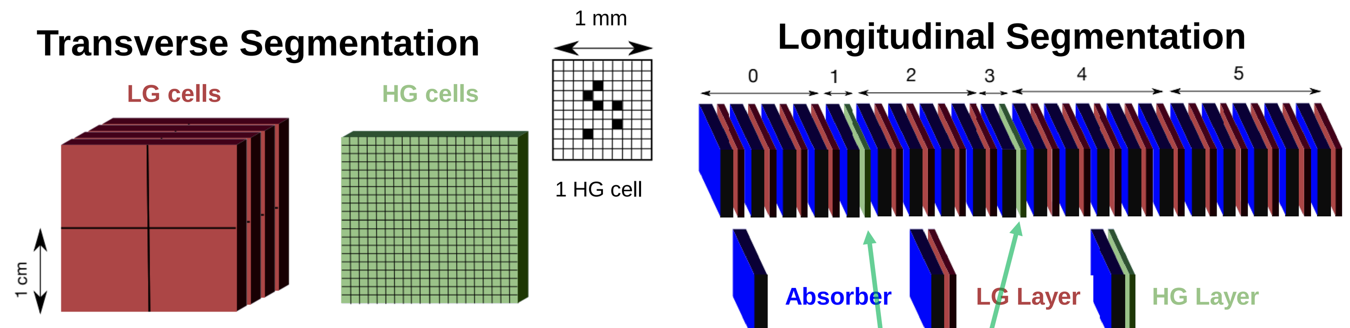
Separate γ from π^0 at large momentum

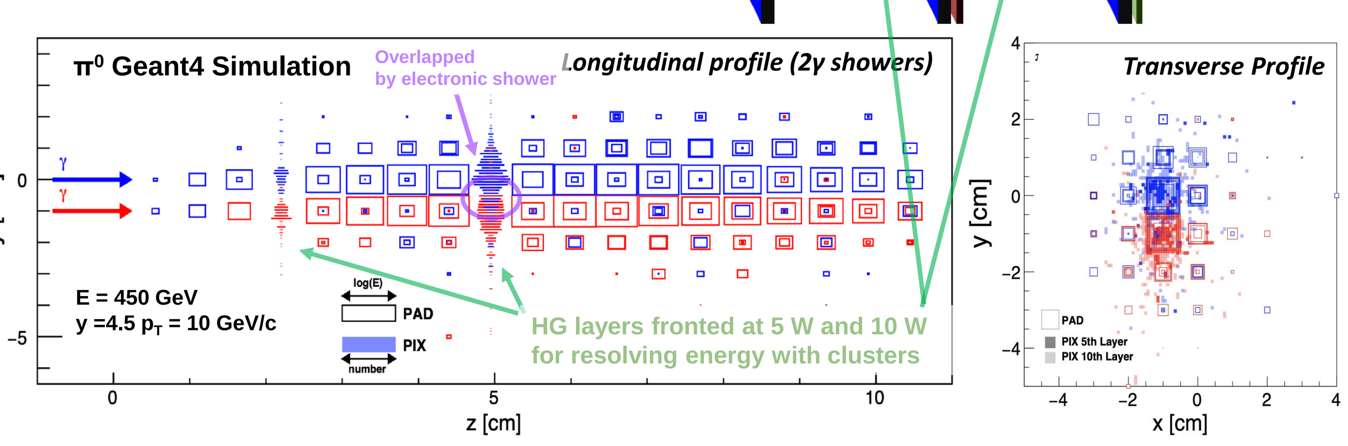
FoCal-E Hybrid Design

1. (LG cells) Silicon Pads with CMS HGCROC
   - provide shower profile, E_{total}, large dynamic range
2. (HG cells) ALPIDE CMOS pixels
   - position resolution to resolve overlapping showers



$$Q_s^2 \approx \frac{x g_A(x, Q^2)}{\pi R_A^2} \propto A^{1/3} x^{-\lambda} \qquad x \approx \frac{2p_T}{\sqrt{s}} \exp^{-\eta}$$

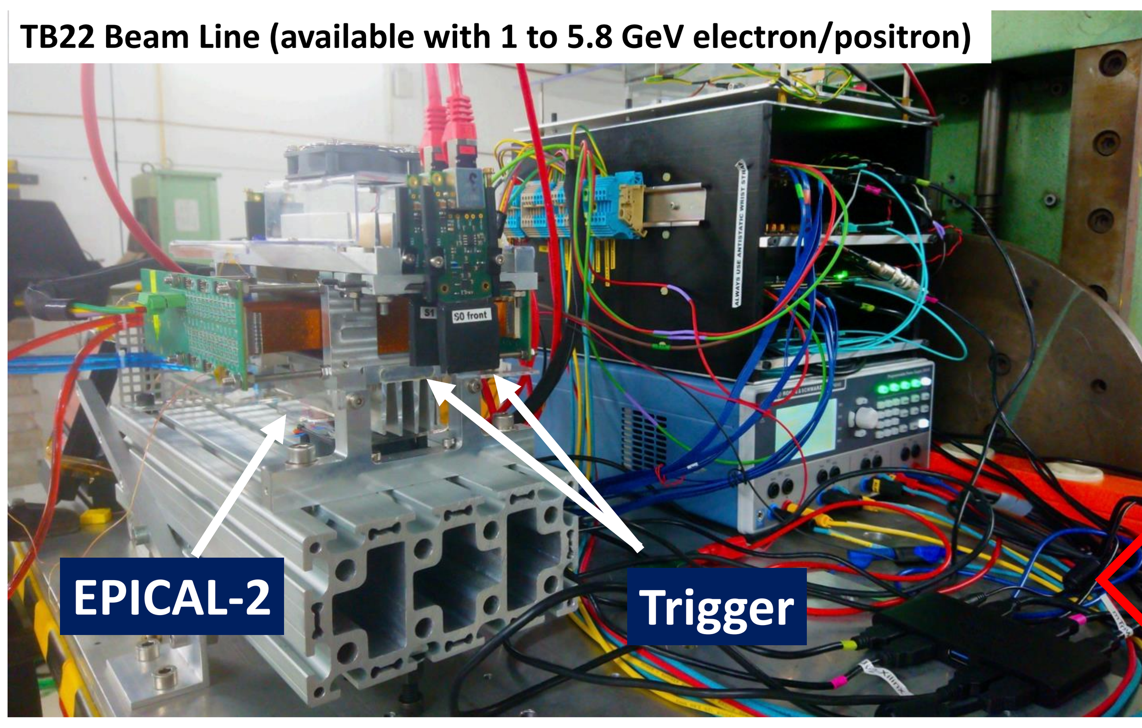




Prototype Tests

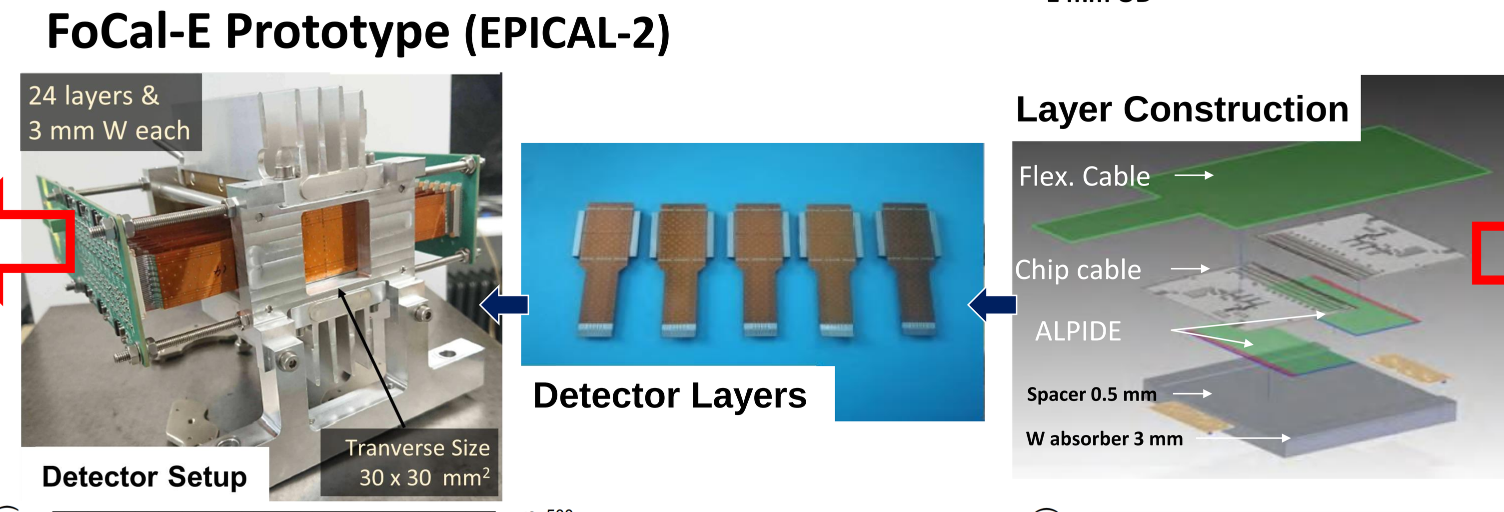
Beam Test at DESY (2019/2020)

TB22 Beam Line (available with 1 to 5.8 GeV electron/positron)



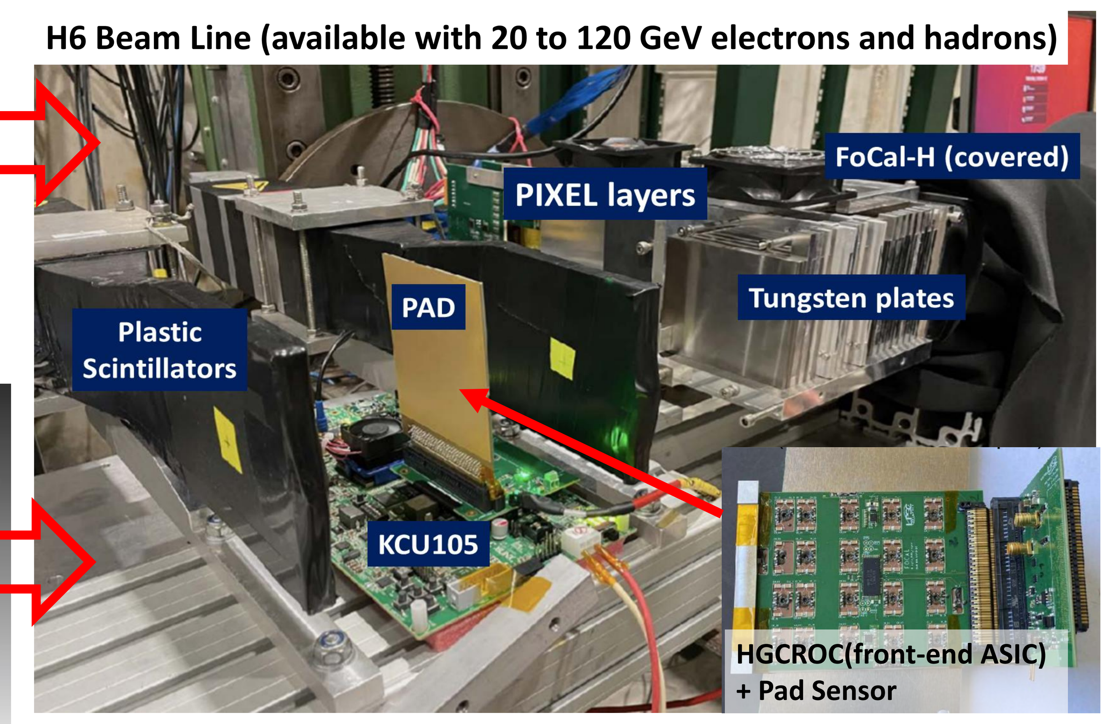
FoCal-H Prototype (Scintillation fibers + SiPM)

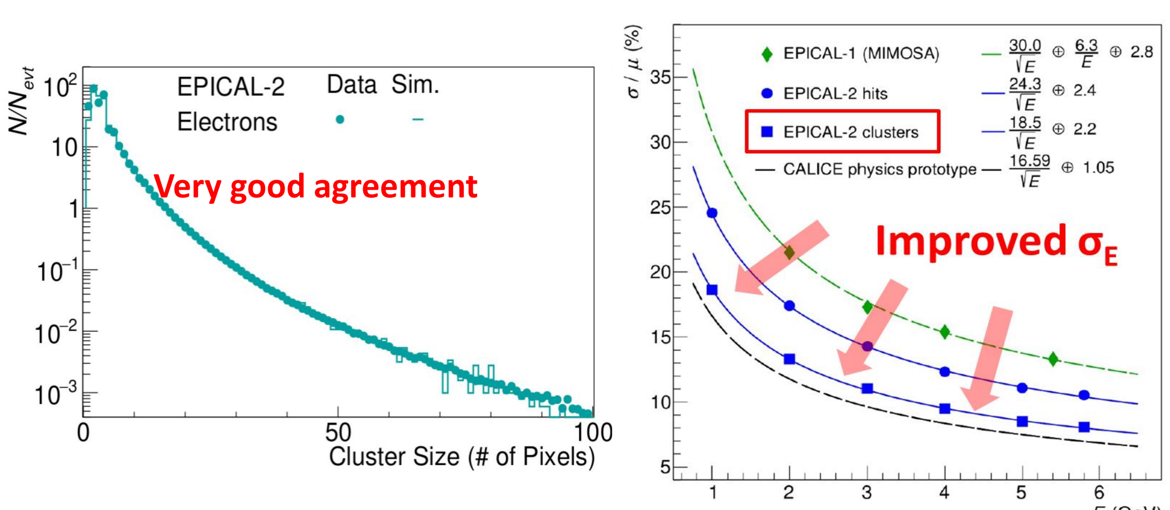
FoCal-E Prototype (EPICAL-2)

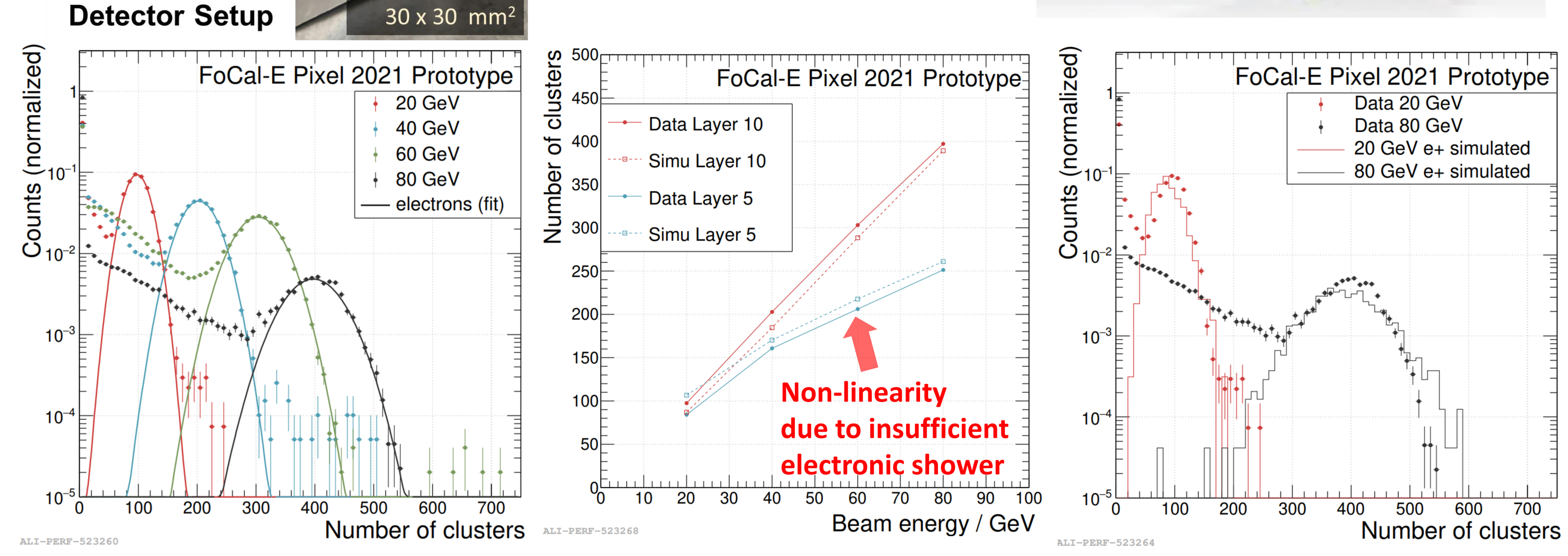


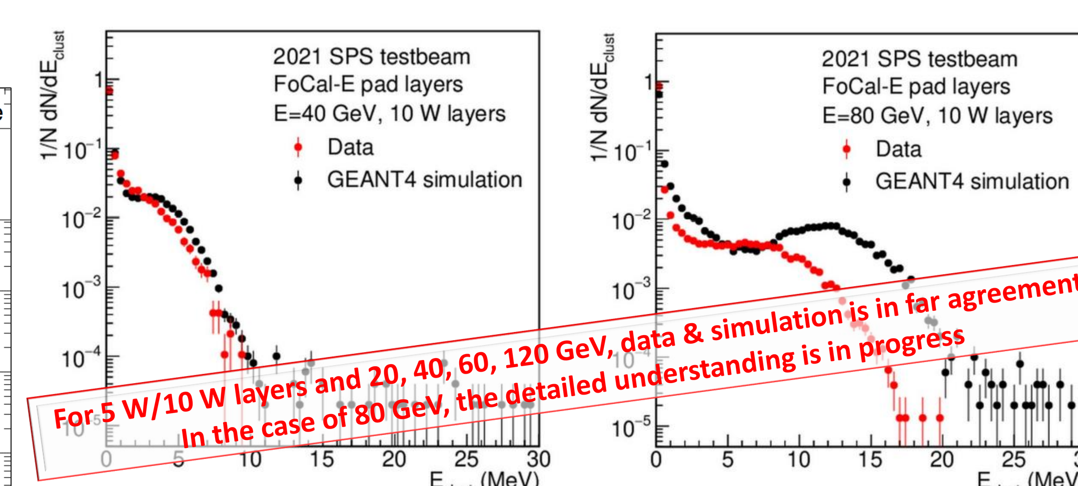
Beam Test at CERN SPS (2021)

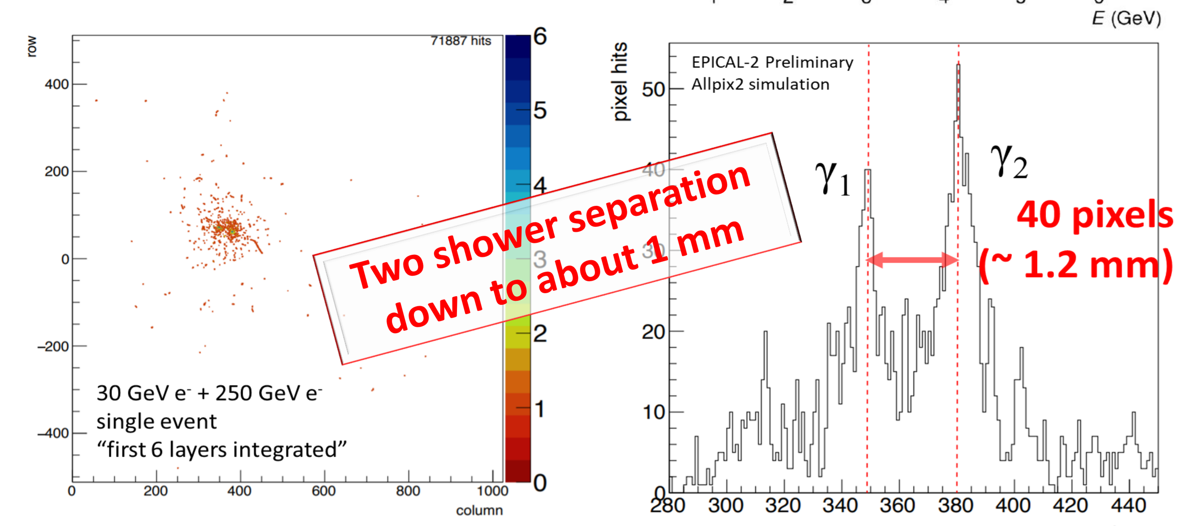
H6 Beam Line (available with 20 to 120 GeV electrons and hadrons)

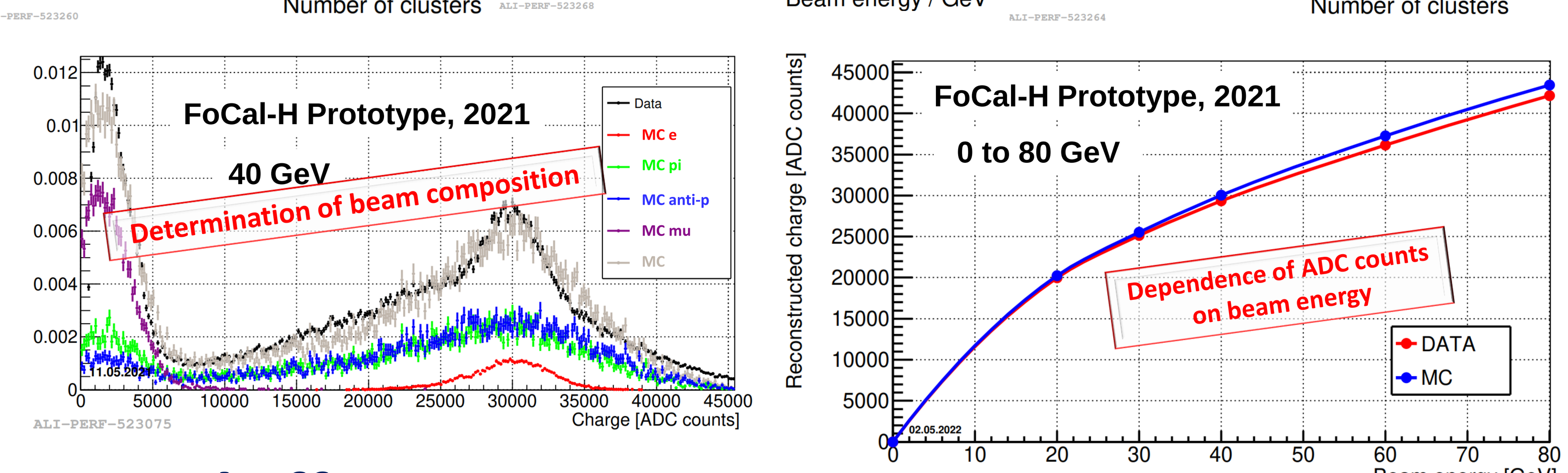


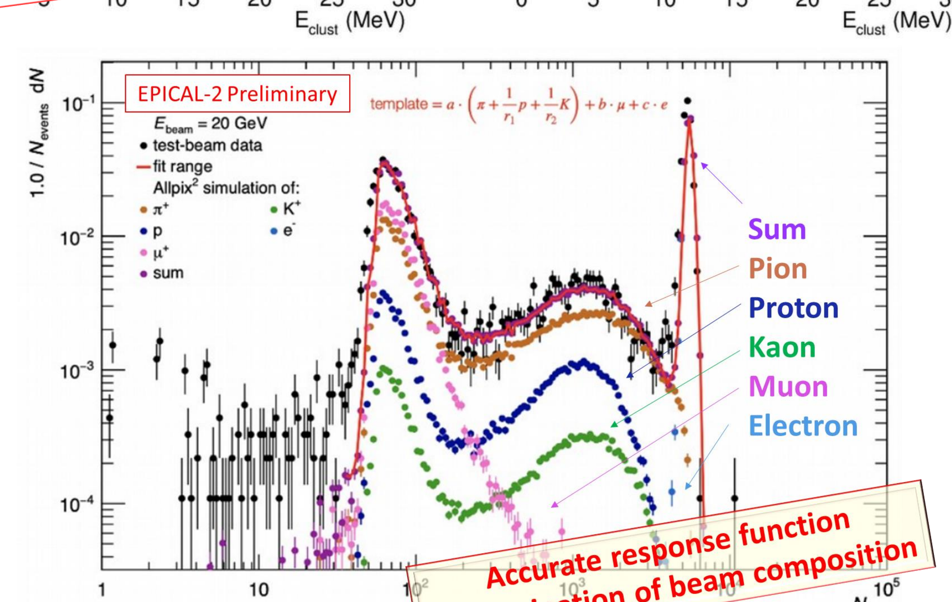






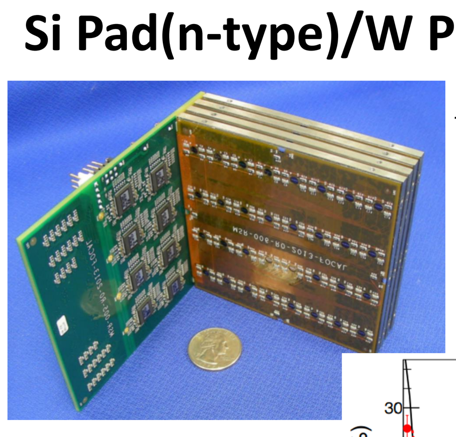




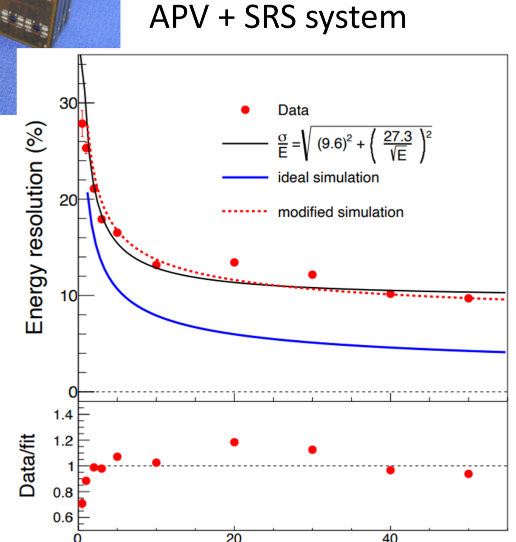


Si Pad(n-type)/W Prototype

NIM A 988 (2021) 164796



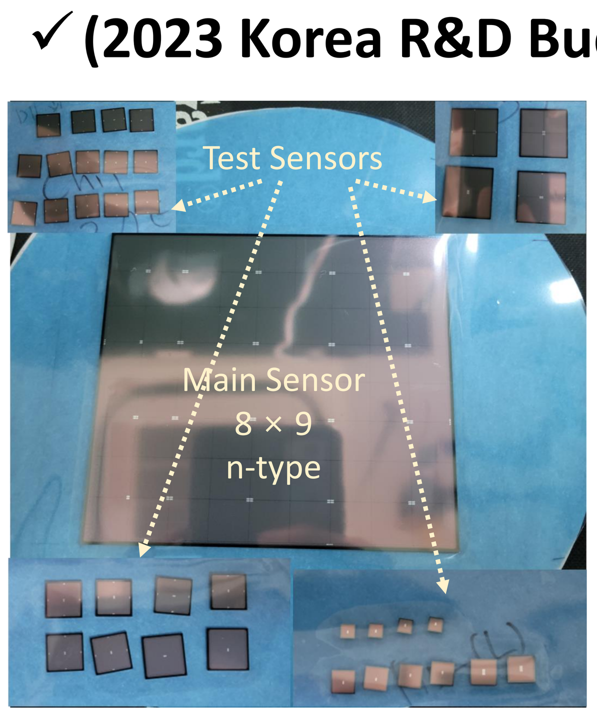
Analog sum of 4-layers and read out by APV + SRS system



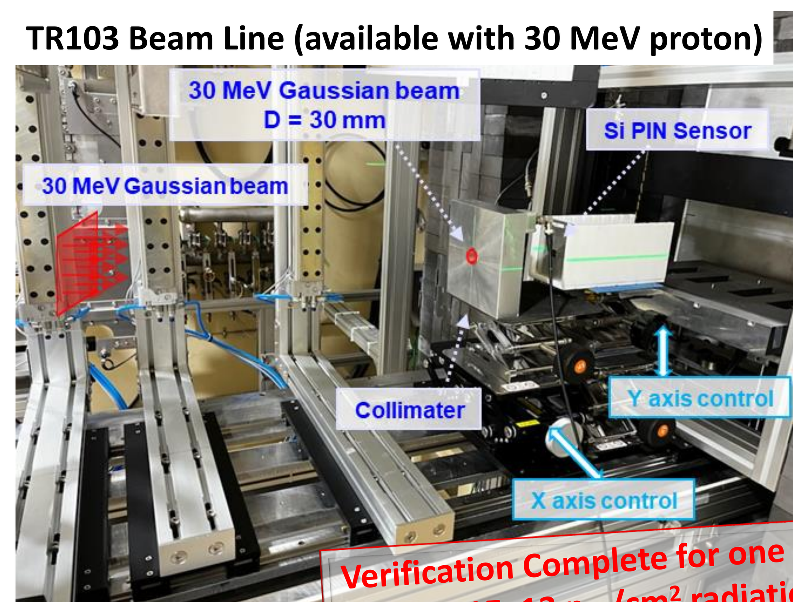
FoCal R&D Local Effort

✓ **(Ongoing)** R&D of Si n-type pad sensor for verification of sensor performance and radiation hardness

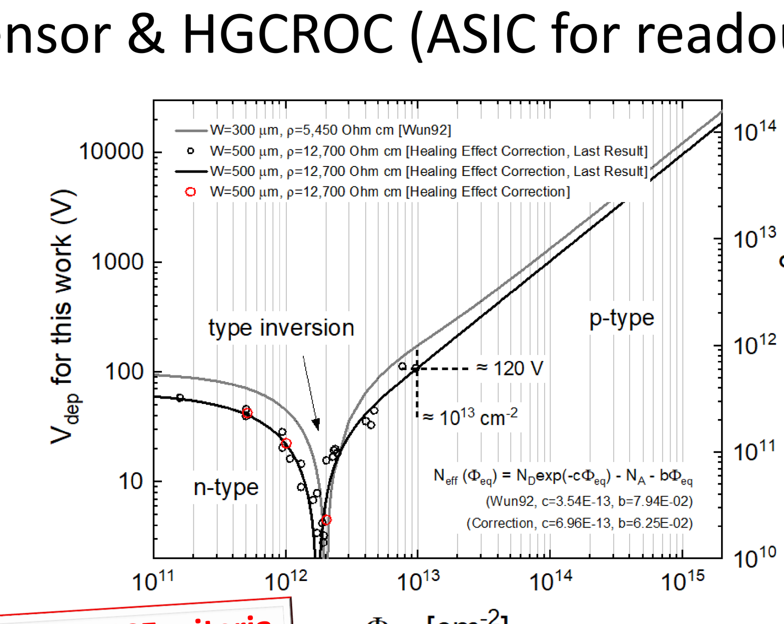
✓ **(2023 Korea R&D Budget Plan)** R&D of Si n-type pad sensor & HGCROC (ASIC for readout)

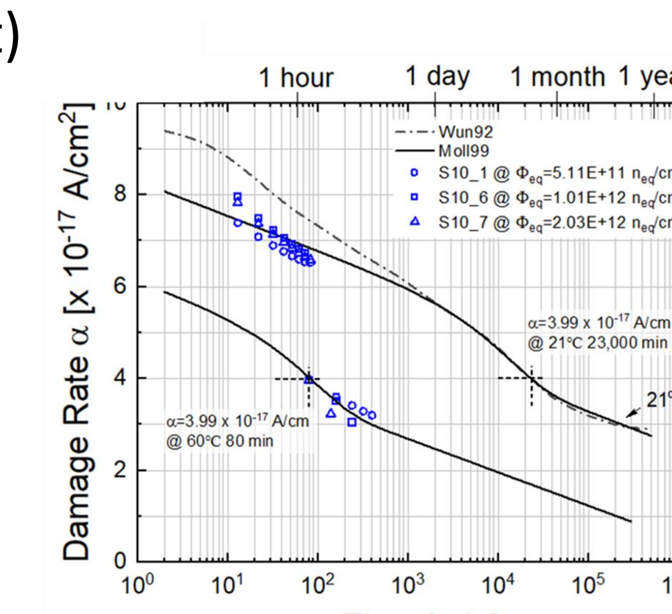


TR103 Beam Line (available with 30 MeV proton)



Verification Complete for one of the ALICE criteria $1E{+}13\ n_{eq}/cm^2$ radiation hardness





⇨ Surface effect & crosstalk of main sensor will be tested by 2.5 MeV electron irradiation

Summary & Outlook

- Strong low-x program enabled by the forward measurements with FoCal
- Various R&D efforts toward TDR 2023

- Outlook
  - Two test beams in 2022: June at CERN PS & Autumn at CERN SPS
  - Summer 2023: Finalization of R&D and Technical Design Report
  - LHC LS3 (2026-2028): FoCal Installation and commissioning