The Forward Calorimeter project in ALICE

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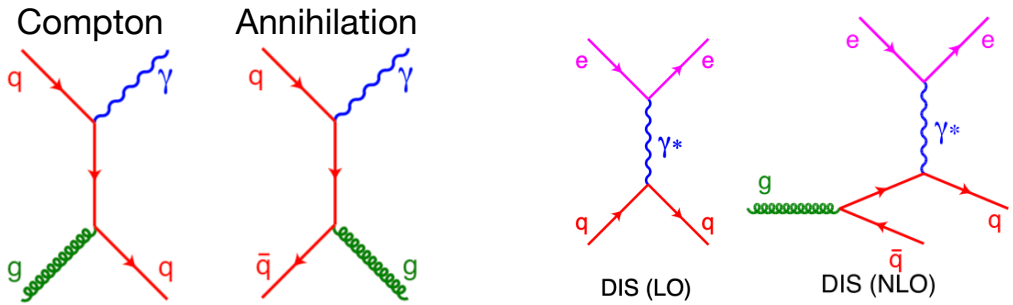
on behalf of the FoCal collaboration

26.08.2020 (v1)

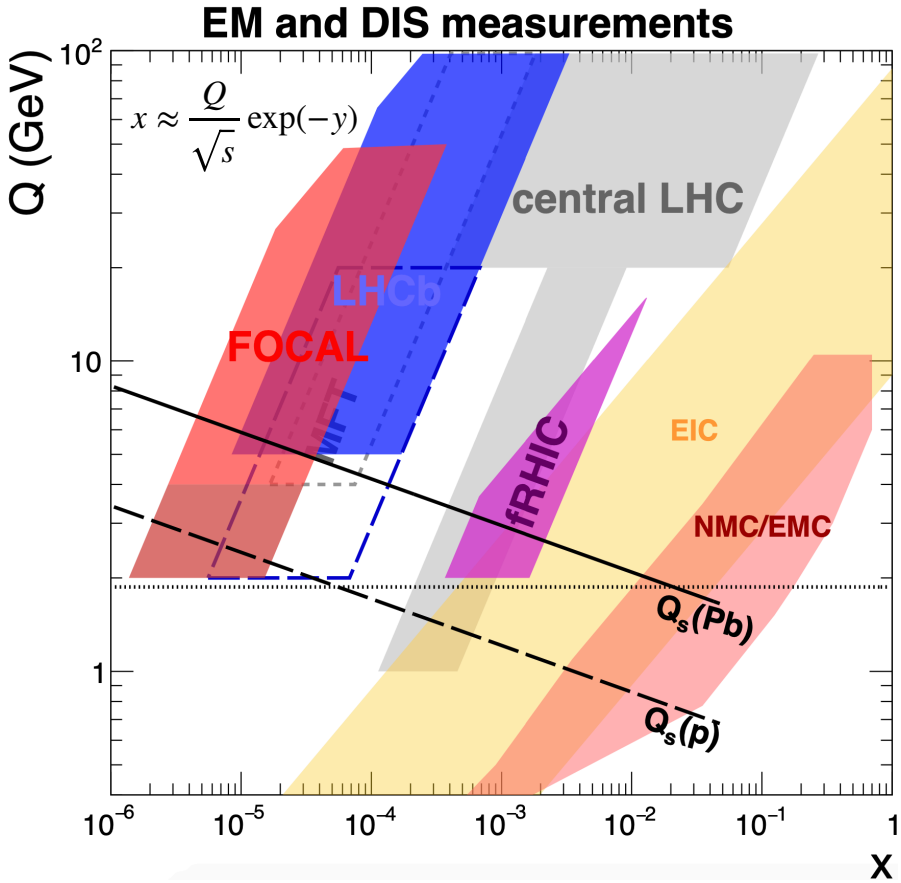
See talk from 08/05/2020

Forward isolated photons and the LHC small-x program



- Measure isolated photons forward
  - At LO more than 70% from Compton with direct sensitivity to gluon density
  - Not affected by final state effects nor hadronization
  - Uniquely low-x coverage at LHC (similar to LHeC)

- Goal
  - Explore non-linear QCD evolution at small x
    - Constrain nuclear PDFs at small x
  - Logarithmic dep. of QCD evolution on Q and x, requires several measurements over largest possible range



Strong small-x program at LHC

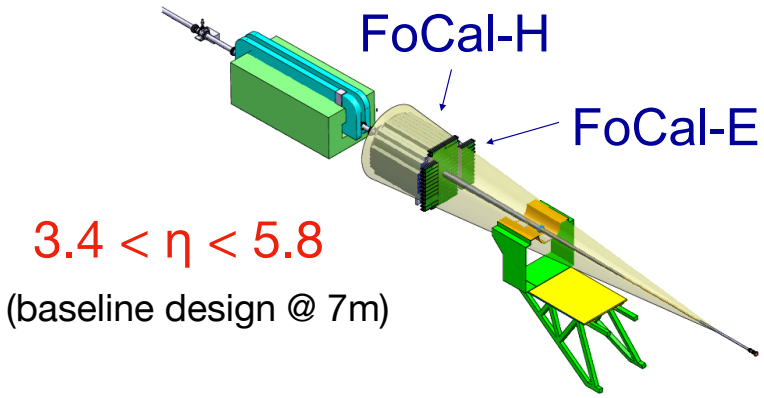
- Various experiments/measurements: isolated γ, DY, open charm (+UPC)
- Test factorization/universality
- Complementary to fRHIC + EIC

The FoCal proposal

FoCal-E: high-granularity Si-W sampling calorimeter for photons and π^0
FoCal-H: conventional metal-scintillator sampling calorimeter for photon isolation and jets

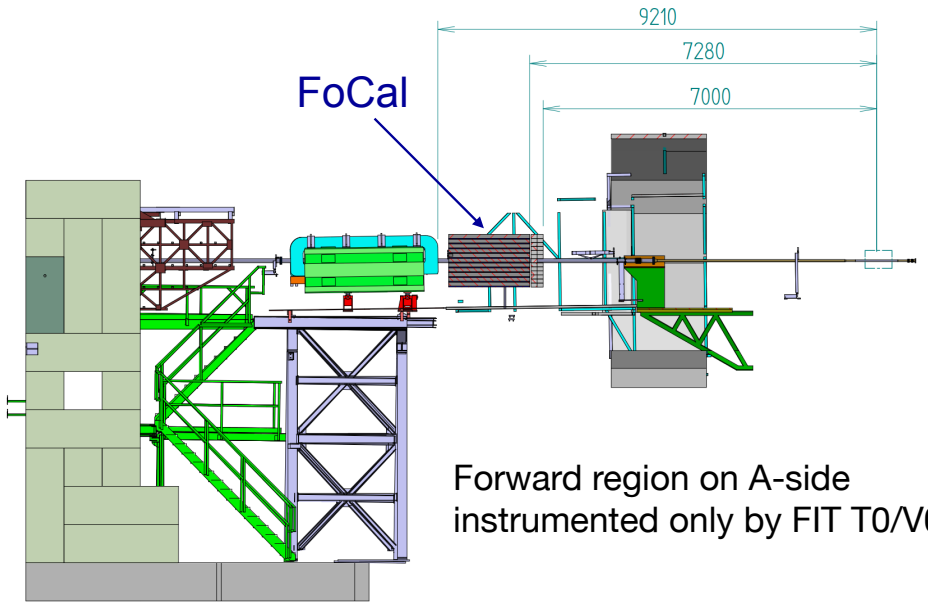
Observables:

- π^0 (and other neutral mesons)
- Isolated (direct) photons
- Jets (and di-jets)
- J/ψ (Y) in UPC
- W, Z
- Event plane and centrality



$3.4 < \eta < 5.8$

(baseline design @ 7m)



Forward region on A-side instrumented only by FIT T0/V0

Letter of Intent:

CERN-LHCC-2020-009

Physics programme

1. Quantify nuclear modification of the gluon density at small-x
   - Isolated photons in pp and pPb collisions

2. Explore non-linear QCD evolution
   - Azimuthal π^0-π^0 and isolated photon-π^0 (or jet) correlations in pp and pPb collisions

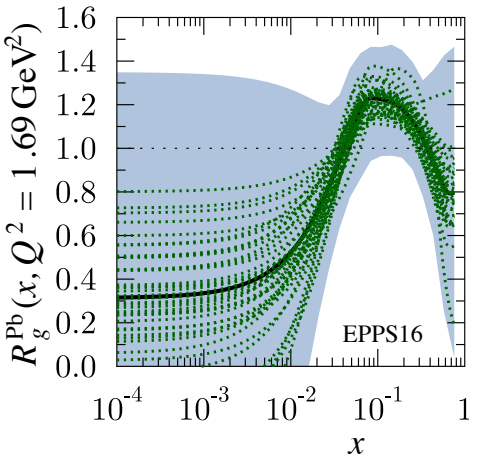
3. Investigate the origin of long range flow-like correlations
   - Azimuthal π^0-h correlations using FoCal and central ALICE (and muon arm) in pp and pPb collisions

4. Explore jet quenching at forward rapidity
   - Measure high p_T neutral pion production in PbPb

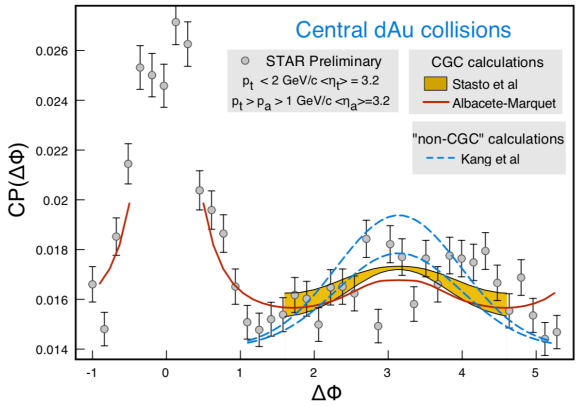
5. Other measurements
   - Jets and dijets in pp/pPb and UPC
   - Quarkonia in UPC (and pp*)
   - Photon and pion HBT (*)
   - W,Z in pp/pPb?
   - Isolated photons in PbPb (*)
   - Measurements at 14 TeV
     - Universality at small-x
     - Saturation in pp
     - High-x (>0.1) gluon constraints (*)

(*=feasibility not yet explored)

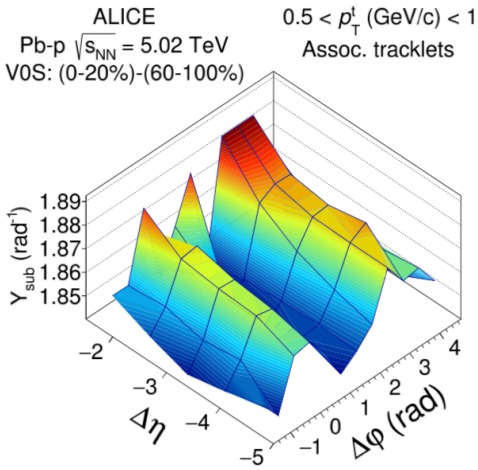
1. Nuclear PDFs



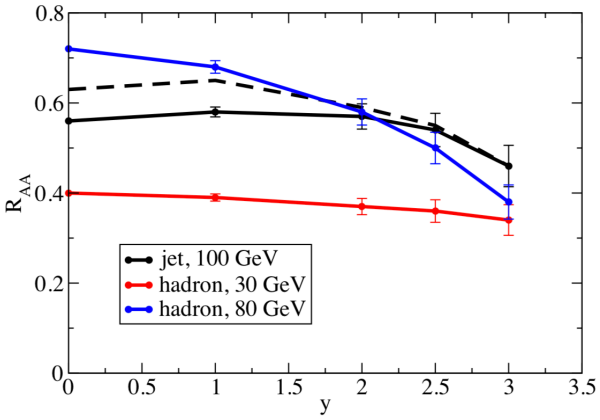
2. Non-linear evolution



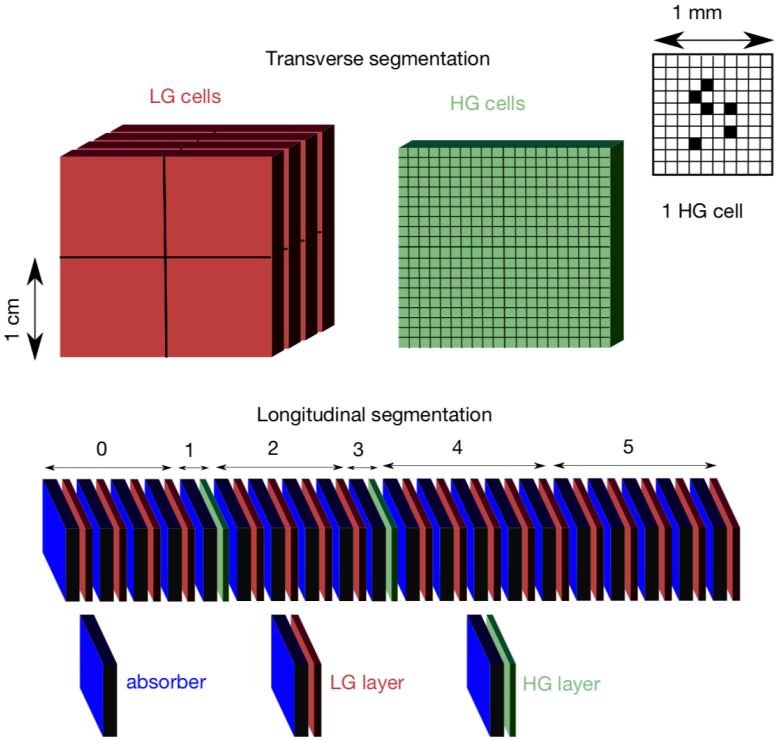
3. Long-range correlations



4. Jet quenching



FoCal-E conceptual design

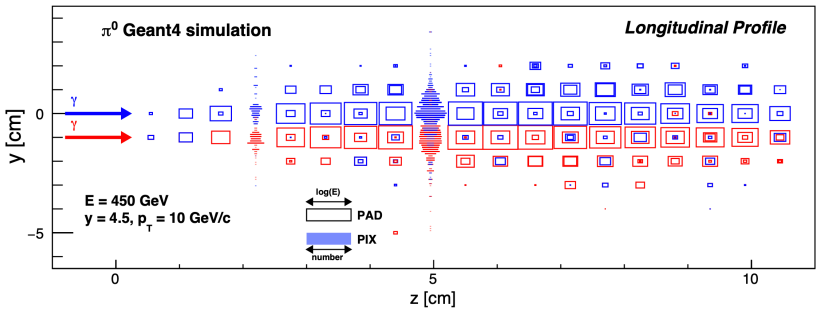


Studied in simulations 20 layers:
W(3.5 mm ≈ $1X_0$) + silicon sensors
Two types: Pads (LG) and Pixels (HG)

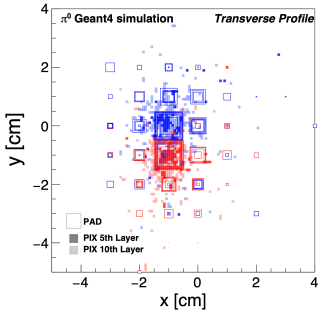
- Pad layers provide shower profile and total energy
- Pixel layers (ALPIDE) provide position resolution to resolve overlapping showers

- Main challenge: Separate γ/π^0 at high energy
  - Two photon separation from π^0 decay (p_T=10 GeV, η=4.5) ~5mm
  - Requires small Molière radius and high granularity readout
  - Si-W calorimeter with effective granularity ≈ 1mm²

Longitudinal profile (2γ showers)



Trans. profile

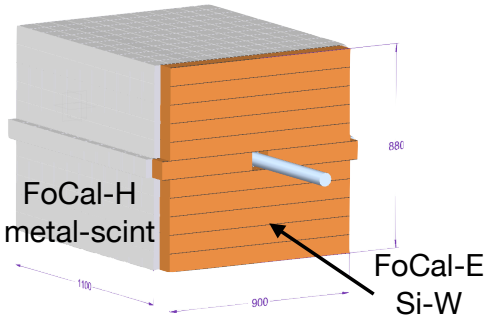


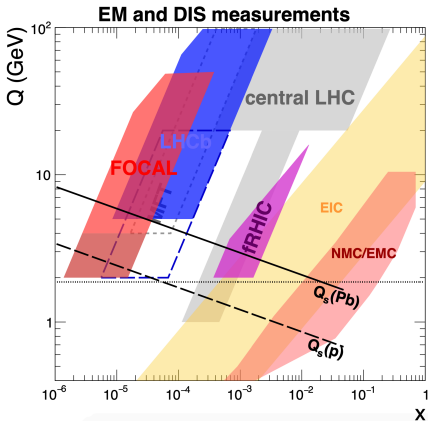
For performance studies, and R&D, see talk from 08/05/2020

Summary

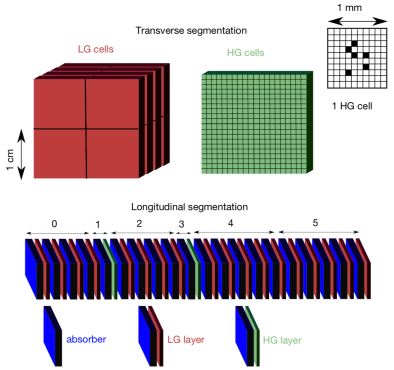
CERN-LHCC-2020-009

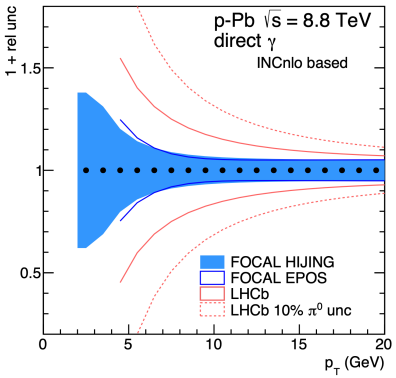
$3.4 < \eta < 5.8$

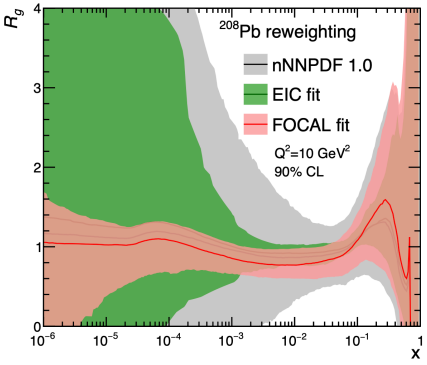


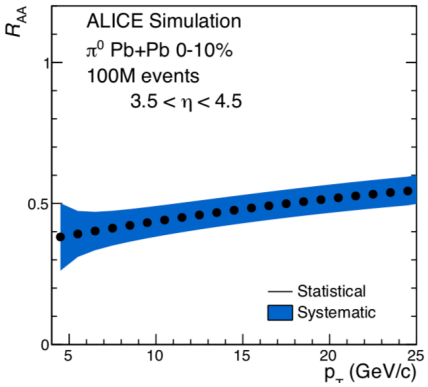


- FoCaL very forward, highly-granular Si+W "shower tracking" ECal with HCal
  - Rich physics programme in pp, pPb, PbPb and UPC
  - Main physics goal to explore non-linear QCD evolution
    - Isolated photons, UPC, correlations
    - Excellent performance over large η down to low p_T with small uncertainties as necessary to constrain nPDFs and to observe deviations from linear evolution
    - Strong small-x program at LHC together with LHCb; smaller x-region than at fRHIC and EIC
- Exciting calorimeter concept and technology
  - Large experience with prototypes
  - Technology synergy (ALPIDE, HGCROC)
  - Feasibility (choice of technology, integration, adequate resources) established
- Challenging and interesting times ahead towards the TDR
  - Individuals and institutions are very welcome to join the effort









+ UPC, correlations, jets