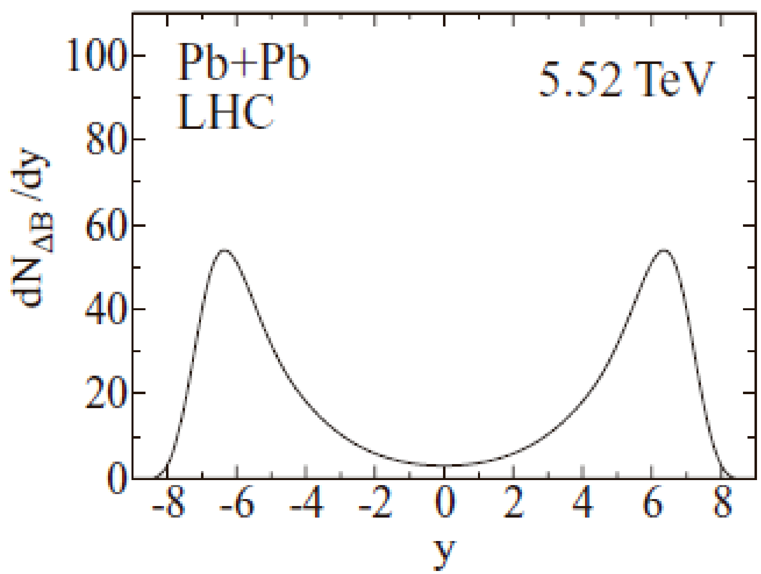
Exploring the very forward region – physics ideas and detector challenges

- Physics of the Nuclear Fragmentation Region
  - Baryon stopping (p+p, p+A, A+A)
  - Gluon saturation effects (p+p, p+A)
  - …
- Observables
  - Direct photons
  - Neutral pions
  - Baryons and Antibaryons
  - ....

Fragmentation region I

- **Baryon transport – stopping**



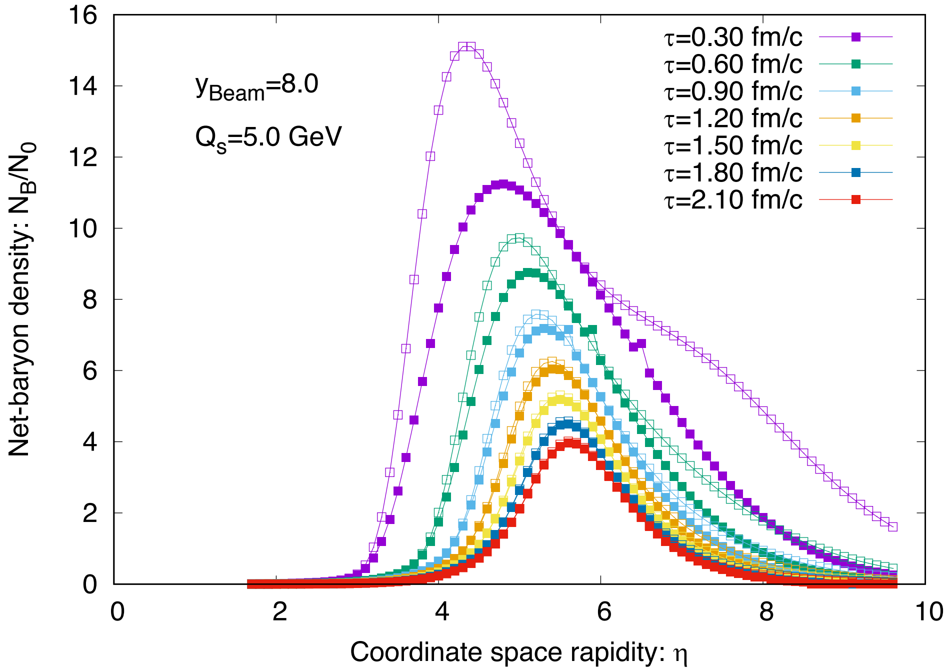
- **Stopping:**
  quark di-quark (q−qq) string fragmentation and/or junction anti-junction loops?

- **Saturation models:**
  net-baryon fragmentation peak position -> gluon saturation scale

Y. Mehtar-Tani and G. Wolschin, Phys. Rev. C80, (2009) 054905

Fragmentation region II

- **Baryon transport – stopping**



- **Energy density in the fragmentation region are sufficient to create quark matter -> Baryonic CGC**

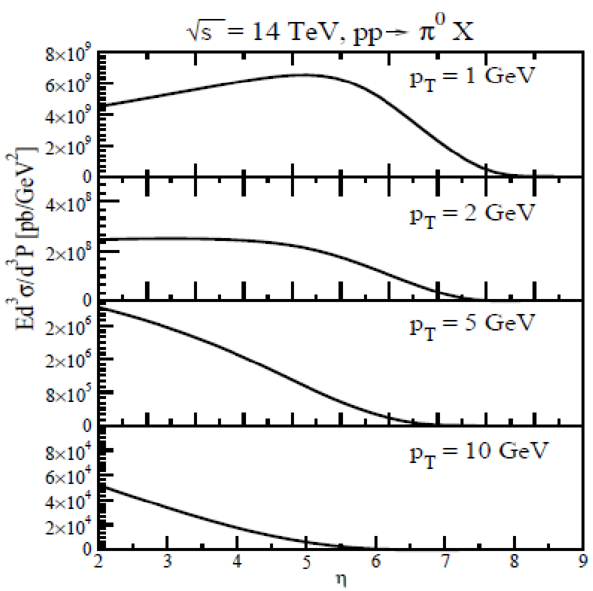
- **Saturation scale -> Baryon density**

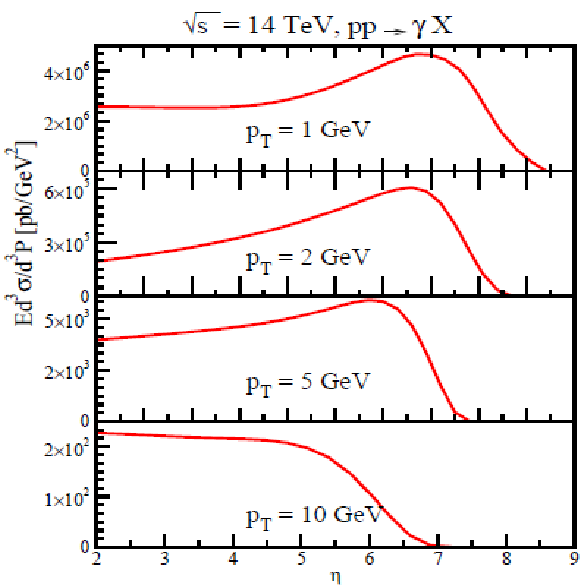
L. McLarren, S. Schlichting, S. Sen, arXiv:1811.04089 (2018)

L. McLarren, http://www.int.washington.edu/talks/WorkShops/int_18_3/

Forward physics I

- **Hadrons and direct photons in pp collisions at forward rapidities and saturation effects**





- **direct photon and hadron production at forward rapidities are sensitive to saturation**

- **prediction of a clear enhancement of the photon production rate at y=6-7 (in p+p)**

A.H. Rezaeian and A. Schafer, Phys. Rev. D81 (2010) 114032.

Forward physics II

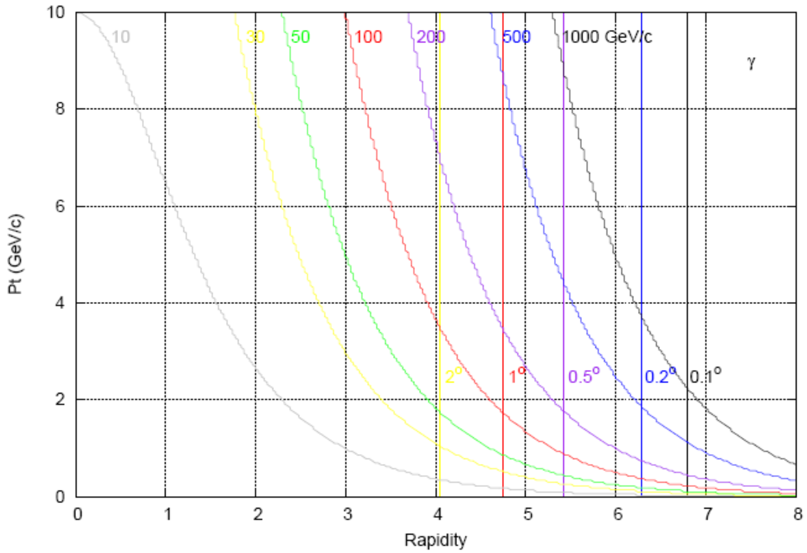
M. Strikman,
arXiv:1010.2443 [nucl-th]

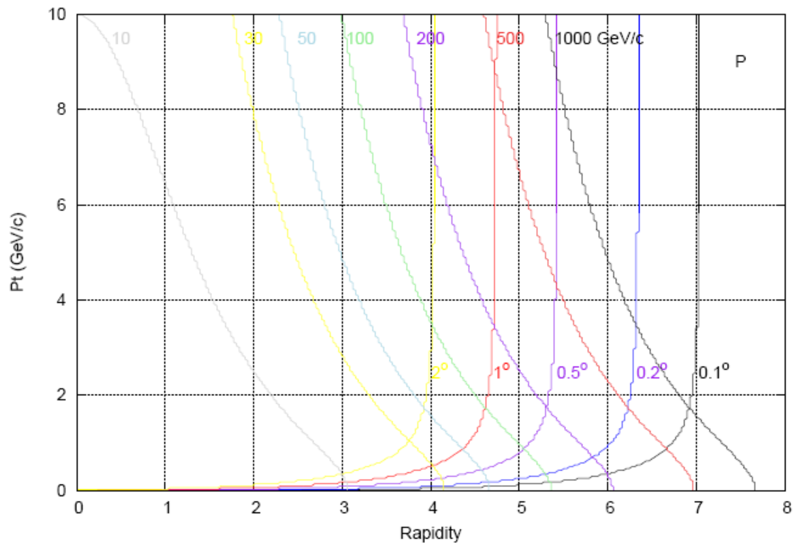
- **Hadron production**
  - Leading twist nuclear shadowing
  - suppression of leading parton spectrum at forward rapidities
    -> suppression of hadrons in pA
  - " … in the black disk regime interactions with the target select configurations in the projectile wave function where the projectile's energy is split between constituents much more efficiently than in the DGLAP regime…"

- **Forward pion correlations**
  - signal of double-parton interactions
    -> obtain unique information about double quark distributions in nucleons

ALICE upgrade: very forward spectrometer

- **Requirements:**
  - Rapidity coverage: 5-6(7?), pT up to 10 GeV/c
  - Measurement of direct gammas and neutral pions
  - Identification of protons and antiprotons
    - » Charge separation and momentum selection by the magnetic field of the compensator magnet
    - » Tracking in front and behind the magnet

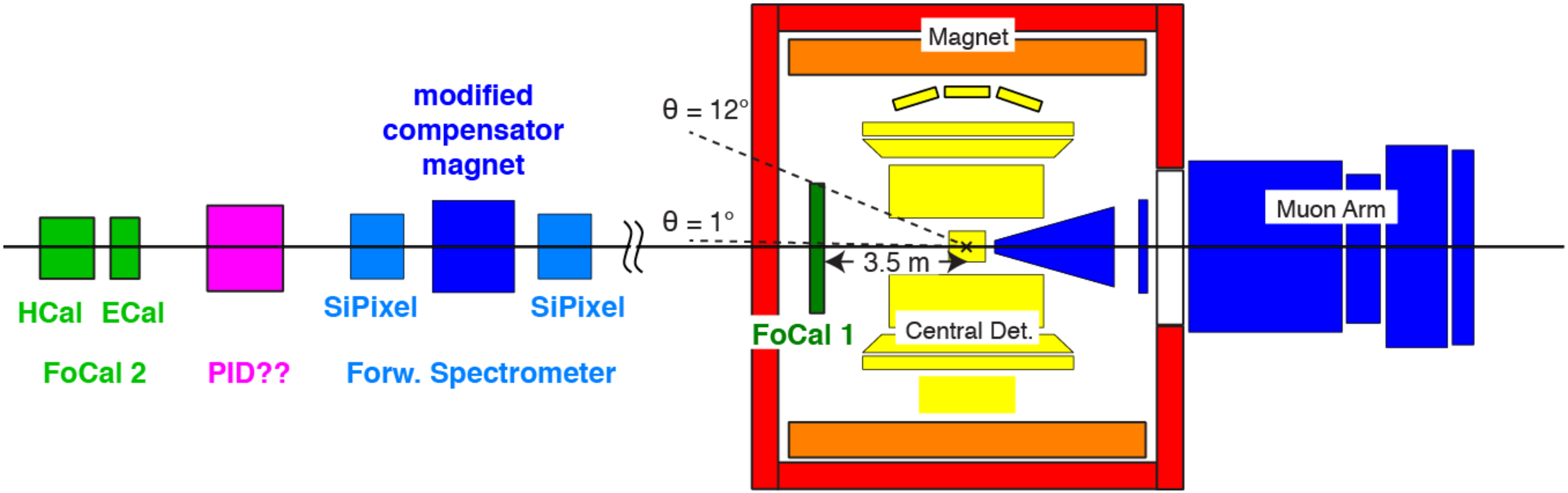




Forward spectrometer – conceptual design

- **Spectrometer**
  - **Symmetric single arm spectrometer**
  - **$\Delta p/p = p / (\kappa \cdot q \cdot B \cdot L) \cdot 8 \cdot \sigma / (l \cdot \sqrt{M})$**

κ = 0.3 GeV/c / Tm
σ = spatial resolution
BL = 3 Tm
M = number of tracking layers
l = length of single arm



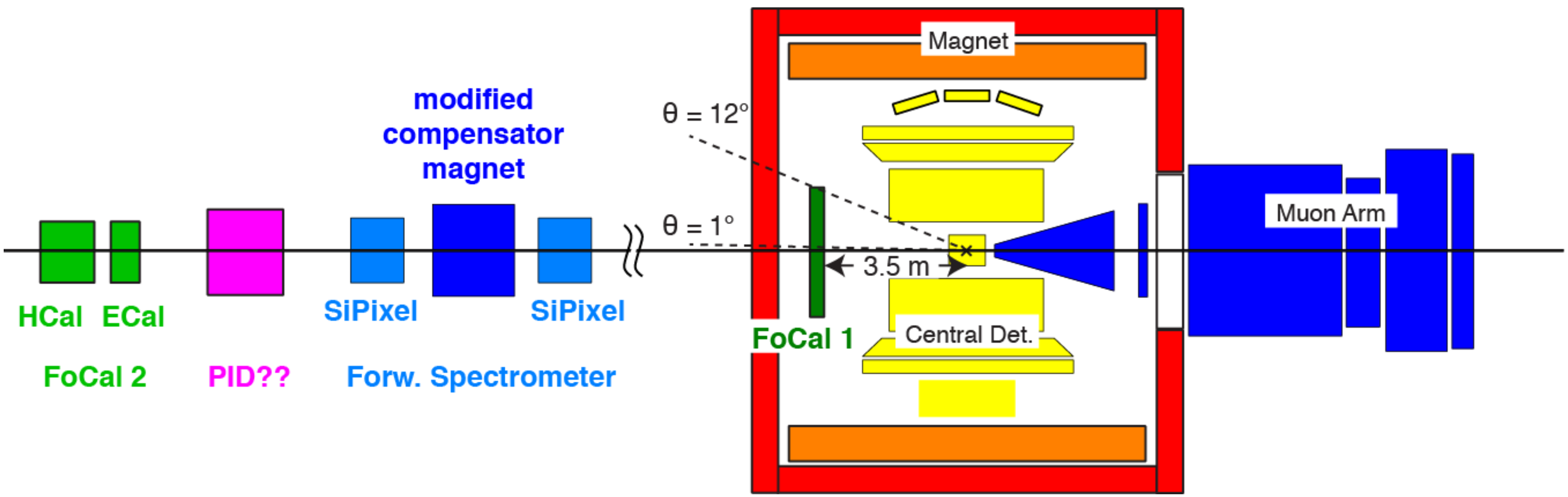
Forward spectrometer - resolution

Examples

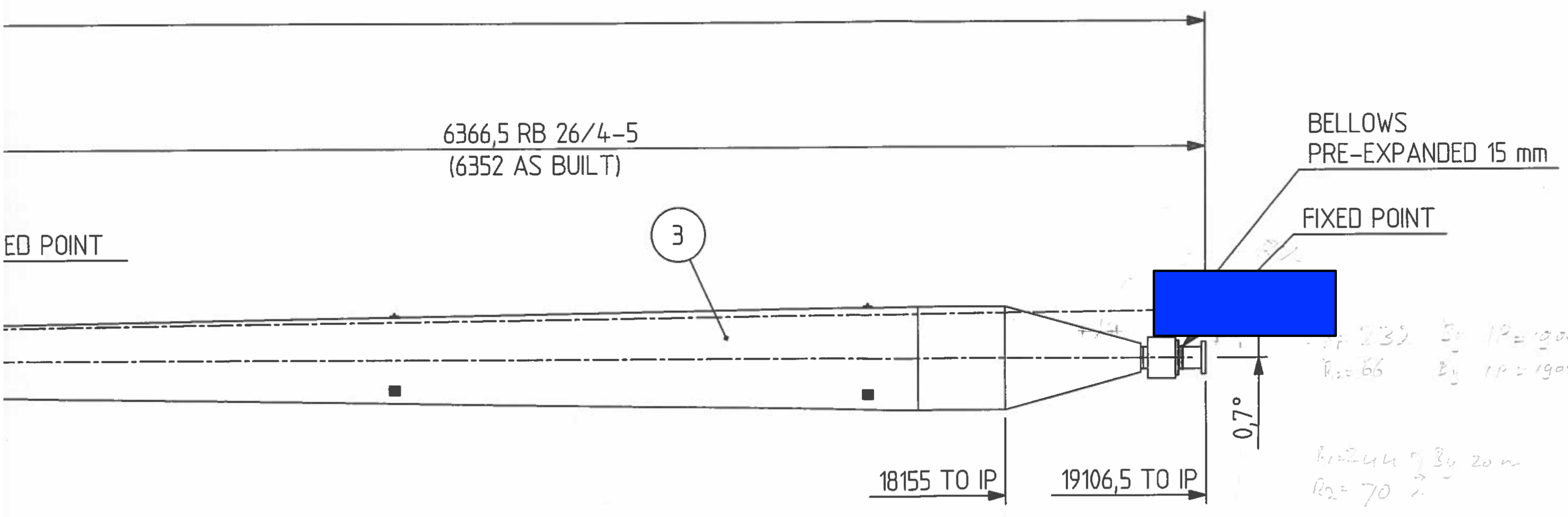
- **Spectrometer**
  p = 1000 GeV/c
  l = 10 m
  σ = 5 μm
  M = 4
  → Δp/p = 2%

- **EMCAL**
  - **π^0 -> 2γ kinematics at y=5 (two γ separation)**

p_T (GeV/c)	1	10
p_{tot} (GeV/c)	74	742
$\theta_{2\gamma}^{\min}$	0.0038	0.00038
$\Delta\ell(\mathrm{L} = 50\ \mathrm{m})$	20 cm	2 cm



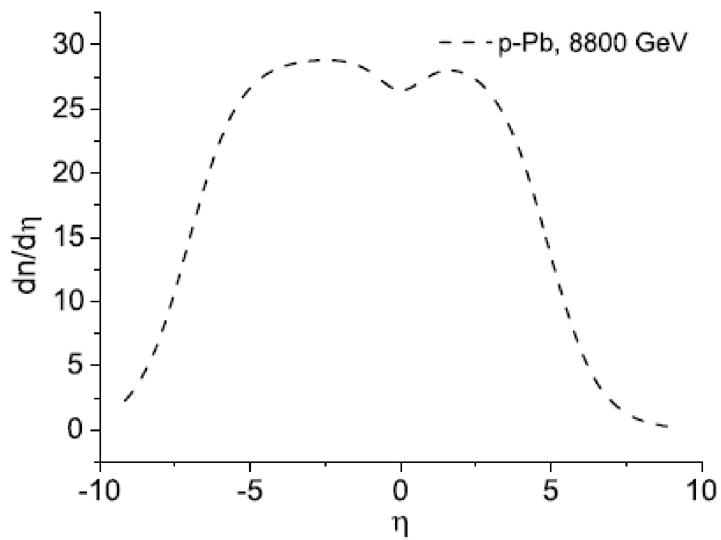
C-side

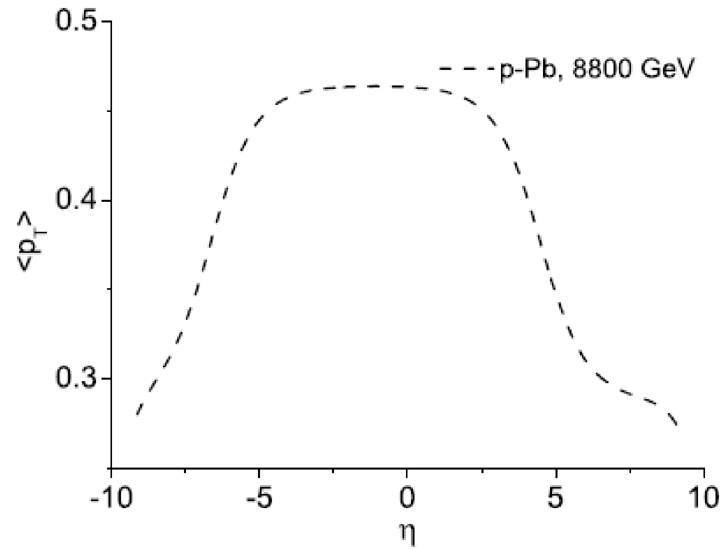

6366,5 RB 26/4-5
(6352 AS BUILT)
ED POINT
3
BELLOWS
PRE-EXPANDED 15 mm
FIXED POINT
0,7°
18155 TO IP
19106,5 TO IP

Conclusion

Forward physics III

- **Saturation models impose a strict relation between the average transverse momentum and the rapidity density**





P. Brogueira, J. Dias de Deus and J.G. Milhano,
Nucl. Phys. A832 (2010) 76.