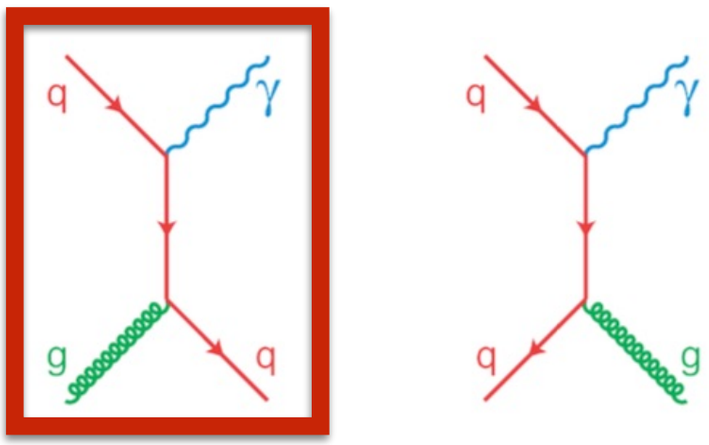
Kaon-induced prompt-photon production with RF-separation at the M2 beamline

on behalf of the AMBER Prompt-photon working group

A. Guskov, JINR 10.5.22

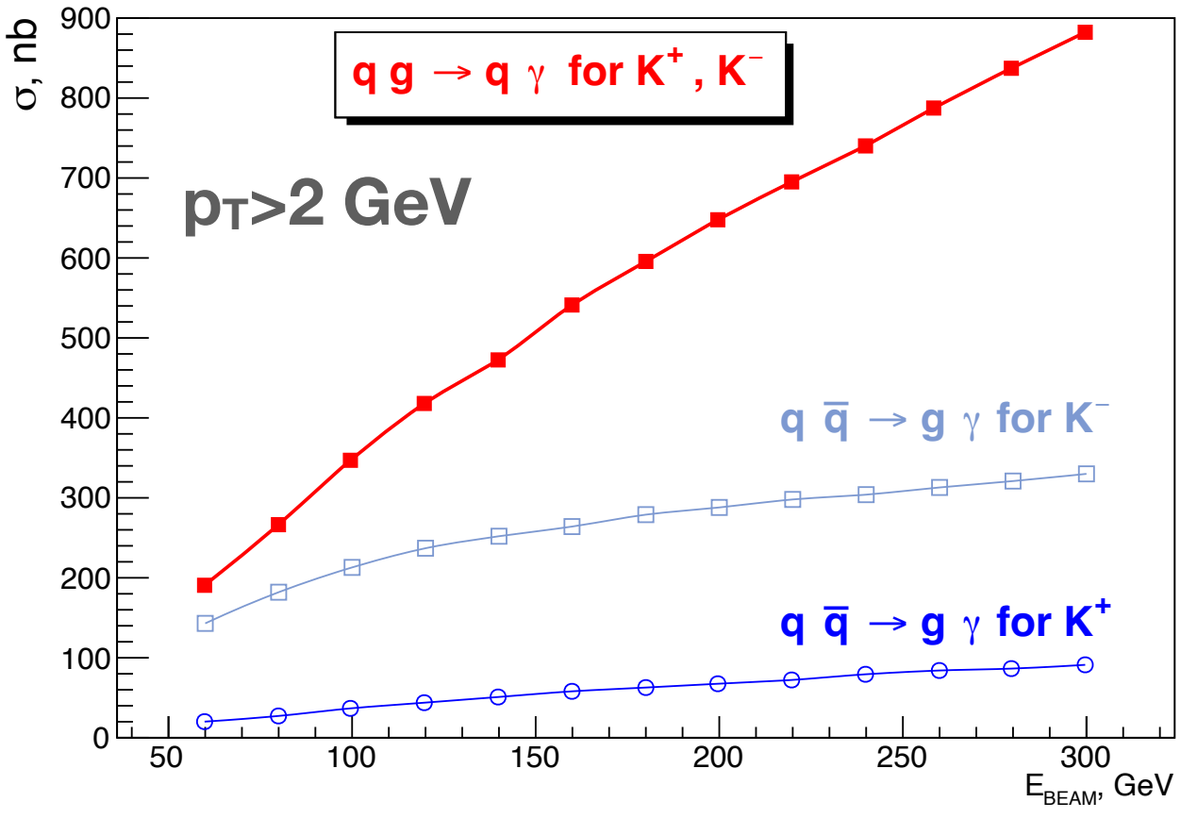
Prompt photons and gluon PDFs



$$data \rightarrow \sigma_{inclusive\ \gamma}(p_T, x_F) \rightarrow g_K(x_K)$$

Gluon Compton scattering

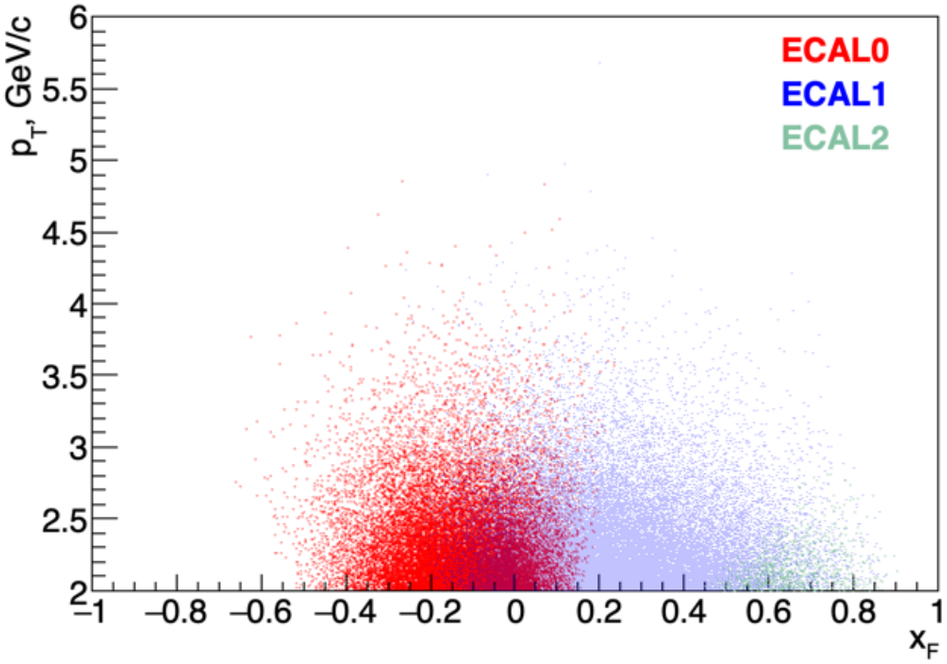
$$d\sigma_{AB} = \sum_{a,b=q,\bar{q},g} \int dx_a dx_b f_a^A(x_a,\mu^2) f_b^B(x_b,\mu^2) d\sigma_{ab\to\gamma X}(x_a,x_b,\mu^2).$$

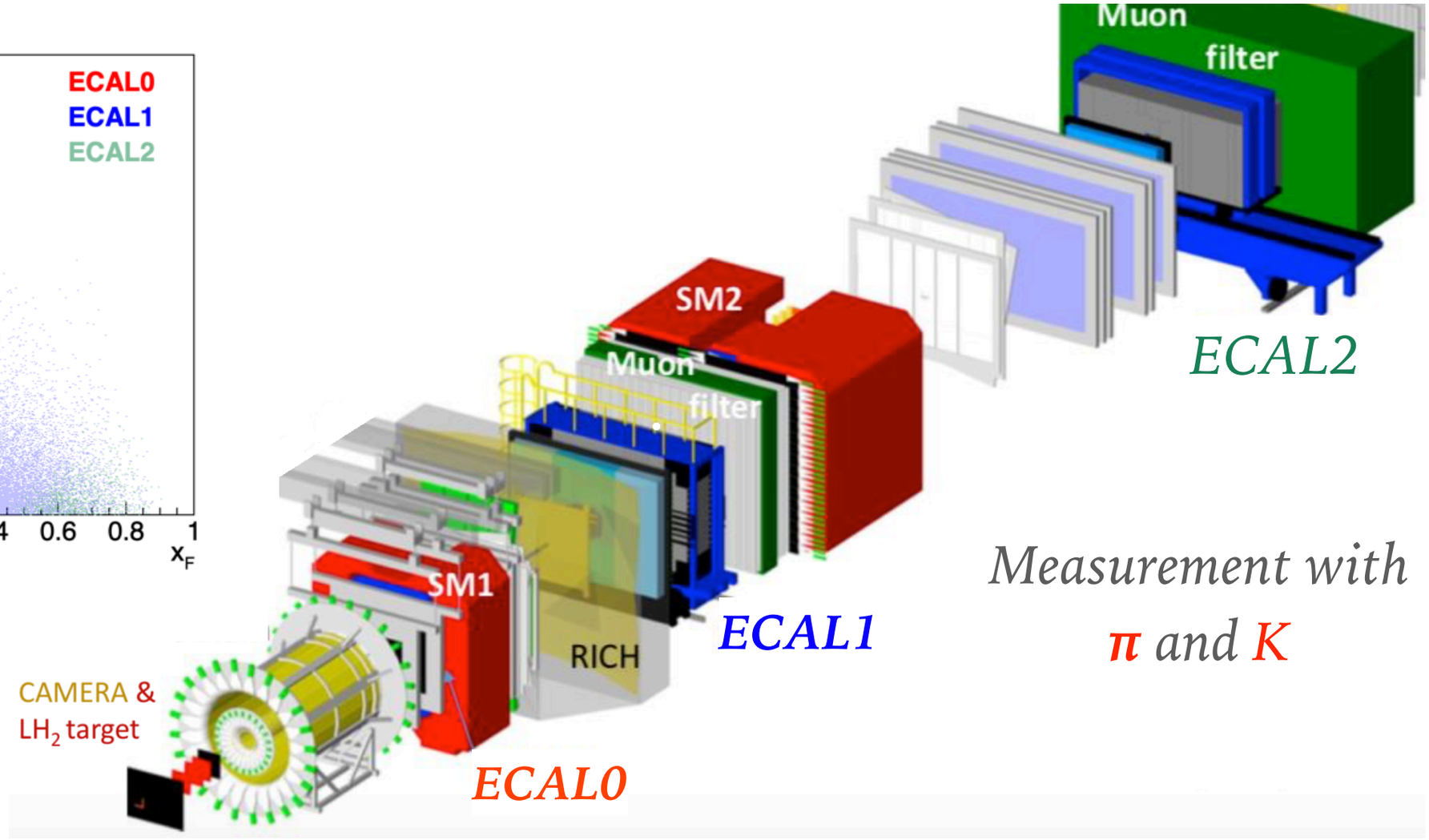


Experiment	Beam and target	$\sqrt{s}$, GeV	y range	x_T range
E95 (1979)	p; Be	19.4, 23.75	-0.7 – 0.7	0.15 – 0.45
E629 (1983)	p, π^+; C	19.4	-0.75 – 0.2	0.22 – 0.52
NA3 (1986)	p, π^+, π^-; C	19.4	-0.4 – 1.2	0.26 – 0.62
NA24 (1987)	p, π^+, π^-; p	23.75	-0.65 – 0.52	0.23 – 0.59
WA70 (1988)	p, π^+, π^-; p	22.96	-0.9 – 1.1	0.35 – 0.61
E706 (1993)	p, π^-; Be	30.63	-0.7 – 0.7	0.20 – 0.65
E704 (1995)	p; p	19.4	<0.74	0.26 – 0.39
UA6 (1993,1998)	$\bar{p}$; p	24.3	-0.2 – 1.0	0.34 – 0.50

100 GeV kaon beam →
√s=13.7 GeV →
extremely challenging task

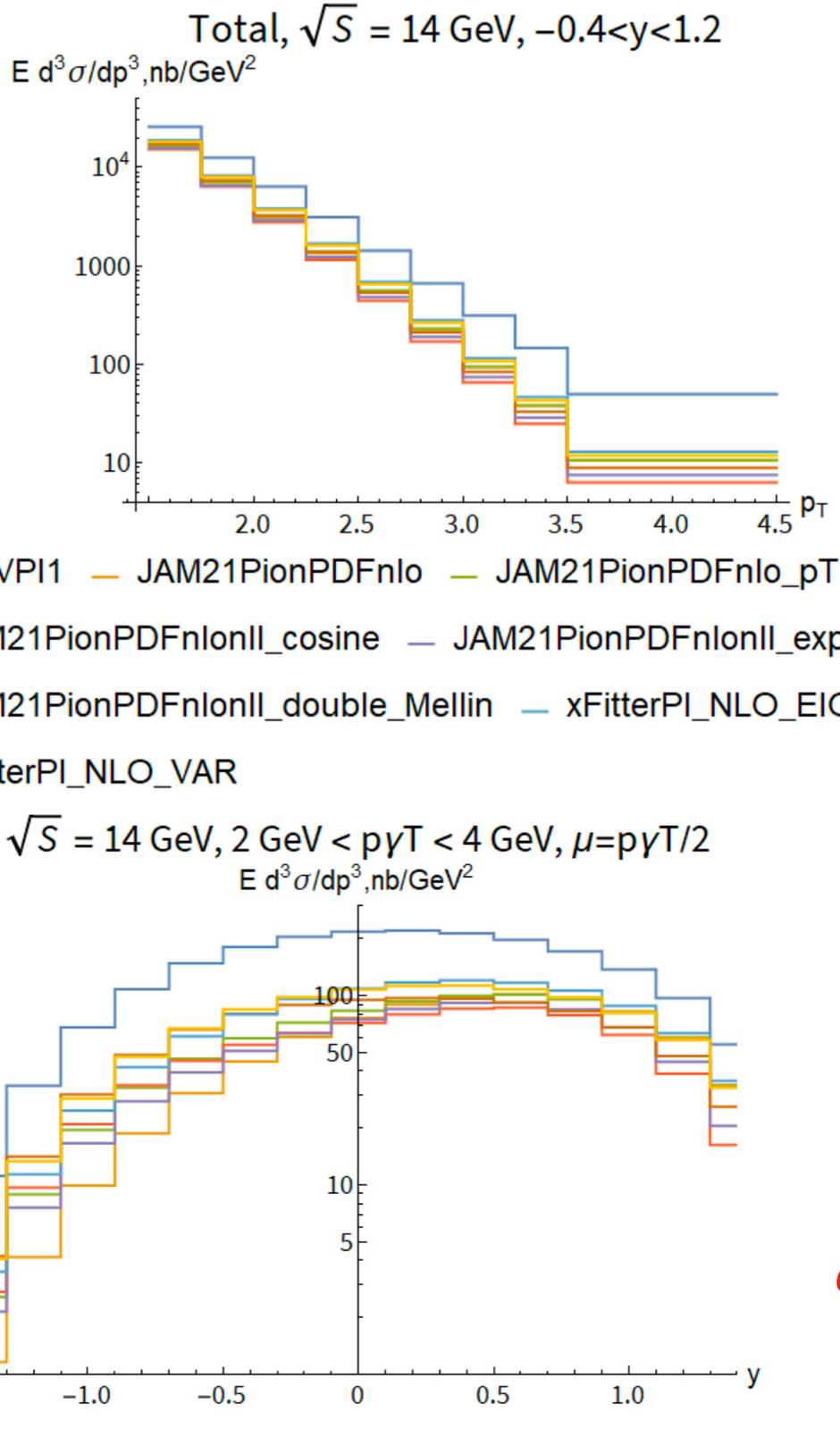
Prompt photons at AMBER

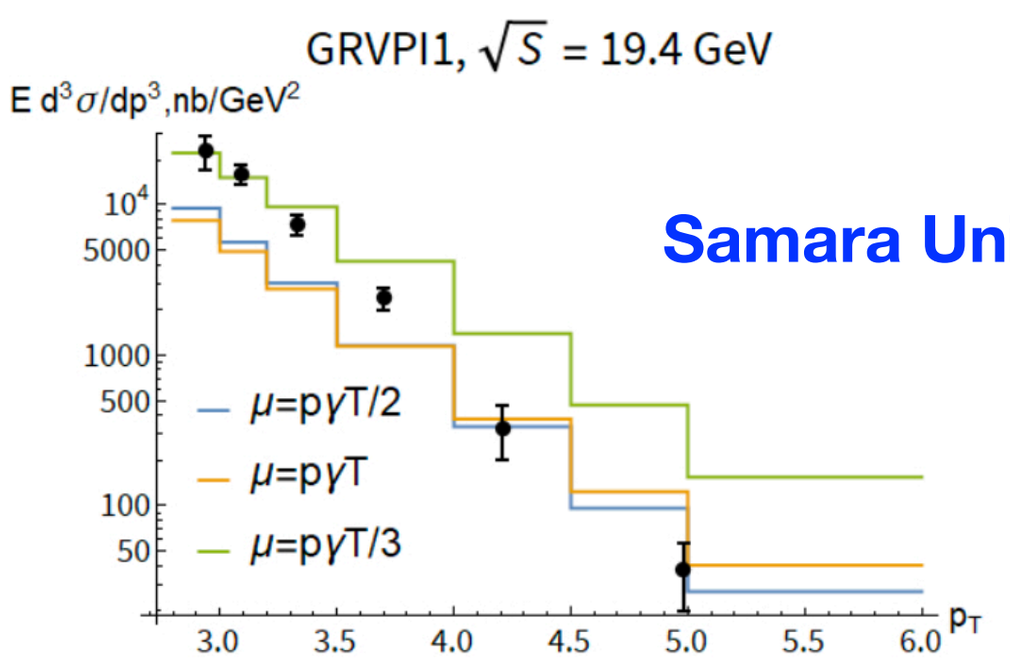




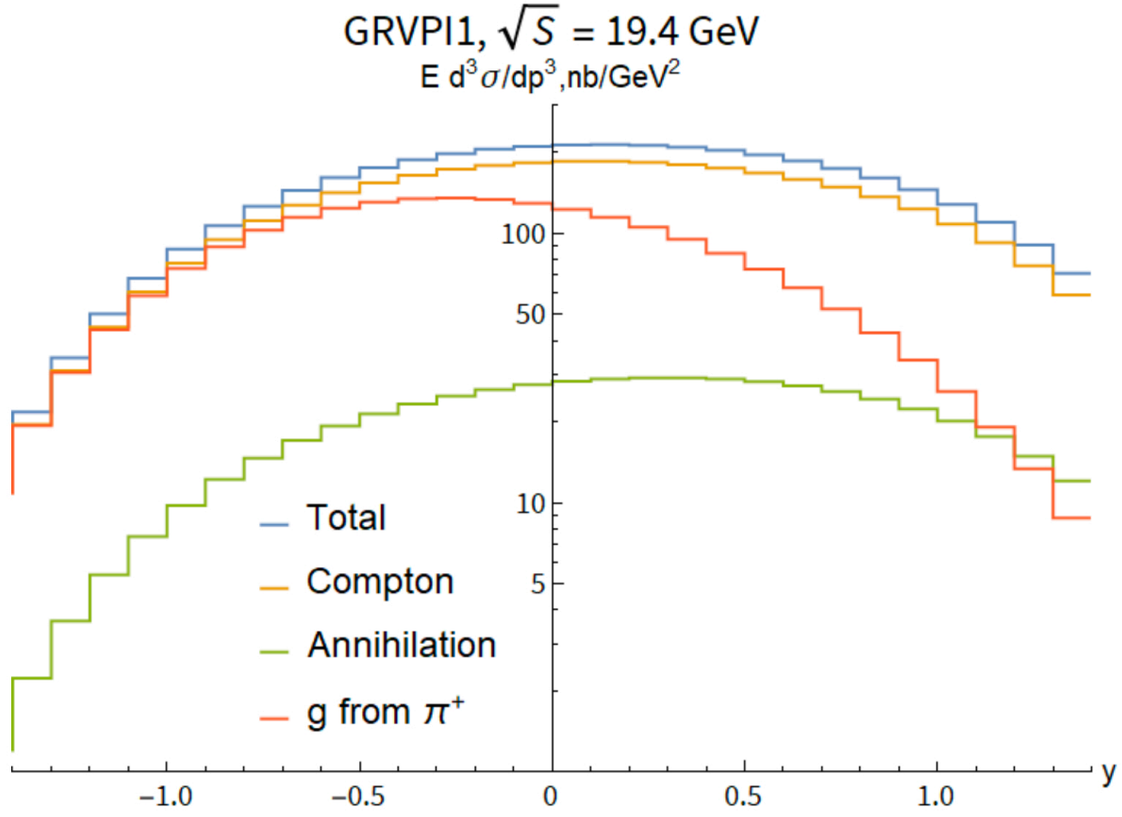
- COMPASS DVCS-like setup
- We have some amount of 2017 data with pion beam that we are trying to use for tests

Observables





Samara Univ. group



$\sigma_K, \sigma_{K^+} - \sigma_{K^-}, \sigma_K/\sigma_\pi, (\sigma_{K^+} - \sigma_{K^-})/\sigma_\pi, \ldots$

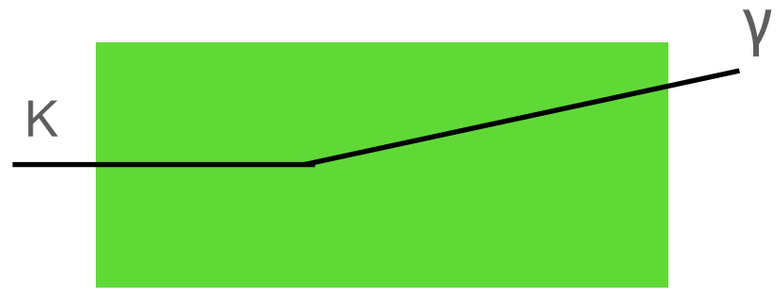
Optimization is ongoing

Setup optimisation

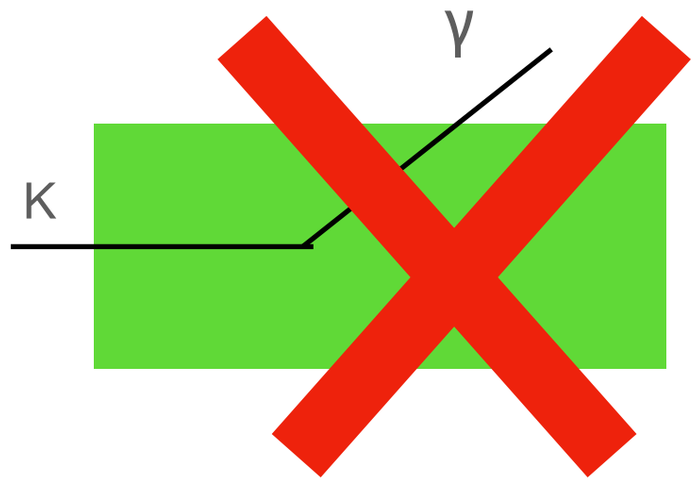
- Target thickness & material
- Hodoscope in front of ECAL0
- Shielding upstream the target
- Transparency of the setup
- Trigger conditions

Target

$$R \sim \frac{\Lambda_K \lambda_\gamma}{\Lambda_K - \lambda_\gamma} \times (e^{-h/\Lambda_K} - e^{-h/\lambda_\gamma})$$

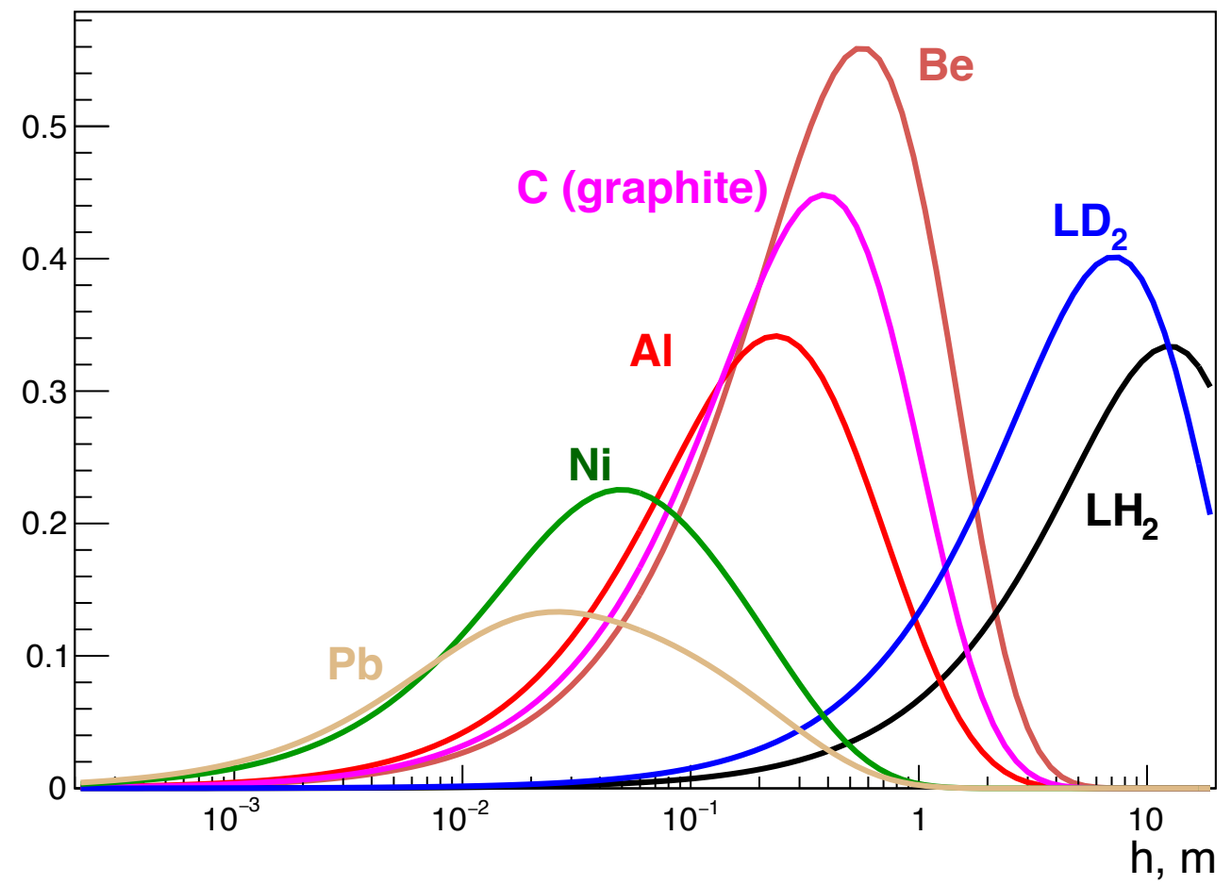


Wide-target approximation: R is large enough



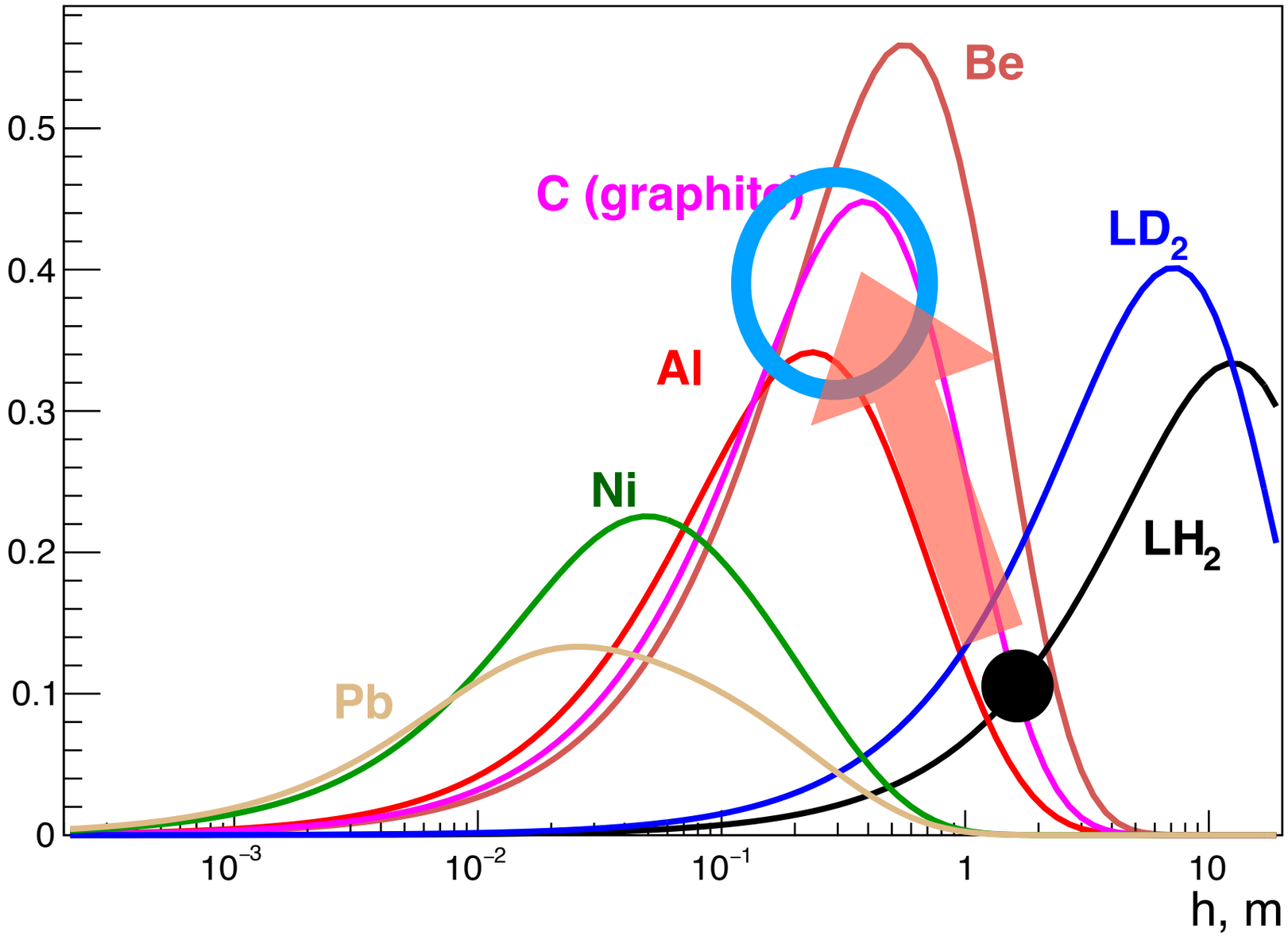
20-50 cm of graphite or aluminium looks to be the most realistic.

prompt-γ production rate



Target & statistics

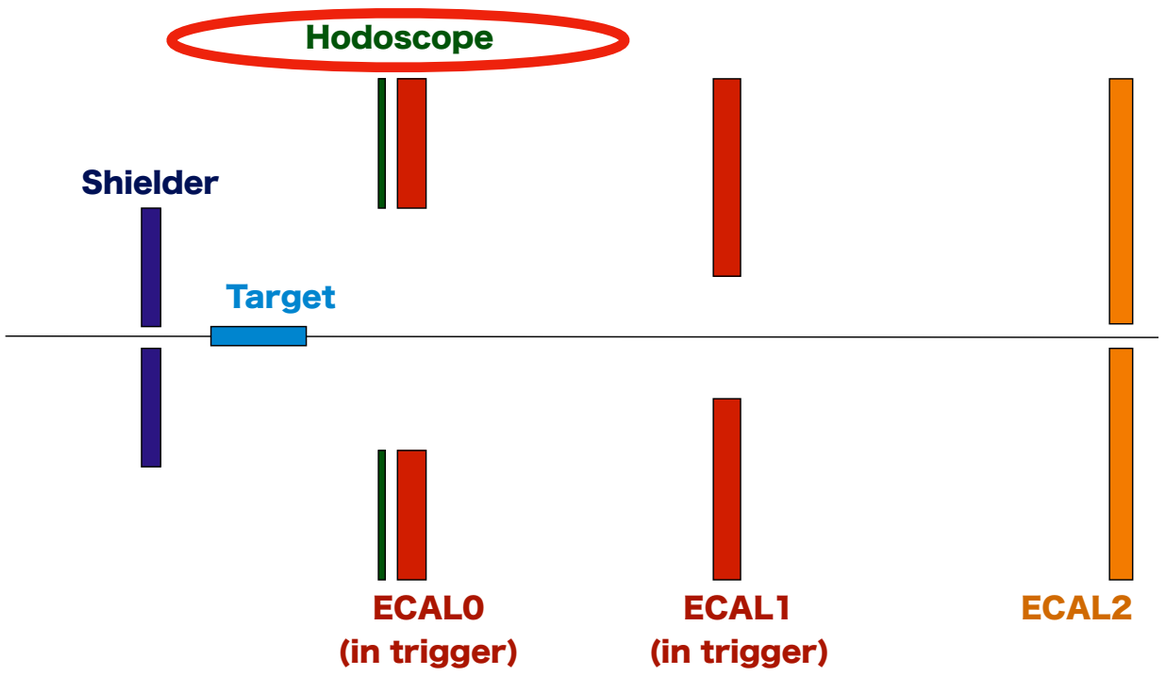
prompt-γ production rate



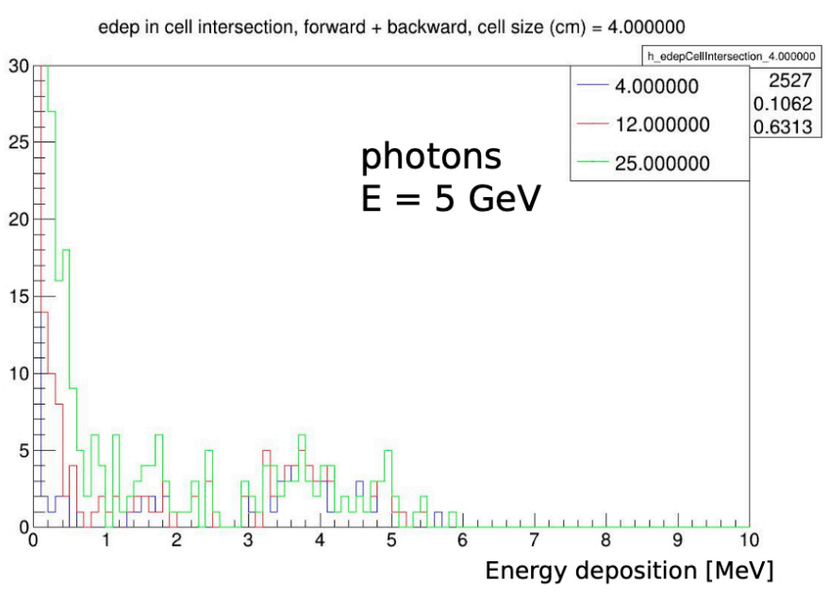
x4 higher yield with respect to the LoI !

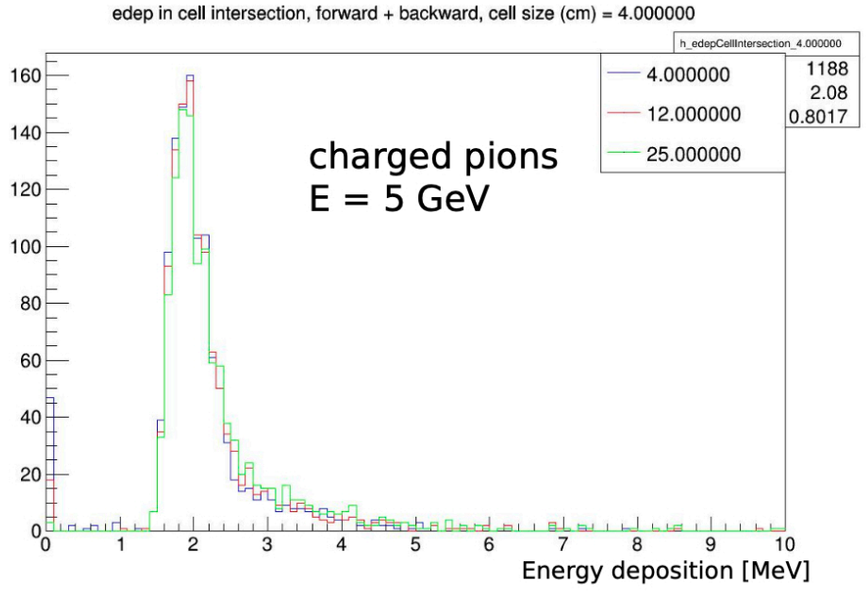
So, even for the kaon beam intensity of 5e5 per spill we could have more than 100k events per year (p_T>2 GeV/c)

Hodoscope in front of ECAL0



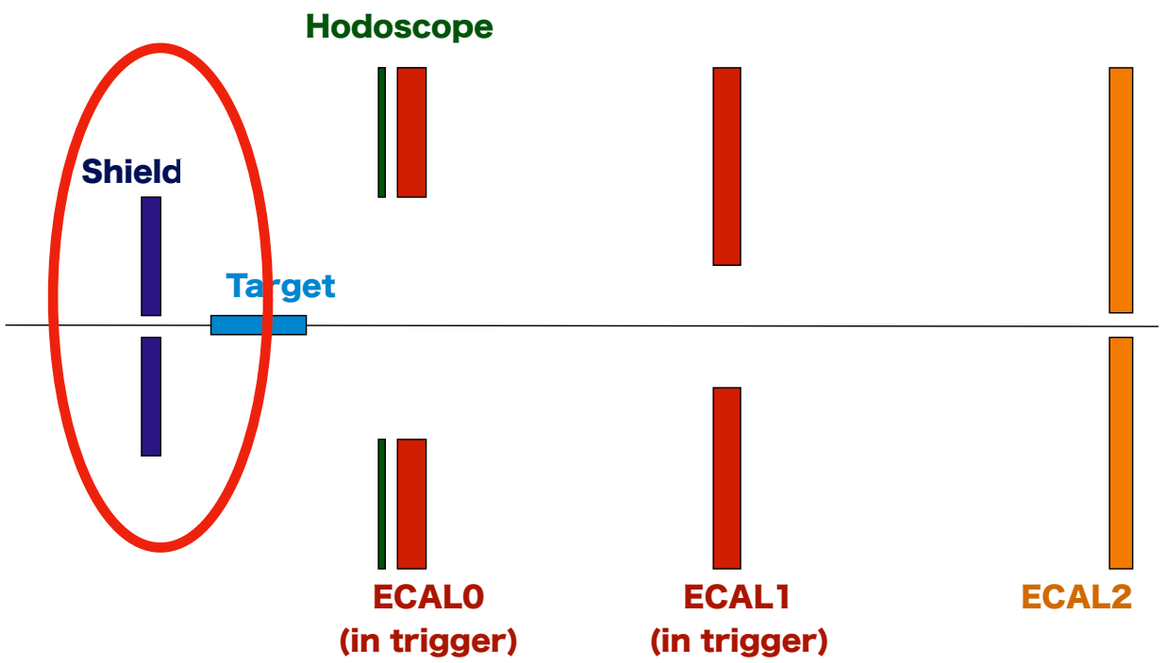
- needed to distinguish charged and neutral clusters in ECAL0
- lack of free space for full tracking system
- large incident angles
- albedo particles from developing EM shower in ECAL

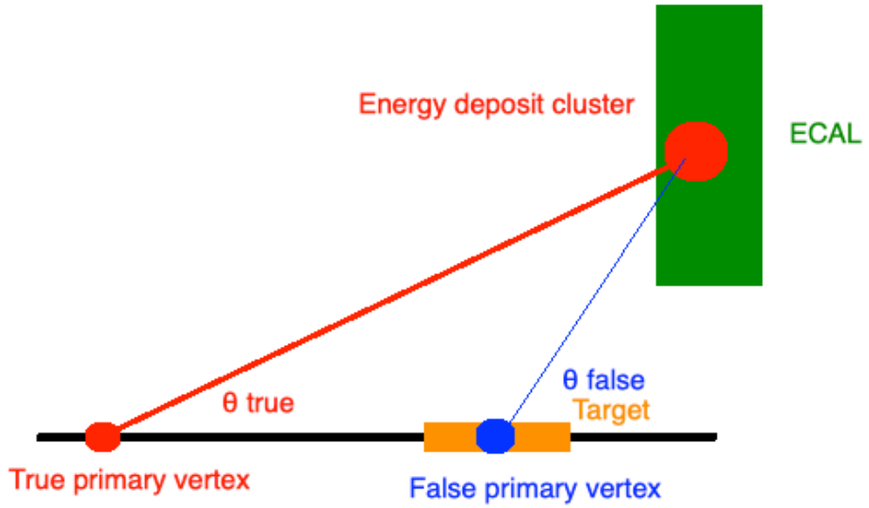




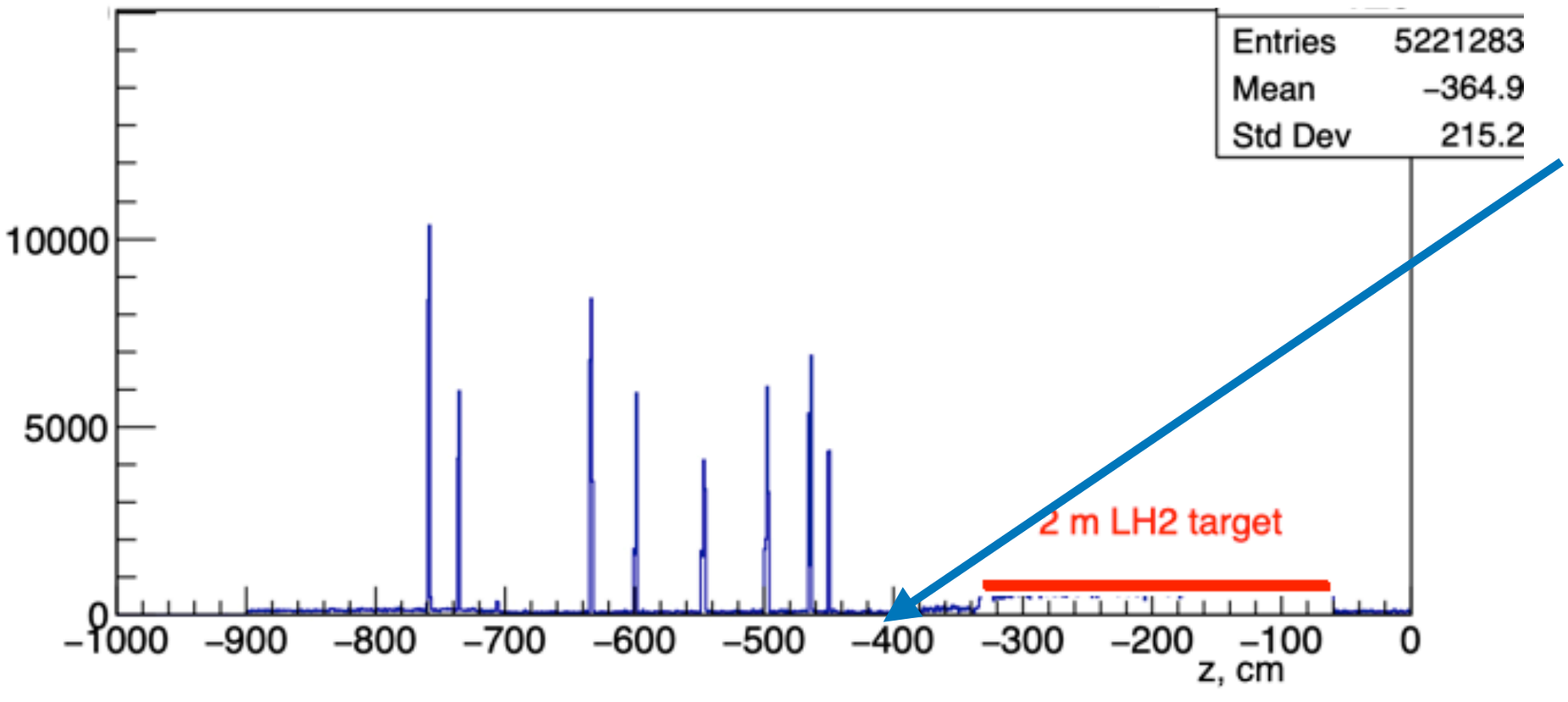
So, now we sure that neutral and charged clusters can be effectively separated, it is a question of further optimisation of the hodoscope (one or 2 coordinates, slab width, distance to the ECAL surface etc.

Shielding upstream the target



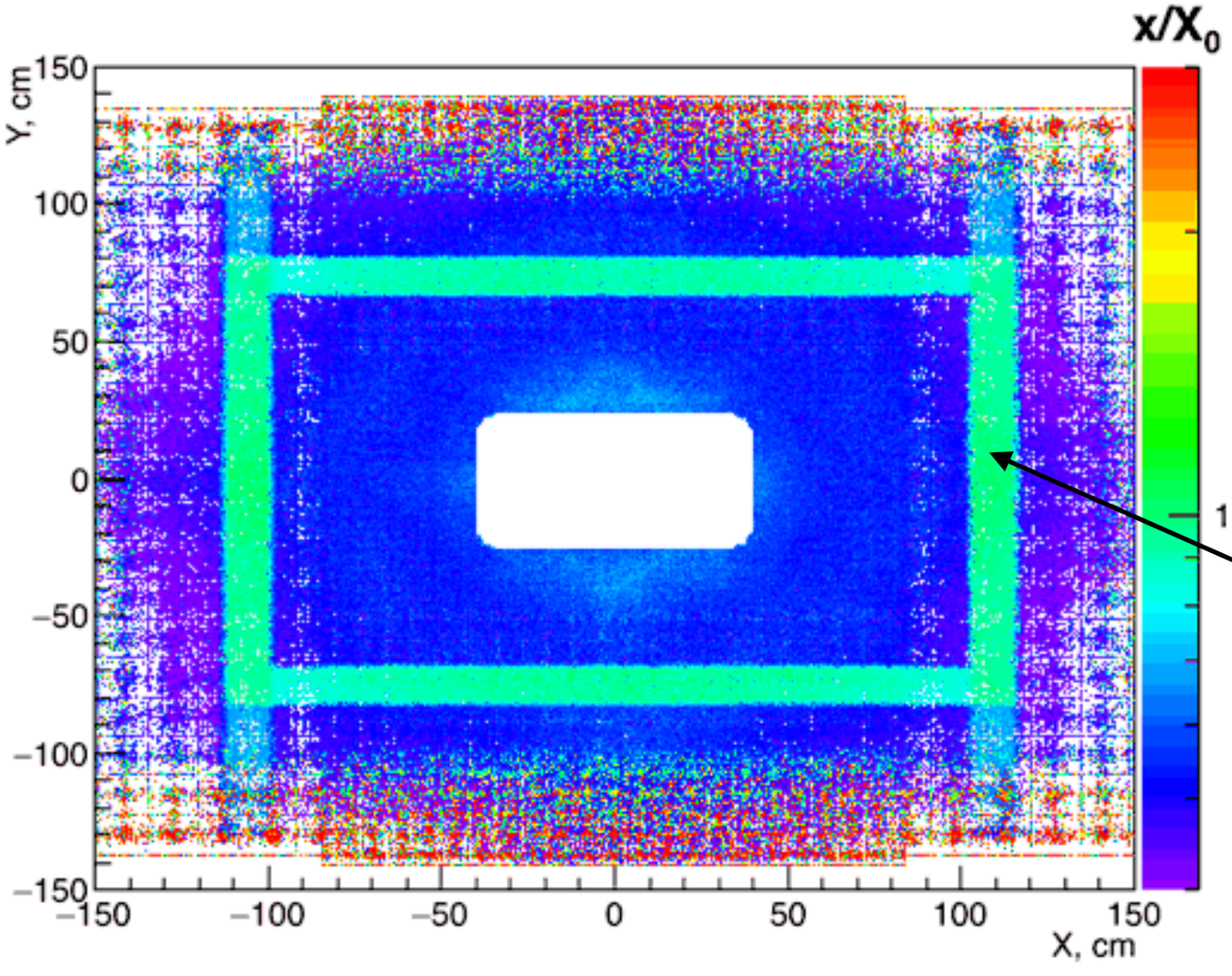


$$p_{T\,false} \gg p_{T\,true}$$



iron or concrete shielding

Setup transparency



Fraction of rad. lengths passed by photon from the target center to the ECAL1 acceptance

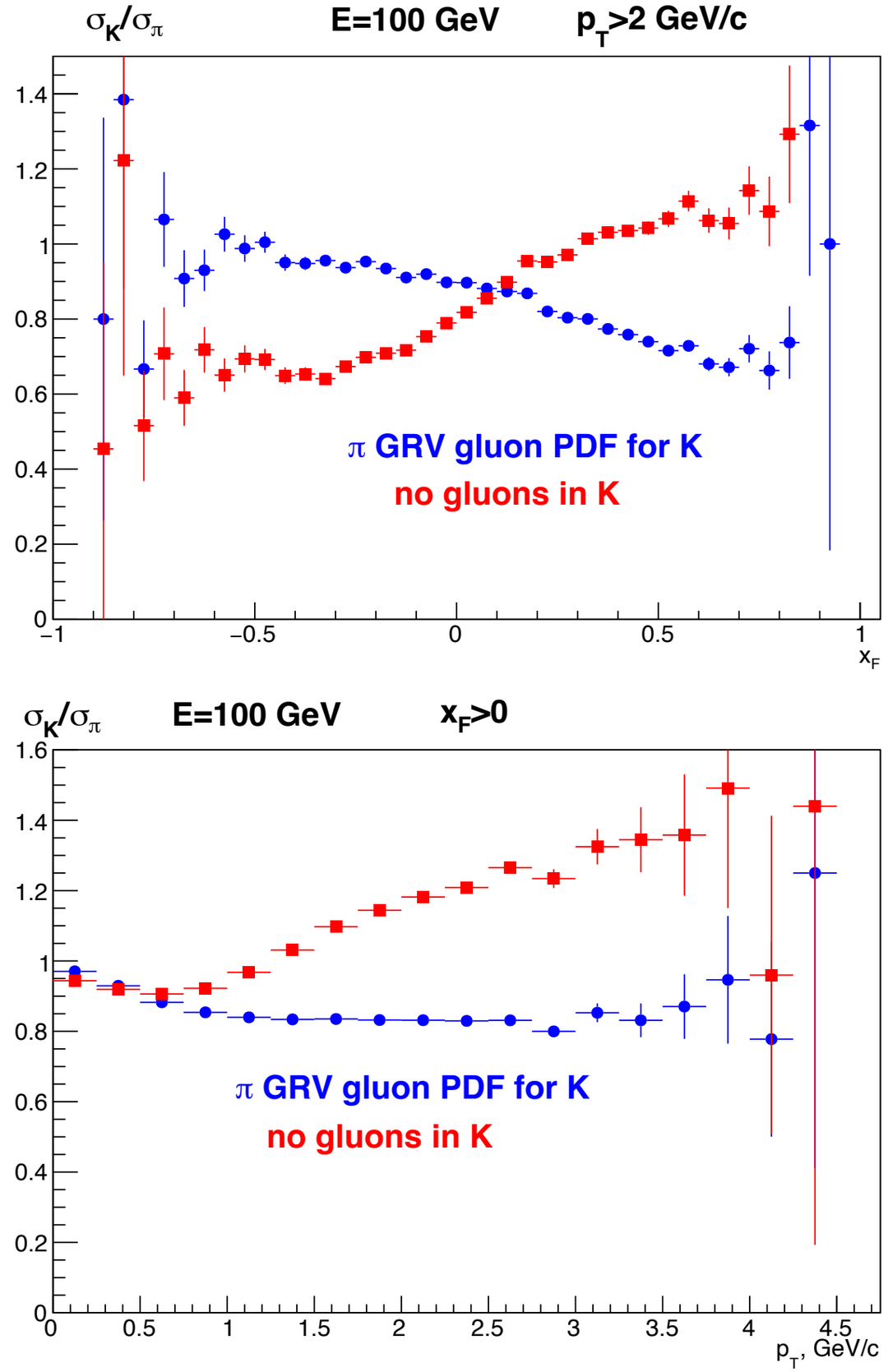
+20% of attenuation!

Trigger

- We should have ECAL0 and ECAL1 in the trigger
- Clusters with high p_T
- Digital trigger (?)

Not only prompt photons!

High-pT π^0 are not only a background fc prompt-photon signal. They also a **complimentary** way to access the gluor content!



100 GeV K+ beam (pion GRV PDF for gluons

LO

qg→qg	51 %
gg→gg	33 %
qq→qq	15 %
qqbar→qqbar	1 %
qqbar→gg	
gg→qqbar	

Summary

- Prompt-photon production is an instrument to access gluon content of kaon;
- COMPASS-based experimental setup looks to be convenient for study of the kaon-induced prompt-photon production but some optimization is needed;
- Production of high-pT neutral pions is a complimentary way to access gluons with the same experimental setup;
- AMBER Prompt-Photon working group works on preparation of the corresponding part of the Phase II Proposal.