Joint meeting PID and Calorimetry

Calorimetry working group perspective

- Electron identification is one of the main topics of the Calorimetry working group
- Identification is depends on activity of the three groups: calorimetry, PID, tracking
- Ideally 4π coverage by calorimetry
- Space for barrel limited, compact detector solutions
- Challenging region is electron endcap (backward region), expected degradation of the tracking momentum resolution, need very high resolution calorimetry. Adding material impact the resolution

Detector Matrix for the calorimeters

η	Nomenclature	EmCal						HCal			
		Energy resolution %	Spatial resolution mm	Granularity cm^2	Min photon energy MeV	PID e/π πsuppression	Technology examples*	Energy resolution %	Spatial resolution mm	Granularity cm^2	Technology solution
-3.5 : -2	backward	2/√E ⊕ 1	3/√E ⊕ 1	2x2	50	100	$PbWO_4$	50/√E⊕10	50/√E ⊕ 30	10x10	Fe/Sc
-2 : -1	backward	7/√E ⊕ 1.5	3(6)/√E ⊕ 1	2.5x2.5 (4x4)	100	100	DSB:Ce glass; Shashlik; Lead glass	50/√E⊕10	50/√E ⊕ 30	10x10	Fe/Sc
-1 : 1	barrel	(10-12) /√E ⊕ 2	3/√E ⊕ 1	2.5x2.5	100	100	W/ScFi	100/√E⊕ 10	50/√E ⊕ 30	10x10	Fe/Sc
1 : 3.5	forward	(10-12) /√E ⊕ 2	3/√E ⊕ 1	2.5x2.5 (4x4)	100	100	W/ScFi Shashlyk, glass	50/√E⊕ 10	50/√E ⊕ 30	10x10	Fe/Sc

*Technology selection depends on the space available
Several other technologies are under consideration

e/π: pion suppression depends on the energy, and the energy and momentum resolutions
Material in front will affect the resolution

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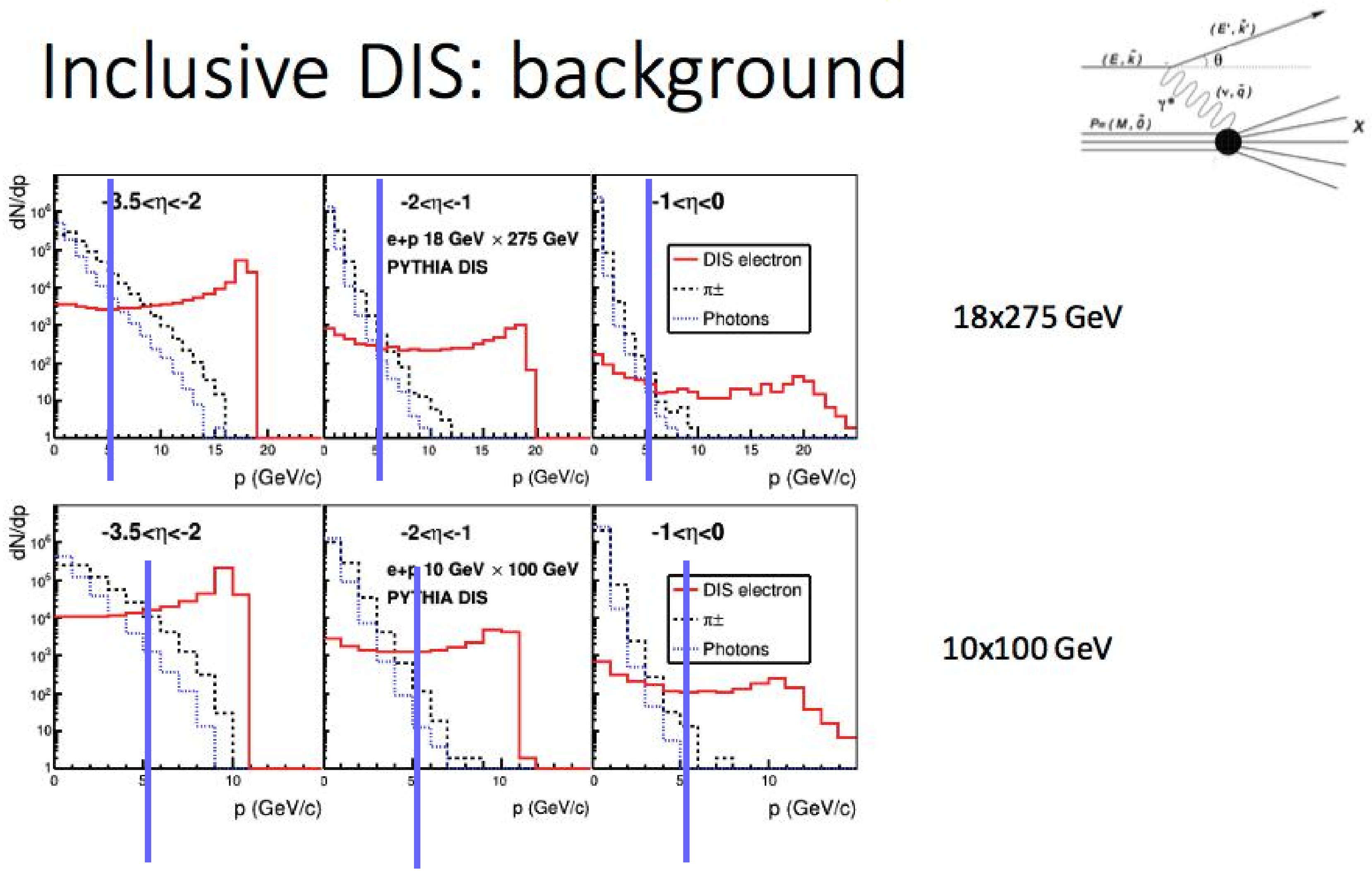
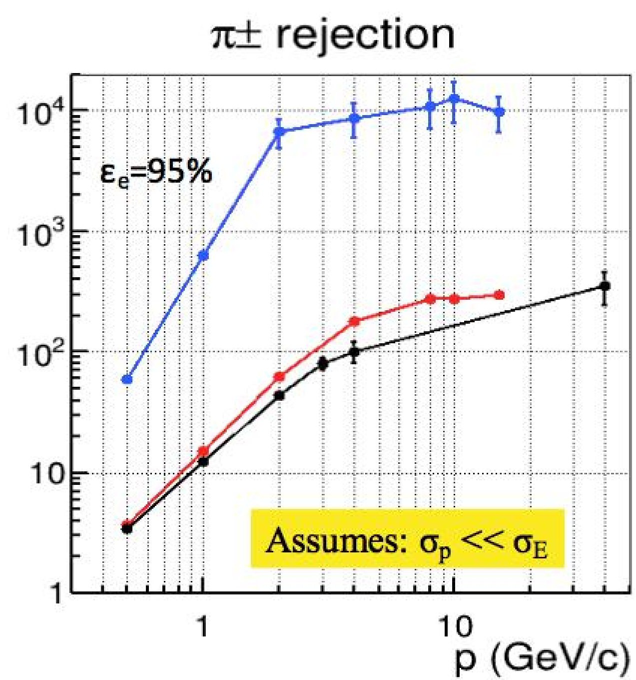
- More details see Alex Bazilevsky talk https://indico.bnl.gov/event/8231/contributions/37820/
- DIS electrons, DIS background: charge pions, photons from decays.
- Starting from high momentum expect clean sample of electrons
- Lower momentum <5 GeV/c eID is crucial



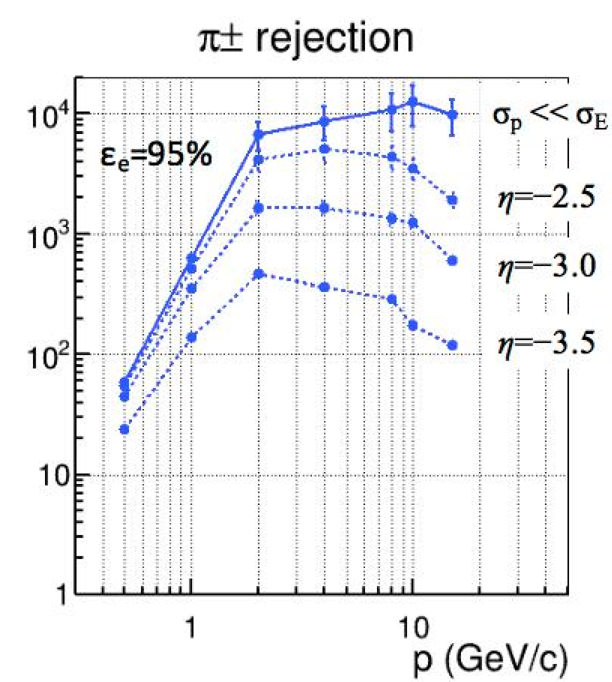
- Stand alone simulations
- No material in the way of EmCal in “ideal world”
- Perfect EmCal with no gaps, cracks
- Gaussian respond to electron
- Π± rejection with E/p cut applied for various calorimetry solutions
- Π± rejection dependence on momentum resolution in PWO case

	$PbWO_4$ Crystal	W/SciFi	PbSc
Depth, X_0	20	~20	18
$\frac{\sigma_E}{E}$	$\frac{2.5\%}{\sqrt{E}} \oplus 1\%$	$\frac{13\%}{\sqrt{E}} \oplus 3\%$	$\frac{8\%}{\sqrt{E}} \oplus 2\%$
Depth, λ_I	0.87	~0.83	0.85
e/h	>2		<1.3



E/p > 1 - 1.6 · σ_{EMC} to keep ε_e=95%

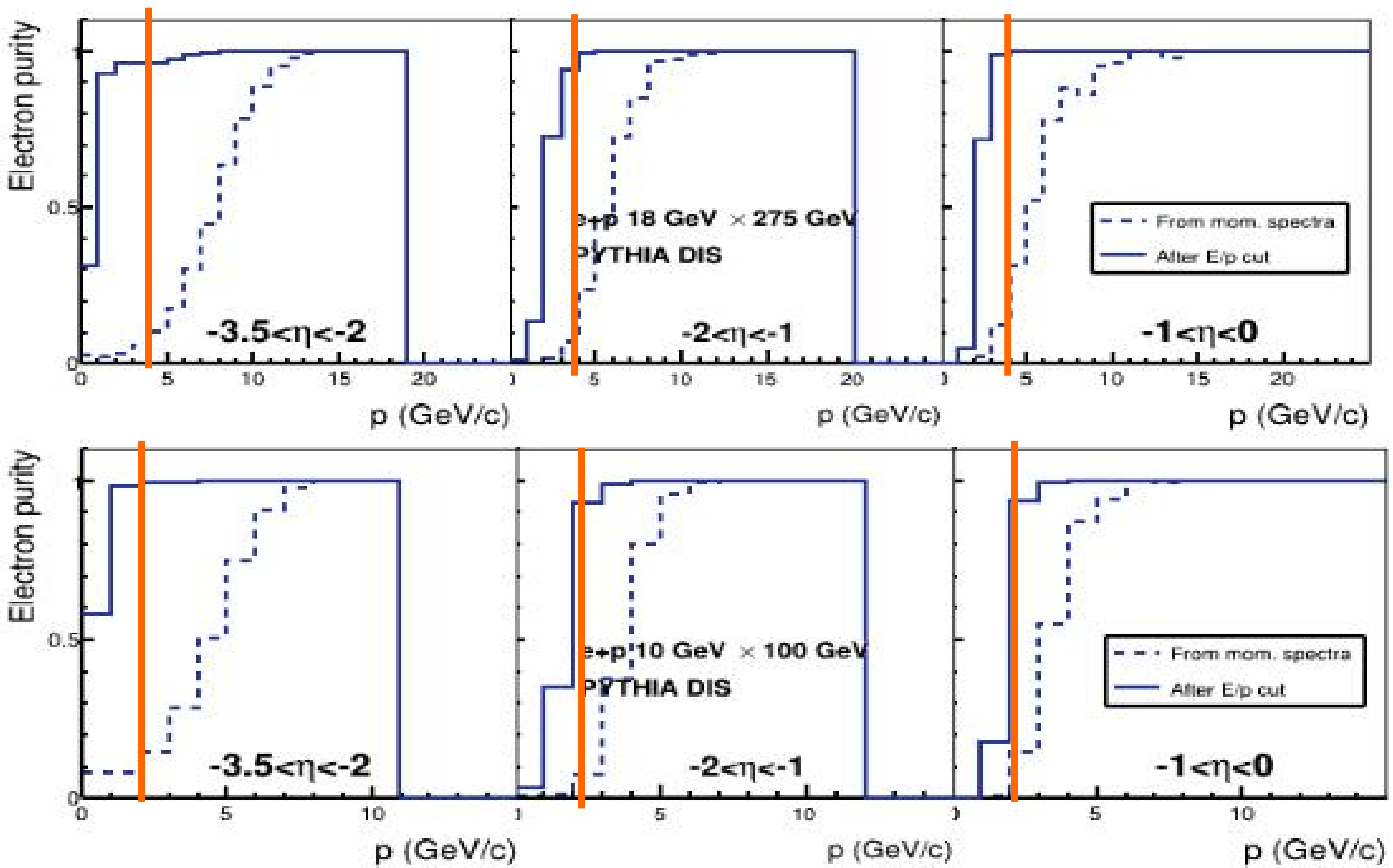
E/p > 1 - 1.6 · $\sqrt{\sigma_{EMC}^2 + \sigma_p^2}$ to keep ε_e=95%



- Simulation done for “Ideal world”
- Clean eID at <4GeV/c for 18x275
- Clean eID at <2GeV/c for 10x100
- More detailed studies results

DIS scattered electron purity

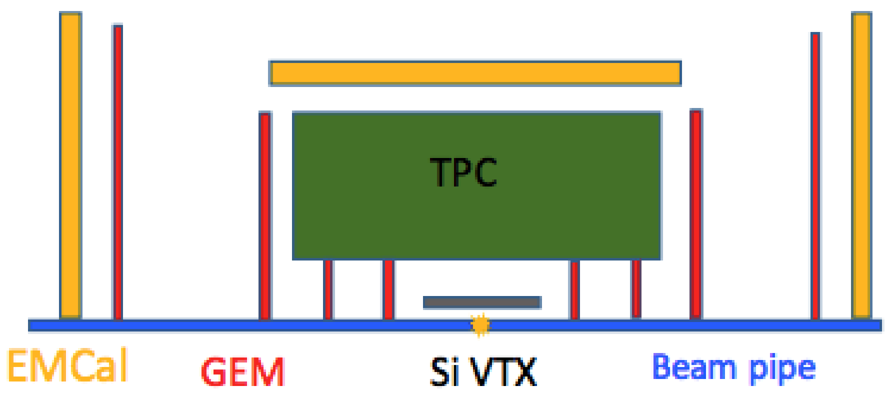
$-3.5<\eta<-2$	$-2<\eta<-1$	$-1<\eta<1$
$\frac{\sigma_E}{E} = \frac{2.5\%}{\sqrt{E}} \oplus 1\%$	$\frac{\sigma_E}{E} = \frac{7\%}{\sqrt{E}} \oplus 2\%$	$\frac{\sigma_E}{E} = \frac{12\%}{\sqrt{E}} \oplus 2\%$

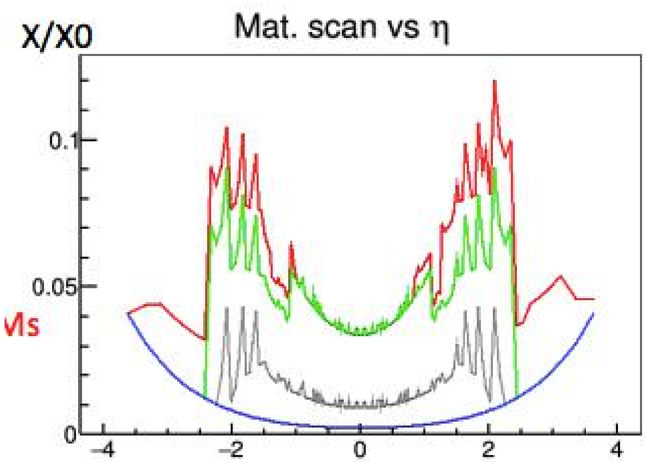


18 GeV x 275 GeV

10 GeV x 100 GeV

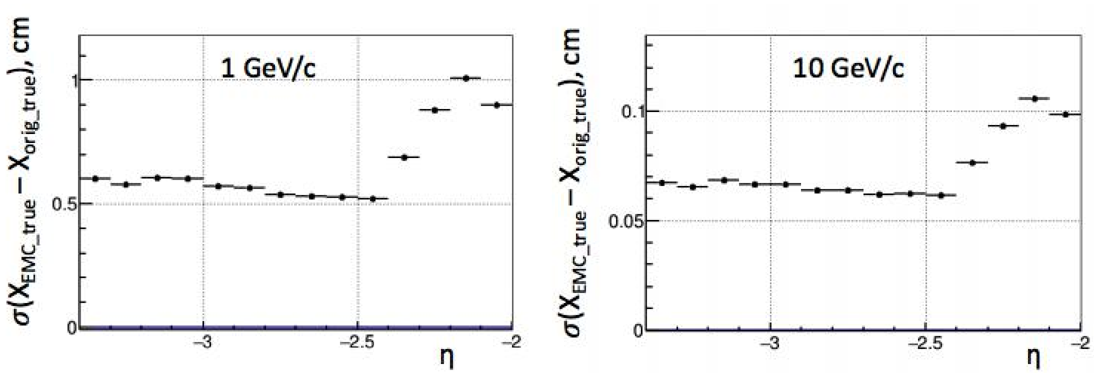
- Effect of the material in front of calorimeters, studies in progress
- https://indico.bnl.gov/event/8854/ More details
- Results for PWO calorimeter under specific configuration
- No PID detectors included, no dead material from services and gaps
- Effect dominant at low momenta



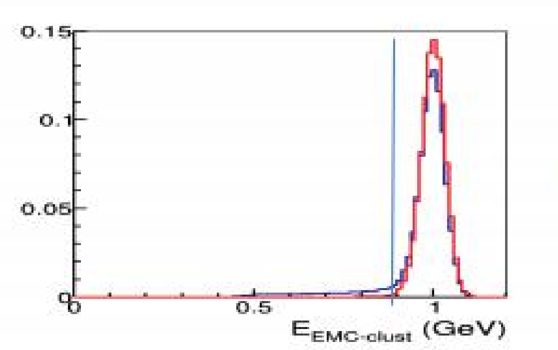


GEM: ~0.7% of X0 per plane

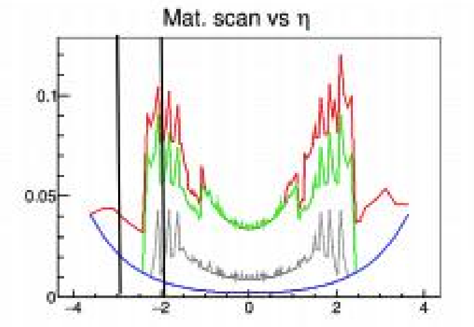
Electron position smearing (in cm) at the PWO EMCal due to multiple scattering



"Efficiency" of *e* reco

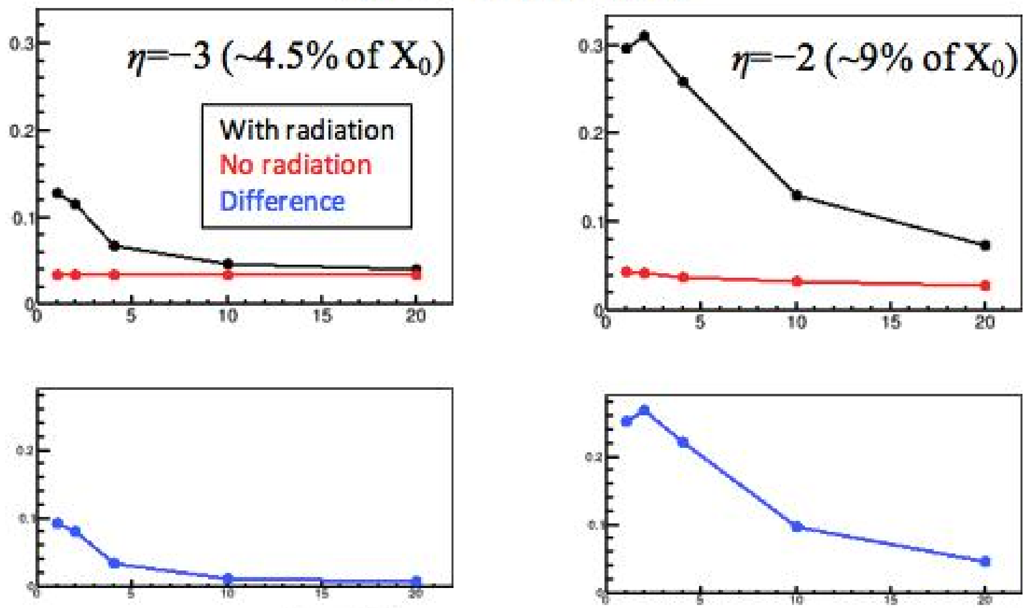


$E_{EMC} > E_{nom} - 2\,\sigma_{EMC}$



How electron is "modified" as seen by the EMCal

Losses vs p (GeV/c)



Expected to be 2.3% for a pure gaussian response

Huge effect from η=−3 to η=−2

Discussion topics:

- Technology solution for various momentum regions, especially <(2-3)GeV/c
- Threshold, lowest momentum
- Dead material introduce by PID detectors services
- Material budget close to IP and in front of the calorimeter towers
- Complementarity of various solutions
- Path forward