Electron momentum reconstruction study with PANDARoot

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Outlook

- Studies of e^- momentum reconstruction with Kalman Filter.

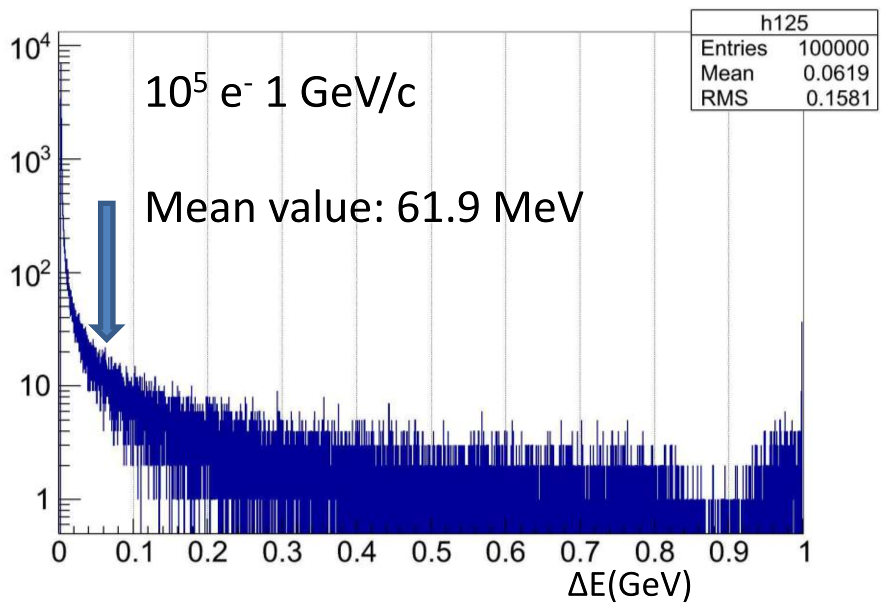
- Studies of Bremsstrahlung γ emission.

- Our proposal: use the measured Bremsstrahlung photon energy in EMC to solve the problem of e^- momentum reconstruction with Kalman Filter.

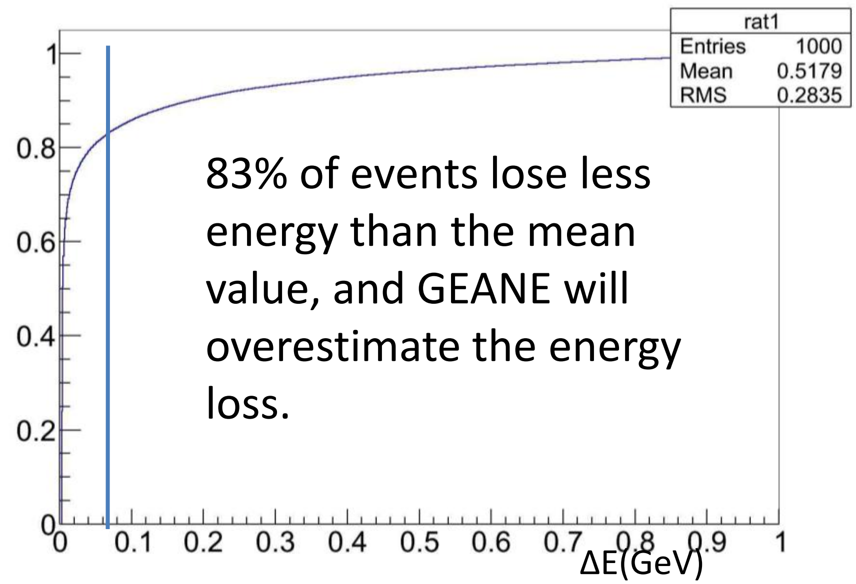
Problem of e^- reconstruction with Kalman Filter

- Track follower of Kalman Filter(KF): GEANE
- GEANE calculates the mean electron energy loss and the rms, but Bremsstrahlung is highly non-gaussian!

Electron energy loss in tracking system



Proportion of events with energy loss below ΔE

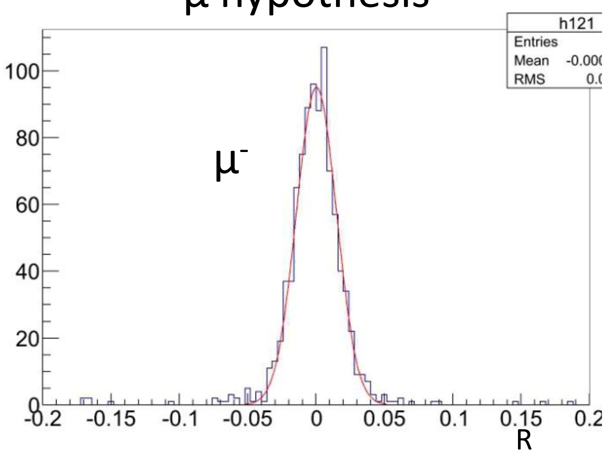


So, KF can not handle the problem correctly

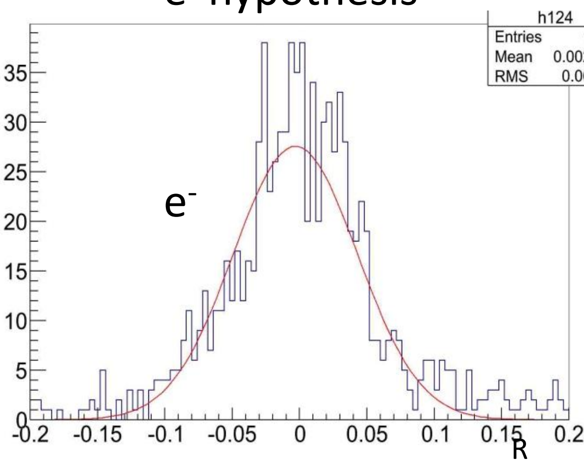
e^-/μ^- momentum reconstruction with KF

P = 1GeV/c, ϑ= 90°, ϕ = 120°.

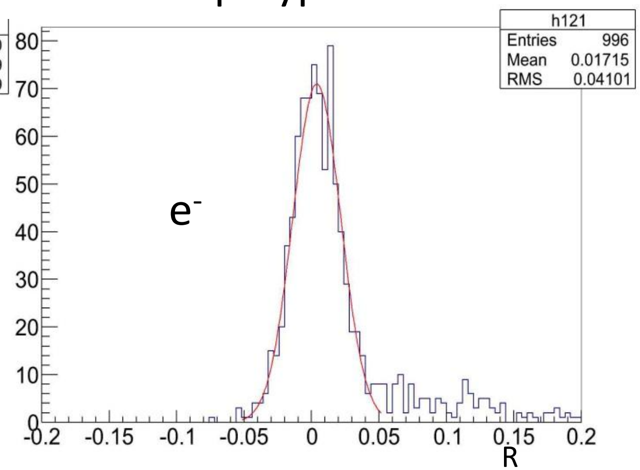
μ hypothesis



e^- hypothesis



μ hypothesis



$R = (P_{MC}-P_{rec})/P_{MC}$

	μ (μ hypo)	e^- (e^- hypo)	e^- (μ hypo)
Mean(gauss)	<0.1%	-0.32%	0.37%
Sigma	1.6%	4.6%	1.8%

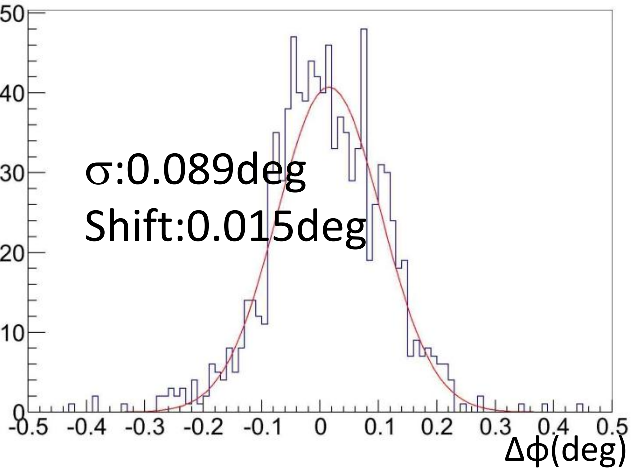
e^- hypothesis: Bremsstrahlung taken into account in GEANE.
μ hypothesis: only multi scattering and ionization in GEANE

e^- with e^- hypothesis: momentum resolution very bad (σ=4.6%).
e^- with μ hypothesis: better result but with large tails.

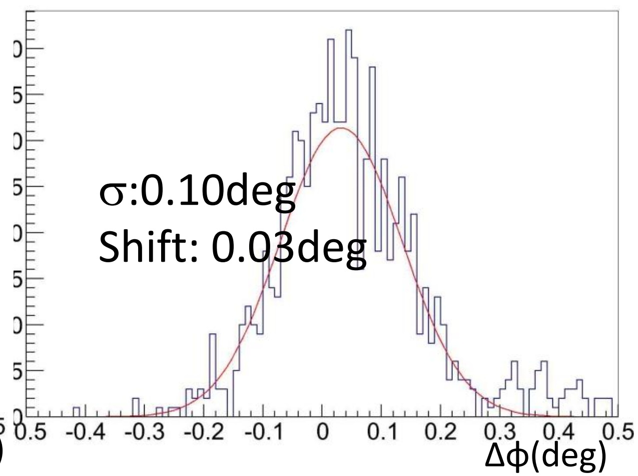
e^- and μ^- angular resolutions

P=1GeV/c, ϑ=90° , ϕ=120°

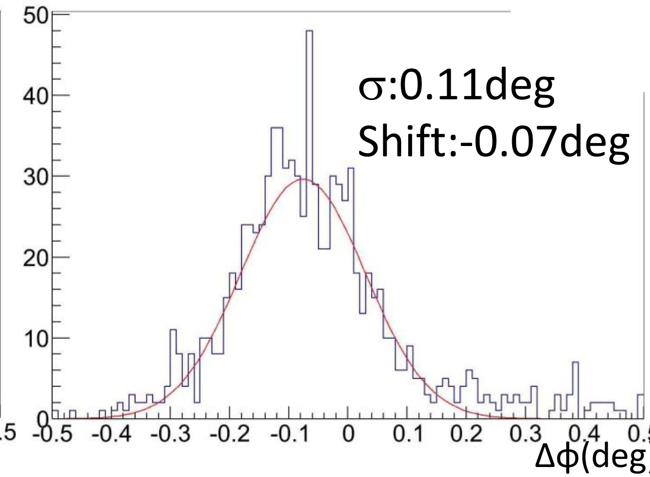
μ^- (μ hypothesis)



e^- (μ hypothesis)



e^- (e^- hypothesis)



	$\sigma(\phi)$ (deg)	$\sigma(\vartheta)$ (deg)
μ^- (μ hypothesis)	0.089	0.066
e^- (μ hypothesis)	0.10	0.068
e^- (e^- hypothesis)	0.11	0.068

Good angular resolution for e^- with μ hypothesis.

Tiny worsening of angular resolution for electron.

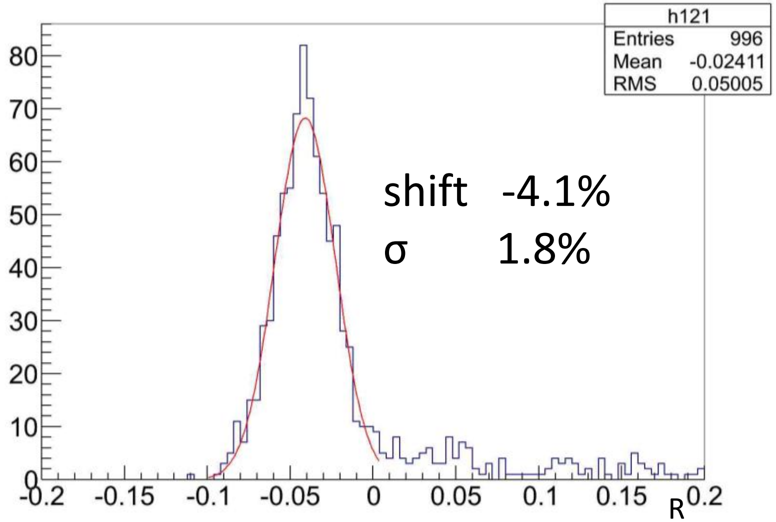
Small shifts: 0.03 deg. This is due to the fact that photons are emitted in the direction of the electron.

Proposal from Lia

- Hypothesis: the bad resolution for the electron hypothesis is due to the treatment of the fluctuation of energy loss in the case of Bremsstrahlung.
- Set the error of energy loss due to Bremsstrahlung in GEANE to 0. (σ_2: multi scattering, ionization, ~~Bremsstrahlung~~)
- Energy loss: mean value. (ΔE: multi scattering, ionization, Bremsstrahlung)

$$x(t_2) = \frac{\frac{m}{\sigma_m^2} + \frac{x(t_1,t_2)}{\sigma_2^2}}{\frac{1}{\sigma_m^2} + \frac{1}{\sigma_2^2}}$$

Pt = 1GeV/c, ϑ= 90°, ϕ = 120°, e^- hypothesis



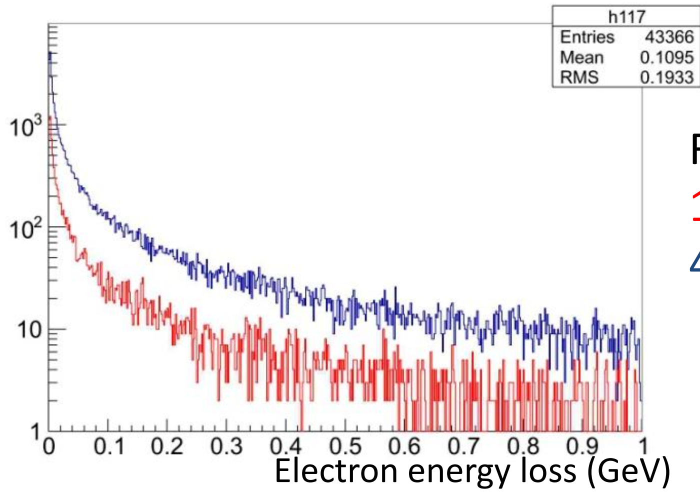
Better resolution than in electron hypothesis.(σ=4.6%→1.8%)

But 4% of shift for the peak, the tail is not reduced.

Setting the fluctuation of Bremsstrahlung to zero can not solve our problem perfectly .

Can the Bremsstrahlung γ be recovered in the EMC?

Photons emission in the tracking system



For 100 000 e^-, P_t=1 GeV/c, ϑ= 90°, ϕ=120°

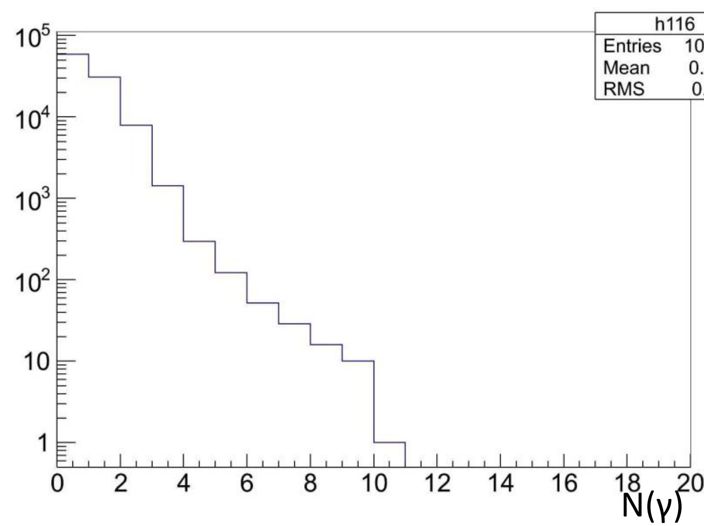
10200 photons created in STT

43300 in MVD

Threshold of photon energy: 1MeV

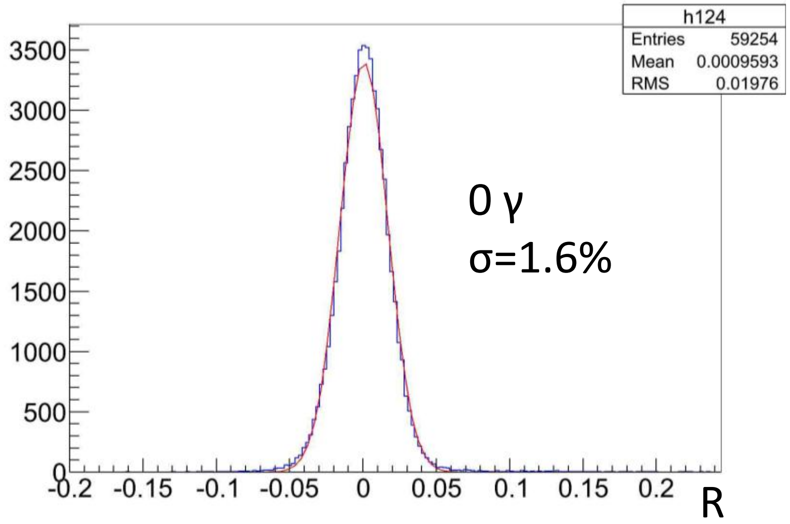
Numbers of γ	Percentage(%)
0	59.1
1	30.7
2	7.8
3 and more	2.4

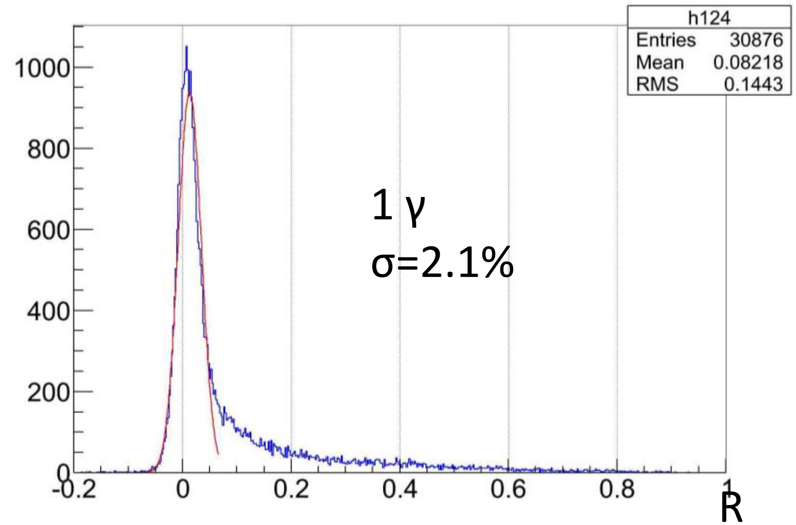
Numbers of photons created in STT+MVD

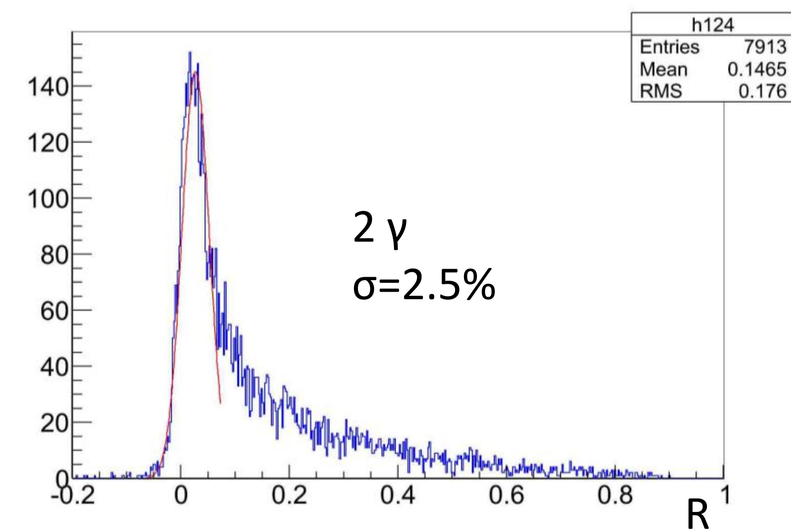


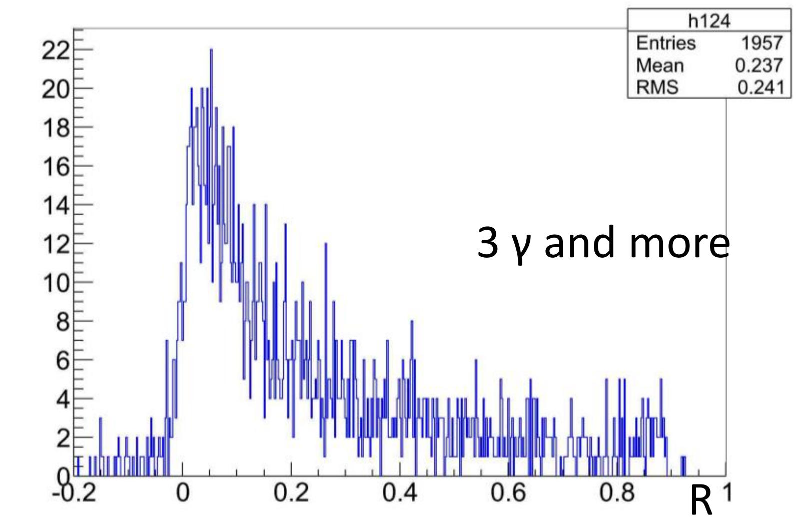
Momentum resolution for different numbers of γ

10^5 e^- 1 GeV/c, ϑ=90°, ϕ = 120°, μ hypothesis, Eγ > 1MeV





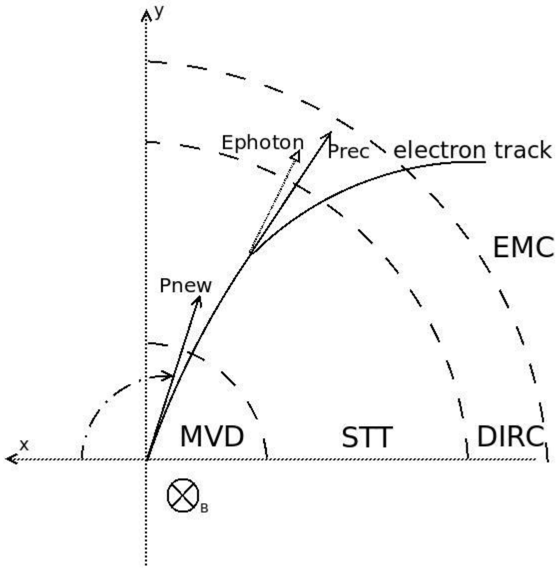




$R = (P_{MC}-P_{rec})/P_{MC}$

Our proposal

- Handle the problem event by event, and use the Bremsstrahlung γ.
- Initial value of momentum reconstructed with μ hypothesis. (P_{rec})
- Searching the Bremsstrahlung γ in the EMC.(E_{γ})
- Add the energy of γ to the reconstructed e^- momentum. $P_{new} = P_{rec} + E_{\gamma}$



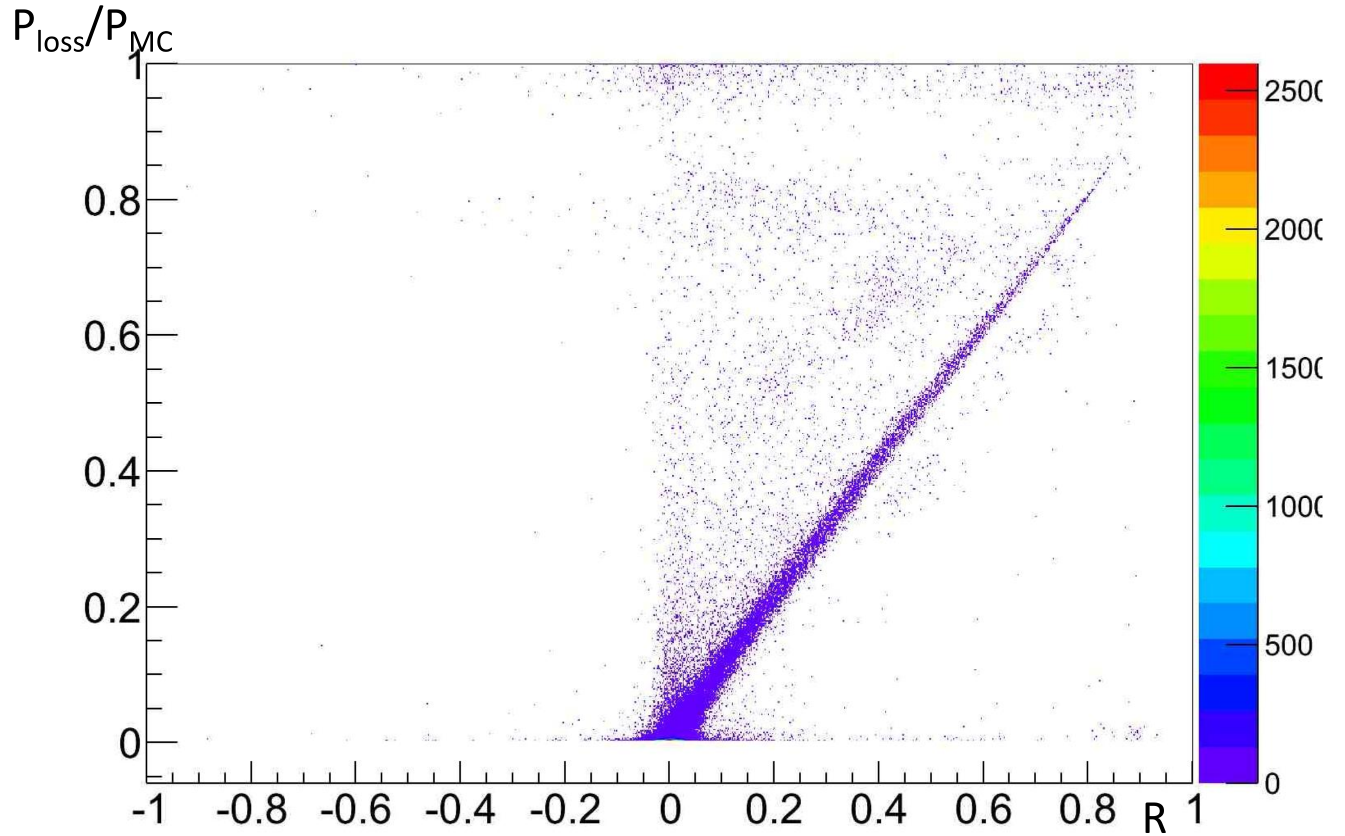
Correlation between resolution and e^- momentum loss

P_{loss}
Momentum loss in the tracking system

$R = (P_{MC}-P_{rec})/P_{MC}$

P_{MC}: e^- momentum at the level of MC

P_{rec}: reconstructed momentum by μ hypothesis

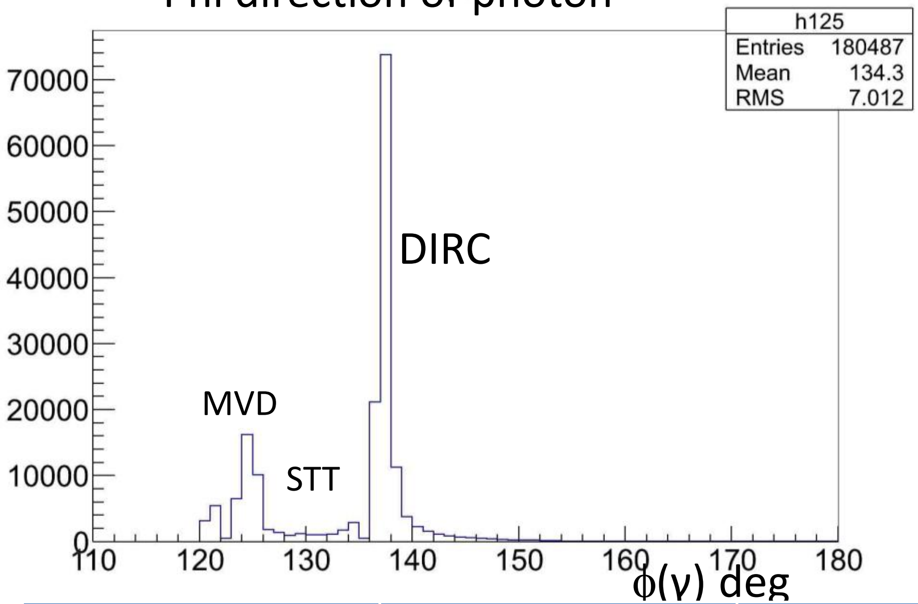


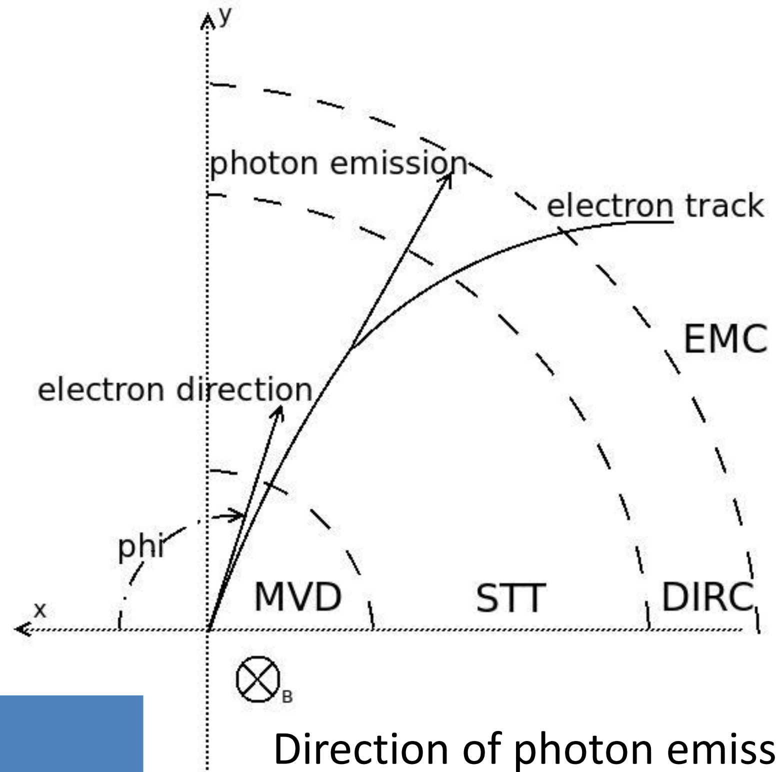
The KF reconstructs the momentum after γ emission with a good resolution.
→***Adding the γ energy should improve the resolution?***

Photon direction from MC

e^- 1GeV/c, ϑ=90°, ϕ = 120 °

Phi direction of photon



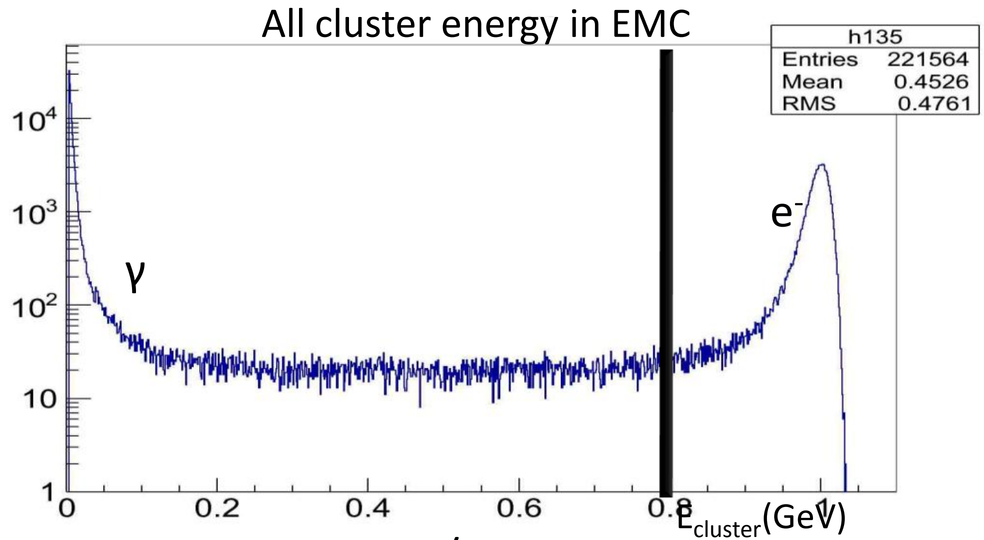


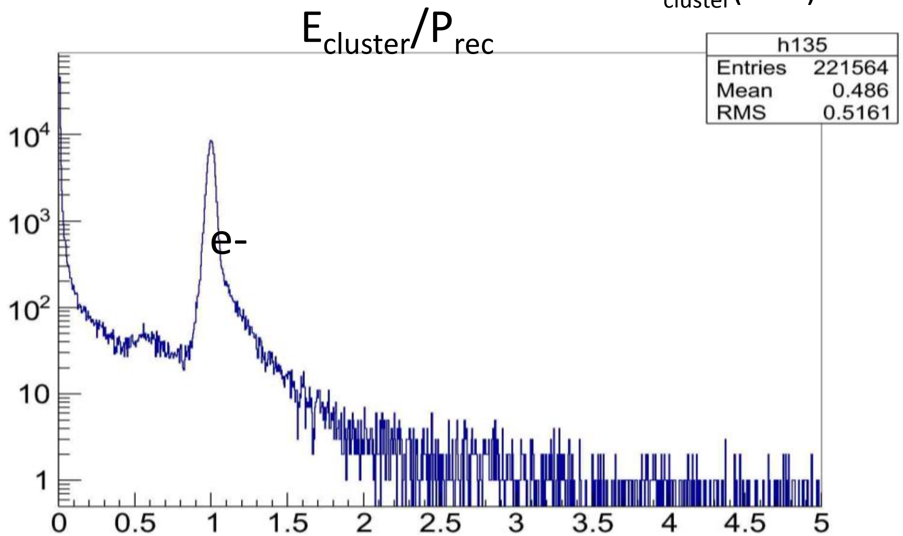
	Phi photon(deg)	Phi electron(deg)
MVD(0-16cm)	120 - - 126	120 - - 125.6
STT(16-40cm)	126 - - 135	125.6 - - 134
DIRC(40-50cm)	135 - - 139	134 - -137.2

Direction of photon emission = Direction of electron

threshold of tracking system and DIRC: 135 deg

Global cluster energy in EMC





rough selection of gamma came from tracking system:

→ e^-

(rejected by $E_{cluster}/P_{rec}$)

$0.9 < E_{cluster}/P_{rec} < 1.2$

→γ

γ from tracking system (which we need)

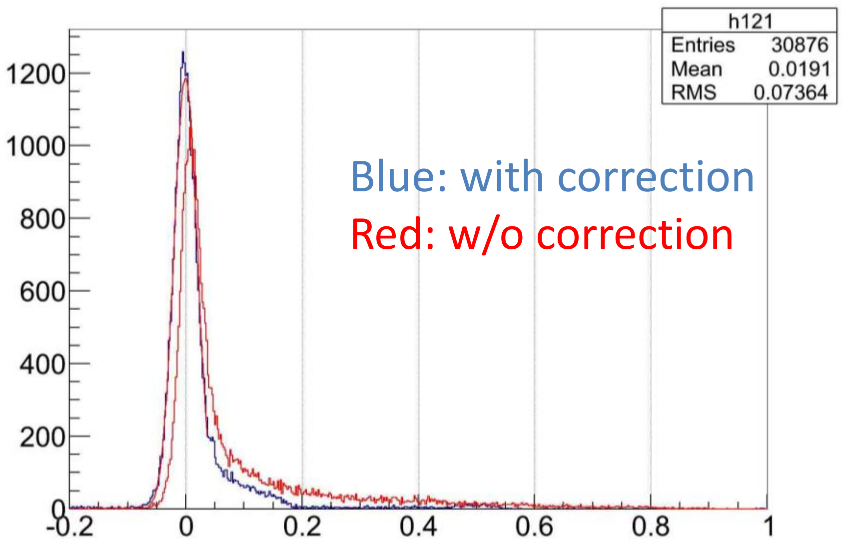
120<phi<135

γ from DIRC (rejected by phi)

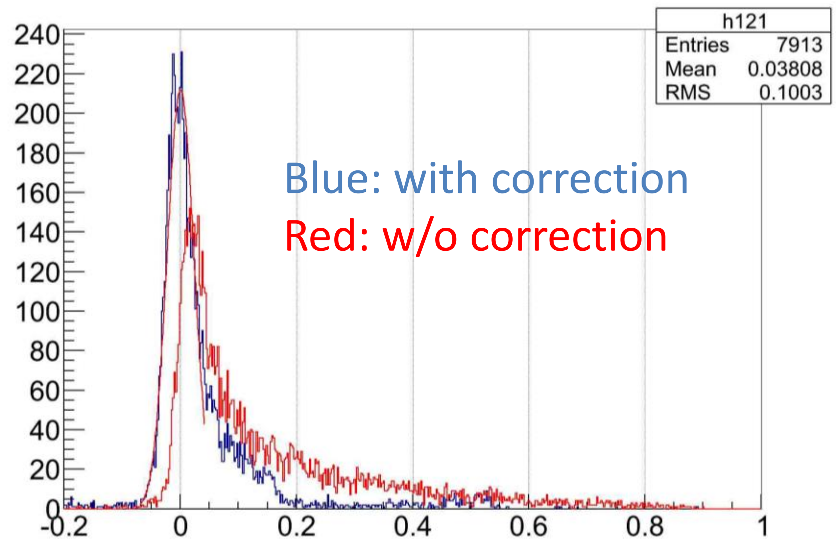
phi>135

Preliminary result

Momentum resolution for 1 photon emission



Momentum resolution for 2 photon emission



N(γ)		Mean(gauss fit)	Sigma(gauss fit)
1 gamma	With E(γ)	<0.01%	2.0%
	w/o E(γ)	1.2%	2.0%
2 gamma	With E(γ)	<0.1%	2.3%
	w/o E(γ)	2.5%	2.4%

Shift of the peak reduced to 0

Width almost unchanged

Conclusion

- Adding the photon energy from EMC to the reconstructed energy of electron can reduce the tail of resolution peak.

- On-going work:

→better selection of cluster due to photon from tracking system.

→apply this method to all angle and a range of momentum of electron.

Backup slides

Kalman Filter and particle hypothesis

$$x(t_2) = \frac{\dfrac{m}{\sigma_m^2} + \dfrac{x(t_1, t_2)}{\sigma_2^2}}{\dfrac{1}{\sigma_m^2} + \dfrac{1}{\sigma_2^2}}$$

GEANE:
mean: ΔE
σ_2: multi scattering, ionisation, bremsstrahlung

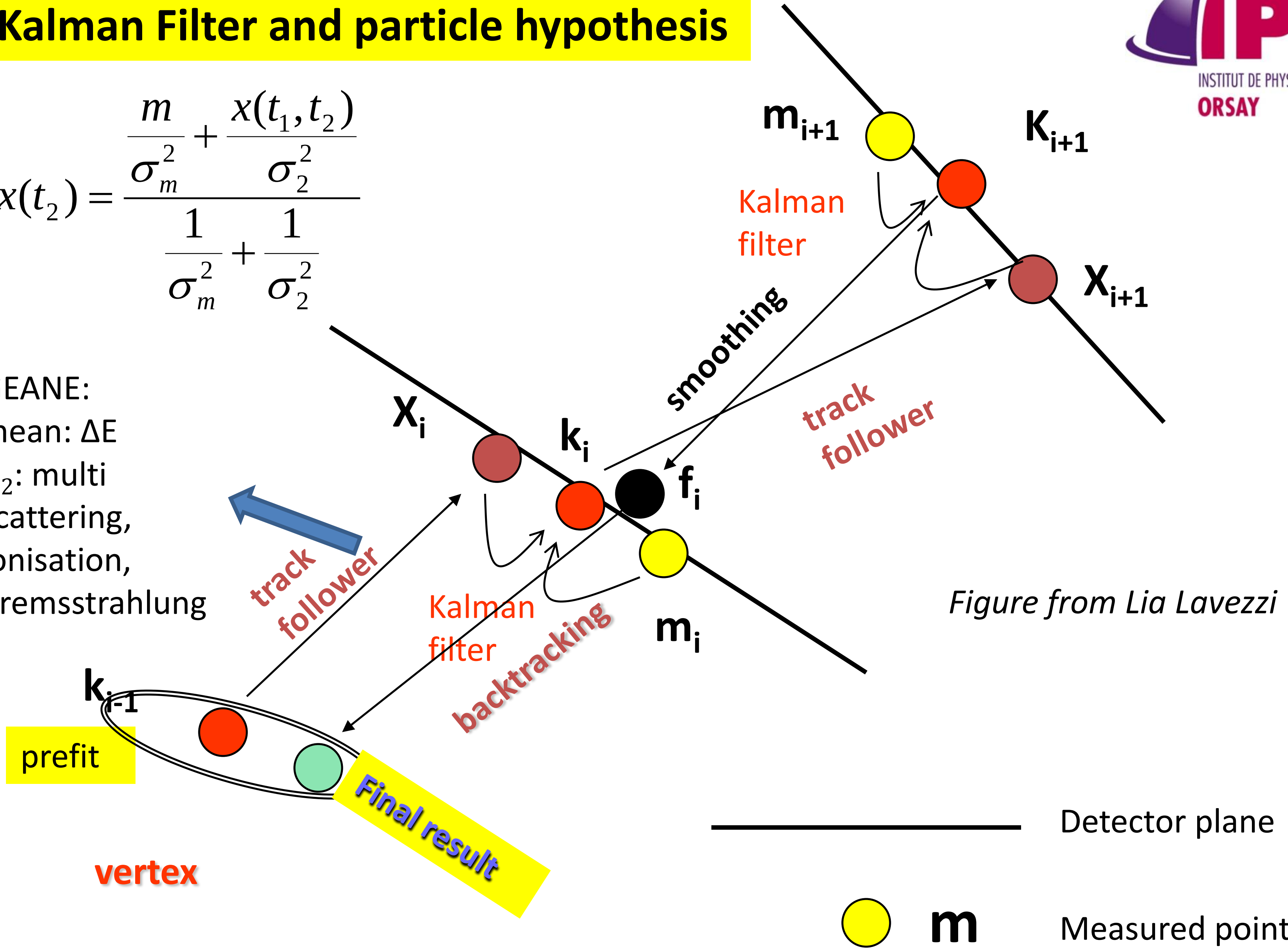


Figure from Lia Lavezzi