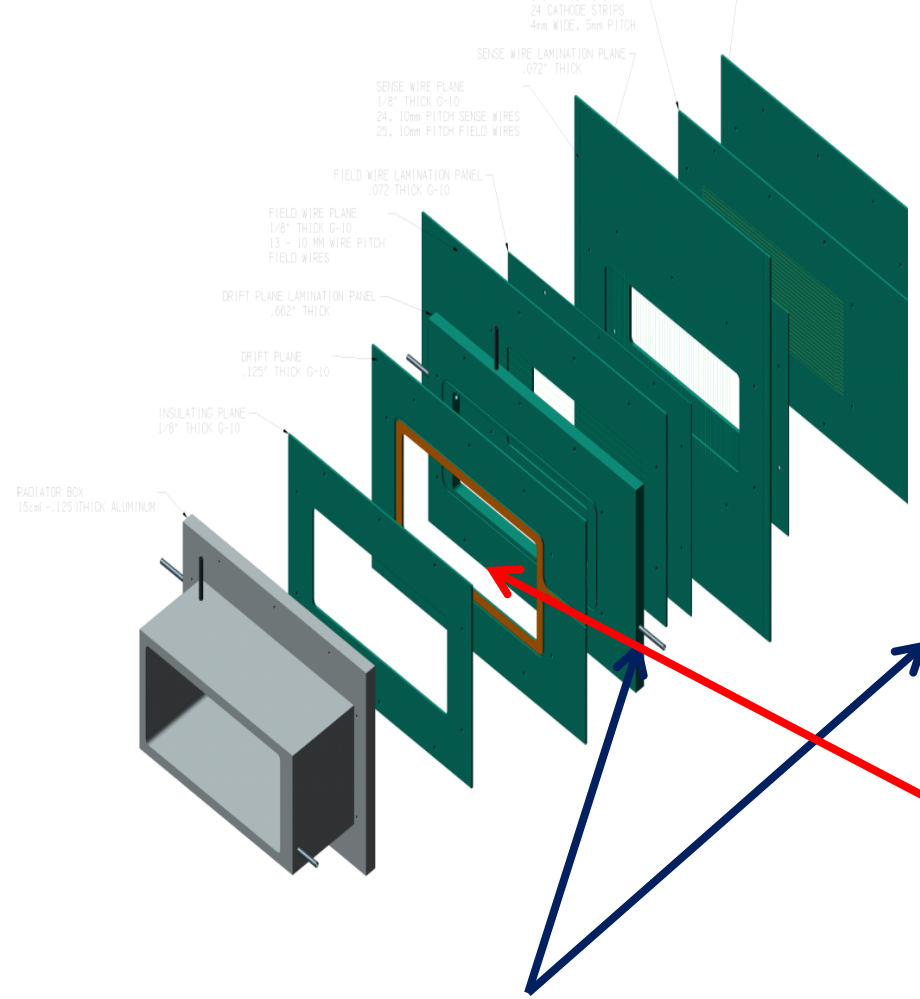
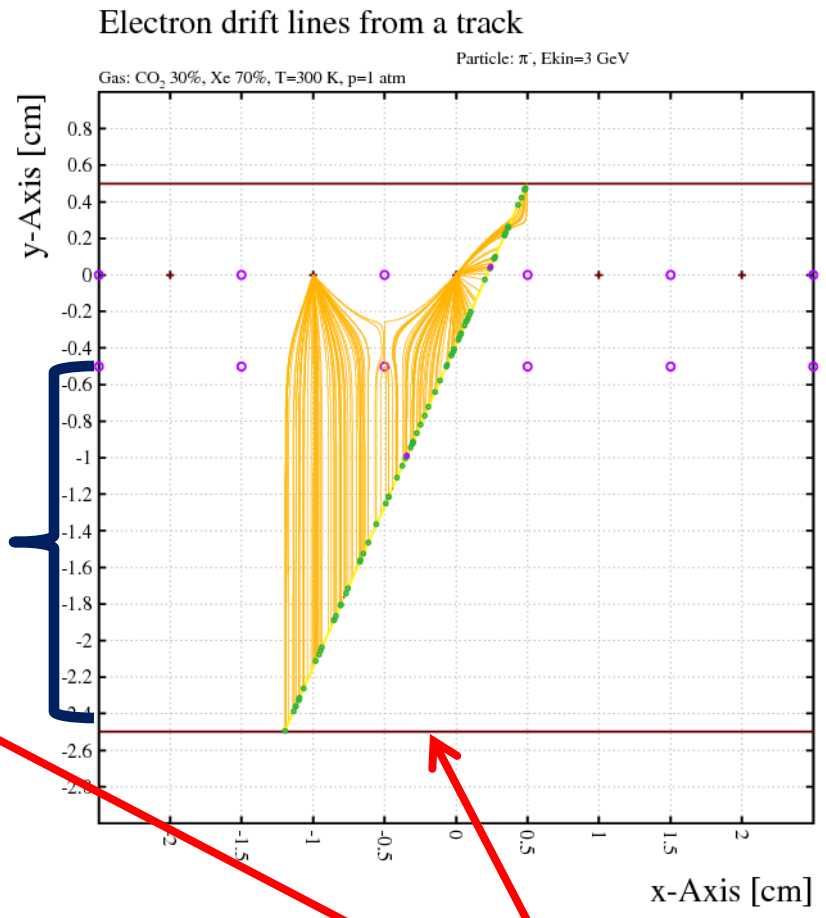
TRD: status and future plans

- Short update from the latest TRD tests
- Why do we need TRD?
  - Pion suppression with calorimeters
  - Including dE/dx from CDC
  - Complications in J/ψ analysis
- Possible physics
- Other advantages
- Possible configuration
- Cost estimates

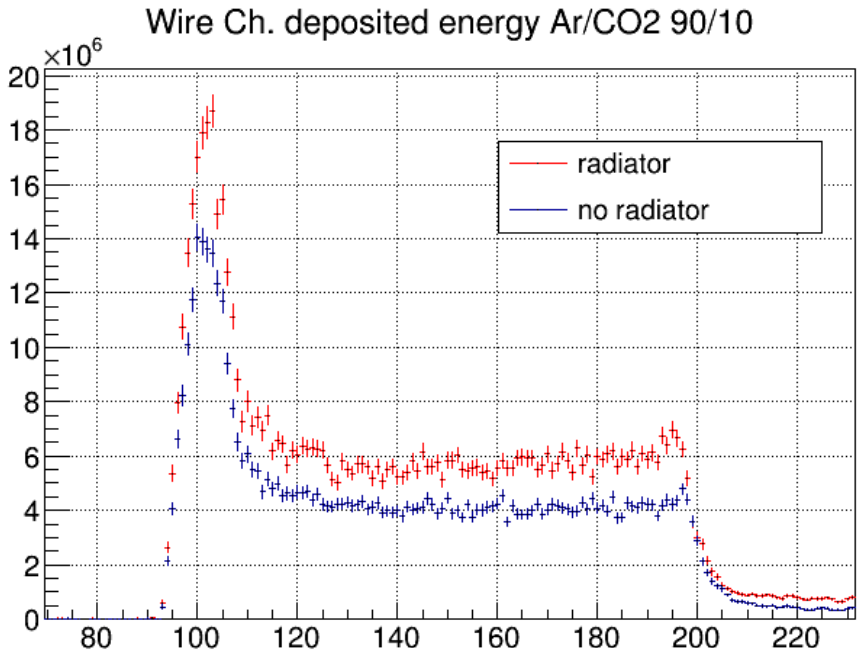
Spring 2018 tests – two modifications

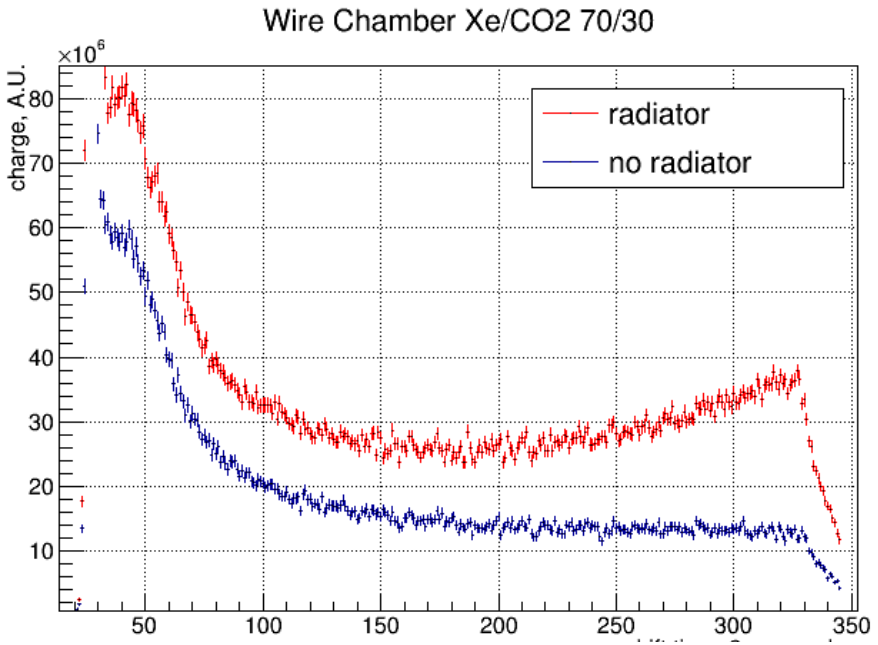




1. Drift distance increased from 2cm to 3cm – more TR photons will interact
2. Entrance cathode foil replaced: Aluminized (3μ Al) Kapton → Chromium (0.1μ)

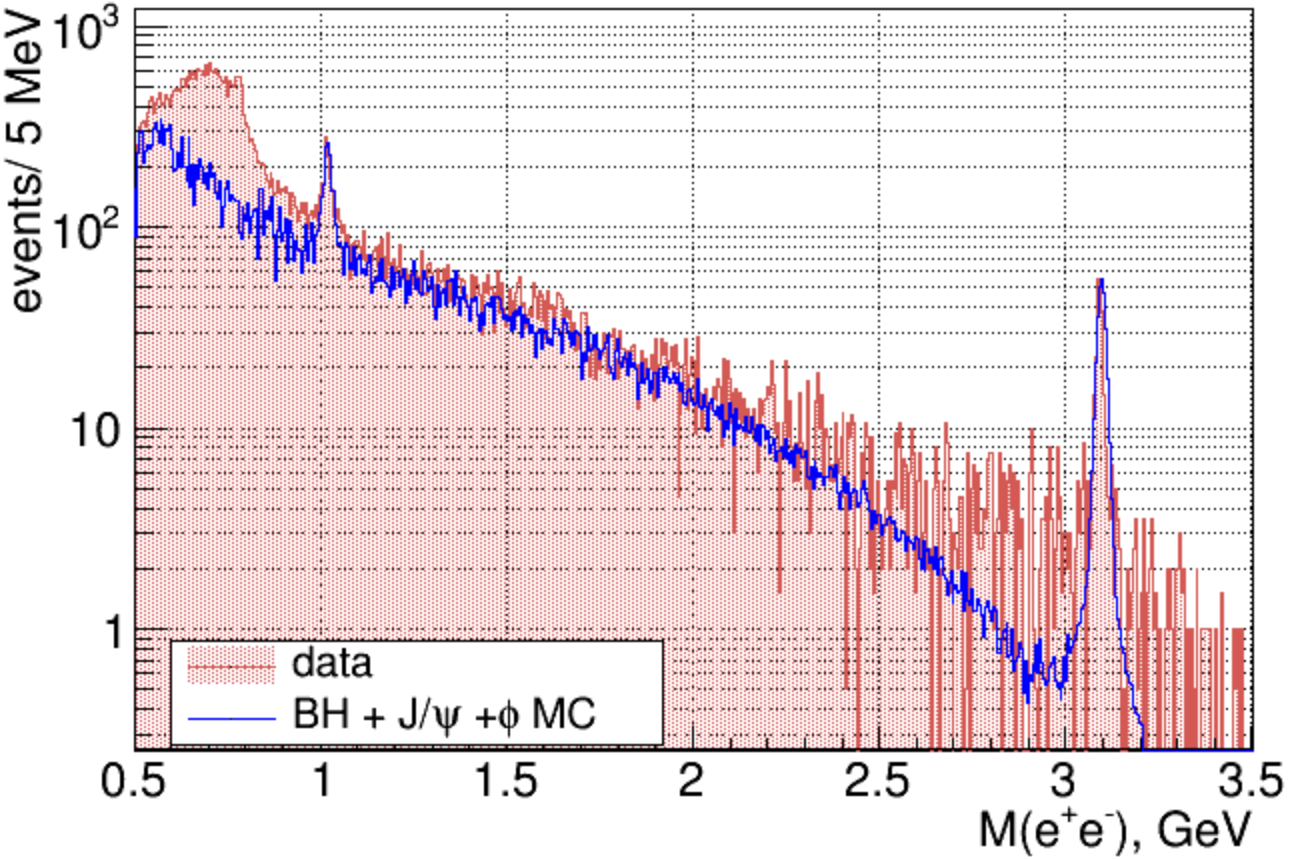
TRD prototyping: spring 2018 tests





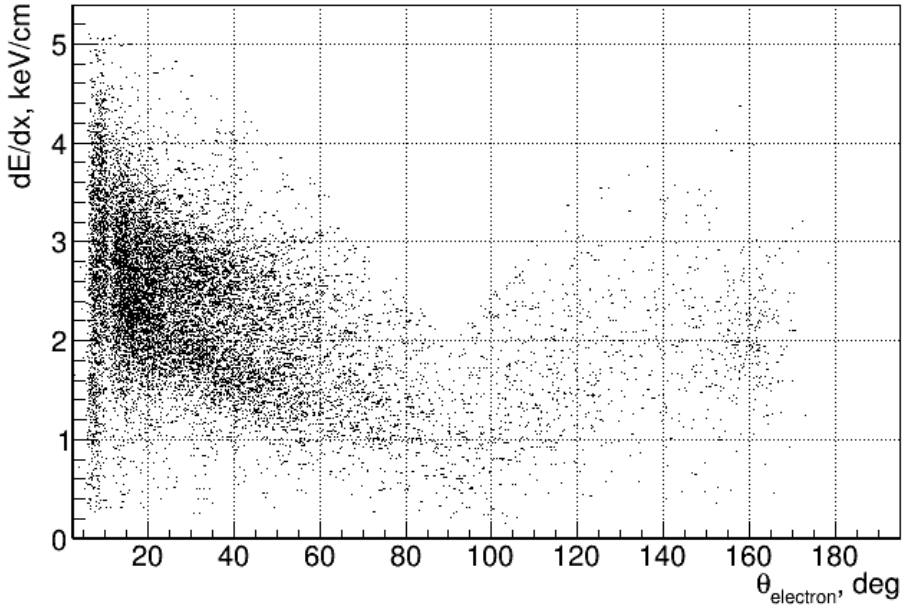
Best results so far – flat distr. with Ar and enhancement with Xe
Need little more work with field wire HV (will do it during next run)

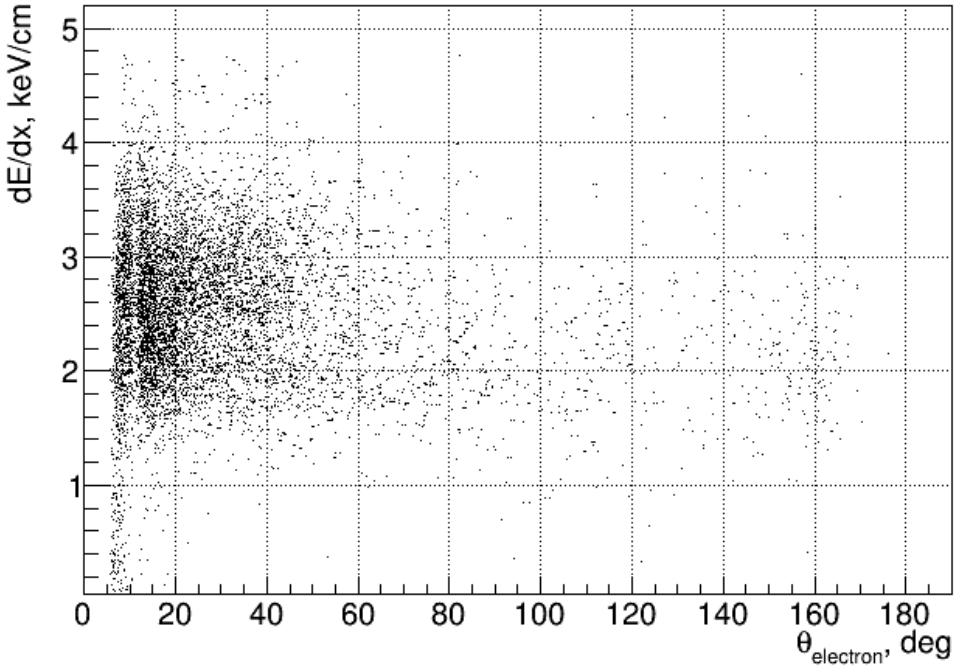
Pion background with the current detectors

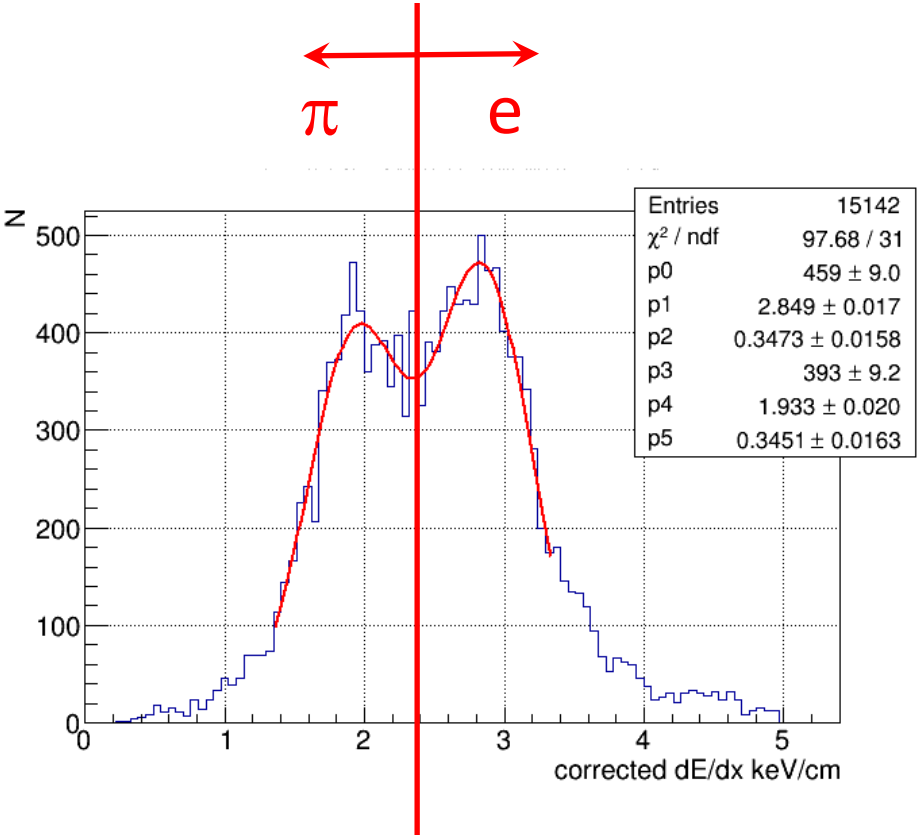


Currently 36% π contamination in $1.5<M(e^+e^-)<2.5$ GeV
Using all available cuts, except dE/dx from CDC

Pion background estimation – using dE/dx from CDC

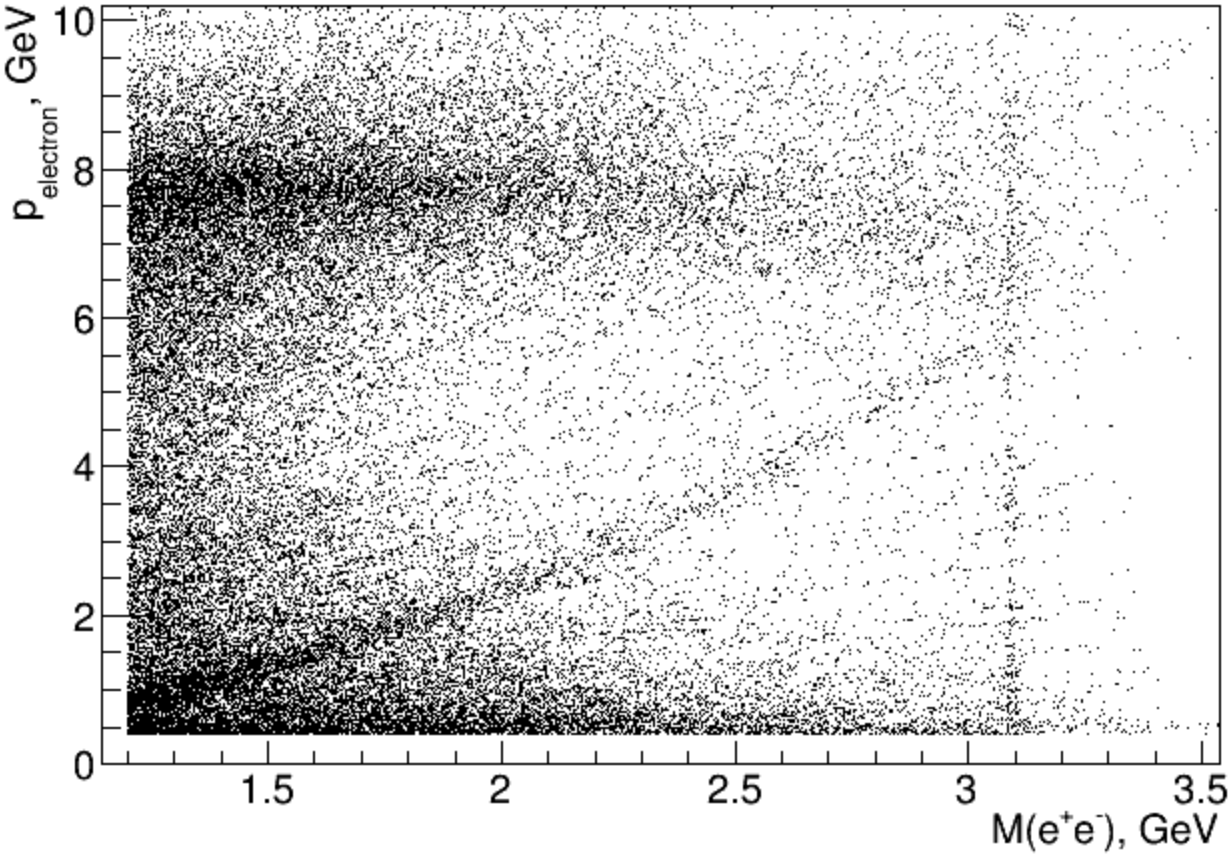






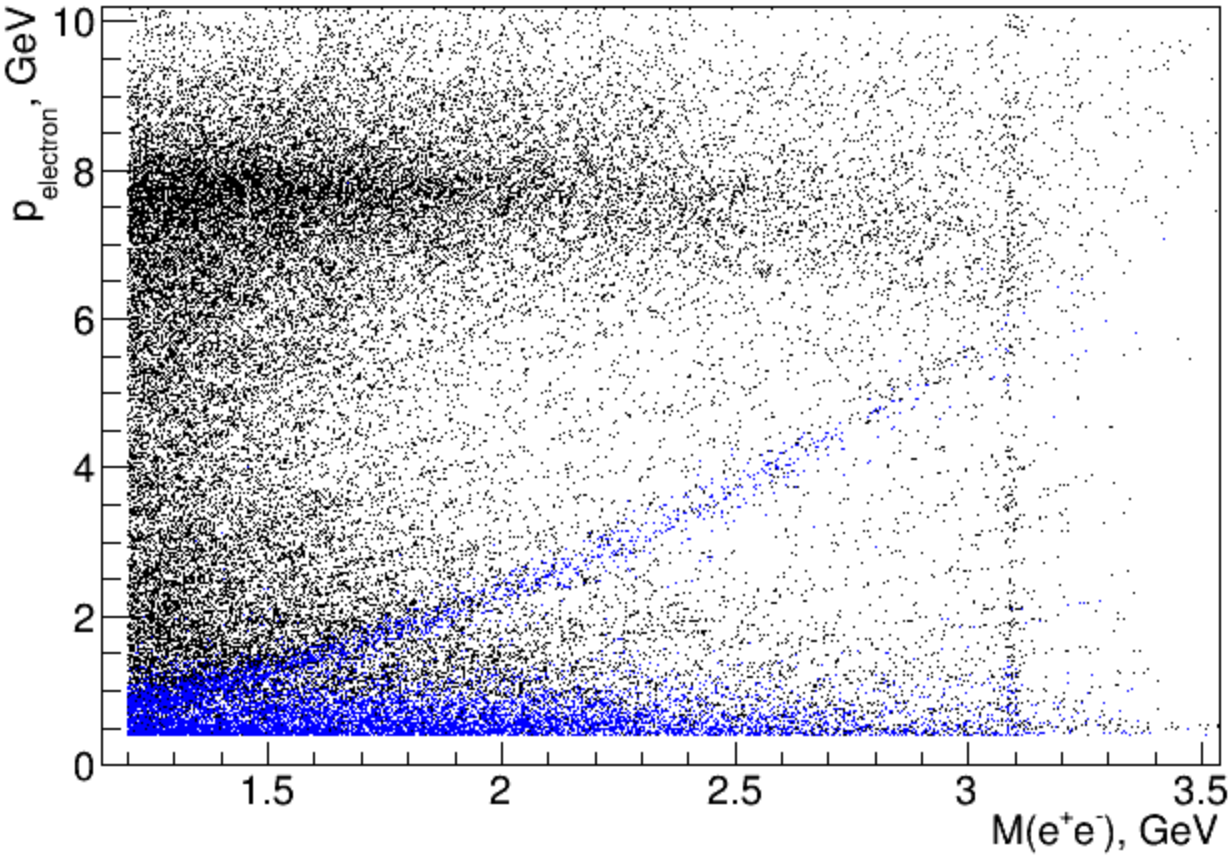
Pion background estimation – using dE/dx from CDC

p vs M(e+e-) distribution - all events with E/p cut
and p>0.4GeV and θ>2deg



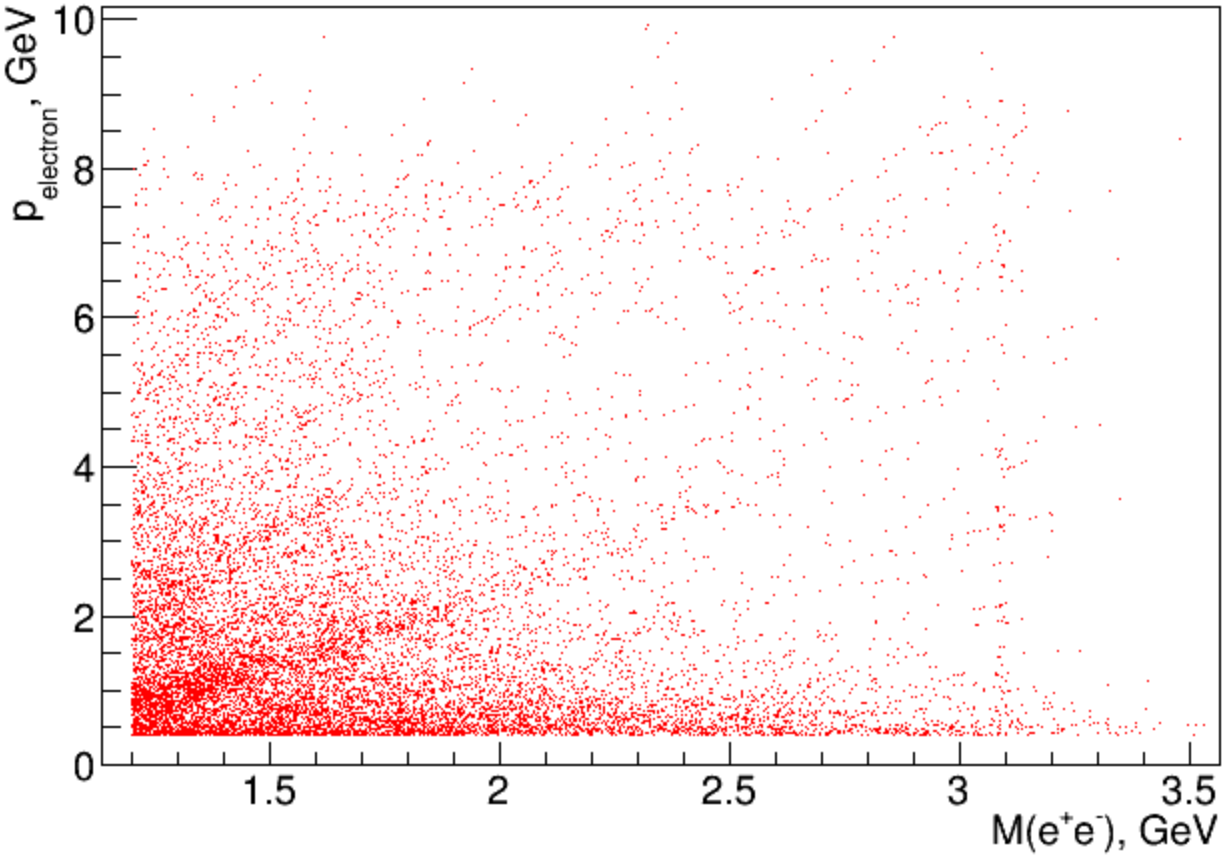
Pion background estimation – using dE/dx from CDC

p vs M(e+e-) distribution **1.132< M(pπ)<1.332**



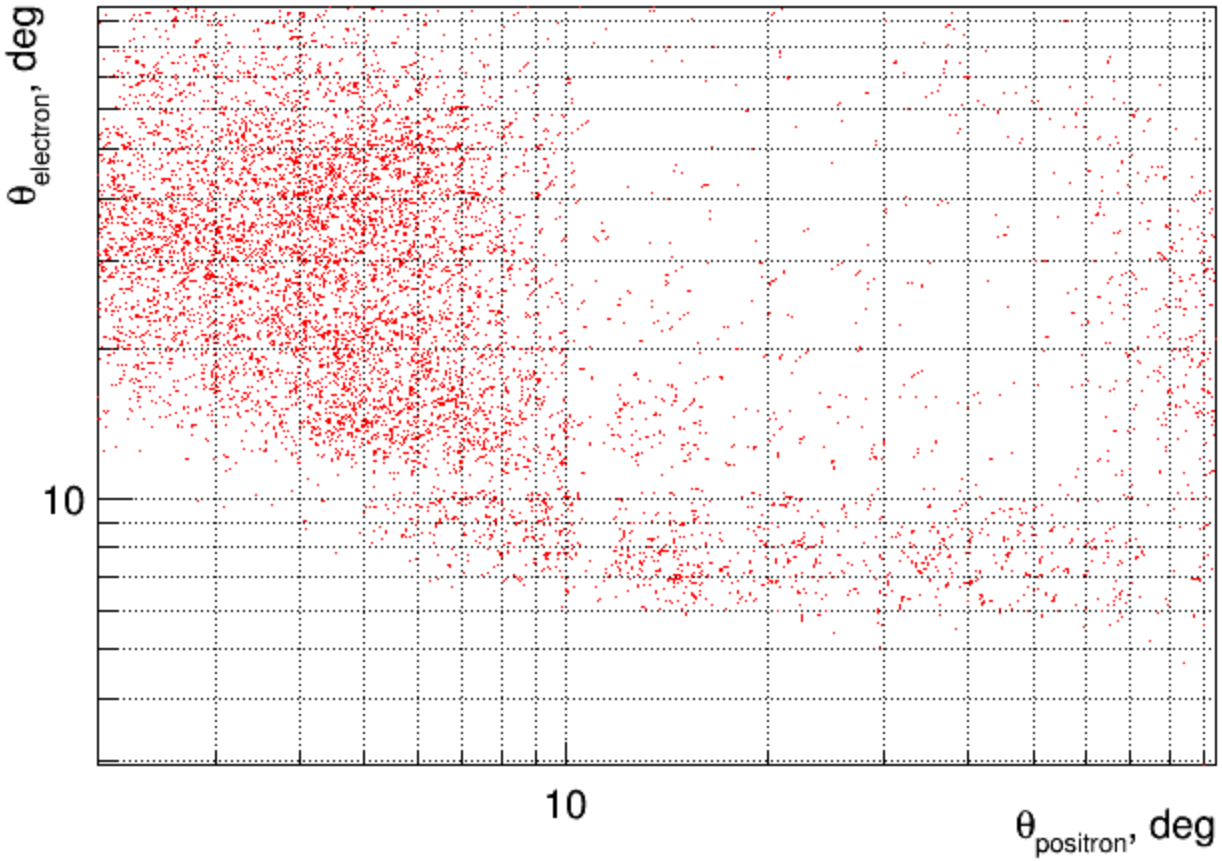
Pion background estimation – using dE/dx from CDC

p vs M(e+e-) distribution – 0<dE/dx<2.4 keV/cm (pions in CDC) and p>0.4GeV and θ>2deg



Pion background estimation – using dE/dx from CDC

Where is the other “electron”? – 90% in forward direction



Why pion contamination is bad for J/ψ analysis

- 36% contamination in BH resulting in some systematic effect that depends on BCAL, FCAL resolution (not dominating now but in the future we may want to improve it)
- Requires cuts on momentum and angle that limit the acceptance and makes it more difficult to simulate
- More background in the J/ψ mass region makes it more difficult to do event-by-event analysis
- With additional PID detector one can study the calorimeter efficiency of the E/p cut

Possible physics with TRD and other advantages

- Further studies of J/ψ
- TCS – few percent effects require additional suppression of ~10-20
- Rare di-electron decays, CP-violation,…(see Daniel's report)
- ϕ – BH interference
- ……

Other advantages:

- Better tracking
- Will help DIRC
- Can be used to estimate e/π suppression in FCAL
- ….

The hadronic properties of the photon in high–energy interactions*

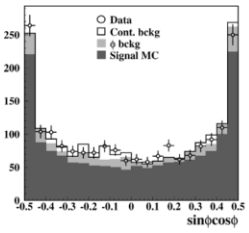
T.H. Bauer ,† R. D. Spital,‡ and D. R. Yennie
Laboratory of Nuclear Studies, Cornell University, Ithaca, New York 14853
F. M. Pipkin
Department of Physics, Harvard University, Cambridge, Massachusetts 02138

High-energy photon interactions are discussed in terms of the hadronic structure of the photon, which is expressed by means of a formulation which is akin to, but somewhat more general than, vector-meson-dominance or specific generalized vector-dominance models. Experiments which demonstrate and yield information about this hadronic structure are discussed critically, and the resulting information is carefully evaluated. Special attention is paid to diffractive processes such as the photoproduction of vector mesons and to photon shadowing effects on nuclei. Relationships to other views of photon interactions, such as the parton model and the space-time description, are also discussed; these views are seen to complement the hadronic structure picture rather than to be in conflict. The general overview is that there is ample evidence which shows that the photon's hadronic structure plays a significant role in its interactions. What further work would most significantly enhance the understanding of the hadronic structure of the photon is also pointed out.

CONTENTS

I. Introduction 262
A. The internal structure of the photon 262
B. Brief historical review 264
II. General Features of Hadronic Electrodynamics 269
A. Analogies between photon- and hadron-induced processes 269
B. The physical photon state and the notion of vector-meson dominance 271
C. Space-time aspects of real and virtual photon
b. Comparison of $d\sigma/dt$ for hydrogen from different experiments 318
c. Deuterium 319
d. Complex nuclei 321
e. ρ–ω interference 322
f. Leptonic decay of the ρ^0 323
g. Real part of the production amplitude 323
h. ω–φ relative phase 323
i. Independent determination of σ_ρ 324
j. Angular distribution of ρ^0 decay 324
D. Omega photoproduction 327

$\eta \to \pi^+\pi^- e^+ e^-$ Recent Measurements



KLOE: Analysis of $\eta \to \pi^+\pi^- e^+ e^-$

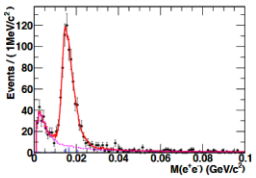
- ~ 1.6 k Events in the final sample[(b)]
- $\frac{\Gamma(\eta\to\pi^+\pi^- e^+ e^-)}{\Gamma_\eta} = (2.68 \pm 0.09_{stat} \pm 0.07_{sys}) \cdot 10^{-4}$
- $A_\Phi = (-0.6 \pm 2.5_{stat} \pm 1.8_{sys}) \cdot 10^{-2}$

(b) KLOE coll. *Phys. Lett.*, B675:283-288,(2009)

BESIII: Analysis of $\eta' \to \pi^+\pi^- e^+ e^-$

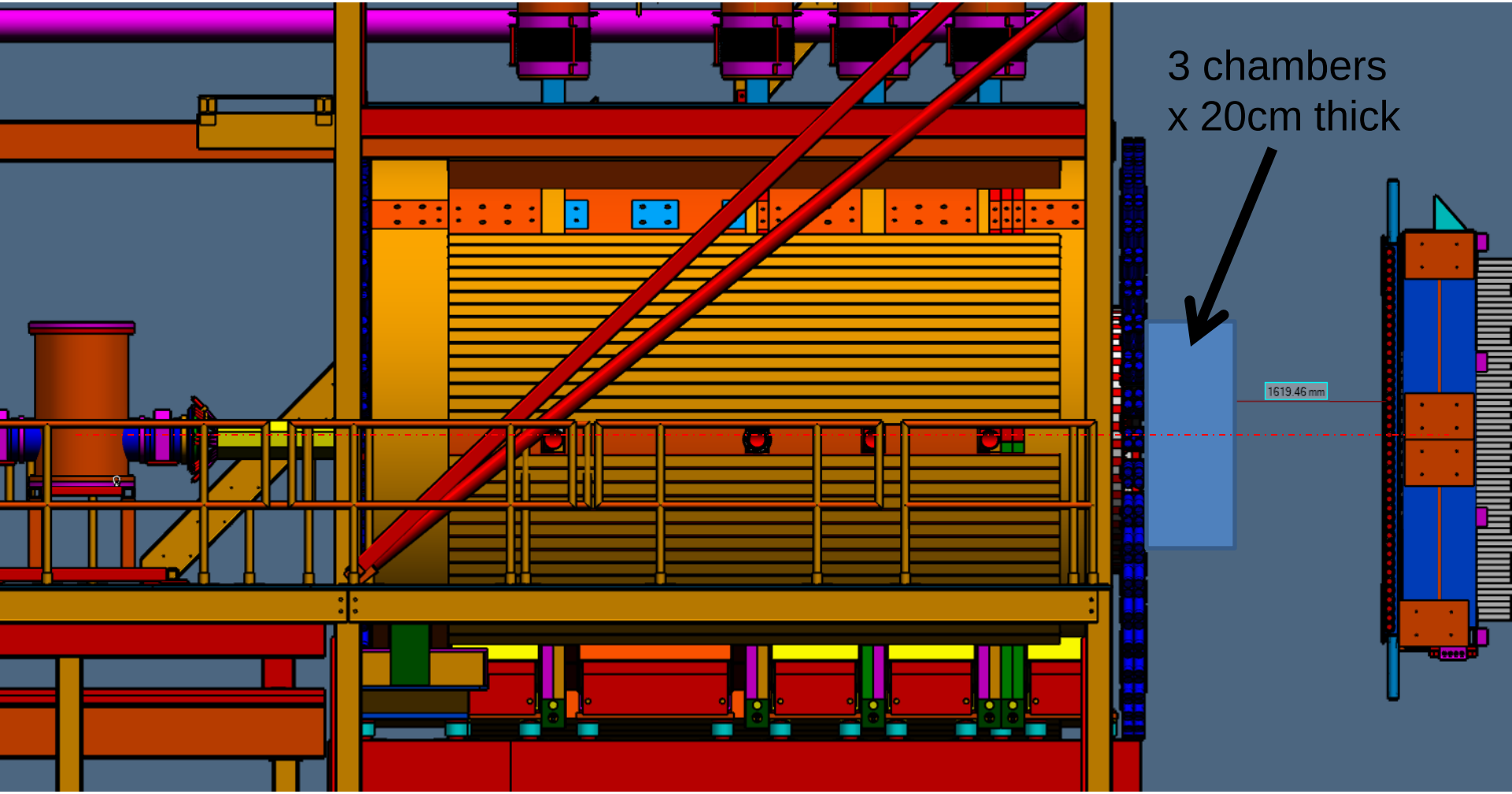
- ~ 429 Events in the final sample[(c)]
- $\frac{\Gamma(\eta'\to\pi^+\pi^- e^+ e^-)}{\Gamma_{\eta'}} = (2.11 \pm 0.12_{stat} \pm 0.15_{sys}) \cdot 10^{-3}$

(c) BESIII coll. arXiv: 1710.05173v2



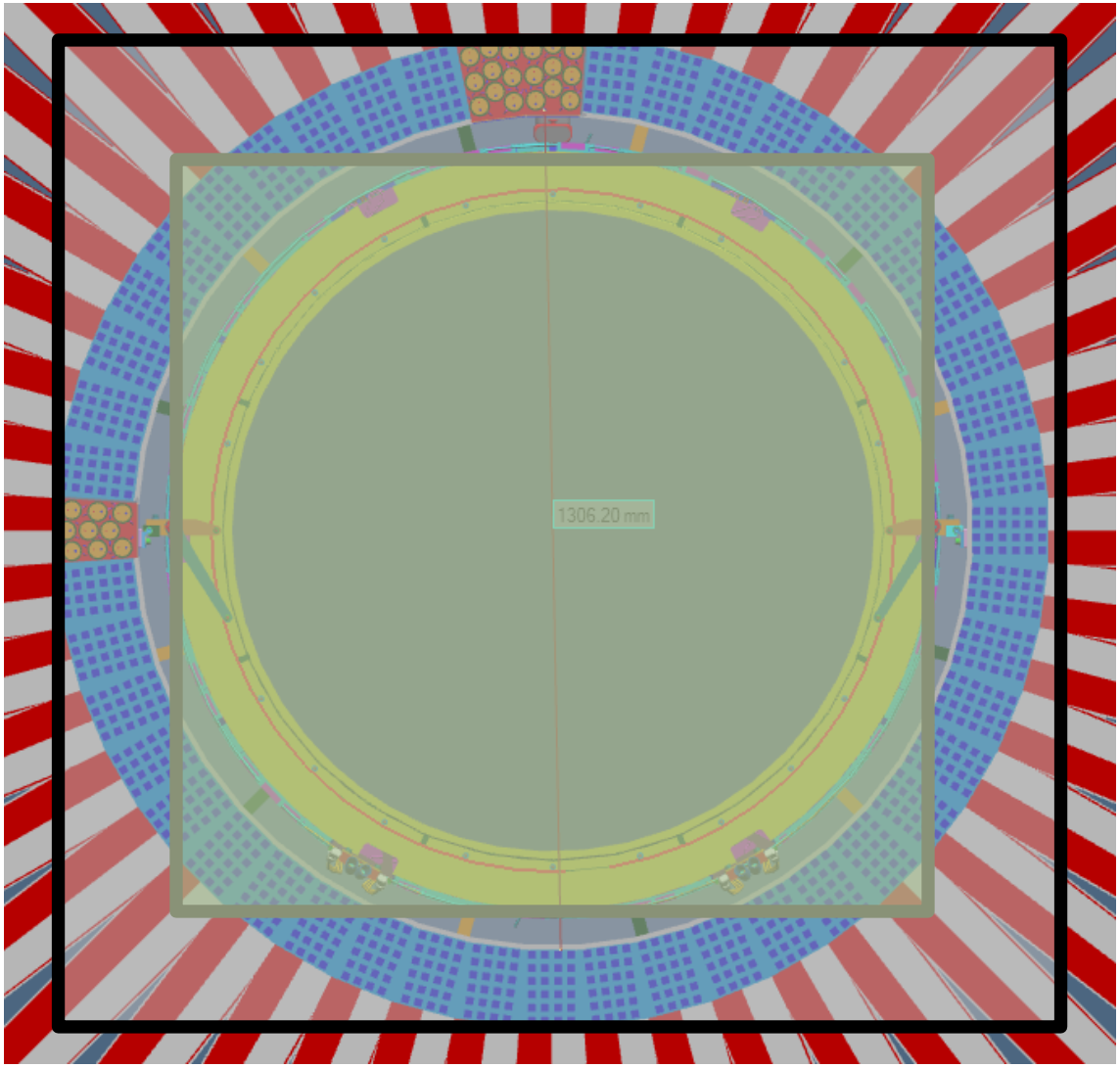
⇒ GlueX: Simultaneous analysis of: $\eta^{(\prime)} \to \pi^+\pi^- e^+ e^-$

Approximate location/sizes



Approximate location/sizes

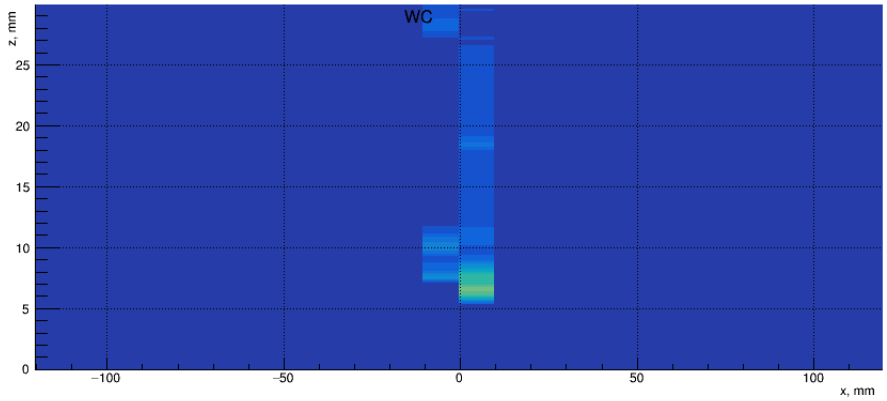
120x120 cm^2 sensitive area

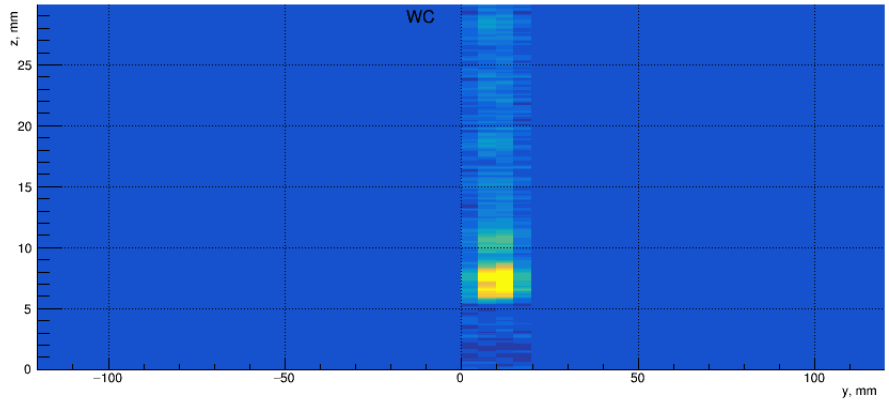


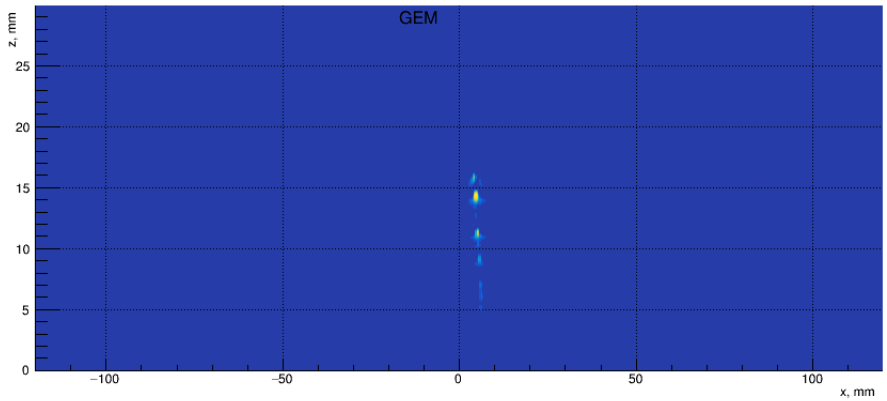
Possible configuration and cost estimates

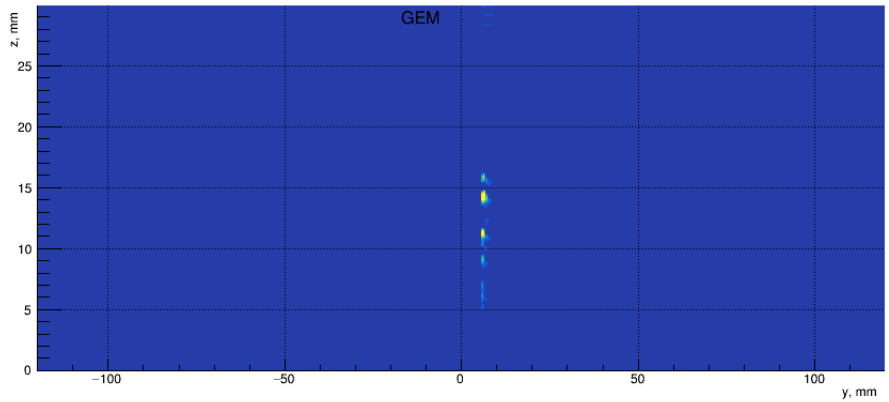
- 3 chambers (each factor 4-5 suppression at least)
- Each chamber 120 wires and 240 strips
- Total of 1,080 channels, 15 fADC125, 1 VXS crate
- Gas system cost depend on requirements – will do studies with spare FDC package, need to evaluate minimal gas flow and possible contaminations

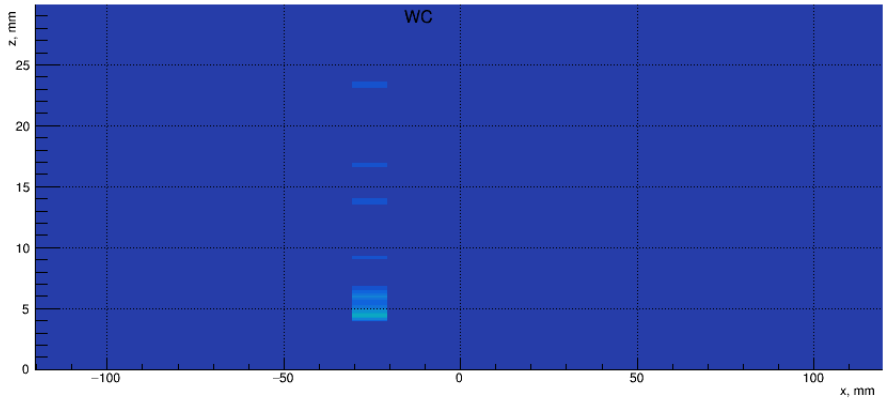
item	$k
Electronics $100/chan. ($55/ch for FDC)	108
Materials for the detectors	100
Gas system	100-150
Total	308-358

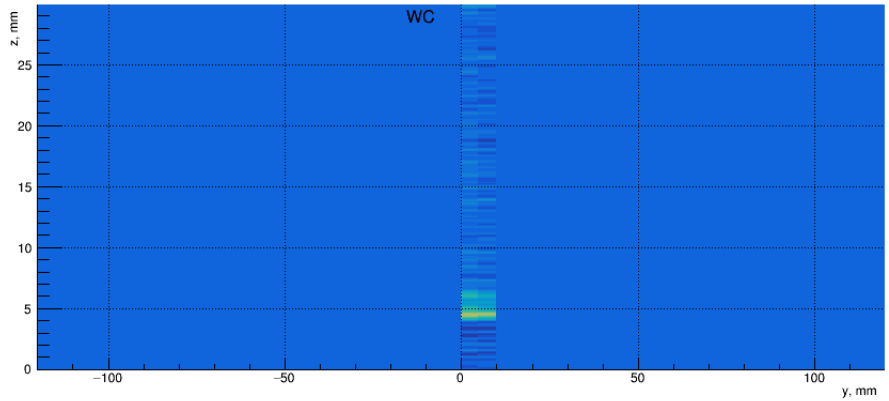

WC
z, mm
x, mm

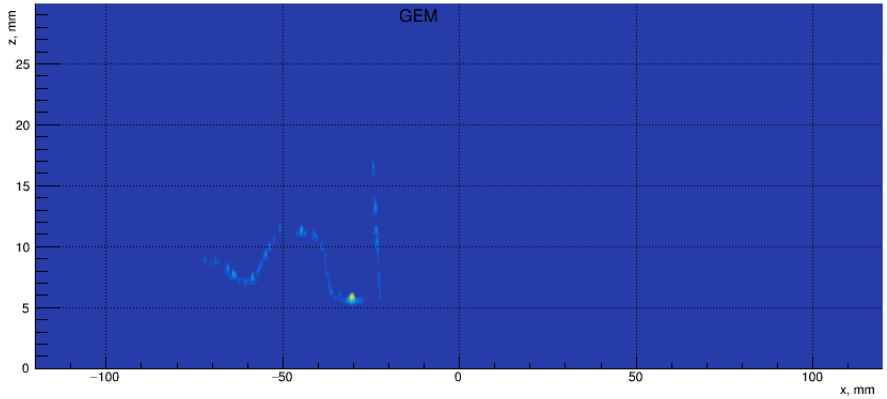

WC
z, mm
y, mm

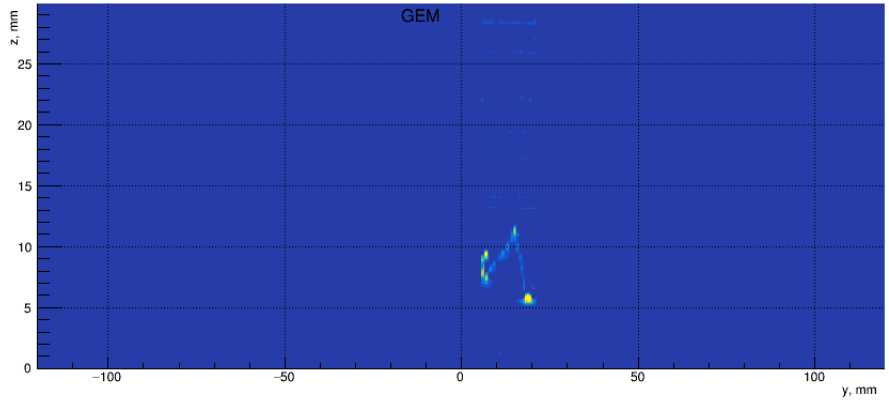

GEM
z, mm
x, mm


GEM
z, mm
y, mm

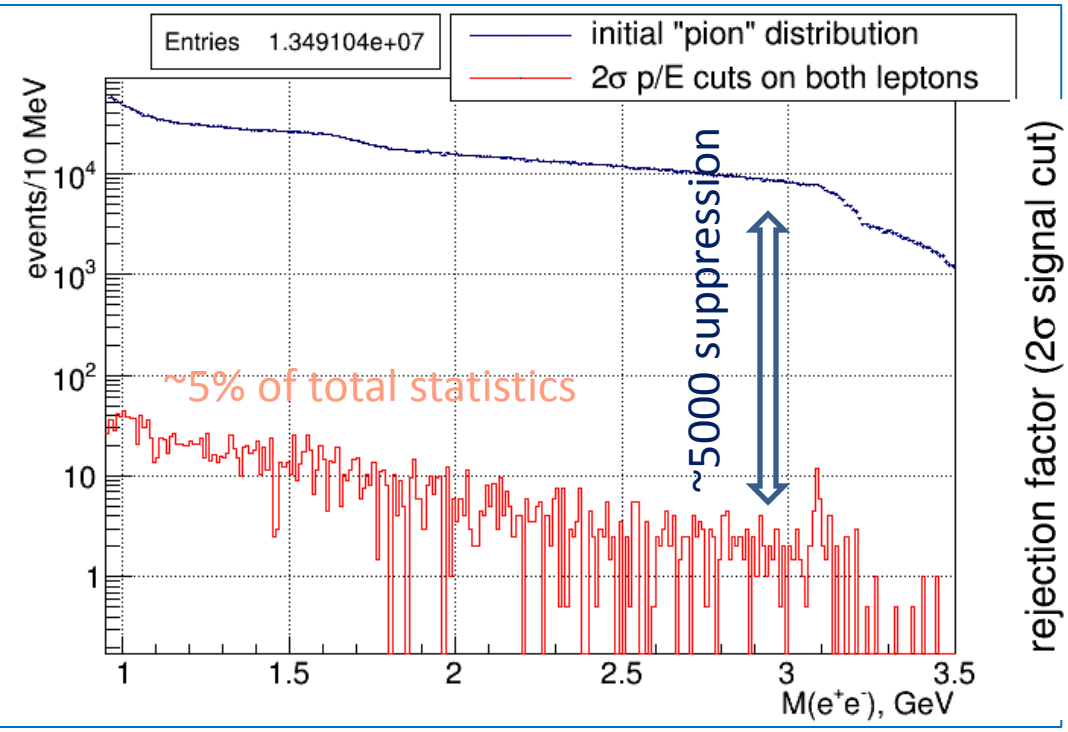

WC
z, mm
25
20
15
10
5
0
−100
−50
0
50
100
x, mm

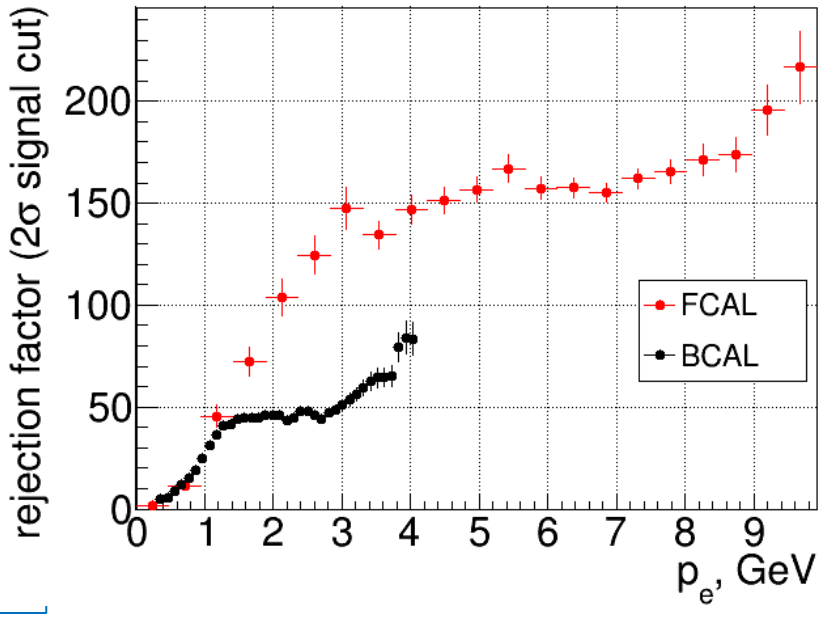

WC
z, mm
25
20
15
10
5
0
−100
−50
0
50
100
y, mm


GEM
z, mm
25
20
15
10
5
0
−100
−50
0
50
100
x, mm


GEM
z, mm
25
20
15
10
5
0
−100
−50
0
50
100
y, mm

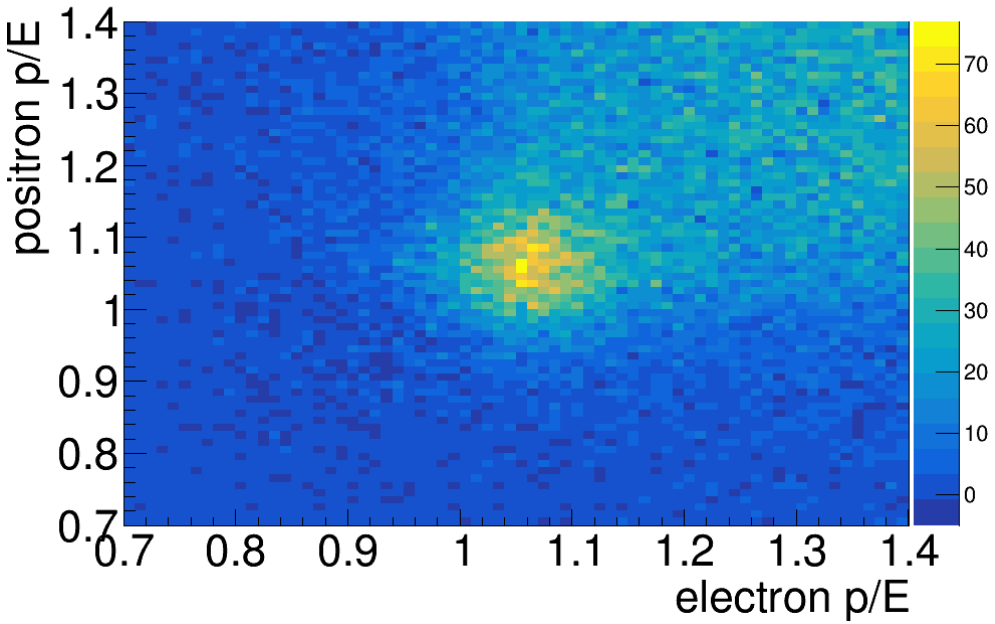
What we have now: e/π separation using p/E

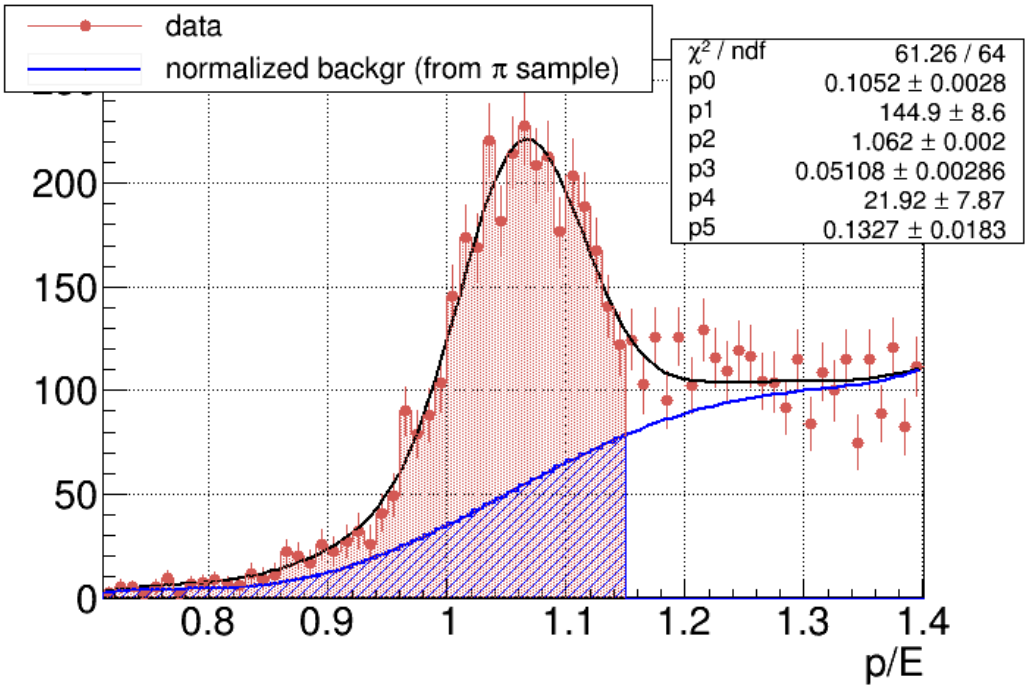




- Suppression factor of ~5000 by p/E cuts only
- Different for BCAL and FCAL; depends on energy
- Still 36% π contamination in $M(e^+e^-) > 1.5$ GeV region

What we have now: e/π separation using p/E





- 36±1.2% contamination in 1.5-2.5 GeV M(e^+e^-) region with 2σ cut on electrons
- BH yields corrected in bins of energy – percentage slightly varies with energy
- Background shape from pion sample (p/E anti-cuts)