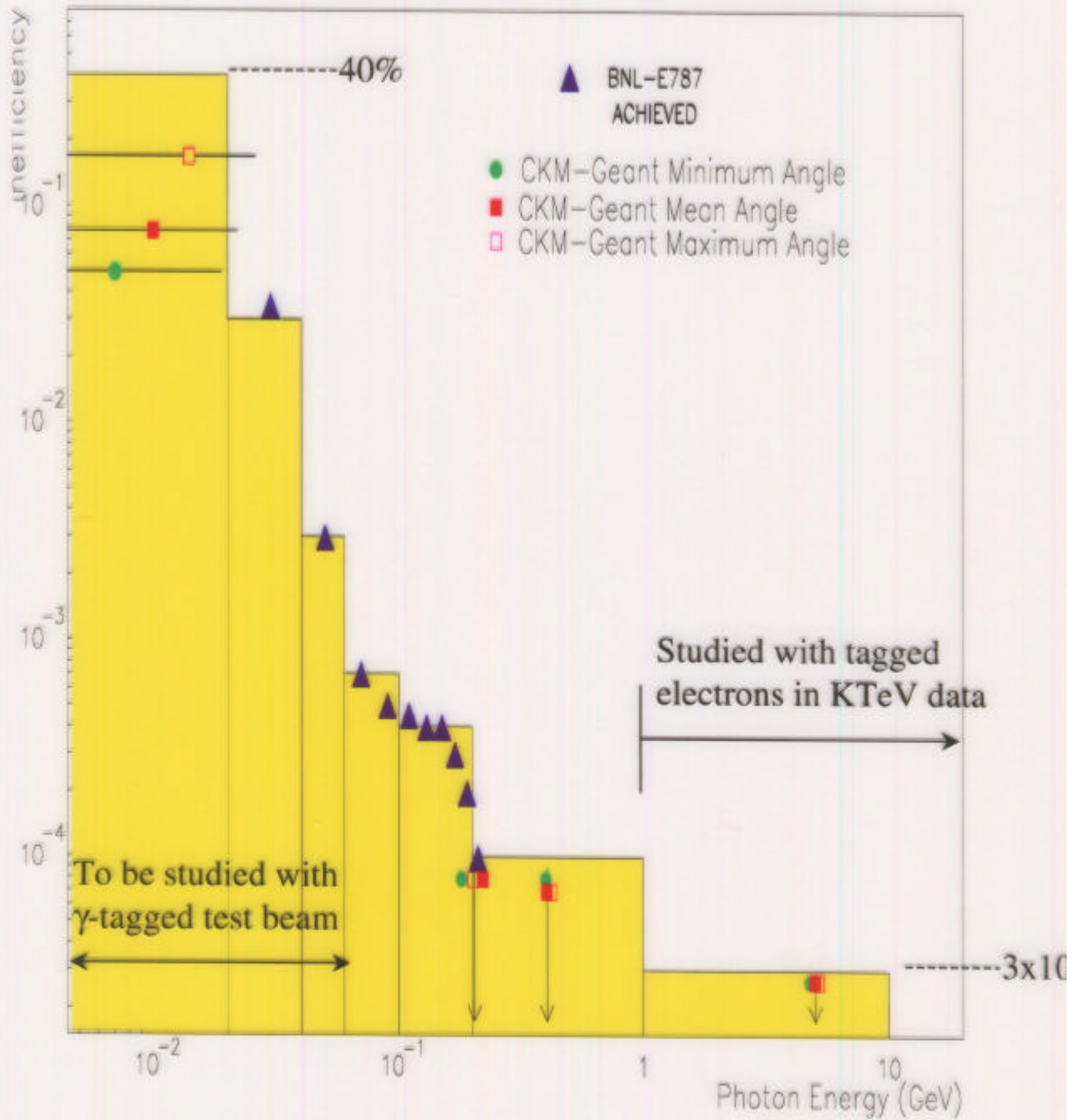


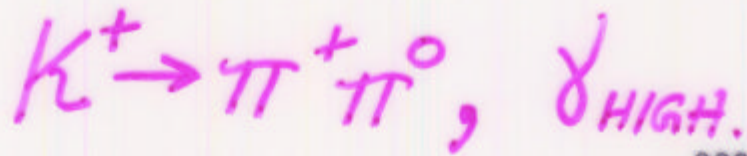


61-20-AP

REQUIRED DETECTION INEFFICIENCY FOR Pb/S_c DETECTORS (HISTOGRAM)

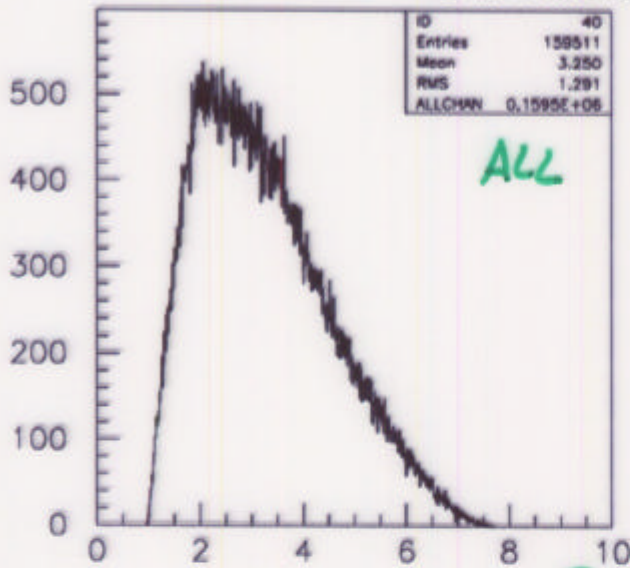


$\rightarrow \bar{\epsilon}_{\pi^0} = 1.5 \times 10^{-7}$



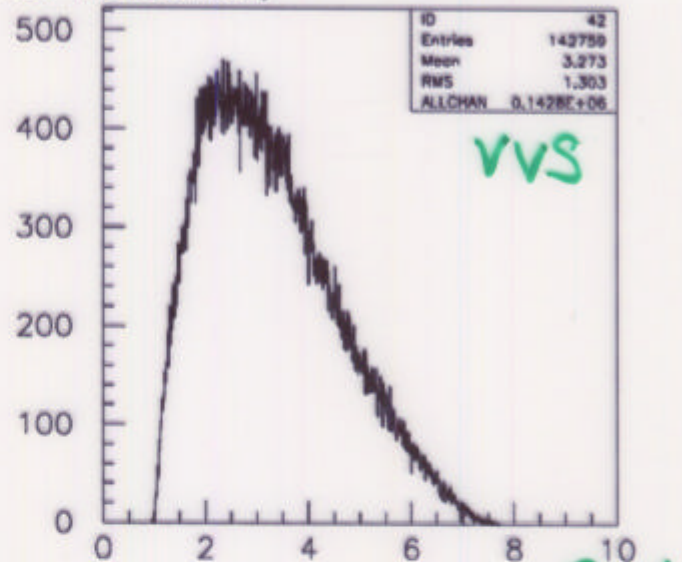
2000/12/12 17.51

CKM Photons New VS Geometry



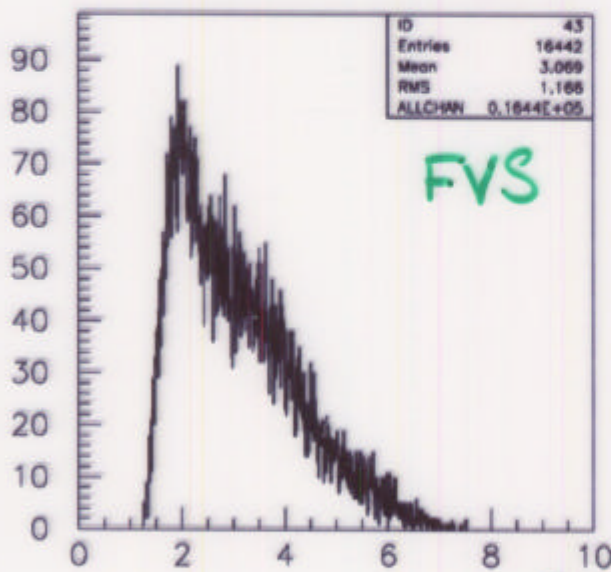
High Energy Photon ALL

Gev



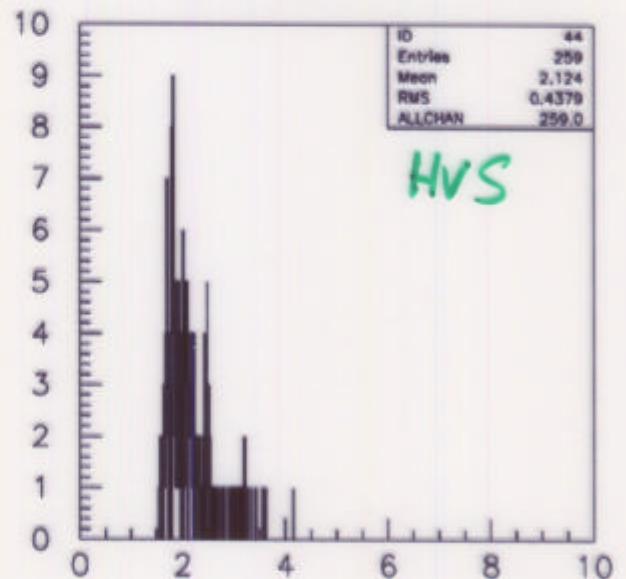
High Energy Photon VVS

Gev



High Energy Photon FVS

Gev



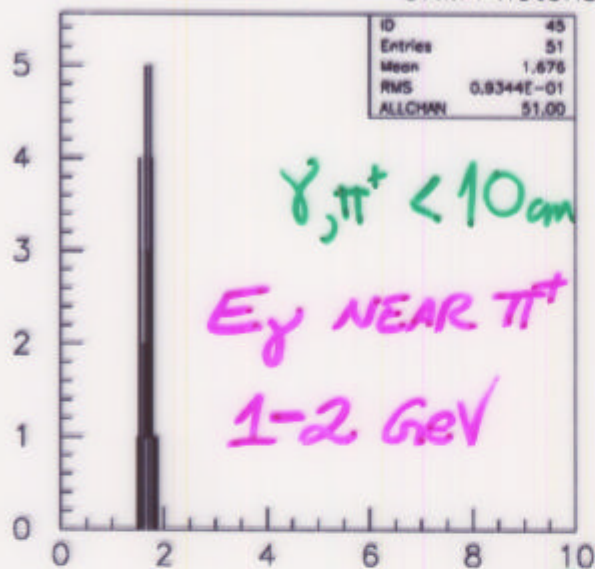
High Energy Photon HVS

Gev

$$K^+ \rightarrow \pi^+ \pi^0, \gamma_{\text{Low}}$$

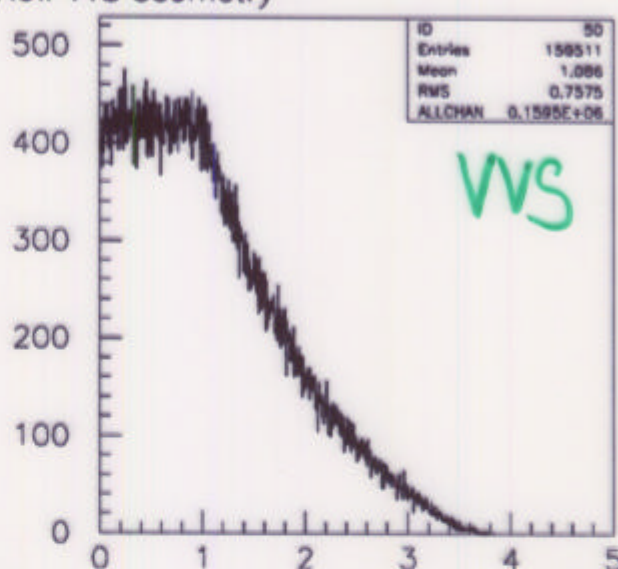
2000/12/12 17.51

CKM Photons New VS Geometry



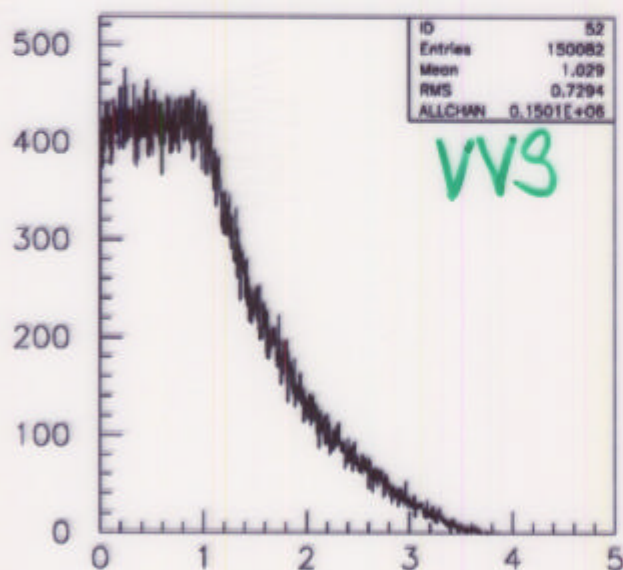
High Energy Photon c=5

GeV.



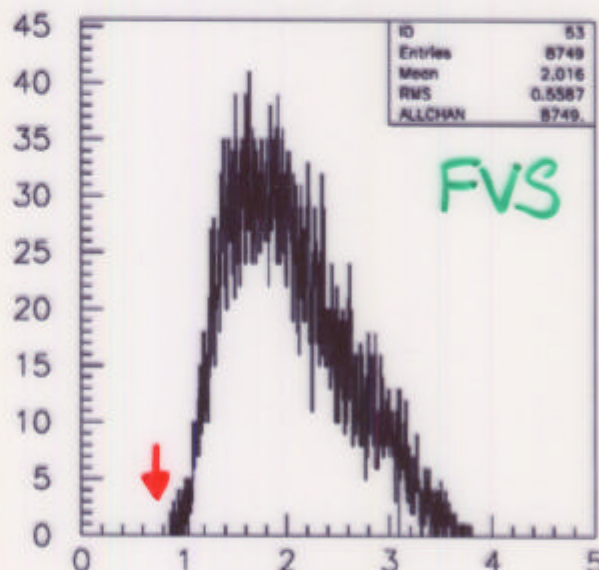
Low Energy Photon ALL

GeV



Low Energy Photon WS

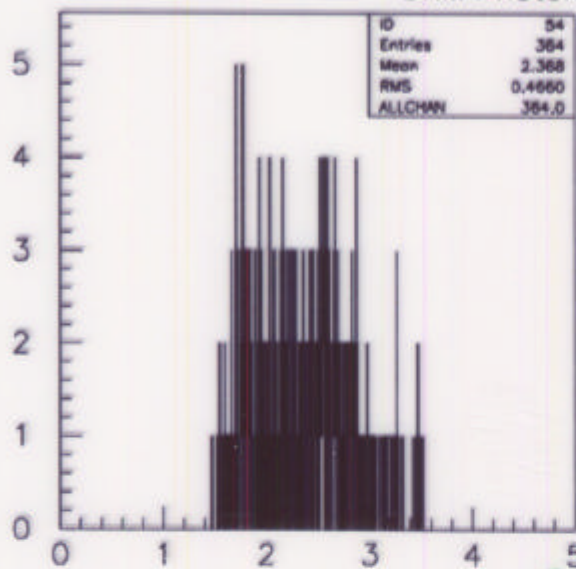
GeV



Low Energy Photon FVS

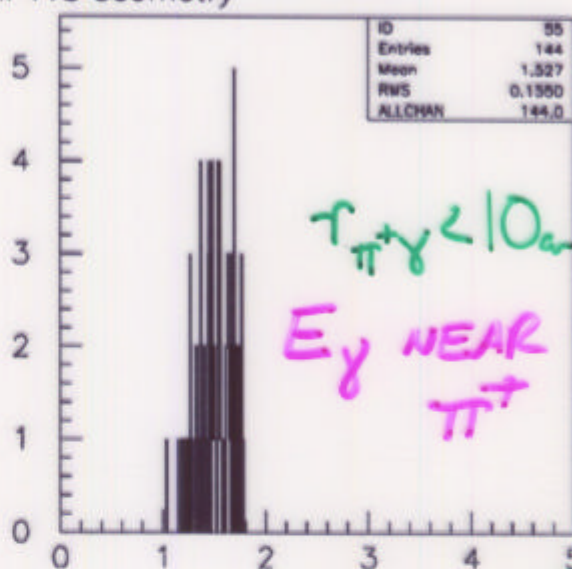
GeV.

CKM Photons New WS Geometry



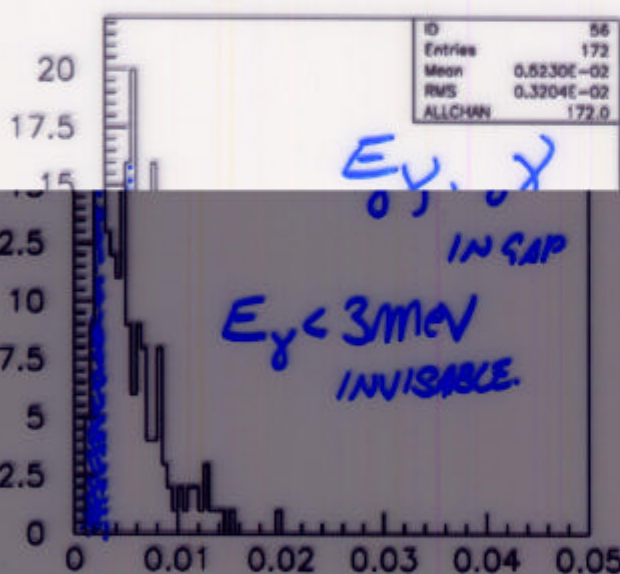
Low Energy Photon HVS

GeV



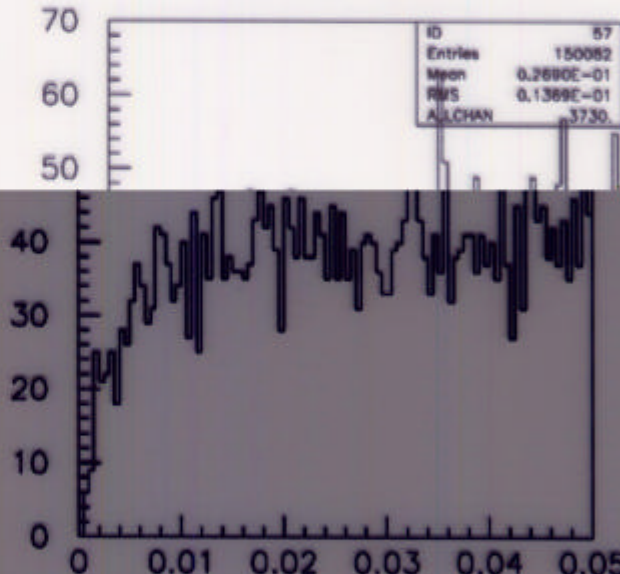
Low Energy Photon c=5

GeV



Low Energy Photon WS-gap

GeV



Low Energy Photon WS

GeV

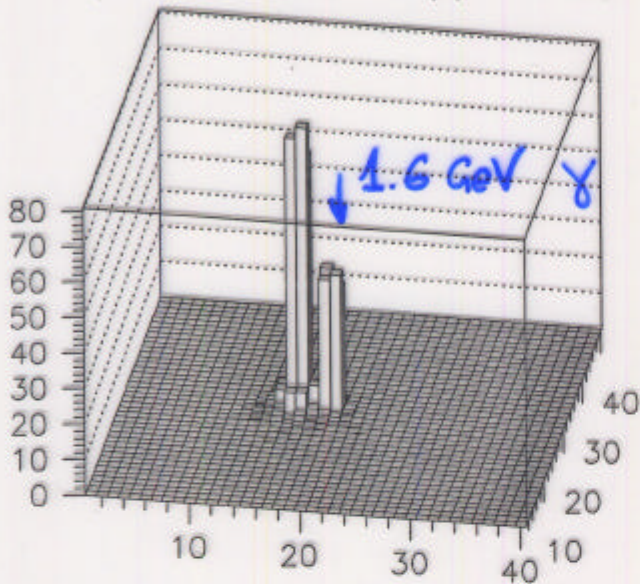
γ IN-GAP

NON-GAP

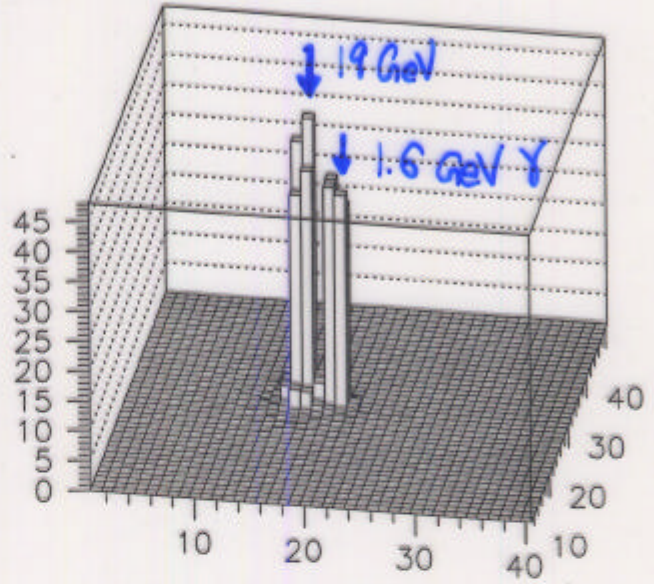
GEANT STUDIES γ/π^+ FUSION.

\downarrow 19 GeV π^+

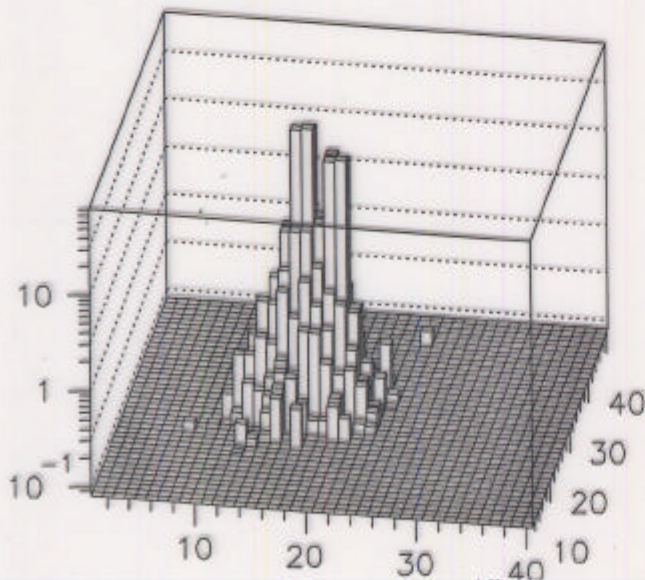
15 cm Pi^+ /photon separation - 50 cm vs 27 cm CsI



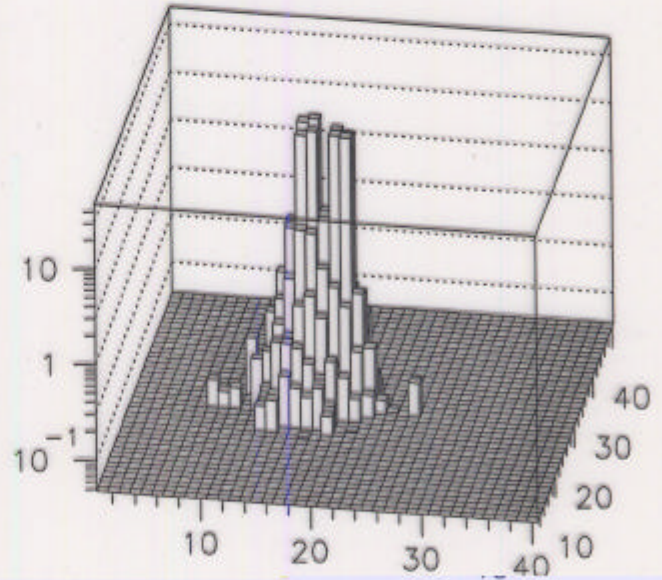
Lateral energy



Lateral energy



Lateral energy



Lateral energy

50 cm CsI
5 cm x 5 cm

27 cm CsI
5 cm x 5 cm.

Zoology of the $K^+ \rightarrow \pi^+\pi^0$ Background.

- **Required π^0 Inefficiency:**

- Proposal first edition requires $\epsilon_{\pi^0}^- < 2.0 \times 10^{-7}$
- Fast MC against γ -efficiency table achieves $\epsilon_{\pi^0}^- = 1.5 \times 10^{-7}$

- **Inefficiency Mechanisms:**

- 22% (VVS-gap) \times (VVS-nominal).
- 43% (VVS-nominal) \times (VVS-nominal).
- 34% (VVS-nominal) \times (FVS π^+/γ fusion).

- **Observations:**

- VVS filling fraction (1/2) in decay volume validated.
- Not very sensitive to FVS π^+/γ fusion.
- Not very sensitive to low-energy ($< 20\text{MeV}$) γ -inefficiency.

Zoology of the $K^+ \rightarrow \pi^+\pi^0$ Background.

• Observations (continued):

- Total background weakly depends on the large changes to the medium energy (40 – 400 MeV) inefficiency:
 - * Increasing $\epsilon_{\gamma}^{-}(40 - 400 \text{ MeV})$ by $\times 2$ increases total background by 4%.
 - * Increasing $\epsilon_{\gamma}^{-}(40 - 400 \text{ MeV})$ by $\times 4$ increases total background by 12%.
- The forward veto systems, FVS and HVS, do not intercept any $K\pi^2$ background photons of energy less than 1 GeV. Low energy performance is only required in the VVS.
- Total background is proportional to high-energy ($> 1 \text{ GeV}$) γ -inefficiency.....**ONLY** common lever-arm among the background classes.

How can you miss a 1 GeV Photon?

- **Physics:**

- We have a reasonable case that the physics of γ -nuclear ($< 1\text{GeV}$), and γ -production ($> 1\text{GeV}$) interactions contribute inefficiency at no more than the $(1 - 3) \times 10^{-6}$ level.

- **You can miss it if you aren't looking! The key is really Hermeticity—careful design here can provide a safety factor.**

- In space, time, and electronics the real challenge is to develop a conceptual design for a system that has a **verifiable** dead space \times time of less than 3×10^{-5} . Example: If *one* of our ~ 1000 VVS sectors has a 3% inefficiency we've blown the budget.
- A hermetic design will require continuous monitoring, multiple parallel PMTs and readout channels per veto module.
- Ultimately the best demonstration comes ~~from the data, in the form of pointed photons mapping out the detector, and similar inefficiency studies.~~

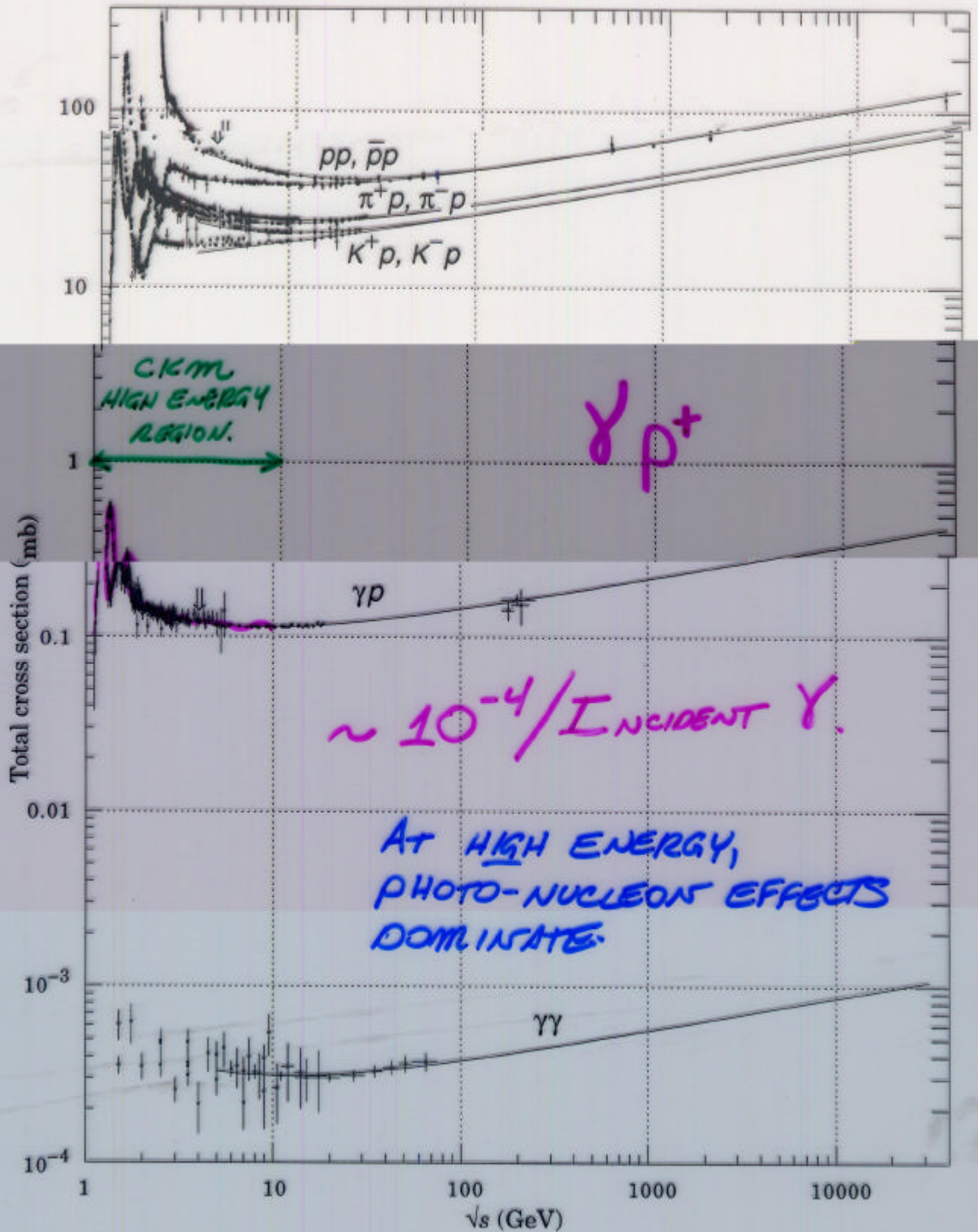
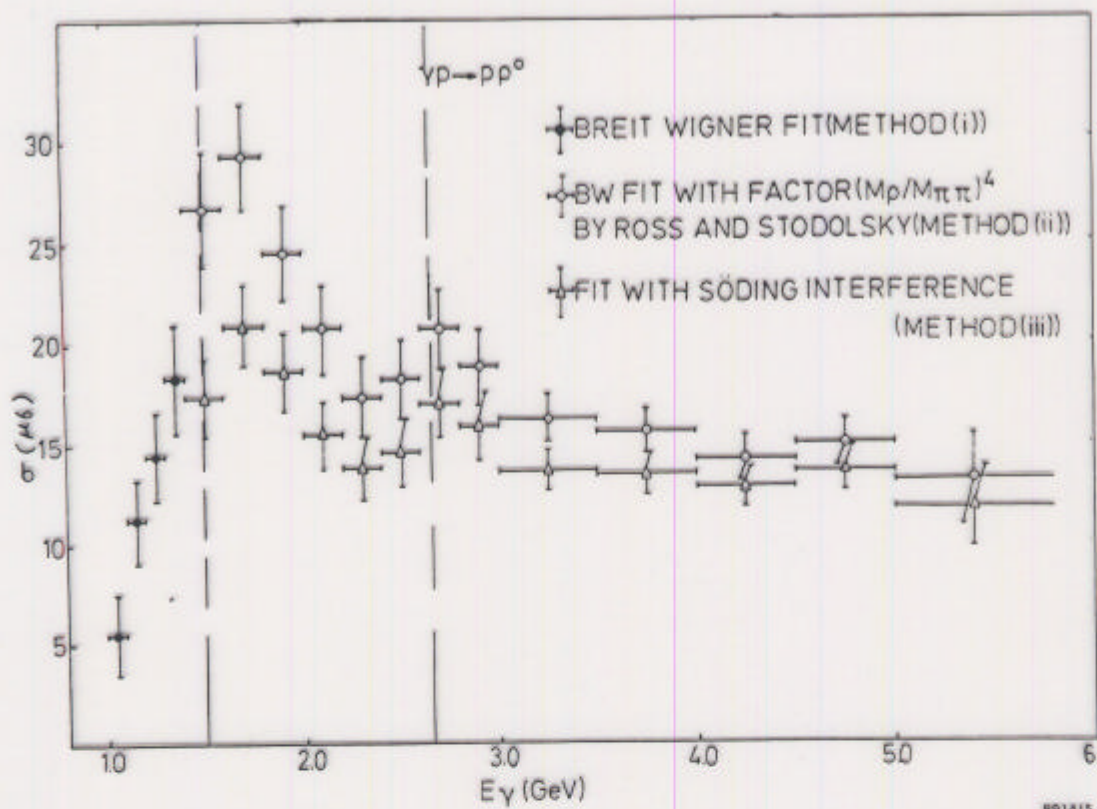


Figure 37.18: Summary of hadronic, γp , and $\gamma\gamma$ total cross sections. Corresponding computer-readable data files may be found at <http://pdg.lbl.gov/xsect/contents.html> (Courtesy of the COMPAS group, IHEP, Protvino, Russia, August 1999.)



$\gamma \rho^+ \rightarrow \rho^0$
 $\rho^0 \rightarrow \pi^+$
 $\sim 15 \mu$

FIG. 15 -- Total cross section for the reaction $\gamma p \rightarrow \rho^0 p$ as a function of the photon energy E_γ . The different points were obtained by three different fitting procedures.

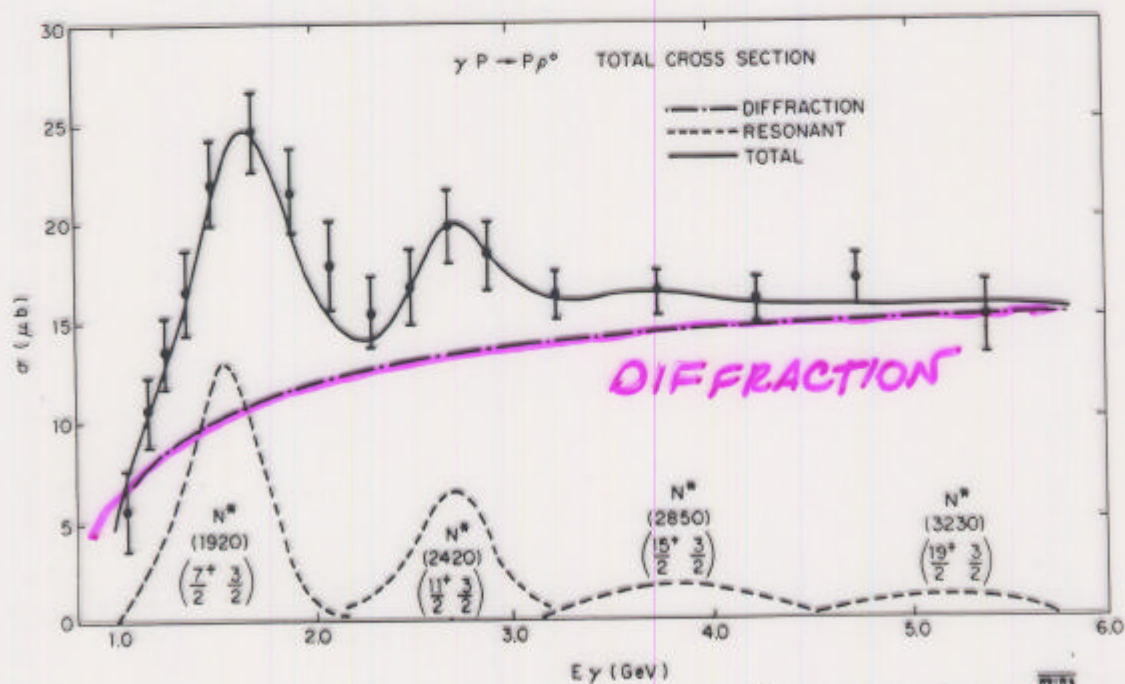


FIG. 16 -- A fit to the total cross section of $\gamma p \rightarrow \rho^0 p$ using the diffraction model plus s-channel resonances for the $\rho^0 p$ system.

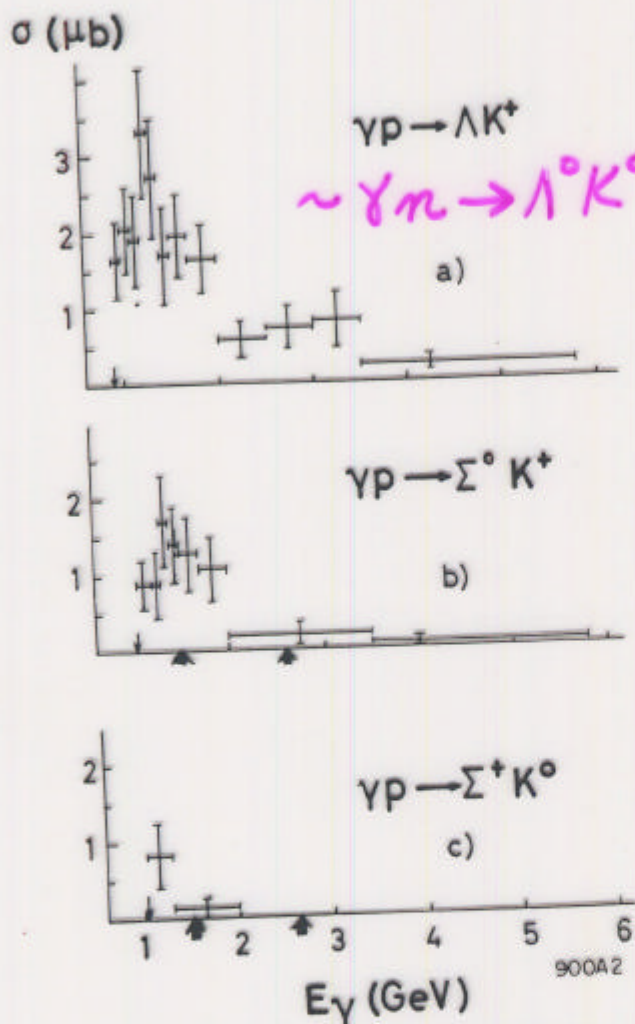


FIG. 2 -- Total cross sections for (a) $\sigma p \rightarrow \Lambda K^+$ (b) $\sigma p \rightarrow \Sigma^0 K^+$ (c) $\sigma p \rightarrow \Sigma^+ K^0$ as function of photon energy E_σ (from Ref. 4).

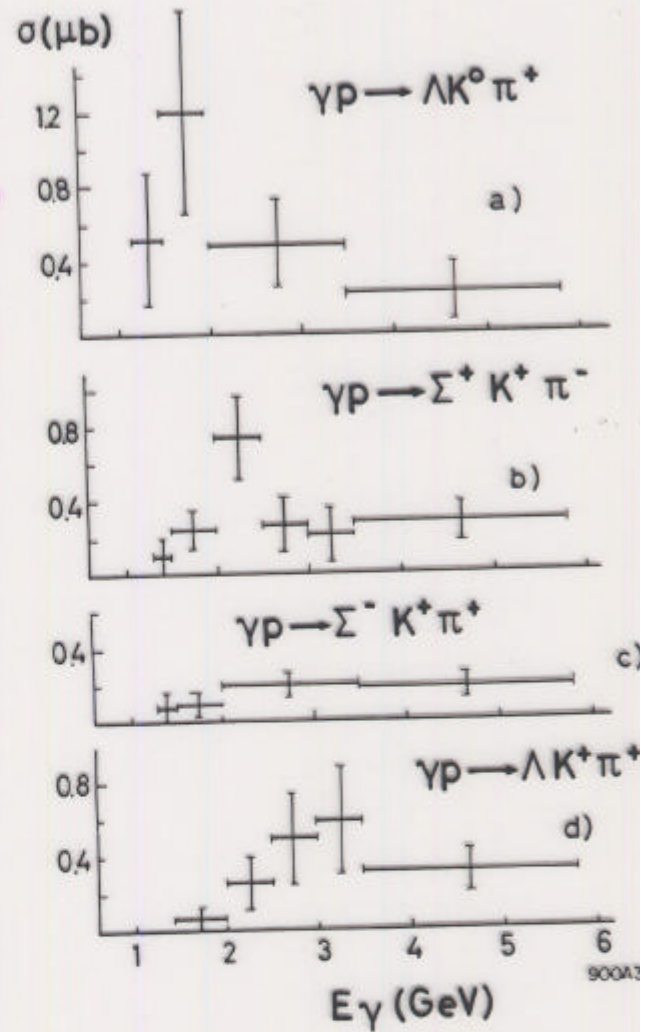


FIG. 3 -- Total cross sections for (a) $\sigma p \rightarrow \Lambda K^0 \pi^+$ (b) $\sigma p \rightarrow \Sigma^+ K^+ \pi^-$ (c) $\sigma p \rightarrow \Sigma^- K^+ \pi^+$ (d) $\sigma p \rightarrow \Lambda K^+ \pi^+$ as function of photon energy E_σ (from Ref. 4).

$$\gamma \pi^- \rightarrow K^0 \Lambda^0$$

$$\gamma p \rightarrow \pi^+ n$$

KTEV Event Display

/usr22046/ktev/tmp/kdc/R0689
9_ETAPM_00001

Run Number: 6899
Spill Number: 1
Event Number: 857
Trigger Mask: 1
All Slices

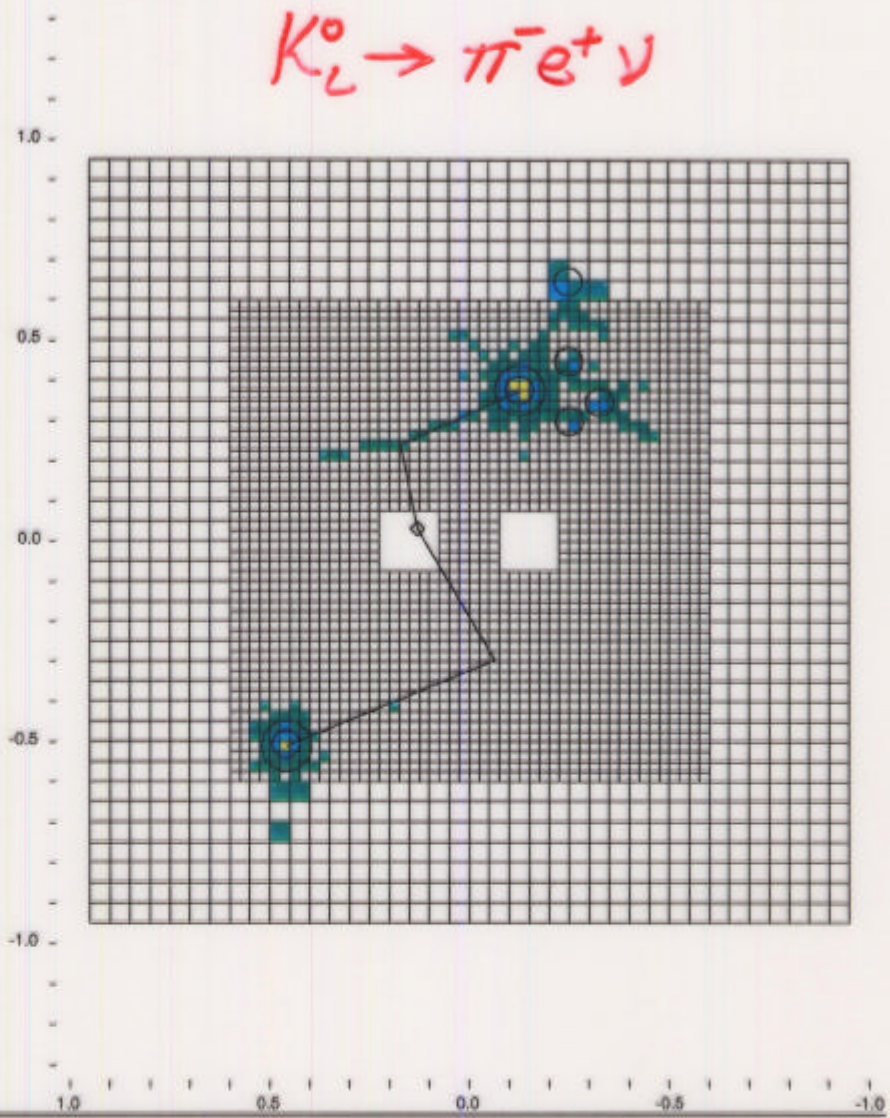
Track and Cluster Info

ID	Xcsi	Ycsi	P or E
T 1:	-0.1275	0.3751	+19.72
C 5:	-0.1266	0.3776	11.78
T 2:	0.4576	-0.5096	-9.92
C 1:	0.4600	-0.5055	10.28
C 2:	-0.2485	0.6483	0.50
C 3:	-0.3269	0.3474	0.78
C 4:	-0.2514	0.3000	0.23
C 6:	-0.2502	0.4488	0.52

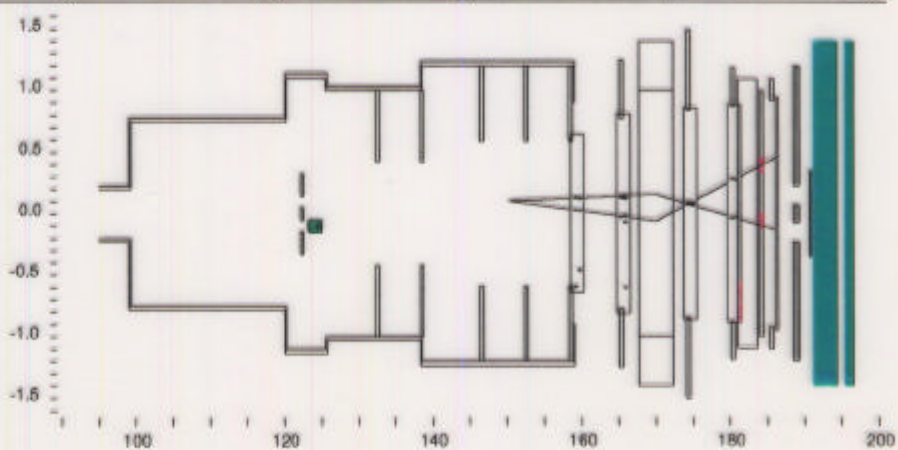
Vertex: 2 tracks

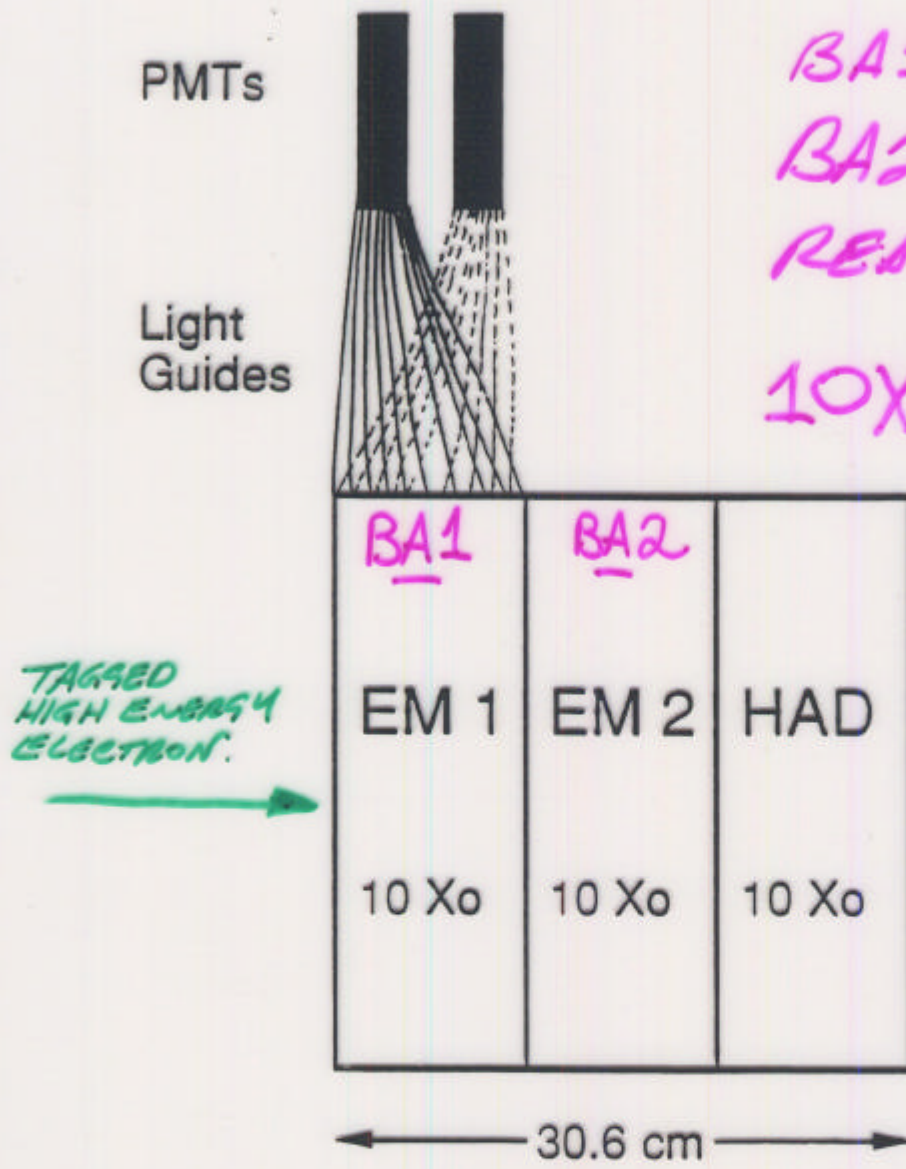
X	Y	Z
0.1043	0.0263	150.164

Mass=0.4793 (assuming pions)
Chisq=0.13 Pt2v=0.003992



- - Cluster
- - Track
- (red) - 10.00 GeV
- (yellow) - 1.00 GeV
- (blue) - 0.10 GeV
- (green) - 0.01 GeV





BA1(L) AND
BA2(L) WILL BE
READ OUT.

$$10X_0 = 20 * \frac{1}{2} X_0$$

TAGGED
HIGH ENERGY
ELECTRON.
→

Figure 6: BA longitudinal grouping showing EM and HAD subdivisions. Also shown is simplified drawing of light guide PMT arrangement for two vertical pmts.

"TAGGED" $Ke3$ TEST BEAM

KTEV Event Display

/home/user2/molchan/tmp/proc
.dat

Run Number: 15533
Spill Number: 12
Event Number: 2858709
Trigger Mask: 1
All Slices

Track and Cluster Info

HCC cluster count: 0

ID Xcsi Ycsi P or E

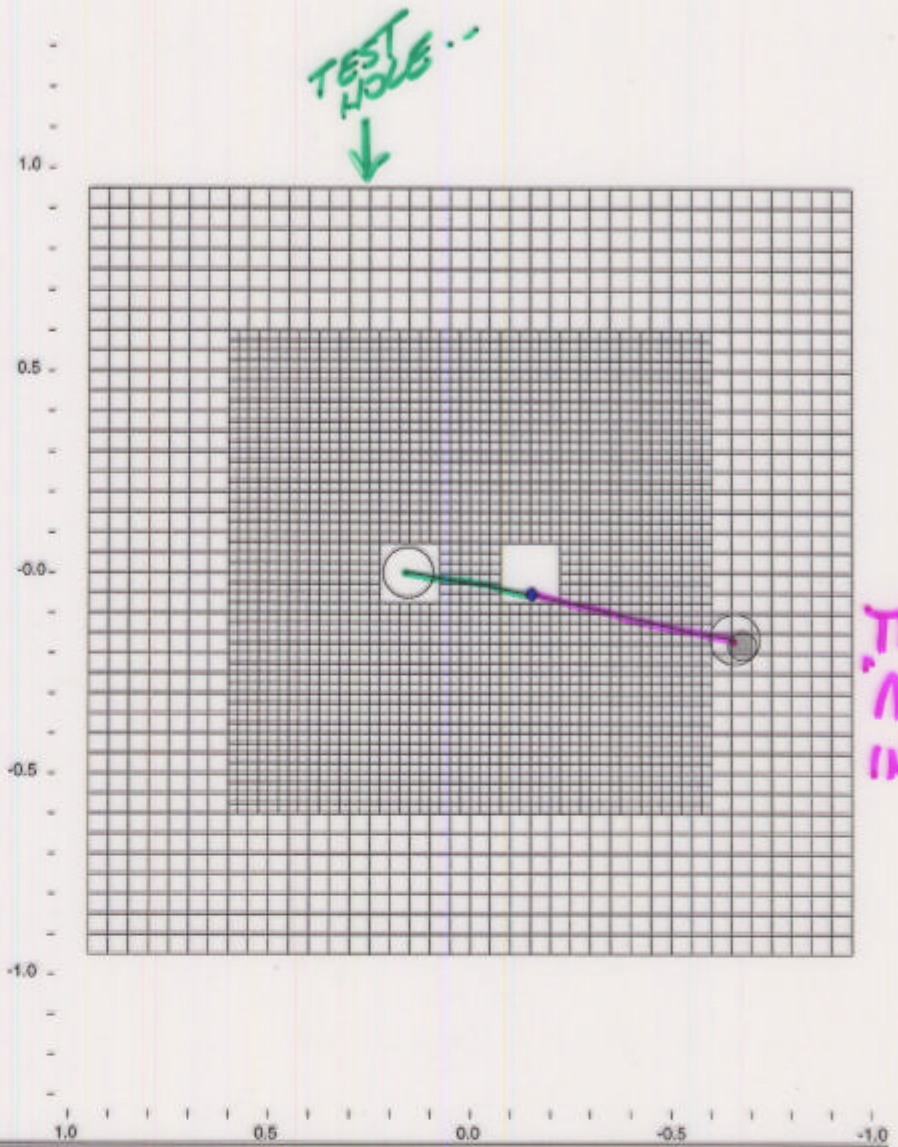
T 1: -0.6582 -0.1626 +120.88
C 1: -0.6771 -0.1788 0.40
T 2: 0.1545 0.0026 -225.04

Vertex: 2 tracks

X Y Z
-0.0786 -0.0267 94.885

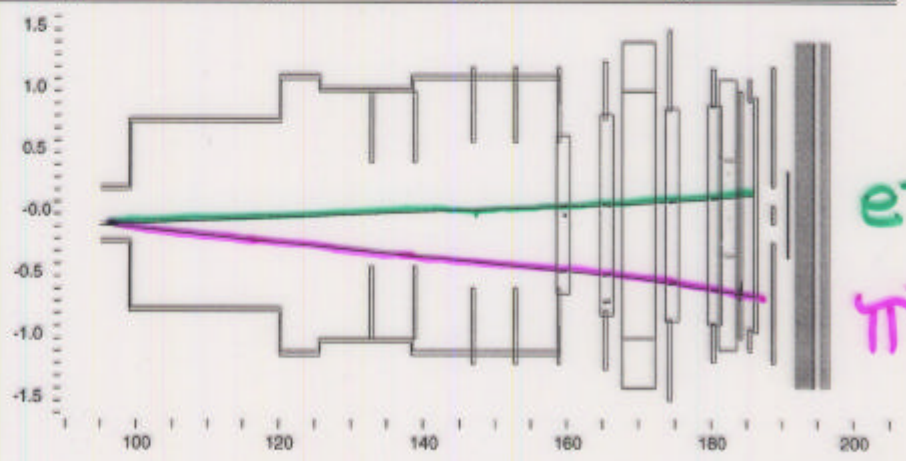
Mass=1.3849 (assuming pions)

Chisq=170.07 Pt2v=0.009506



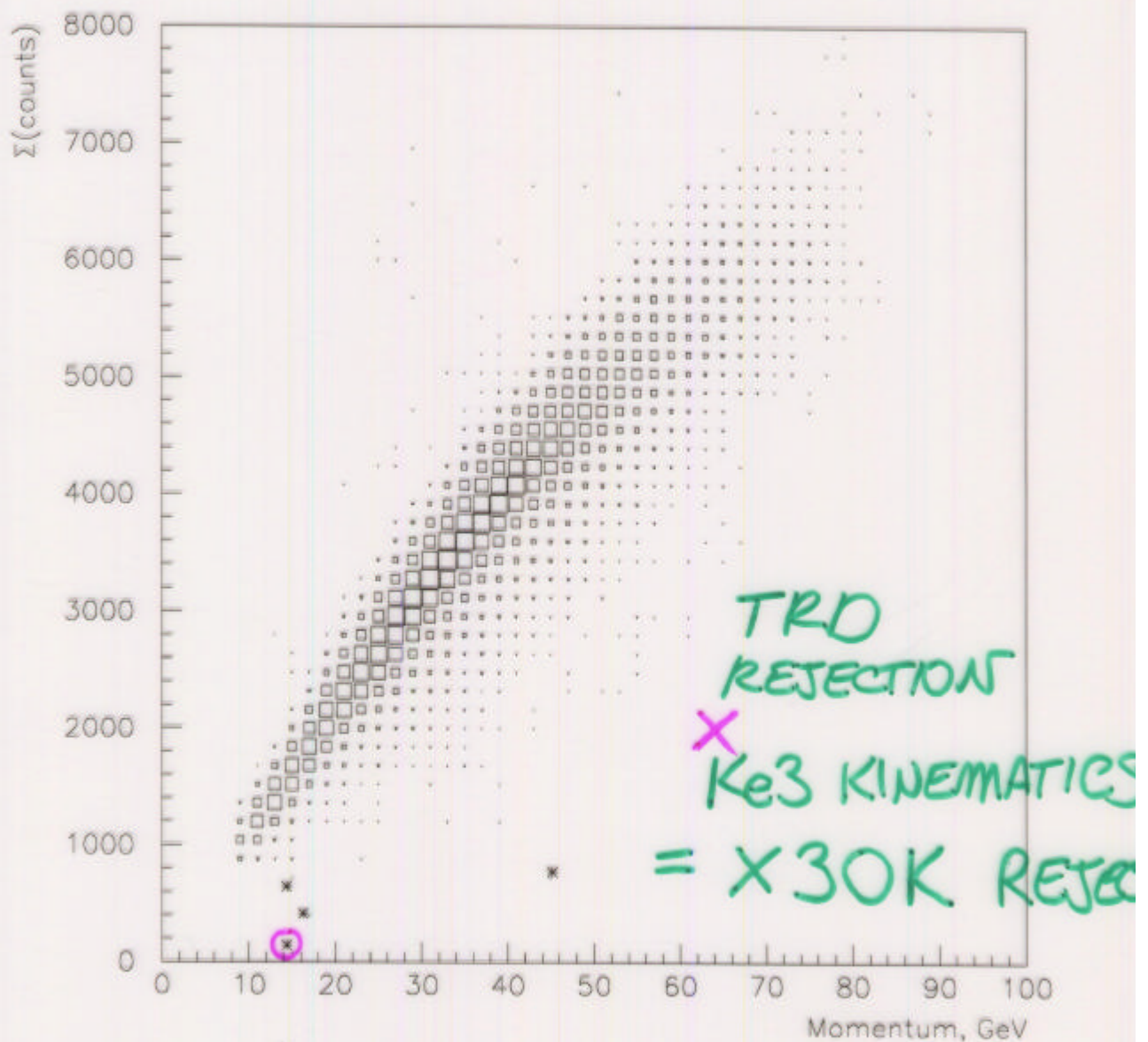
π^+
M
15

- - Cluster
- - Track
- - 10.00 GeV
- - 1.00 GeV
- - 0.10 GeV
- - 0.01 GeV



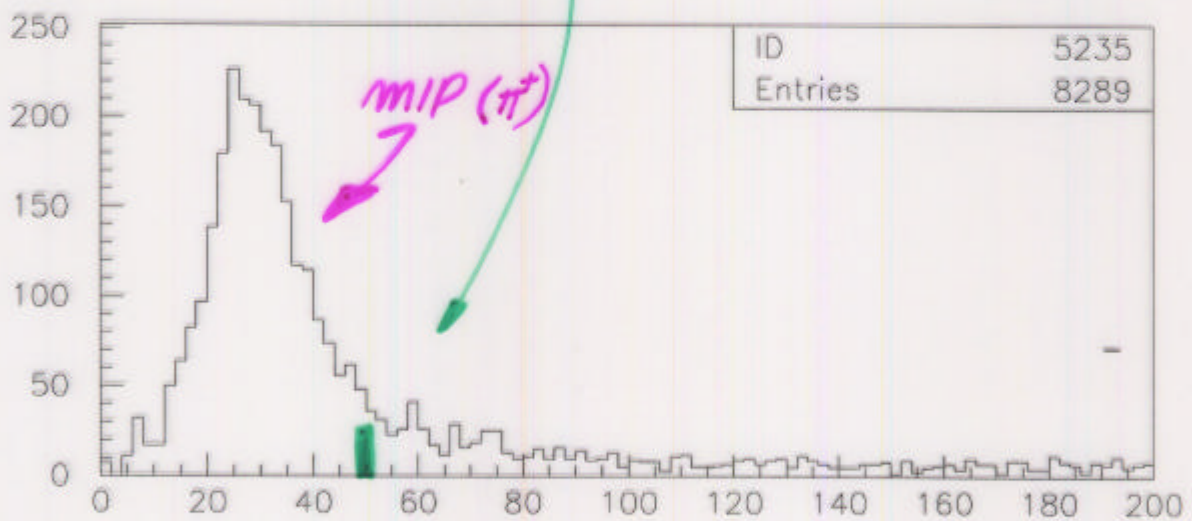
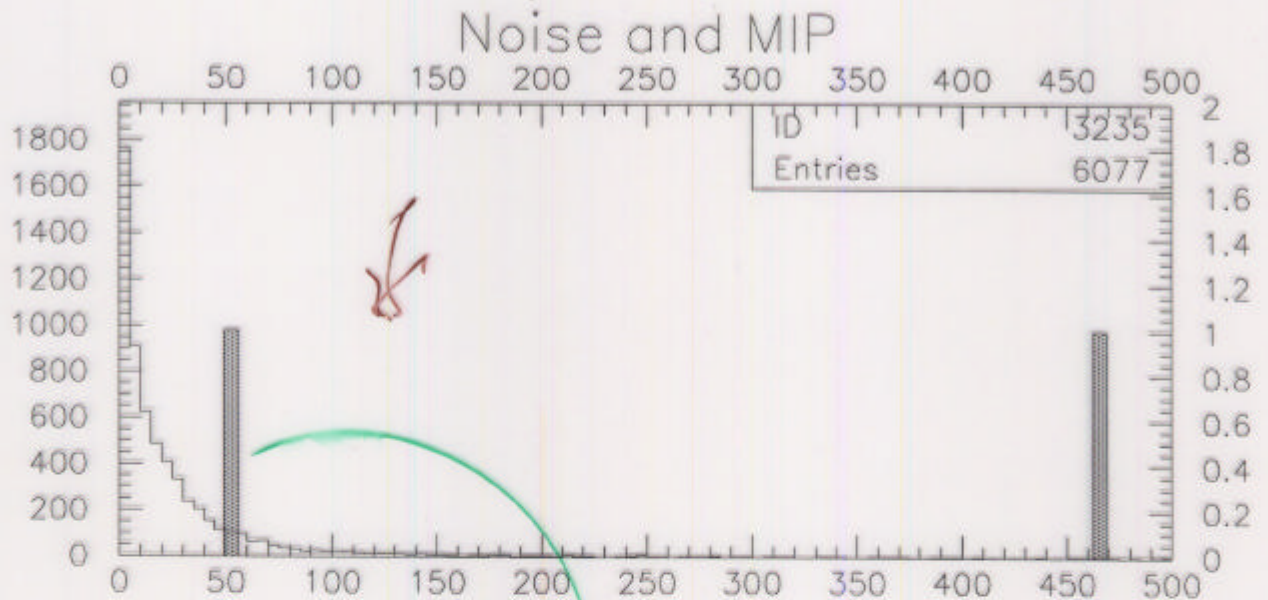
TRD SYSTEM
SHIFTED TO BE
 e^-/π^+ REJECT X

Tagged Electrons on KTeV 20X₀ Sampling Beam Hole Calorimeter



- No inefficiency observed out of 56K tagged electrons
- Probes inefficiency at 2×10^{-5} level

EFFICIENCY OF HIGH ENERGY ELECTRONS



$\Sigma(BA1+BA2)$

SET ENERGY CUT > MIP PEAK

VETO \rightarrow 52K EVENTS CLEANLY VETO'D.

$$\rightarrow \bar{\epsilon} < 3 \times 10^{-5}$$

SUMMARY & OUTLOOK.

- WE CONTINUE TO BE OPTIMISTIC ABOUT CKM'S PROSPECTS FOR A PRECISION MEASUREMENT OF $K^+ \rightarrow \pi^+ \pi^0$
- WE ARE SUBMITTING A SECOND VERSION OF OUR PROPOSAL TO FERMI LAB ON APRIL 15

NEW IN VERSION 2:

- DETAILED UNDERSTANDING OF γ -VETO REQUIREMENTS, DATA BASED ARGUMENTS ON FEASIBILITY.
- μ -VETO PROTOTYPE TESTS.
- HIGH STATISTICS STUDY OF SELECTION RICH PERFORMANCE.
- FULL GEANT SIMULATION OF BEAM AND DETECTOR & RECONSTRUCTION

→ WE EXPECT AND ARE
PLANNING ON STAGE-I
SCIENTIFIC APPROVAL IN
LATE JUNE OF THIS YEAR

—H—