

SHMS Calorimeter Studies

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- Shower only Calorimeter Studies.
- Shower & Preshower Calorimeter Studies.
- Photoelectron production and Pion rejection.
- Conclusion

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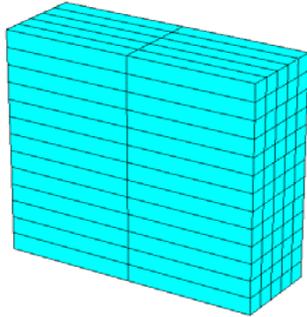
Hall C Collaboration meeting 27 January 2007

General requirements for SHMS Calorimeter are:

- **Effective area** : 120x130 cm² (actual physical size +5cm from each side)
- **Total thickness**: ~ 20 rad. length
- **Dynamic range**: 1.0 - 11.0 GeV/c
- **Energy resolution**: ~6 % at 1 GeV/c
- **Pion rejection**: ~100:1 at P > 1.5 GeV/c
- **Electron efficiency**: > 98 %

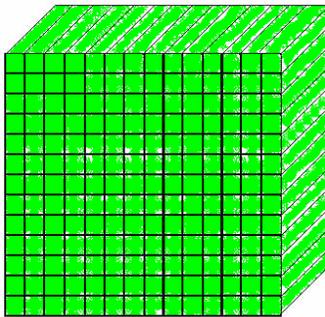
The SHMS magnetic spectrometer is aimed to cover small forward angles and higher momentum settings not available so far in Hall C .

SHMS Calorimeter Versions



Version 1. The blocks are oriented **horizontally** with respect to the central ray of the spectrometer with PMTs looking sideways.

a) TF-1 $10 \times 10 \times 70 \text{ cm}^3$ 130 blocks.

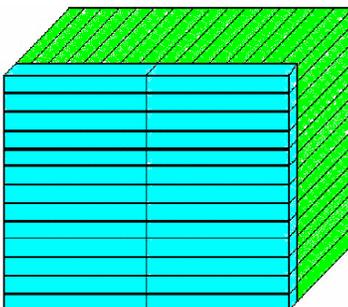


Version 2. The blocks are oriented **longitudinally** with respect to the central ray of the spectrometer with PMTs looking upstream.

a) F-101 $9 \times 9 \times 50 \text{ cm}^3$ 224 blocks.

b) TF-1 $10 \times 10 \times 40 \text{ cm}^3$ 182 blocks.

c) TF-1 $10 \times 10 \times 50 \text{ cm}^3$ 182 blocks.



Version 3. The blocks are oriented **longitudinally on shower part** and **horizontally on preshower part**, with respect to the central ray of the spectrometer with PMTs looking **upstream on shower part** and **sideways on preshower part**.

a) TF-1 $10 \times 10 \times 70 \text{ cm}^3$ 26 blocks preshower,

F-101 $9 \times 9 \times 50 \text{ cm}^3$ 224 blocks shower.

b) TF-1 $10 \times 10 \times 70 \text{ cm}^3$ 26 blocks preshower,

TF-1 $4 \times 4 \times 40 \text{ cm}^3$ 1120 blocks shower.

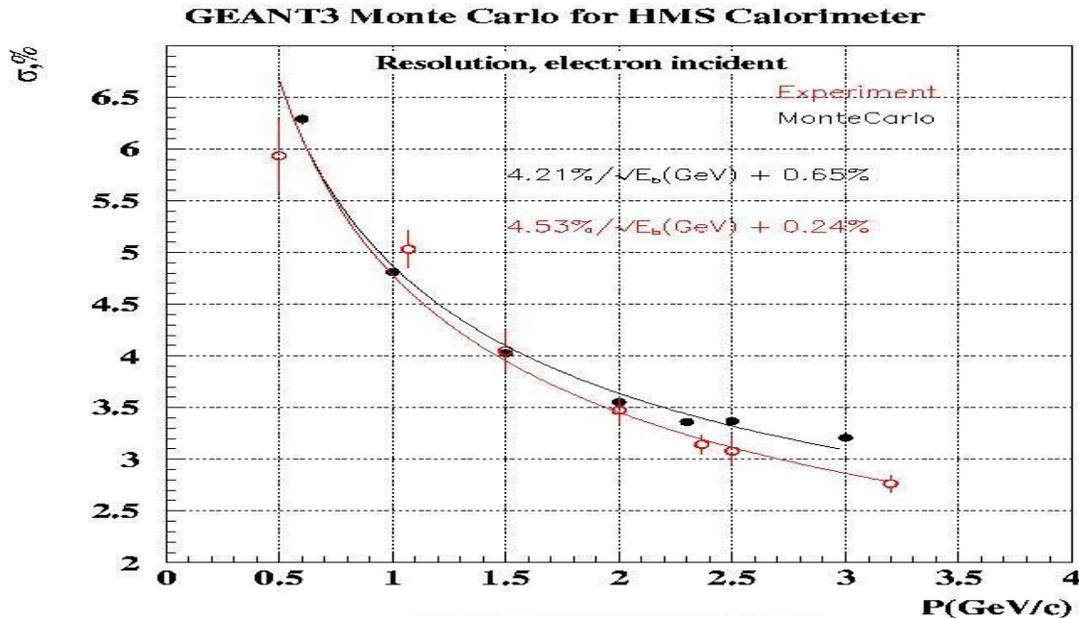
Monte Carlo Simulation

- The Monte Carlo program is based on GEANT- 3.21 simulation package.
- The GEANT part of the code included:
 - electromagnetic and hadron shower developments,
 - the Cherenkov light generation,
- The user code takes care of:
 - the realistic optics tracing of the light photons,
 - absorption in the lead glass,
 - reflection off the optical coating of the modules,
 - passage through the optical coupling to the PMT are scrupulously.

The part of the code for detector description was modified for adapting it to the SHMS calorimeter simulations, and a separate modification was created for each of the versions.

Monte Carlo Program Check

In order to gain in confidence to the Monte Carlo program, results of Monte Carlo calculations are checked against experimental data.



HMS calorimeter resolution.

Experimental data are in red (open).

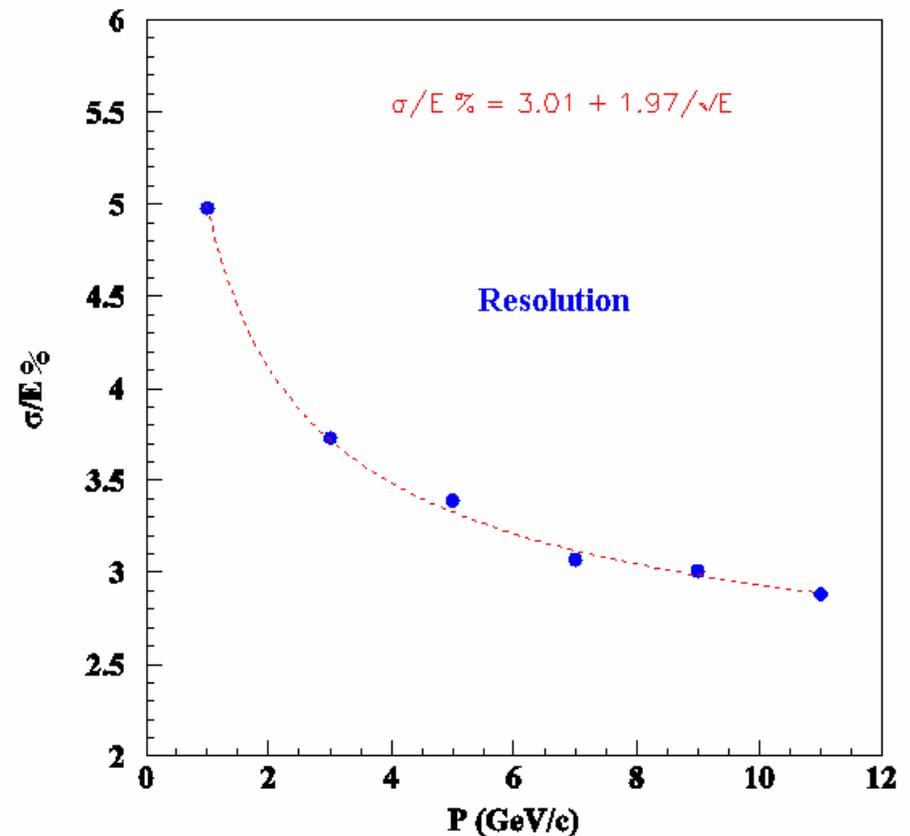
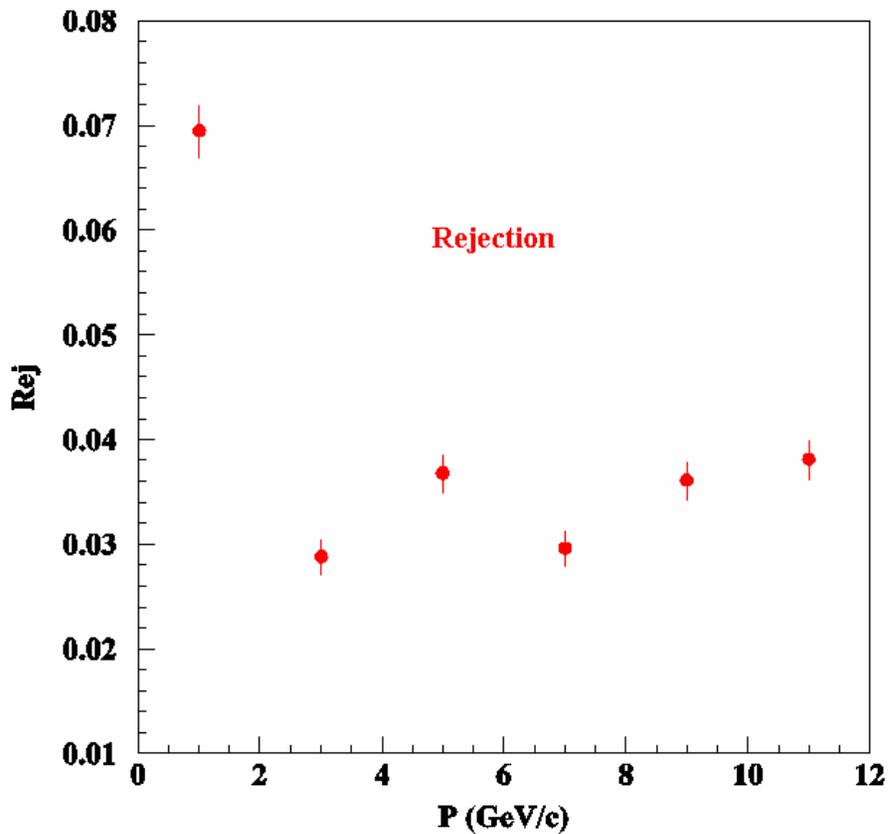
Monte Carlo data are in black(solid).

The two lines are fits to data.

Energy Resolution and π^- rejection

Version 2a: Shower Only (F-101)

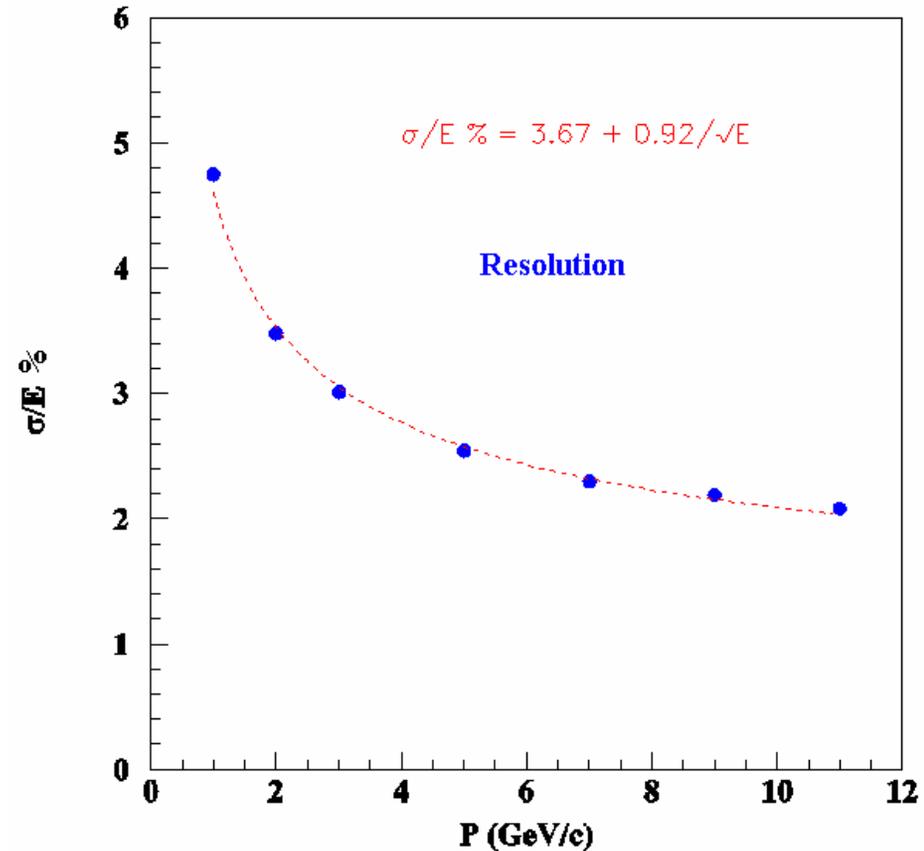
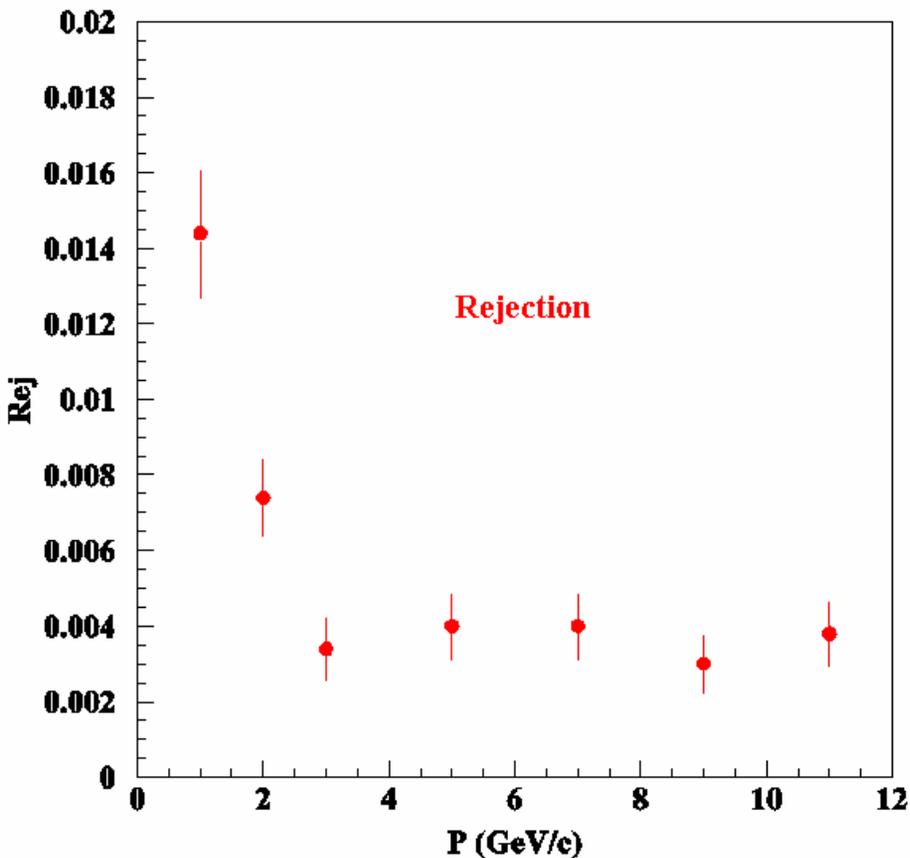
Energy resolution of the calorimeter (F-101 Shower Only): $\sigma/E = 3.01 + 1.97/\sqrt{E}$
Pion rejection factor at 98% electron detection efficiency for e^- : $\sim 3.5 \times 10^{-2}$ for $P > 2 \text{ GeV}/c$



Energy Resolution and π^- rejection

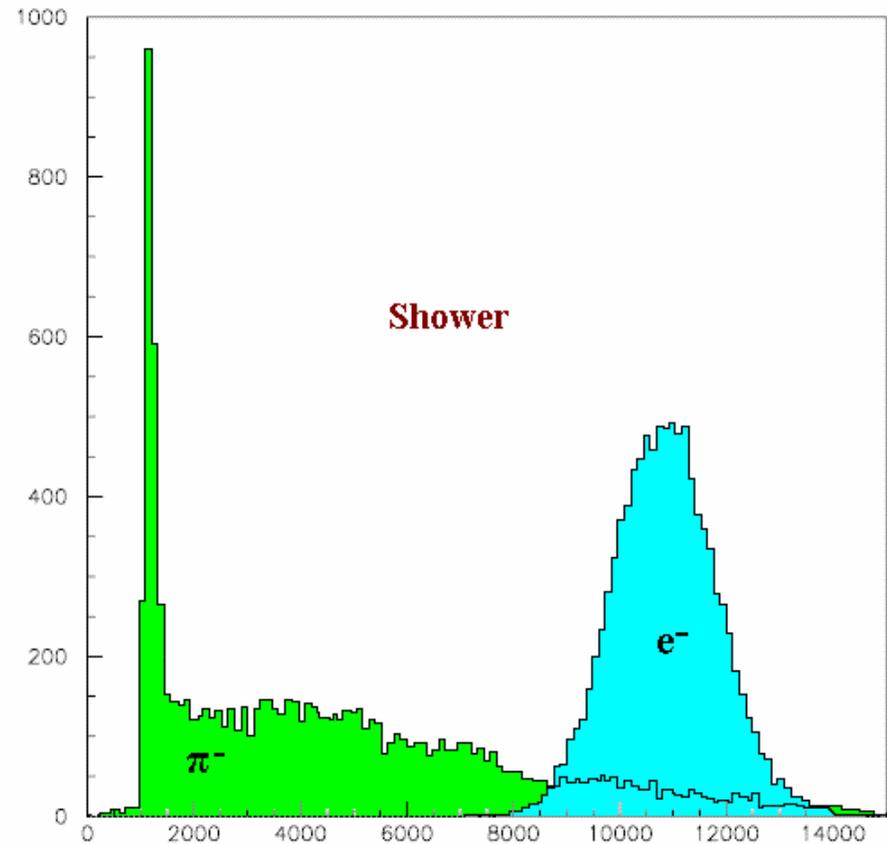
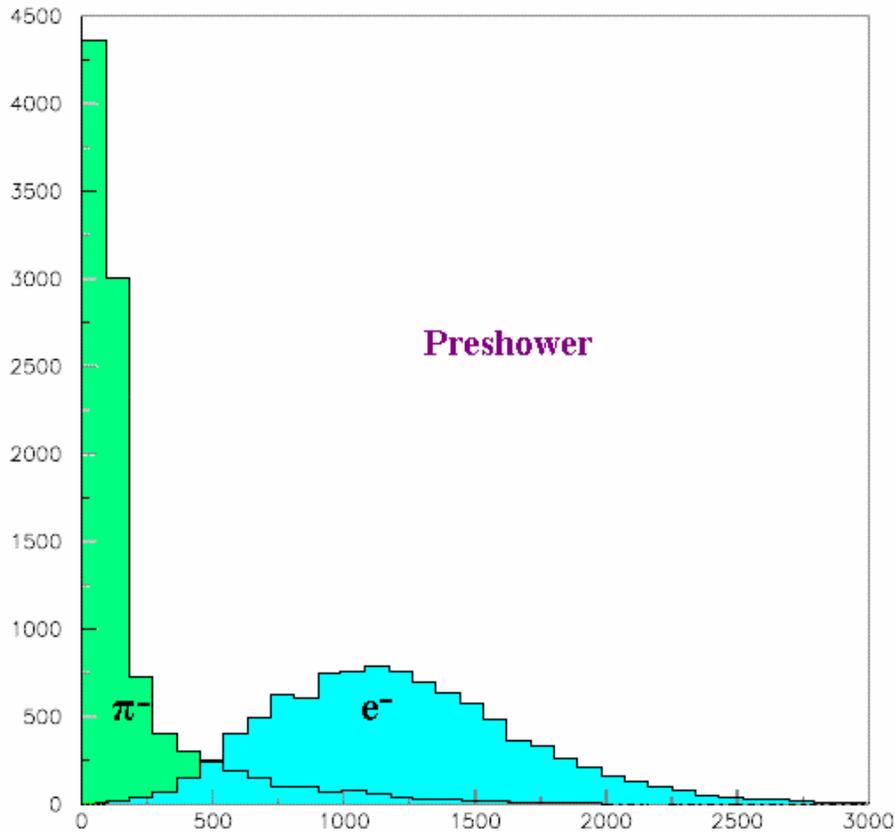
Version 3a: Shower(F101)/Preshower(TF-1)

Energy resolution of the calorimeter (F-101 Shower and TF-1 Preshower):
 $\sigma/E = 3.67 + 0.97/\sqrt{E}$. Pion rejection factor at 98% electron detection efficiency
for e^- : $\sim 4 \times 10^{-3}$ for $P > 2$ GeV/c

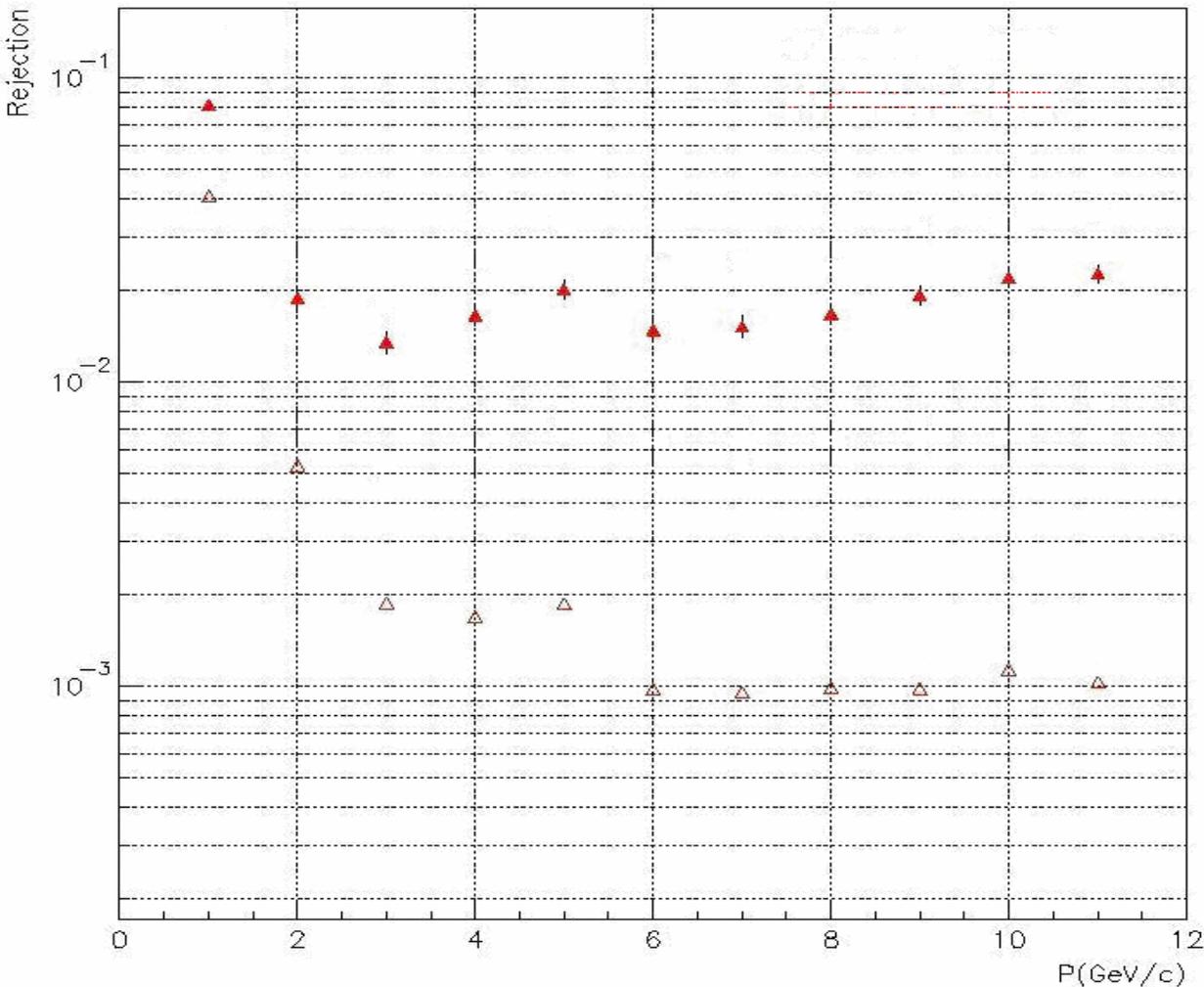


Photoelectron production in Shower/Preshower.

Number of photoelectrons produced by incident electron and pion at 9 GeV/c .



Pion rejection with Shower/Preshower



Red (solid) symbols
rejection with shower
only.

Blank (open) symbols
rejection with Preshower
and Shower.

Pion rejection at 98 % efficiency for e^- .

Conclusion

- The **energy** resolution of $\sigma < \sim 5\%$, π/e rejection factor $\sim 2 \times 10^{-2}$ at electron detection efficiency $\sim 99\%$ for the case without **Preshower** are expected at $P_{SHMS} > 1 \text{ GeV}/c$
- **Preshower** improves π/e rejection at least by factor **4**.
- The **energy resolution** with and without **Preshower** are **similar**.
- The use of radiative hard **F-101** type lead glass from **HERMES** for **Shower** part will be an **optimal solution**.
- We may use **TF-1** type blocks from **SOS shower** detector to built **Preshower** for **SHMS** Calorimeter (**26** from existing **44**).
- A good choice is also to use **TF-1** type blocks for all part (**Shower/Preshower**). In this case an additional time and expenses should be allotted to order new **~182** blocks.
- The **Yerevan** Collaboration is **ready** for the **construction** and **assembly** of **SHMS** calorimeter.