

Dark Matter Detection in Liquid and Solid Noble Gases

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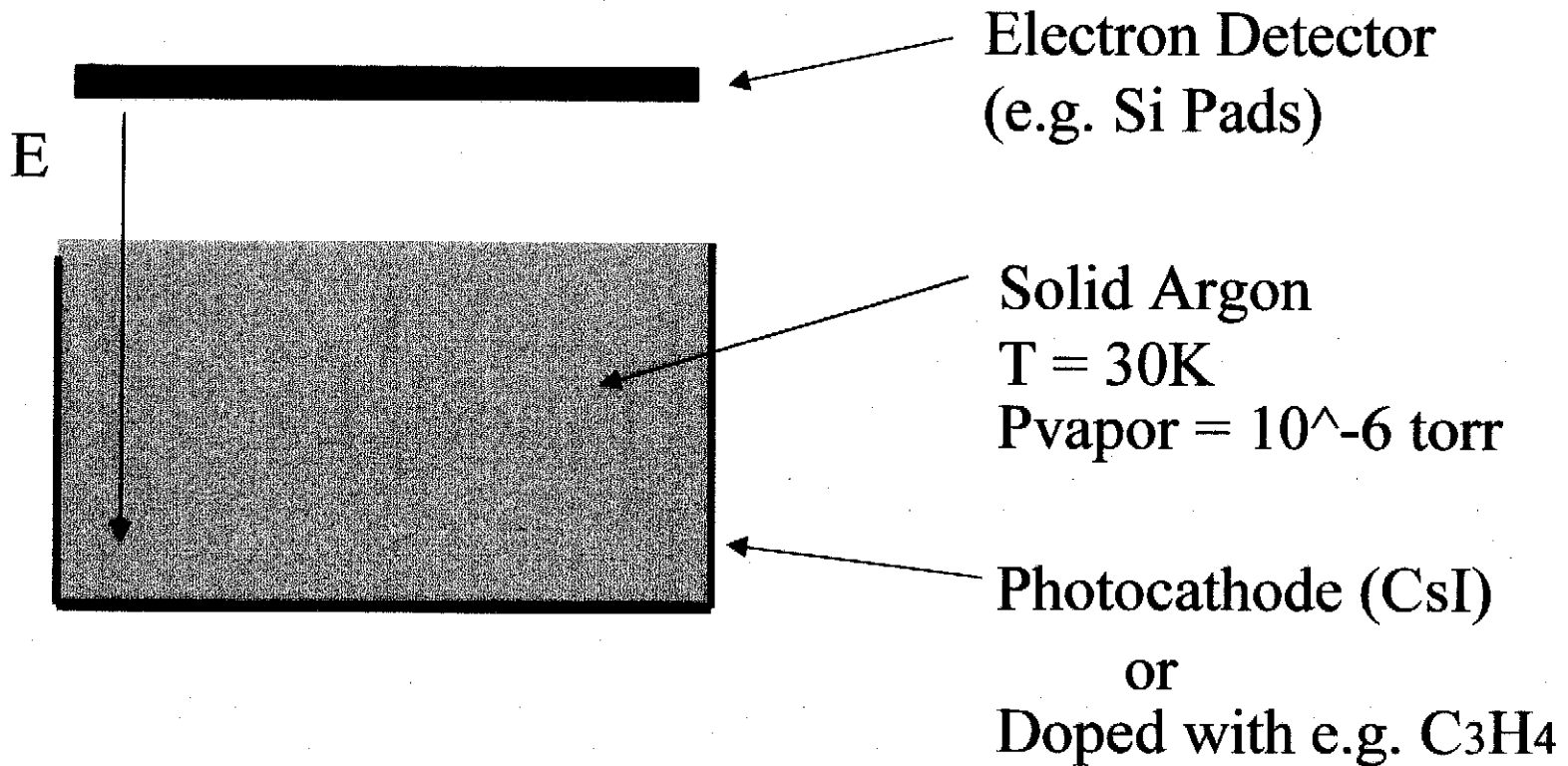
Snowmass - July 9, 2001

Outline

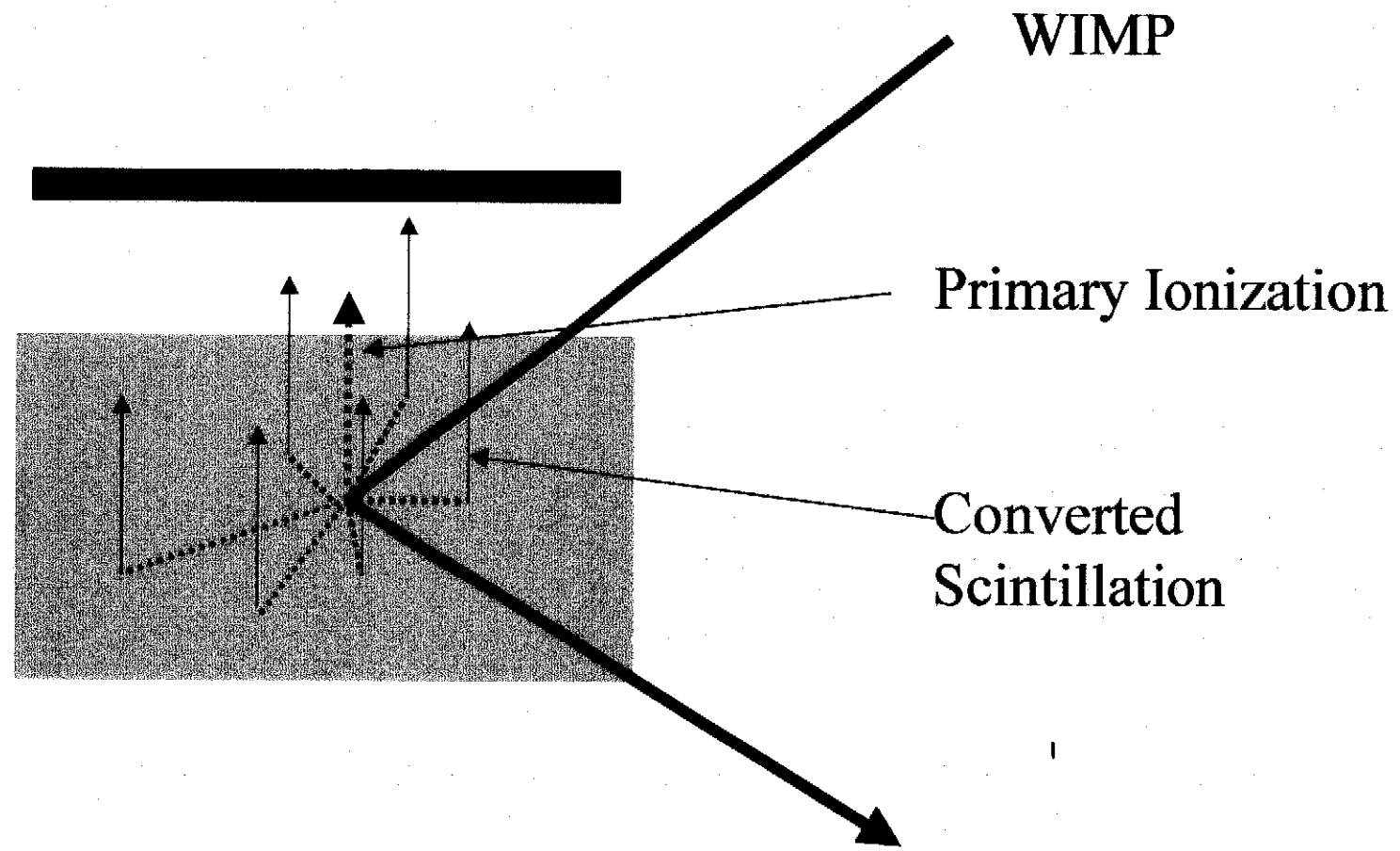
- Solid Argon
- Liquid Argon
- High Pressure Neon
- Solid Xenon

Solid Argon

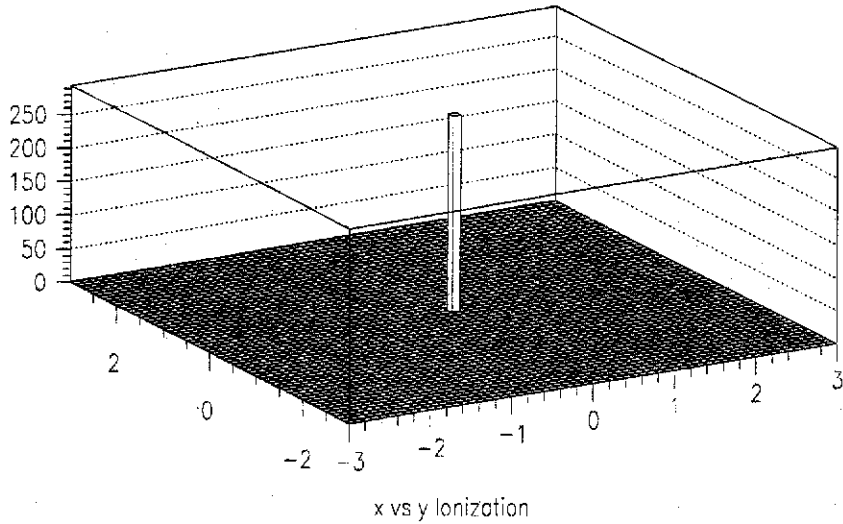
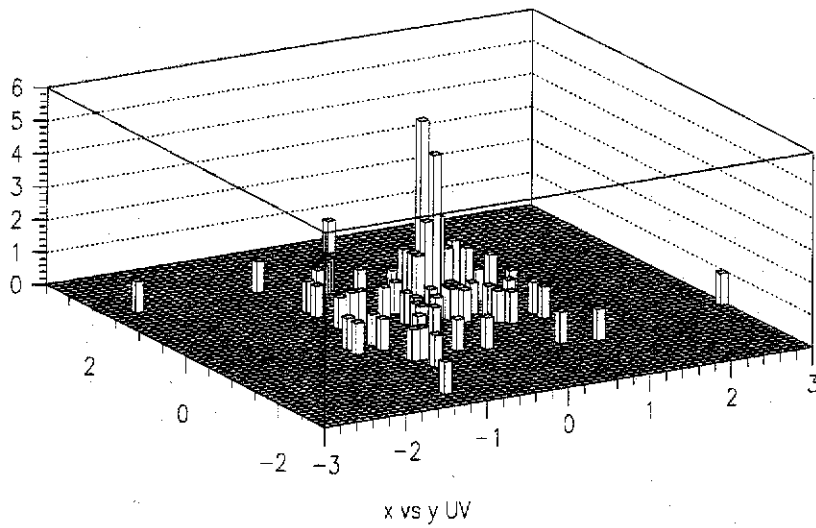
Concept:



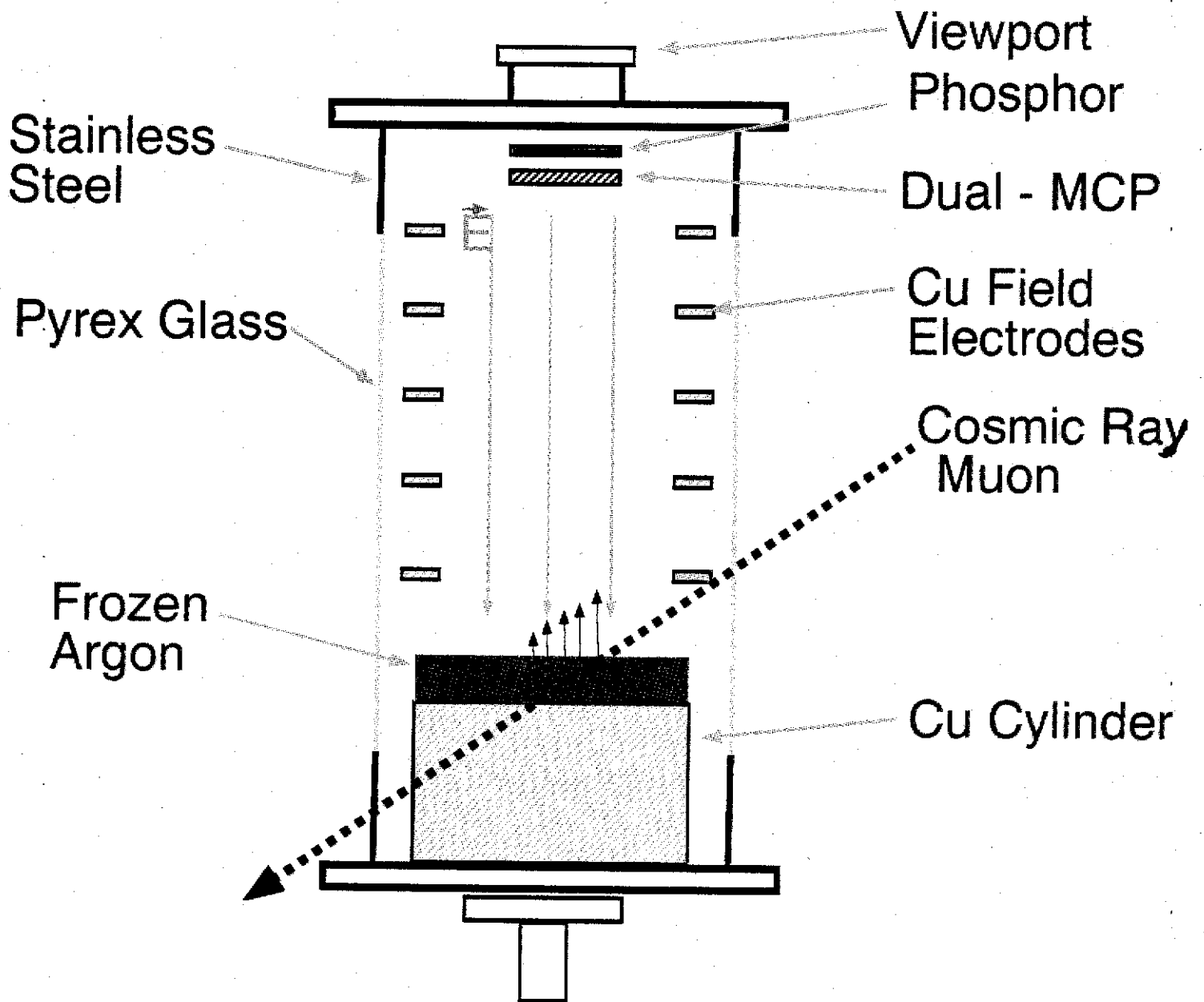
Solid Argon

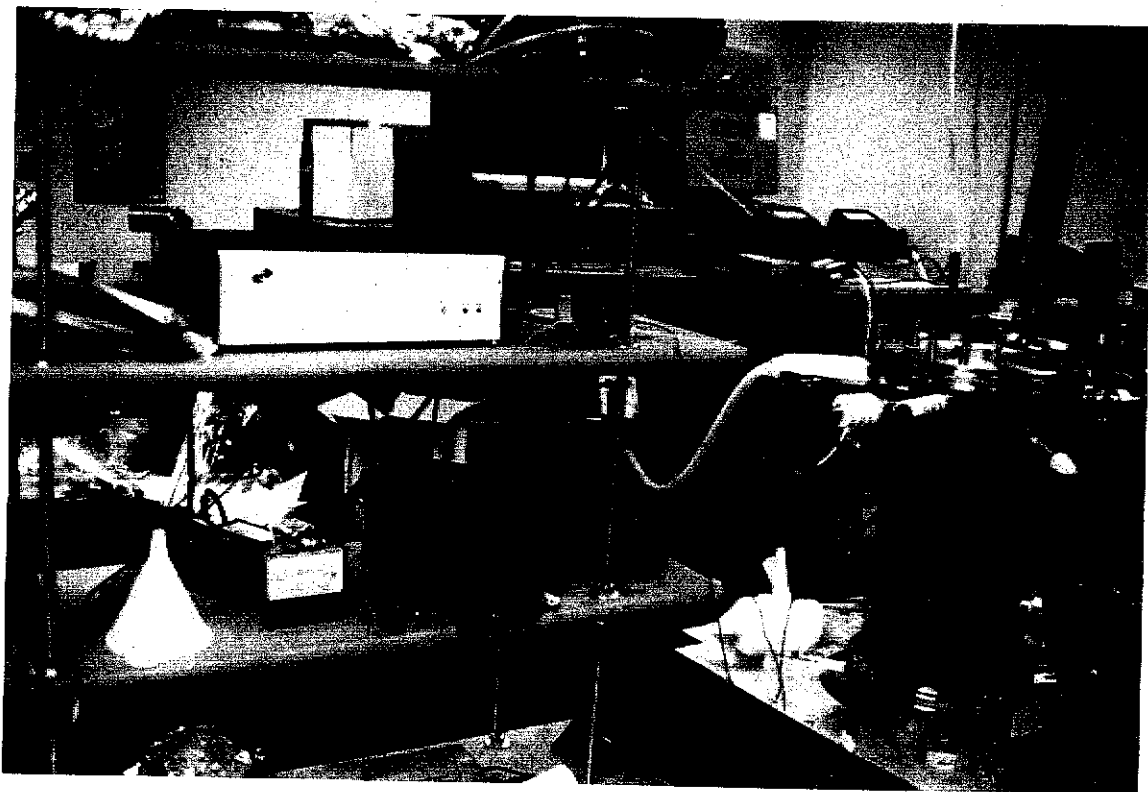


Event



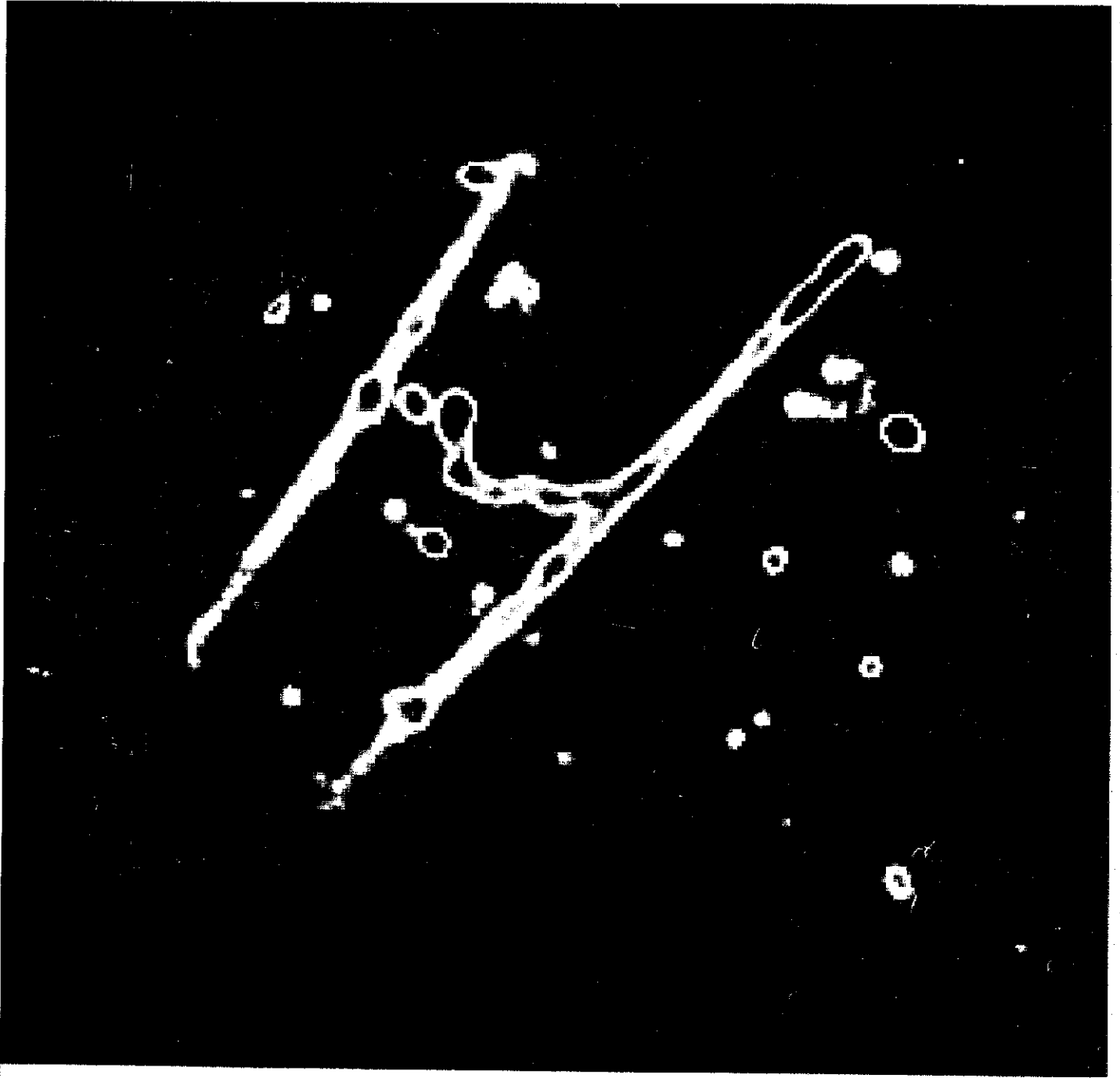
Test Chamber

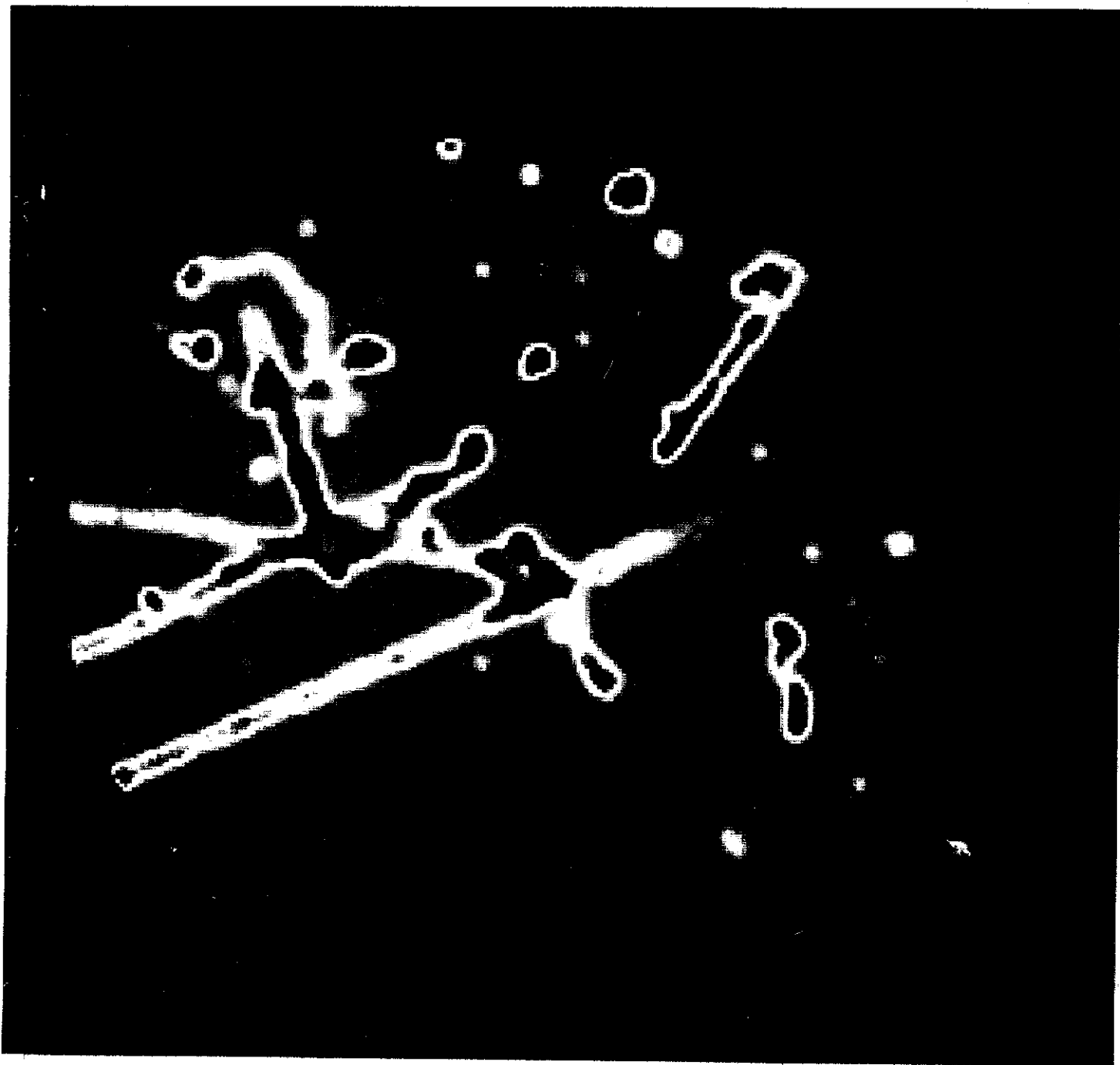


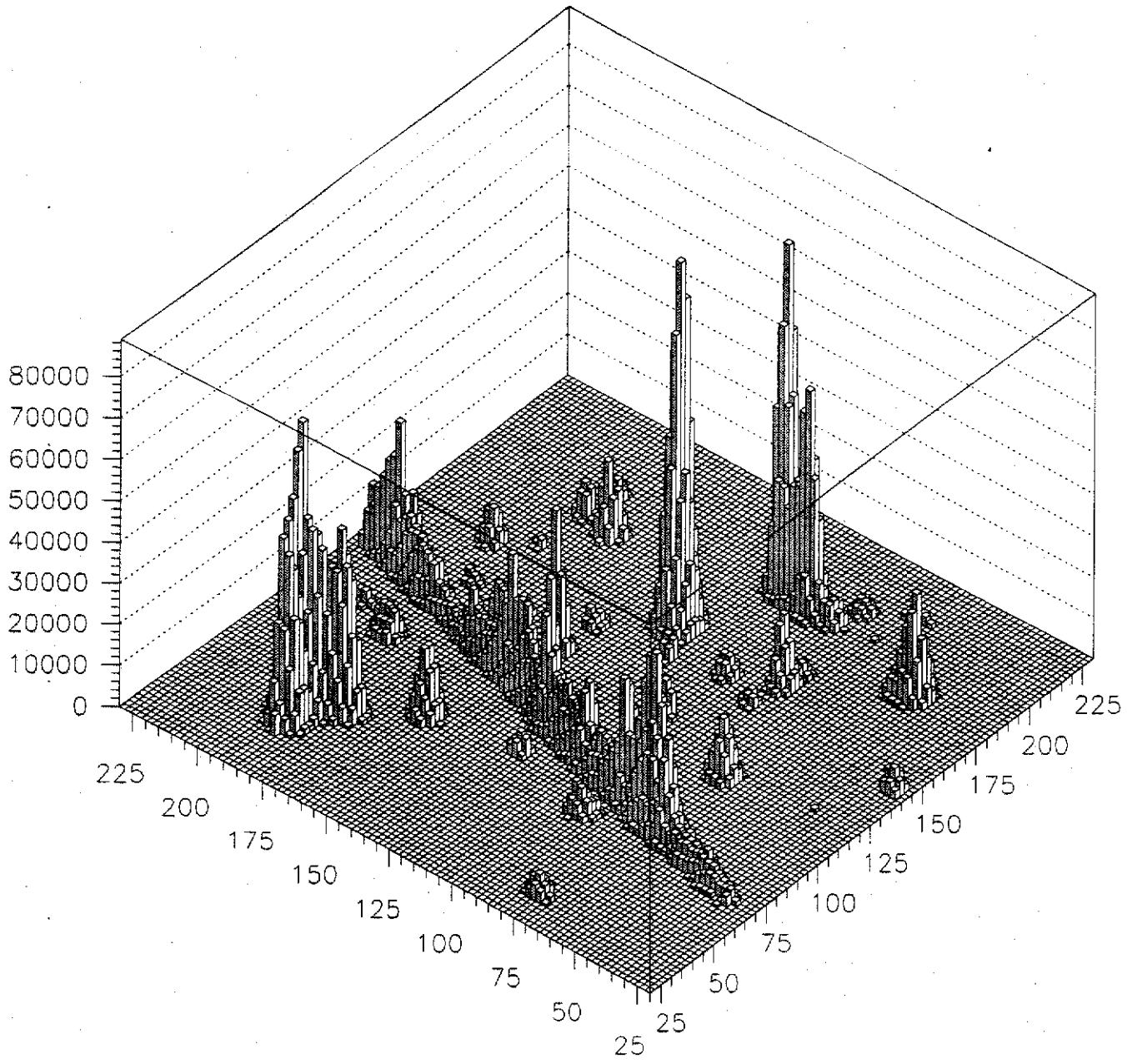




1112C 010





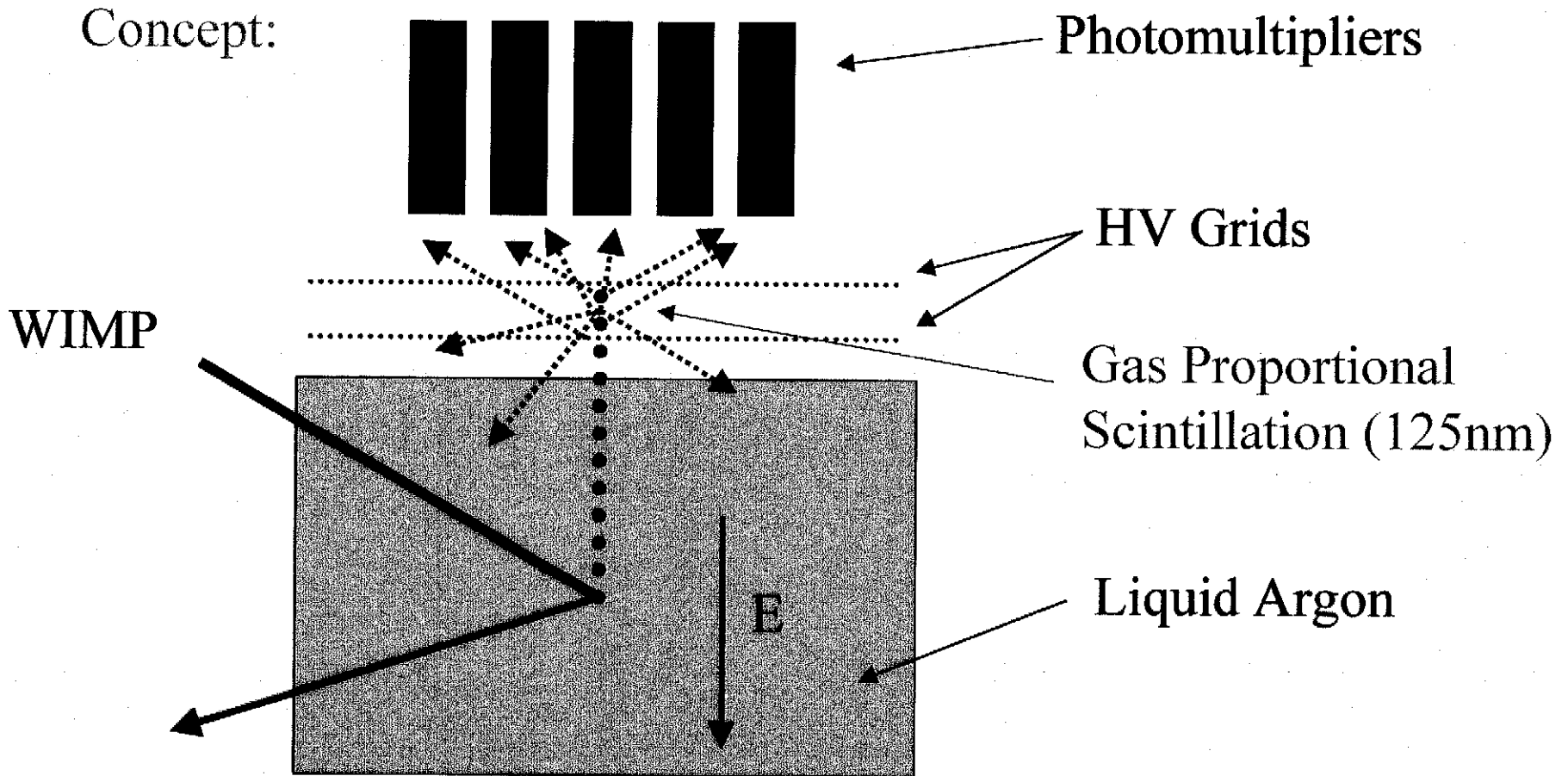


1115c049

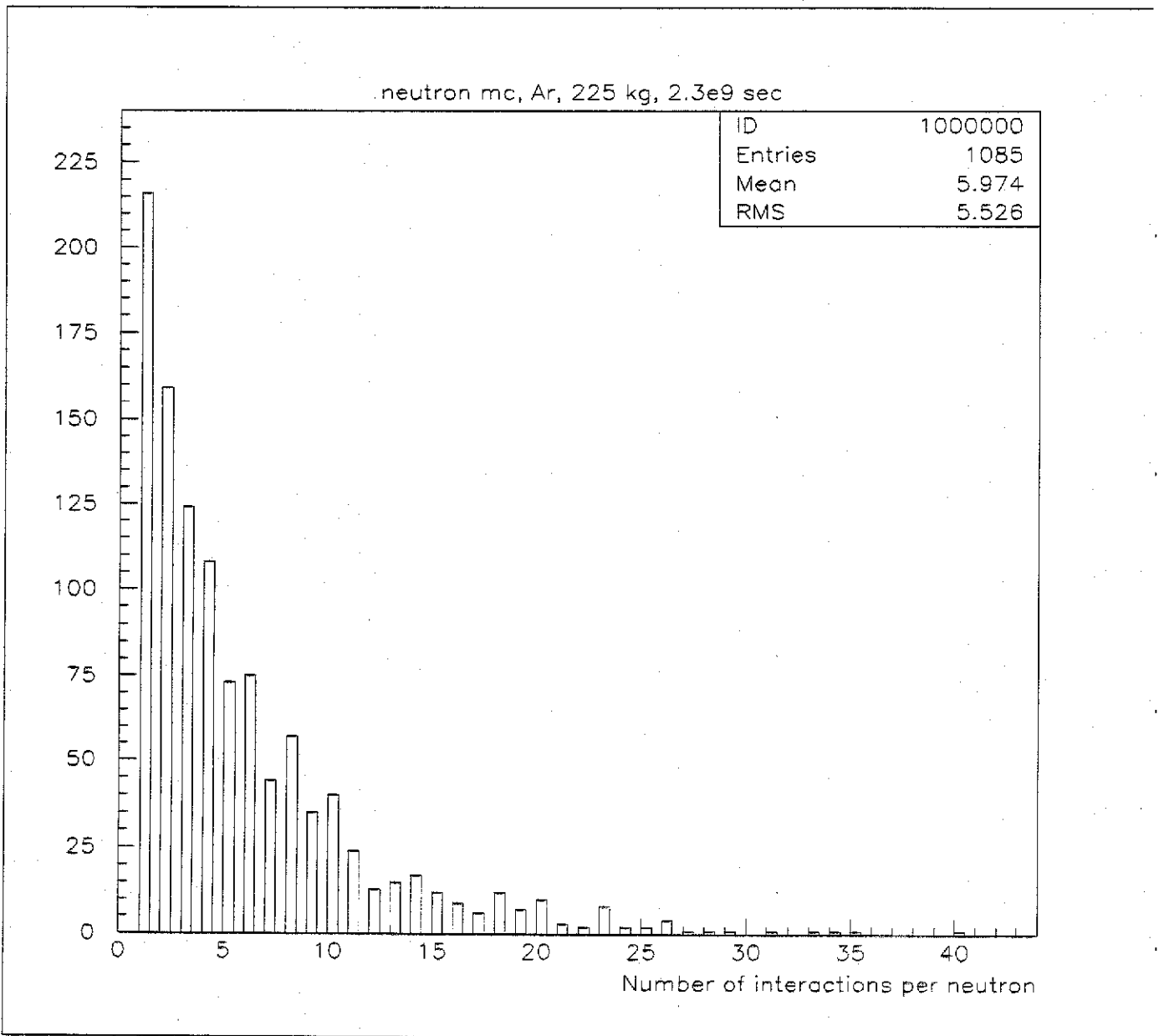
Solid Argon - Conclusions

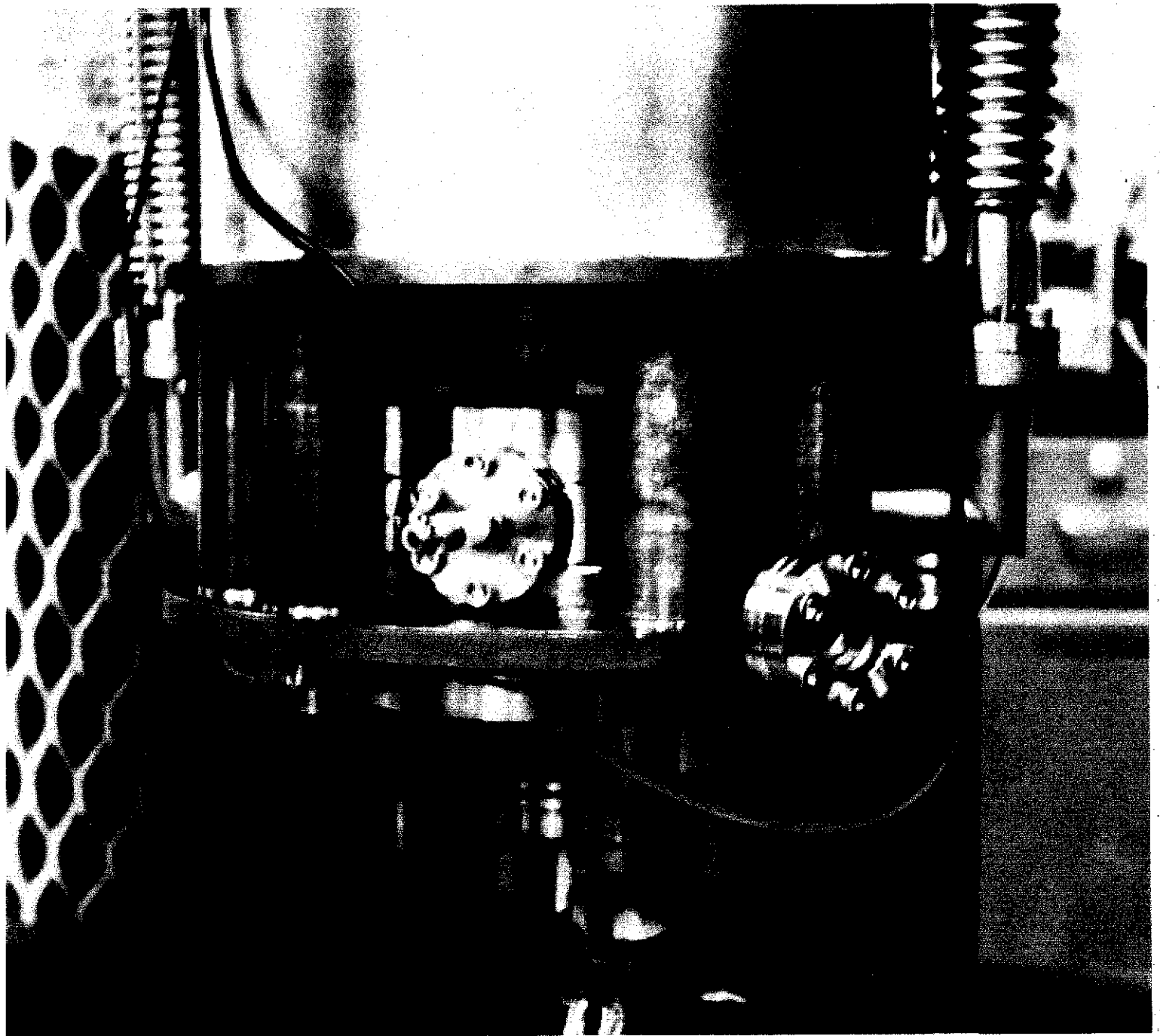
- Electron extraction works - qualitatively
- Large crystals needed --- does not look easy!

Liquid Argon

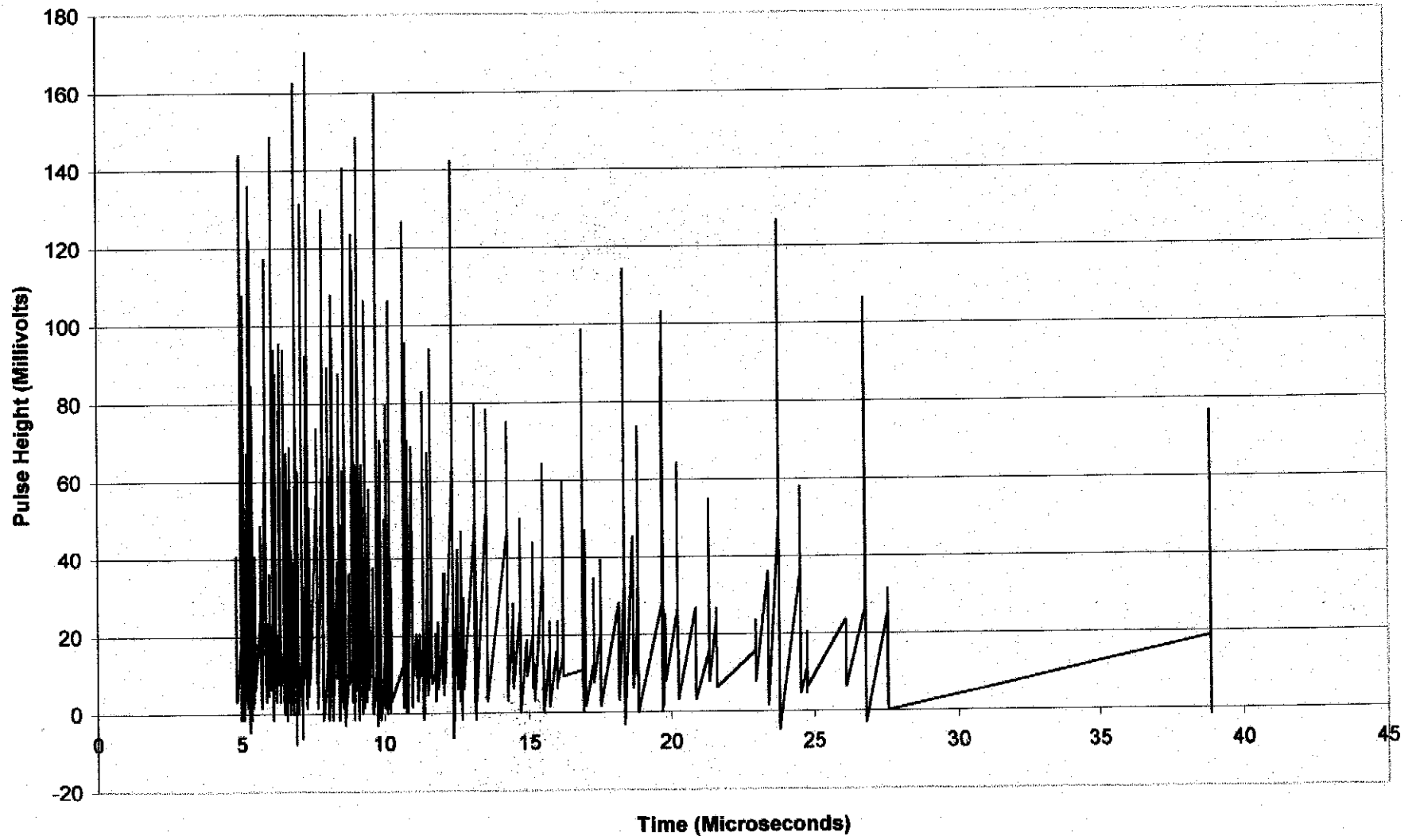


Neutron Scatter multiplicity

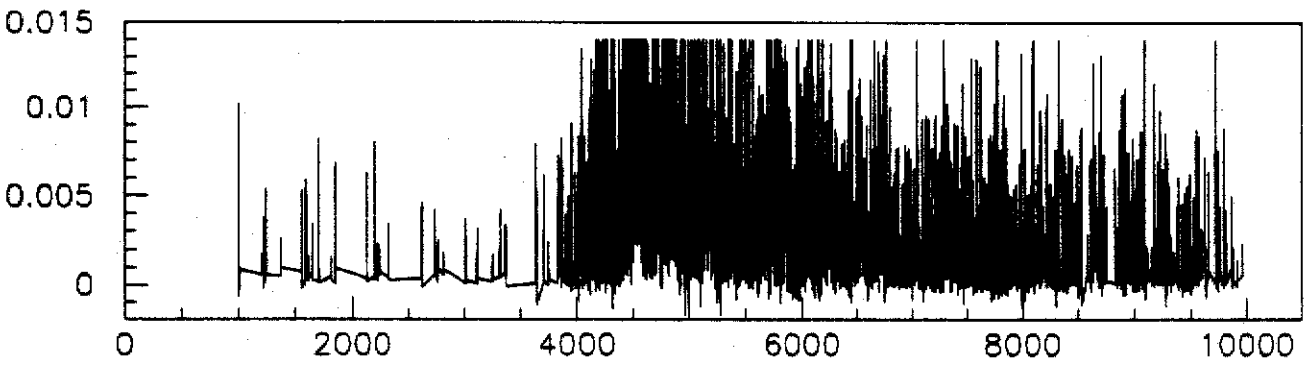
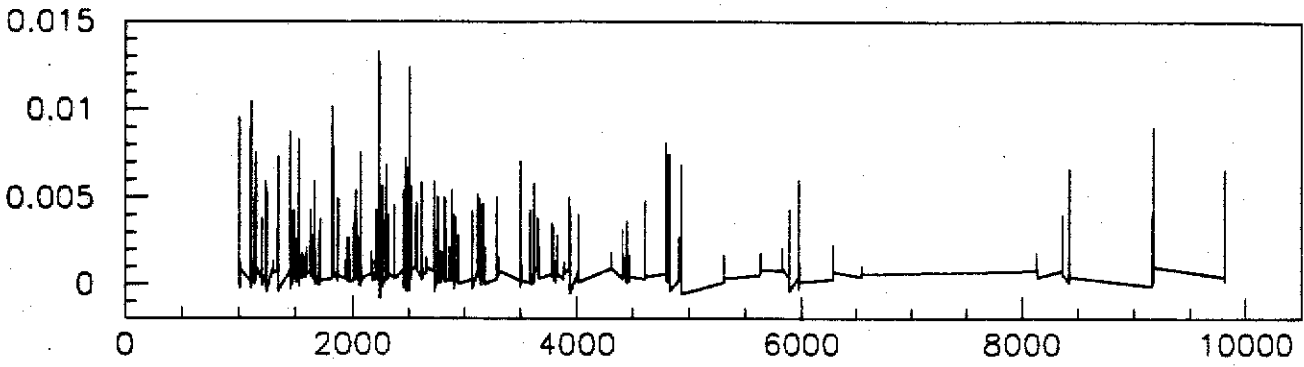
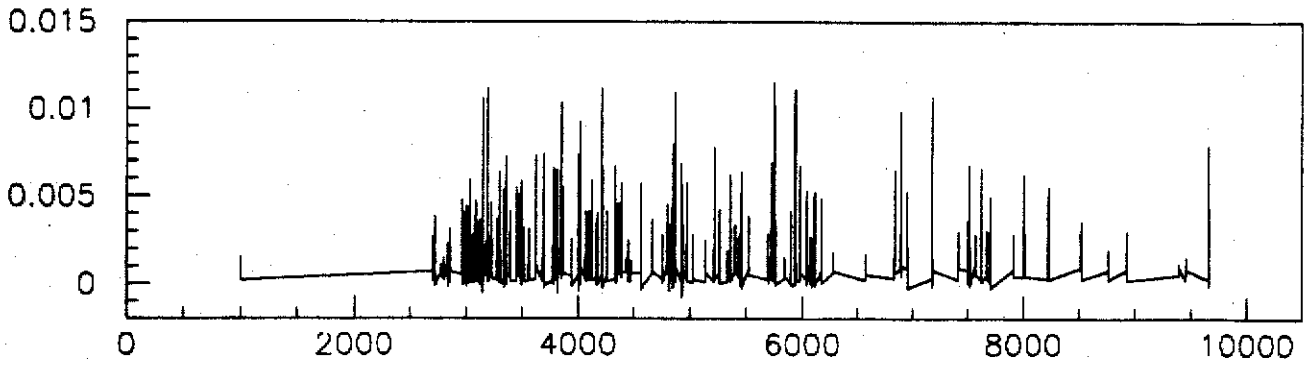




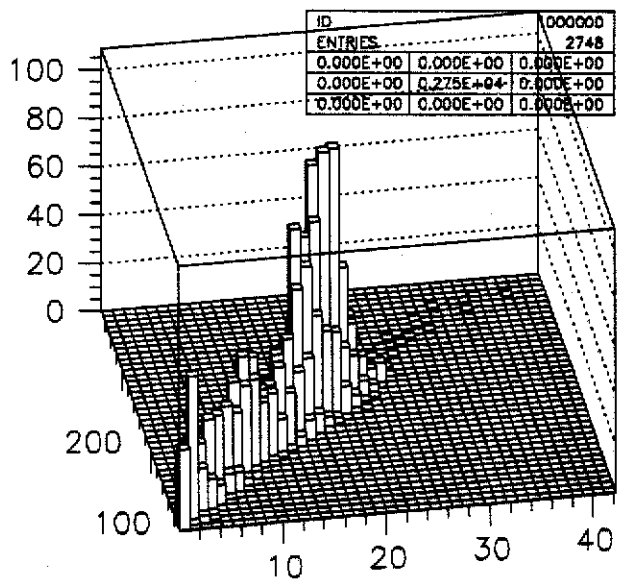
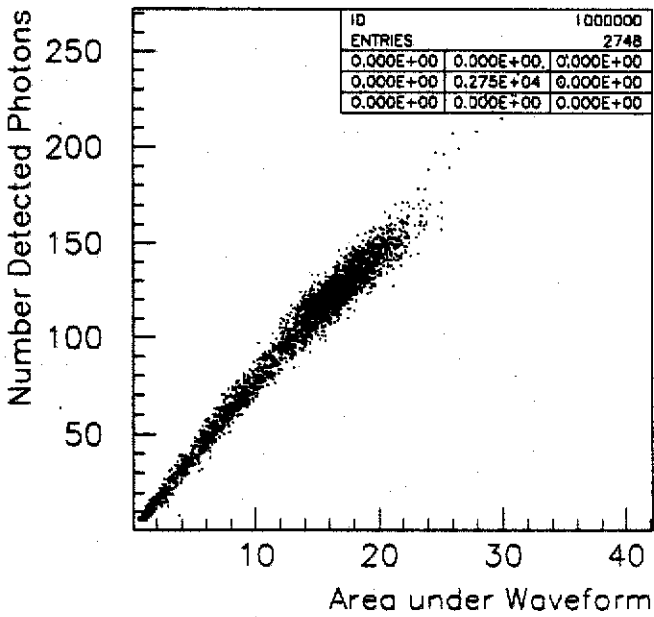
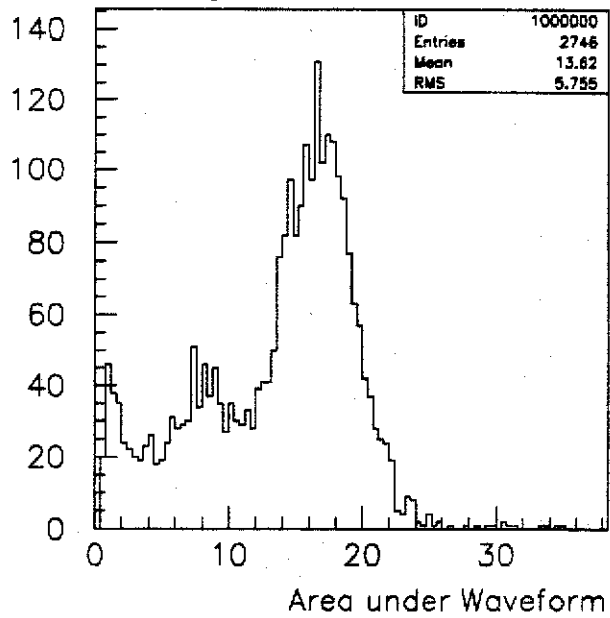
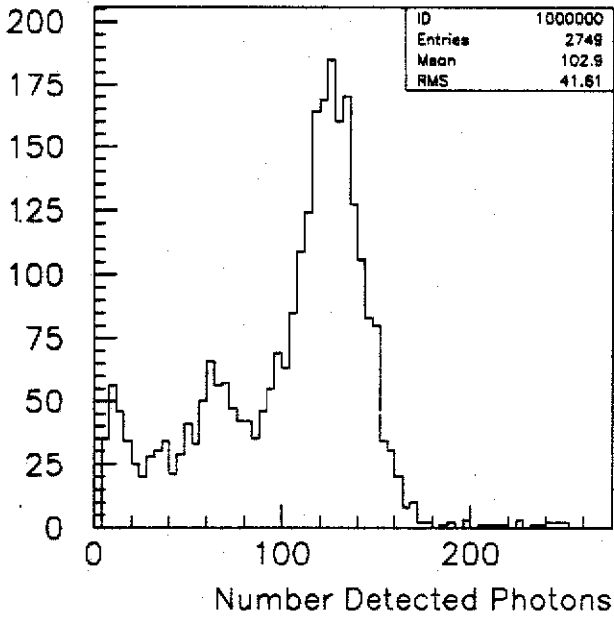
Run A215, Event 4



5.9keV γ



Run 174 - TBP Phosphor, Ni grids

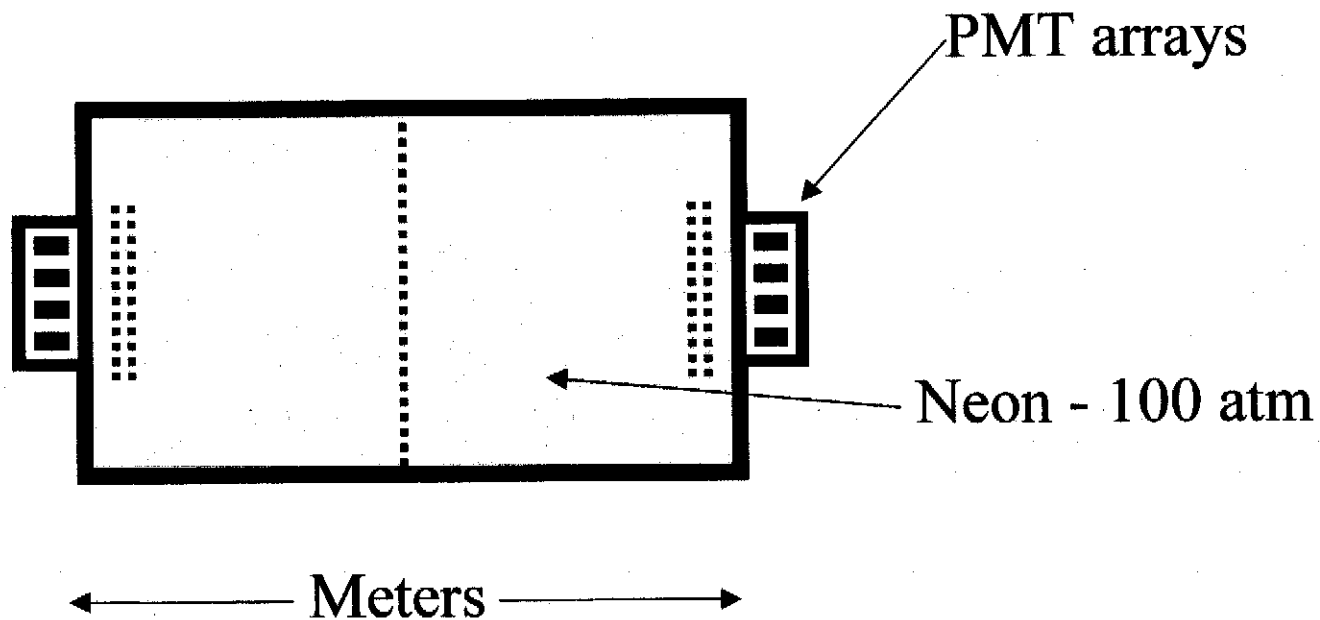


Liquid Argon - Conclusions

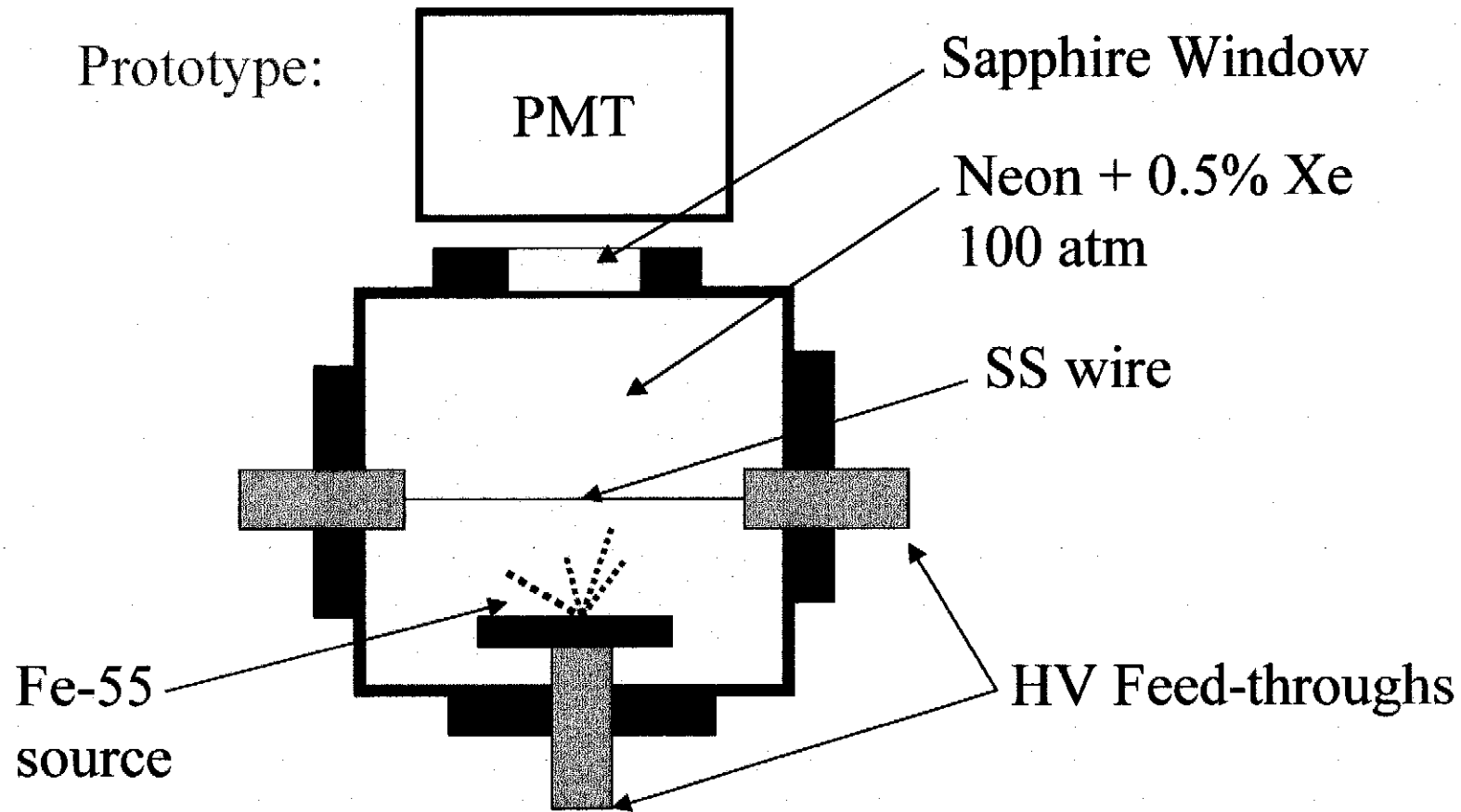
- Electron extraction demonstrated
- Single electron detection efficiency
- Very large mass feasible
- BUT!! Ar-39 ~ 1 part/10¹⁶ ! Cannot be removed easily. “Ancient” Argon not necessarily more radio-quiet!

High Pressure Neon

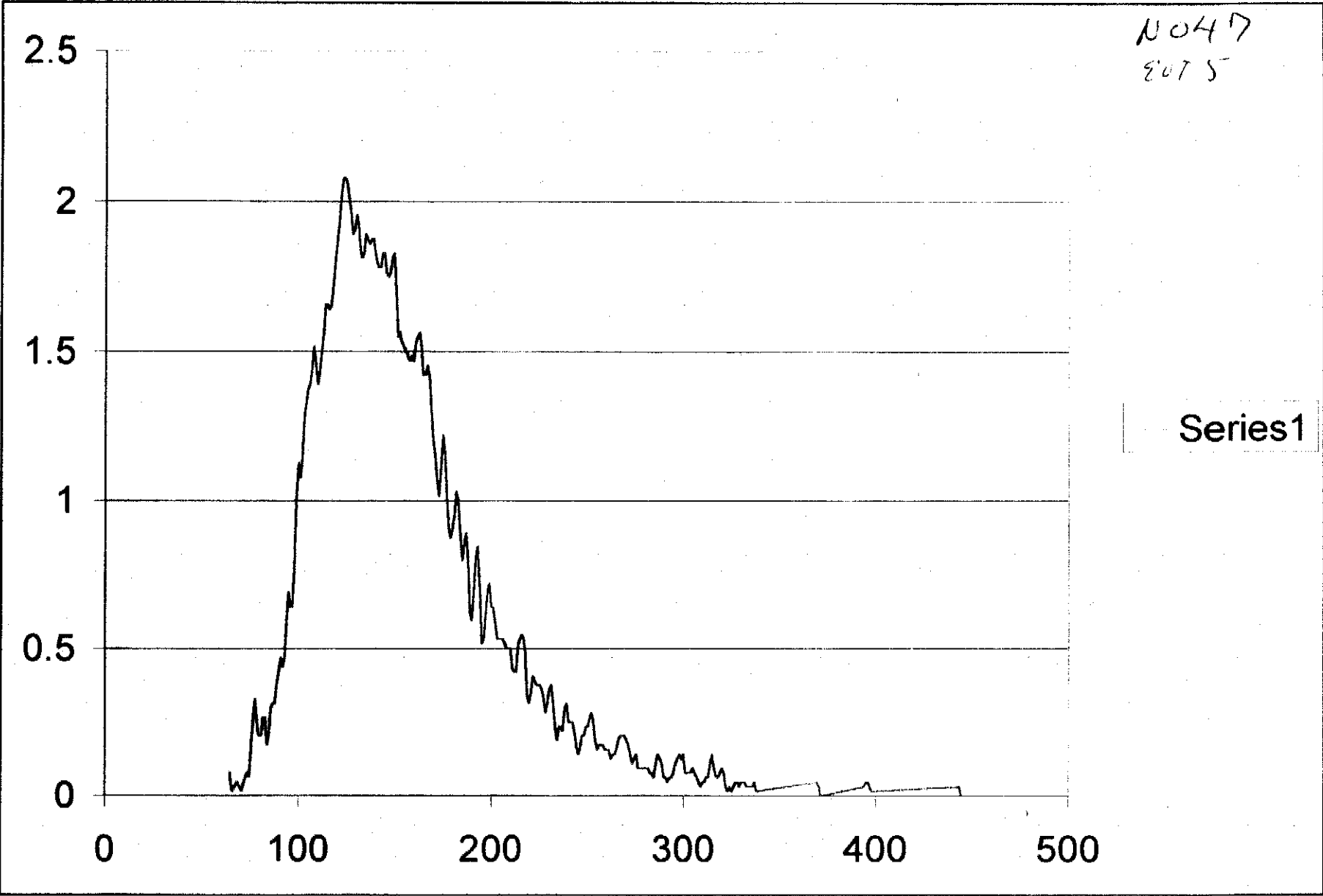
Concept: Gas Proportional Scintillation



High Pressure Neon



N047
8075

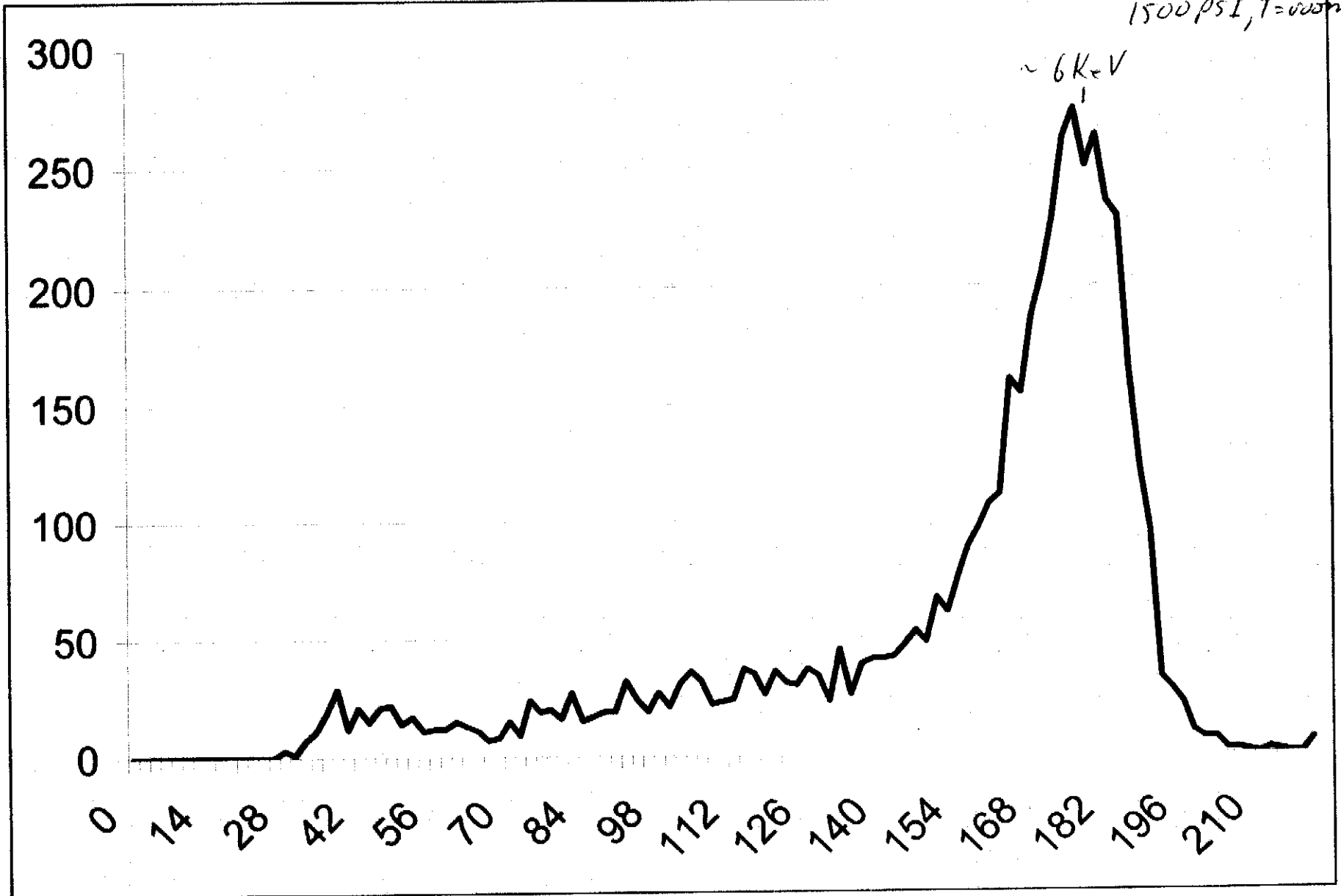


Series1

D046

1500 PSI, T=000m

~ 6 KeV

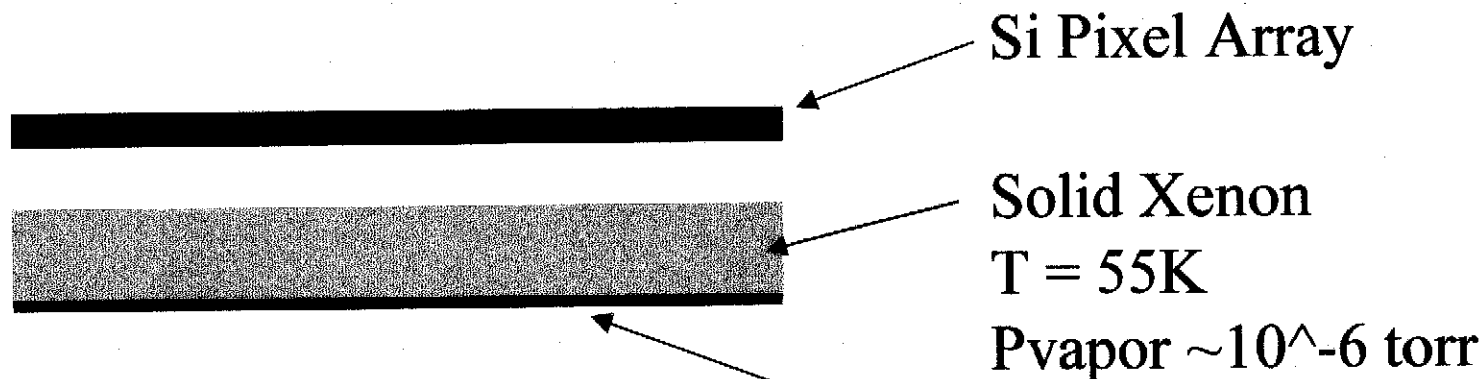


High Pressure Neon - Conclusions

- Very high light output -- single electron efficiency
- Neon radio-quiet, but A^2 small \implies need very large mass.
- Container? SS ? , Composites? Probably too radioactive.
- L-Ne still possible?

Solid Xenon

Concept:



If:

Diameter 30 cm

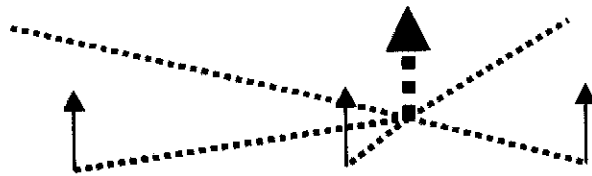
Thickness 4.2 cm

Mass 10 kg

Photocathode solid angle > 30% ⇒ Efficiency > 10%
QE > 35%

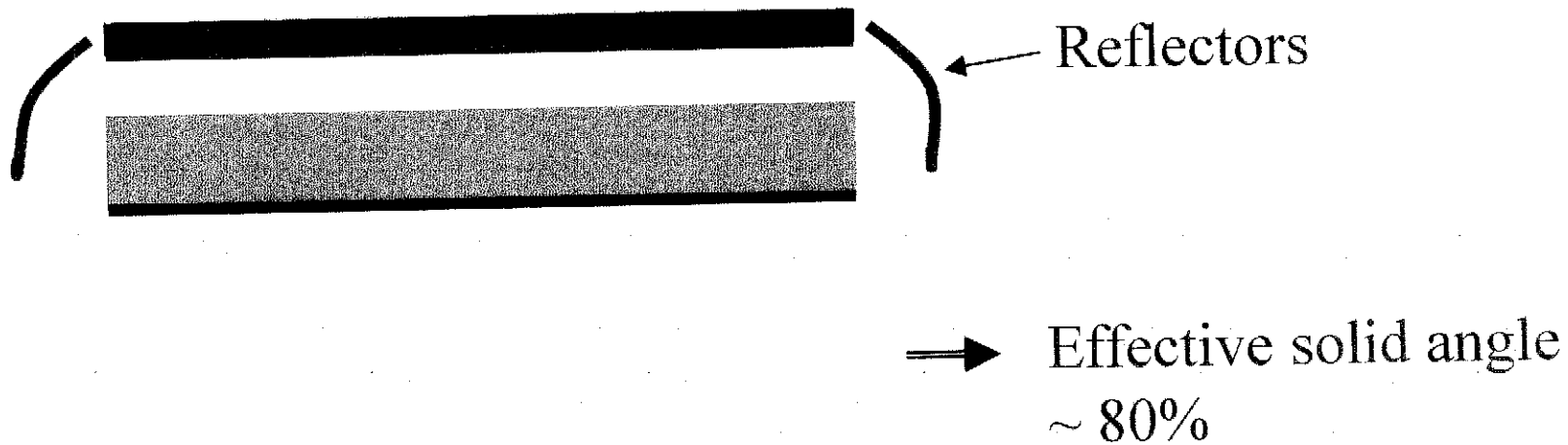
Solid Xenon

Concept:



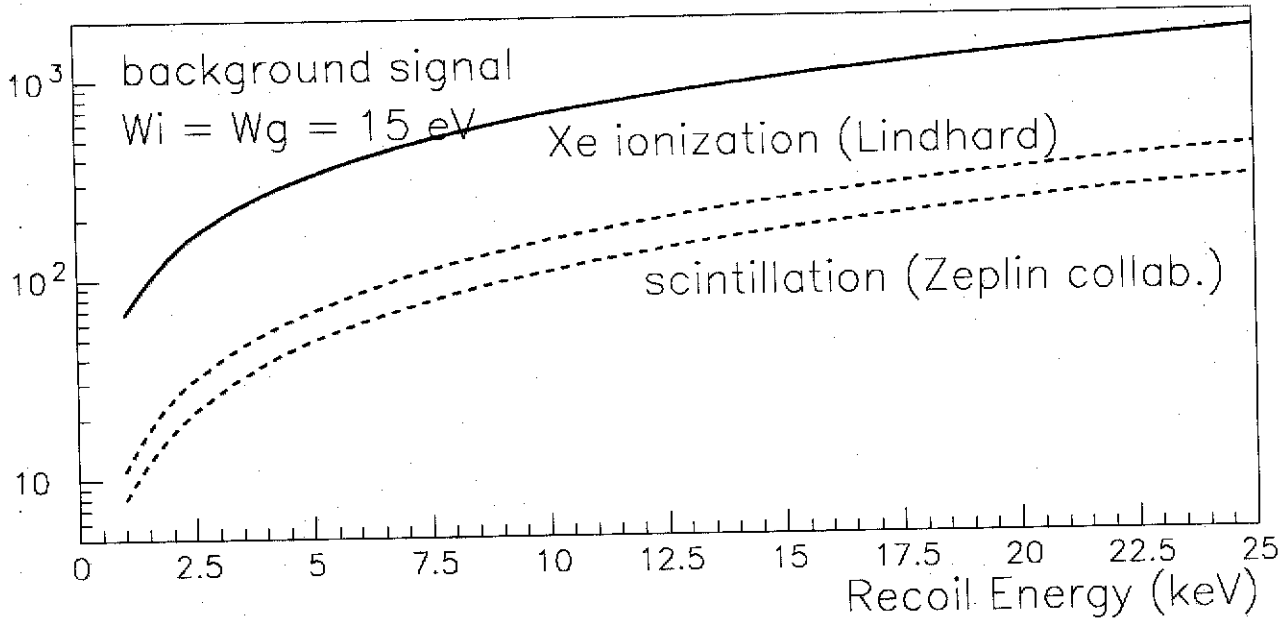
Solid Xenon

Concept:

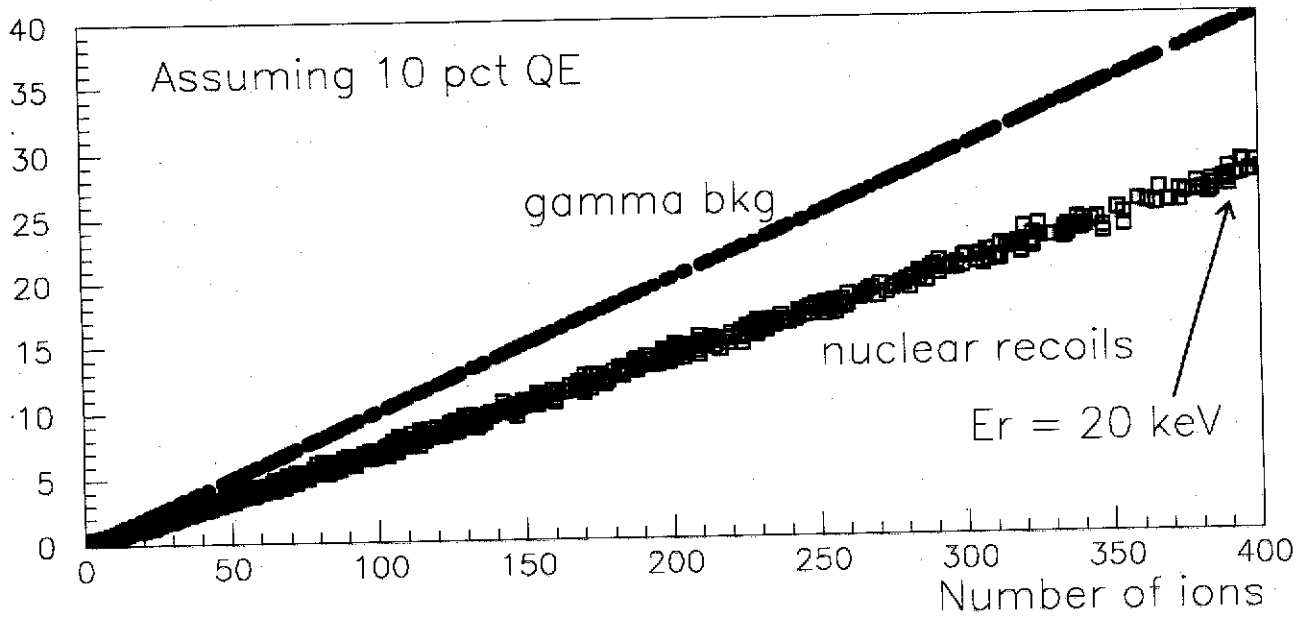


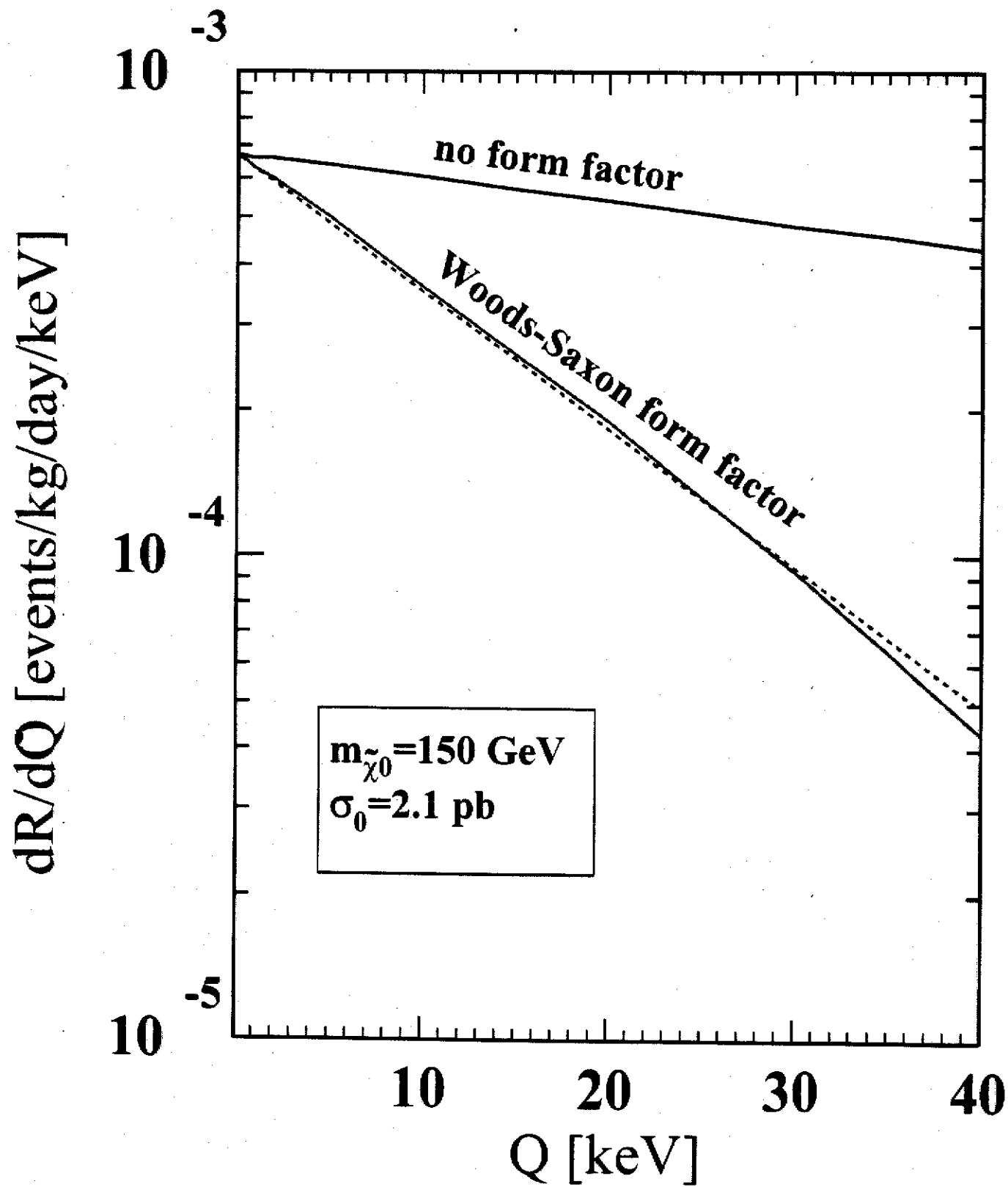
Ionization and Scintillation Yield in Xenon

ions and photons

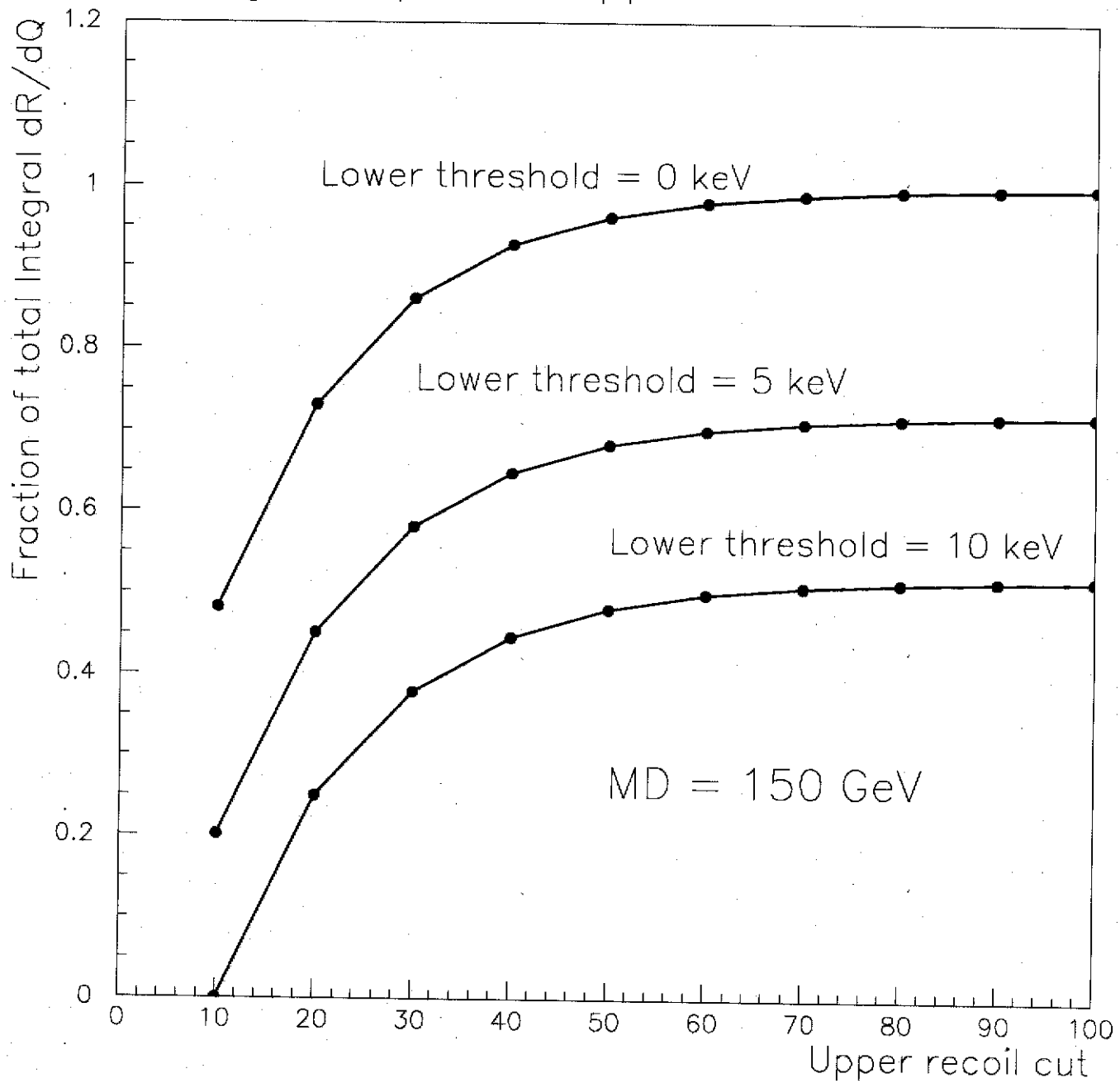


Number of detected photons

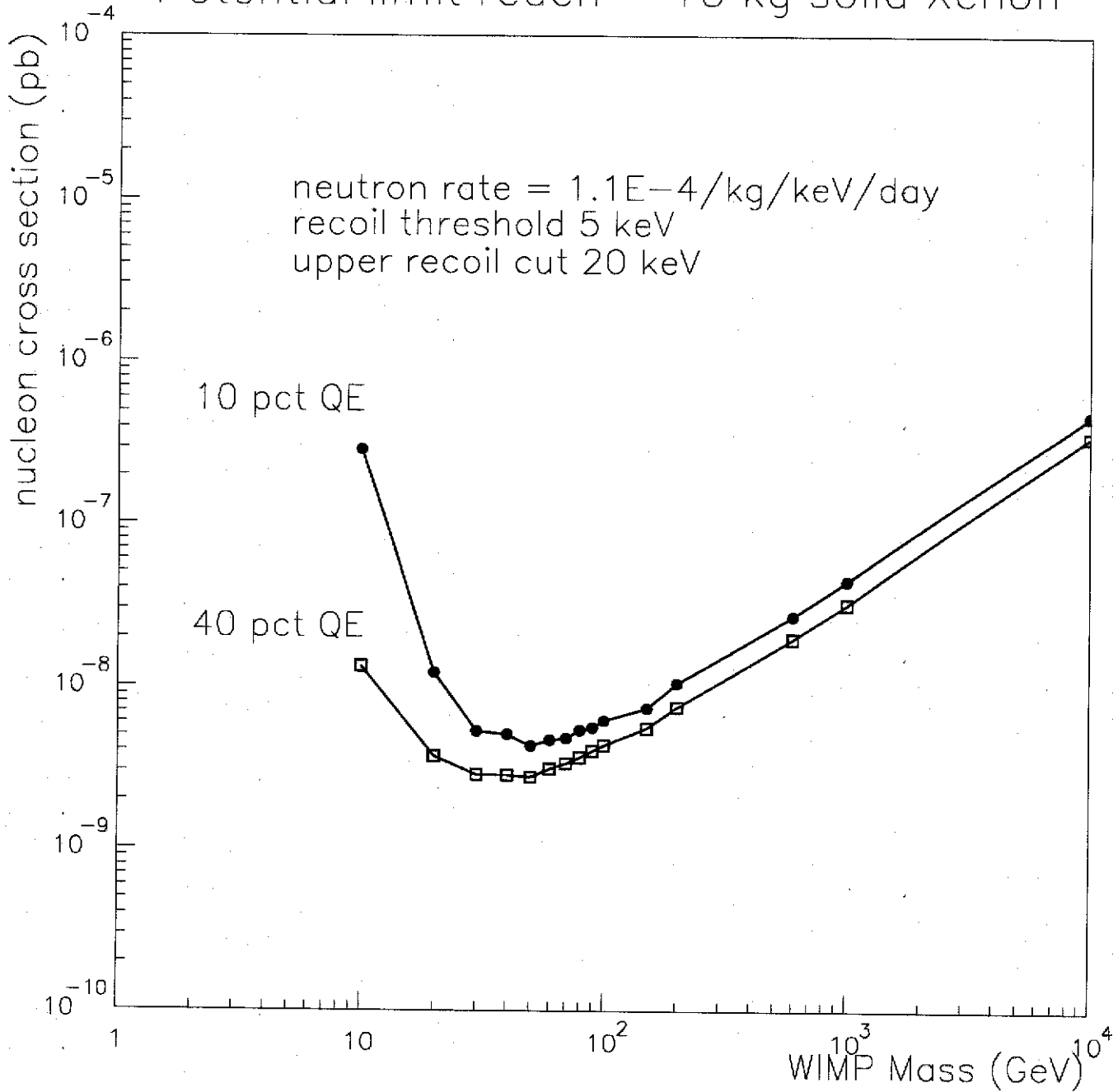




Integral dR/dQ vs Upper threshold – SXe



Potential limit reach – 10 kg solid Xenon



Solid Xenon - Conclusions

- Electron drift attenuation length = ?
- Electron extraction time? - is it fast enough for interaction location?
- Looks worth taking a look -- but not sure if there are any advantages over liquid xenon.

Overall Conclusions

- For future very-large experiments, might be worth investigating Ar purification with plasma centrifuge, or ?
- Xenon looks best of the noble gases for post-CDMS II reach potential
- Plan to see if there are any advantages for solid vs liquid xenon.