Intense 3~8 MeV Positron Source

- Introduction
- Geometry, e^+ production rate
- Energy & emission angle distributions
- Heat inside target
- Target destruction experimental tests
- Electrons after the foil?

R&D P. Pérez et A. Rosowsky NIM A Vol 532, pp 523-532 2004

Introduction

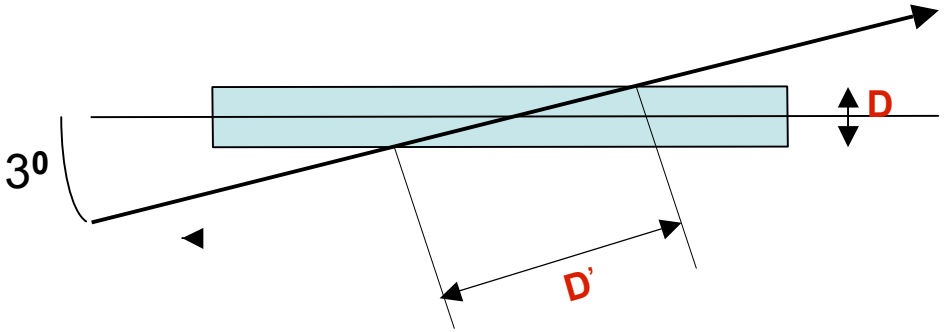
- Beam energy/intensity: 10 MeV 2 ~ 10 mA
- Target geometry: thin foil at grazing incidence ($3^{\mathbf{0}}$)
  - thermal effects: X-rays + e^- leak
  - probability of first interaction (e^+ and X-rays)
- Designed for $e^+ < 1$ MeV :
  - what happens for $e^+ > 3$ MeV ?

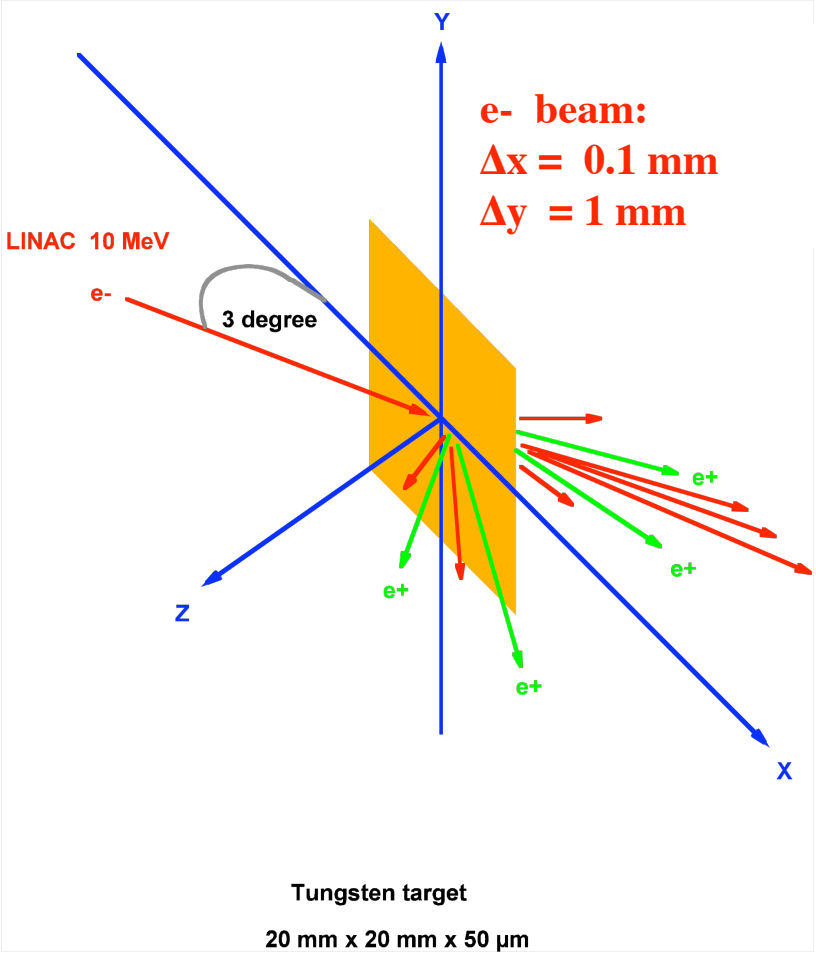
Thin target at grazing angle

Study energy deposit as a function of incidence angle

Thickness = D

equivalent thickness: D' = D / sin 3^0

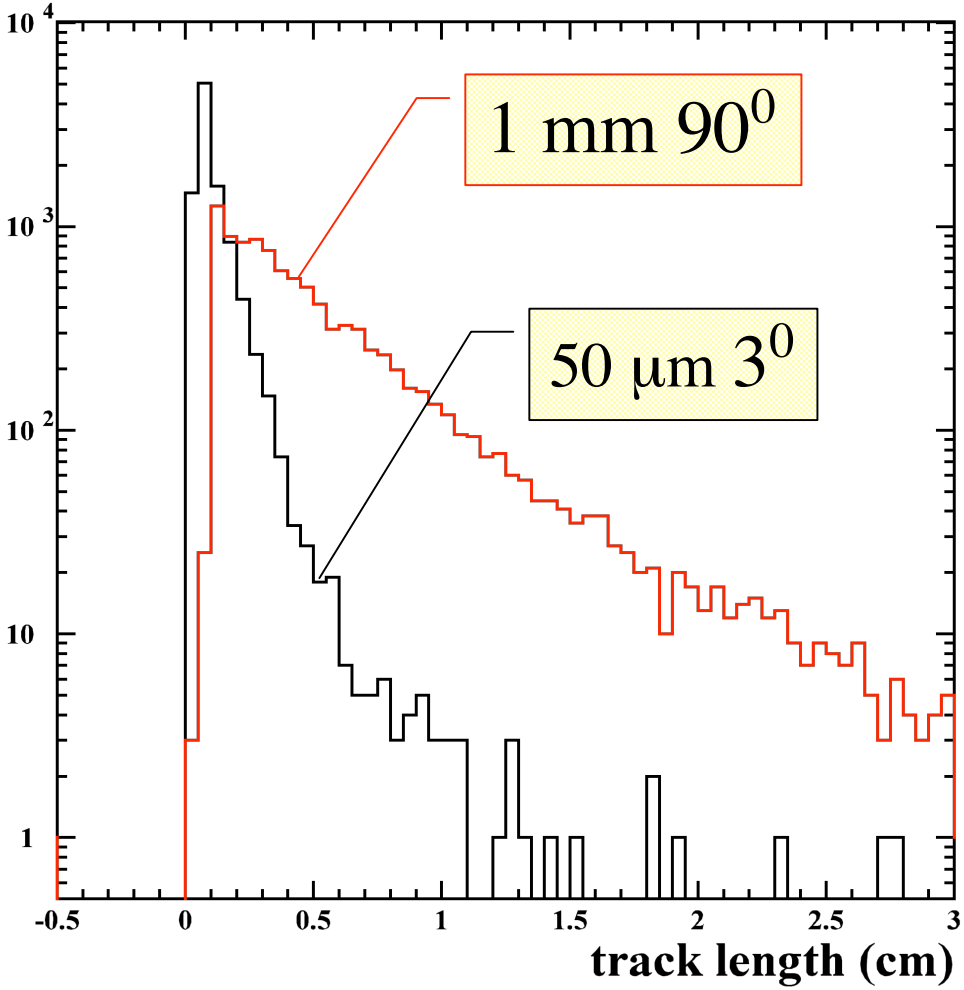




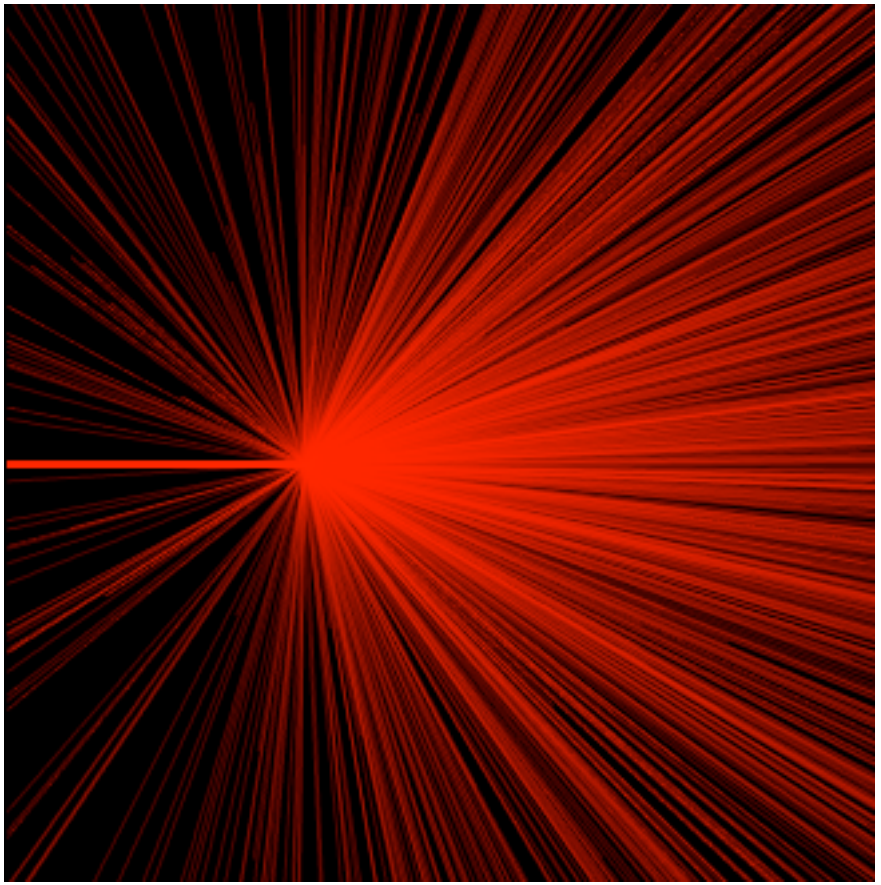
Track length inside target

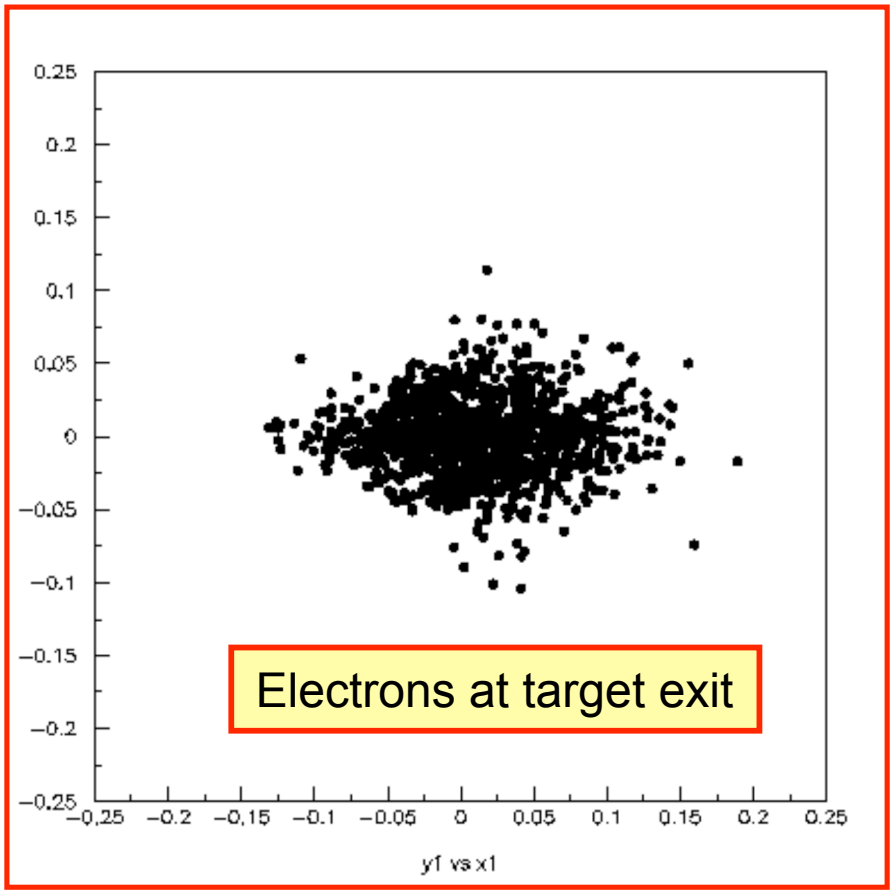
e⁻ track length inside targets of 1 mm equivalent thickness

	<L>	rms
3^0	0.11	0.11
90^0	0.53	0.48



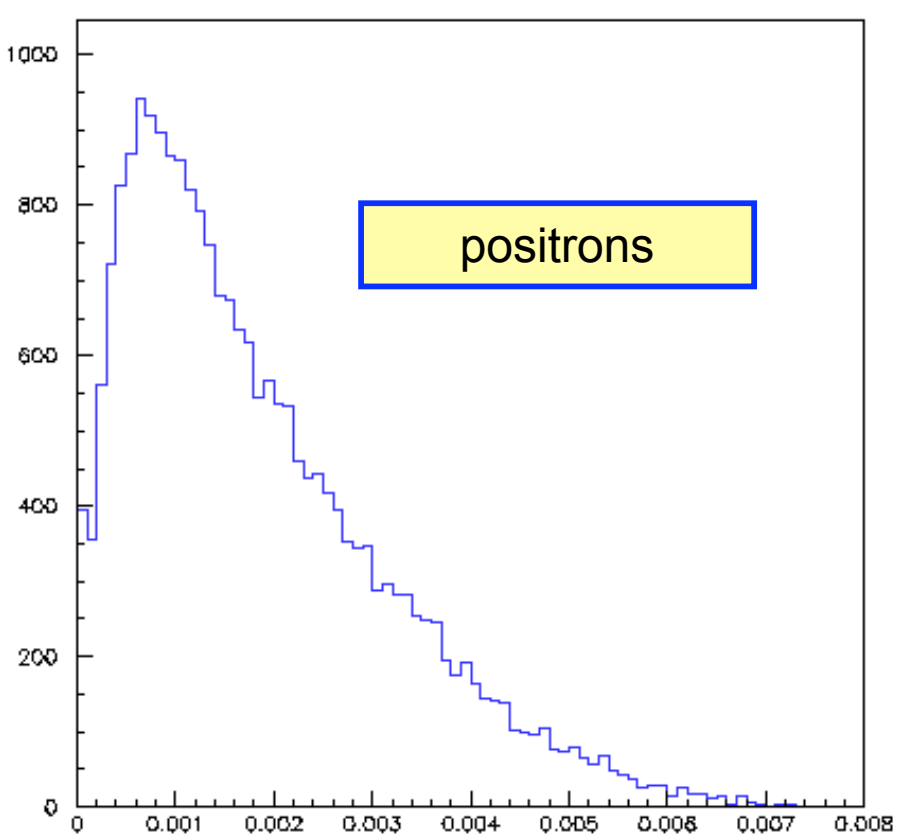
Geant 3.21 Simulation



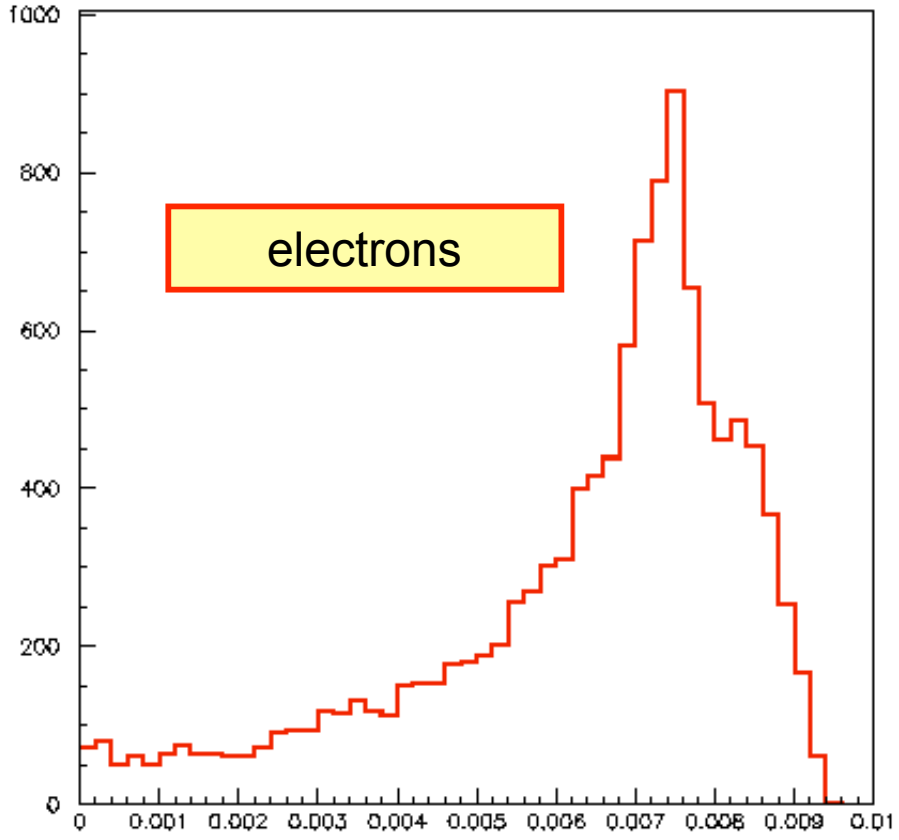


10 MeV electrons

Kinetic energy at target exit



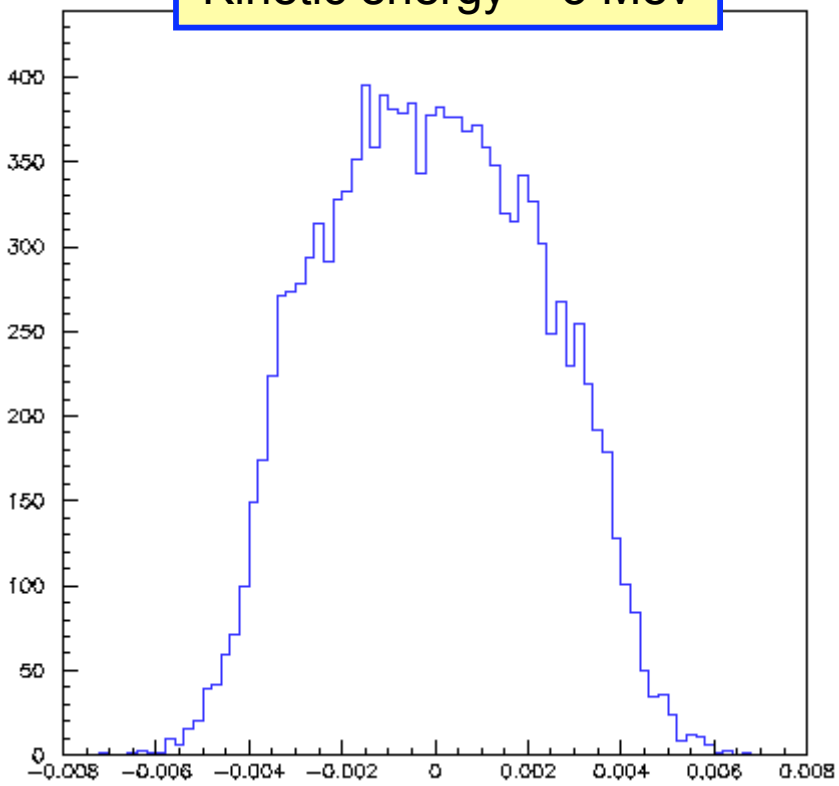
Kinetic energy (GeV)



Kinetic energy (GeV)

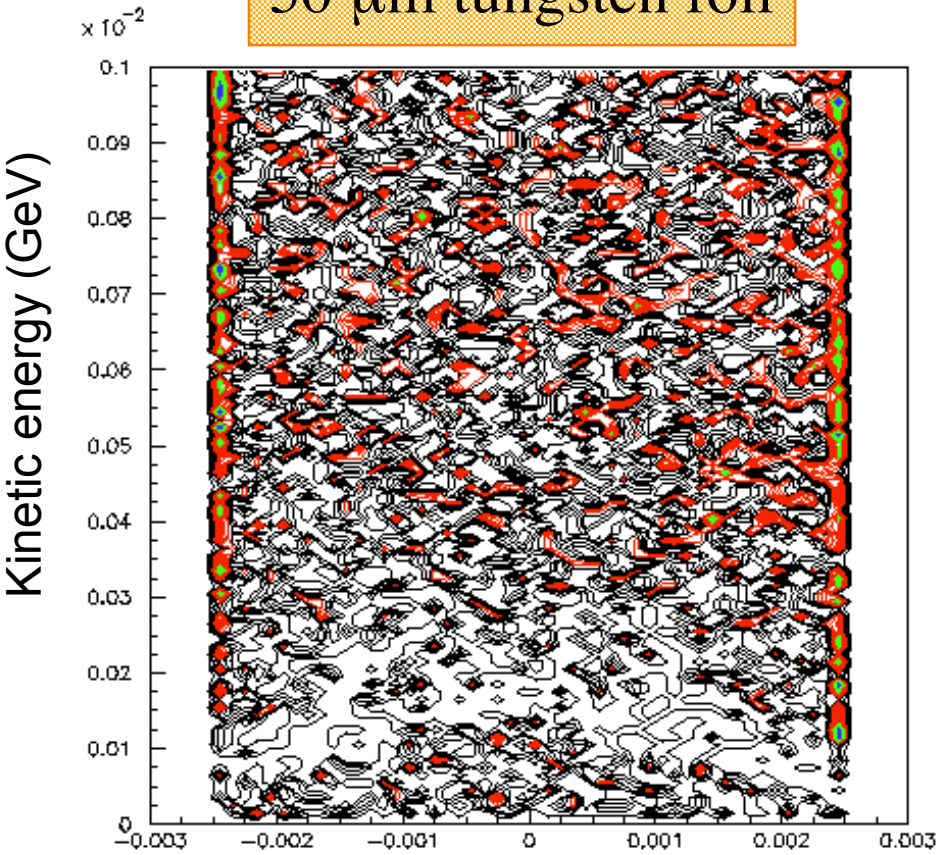
Positrons at target exit

Kinetic energy > 3 Mev



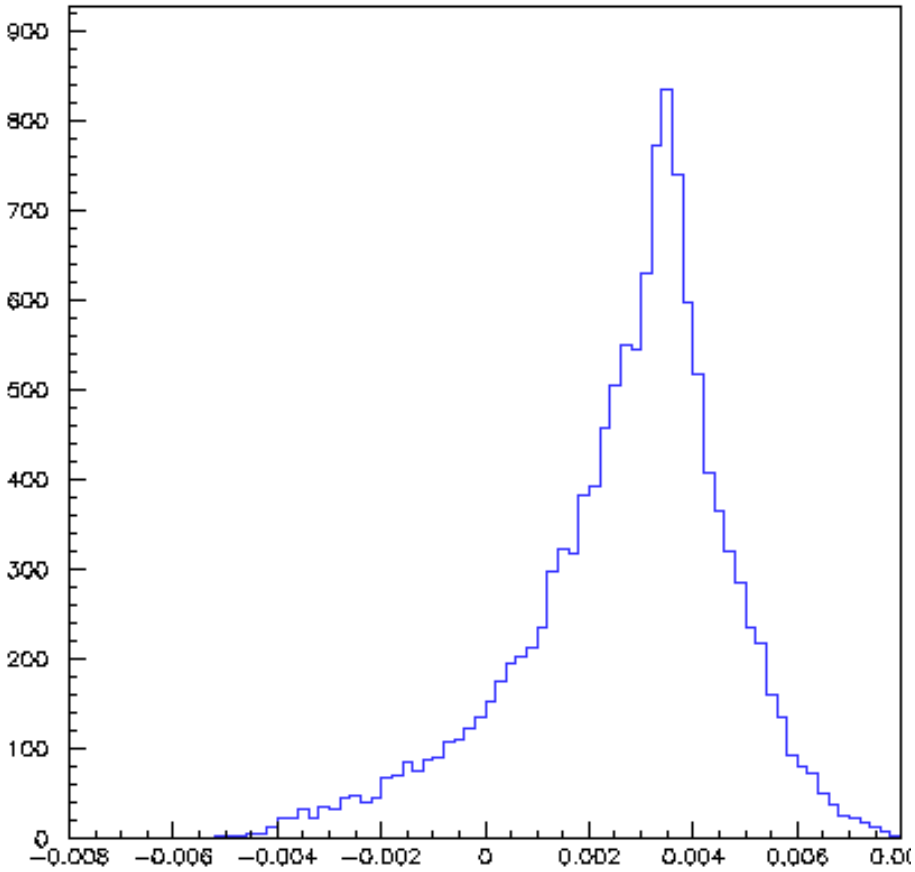
Pz (MeV/c)

50 μm tungsten foil

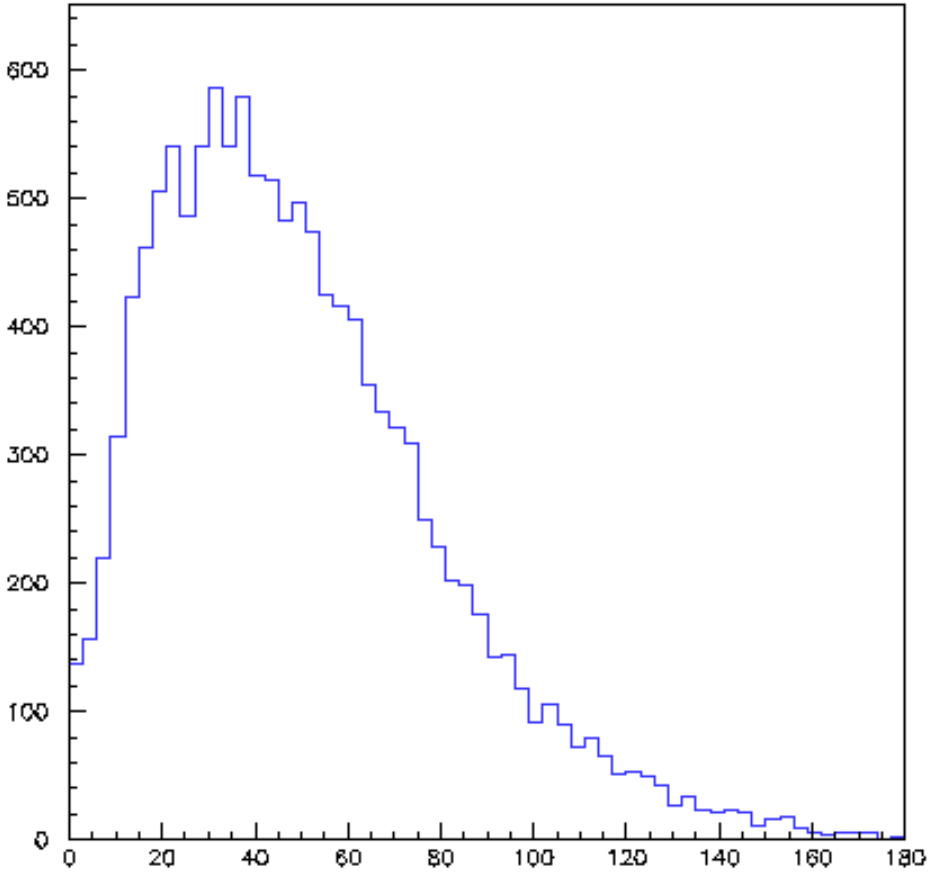


z at e+ creation location

Positrons at target exit ..



Px (MeV/c)



θ (degree)

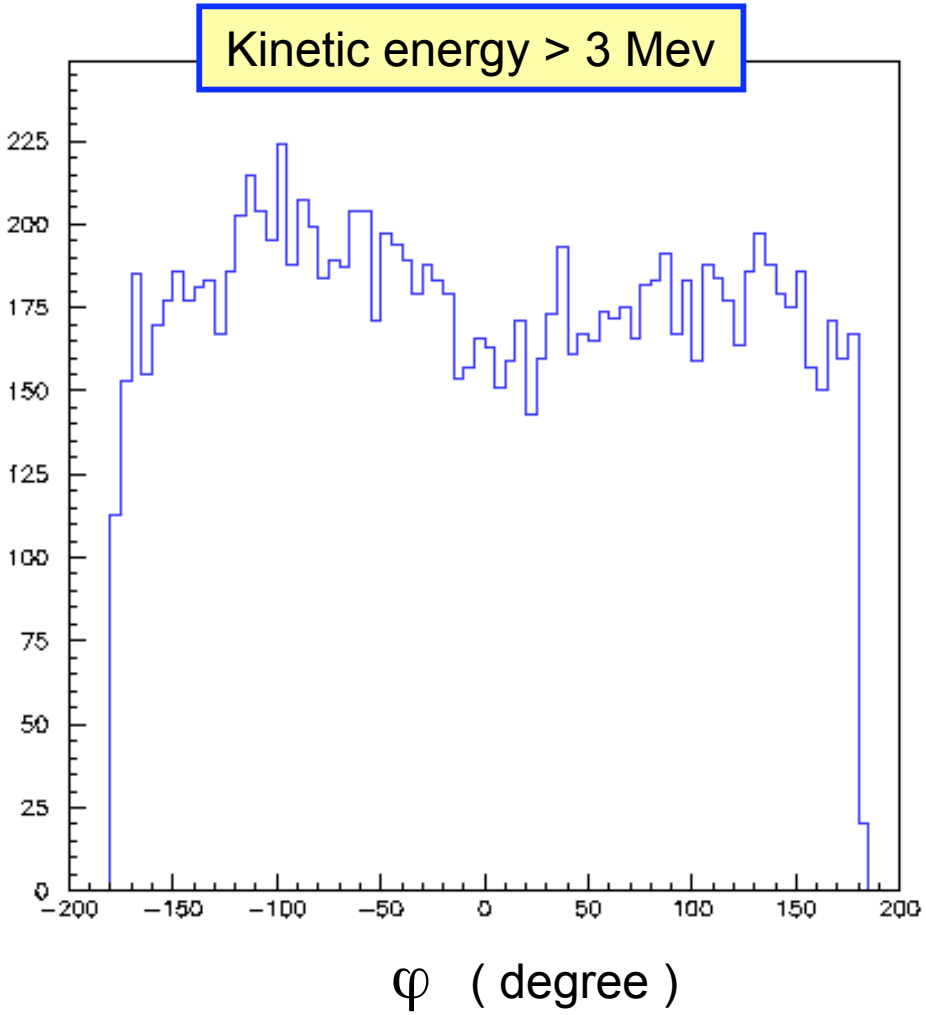
Kinetic energy > 3 Mev

Positrons at target exit …

Example of selection:

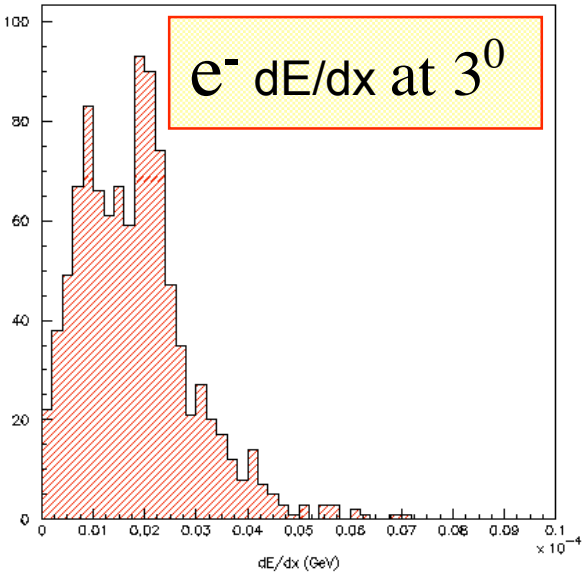
$25^0 < \theta < 35^0$

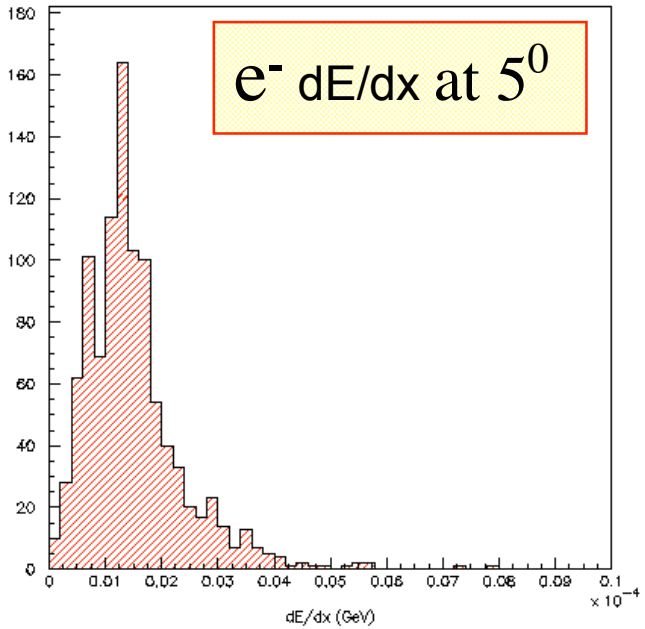
$-95^0 < \varphi < -85^0$

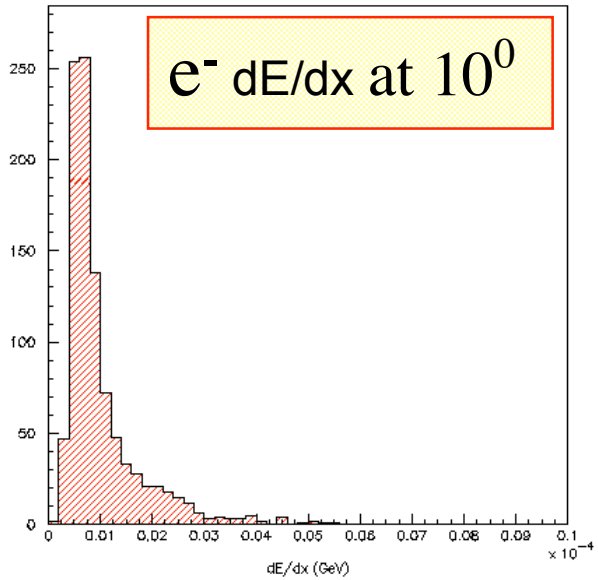


Nb e^+ at target exit / total e^-	
3 < K < 8 MeV	1.90 e-6
3 < K < 5 MeV	1.52 e-6

Geometrical effect on thin target energy leak







Experimental target tests (1)

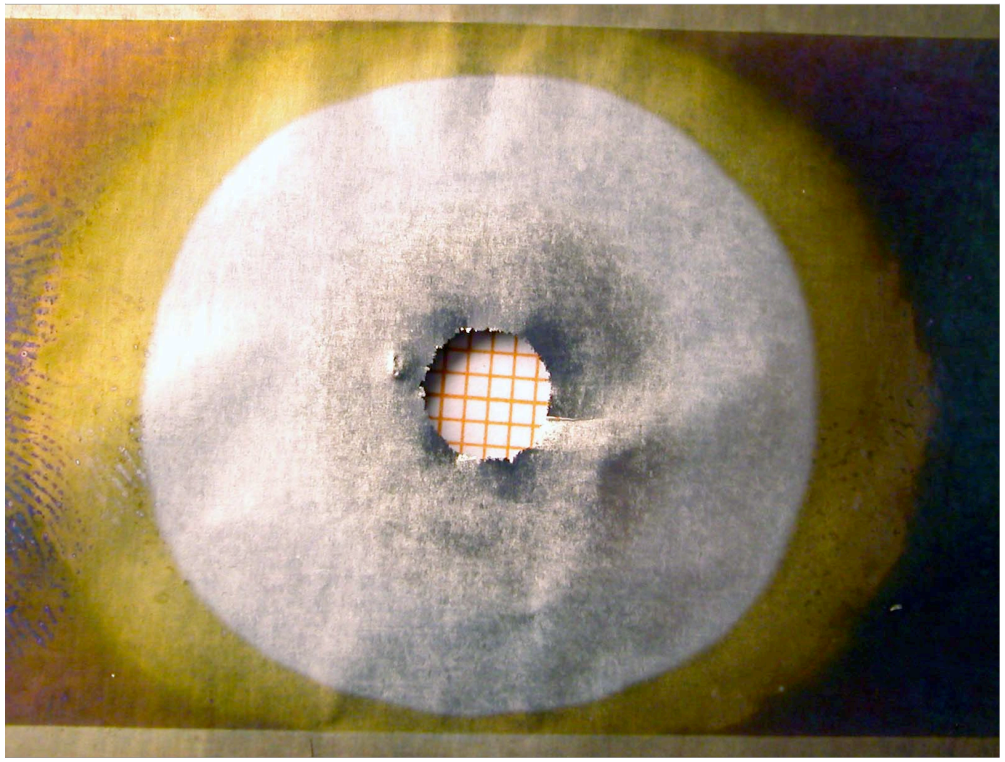
e⁻ soldering test on

Tungsten 50 µm

40 kV / 20 mA on 20 mm²

not perforated at 15 mA

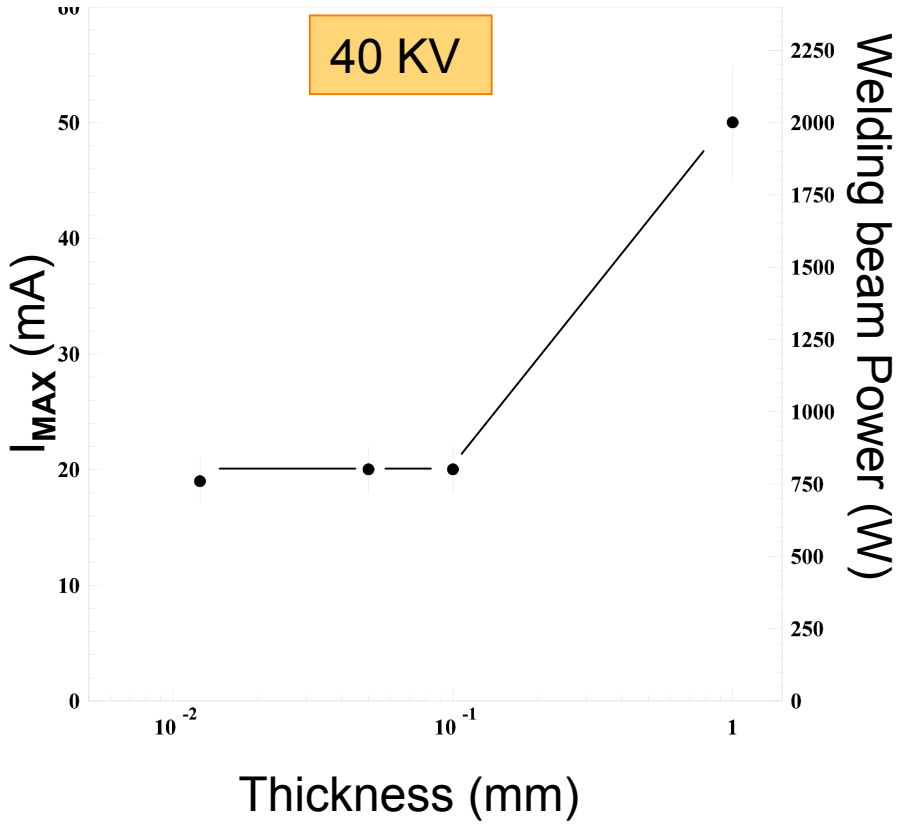
Study hypothesis:
1 k W / cm²

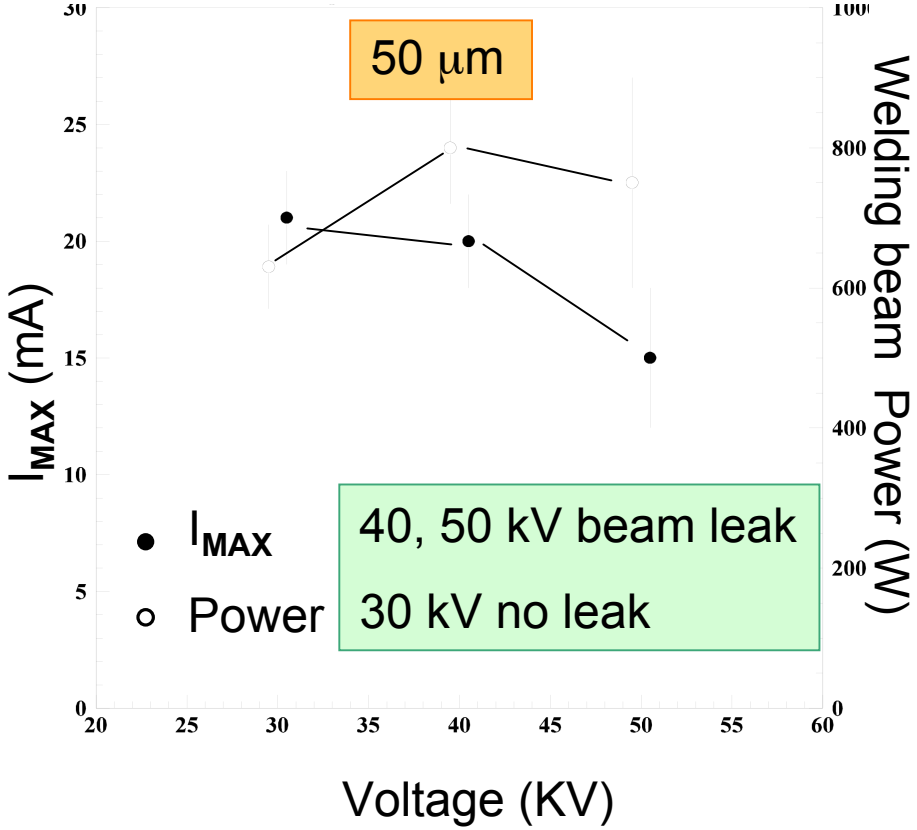


Tungsten foils 5 cm x 5 cm on a tungsten holder (same expansion)

Electron welding tests

Illuminated area = 0.2 cm^2



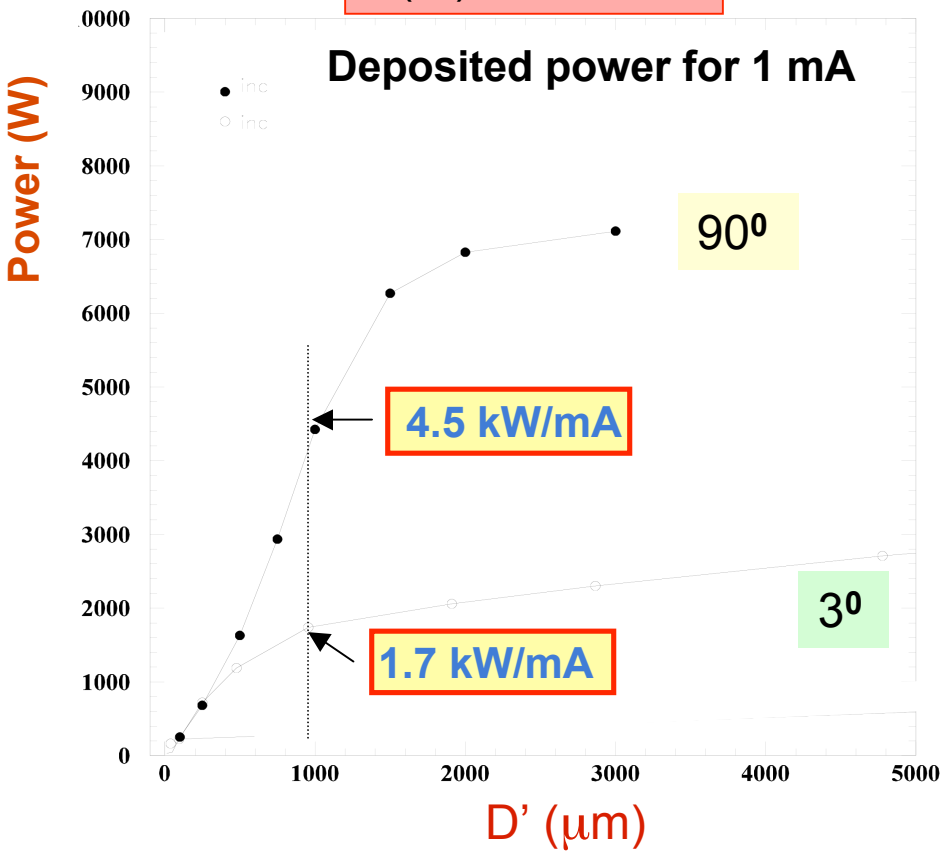


Power limit < 3.15 kW

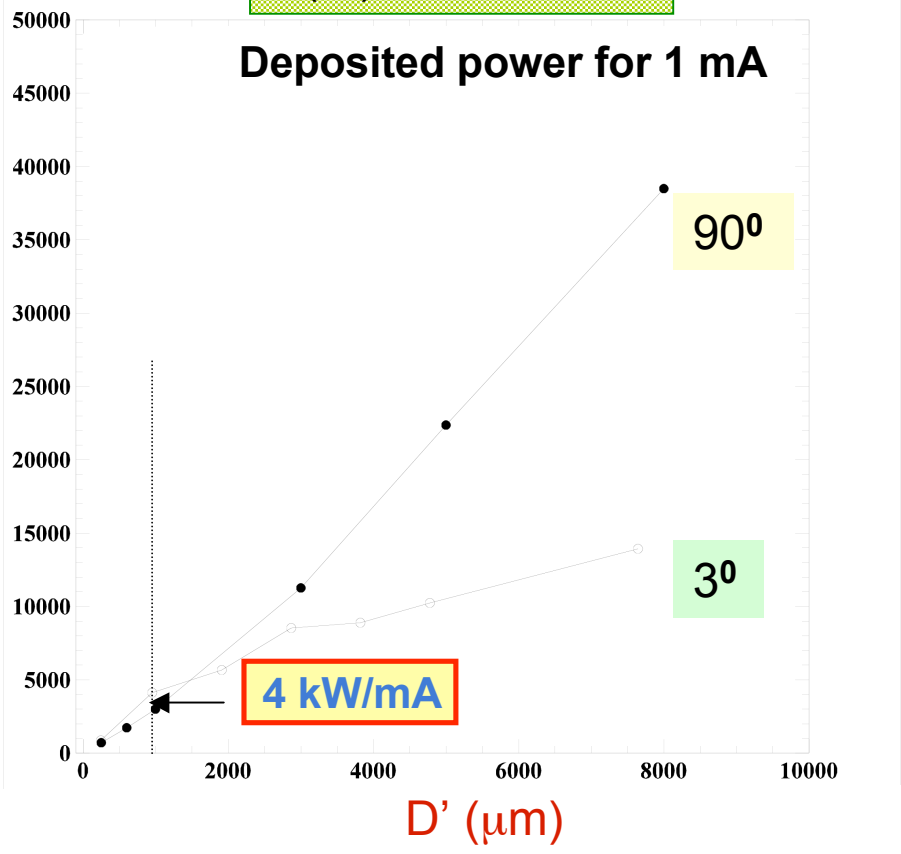
Energy deposit in 1cm^2 target

Simulation with GEANT

E(e$^-$) = 10 MeV



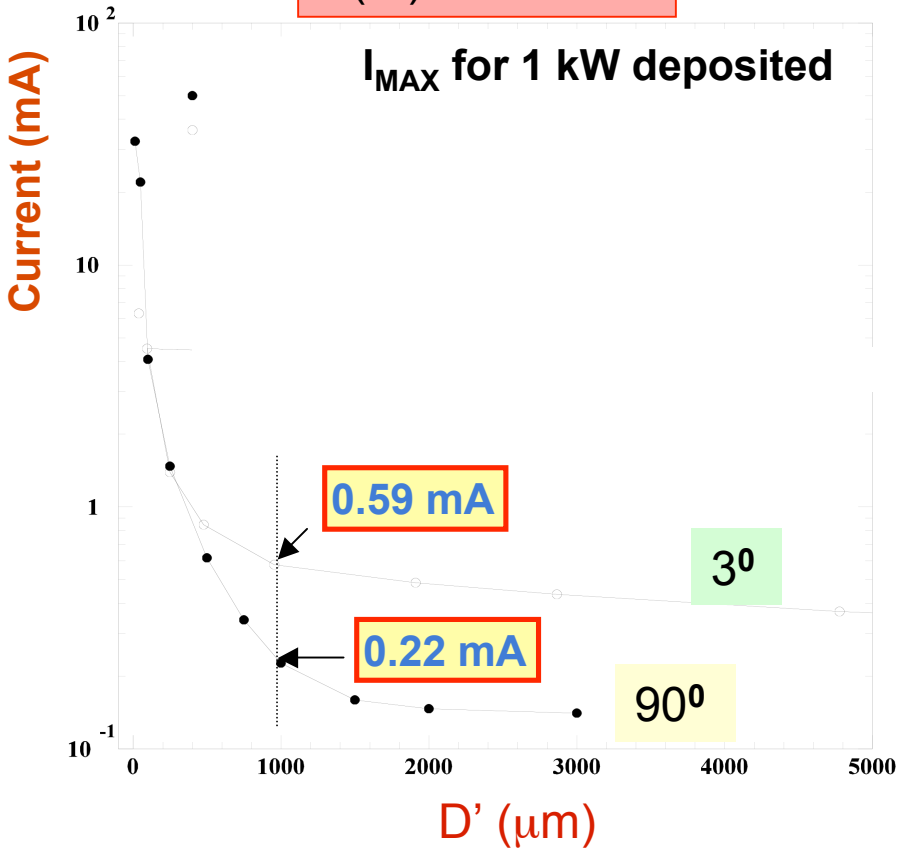
E(e$^-$) = 100 MeV



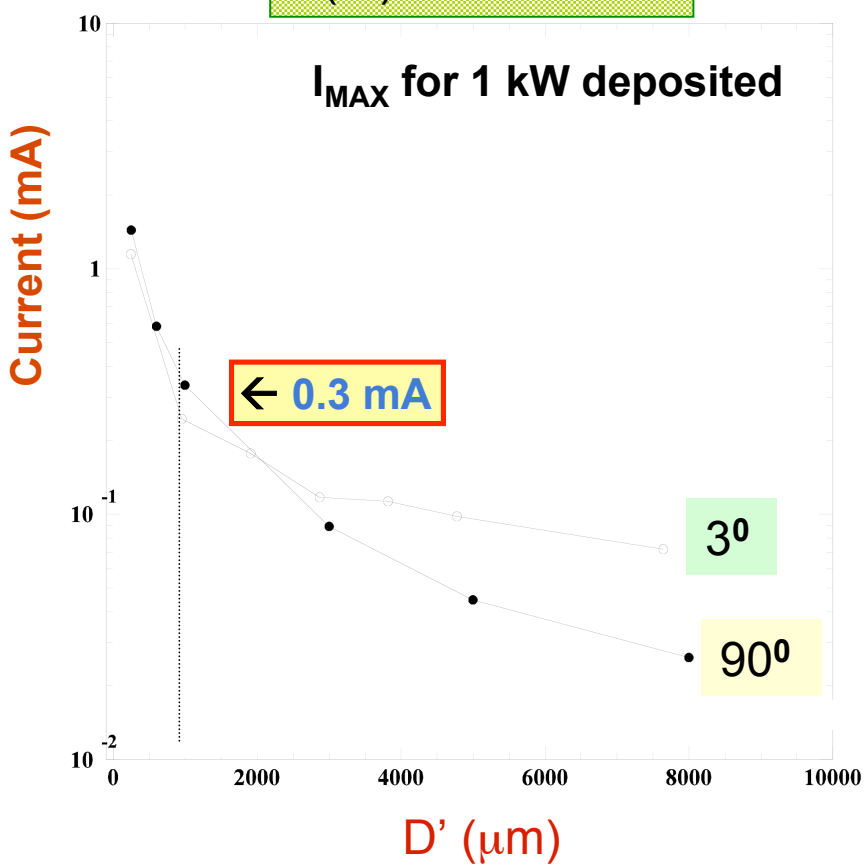
Maximum input current

Simulation with GEANT

E(e⁻) = 10 MeV

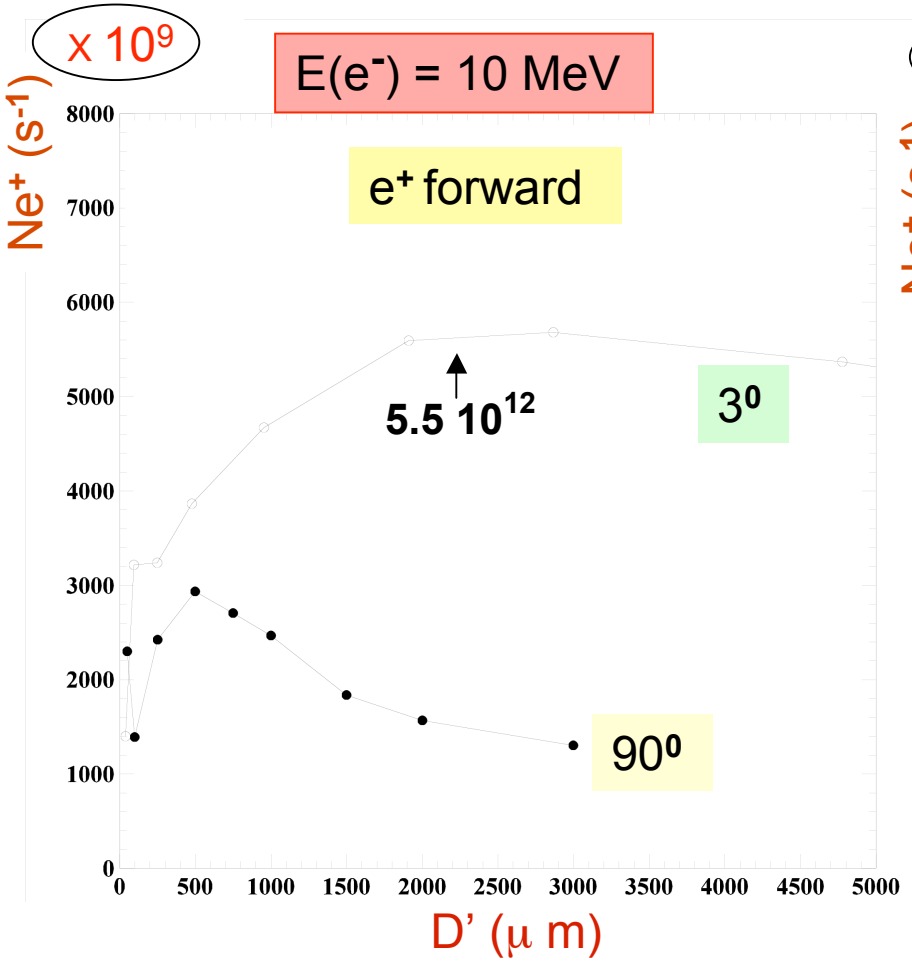


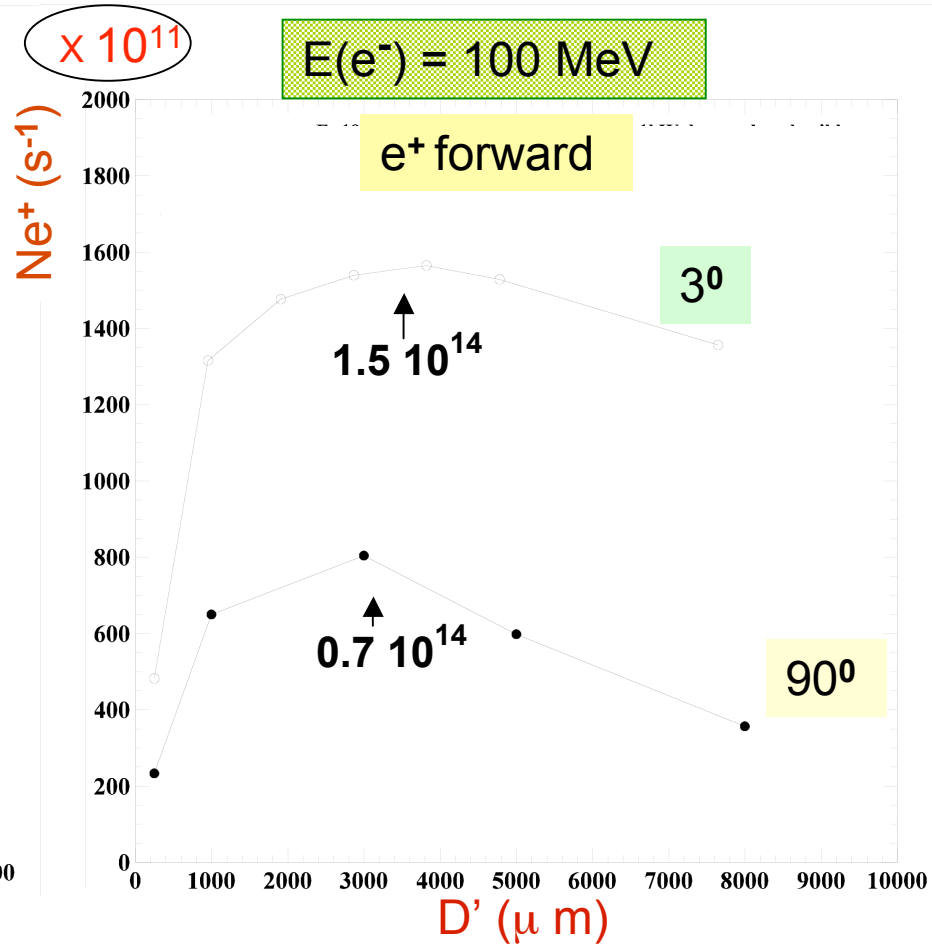
E(e⁻) = 100 MeV



Optimal production rates (forward)

Power deposited in 1 cm^2 target = 1 kW





Experimental target tests (2)

10 MeV Linac:

Laser driven e^- photo-emission

Macro-pulse 70 μs 10 Hz

Tungsten target 100 μm ➪

Center: 96 μm

Edge: 99 μm

Beam incident angle: 45^0

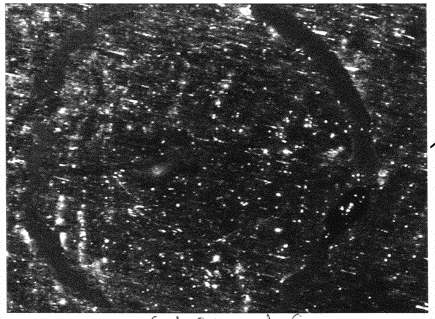
Beam energy deposited = 2 %

Visible target hole:

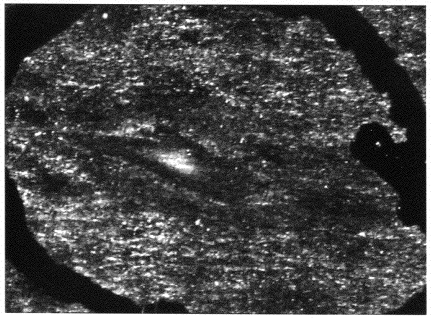
~ 1.3 mm x 0.3 mm

➪ 2.0 ± 0.6 kW / cm^2

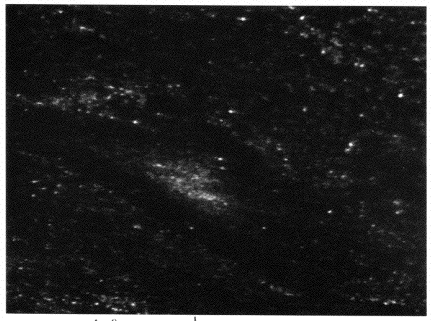
Experimental target tests (2) ..



Coté bombé

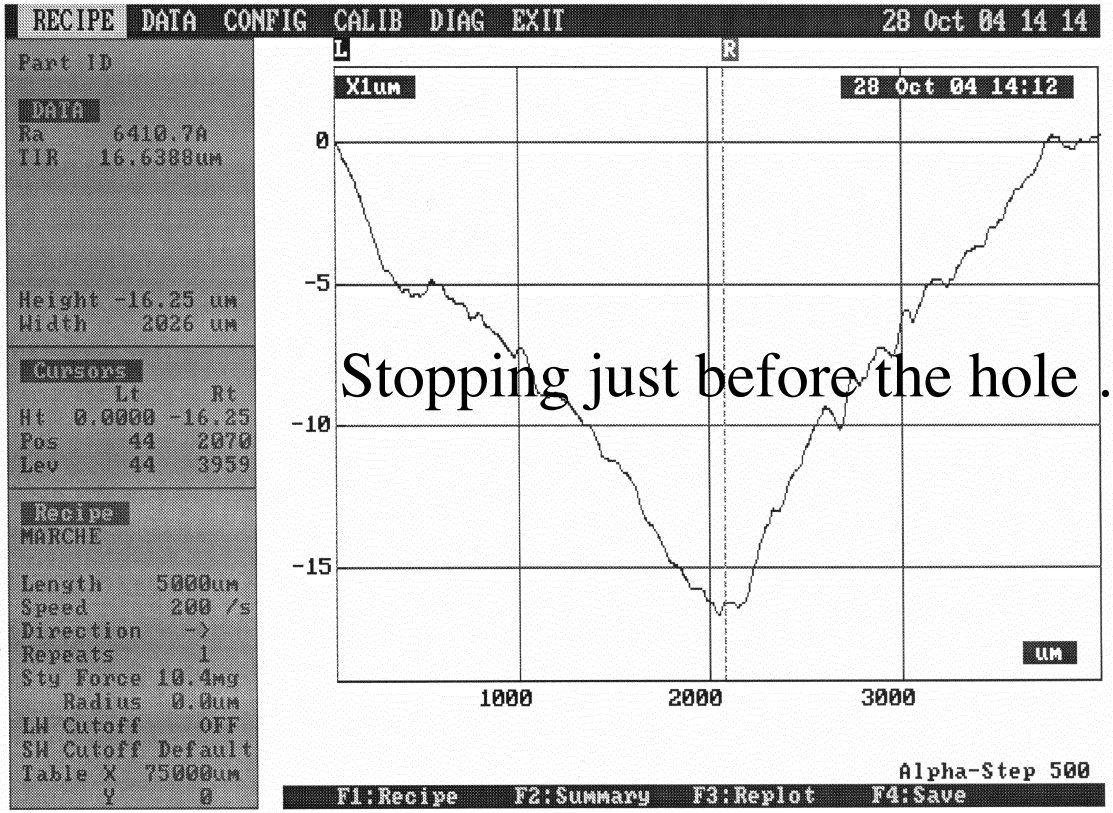


Coté impact



Coté impact.

Target hole



Stopping just before the hole …

coté impact : Scan de 5mm centré sur le creux.

Rotating disk target?

Target: tungsten 50 μm

Rotating disk:
100 t/s (?) Ø 25 cm →
power ~ 1 / 785 x beam

Beam spot on target:
1mm x 2mm = 2 mm²
→ 1 / 50 cm²

Deposited at 3^0 ~ 1 kW = 0.58 mA

e^- 10 MeV 10 mA 3^0
0.64 mA / cm² = 1.1 kW / cm²

$25^0 < \theta < 35^0$

$-95^0 < \varphi < -85^0$

Number of e^+ at target exit	
3 < K < 8 MeV	1.19 10^{11} s^{-1}
3 < K < 5 MeV	0.95 10^{11} s^{-1}

Electrons after the target

Mimic the collector with an iron cylinder

% of total beam energy deposited inside Iron cylinder L = 20 cm R1-R2 = 10-15 cm	
edge at 10 cm	37.3 %
edge at 20 cm	23.7 %
edge at 30 cm	12.36 %