IFE Materials Response

RHEPP/MAP Materials Studies

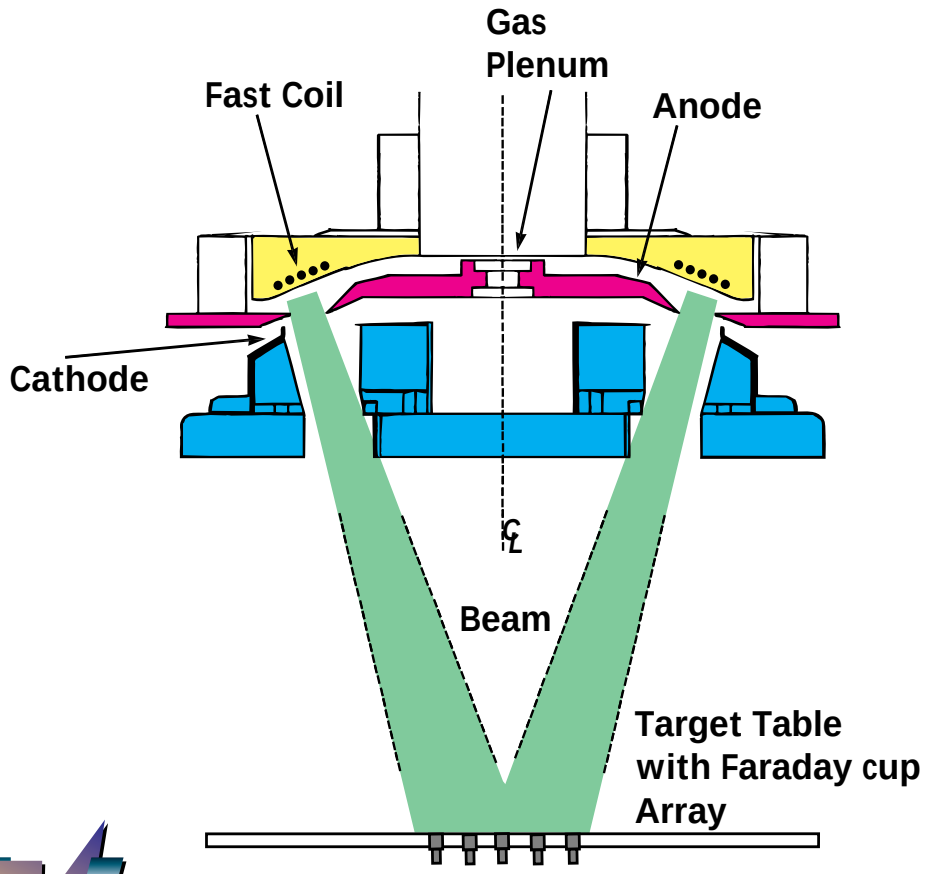
November 14, 2001

Tim Renk
Sandia National Laboratories
Beam Applications & Initiatives Department

Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company,
for the United States Department of Energy under contract DE-AC04-94AL85000.

Sandia National Laboratories

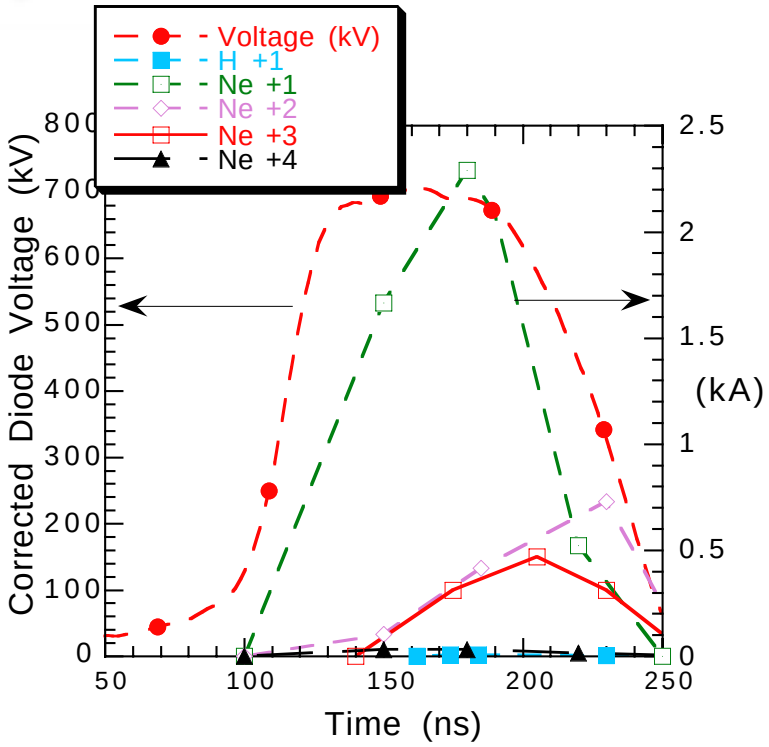
The MAP (Magnetically Confined Anode Plasma) Ion Source can generate multiple ion beams on RHEPP-



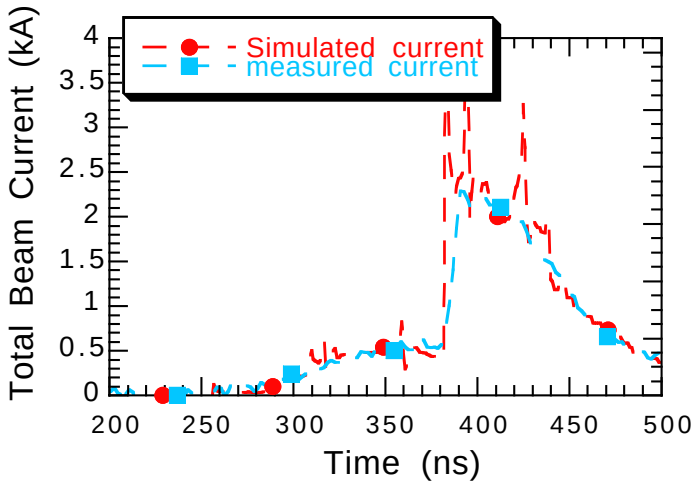
- **500-750 kV**
- **≤ 250 A/cm^2**
- **Beams from H, He, N_2, O_2, Ne, Ar, Xe, and CH_4 gas**
- **Overall Treatment area ~ 100 cm^2**
- **Diode vacuum ~ 10^{-5} Torr**

Materials Modification Laboratory

Ion Species Study of RHEPP/MAP Beam

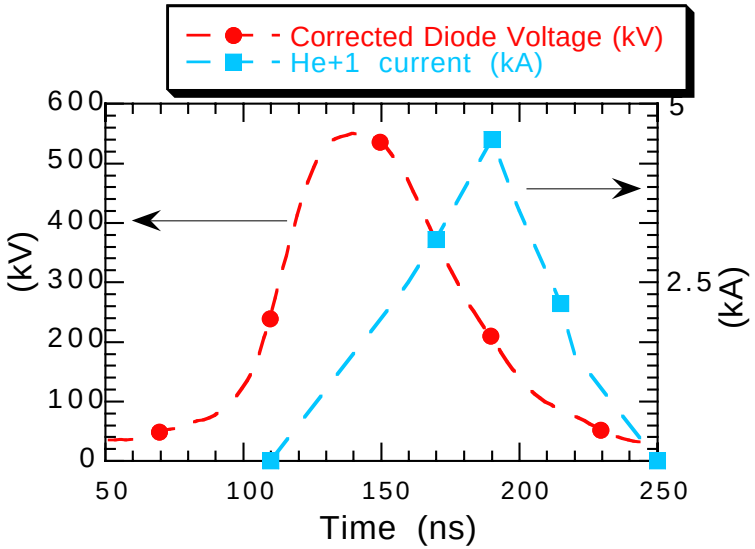


- Beam composition posited, propagated to Fcup array using corrected diode voltage
- Composite compared to averaged total Fcup signal
- 7 Fcups located 2 cm apart, for 25 < z < 63 cm
- Beam from 6 < r < 10 cm not counted (estimate 30% of total)

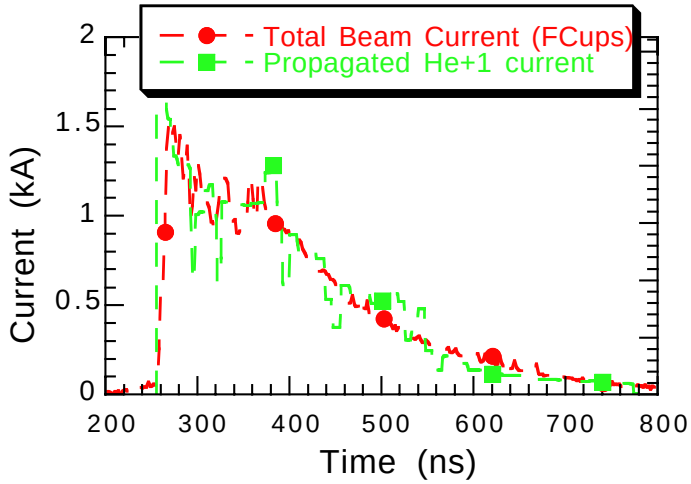


Materials Modification Laboratory

He injection leads to long-lived pulse of pure He+1



- Unlike Ne generation, current lags voltage, leading to debunching
- Current pulse width at 63 cm is almost 0.5 µsec long
- Beam here was intentionally attentuated



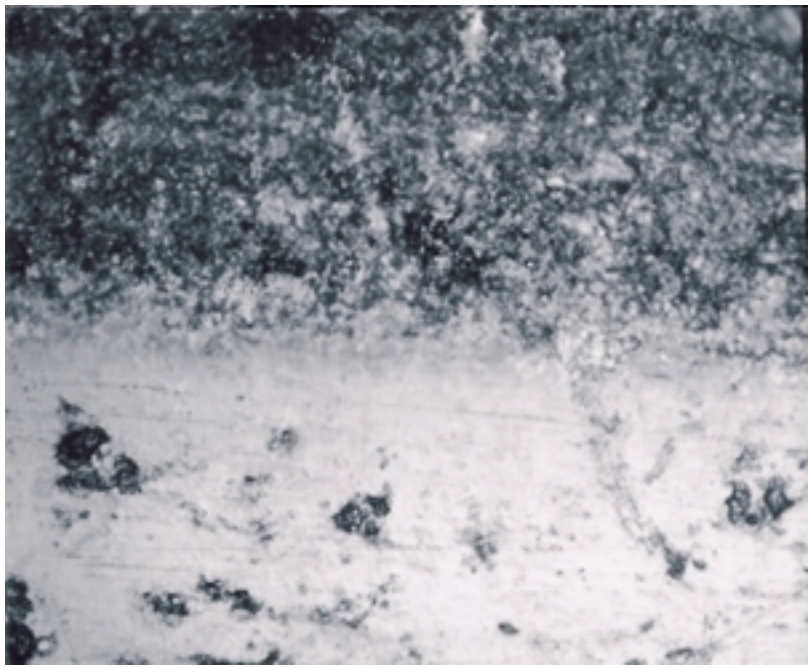
Materials Modification Laboratory

Proposed and tested samples for RHEPP

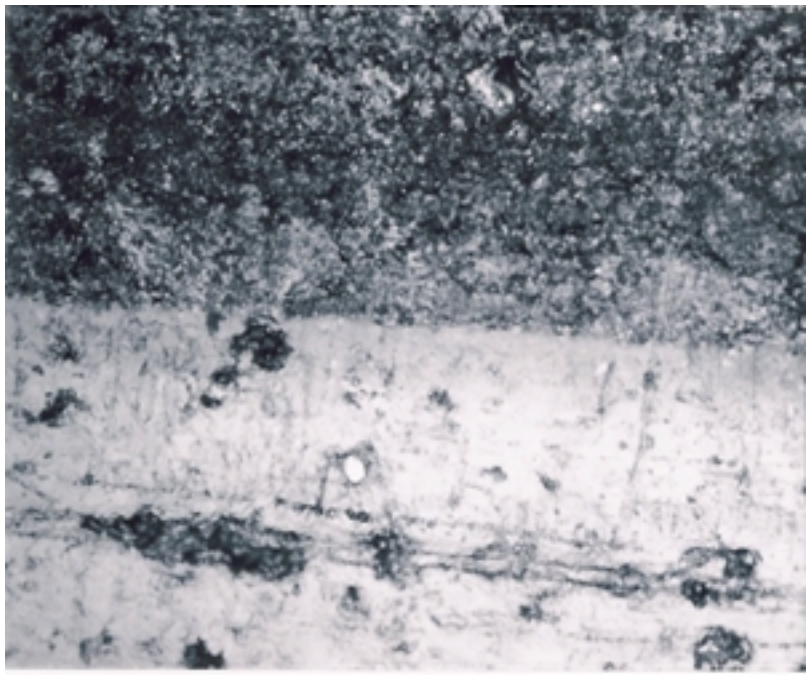
	Material	Fluence	Application
✓	Graphite (Poco)	0.25-8 J/cm^2	Dry wall
✓	Tungsten	1-8 J/cm^2	Dry wall
✓	Tantalum	1-8 J/cm^2	Dry wall
✓	Carbon velvet	1-8 J/cm^2	Dry wall
	Silicon Carbide		Dry wall
	Carbon Composite		Dry Wall
	Aluminum		Reference material

Materials Modification Laboratory

Poco subjected to 400 shots from He beam, Shows visible change down to 0.5 J/cm^2

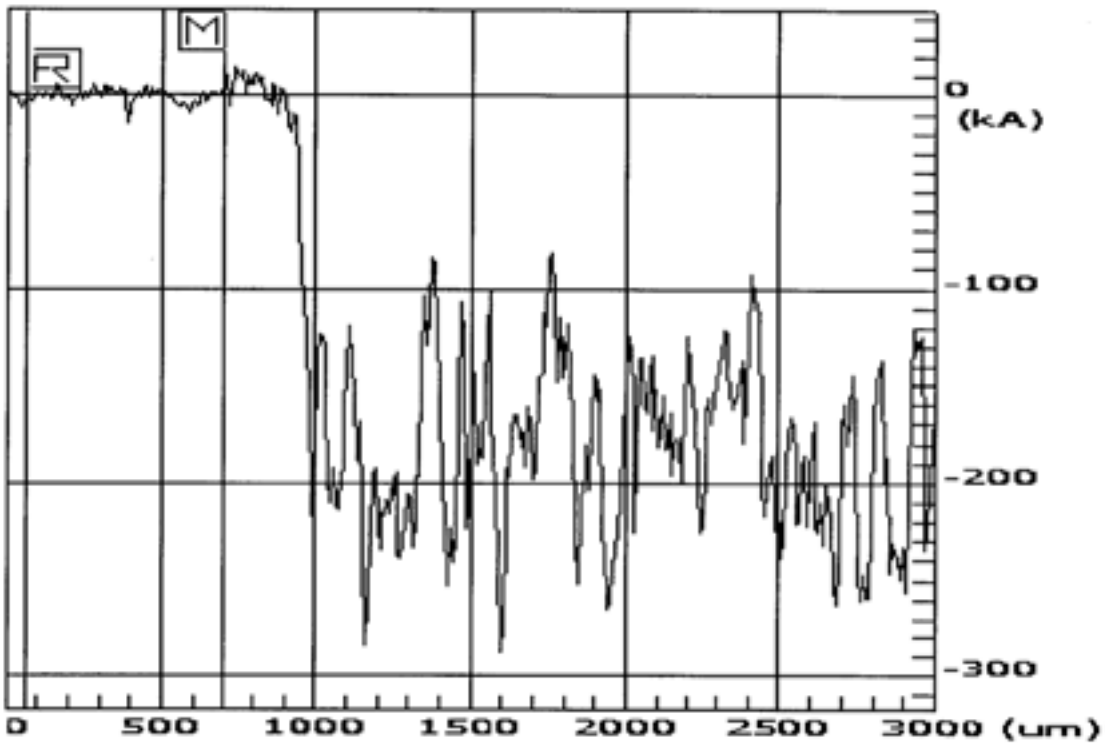


Interface, untreated Poco (bottom) and 0.25 - 0.5 J/cm^2 (top) - image 20x



Interface, untreated Poco (bottom) and 0.5 - 1 J/cm^2 (top) - image 20x

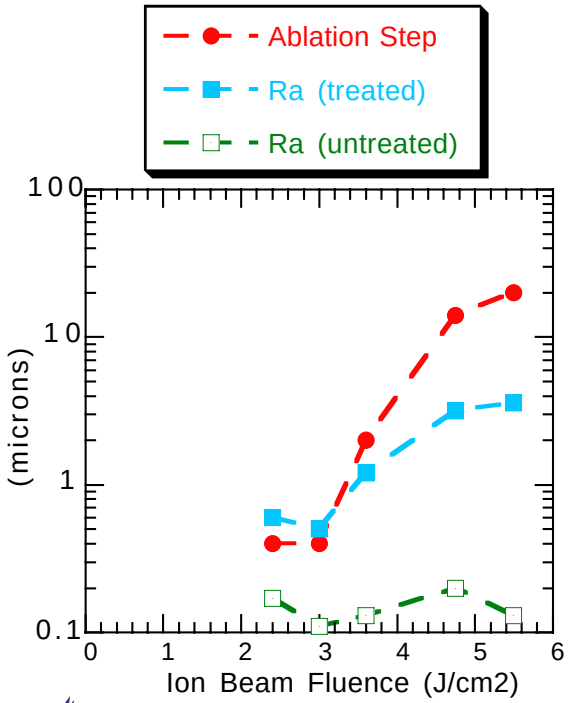
Poco Graphite exposed to 5.5 J/cm^2 carbon/proton beam ablated at rate of 0.3 microns/pulse



- mechanically polished Poco graphite exposed to 75 pulses of 70% C/30% H beam at average dose of 5.5 J/cm^2
- Profilometer scan across interface (left) shows ~ 20 micron step (0.27 µ/pulse)
- Ra (original) = 0.23 microns
- Ra (treated) = 3.6 microns

Materials Modification Laboratory

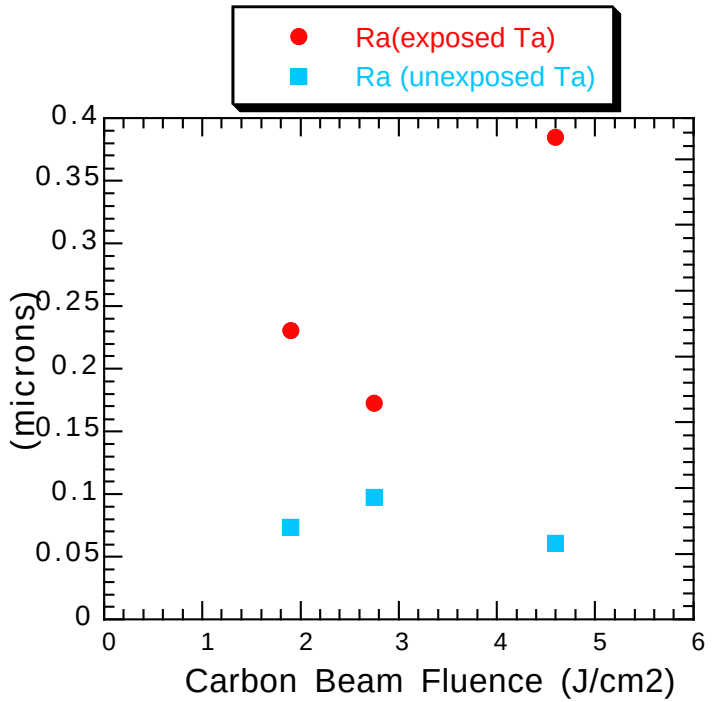
Ablation threshold appears to be 3 J/cm^2, But surface roughening occurs down to below 1 J/cm^2



- Mechanically polished Poco graphite exposed to 75 pulses of 70% C / 30% H beam at dose of 2 to 5.5 J/cm^2
- Pre-treatment R_a ~ 0.1 - 0.2 µ
- R_a (treated) as high as 3.6 µ
- Step measurement accuracy ~ 0. 4 µ reached @ 3 J/cm^2

Materials Modification Laboratory

Ta (and W) treated samples show roughening below the melt threshold



- Mechanically polished Ta exposed to 30 pulses of 70% C / 30% H beam at dose of 2 to 5.5 J/cm^2
- Pre-treatment R_a < 0.1 µ
- R_a (treated) roughly increases with dose
- Modeling shows surface temperature reaches ablation at ~ 3 J/cm^2

Materials Modification Laboratory

Summary

- RHEPP/MAP can generate multiple ion beam species, in 500 kV pulses of ~ 0.5 µsec
- Poco Graphite
  1) at higher doses (5.5 J/cm^2) suffers significant erosion (0.3 µm/pulse)
  2) at 0.25 - 1 J/cm^2 doses, shows enhanced roughness
- Ta/W shows increased roughness after treatment, but no discernable ablation, even at doses above vaporization
- Velvet may represent a clear improvement over 1-d surface performance

Materials Modification Laboratory