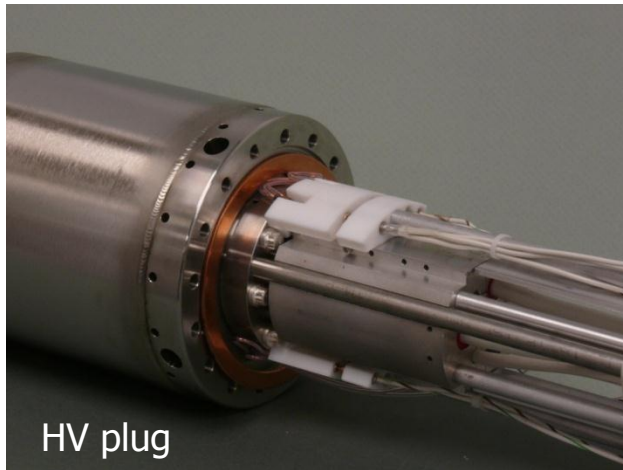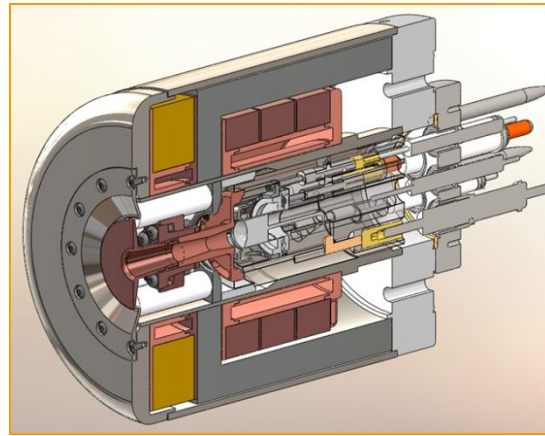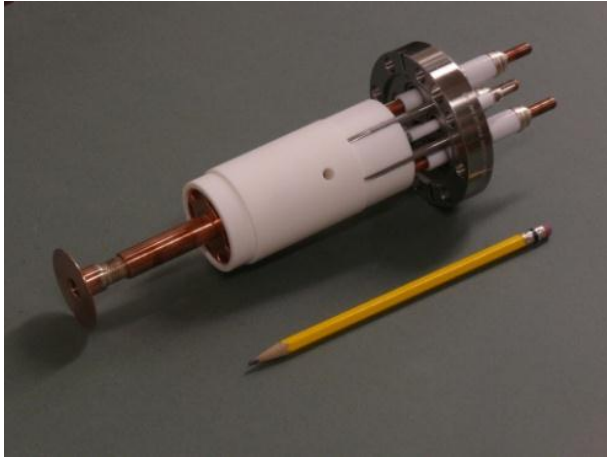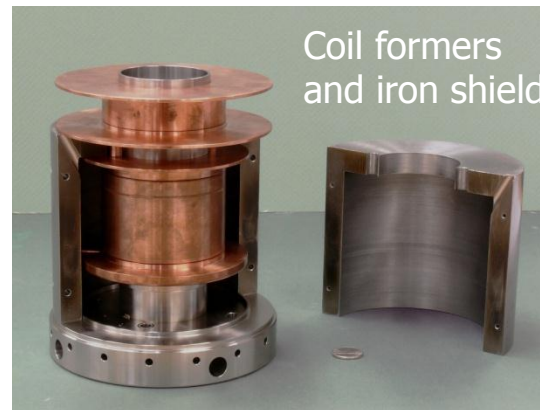# The electron gun in the NSCL EBIS/T charge breeder

Core
= cathode, focus + anode

assembled

HV plug

Coil formers and iron shield

installed

National Science Foundation
Michigan State University

MICHIGAN STATE
UNIVERSITY

S. Schwarz, HIE-EBIS Workshop 10/12
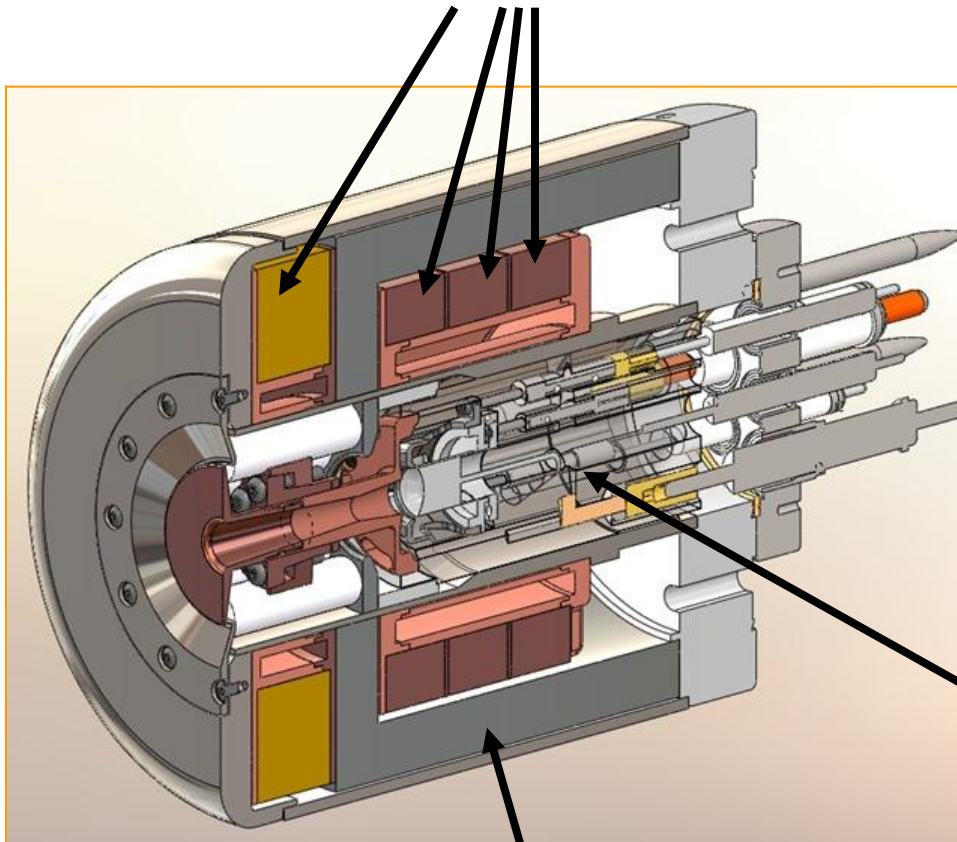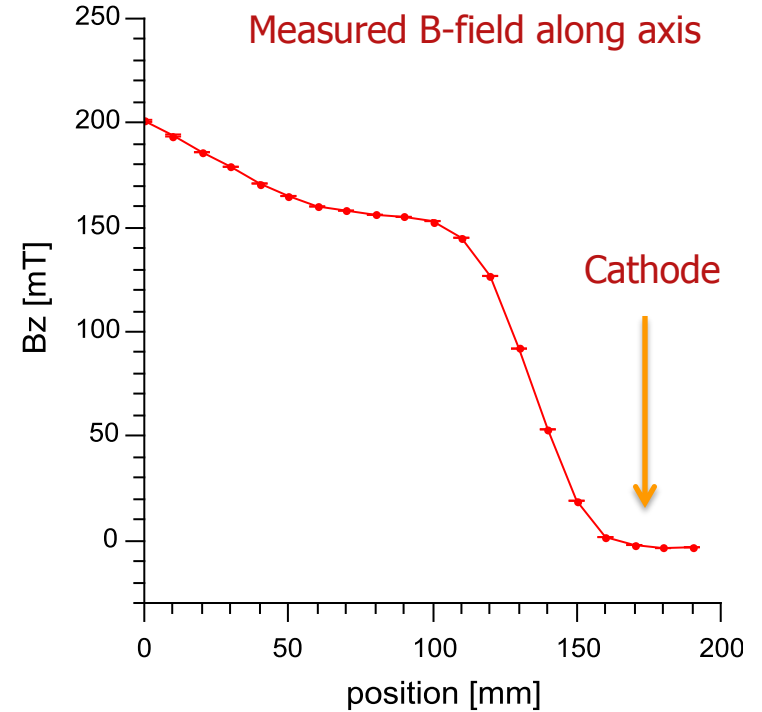
NSCL

Flexibility by modular design - shape electric & magnetic fields as needed

Bucking coils
- 3 inside iron shield → ~ 60 G per A
- 1 at front → ~ 120 G per A

Measured B-field along axis

Cathode

Bz [mT]

position [mm]

Core
= cathode, focus + anode
assembly comes
out through front

Soft-iron shield

Two cathode options:
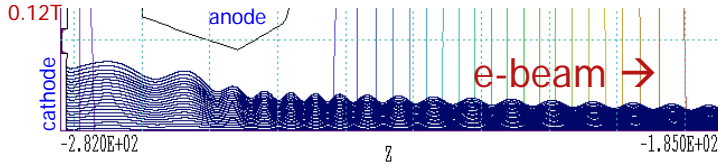Heatwave ¼″ + ½″. Type 61280M
Nominally 16.5 A/cm^2
1.4 A(1.1μP) / 2.4 A (1.8μP)

Want: High current density
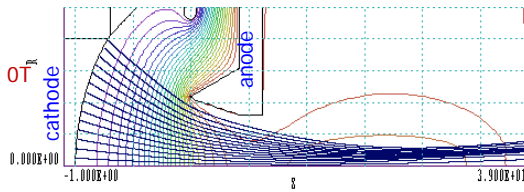Use: Magnetic compression
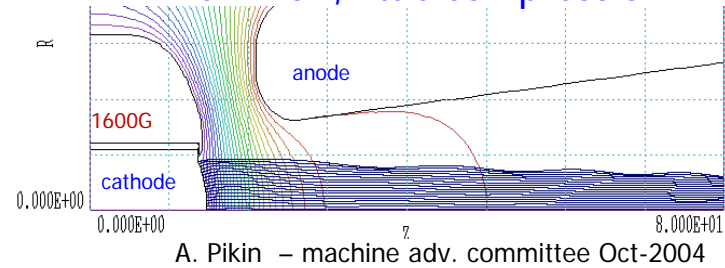Fight: Space charge

Titan - EBIT – 0.44A

e-beam →
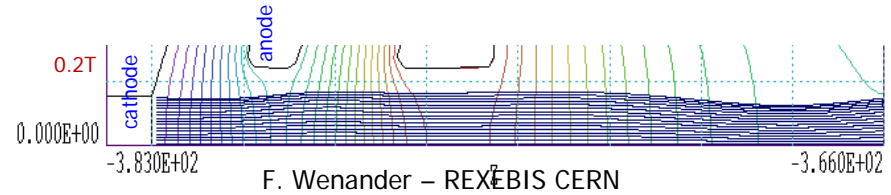
Frost – scaled to 2 A
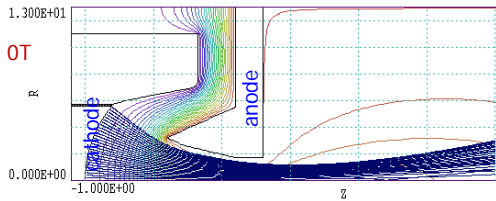
Frost3 – scaled to 1.55 A

R. D. Frost-proc-IRE-50(1962)1800
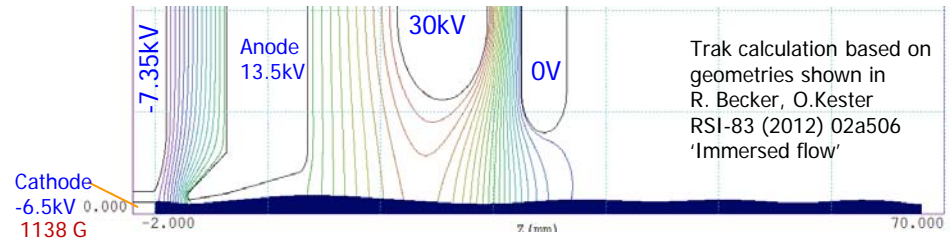
Shanghai - EBIT – 0.25A

X. Zhu nim-b235 (2005) 509

REXEBIS – 412 mA

F. Wenander – REXEBIS CERN

RHIC – 20A, little compression

A. Pikin – machine adv. committee Oct-2004

MAXEBIS – 480 mA

Trak calculation based on geometries shown in R. Becker, O.Kester RSI-83 (2012) 02a506 'Immersed flow'
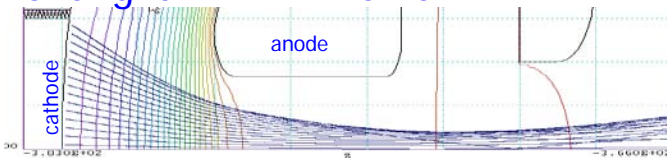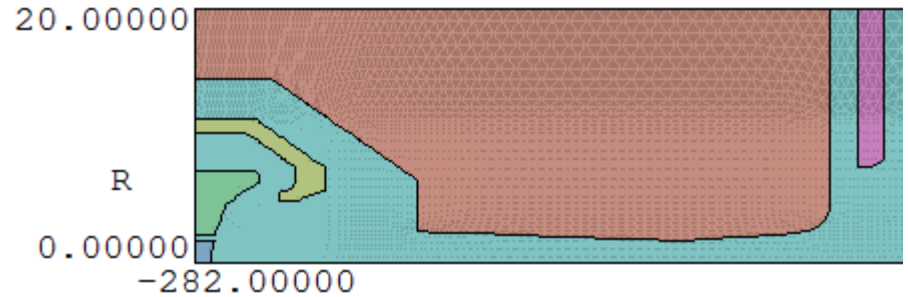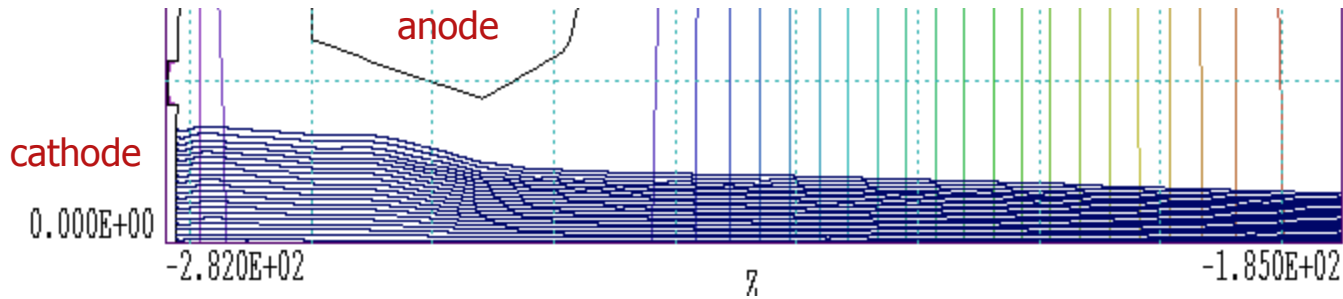
Tokyo- EBIT – 0.28A
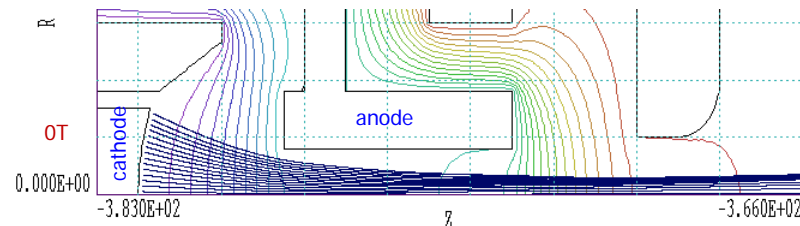
H. Watanabe – nim B 205 (2003) 239

(M. Kostin + SCS)

Cathode: -2000V
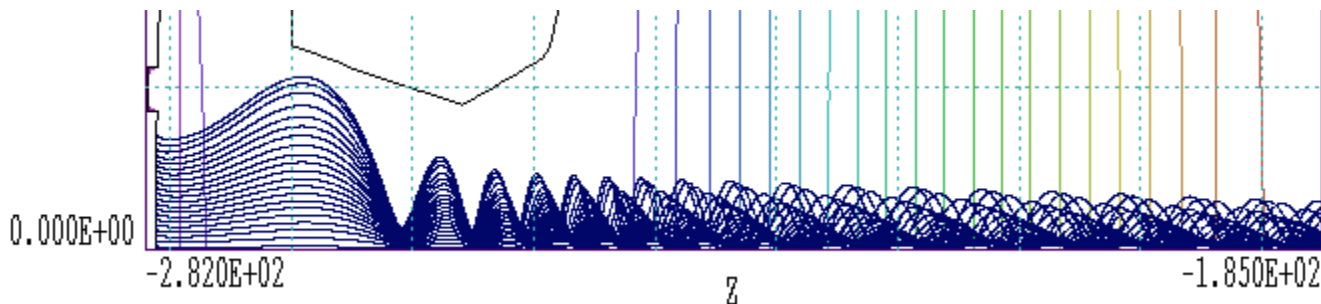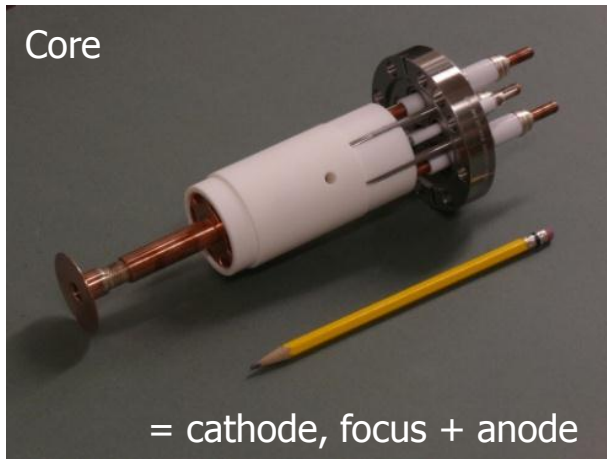Extraction electrode: 5640V
Anode: 4100V

Cathode B-field: **0.18T**

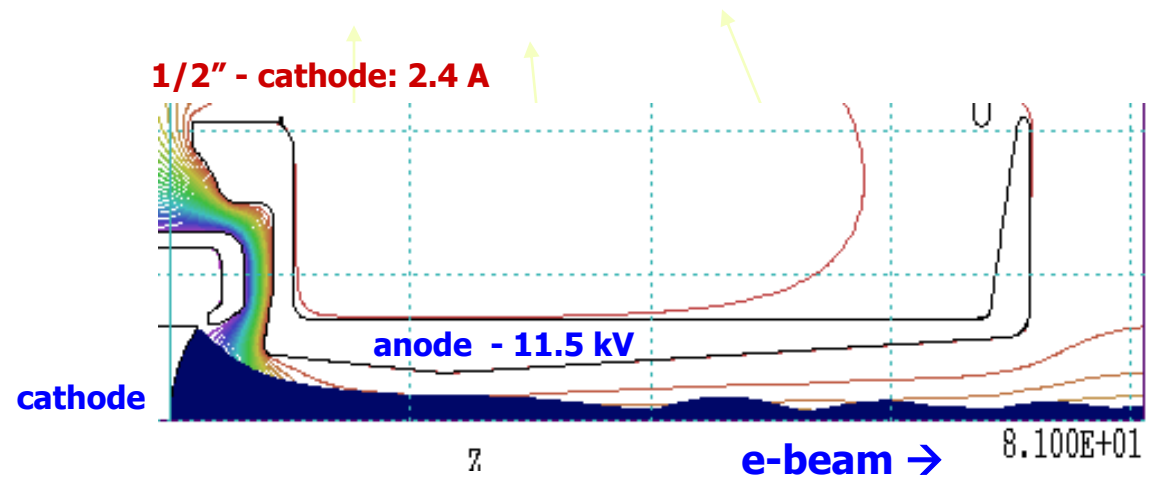**Extracted current: 0.44A**

Cathode B-field: **0.0265T / 265G**

The electron gun

¼" cathode

Core

= cathode, focus + anode

assembled

Simulation of extracted beam:
Challenge: Space charge + injection into magnetic field

1/4" - cathode: 1.4 A

housing

anode - 11.5 kV

cathode

e-beam →

1/2" - cathode: 2.4 A

anode - 11.5 kV

cathode

Z

8.100E+01

e-beam →
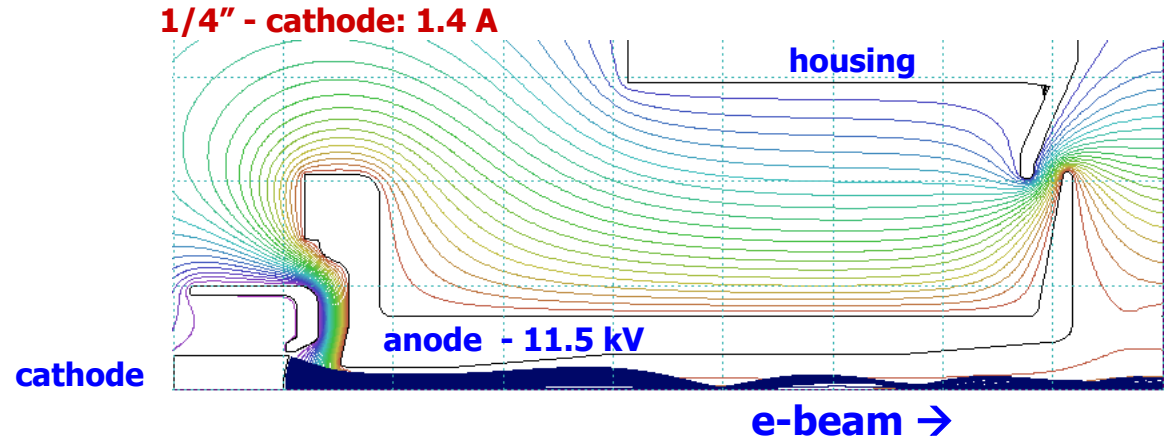
Calculations for injection into 0.4T test magnet …
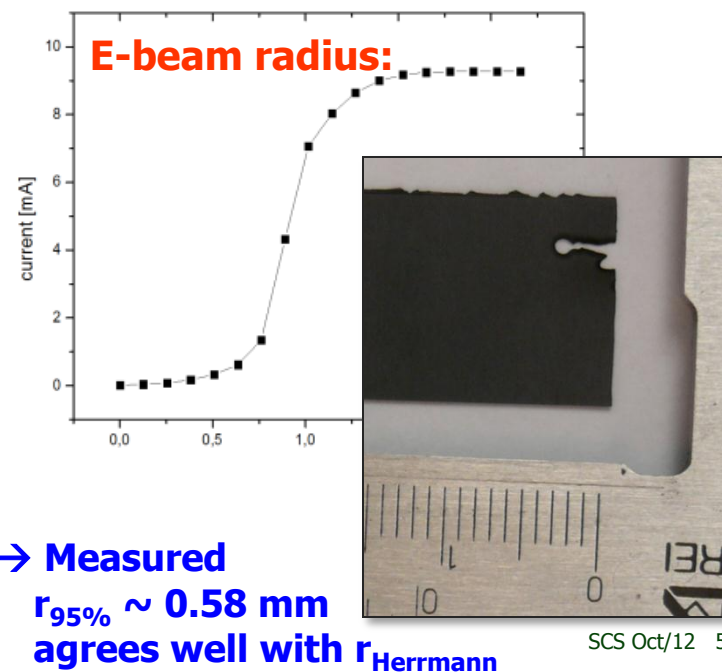
... with a 0.4 T RT coil
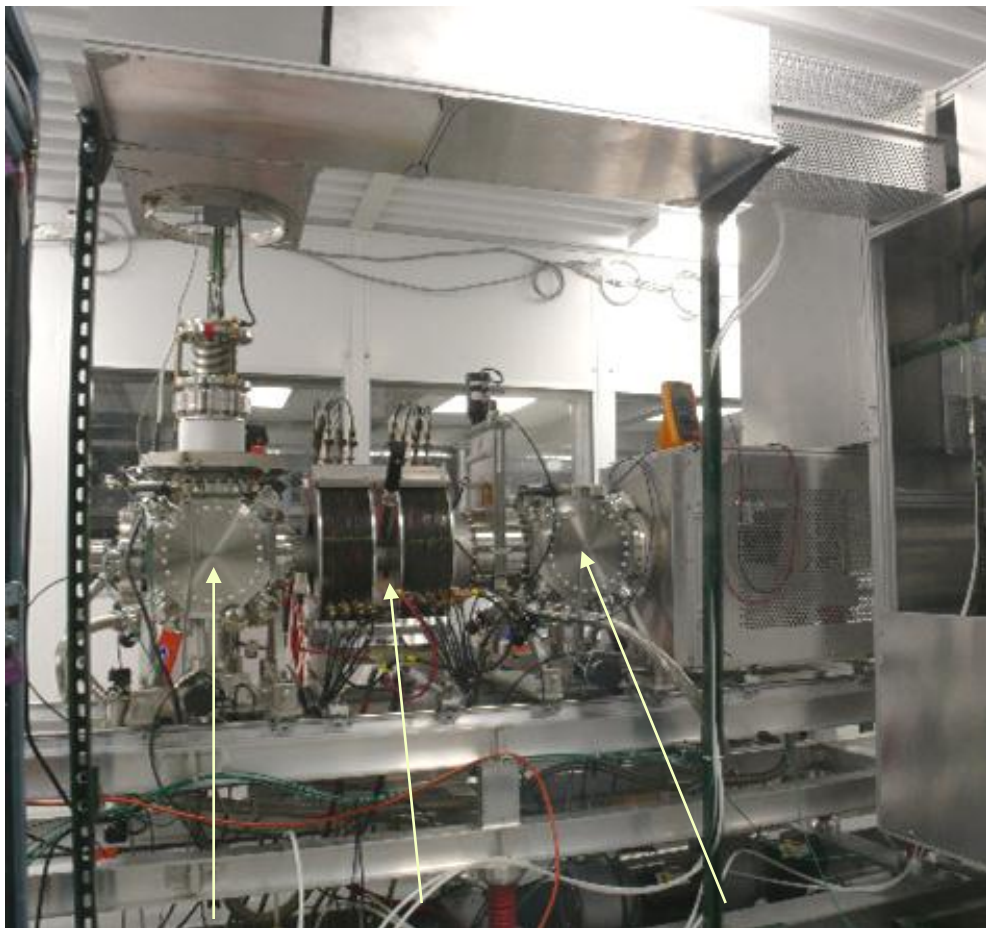
collector   test coil   e-gun

To be repeated with the 6T SC magnet

Measured extracted current:

→ **Perveance ~ 0.84 μP**
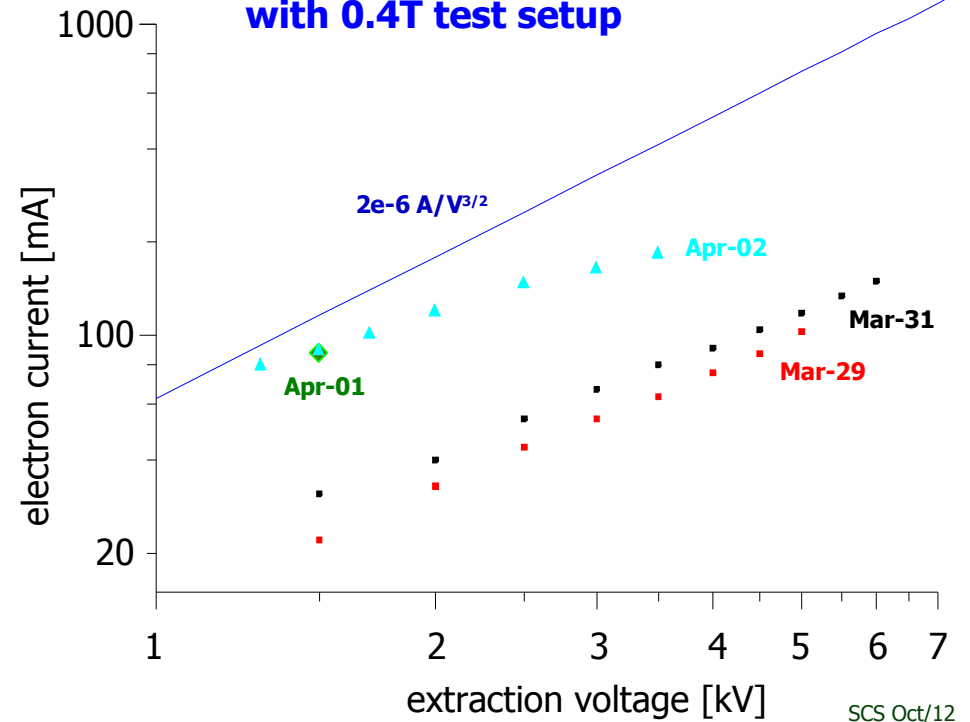
→ **Emissivity > 3 A/cm²**

E-beam radius:

→ **Measured r$_{95\%}$ ~ 0.58 mm agrees well with r$_{Herrmann}$**

1/2" cathode

Papa core

Measured extracted current in 2009:
with 0.4T test setup
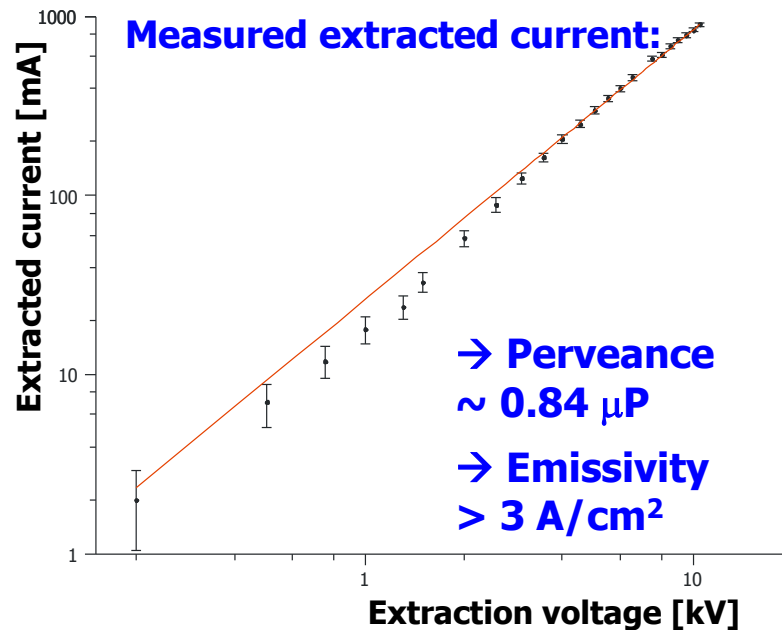
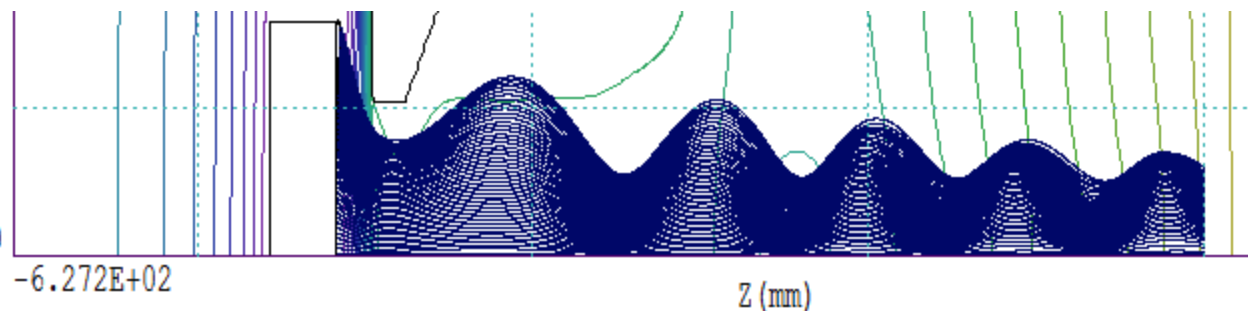'Papa'-cathode: 2.4A at 11.5 kV

Currently ... reached 250mA of e-beam.
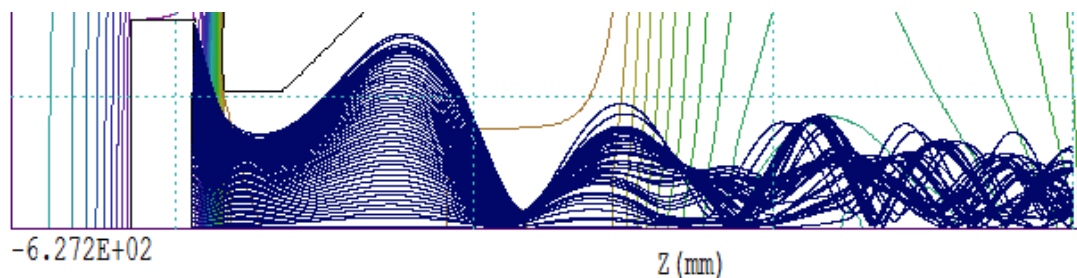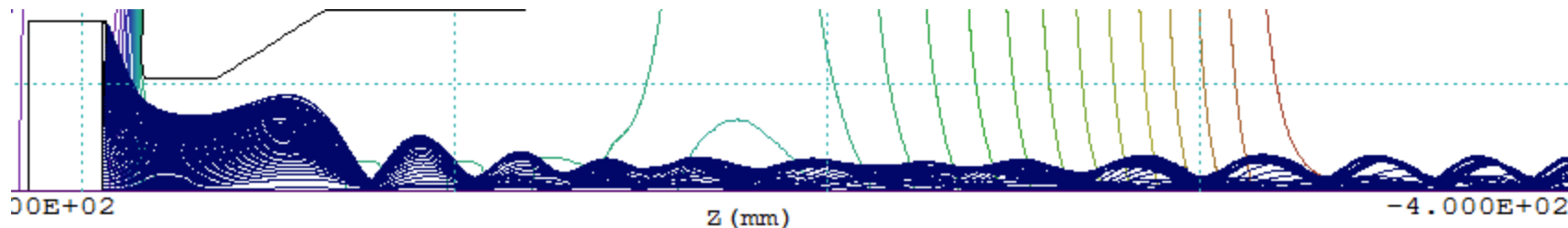
= BAD.

Limited by radial energy gain during launch.
For injection into SC magnet: Cathode likely at bad position:
   Highest B-field gradient beyond 'crossover' point of electrostatic launch.

➔ Try to move cathode towards trap (~18mm relative to current posiition):

TriComp:
At this position, even
1A ➔ 6T should be possible