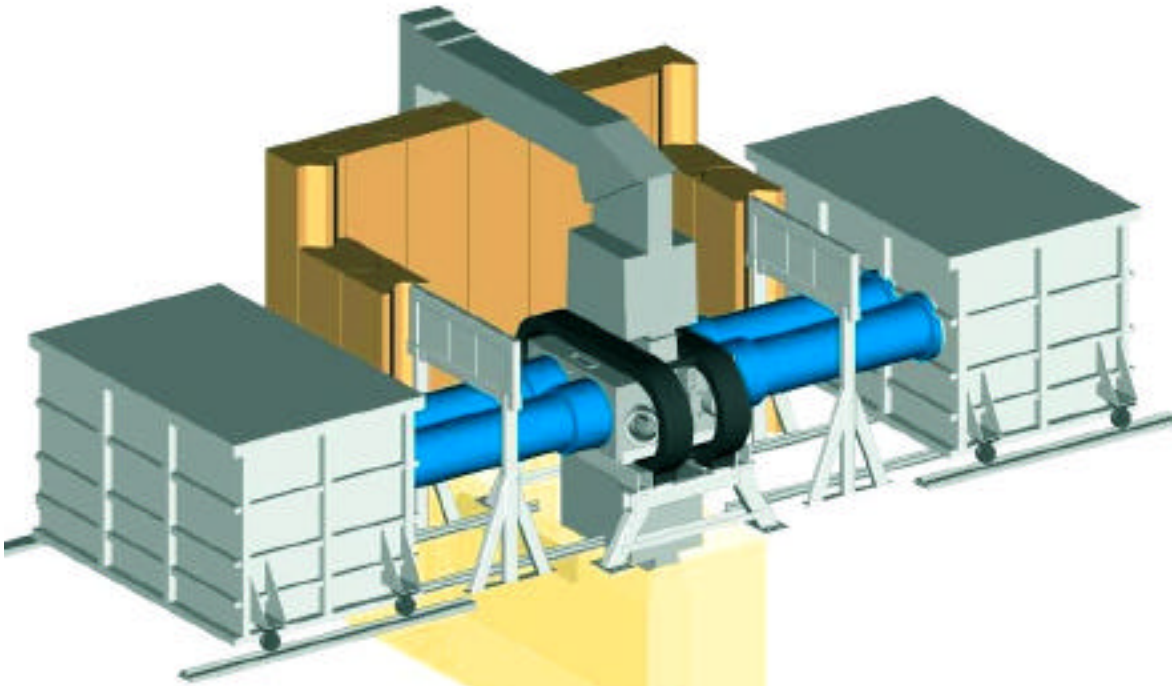


A Repetitively Pulsed, High Energy, Krypton Fluoride Laser

Presented by John Sethian

Naval Research Laboratory

June 1, 2001

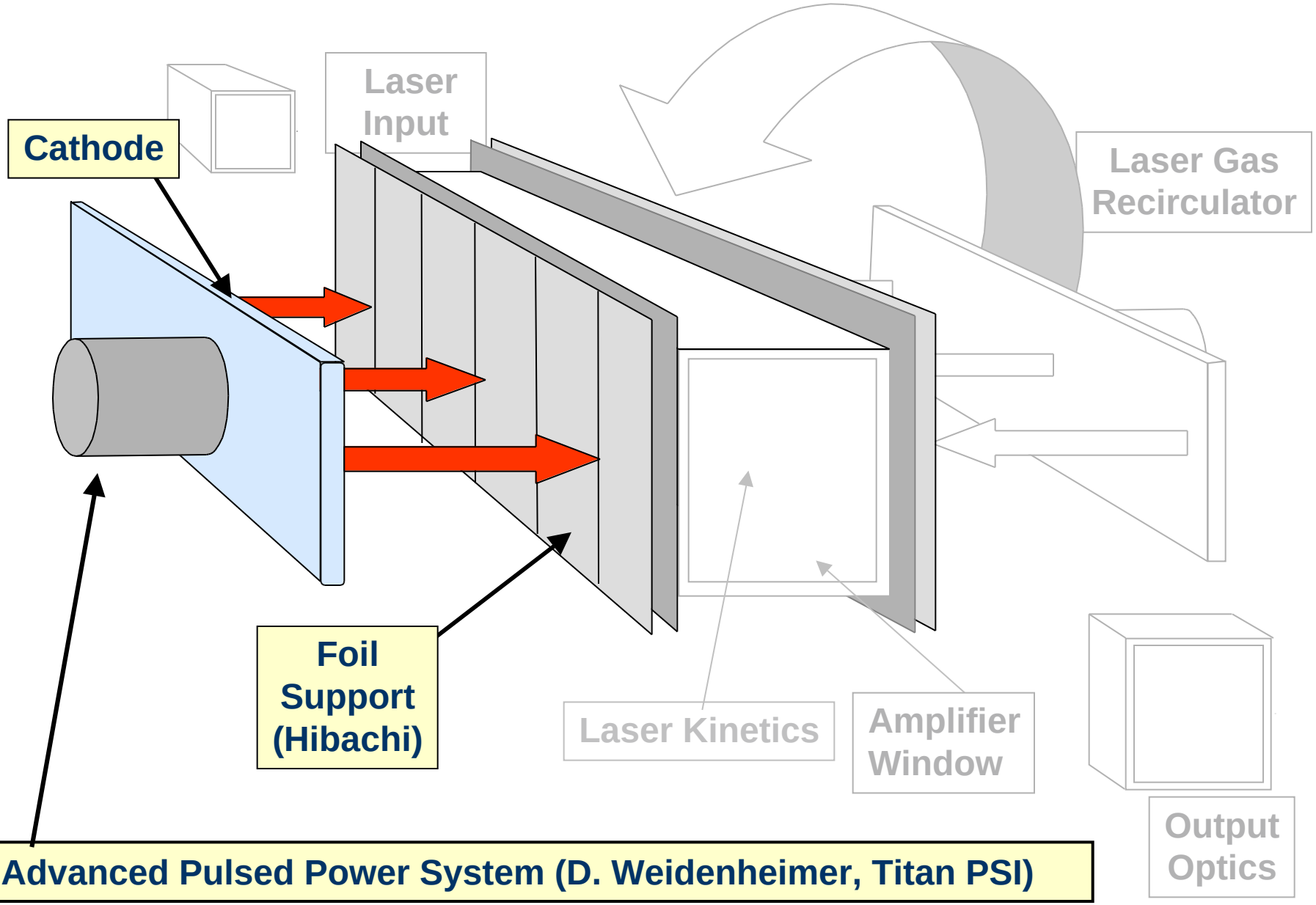
NRL
M. Friedman
M. Myers
S. Obenschain
R. Lehmberg
J. Giuliani
P. Kepple

JAYCOR
S. Swanekamp

Commonwealth Tech
F. Hegeler

Pulse Sciences, Inc
D. Weidenheimer

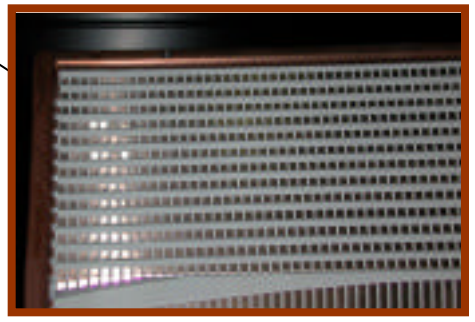
Topics this time



We have looked at 18 types of cathodes/materials

"You have to kiss a lot of frogs to find a prince" Norman Rostoker

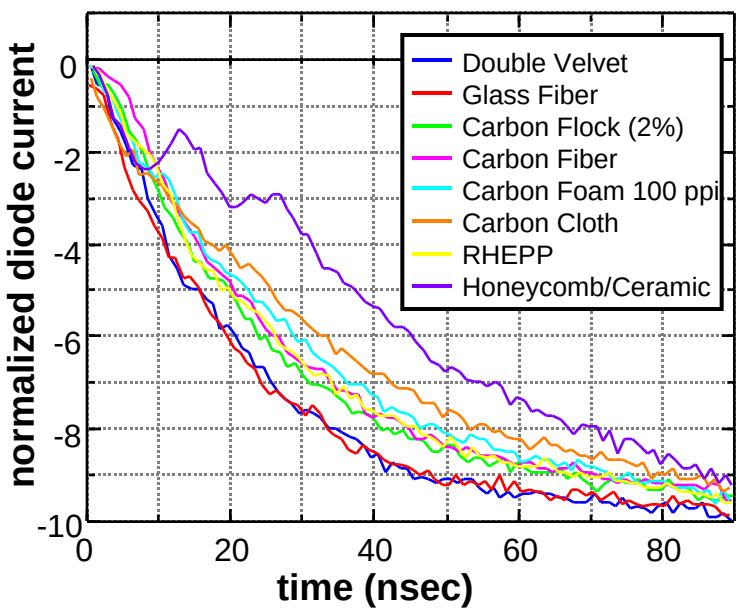
- **Dielectric Fiber**
  - **Double Velvet**
  - **Other Velvets**
  - **Glass**
- **Carbon**
  - **Fiber**
  - **Cloth**
  - **Foam 100 ppi**
  - **Foam 500 ppi**
  - **Flock -2% (ESLI)**
- **Metal/Dielectric**
  - **Ceramic/Honeycomb**
  - **Metal/ceramic surface flashover**
  - **RHEPP**
  - **Fine scale RHEPP**
- **Patched Cathodes**
  - **Silicon Carbide**
  - **Carbon/Carbon Fiber**
  - **Diamond-like Carbon**
- **CsI Coated Patches**
  - **Double Velvet**
  - **Carbon/Carbon ESLI**
  - **Silicon Carbide**

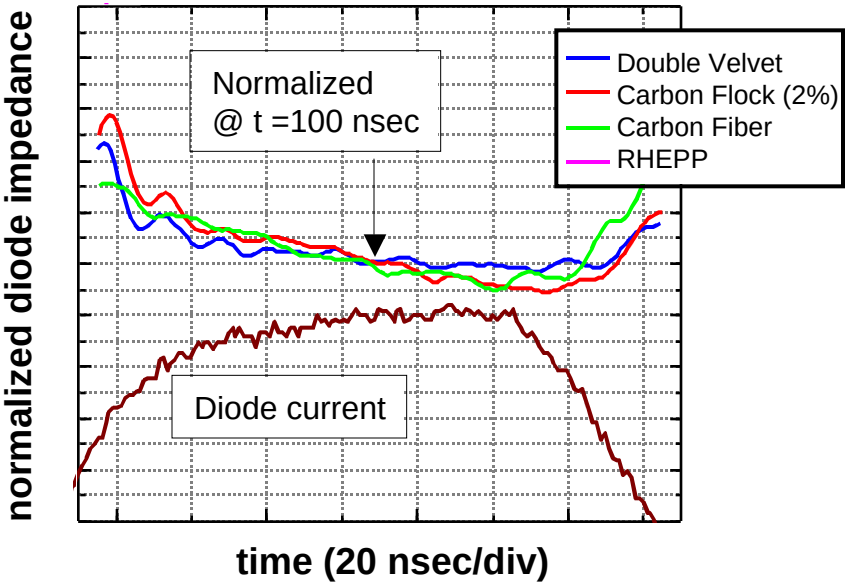


The best so far

Cathode workshop on May 10 at NRL held by F. Hegeler

We evaluate cathodes for turn on, uniformity, gap closure and durability

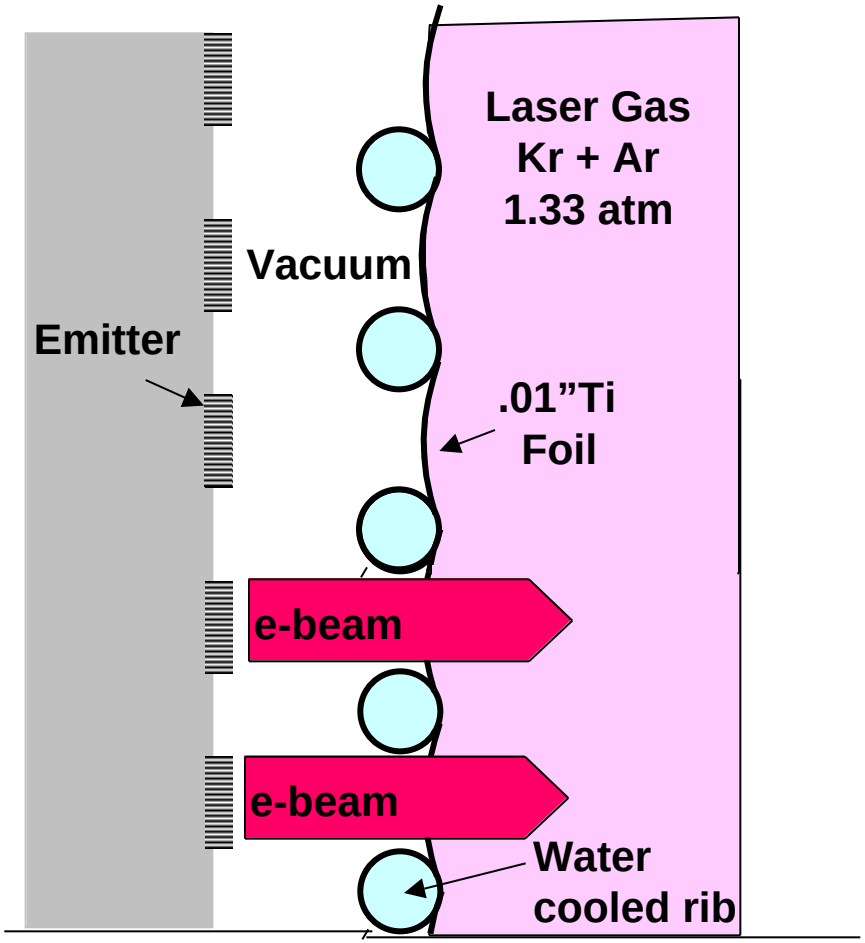




	UNIFORMITY		LONGEVITY	
CATHODE	Current Density Variation (rad. film)	No. Shots	Change in V or I first-last ?	Pressure @ end of run
Double Velvet	6%	500	No	2.00E-04 →
Glass Fiber	25%	É .	É .	É .
Carbon Flock (ESLI)	15%	800	Slight	2.40E-05 →
Carbon Fiber (Eusebio)	41%	3100	No	2.30E-05 →
Carbon Foam (100 ppi)	19%	É .	É .	É .
Carbon Cloth	57%	É .	É .	É .
RHEPP	50%	300	Slight	2.00E-05 →
Fine Scale RHEPP	25%	É .	É .	É .
Honeycomb/Ceramic	32%	É .	É .	É .

We are developing the emitter & hibachi as a single system

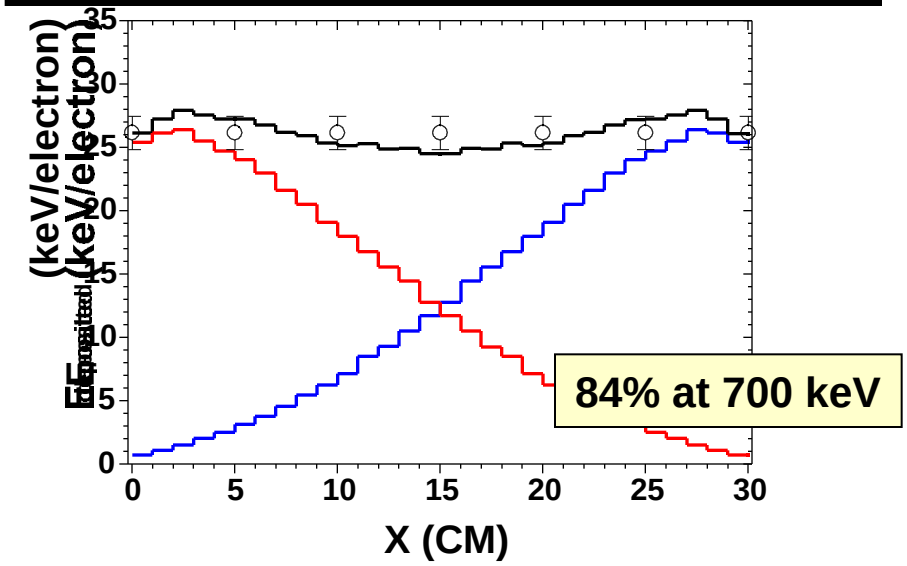
Baseline Design:
Pattern emitter to miss hibachi ribs
Flow water through ribs for cooling



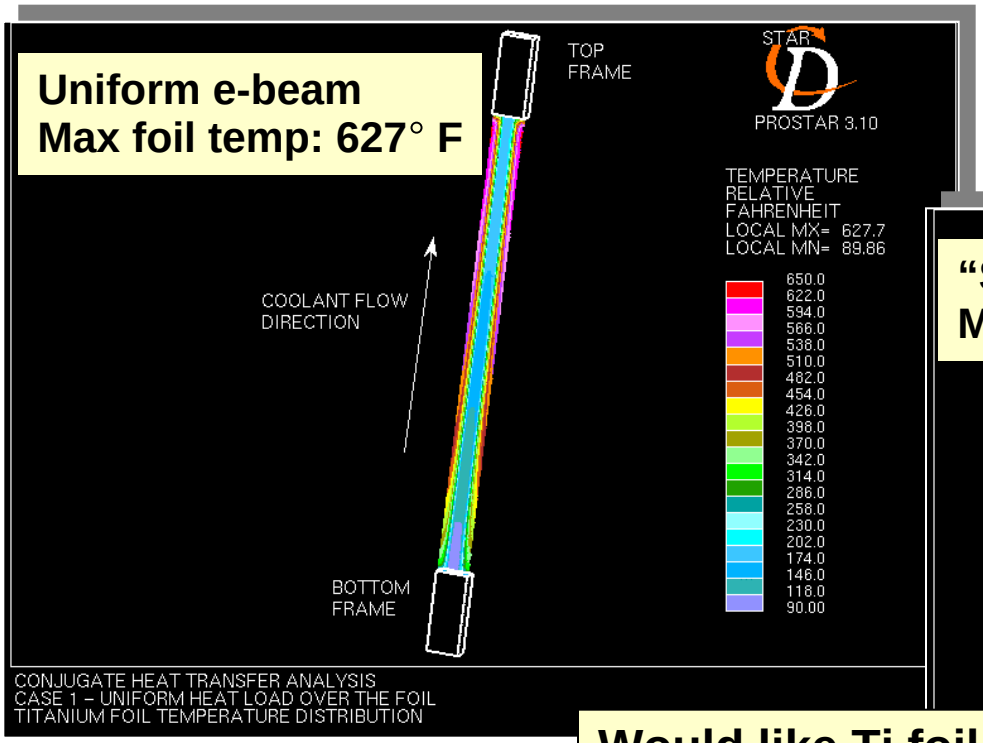
Foil loading 0.9 W/cm^2

1. Transmission
2. Foil cooling
3. Pattern the beam (to miss the ribs)
4. Ribs provide a electrically flat anode
5. Beam uniformly pumps laser gas

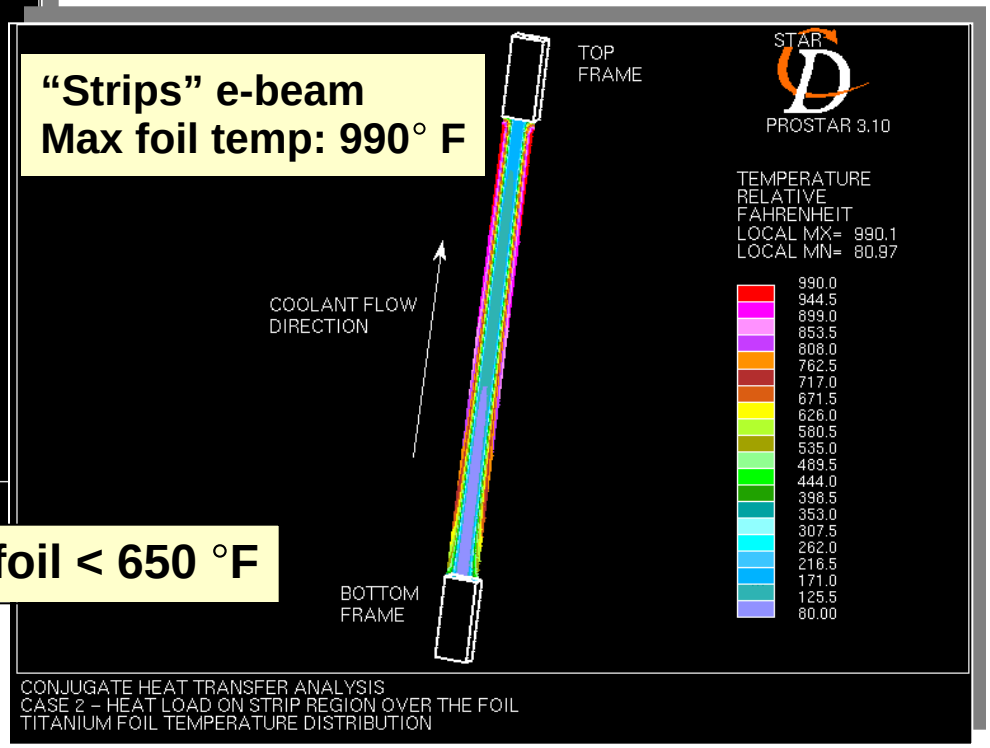
Step 1: 1-D Energy deposition profile shows 78.6%deposited in gas @ 500 keV



Step 2: CFD analysis of foil shows foil cooling ok with uniform e-beam distribution…
but needs work for e-beam in strips (2 x current density)



Measured e-beam heat loading used as input



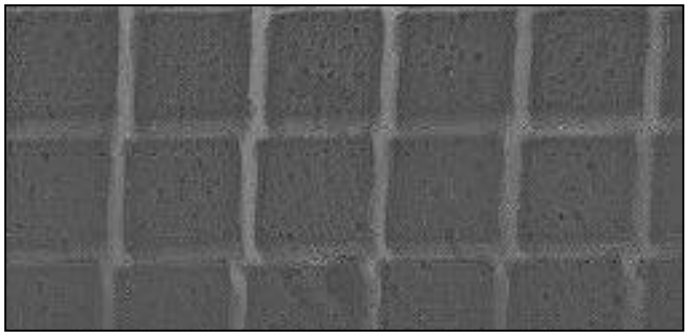
Would like Ti foil < 650 °F

Solutions:

- **Decrease rise and fall of beam,**
- **Better T_c materials**
- **Higher allowable temp**
- **and…. *experimental verification***

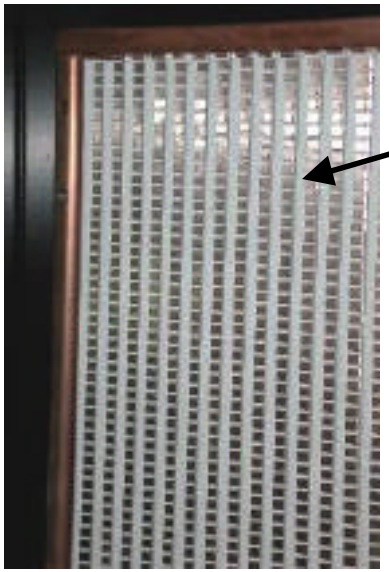
Step 3: We can pattern the electron beam

PATCH CATHODE (3 cm x 3 cm)

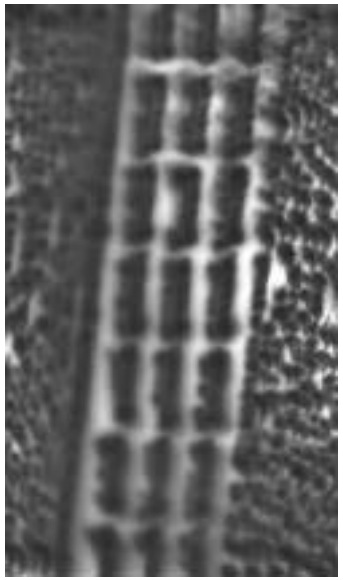


Radiachromic Film at anode (5 X Mag)

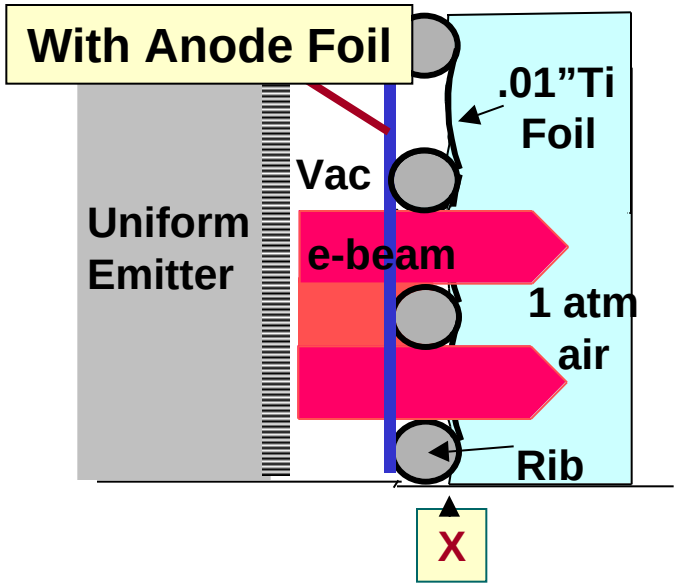
STRIP CATHODE (3 cm x 1 cm)

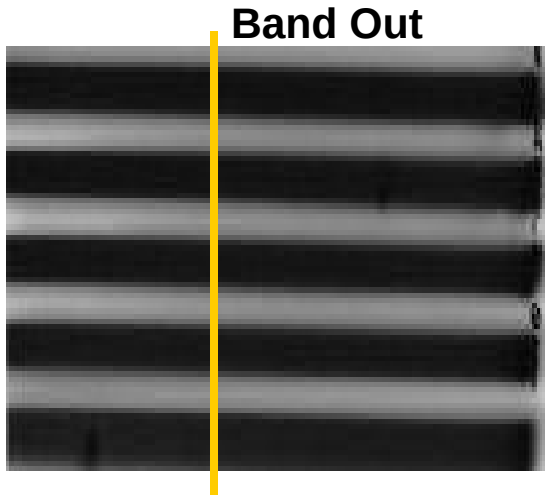


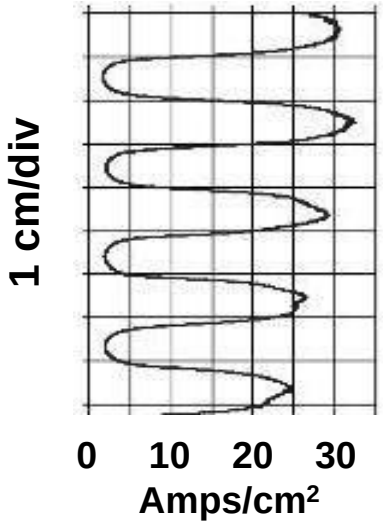
Actual cathode has finer spacing and some sections removed



Step 4: Close spaced ribs may be an “electrically flat” anode

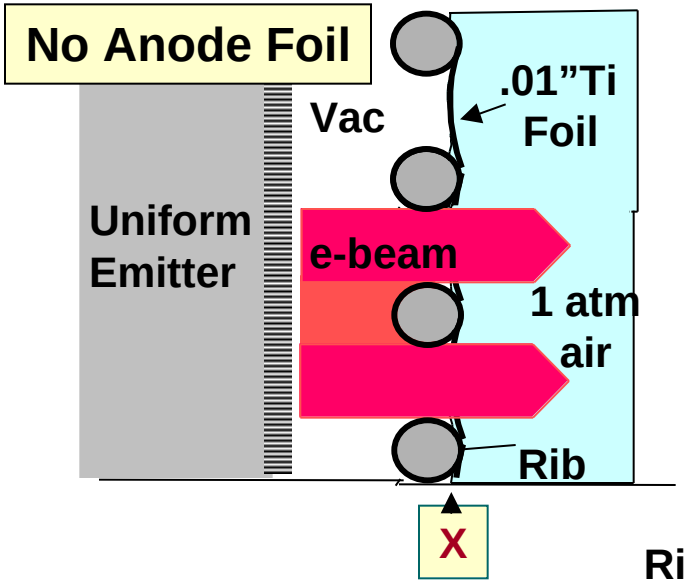


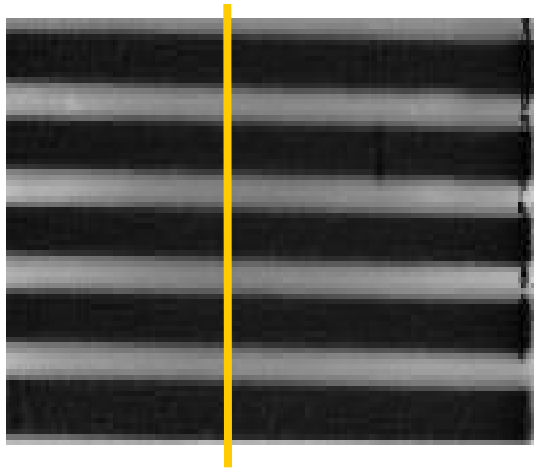


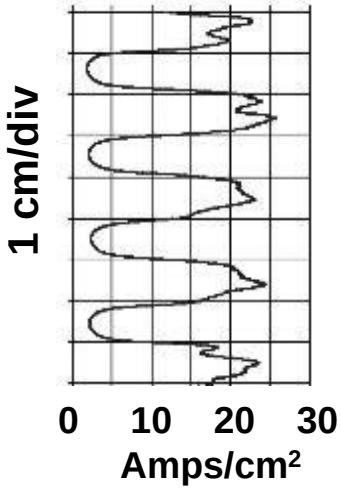


1 mm Wide Band

Radiachromic Film
after hibachi foil (“X”)

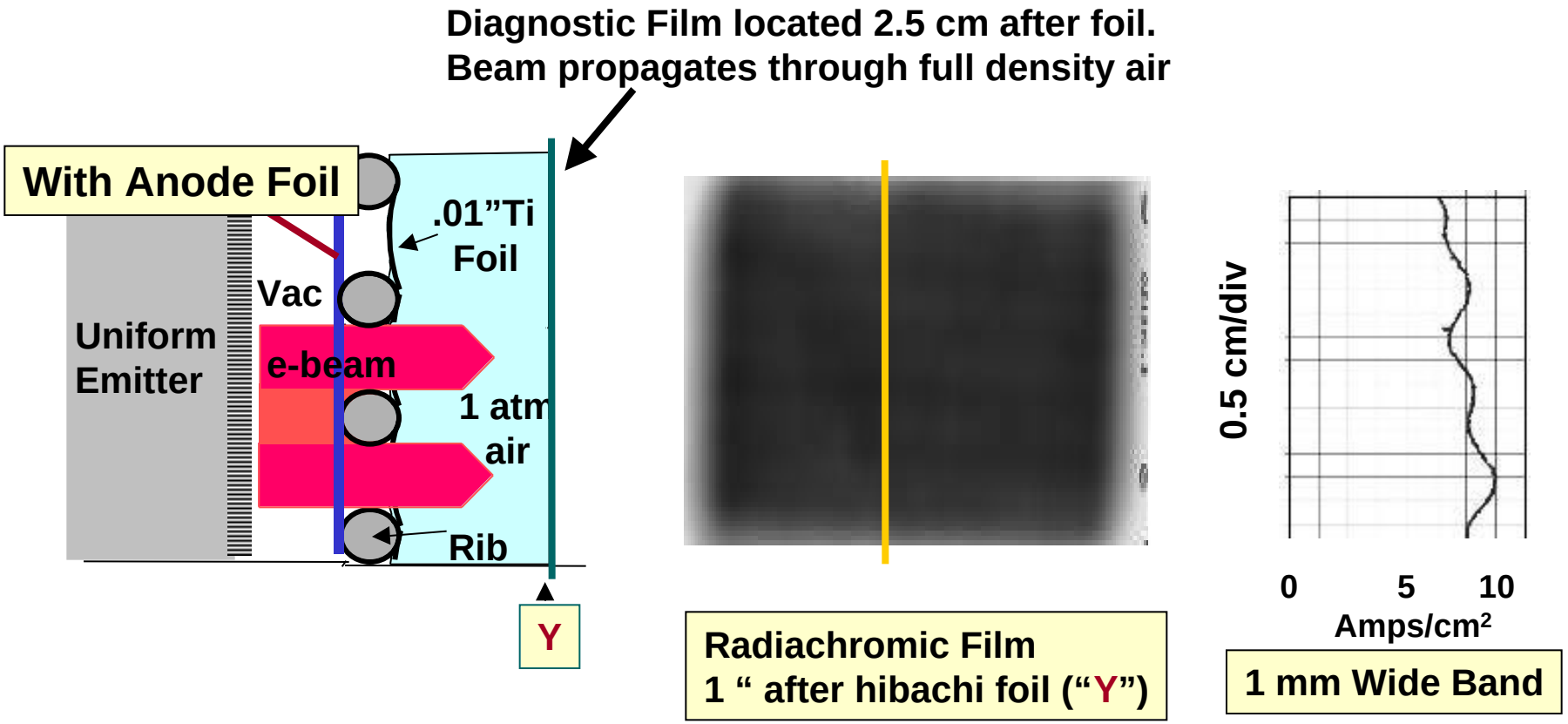






Ribs can be a ferritic material !

Step 5: This hibachi configuration should allow the beam to uniformly pump laser gas



Scattering length will decrease with:

- Higher Z of laser gas as scattering goes as Z^2 (Kr = 36, air = 7)
- Possible use of higher Z foils

We are evaluating "HAVAR" as a hibachi foil material

HAVAR: (Co 42 / Cr 20 / Ni 13 / W 2.7 / Mo 2.2 / Mn 1.6 / C .2 / Fe 19.1)

Specifications, Compared to Ti:

	Ti	HAVAR
Density	4.5	8.3
Tensile strength (MPa)	460	1860
Thermal Cond (W/m-°K)	22	15
Z_{eff}	22	39
Chemical resistance	good	Ex*
Melting temp (°C)	1660	1480

* Fluorine resistance undocumented

Our measurements:

	Ti	HAVAR
248 nm refectivity (exp to F_2)**	>0.3	TBD
Burst Test 1 mil foil (no exp)	500	1100 psi
Burst Test 1 mil foil (no exp)	1100	TBD
Burst test 2 mil foil (exp to F_2)	1100	TBD

** lower reflectivity reduces losses (ASE)

Doug Weidenheimer
Titan-PSI
on
Advanced Pulsed Power for Electra

Summary of progress since last meeting

Ultimate cathode is still elusive, but have candidates

New Baseline Hibachi design looks good so far,
- **Needs more testing**

Advanced Pulsed Power program developing components

- **Identified three systems that can meet requirements**
- **Started component development**
  - **Advanced photonically triggered switches**
  - **End of life testing of existing components**