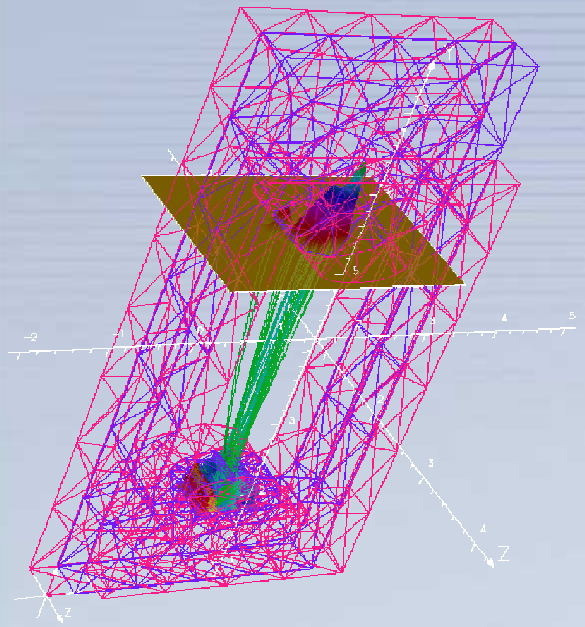
SAND2012-9183C

Surface Mounted Neutron Generators Neutristor



Juan M. Elizondo-Decanini PhD
Sandia National Laboratories

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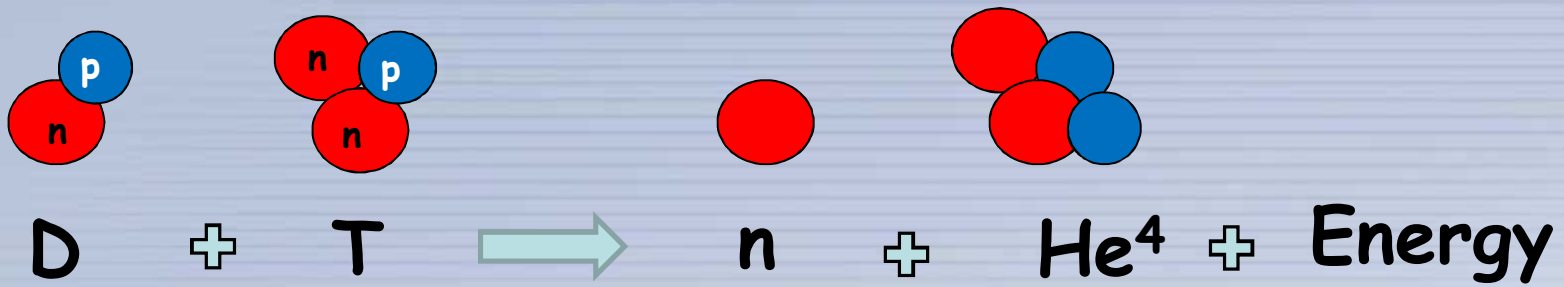
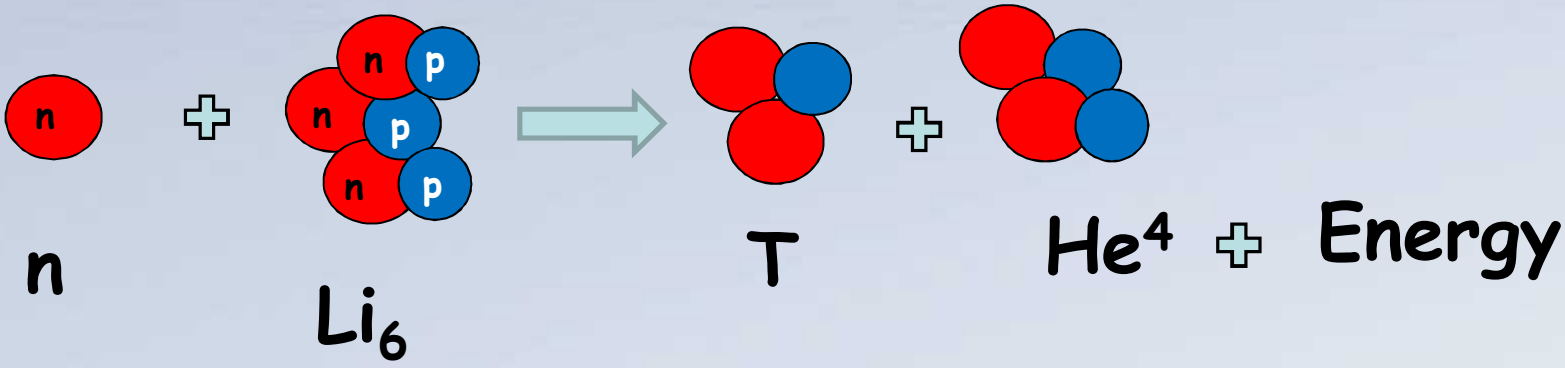
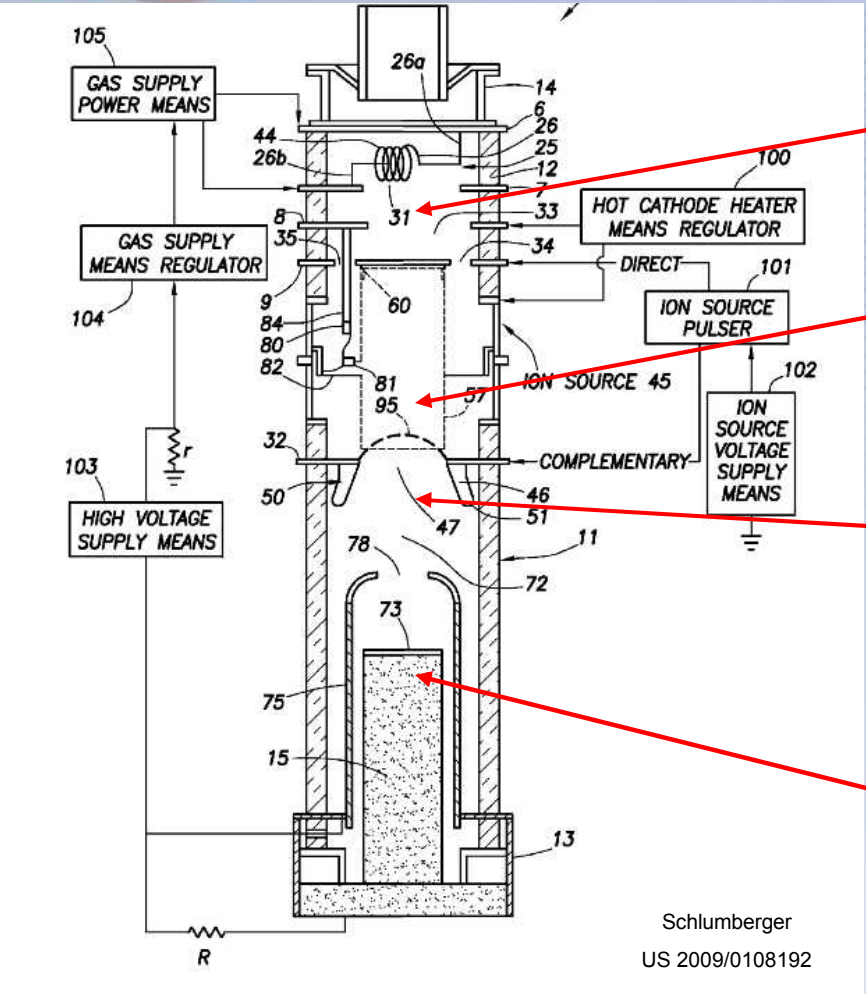
What is fusion ?

DT, DD, etc…..





What is a Neutron Tube



Schlumberger

US 2009/0108192

Ion Source
D^+

Ion beam extraction and shaping

Acceleration Region

TARGET
Tritium loaded

Everyone needs a push sometimes….

- The Box:
  - Neutron generators have very strict requirements, on size, weight, shape, power, etc., etc., etc., etc…, etc……

- "I need neutrons at this location I do not care how you produce them……."

the call .....

Something we do not know ….

A computer memory chip has 2 transistors per bit, can we produce one neutron per transistor ???

The world does not disclose its nothingness to one who has not first posit them as possibilities

Sartre 1943

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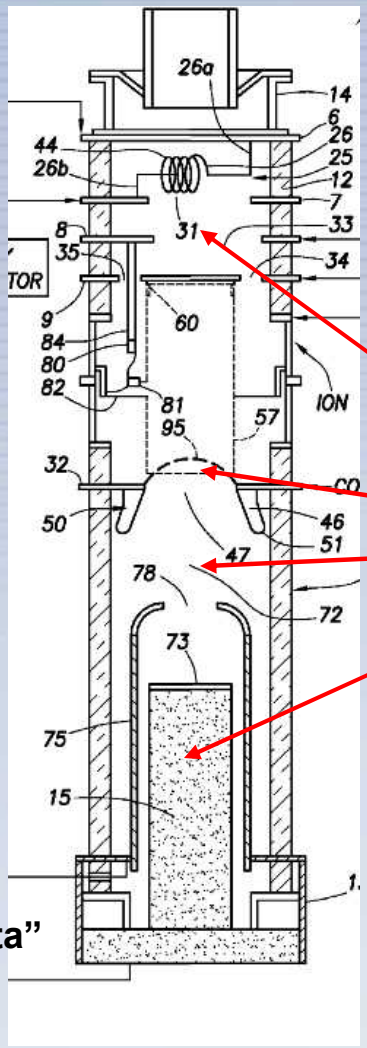
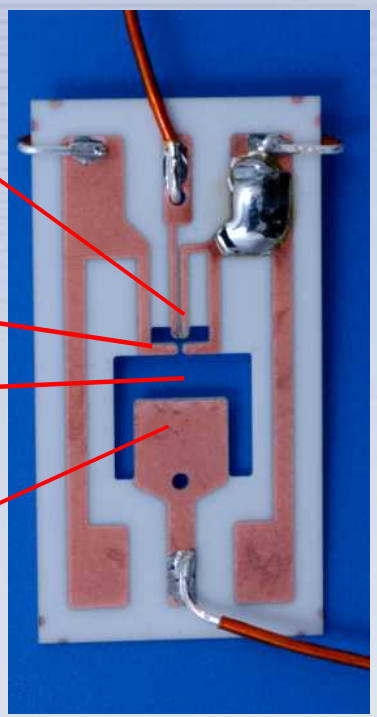
Project challenges

- Knowledge mapping indicated no surface mounted technology, no solid state based or micro-engineered (MEMS) reported, published, or patented; not even a hint of it.
- The all familiar cylindrically symmetric geometry seemed the end of the road.
- A cross section of the simplest possible neutron tube produces the ideal surface mounted topology
- Photoconductive or laser induce photoelectron carrier production provided the first idea to use everything possible from solid state and other technologies to fabricate and demonstrate neutron production
- Electric field management and flat packaging were listed as a minor challenges.
- Ion beam shape and control was identified as the major challenge to overcome.





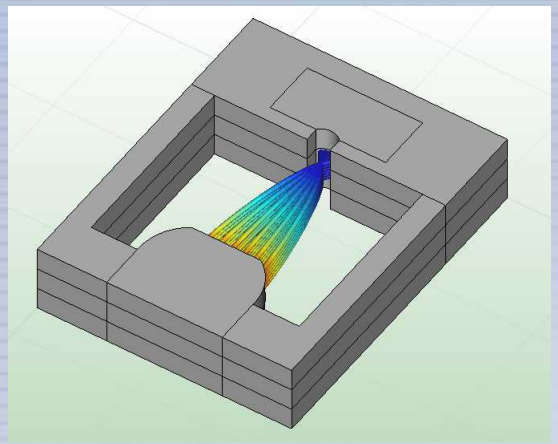
“Urgent change in the perception and evaluation of familiar data”

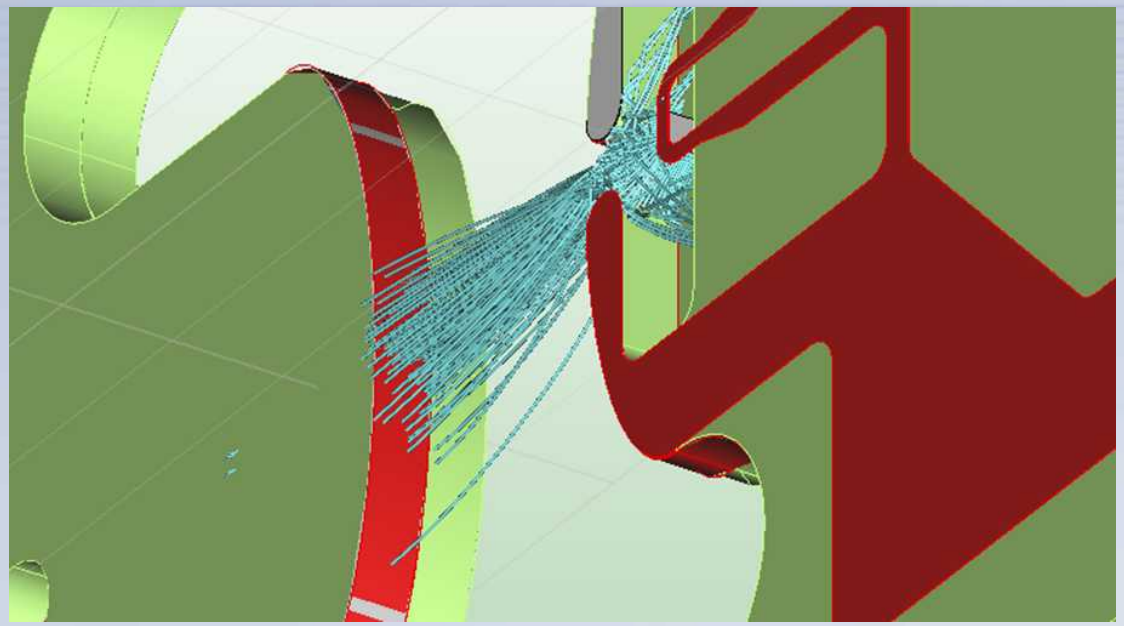
Kuhn 1962 Structure of Scientific Revolution

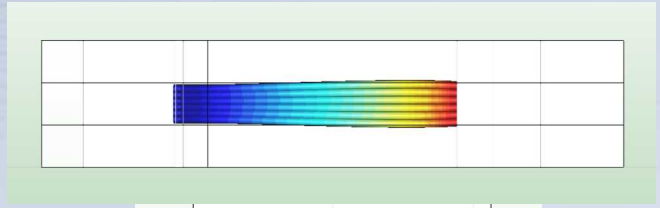
Project Maturation, modeling…

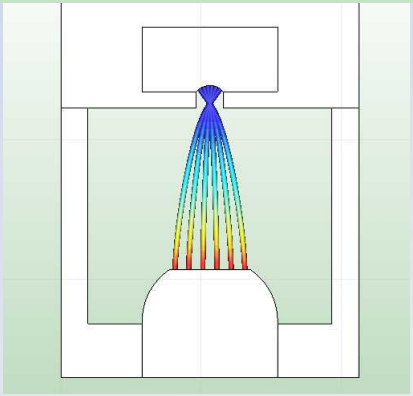
The project advanced rapidly due to intense use of analytical modeling and computer simulation.

Once the ion lens was configured a number of other applications/innovations became apparent.



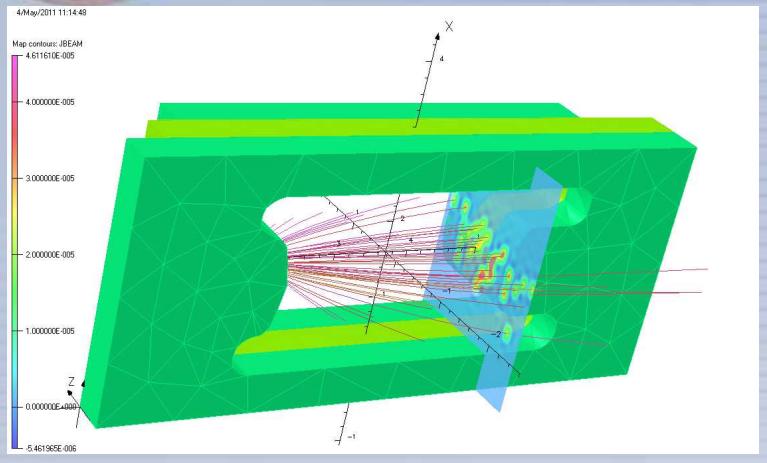


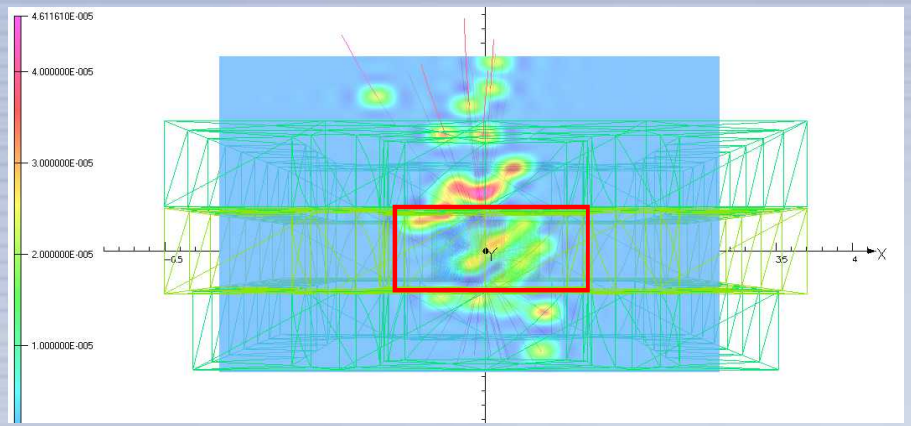


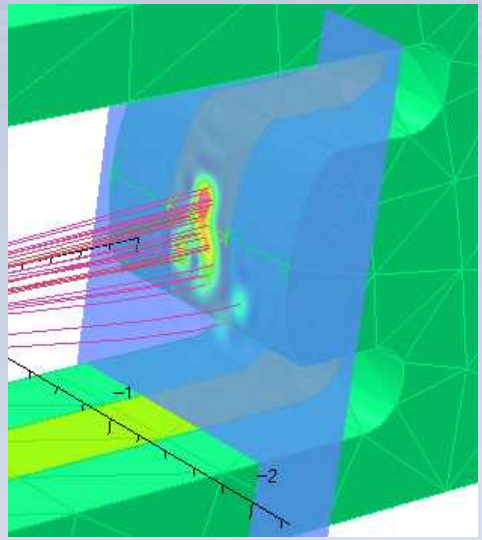


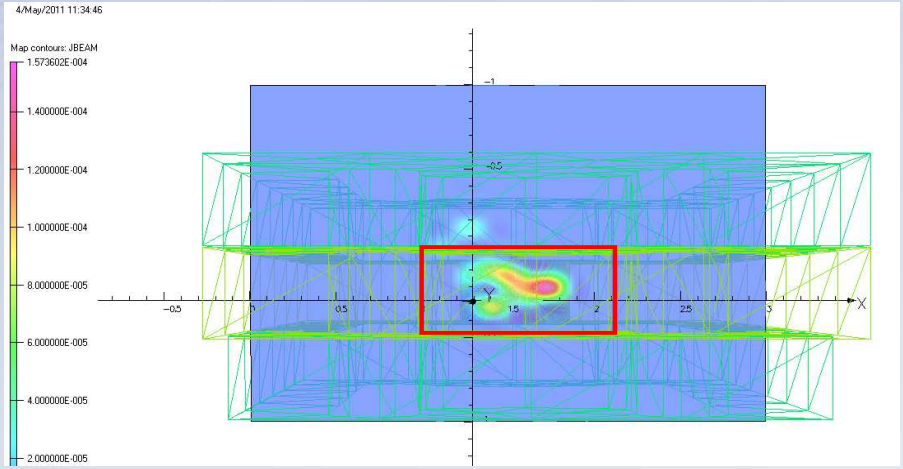
Neutristror Animation.wmv

The lens design and its implementation is one key innovation that allowed further than anticipated developments.









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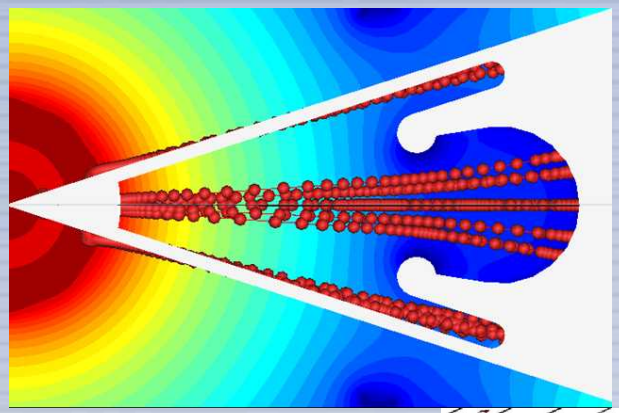
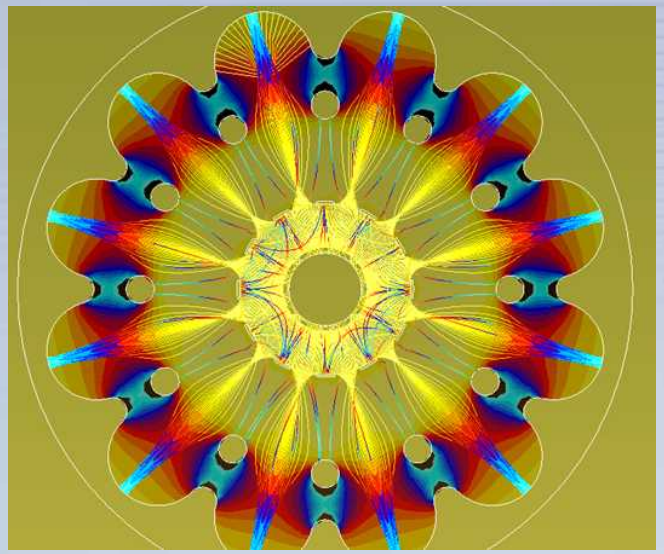
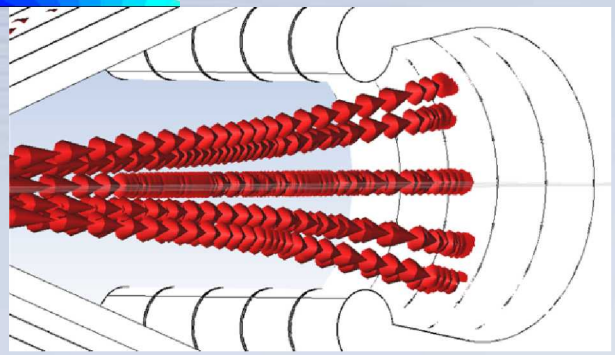
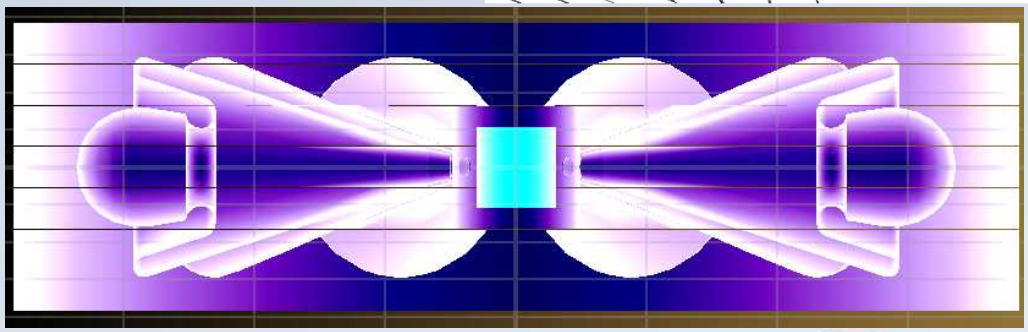
DD/DT Accelerator Based Neutron Production from the Surface Mounted LDRD Concept Evolution









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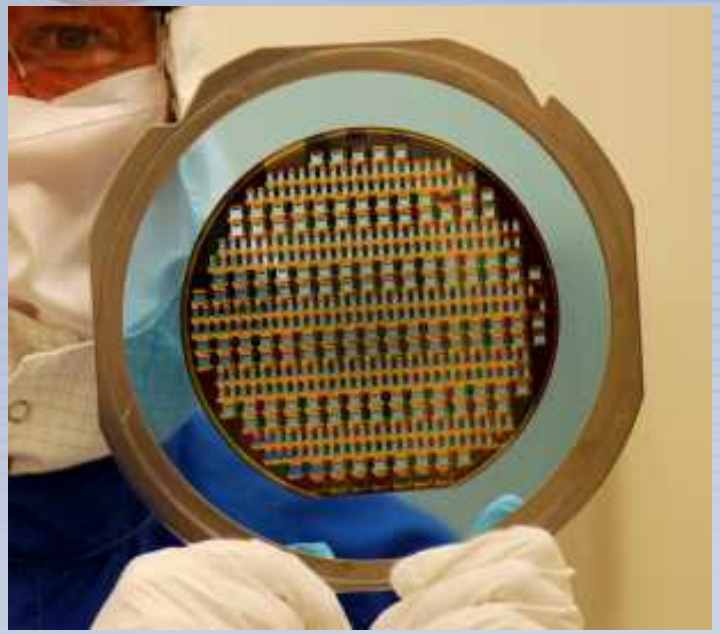
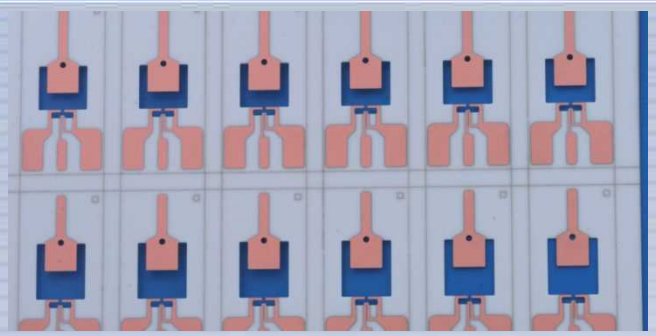
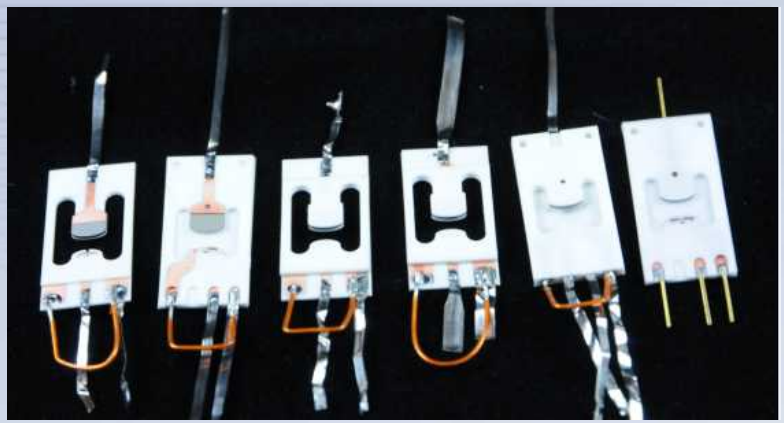
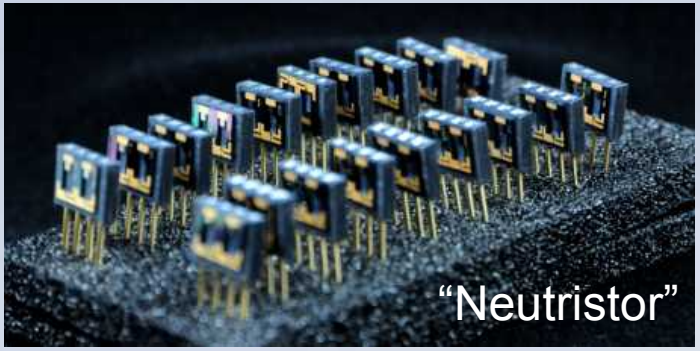
After that, prototype fabrication…..









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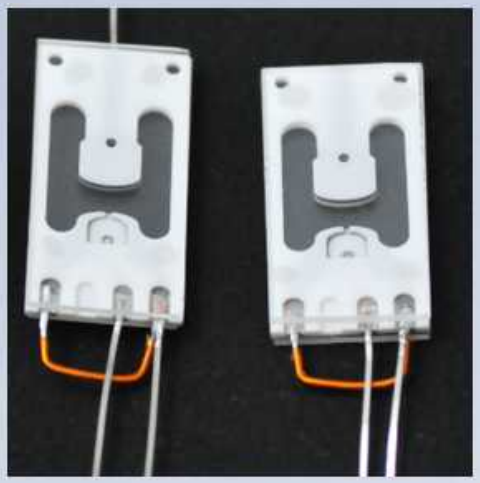
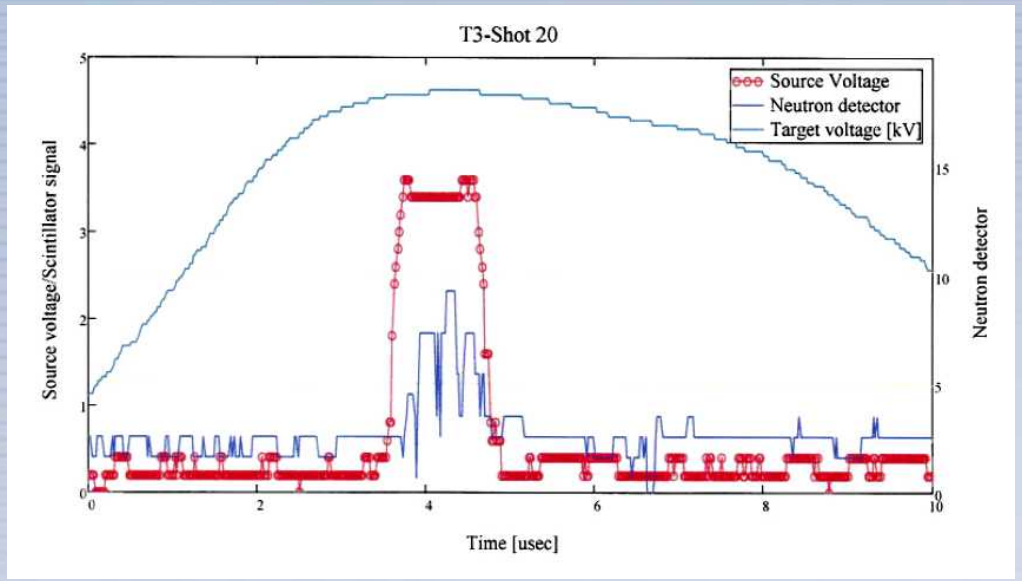
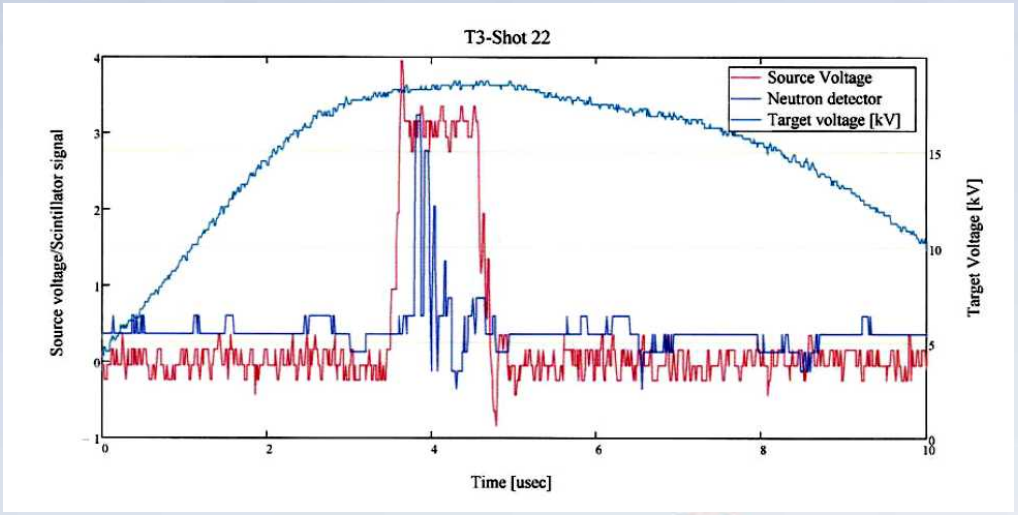
Project Maturation, testing…

- Samples with ceramic substrates and deuterium loaded titanium were tested next
- Tritium loaded targets were designed and fabricated next.
- We estimated a minimum of 2 x 10^3 isotropic neutrons per pulse using tritium targets.
- The ion lens proved to be the challenge in the performance of the device.







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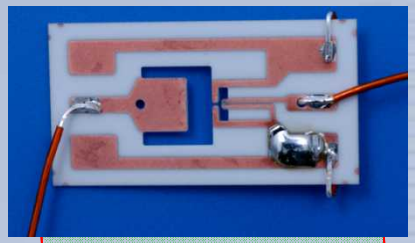


10^4

neutrons/pulse

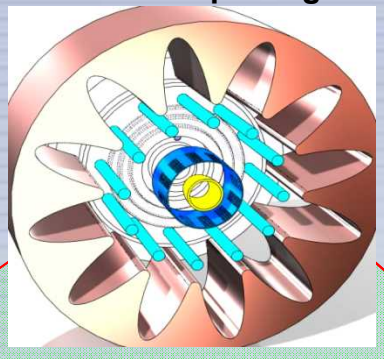
mm^2 package

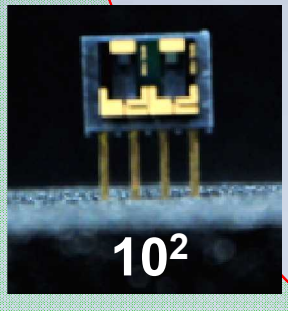
Surface mounted topology open the door for a series of developments and applications, from a low dose body-implantable devices, for neutron capture cancer therapy, to a well logging high output and rugged device.

$>10^{12}$

neutrons/pulse

mm^2 to m^2 package

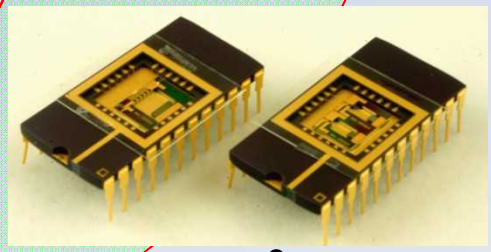




10^2

neutrons/pulse

μm^2 package



10^9

neutrons/pulse

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Project Results

- Demonstrated neutron production using a mm printed circuit flat design
- Demonstrated production of neutron using micro-engineered surface deposited sources in the µm size
- Demonstrate computer chip size neutron sources

Future

- A patent application has been filed to use a low yield design for Cancer "Neutron Capture Therapy"
  - The device allows a patient to carry a battery powered neutron source and receive a low rate long term treatment at home.
- A patent is in process to use a high yield design version to activate short half-life elements (such as Cs-132) to replace their long half-life active sisters.
- Replacement of, specifically radioactive Americium-Beryllium (AmBe), and Plutonium-Beryllium (PuBe) sources often used in well logging devices.