Positron Source Prototyping

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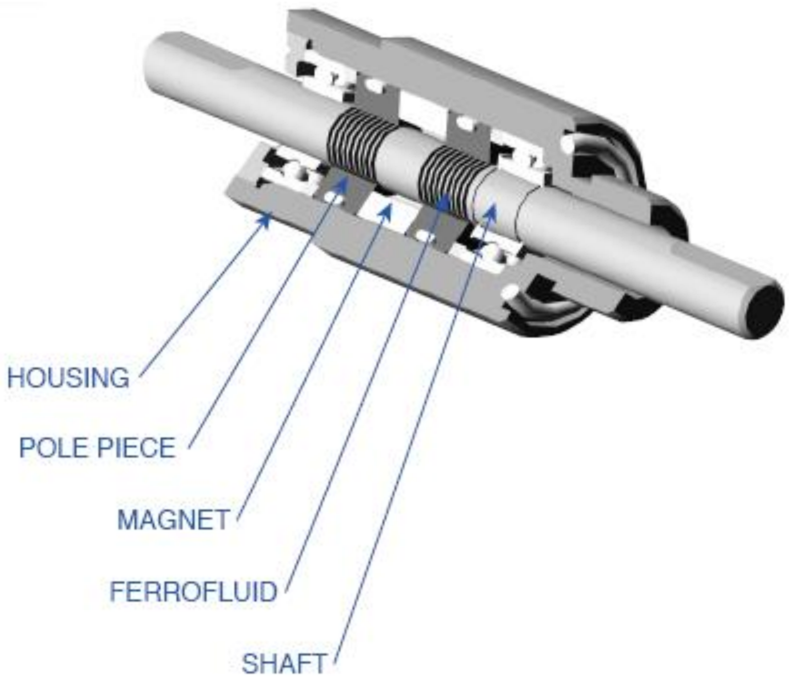
Risk Area – Ferromagnetic rotating vacuum seal

- **Target Feedthroughs**
  - **Target is in vacuum with no windows between the main accelerator and capture accelerator sections**
  - **Target motor and water coupling are in air. Target shaft must pass through a rotating seal into the vacuum**
  - **Propose: Ferromagnetic rotating seals**
  - **Concerns:**
    - **Vacuum quality**
      - **Can we achieve pressure spec**
      - **Will ferromagnetic fluid contaminate the space**
    - **Interaction with capture magnet**
    - **Radiation Hardness**

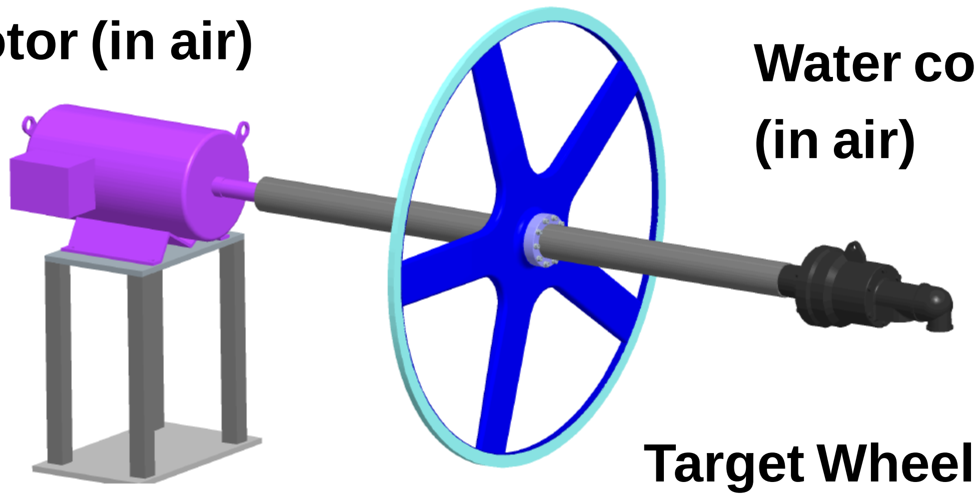
Ferrofluidic seals promise what we need

Temperature range (Uncooled)	20-210°F/-6-100°C*1
Vacuum pressure	10^{-9} mbar*2
Leakage rate (mbar l/s)	10^{-11} mbar l/s*3
Gas compatibility	inert gas*4
Housing material	300 series SS*5
Shaft material	400 series SS*6 or 17-4 PH*7
Maximum shaft run-out	0.003"/0.076 mm

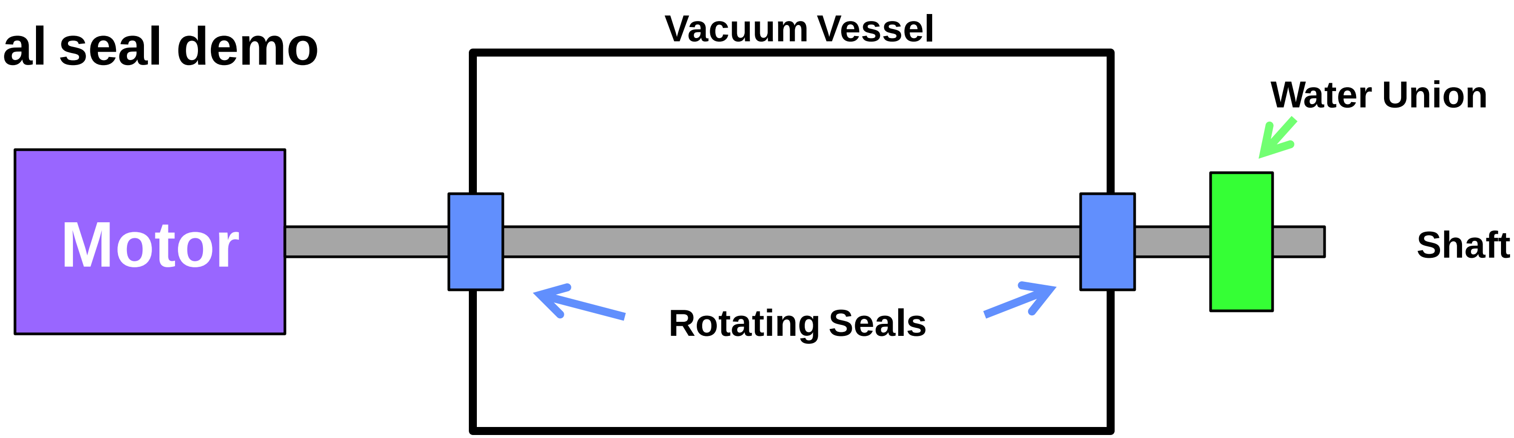
- **Vendors exist who have devices that match our needs**
- **No spec for interaction with external magnetic fields**
- **Choice of ferrofluid must be rad hard for our application**



Wheel-less mockup of rotating shaft and seals



Minimal seal demo



Tests

- Normal operation for an extended period
  - Measure achieved vacuum
  - Look for water leaks
  - Look for contamination of inner surface of vacuum vessel

- Destructive test of ferrofluidic seal and external magnet
  - Measure vacuum under external magnetic field
  - Look for contamination
  - Ramp up magnetic field until seal fails

- Radiation Hardness
  - Replace seal
  - Operate in high radiation environment
  - Look for degradation of ferrofluid, outgassing or contamination
  - 1 ILC/year dose in design environment
  - Look for partner lab with active beam dump?

Risk Area – Pulsed Flux Concentrator

- **Design based on Brechna Magnet**
  - **— Pulsed flux concentrator**
  - **— Cryogenic for long flat top and reduced energy consumption**

- **Concerns:**
  - **— Can it be cooled.**
  - **— Will it survive the stresses when the pulser fires.**
  - **— Will 5hz operation lead to fatigue and failure.**

Parameter	Brechna	ILC	Units
Field Strength	10	4	T
Pulse Length	40	1	ms
Repetition Rate	1/3	5	Hz

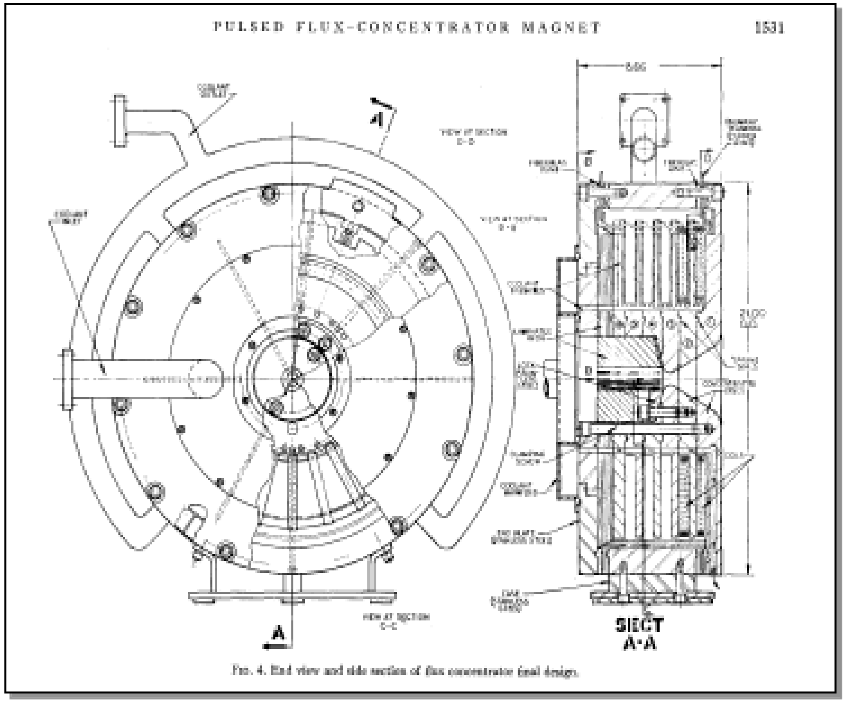


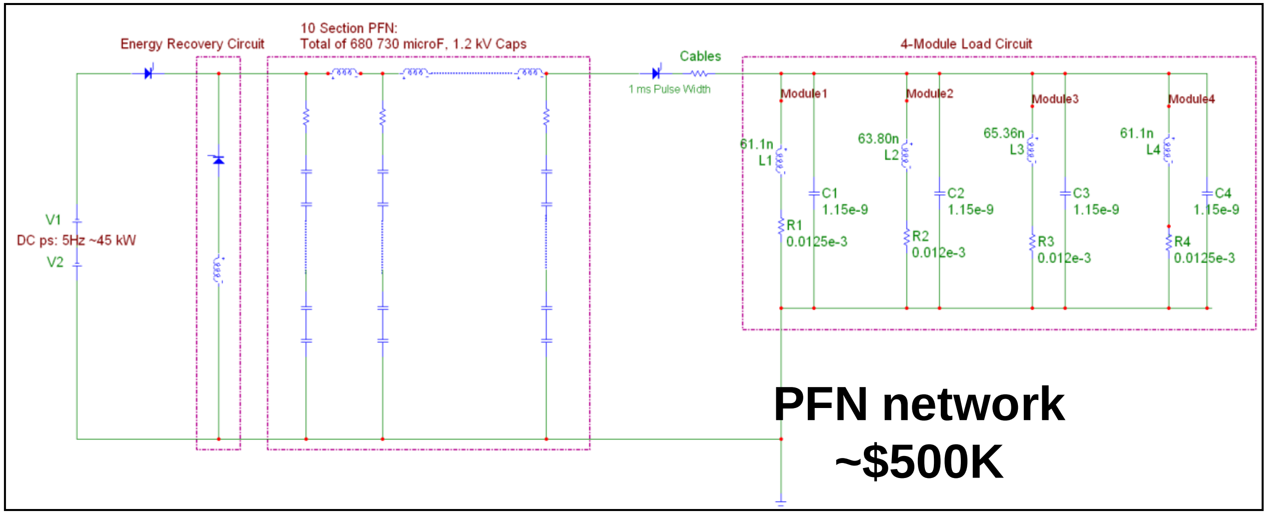
FIG. 4. End view and side section of flux concentrator final design.

Full prototype cost is large compared to R&D budget

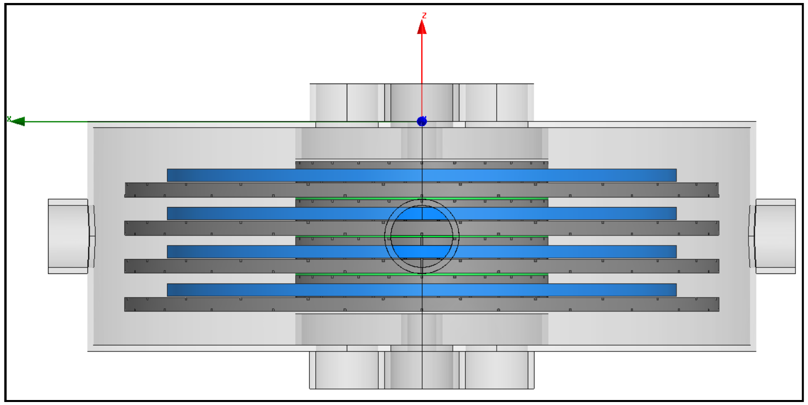
Cryocooler

~$1M capital cost

~$330K/year electrical

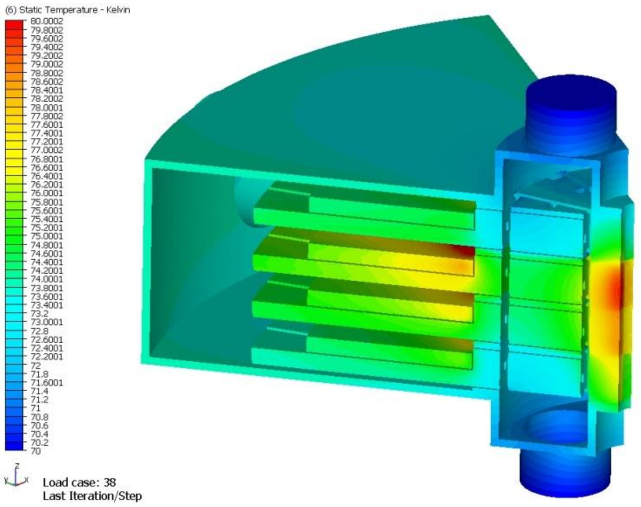


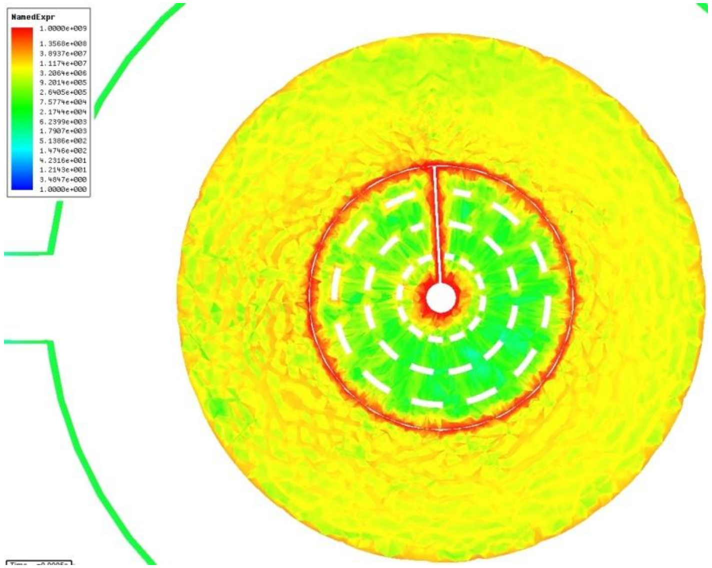
Magnet Fabrication

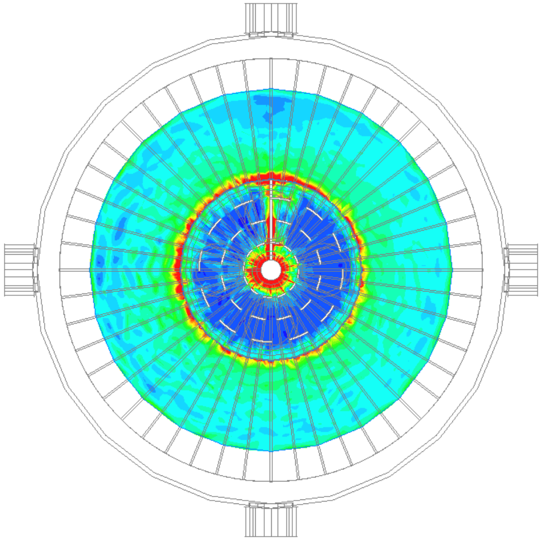


What we want to test

- Cooling
  - — Do we avoid boiling
- Repetitive Stress
  - — Do we stay within elastic limits
- Dynamic forces
  - — Does it shake itself apart







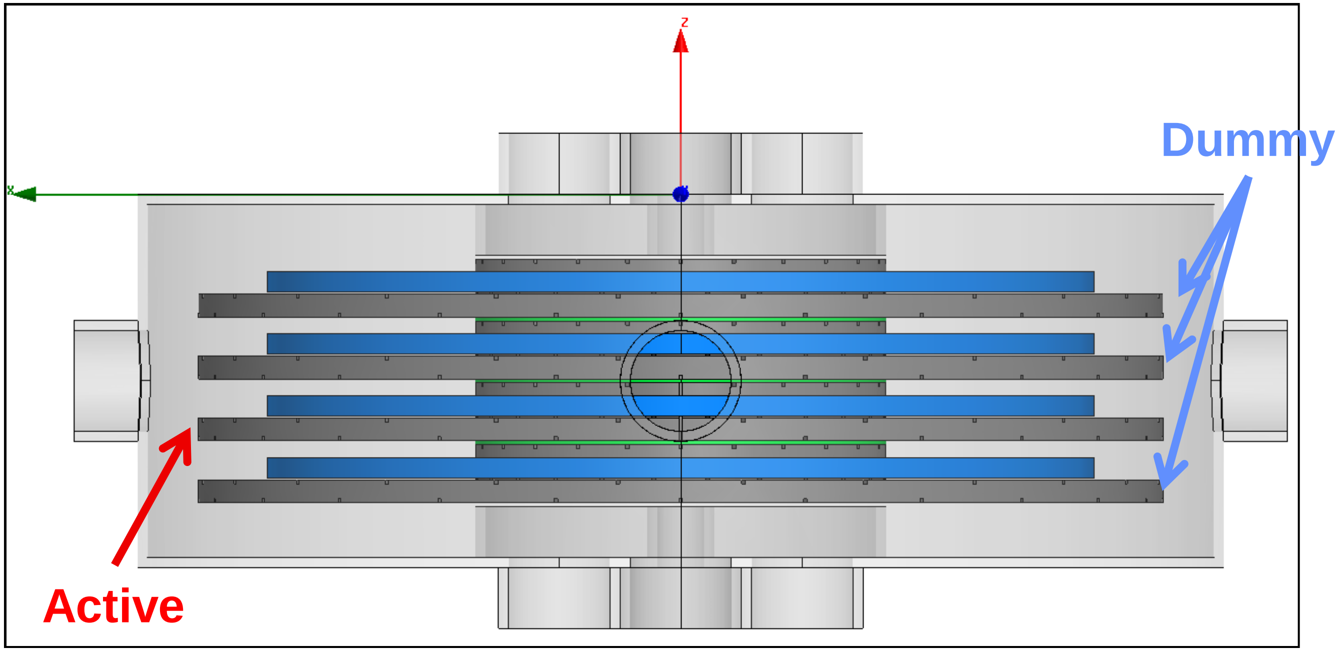
Reduce cost by going to a single disk

Build prototype with four coil/plate stacks but only connect one to the power supply

Reduce power required to ¼

Reduce cooling required to ¼

Cost ¼ of full prototype



- Single plate sees same heating, cooling and stresses as full prototype except for intra-plate forces

- Greatly reduced cost with useful test of the survivability of device

Reduce cost by leveraging existing facilities

- **Can we use a dewar of liquid nitrogen to replace cryocooler?**
  - **No. Input fluid must be below the boiling point to prevent vaporisation at the stack. Requires active cooling.**

- **Can we find a partner lab with an existing cryocooler that can be used?**
  - **Perhaps. We haven't started looking yet.**

- **Can we use an existing pulser to fire the magnet at 5Hz?**
  - **Not the full device but the Marx modulator might be able to run the reduced single stack device. Need to investigate.**

Strawman prototyping & test schedule

	FY10	FY11	FY12
Rotating seals	Construct Test Setup Test out-gassing under normal operation Destructive test using external magnet	Replace seals Operate in radiation environment	
Flux Concentrator	Finish parametric studies Engineering design	Construct single coil prototype with cooling and power supply Operation at 5Hz	Operation at 5Hz Disassembly and diagnostics