Beam Energy Absorber and Converter with Moving Core

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  - Properties of High Power and High Energy Beam Interaction with Absorbers / Targets / Beam Dumps
  - Need in Spreading Energy Deposition
  - Prior Art: Beam Rastering, Liquid / Moving Targets
- Proposed New Solution: Moving Core Energy Absorber
  - Laser Beams
  - Accelerators
  - ADS applications using Moving Targets and Cores
- Conclusions

Continuous Electron Beam Accelerator Facility

- Powerful electron beam
  - Beam energy up to 6 GeV
  - Power up to 800 kW to a Hall
  - Beam transverse size as small as 50x50 micron
  - Huge power density
- Beam line protection
- Fixed experimental targets
- Beam dumps

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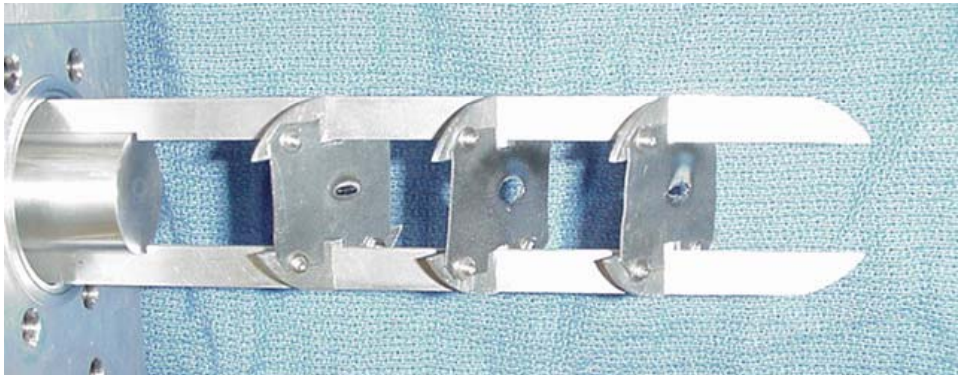
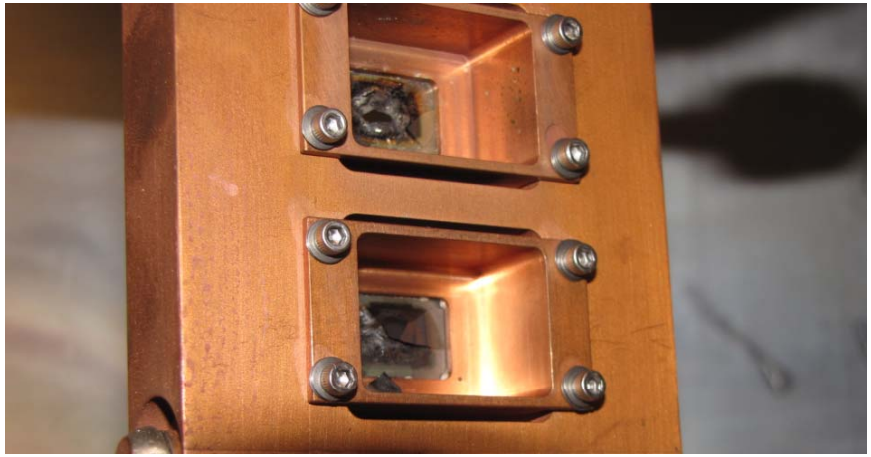
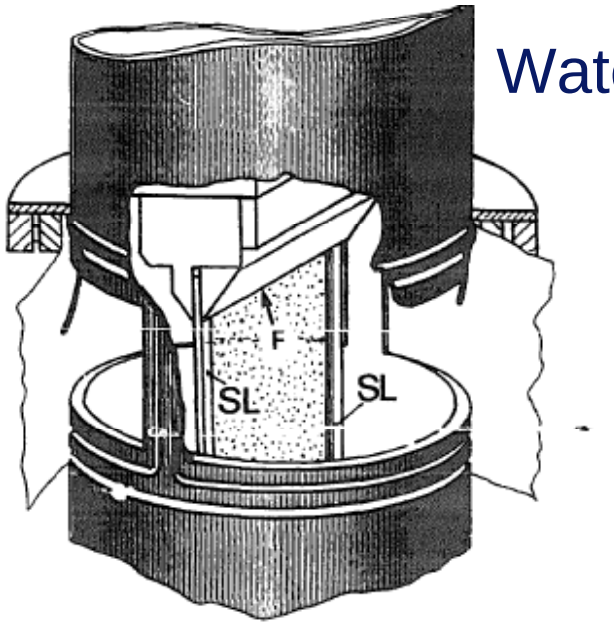
Effects of Localized Beam Losses



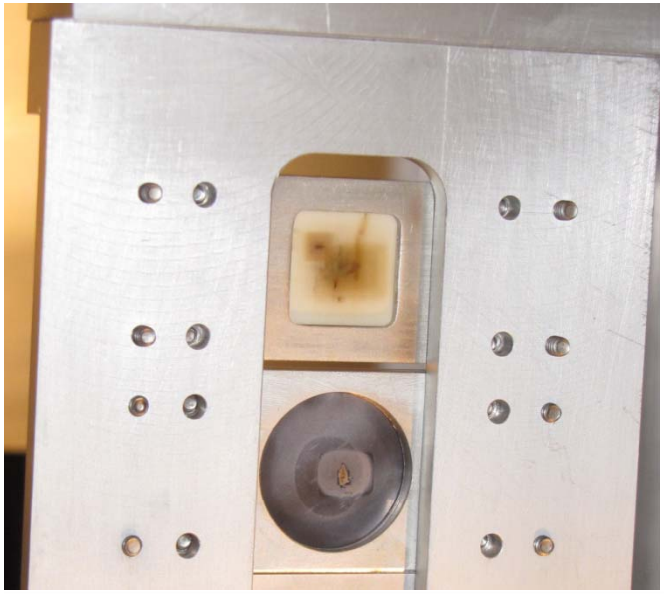


Spread in Energy Deposition

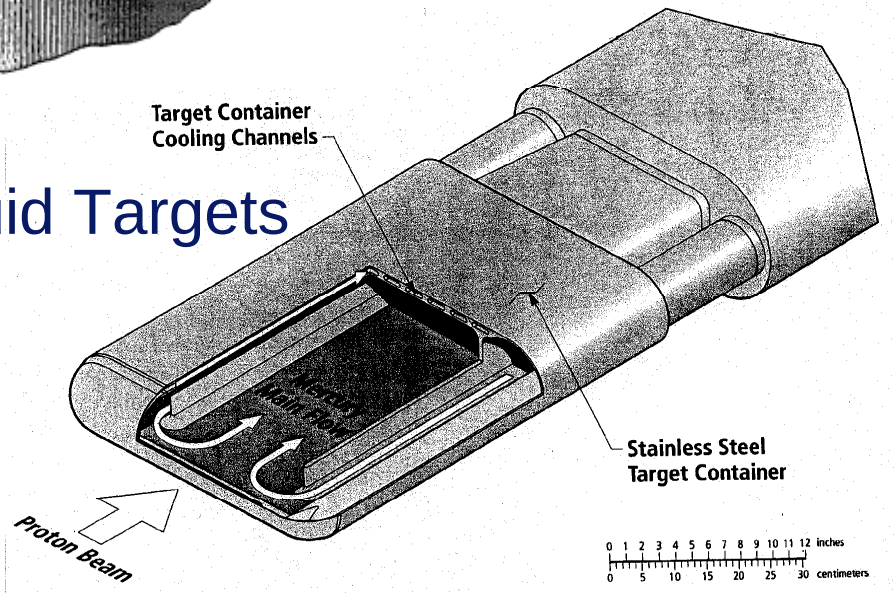
Waterfall Targets



Beam Rastering



Liquid Targets



High Power Energy Absorbers: Prior Art

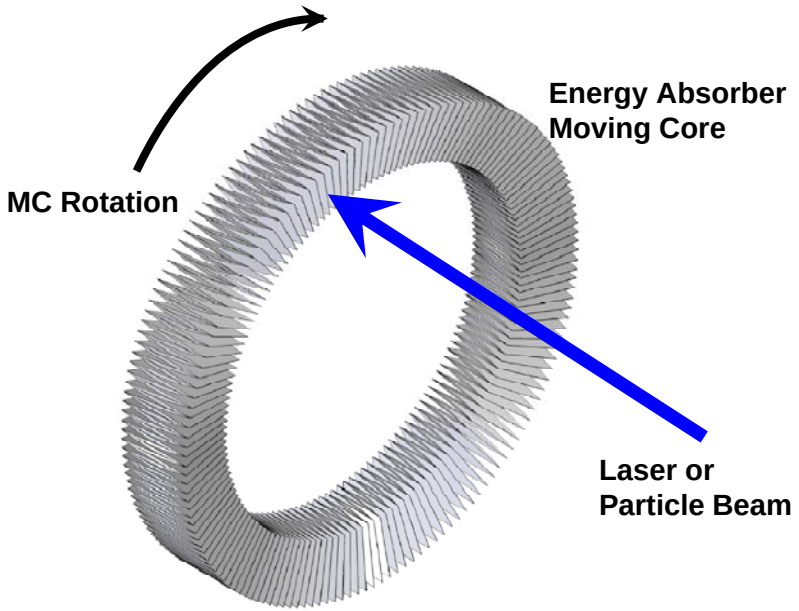
- Solid stationary target options
  - Solid target elements with coolant flow between them
- Liquid target options
  - Liquid material acts both as the target and the coolant

- Limitations:
  - The need in rastering to spread the heat loads on the stationary elements
  - Local material burnout
  - Radioactivity of the coolant as it absorbes a significant portion of the beam energy

Moving Core Energy Absorber

- Another way to spread energy deposition: **Move the Target**
- Advantages:
  - Possibility of limited or no rastering
  - Achieving higher power density in the beam

- Subject of the JLab Invention Disclosure submitted in 2008
- US Patent application filed in 2010 by Jefferson Lab

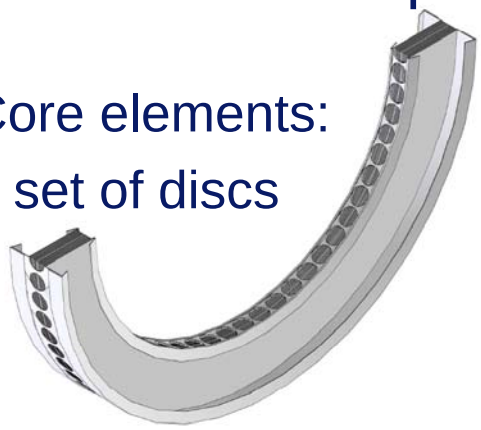


Moving Core Energy Absorber

- Variety of applications
  - Small-to-medium size Moving Cores, suitable for low energy particle beam dumps and targets (MeV beams)
  - Larger design, suitable for spallation targets (GeV)
- Option of coolant flowing through the moving elements would allow absorption of higher beam power

Core elements:

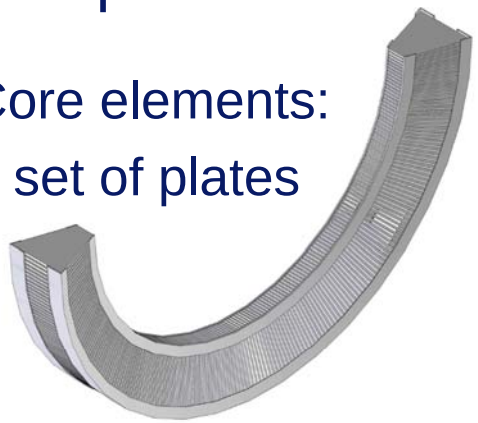
a set of discs



May be used as a target with constant thickness, or a full absorber at low energies

Core elements:

a set of plates



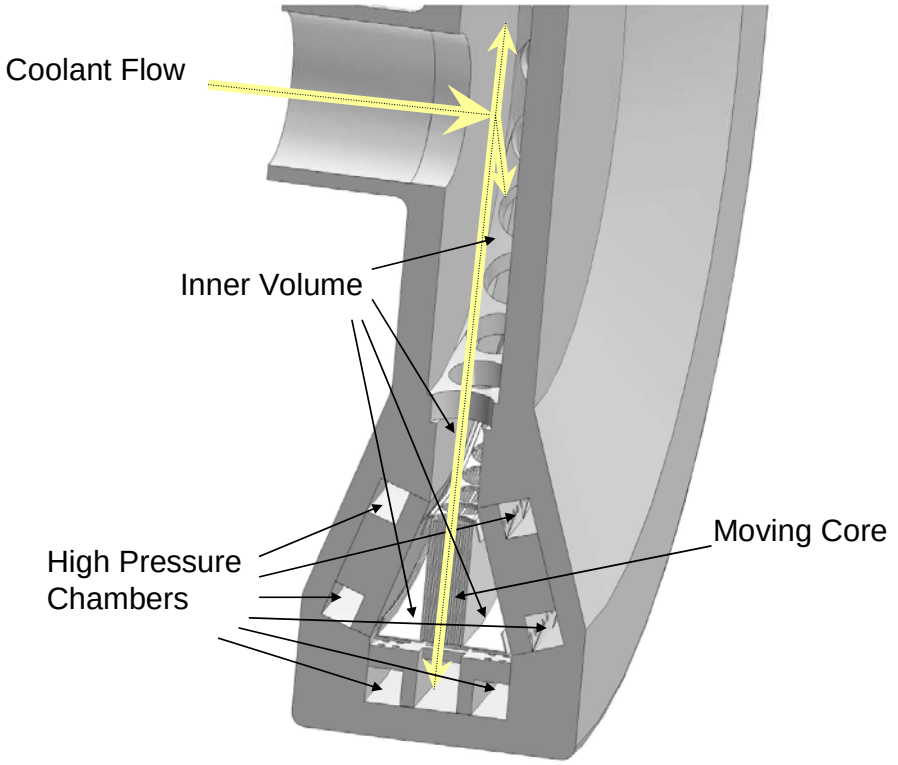
May be used as a full absorber, if the beam is directed at an angle, - or as a beam intensity modulator

Moving the Moving Core

- MC mounting, suspension and movement in the coolant flow can be implemented by standard means of rotors, shafts, bearings, magnetic elements, etc.
- In addition, the present Invention proposes to use Air Bearings, or “Air Hockey”-type methods of suspension and movement of the MC in the coolant flow

Air Bearing Designs

- As in the Air Hockey table design, the High Pressure chamber is connected to the Inner Volume through a multitude of blow holes through which the coolant streams into IV. The MC glides along the surfaces with the blow holes just like an Air Hockey puck
- Coolant pressure in the IV is much smaller, and coolant inlets and outlets provide the coolant flow



Air Bearing Industry

- Air Bearing Industry is well developed, widely used in Precision Manufacturing, Medical Imaging, Optics, etc.

http://www.newwayairbearings.com/

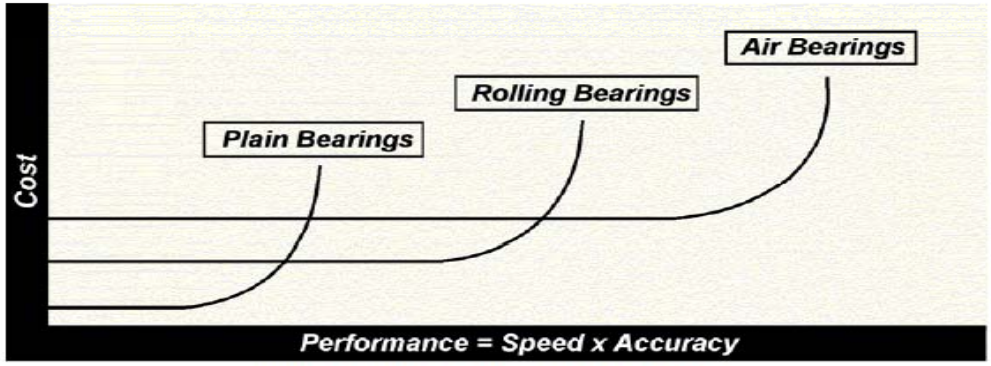
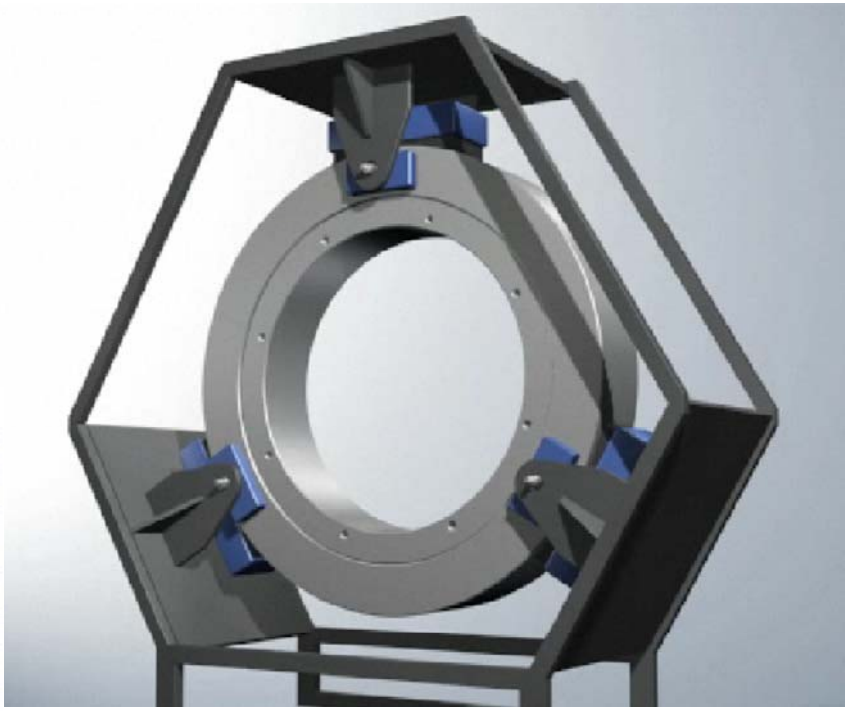
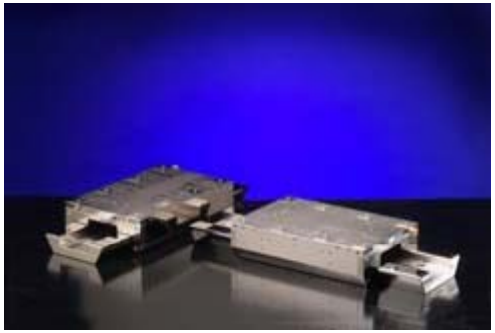
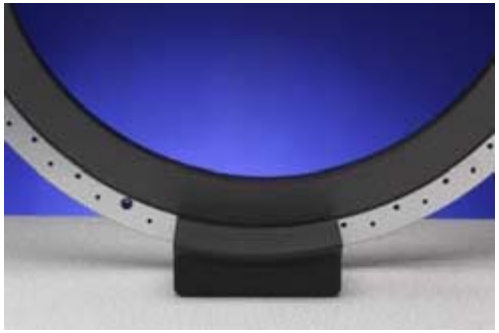


Figure 1 - Bearing Performance vs. Cost





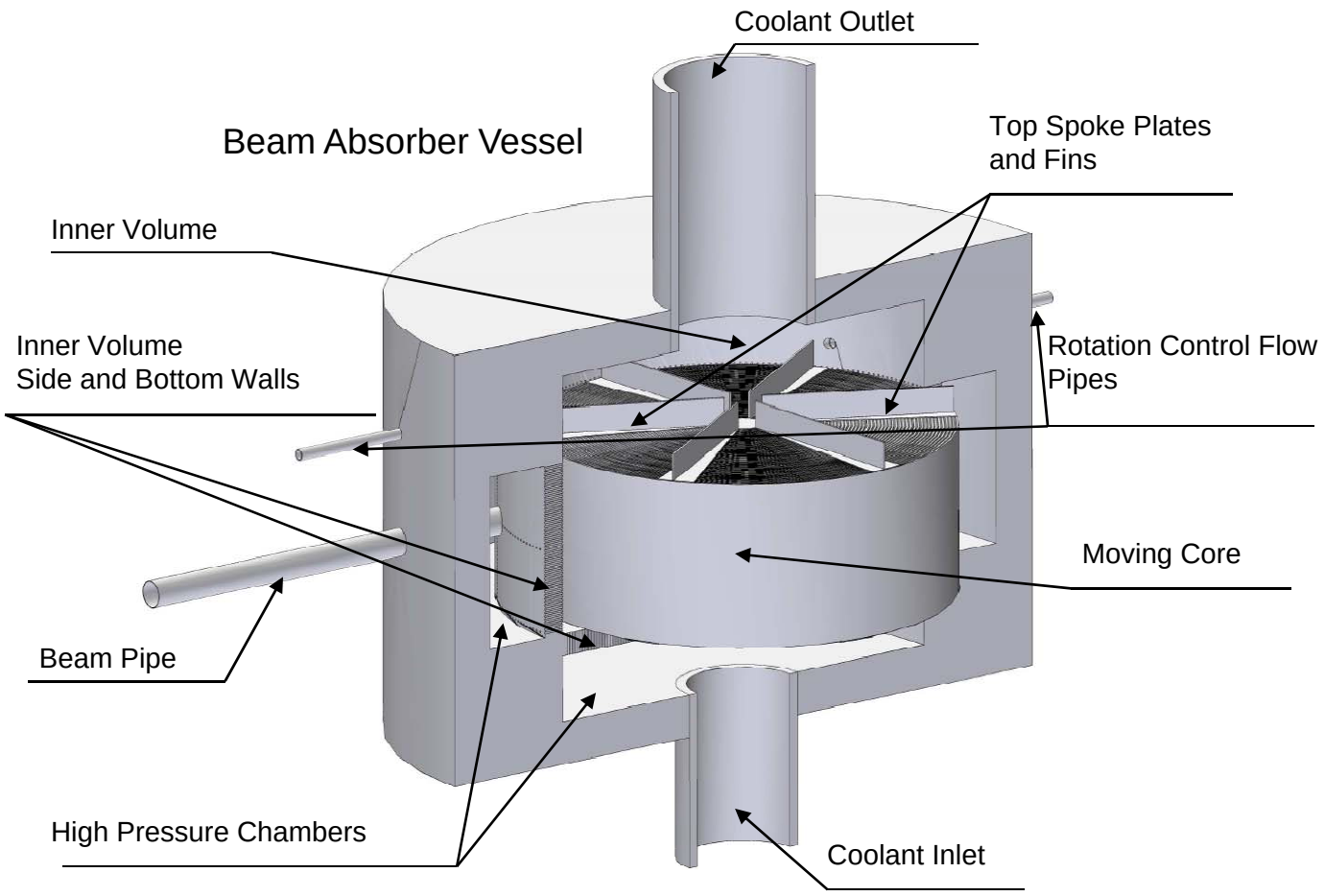


High Power MC Absorber Applications

- Using Moving Core seems to be the practical solution for high power accelerator beam dumps, and also targets:
  - for high power neutron generators (MeV energy range)
  - for spallation neutron sources (GeV energy range)
- Air Bearings, or “Air Hockey”-type solutions for the Moving Core are quite suitable in all such applications, even for high energy absorbers, which should be massive
  - No problem of carrying heavy loads (think autos…)
  - No friction or vibration, extremely good motion stability and precision, reliability, and mechanical longevity
  - Options for the choice of coolant: gas or liquid

High Power Energy Absorber

High power accelerator beam absorber with Moving Core



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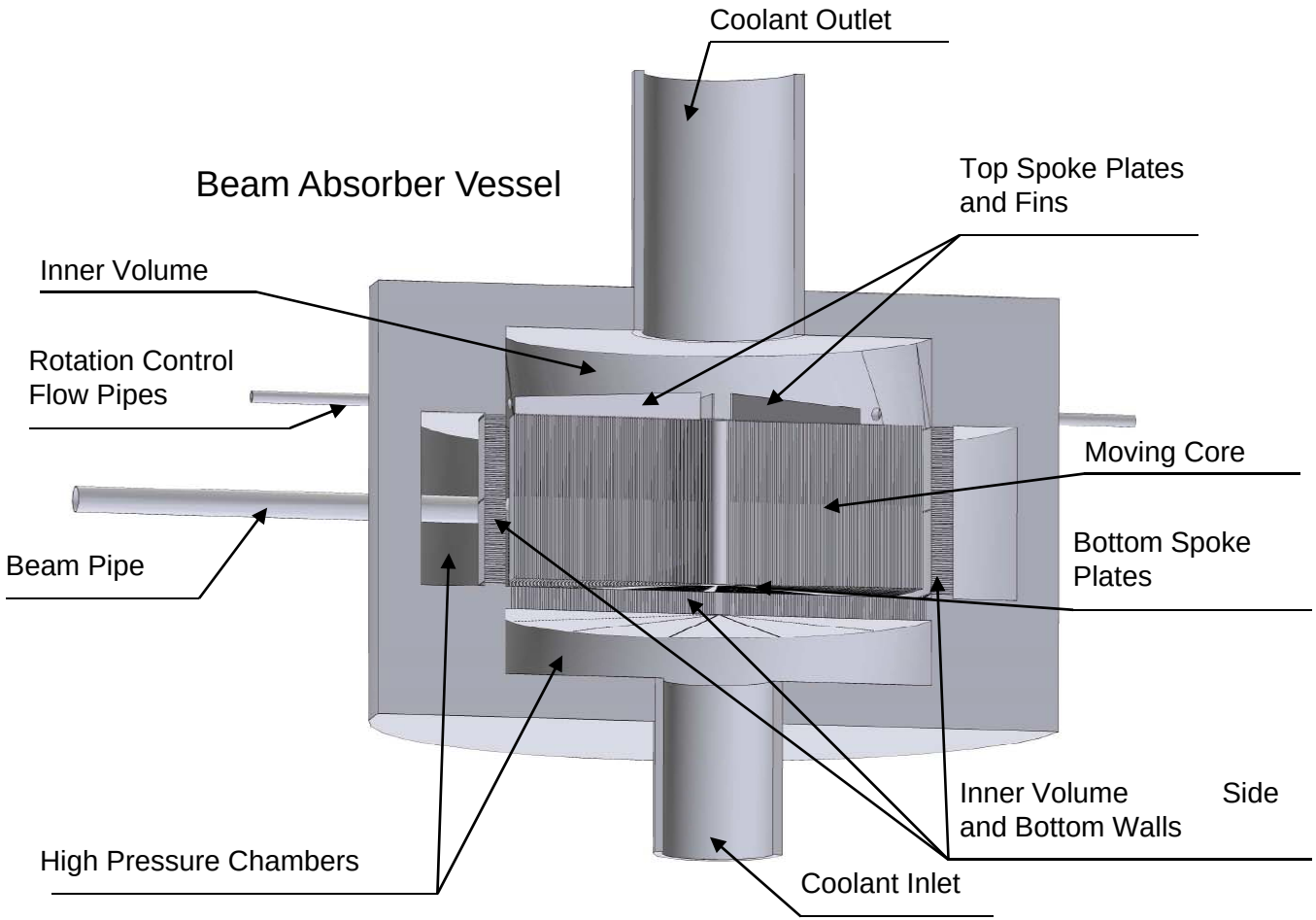
High Power Energy Absorber

High power accelerator beam absorber with Moving Core



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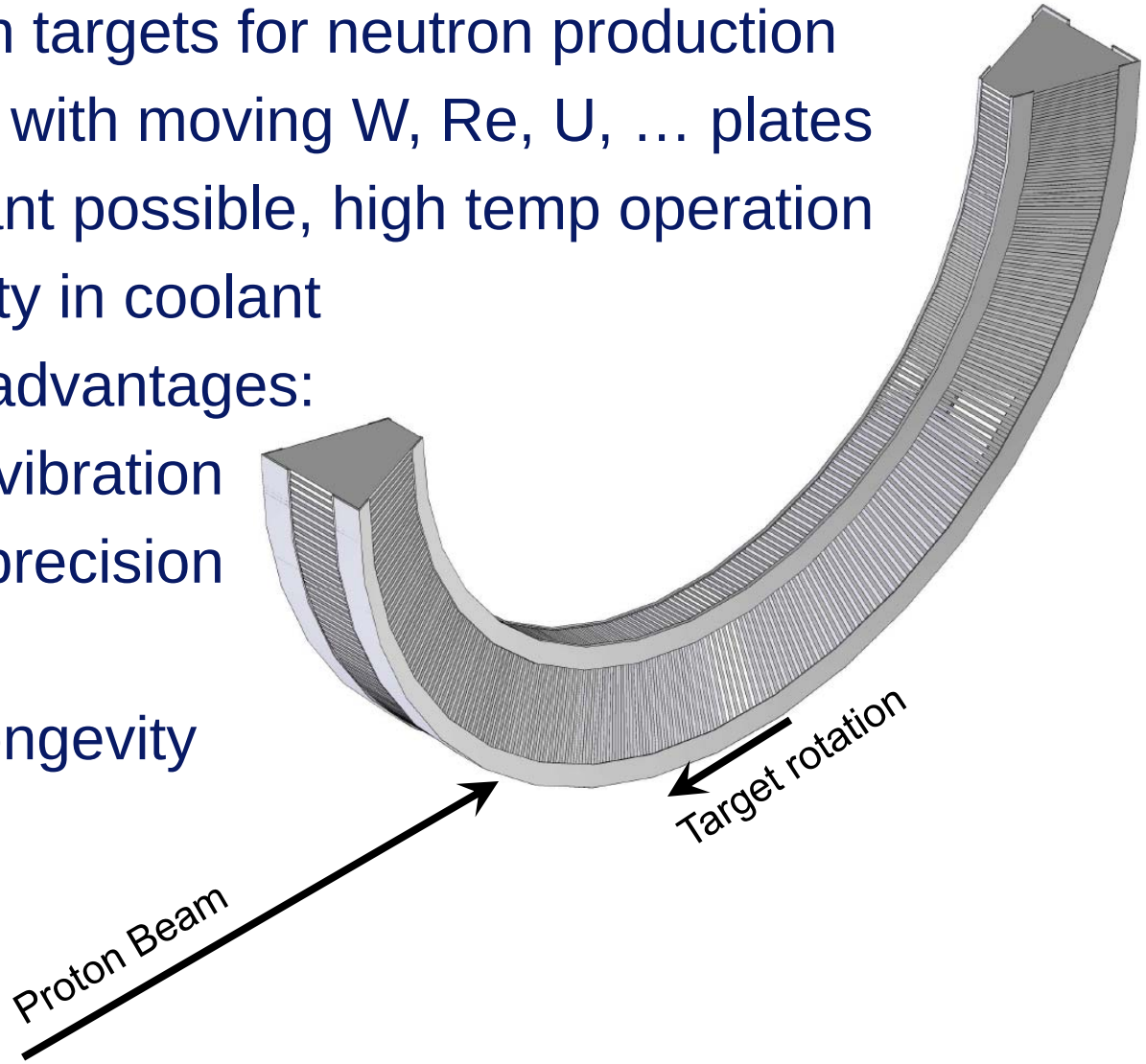
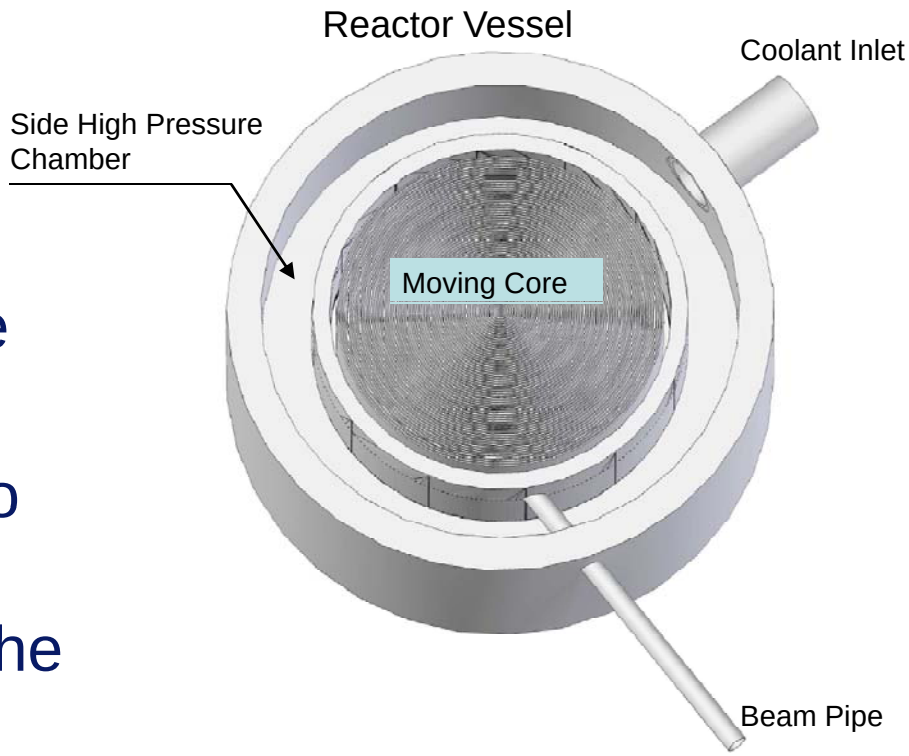
ADS Applications: Moving Targets!

- Spallation, or fission targets for neutron production
  - Replace Hg flow with moving W, Re, U, … plates
  - Use of gas coolant possible, high temp operation
  - Small radioactivity in coolant
  - All air bearings' advantages:
    - No friction or vibration
    - Stability and precision
    - Reliability
    - Mechanical longevity



ADS Applications: Moving Cores?

- Possibility to make the core itself moving, floating in the coolant without much friction
- Firm, temperature resistant structure filled with suitable fissionable materials, with the pathways for the coolant
- Design for the proton beam to generate enough neutrons to sustain power generation in the core
- Feasibility not tested

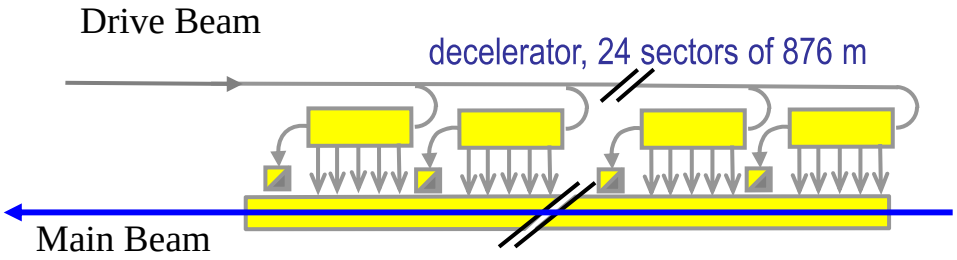


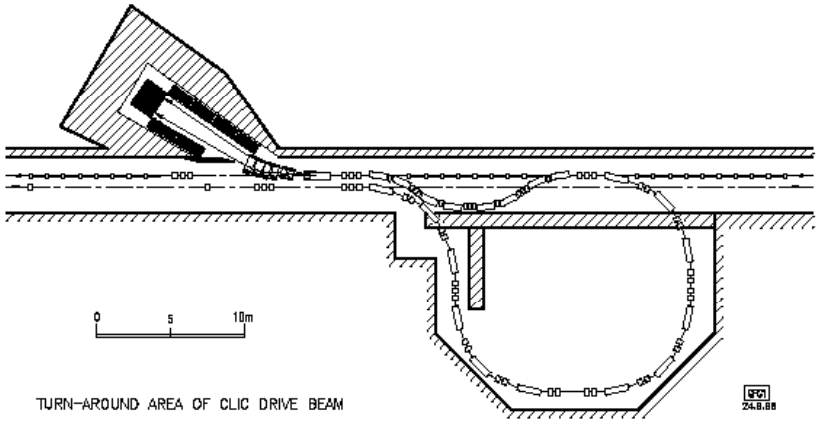
Conclusions

- Moving Core Beam Energy Absorber and Converter solution is proposed for the prevention of overheating of laser or particle beam impact zones
- The solution may be applied to the designs of moving targets, beam dumps, energy generators in laser and accelerator beam systems, including ADS
- Advantages of using the MC designs with Air Bearing type suspensions include compact design, higher limits on maximum absorbed beam power, use of lower density (thus less activated) coolant, more uniform irradiation of the materials
- Jefferson Lab filed the US Patent application in 2010 – contact JLab Technology Transfer Office at http://www.jlab.org/exp_prog/techtransfer/

CLIC Applications: Self Powered?

The CLIC Two Beam scheme





- Drive beam generates RF power for the Main Collider beams
- Need to dump 1-2 MW of electron beam power in each of about 40-50 Drive beam dumps
- Using the Moving Core solutions, could they generate power there?