The Cockcroft Institute
of Accelerator Science and Technology

Current Target Actions

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30/10/08

Target Actions from Zeuthen Meeting

- Complete Eddy current tests at Daresbury – Ian/Leo Nov 08 (store properly afterwards!) Tests starting now. See Leo's talk.
- Generate simulations to compare with experimental results – Jeff / RAL? Nov 08 Simulations started at both LLNL (C. Brown) and RAL (J. Rochford).
- Pressure shock wave analysis – Stefan (next meeting) and numerical modelling – Tom (later) See Stefan's talk..
- Guarding thickness verification – Tom (now) ?.
- Ensure consistency between ANL/DESY simulations – Wei/Andriy (next meeting) Talks by Wei and Andriy yesterday. More discussion needed on future direction.
  - Energy compression before DR
- Lifetime studies of target (LLNL)
- Engineered solution, including prototype tests – water, vacuum, …
- Alternative liquid metal (BINP/KEK tests) – Junji
- Where are ferrofluidic seals used – Ian (next meeting) Next slide…

Ferrofluidic Seals

- Interested in seal characteristics in
  - Radiation environment (See studies by Luis Fernandez-Hernando, CI)
  - External B field (Likely to be negligible)
- Documented uses in ‘similar’ contemporary projects
  - ITER - roughing pumps
  - RIA - rotating beam dump

Nick Balshaw, UKAEA, Culham, (March 2007)

ITER
The Way to Fusion Energy

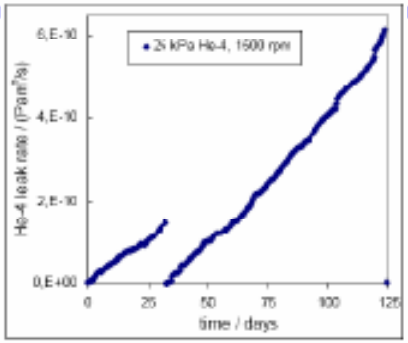
Ferro-fluidic seal tests by EUPT (FzK)

Tests with 250m³/h pump

Ferro-fluidic rotating shaft seal tests

Ferro-fluidic seals unit tested in rotating rig at FZK

- Helium leak tests of 125 days with seal rotating
- Leak rate in the range 10^{-10}Pa.m³/s resulted
- Indication that perhaps leak rate increases with rpm (laminar-turbulent transition ?)
- On leak rate basis, meets ITER requirements



- 250m³/h Roots pump procured from Roots Systems Ltd, fitted with ferro-fluidic seals and magnetic drive
- All stainless steel wetted parts with leak tight casing
- Test continuing at FZK

This company has supplied 3000 m³/h Roots pumps for a neutron spallation source of a similar quality as required for ITER

- Ferro-fluidic seals look very promising for ITER forepumps

shaw, UKAEA

Ferrofluidic Seals at RIA

- S. Reyes et al, “Neutronics and radiation field studies for the RIA fragmentation target area”, NIM

Simulations carried out at LLNL

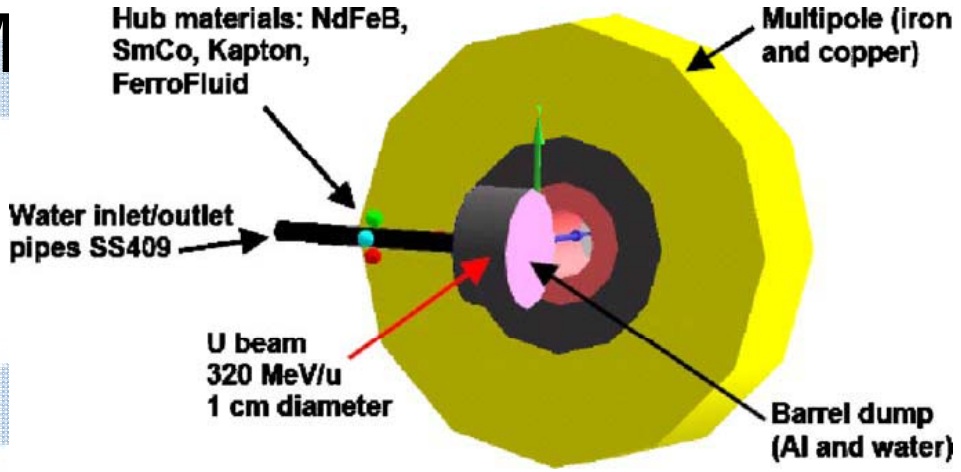


Table 1
Prompt dose and DPA rates to rotating seal materials

Material	Density (g/cm^3)	Dose (MGy/yr)	Limit (MGy)	DPA/yr
NdFeB	6	0.29	0.1	4.5E – 06
SmCo	8.82	0.15	100	5.9E – 06
Kapton	1.42	0.74	10	7.6E – 07
Pseudo-FerroFluid	1.42	1.08	>1?	7.1E – 07

Irradiation of Ferrofluids

- P. Kopcansky, et al, “The Effect of Gamma-Radiation on the Magnetization of the Kerosene Based Ferrofluid”, Radiat. Phys. Chem. Vol 34, 817 (1989).

Table 1. The parameters of unirradiated and irradiated samples of ferrofluid, χ_i—initial susceptibility, I_S—the saturation magnetization, n_0—number of particles in unit volume, D_V—the median diameter, σ—the standard deviation

Dose (Gy)	χ_i/μ_0	I_S (mT)	n_0 (10^{22}m^{-3})	D_V (nm)	σ
0	0.745	6.51	1.89	12	0.336
4.5	0.65	6.15	1.71	12	0.305
17.3	0.45	4.85	1.21	12	0.258

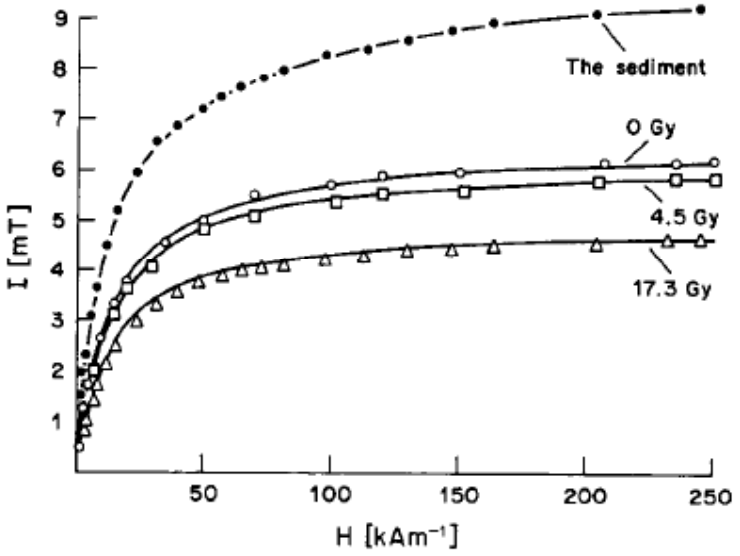


Fig. 1. The magnetization curves of kerosene based ferrofluid. (○) Unirradiated, (□) irradiated by dose 4.5 Gy, (△) irradiated by dose 17.3 Gy, (●) the sediment.

Summary

- ITER studies show vacuum characteristics at high angular velocity.
- Need to follow-up RIA studies