SE JRA High Pressure Task

MNI3 FP7 JRA SE Spring Meeting, Abingdon, UK

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30.04.2012

Inert Gas Cells

Tasks:

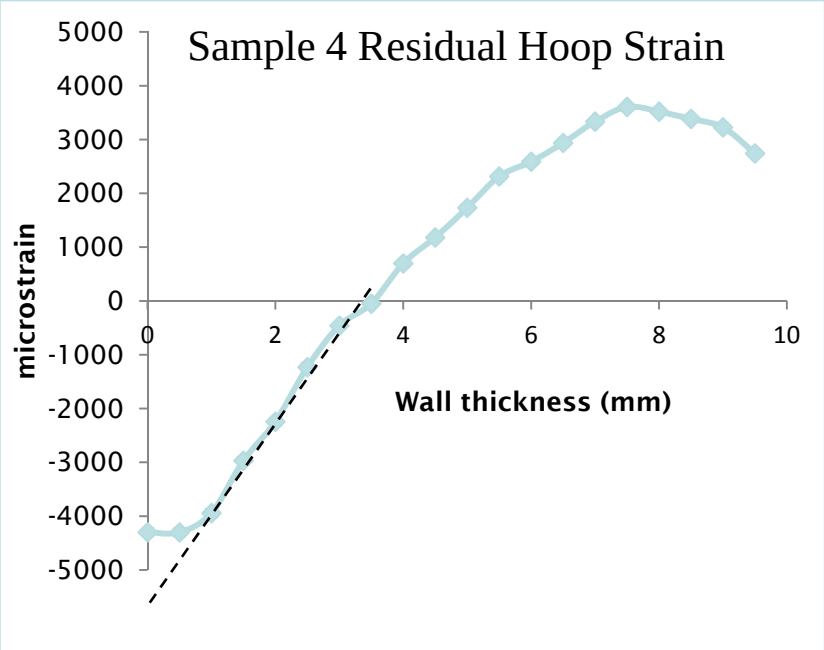
1. ***10 kbar*** *automated gas handling system for inert gases and* ***15 kbar*** *'oil' intensifier for hydraulic testing (ISIS, LLB)*

2. *Design and produce cells and test seal systems up to* ***8 kbar*** *(LT – 300 K) (LLB)*

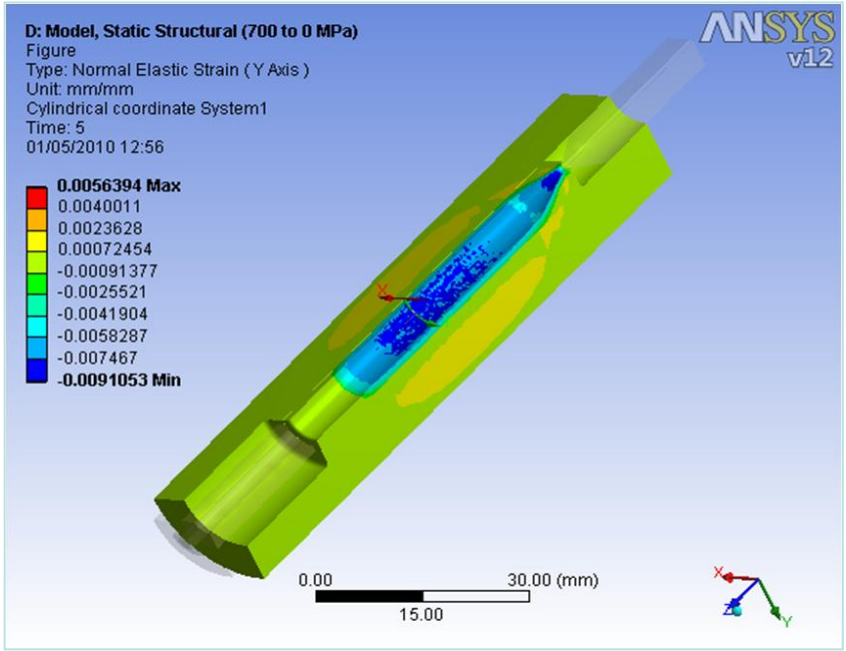
3. *Design and prototype* ***10 kbar*** *cells for 300 K (LLB)*

R. Done, O. Kirichek, B. E. Evans, Z. A. Bowden
High pressure gas vessels for neutron scattering experiments
NMI6, FP7, JRA: Report on current inert gas pressure cell technology
2010 *arXiv* 1007.3135

Developing a prototype of 8 kbar inert gas cell.



(a) Experiment results (**ENGIN_X**)



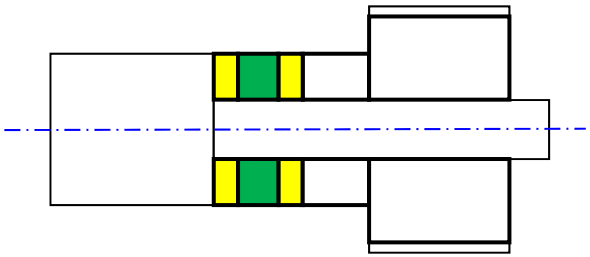
(b) The FEA model

Experiment results and FEA model for sample 4 (**700MPa** autofrettage pressure)

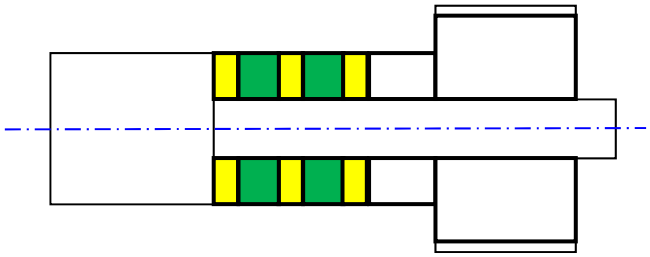
Paper submitted to ***High Pressure Research*** *(2012):*
Y. Ma *et al* A non-destructive experimental investigation of elastic plastic interfaces of autofrettaged thick-walled cylindrical aluminium high pressure vessels

JRA seal options

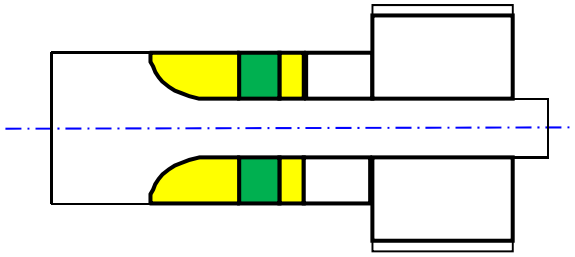
Standard Bridgman seal



Double Bridgman seal



LLB version



Seal test vessel

Aluminium/copper seal combination (left);
Lead/copper seal combination (right).

JRA Bridgman seal test results

Seal Configuration	Room Temp Leak Tight at 2Kbar	Room Temp Leak Tight at 10Kbar	Liquid Nitrogen Leak Tight at 2Kbar	Liquid Nitrogen Leak Test at 10Kbar
Pb\Cu\Pb\Cu\Pb (Copper seals lead plated)	10 mins hold time ✓	3hrs hold time ✓	10mins RT hold time then immersed in N_2 10mins hold time ✓	Pressurised to 10Kbar in N_2 3hrs hold time ✓
Al\Cu\Al\Cu\Al (Copper seals lead plated)	10 mins hold time ✓	Left over night hold time ✓	10mins RT hold time then immersed in N_2 10mins hold time (slight leak observed) ✓	Pressurised to 10Kbar in N_2 (leak sealed) 3hrs hold time ✓
Al\Cu\Al\Cu\Al (Copper seals *not* lead plated)	Seals struggled to seal but finally sealed at 2Kbar ✓	Seal remained leak tight until 7.6Kbar then failed and never resealed during attempt to obtain 10Kbar ✗	Test not performed ✗	Test not performed ✗

O Kirichek, R Done, C M Goodway, M G Kibble, B Evans, Z A Bowden
Development of high pressure gas cells at ISIS
Journal of Physics: Conference Series **340** (2012) 012008

Hydrogen Cells

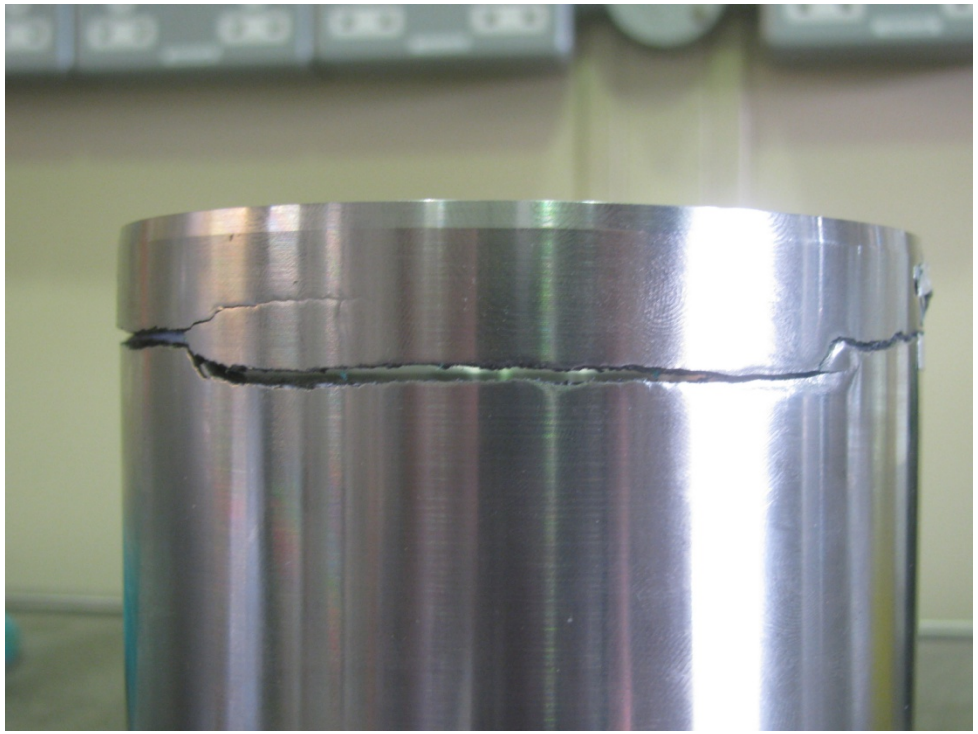
Tasks:

1. *Materials – H_2 compatibility/neutron transmission properties (ISIS, LLB and HZB)*
2. *Sourcing, assembly and commissioning of **8 kbar** and **10 kbar** H_2 intensifiers and gas handling system (HZB, ISIS)*
3. *Produce and test cell for **4 kbar** up to **700 K** and for **6 kbar** up to **300 K** (ISIS, LLB)*
4. *Design and prototype **8 kbar** cells for **LT – 300 K** (ISIS, LLB)*

Hydrogen compatible material tests

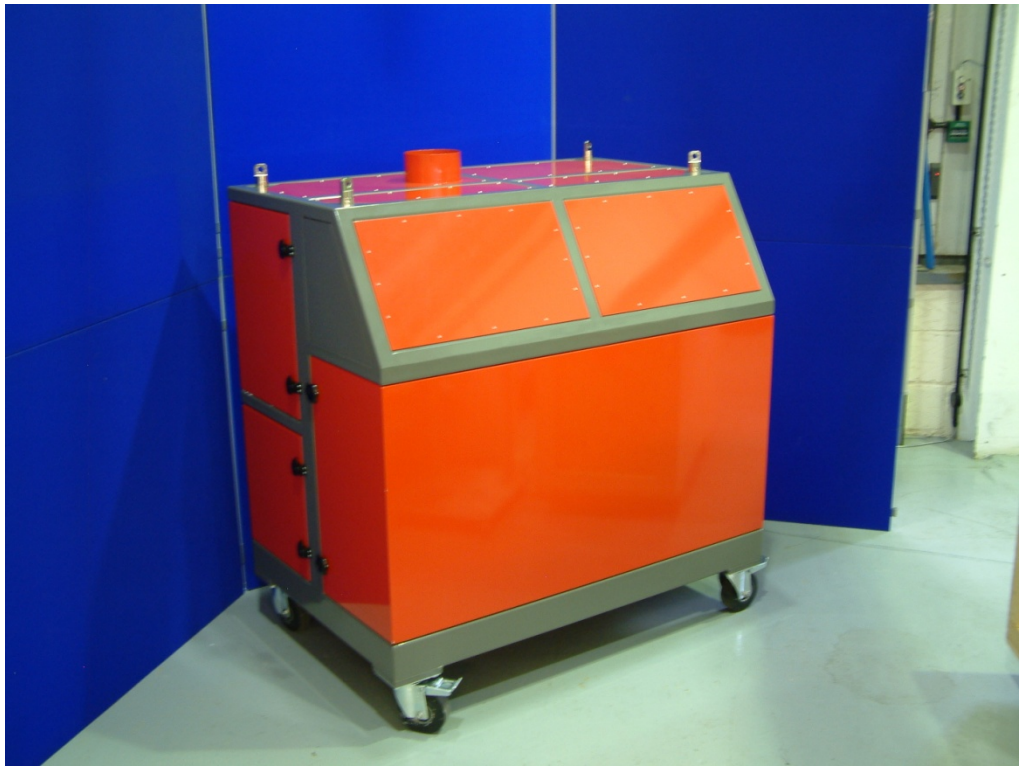
Joint project with Imperial College, the University of London

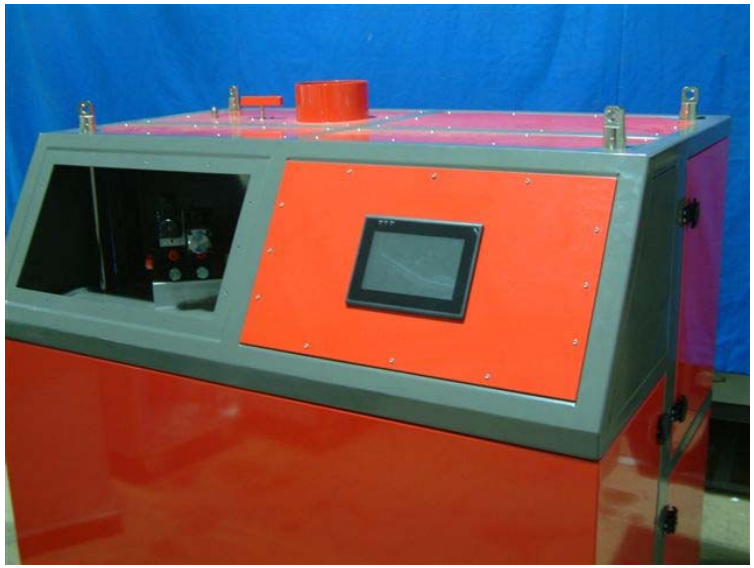
Hydrogen embritlement is a process where certain materials become brittle following exposure to hydrogen. High-strength steels, titanium alloys and aluminium alloys seem particularly vulnerable to this.



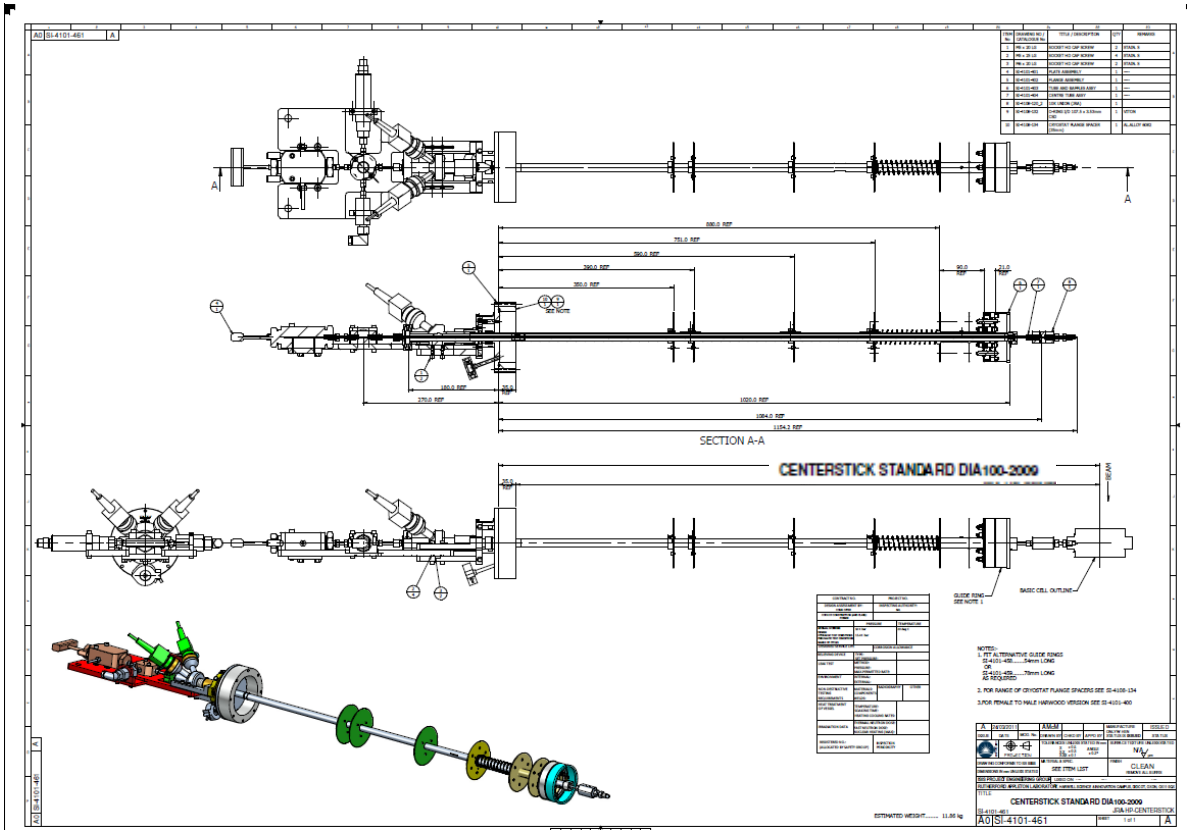
10Kbar Hydrogen Gas Handling System (Intensifier)

Due to financial restraints the 10 Kbar Hydrogen Intensifier is to be assembled and tested at ISIS by the Pressure & Furnace department. Components have been sourced and several of them purchased and the assembly is almost finished. Tests are scheduled for Summer 2012.

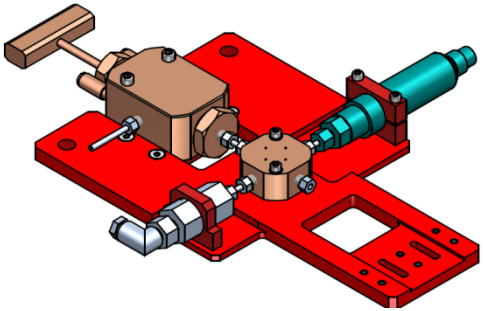


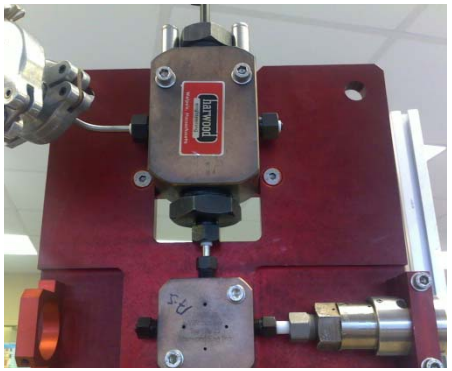


JRA 10Kbar Centre-Stick & H2 Valve



JRA 10Kbar Centre-Stick Drawing





Harwood C-4133 H2 10Kbar valve assembly on Centre-Stick

6kbar and **7kbar** Hydrogen gas cells for **LT – 300 K** have been designed and manufactured . Tests are planned for nearest future.