MICE Target – Design Update and Test Plans

Chris Booth

Sheffield

22nd October 2005

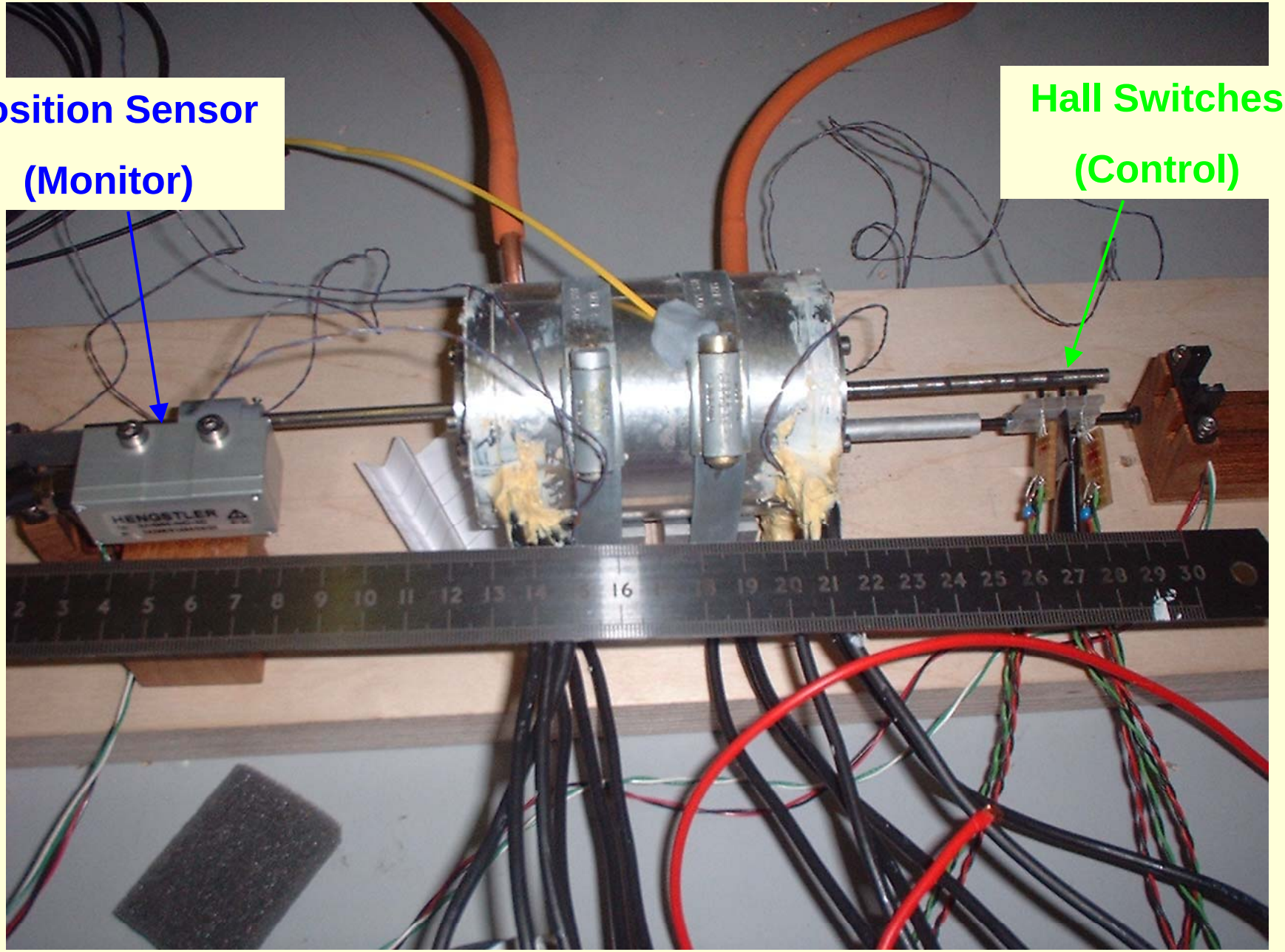
Outline

- Prototype and bench tests
- Changes to design
- Preparations for ISIS test, & test aims
- Outstanding issues

Progress since last meeting:

- Prototype completed and tested (partially) on bench
- Drive electronics developed (ongoing ……)
- Preliminary monitoring software developments
- Continued discussions with RAL & Oxford on vacuum and mechanical issues.
- Meeting with ISIS for December/January installation & tests
- Position readout developments
- Discussions with Daresbury representatives on control electronics.


4 15 16 17 18 19 20 21 22 23 24


Position Sensor
(Monitor)
Hall Switches
(Control)
HENGSTLER

Control Electronics for Bench Tests

- Commutation driven by control magnets and Hall switches.
- Force reversal provided by opto-switches.
- No single shot mode!
- Fixed current through cycle.
- Maximum drive current ~8 A. (Expect to need ~40 A.)
- Maximum operation time before cool-down ~30 s.

Final version will use high-resolution position-sensing to control phase and direction (and amplitude) of drive currents, started on external trigger.

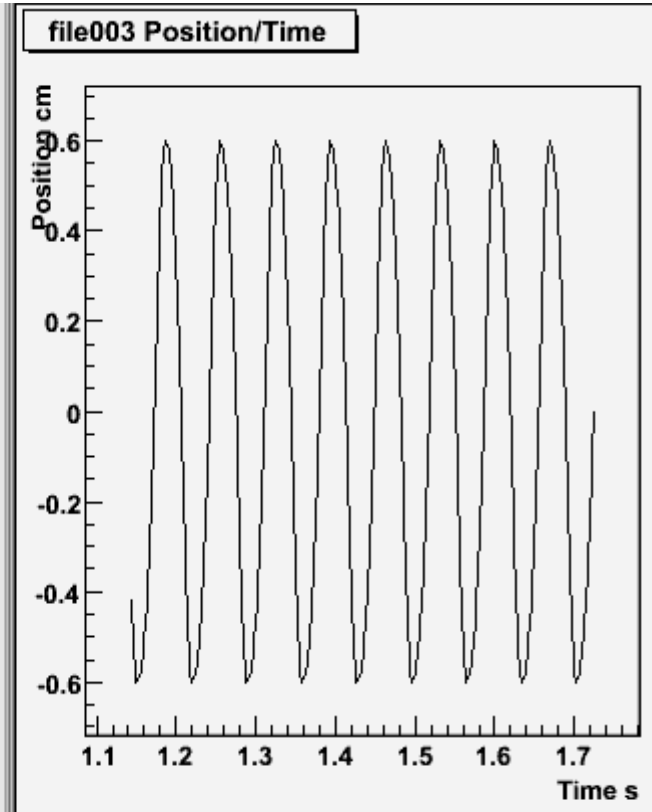
Monitoring Software

- On-line software developed by summer student.
- Offline version reads stored files.
- PC reads position sensor at > 40 kHz
- Plots of position, velocity or acceleration (Fourier filter)
- Monitor of reproducibility

Future version will analyse individual pulses, store parameters for MICE DAQ and offline checks.

Temperature measurement to be integrated.

```
Edit  View  Terminal  G
t button id 10 pressed
me/work/test1/runfile_1_8
o in <TCanvas::Print>: ps
t button id 11 pressed
e happliy/home/work/test1
o in <TCanvas::Print>: ps
t button id 9 pressed
me/work/test1/runfile_1_8
o in <TCanvas::Print>: ps
t button id 9 pressed
me/work/test1/runfile_1_8
o in <TCanvas::Print>: ps
t button id 11 pressed
e happliy/home/work/test1
o in <TCanvas::Print>: ps
t button id 12 pressed
 maximum velocity is 0.62
me/work/test1/runfile_1_8
o in <TCanvas::Print>: ps
t button id 13 pressed
me/work/test1/runfile_1_8
o in <TCanvas::Print>: ps
t button id 11 pressed
```



û
éÿ¿HX@

The Average Travel is 1.18
The Standard deviation is0
The Maximum travel is 1.18
The Average Frequency is 14.9988
The Frequency Standard Deviation is 1.22041
The maximum Velocity is 0.629758
The maximum acceleration is 70.0579

Exit
Plot Position/Time
Plot Velocity/Time
Plot Acceleration/Time
Start DAQ
End DAQ
Next File in series
Previous File in series

/

root@mice1:

Fri Aug

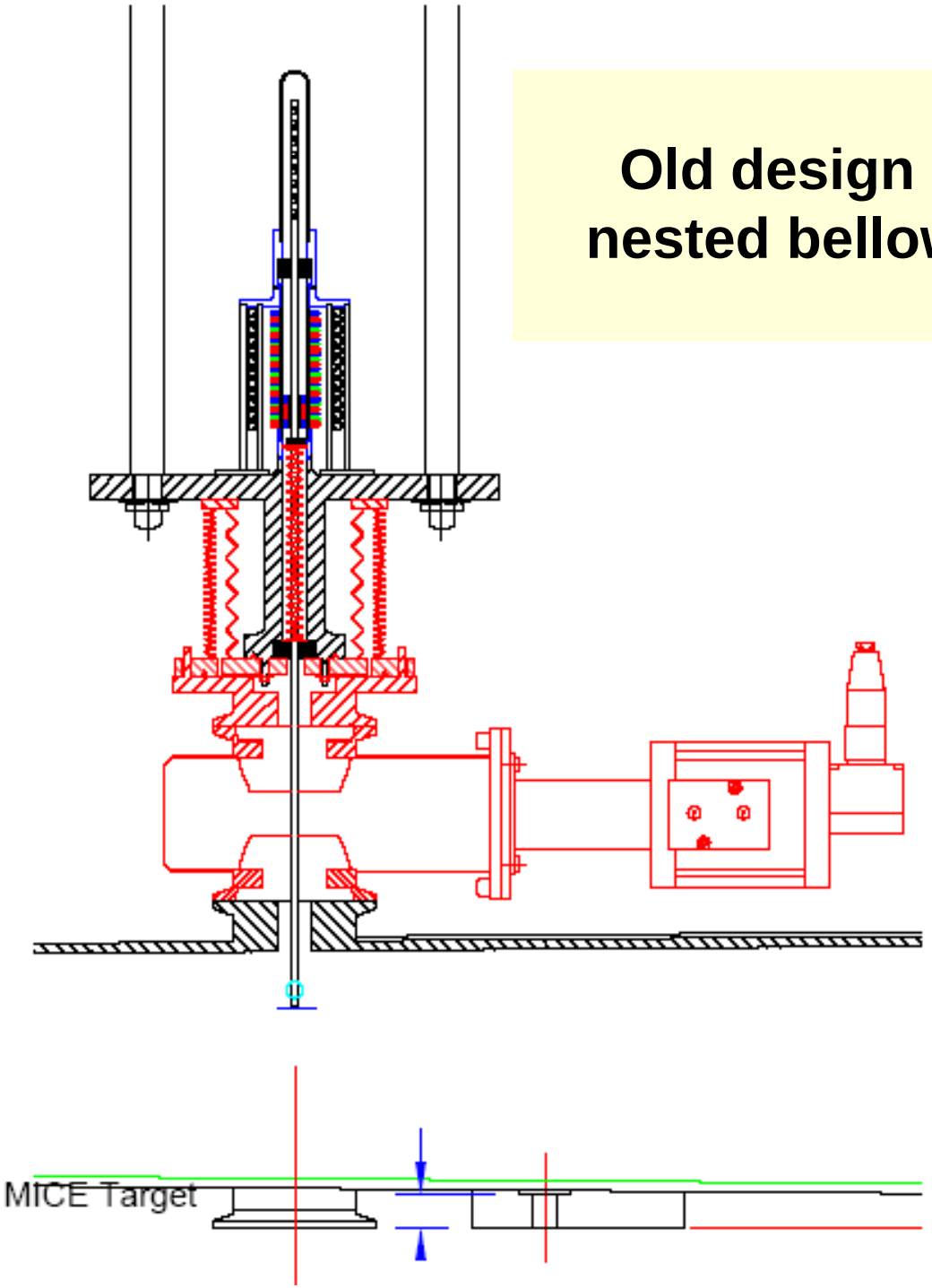
Design Changes

- **Bellows, jacking mechanism and Gate Valve for isolation from ISIS (in case of fault)**
- **Ceramic bearings – no diaphragm springs**
- **No support spring**
- **Ceramic liner – isolates stator material from ISIS vacuum**
- **Optical position readout**

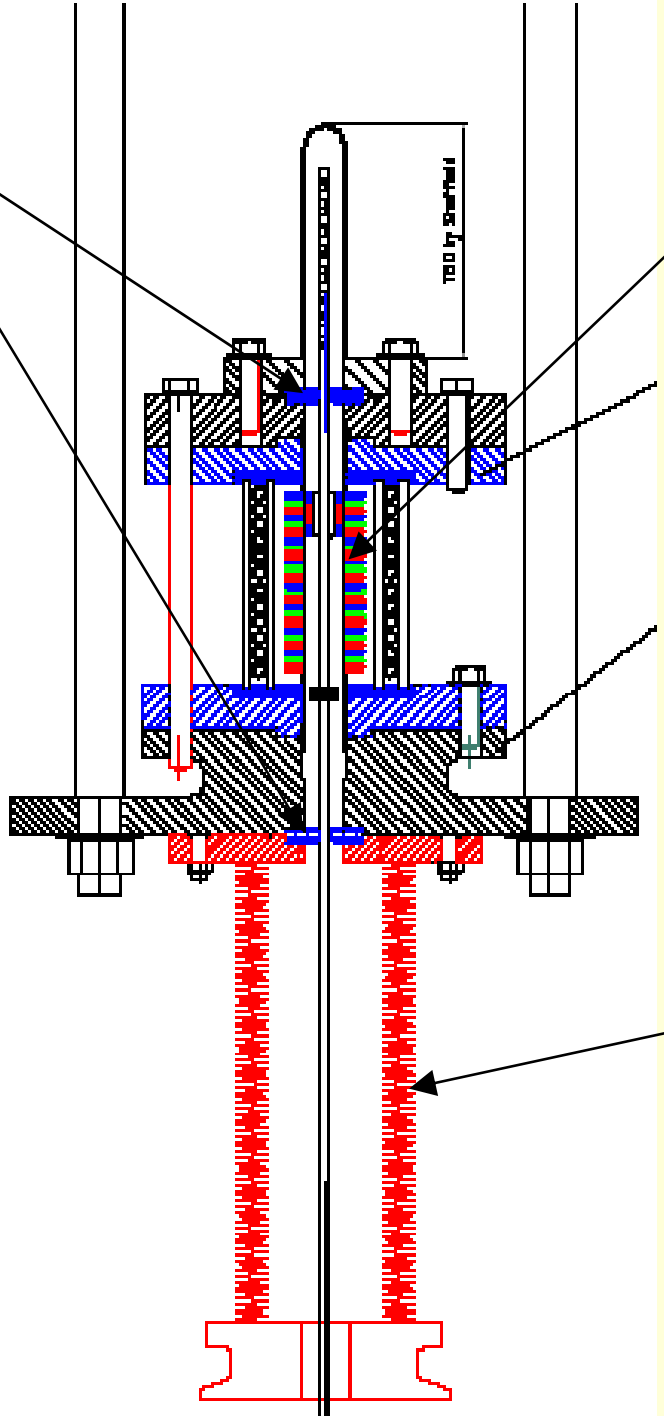
To be tested in ISIS in January (below)

Diagrams courtesy of Stephanie Wang!

Old design – nested bellows

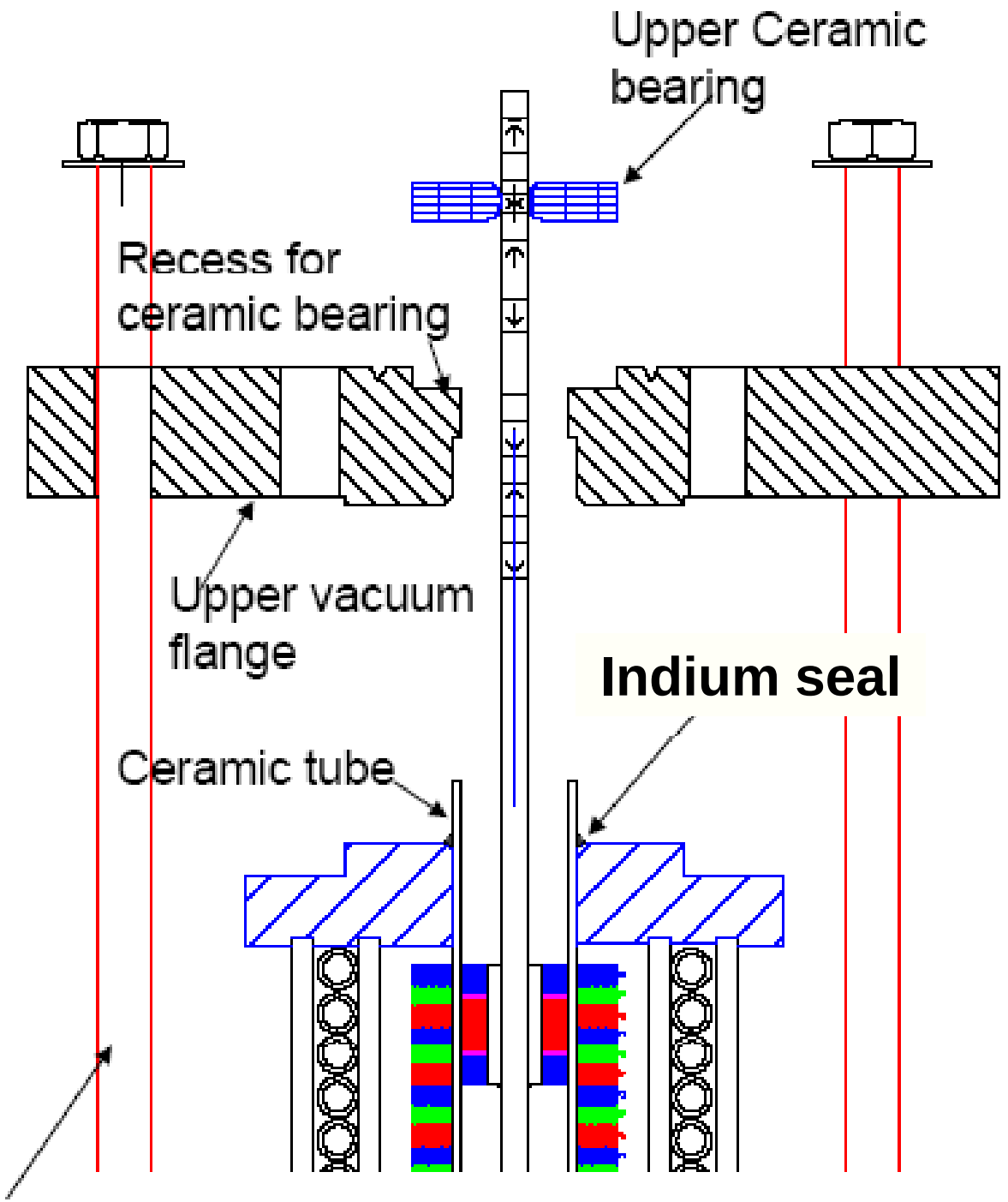


Ceramic bearings



Ceramic sleeve

Edge-welded bellows


Upper Ceramic bearing
Recess for ceramic bearing
Upper vacuum flange
Indium seal
Ceramic tube

Optical Position Readout

- Inductive readout head susceptible to radiation
- Replace with optical quadrature sensor.
- Remote lasers and photo-diode detectors, linked via optical fibres, lenses and glass vacuum chamber “top-hat” (3 channels).
- Lasers focussed to small spots on metal graticule (0.6 mm pitch for 0.15 mm resolution)
- Initial optical tests failed! Inadequate spot-size.
- Now using mono-mode laser and fibres.
- Achieved spot size < 0.1 mm.
- Wire erosion of graticule underway now.

Control Electronics Development

- Basic idea (PJS): use digital position to drive 3-phase commutator and current control.
- Position addresses memory: look-up tables
- External control for synchronisation etc.
- Separate modes for pulsed drive, parking & initialisation
- Look-up tables to be loaded from PC

- Useful discussion at Daresbury
- Hope to use PICs, *internal* memory, built-in interfaces
- Many details still to finalise!

Target Test Preparations

- Two stator bodies in preparation
- Ceramic tubes will be rather late – build coil assemblies on temporary former and insert ceramic when available
- Two shuttles in preparation – Nd-Fe-B and Sm-Co
- Final control electronics will not be ready
  - Hall switch commutator (outside vacuum)
  - Optical sensor for monitoring only (?)

Target Test Timetable

- Construction of parts Sheffield/Manchester/RAL and assembly by 14th November
- Commissioning drive in Sheffield: 14th-18th Nov. (Low power electronics)
- Tests at RAL: 21st-25th Nov. – Vacuum, reliability etc.
- ISIS acceptance decision: 30th Nov.
- Upgrade drive electronics, improve control: Dec.
- Install and operate in ISIS: January

Test Aims & Procedure

Aims

- Understand ISIS beam profile & pion production
- Gain experience of target operation at ISIS

Procedure

- Low ISIS operation frequency
- Gradually adjust target insertion depth & timing
- Record ISIS loss rates and scintillator rates
- Operate for few hundred pulses over couple of days

Data Recording

- Separate DAQ for target system and beam instrumentation
- Time-stamp to cross-reference off-line
- Quasi-online exchange of summary data over network for rapid feedback(?)
- Target system records position profile through cycle (0.1 ms resolution). Also temperatures etc.
- Beam-loss monitors (vs. time in cycle?) recorded by Target PC?
- Pion production vs. time in cycle recorded by beam PC (gated scalars?)

Outstanding Issues

- **Emphasis on preparation for January tests has delayed verification of prototype**
- Maximum acceleration still to be measured.
- Ohmic heating may be a problem – improved cooling??
- 0.5 mm wall ceramic tube not guaranteed!
- Indium seals probably not acceptable to ISIS in long term.

- (Beam heating no longer considered problematic!)

Conclusions

- A lot of progress made. Prototype very promising, but not yet able to demonstrate required acceleration.
- Some mechanical, vacuum & thermal issues still to address.
- Optical readout being prototyped.
- Control electronics designed “in principle”, but considerable work required for detailed design and implementation.
- Huge effort underway to prepare for ISIS tests. Timing is very tight!
- Tests should enable final design of target drive.