THE DIFFUSER

1. Requirements
2. Description
3. Components
4. Trials
5. Schedule

PHYSICS REQUIREMENTS

- **Purpose**
  - **Inflate emittance of beam before cooling**
    - **i.e. heat the beam**

- **Introduce up to ~3 radiation lengths high *Z* material at upstream end of upstream Spectrometer Solenoid**
  - **Ability to vary amount of material**
  - **Steps of 0.2 radiations lengths**

OPERATIONAL REQUIREMENTS

1. Remote control from outside high-field region of Solenoid
2. Manual (local) control
3. Condition available to EPICS system
4. Minimal operation time
5. Minimal maintenance
6. Maximum expected number of operations < 20,000 (?)
7. Long periods when not in use

SPECIAL CONSIDERATIONS

1. Must operate in high magnetic field (~4T)
   - Precludes:
     - Electric motors or actuators
     - Magnetic sensors
     - Any ferromagnetic materials
     - Some grades of stainless steel

2. Possible forces for short periods of time (a few seconds) due to eddy currents if solenoid quenches.
   - Avoid loops of high conductivity materials
     - e.g. aluminium

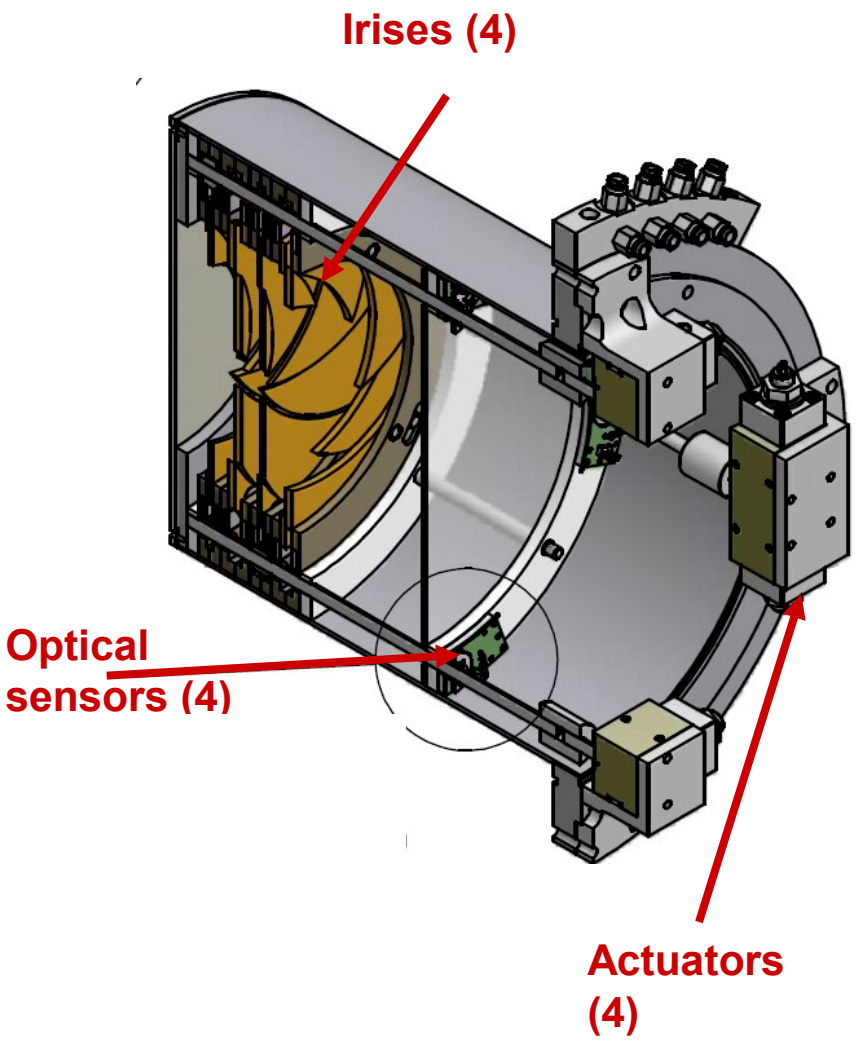
GENERAL DESCRIPTION

- Four in-line irises in ‘cassettes’ stacked in a drum inserted into bore of solenoid.

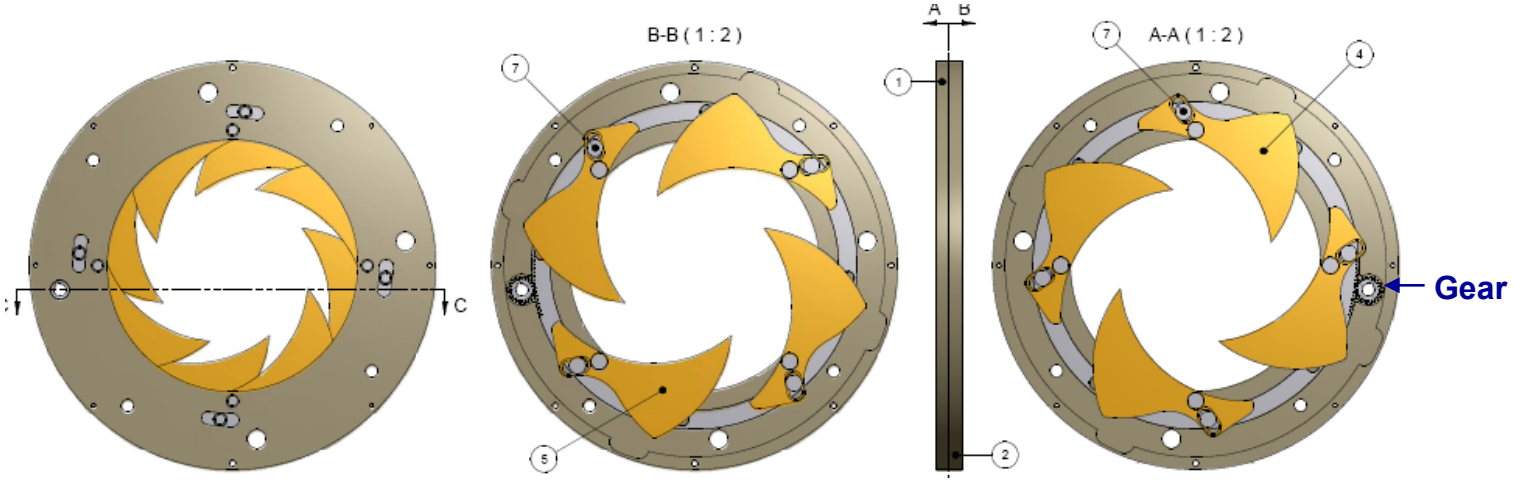
- Irises opened or closed by pneumatic rotary actuators at upstream end of drum.

- Irises of 0.2, 0.4, 0.8 and 1.6 radiation lengths give 0 – 3 radiation lengths in 16 steps of 0.2

- Optical sensors on operating shafts give state (open/closed) of irises

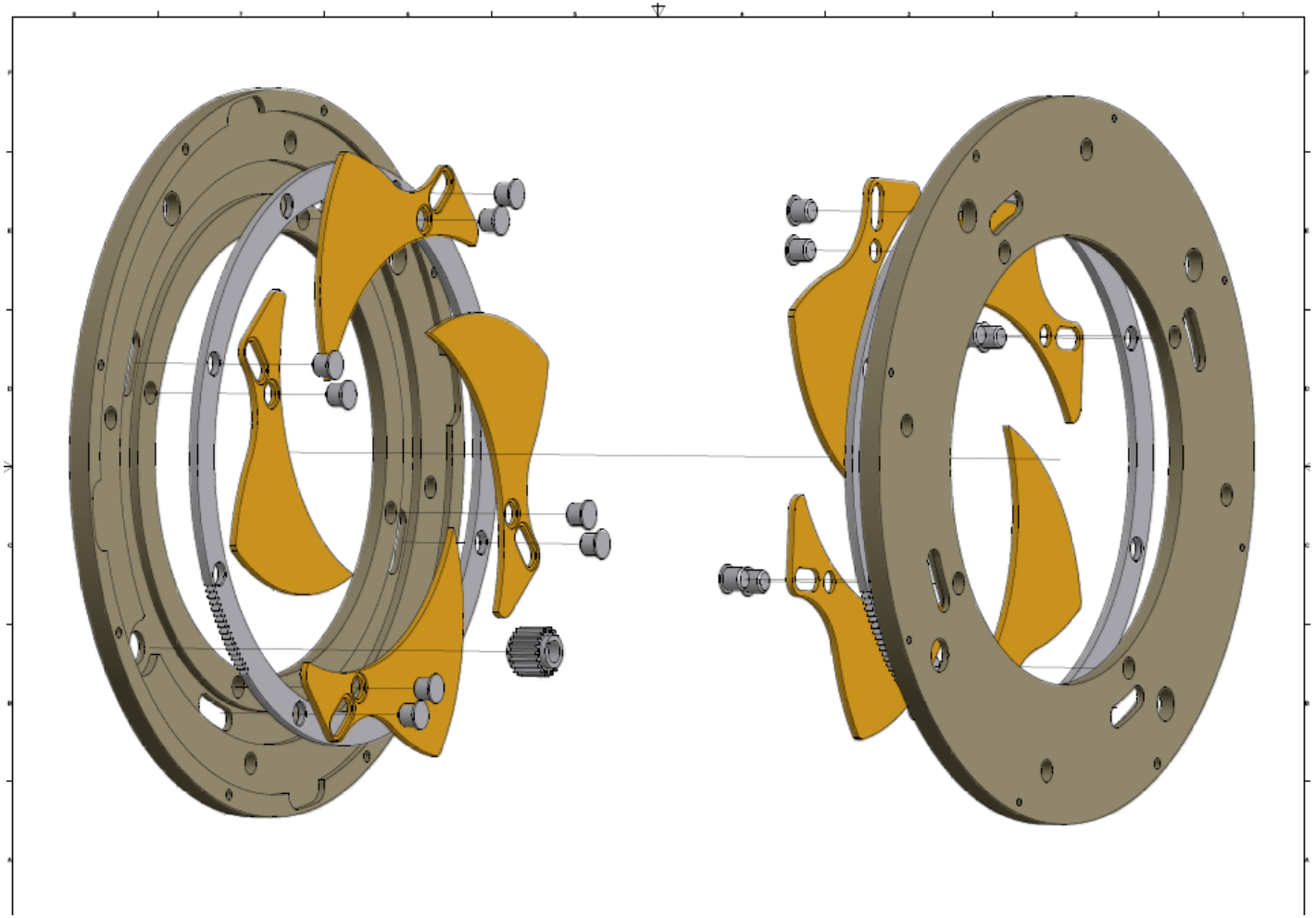


IRIS CASETTES



- Each cassette contains two sets of four ‘petals’ supported by an ‘outer ring’.
- Pins on an ‘inner ring’ engage with slots in the ‘handles’ of the petals
- The inner ring has a short toothed section which engages with a gear
- Rotation of the gear (~120 degrees) will open / close petals
- Petals are adjacent to minimise longitudinal gaps
- Tufnol (proprietary SRBF) used for outer ring to minimise weight
- Four sets of petals: 3 & 6mm brass, 3 & 6mm tungsten

CASSETTE COMPONENTS



Only seven different types of component required for all four cassettes

CONTROLS

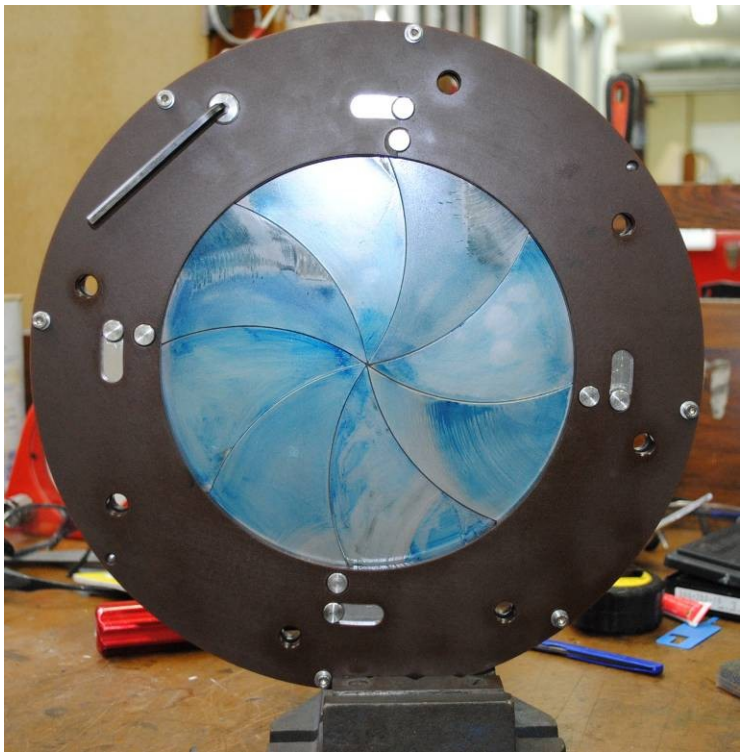
1. **Pneumatics**
   - Re-use air crate of old design
   - Have more than enough solenoid valves &c
   - Rebuild & rewire crate
   - New front panel

2. **Electronics**
   - Re-use electronics crate
   - Some rewiring
   - New front panel (push buttons & indicators)
   - Reprogram FPGA

3. **Controls**
   - Modify existing LabView Code
   - Eventual migration to EPICS

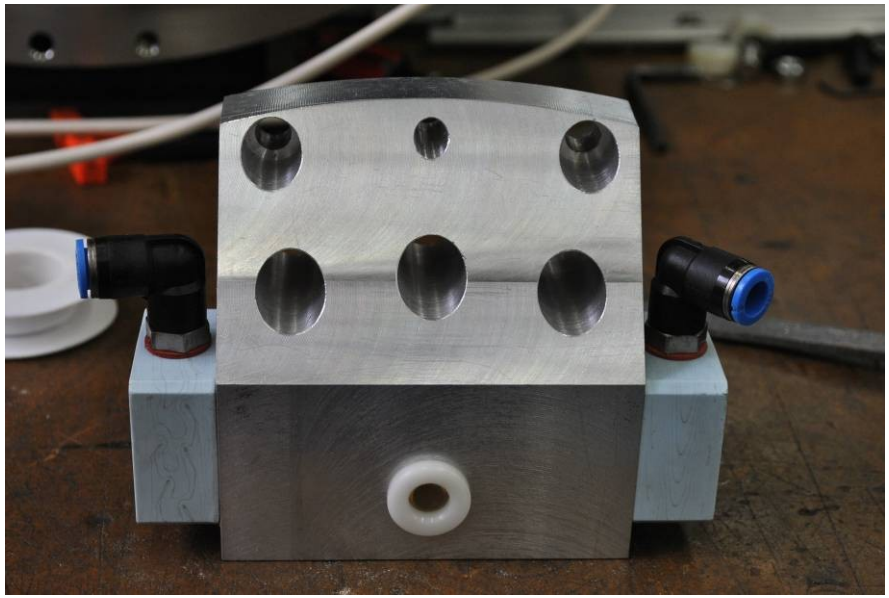
Control required is minimal – only whilst changing setting

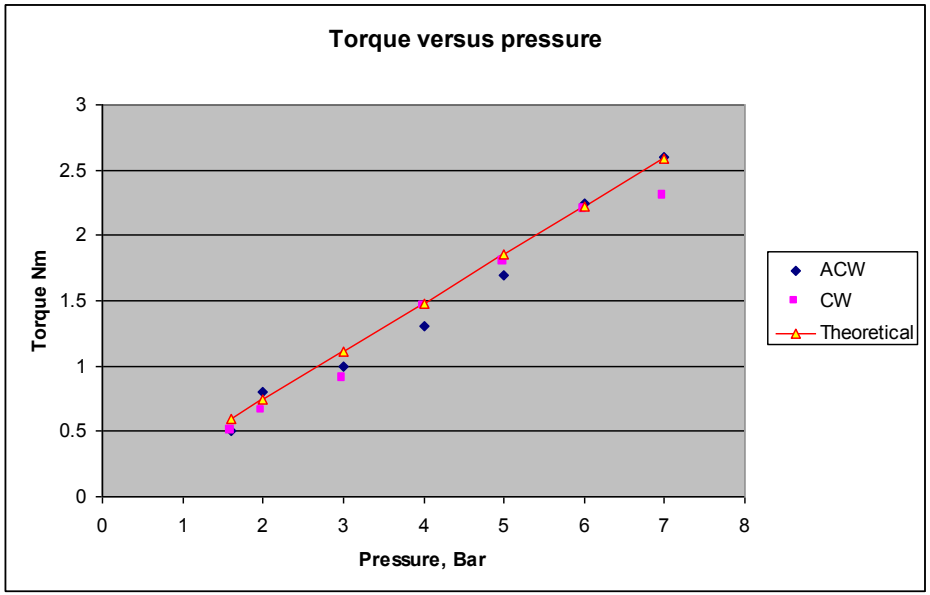
PROTOTYPE CASSETTE



- **Stainless steel petals used for prototype**
- **~0.3 Nm torque required to open/close**
- **Light hand-operation**

ACTUATORS





- Need four pneumatic rotary actuators:
  - 120 degree rotation & ~1Nm at 3 bar

- Non-magnetic components not commercially available
  Commercial custom manufacture probably very expensive

- Make our own (~Chinese copy)
  Works as expected (torques v. hard to measure)
  But ~1.5 bar of 'stiction'

OTHER COMPONENTS

Drum	Finished
Actuators	Made; need better piston seals
Optical sensors	Finished, tested
Cassettes	All made
SS innner Rings	2 to make Flatness difficult to achieve
Brass petals	Finished
Tungsten	Not cut
Electronics crate	Ready; needs new front panel
Air crate	Simple; have solenoid valves Waiting until we know pressures required; may need some reducers

PETALS

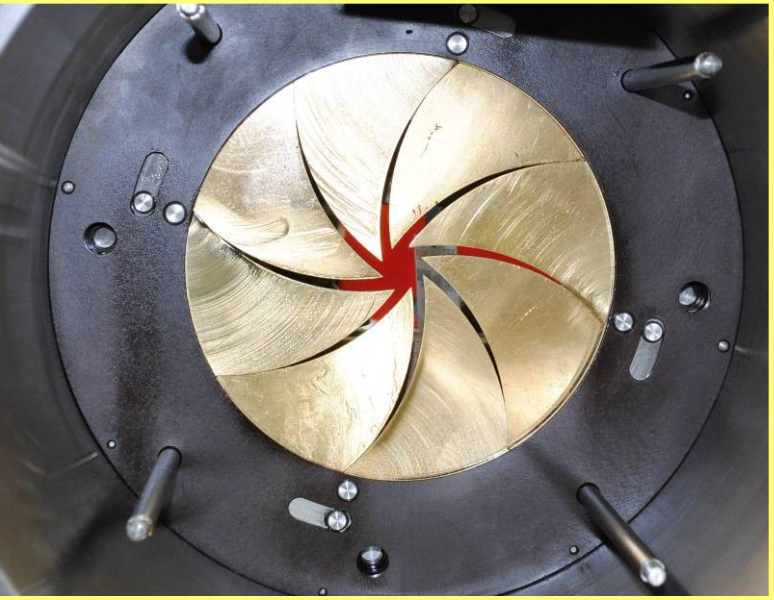
Petals cut with spark eroder & wiring machine

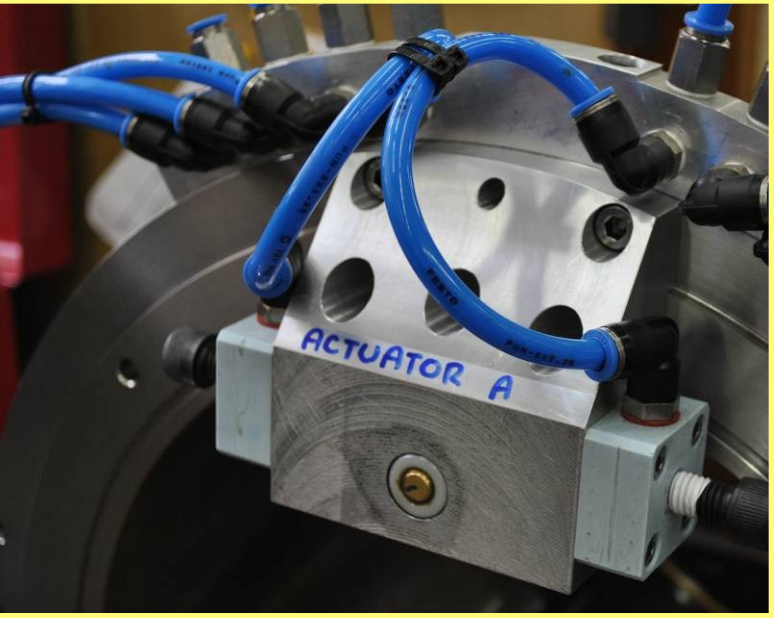
Easy for SS & Brass

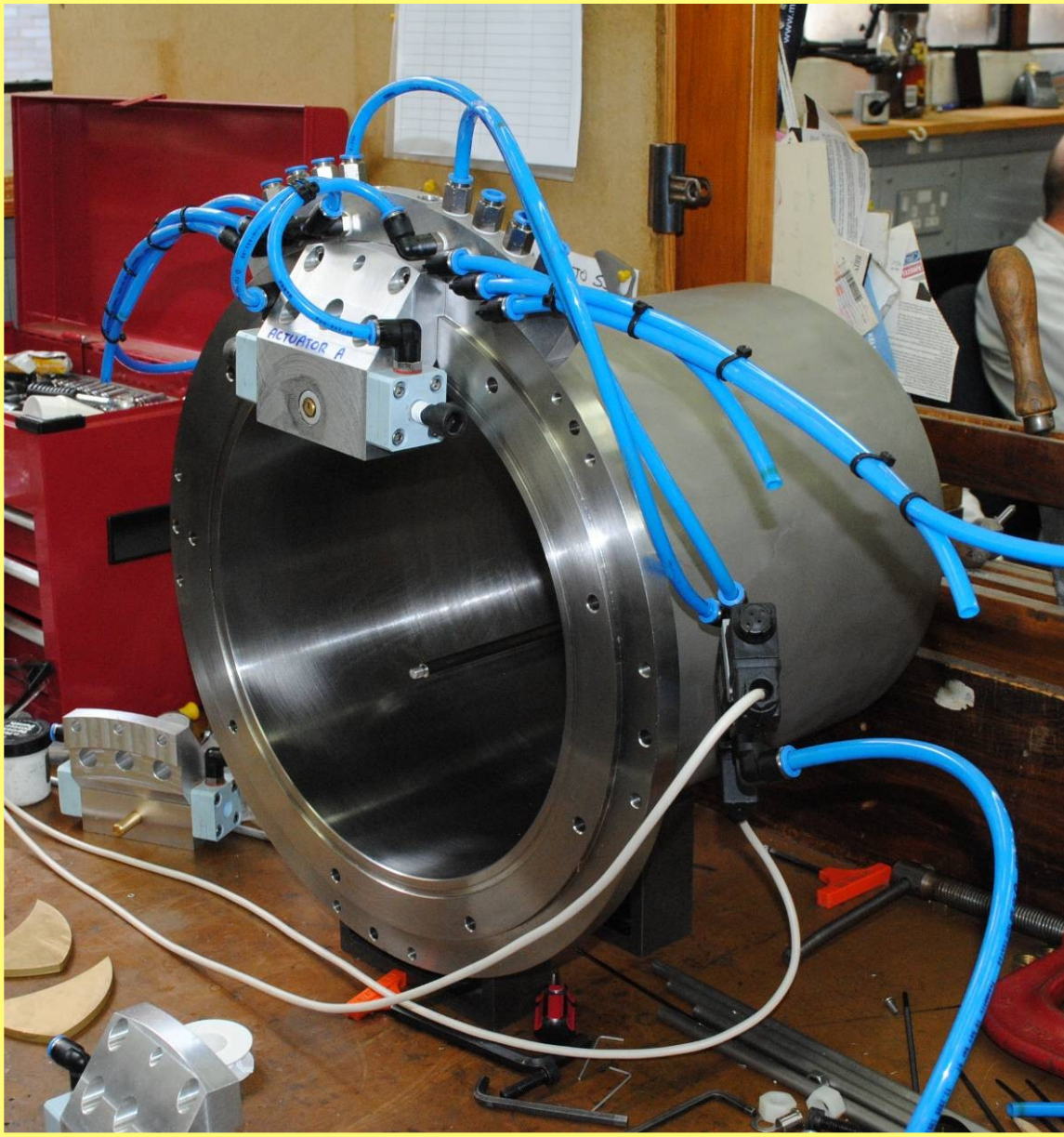
Brass electrode for spark eroder won't cut tungsten

I am assured that copper electrodes will work…

TRIAL ASSEMBLY & TESTING

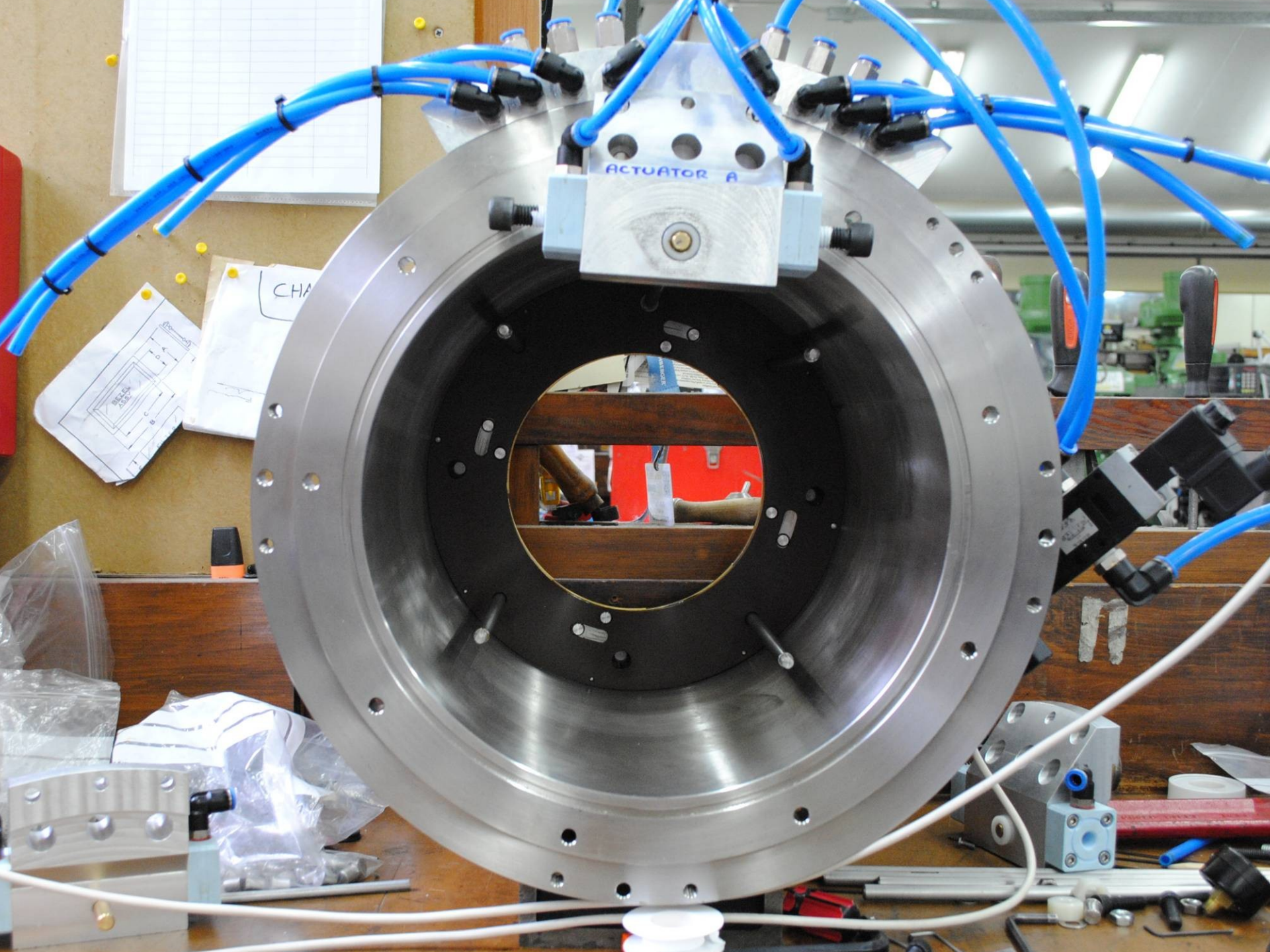


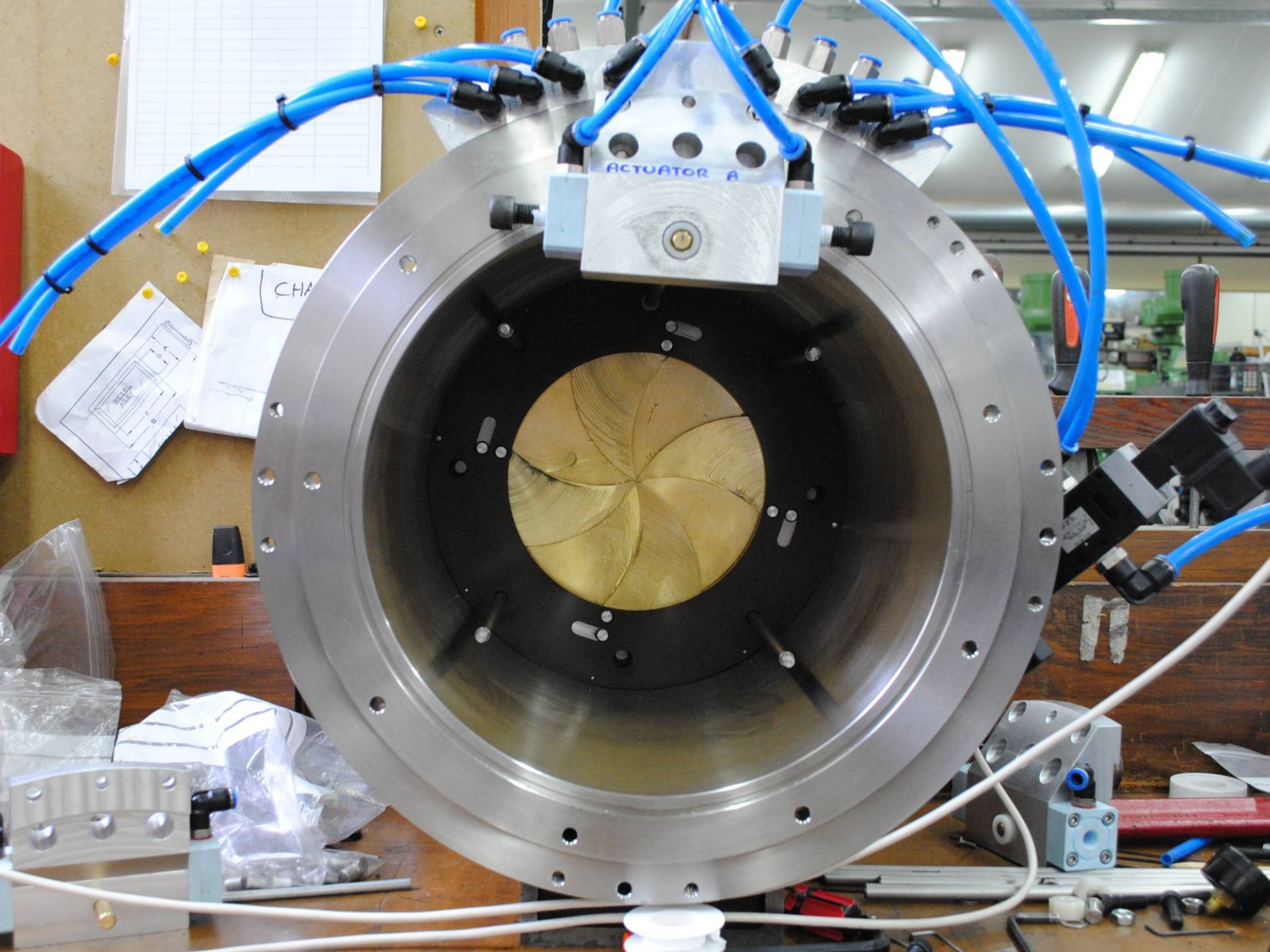




TRIAL TESTING

- 3mm Brass iris + Actuator
- Solenoid valve + oscillator
  - Cycle automatically
  - Few hundred operations
- Operates happily at ~2 bar
  - 1.5 bar for actuator stiction + 0.5 for iris
- Right kind of lubrication is important
  - Grease too thick
  - “3 – in – One” seems to work


ACTUATOR A


ACTUATOR A

KNOWN UNKNOWNS

- **Piston seals for actuators**
  - **Bought some proprietary seals**
    - **Too stiff**
  - **Currently not using seals but close-machined pistons**
    - **Must find suitable – soft – seals**
      - **Service kits for commercial actuators??**

- **Tungsten**
  - **Have not yet cut it…**
    - **Go outside if necessary (would cost)**
  - **Friction**
  - **How to scale operating pressure?**
    - **Scaling by mass ➔ 1.5 + 5 x 0.5 = 4 bar**
      - **Have ~6 bar available**

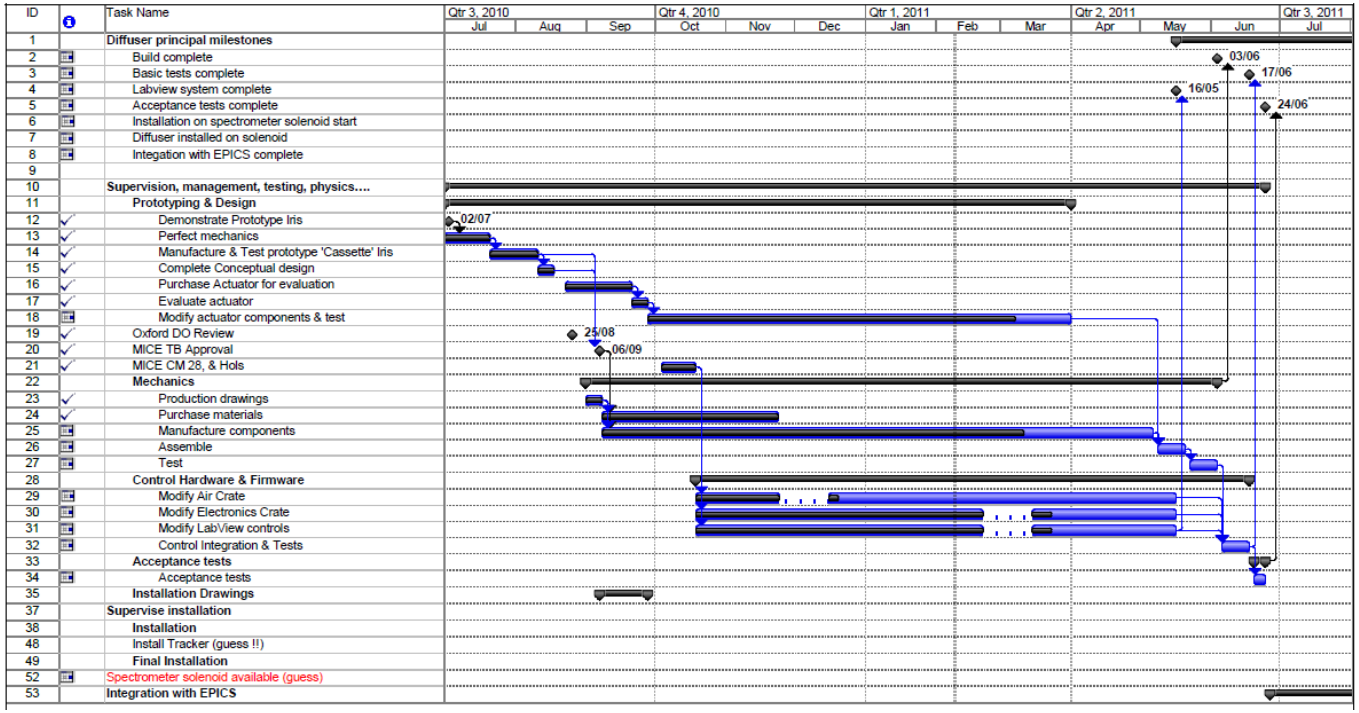
INSTALLATION

Should be plug-and-play:

1. **Install crates**
2. **Install pipes & cables**
3. **Install drum on patch panel & solenoid**
4. **Insert cassette assembly into drum**
   - **May need simple jig (bar) for support**
5. **Mount actuators**
6. **Connect pipes & cables**
7. **Test**
8. **Test with field**
9. **Quench test ??**

Have allowed 16 days in schedule

SCHEDULE



ID	Task Name
1	**Diffuser principal milestones**
2	Build complete
3	Basic tests complete
4	Labview system complete
5	Acceptance tests complete
6	Installation on spectrometer solenoid start
7	Diffuser installed on solenoid
8	Integation with EPICS complete
9	
10	**Supervision, management, testing, physics....**
11	**Prototyping & Design**
12	Demonstrate Prototype Iris
13	Perfect mechanics
14	Manufacture & Test prototype 'Cassette' Iris
15	Complete Conceptual design
16	Purchase Actuator for evaluation
17	Evaluate actuator
18	Modify actuator components & test
19	Oxford DO Review
20	MICE TB Approval
21	MICE CM 28, & Hols
22	**Mechanics**
23	Production drawings
24	Purchase materials
25	Manufacture components
26	Assemble
27	Test
28	**Control Hardware & Firmware**
29	Modify Air Crate
30	Modify Electronics Crate
31	Modify LabView controls
32	Control Integration & Tests
33	**Acceptance tests**
34	Acceptance tests
35	**Installation Drawings**
37	**Supervise installation**
38	**Installation**
48	Install Tracker (guess !!)
49	**Final Installation**
52	Spectrometer solenoid available (guess)
53	**Integration with EPICS**

Man & boy enterprise

Progress determined by availability of Self * JT * Machines in workshop

Most recent estimate “350 man hours of effort” in mechanical workshop

THE END