



## Developing technologies for $\mu$ SR at high pressures

### Tasks:

- Development of a solid-sample pressure cell
- **Development of gas-phase sample cell with RF coils**

### Deliverables:

- Low background solid-sample pressure cell working at pressures exceeding 2.5GPa
- Development of an in-situ NMR spectrometer
- Report of cell performance, including demonstration experiments
- **Gas-phase pressure cell working at pressures exceeding 200 bar**
- **Report of cell performance, including demonstration experiments**



## Background

Built cells operating up to 50 bar to investigate:

- Muon implantation in inert gases:  
demonstrate prompt formation of  $X\text{Mu}^+$  species
  - Chemistry in the gas phase:  
programme to study gas phase radicals (difficult for EPR)
  - Bromine chemistry:  
investigation of muon states, and signature of possible radical state
  - Reactivity of Mu with small molecules (NO and CO):  
revealing quantum mass effects relative to H
- ← Needs 'High' pressures (200bar)

Work carried out as part of an EPSRC grant (UK research council) to develop RF techniques for  $\mu\text{SR}$ , and in collaboration with Don Fleming

## Polymer Cells

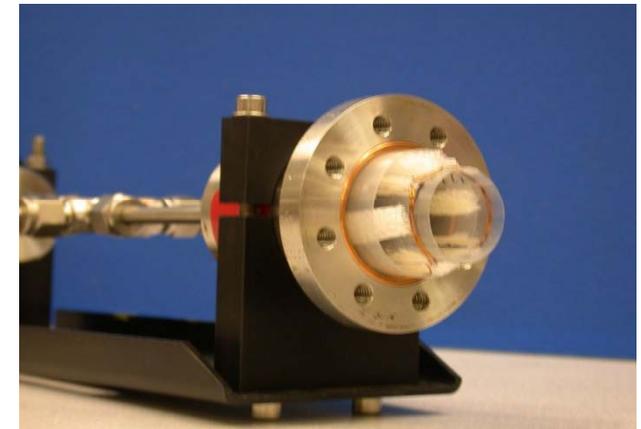


- Constructed from PEEK polymer
- Good  $\mu$ SR properties (>90% missing fraction)
- External RF coil – can easily be moved
- Strength of materials can be a limitation
- outgassing of impurities from the PEEK cell

**No good for gas cells!**

## Metal Cells

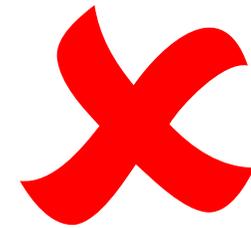
- Constructed from stainless steel with Ti windows
- Single layer and laminate window investigated:  
0.125mm (single): 25 bar, (5 layer): 35 bar  
50 bar achieved with 0.175mm 7 layer laminate
- Internal RF coil – fixed position, narrow pressure
- Requires RF feed-through rated at cell pressure





## Designing 200+ bar cells

- For **surface** muons:
  - muons would stop immediately after window
  - RF coil would hang over end of cell
  - windows and cell body would be non-metallic**We'd need 'magic' window and cell materials!**
  
- For **high momentum** muon beam:
  - windows and cell body would be metallic
  - muons would stop in centre of cell
  - RF coil must be inside cell**We'd need an RF feed-through and a 'clean' coil**





## Programme of Work

1. Design 200+ bar rated pressure cell
  - Metal body
  - Designed for high momentum beamline (ARGUS)
  - Optimise windows to stop beam at cell centre
  - Provision for RF, but no coil and blanked-off feed-through
  - Test experiments
2. Fabricate suitable RF cavity
  - Metal coil and ceramic insulators only for clean system
  - Require high pressure feed-through (to be identified!)
  - Test experiments
3. Experiment study of small gas molecules