A Framework for JRA developments

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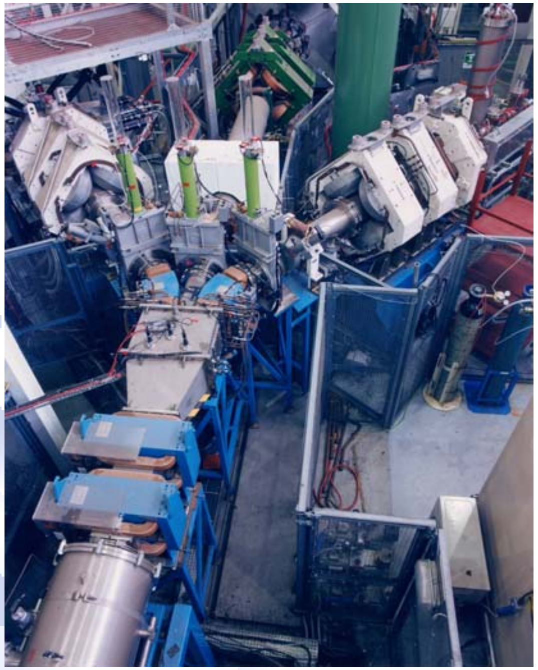


- *Developments at ISIS and PSI*
- *The JRA work packages*
- *WP1 – Detectors*
- *WP2 – Simulation*
- *WP3 – Advanced techniques*
- *Other considerations*

Future Plans

<u>ISIS developments</u>
Facility Development Award (April 2005):
Value: *£2.1M;* Duration: *3 years*

- *Provision of a <u>high field muon spectrometer</u> at ISIS*
- *Spectrometer to be capable of high rates*

<u>PSI developments</u>

PSI: 10 T transverse field spectrometer planned

<u>PSI and ISIS</u>
A variety of other advanced μSR techniques

<u>NB:</u>

TRIUMF: M9A – high luminosity, user-friendly line
J-PARC: whole new instrument suite

High fields, high rates, advanced techniques

Great! But . . . . !

There are a variety of inter-related technical issues:

1. Detector technologies – rates, timing, position-sensitive

   WP1 - Detectors

2. Design of beamline; detector array; magnet; sample environment

   WP2 - Simulation

3. Development of new μSR methods

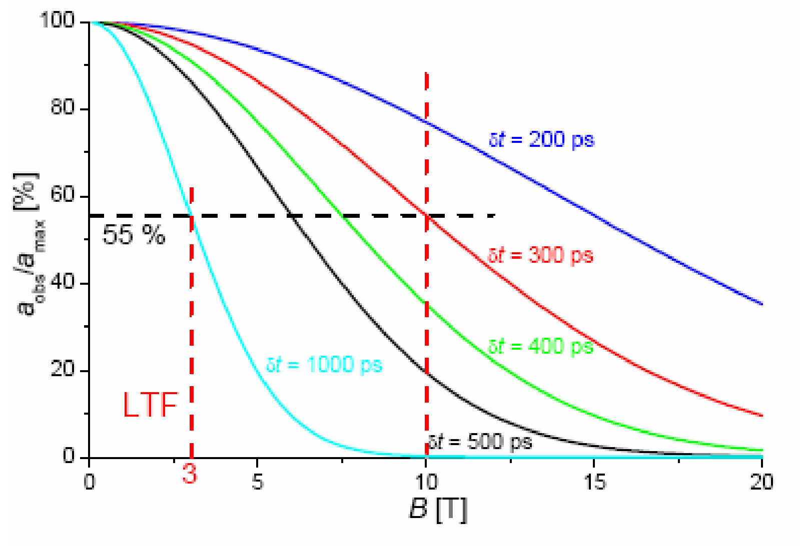
   WP3 – Advanced techniques

1. Detector Technology (WP1)

ISIS, standard μSR:

- high data rates possible:
  - highly-segmented detector array (250+ elements)
    - ? scintillators/PMTs; fibres ?
  - analogue detection (**Robert Scheuermann**)
- RF-μSR: timing ~1 ns

PSI, high-TF:



- needs timing resolution < 300 ps
- but single counting means a small array close to the sample
  - avalanche photo diodes (**Robert Scheuermann**)

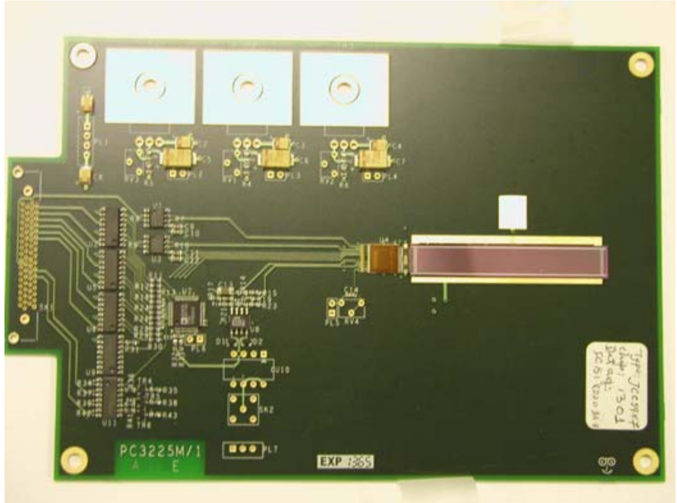
1. Detector Technology (WP1)

High-field operation:

- detectors insensitive to field
- array design needs to consider positron trajectories to avoid missed/multiple counts
  - compact design for PSI not possible for ISIS

Use of small samples:

- position-sensitive detectors for positron tracking (**Toni Shiroka**)
- 'fly-past' at ISIS

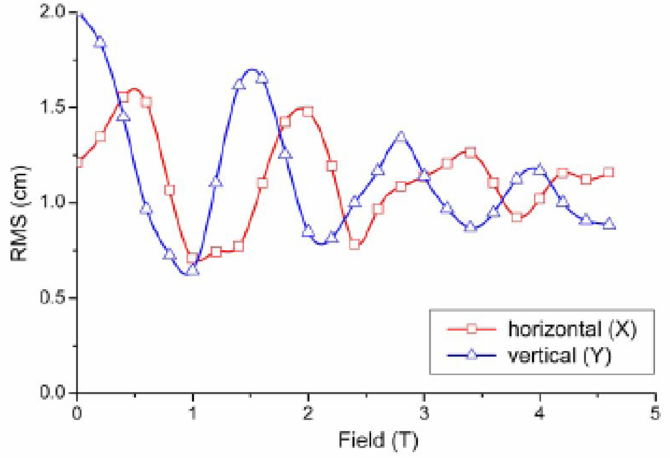


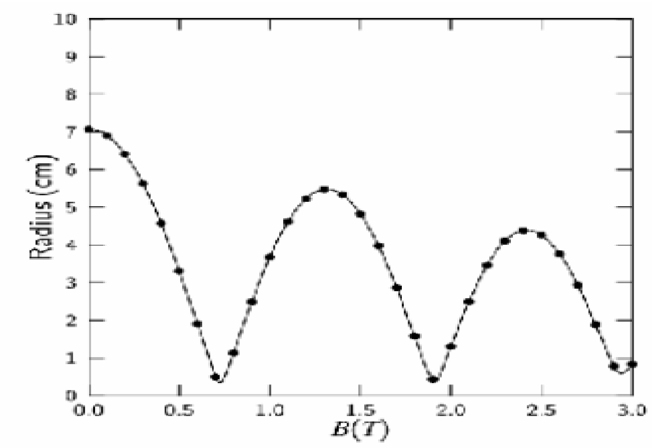
CCLRC

2. Instrument simulation (WP2)

Beamline / magnet design:

- avoid stray fields affecting other beamlines/instruments
- consider effects of field on *spot size*



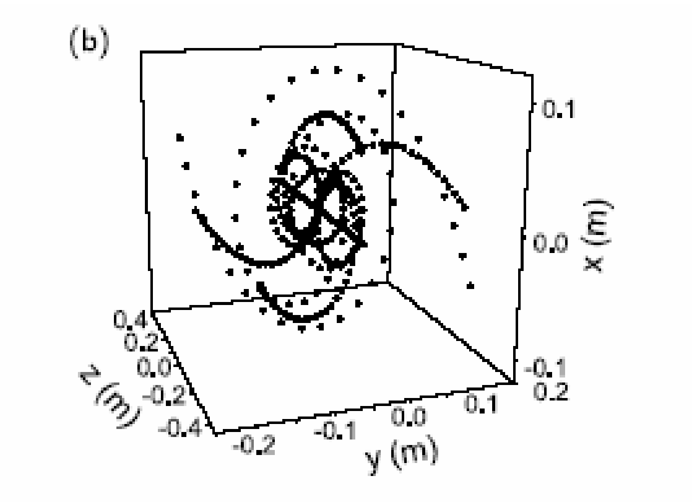


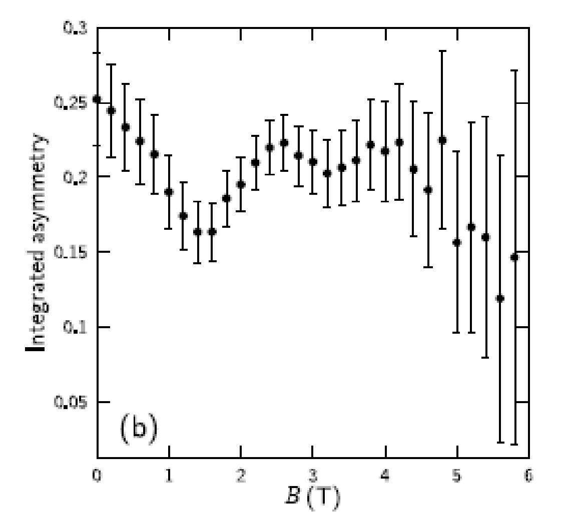
- for TF, consider effects of field on *polarisation*;
  initial muon phase space, momentum bite, collimation very important

2. Instrument simulation (WP2)

<u>Detector array design:</u>

- Consider effects of positron spiralling
- Prediction of ‘asymmetry’ vs. field





•Sample environment equipment

- need to be able to incorporate a dilution fridge
- would like access for RF, etc.
- for TF, need to incorporate detectors

2. Instrument simulation (WP2)

Magnet design

Fields of: ~5 T (ISIS, longitudinal)
~10 T (PSI, primarily transverse)

Issues include:

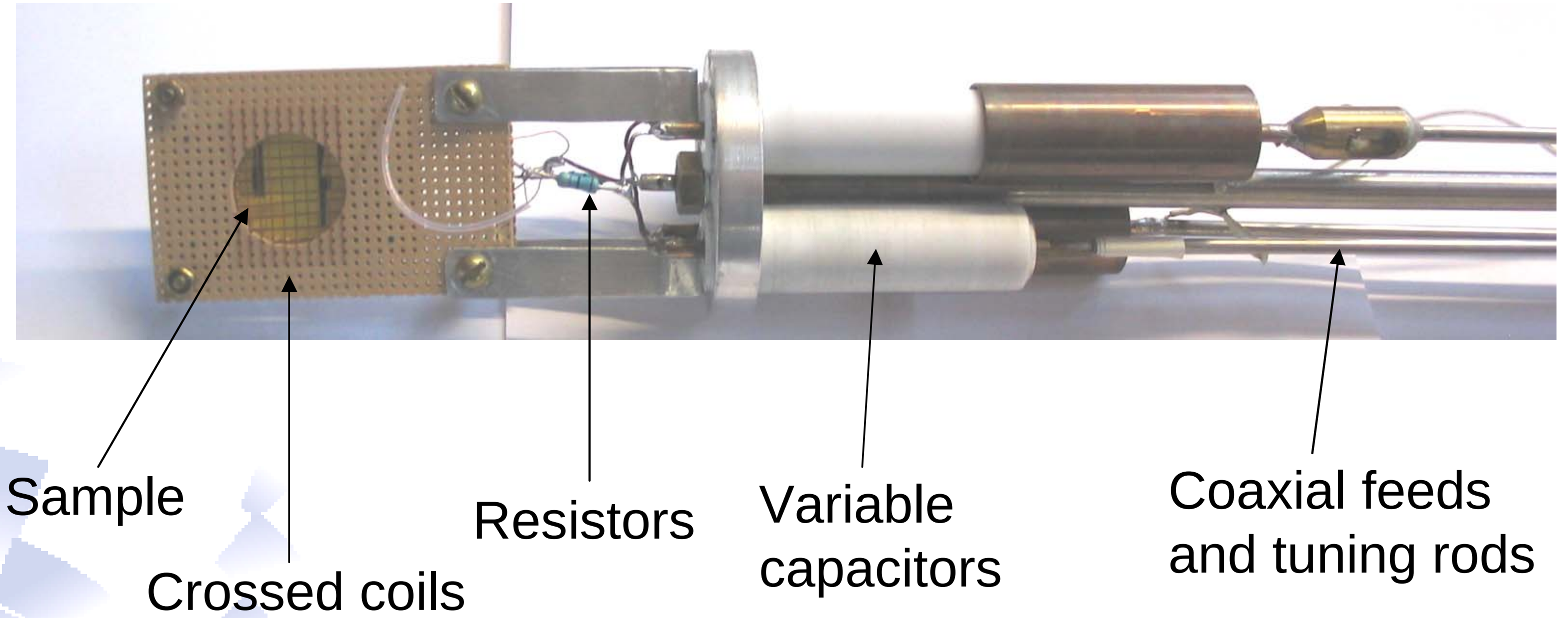
- Homogeneity of ~0.01% over sample area
- Stability < 10^{-6}
- Reasonable ramp rates
- Configuration: pros and cons of split-pair vs. solenoid
- Stray fields: effects on neighbours: field 5 G at 2 m
  effects on phase coherence
  active or passive shielding?
- Integration of calibration and compensation coils

(**Tom Lancaster**)

3. Advanced techniques (WP3)

RF-μSR techniques:

- aid studies of reactions, dynamics, etc. Wide range of science areas
- multi-pulse techniques benefit from high fields



- simultaneous AC-susceptibility

(Steve Cottrell)

Other Considerations

- **Science drivers**

  help prioritise requirements

science / technique →

requirements ↓

	Fluctuations / dynamics / decoupling	***Level crossing resonance***	***RF-μSR studies***	***State preparation***
Field range	▫at least as low as EMU ▫up to as high as possible	▫at least as low as EMU ▫up to around 3 T	▫at least as low as EMU ▫up to around 2 T	▫at least as low as EMU ▫up to as high as possible ▫zero field may be important ▫changing field polarity or sample orientation is important
Stability / homogeneity	▫not so critical (what figures here??)	▫very important (what figures here??)	▫very important (what figures here ??)	▫not so critical (what figures here??)
Field steps / calibration	▫larger steps likely (of order 100s or 1000s of G); sweep rate is therefore important	▫field steps of order 1 G ▫good calibration required (what %?)	▫field steps of order 1 G	▫larger steps likely (of order 100s or 1000s of G); sweep rate is therefore important
Background	▫known and preferably low	▫know, stable and preferably low	▫background less important	▫background not important – measurement at all field values not necessary
Temperature range required	▫As wide as possible (down to mK)	▫10 K to furnace temperatures	▫10 K to furnace temperatures	▫As wide as possible (down to mK)
Rate	▫less important	▫important: resonances can be weak, red/green mode used for switched fields	▫important: resonances weak, red/green mode necessary	▫not important
Other issues	▫This would be a unique facility	▫switched fields (or order several G) required. ▫liquid samples likely		

- **User-friendliness**

Programme

APD detectors for high fields
R. Scheuermann (PSI)

Position sensitive detection for spatial resolution and high segmentation
T. Shiroka (Parma)

Analog detection
R. Scheuermann (PSI)

Instrument simulation
T. Lancaster (Oxford)

RF developments and in-situ AC-susceptometry
S.P. Cottrell (ISIS)

Discussion

Summary and conclusions
C. Bucci (Parma)