

R&D on muons (+ other things) at RAL

“UK Muon Collider Working Group”
Birmingham, Bristol, IC, Oxford, RAL and Sheffield

R&D studies we are working on/interested in:

- High power proton sources - RAL
- H^- stripping - Oxford
- ≥ 4 MW targets** - RAL
- Muon scattering** - Bham, IC, Oxf, RAL
- Pion production and capture - RAL + ?
- Physics simulation and detector design - Just starting

** covered in this meeting

Muon scattering

Why?

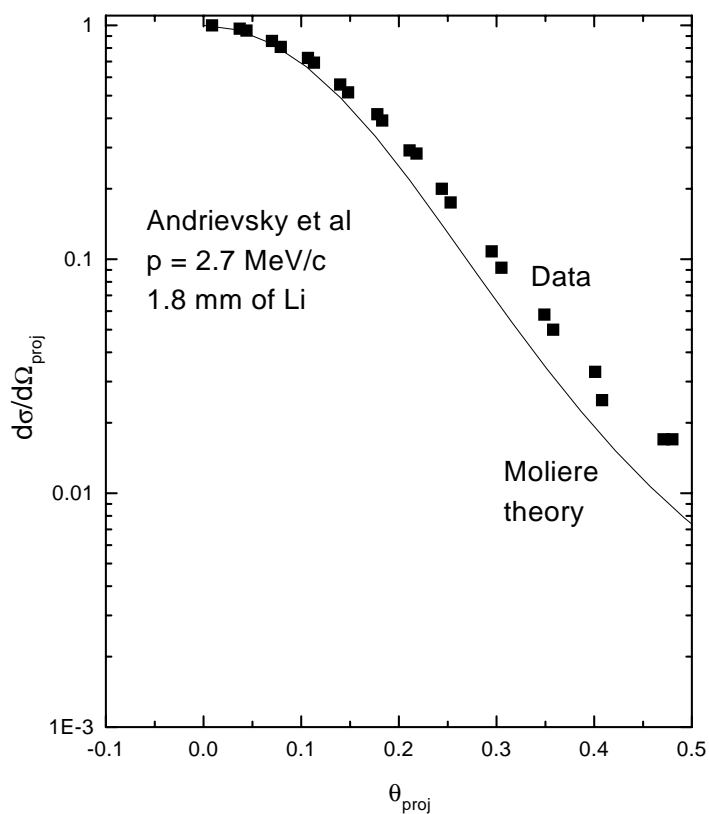
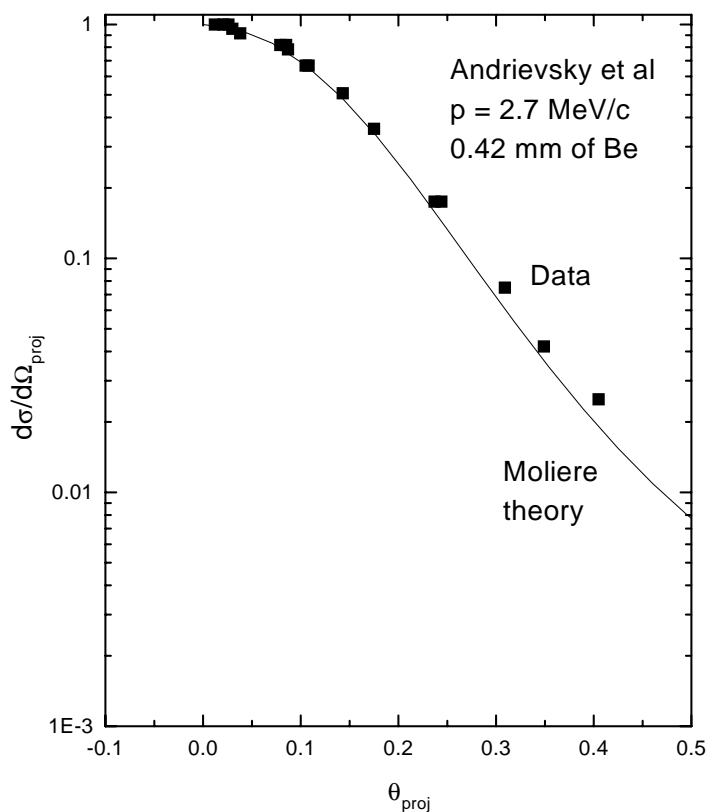
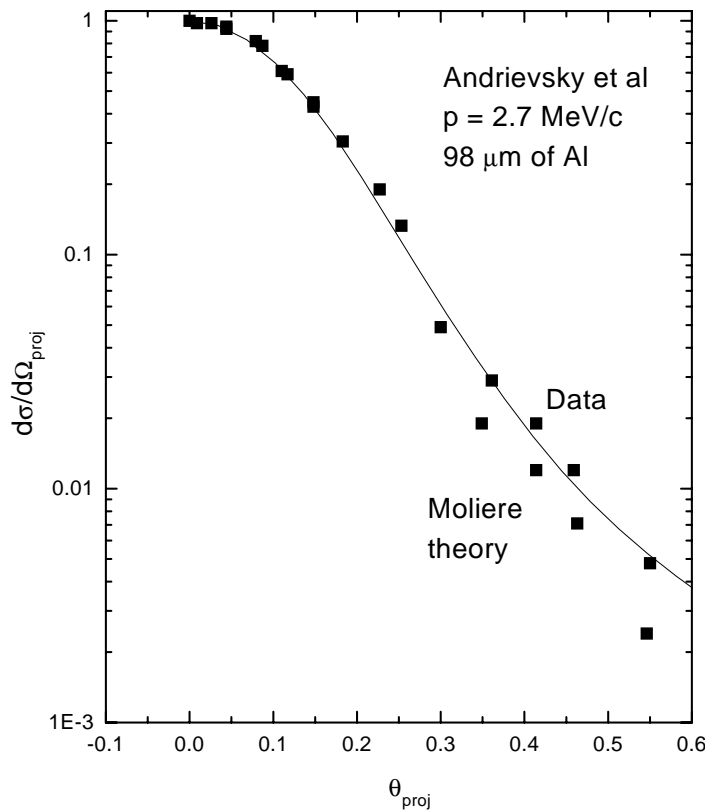
- Ionisation cooling is a balance between the **cooling** from dE/dx and the **heating** from multiple scattering:

$$\frac{d\epsilon_n}{ds} = -\frac{1}{\beta^2} \frac{dE_\mu}{ds} \frac{\epsilon_n}{E_\mu} + \frac{1}{\beta^3} \frac{\beta_\perp (0.014)^2}{2E_\mu m_\mu L_R}$$

L_R = radiation length \implies low Z materials required

- No **directly** relevant experimental measurements
- Important to measure the scattering and compare with the theory being used because
 - **low angle** \implies required cooling not achieved
 - **wide angle** \implies muons lost from the beam
- 55 year old electron scattering suggests there may be a problem for **low Z** materials

Electron scattering measurements:



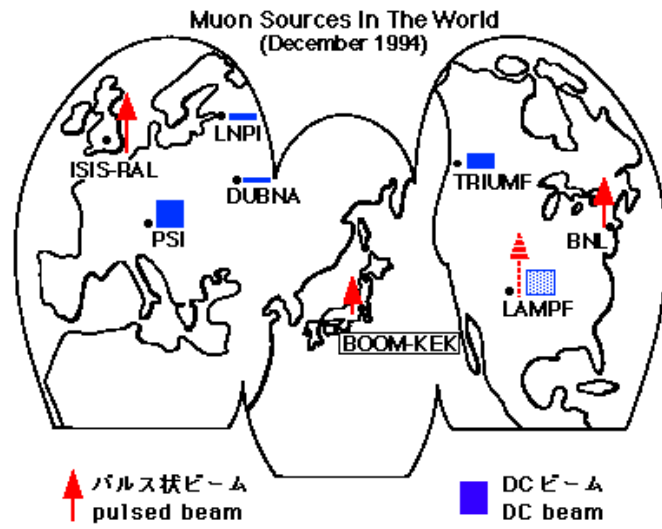
2.7 MeV/c electrons on

- 98 μm of aluminium
- 0.42mm of beryllium
- 1.8mm of lithium

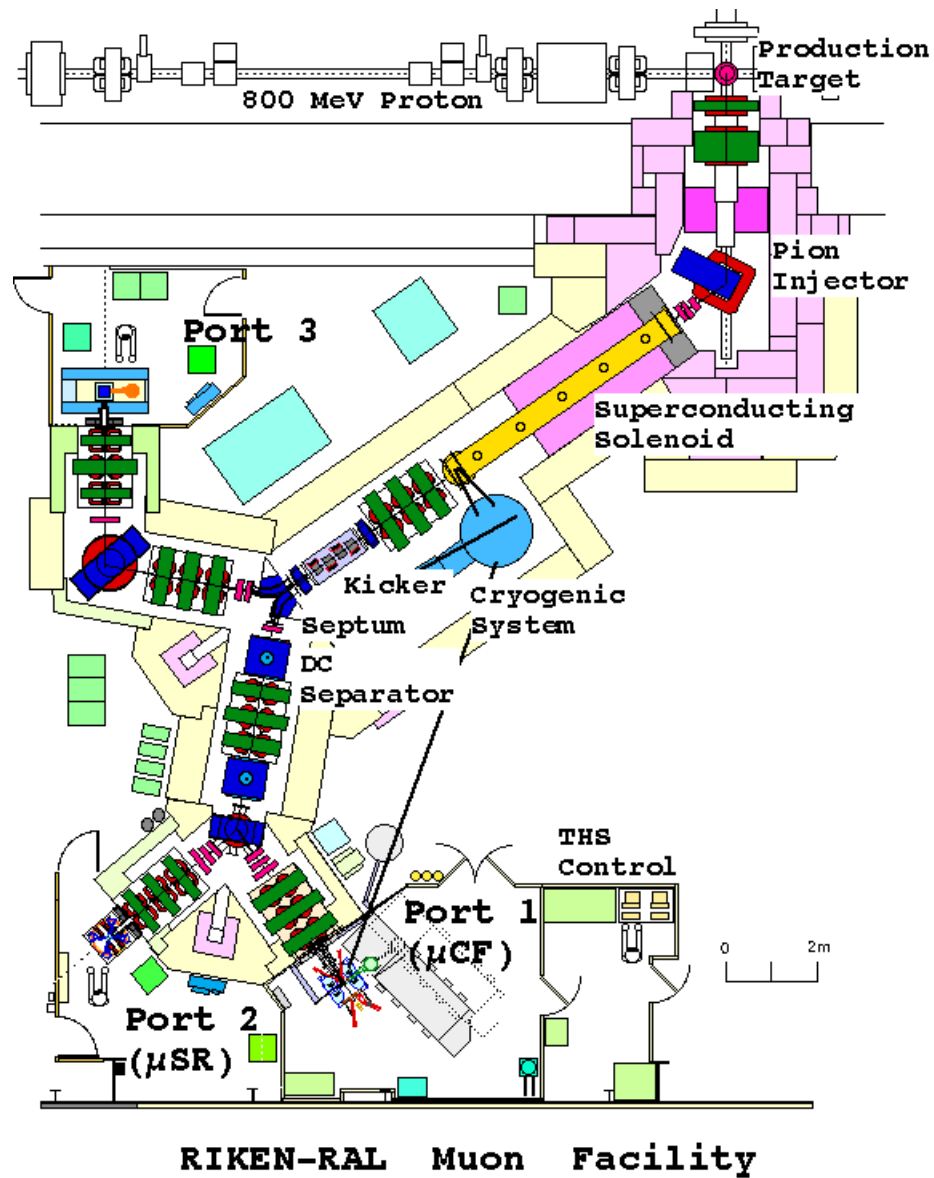
from: Andrievsky et al,
J. Phys 6 (1942) 278

Where?

Muon beams:



Obvious choice \Rightarrow Riken beam at RAL



How?

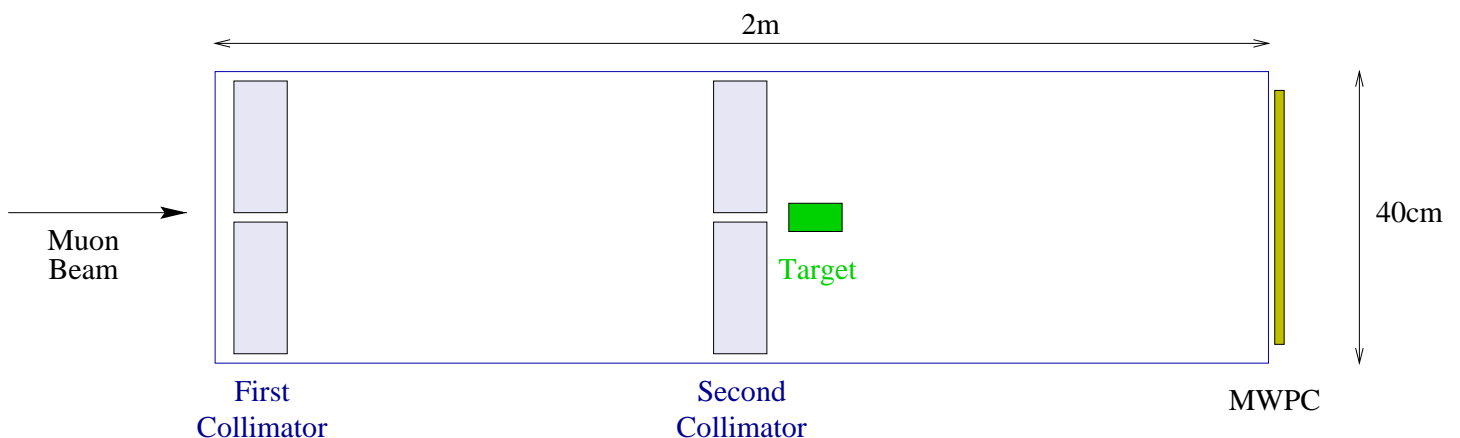
- Measurement required:

- muon angular distribution from 0mrad to $3 \times$ rms scattering angle ~ 30 mrad
- range of momenta
- various low Z materials, e.g. H_2 , Li, LiH, Be, Al

- Beam properties:

	Actual	Required	OK?
muon momentum/MeV	28-120	100-300	Yes
momentum resolution/%	~ 7	???	???
angular divergence/mrad	50×100	1-2	No!
beam size/cm	1.0×0.5	< 0.2	No
intensity	20k/pulse at 50Hz	$\sim 5-10$ at 0°	No
electron contamination	1-2%	a few %	Yes

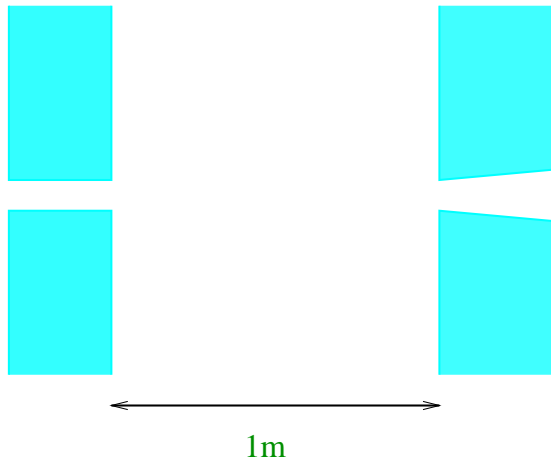
\Rightarrow collimation required!



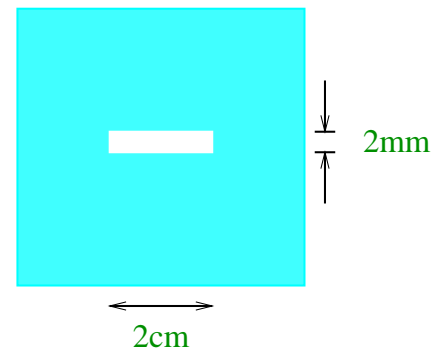
- Collimation and detector being studied by (a Geant4) simulation.

For example

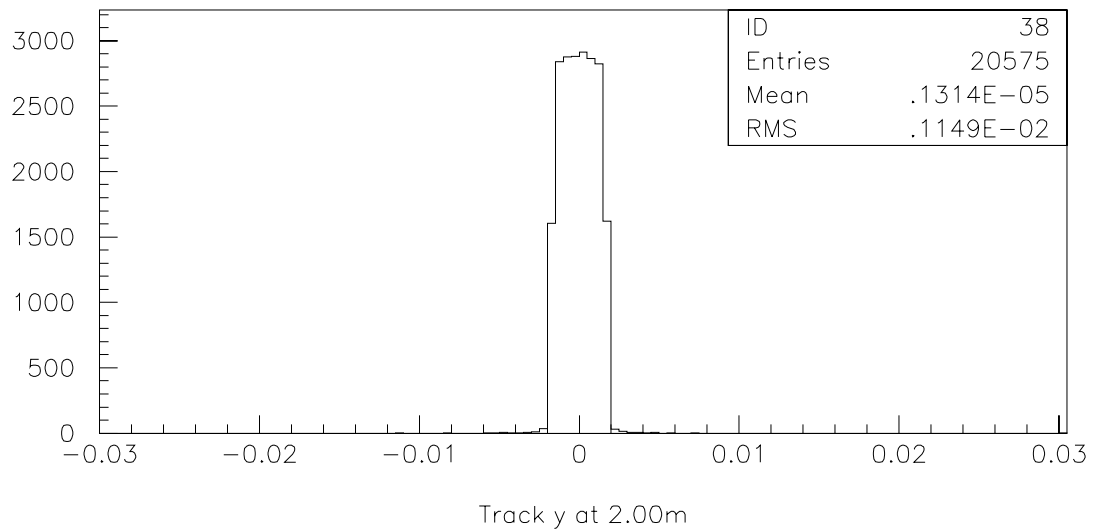
Longitudinal view



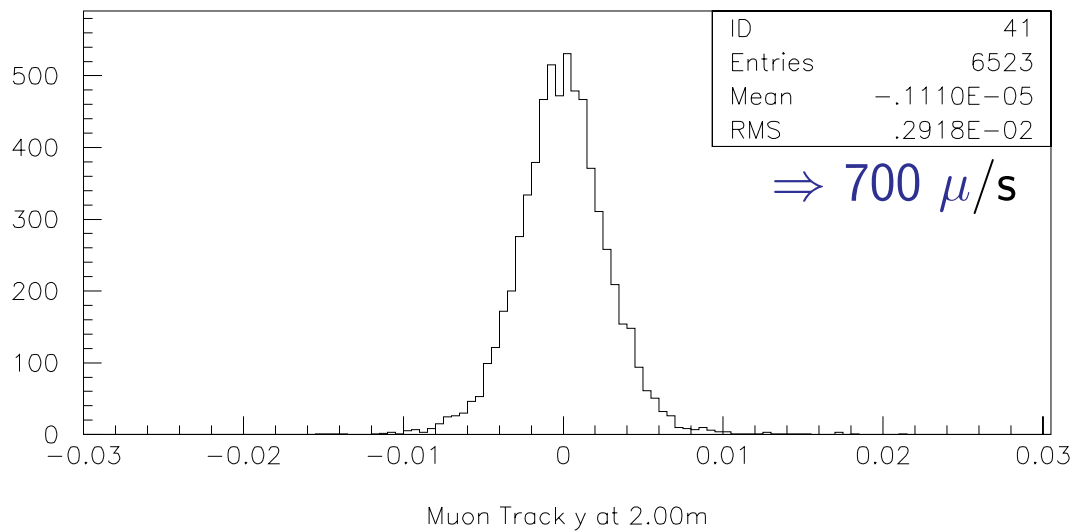
Transverse view



No target
100 MeV/c² μ⁻



10cm of liquid
hydrogen



Status?

- Exact requirements, in particular momentum resolution, being clarified with US
- Collimator and detector design under study by simulation
- Beamtime application procedure has started: LOI submitted.
- 2 stage process suggested:
 - test collimation system first (rates, background)
 - make measurements in 2 separate periods
- Comments welcome!