

Background Measurements and Activities @ Boulby for JRA1

Tim Lawson
University of Sheffield

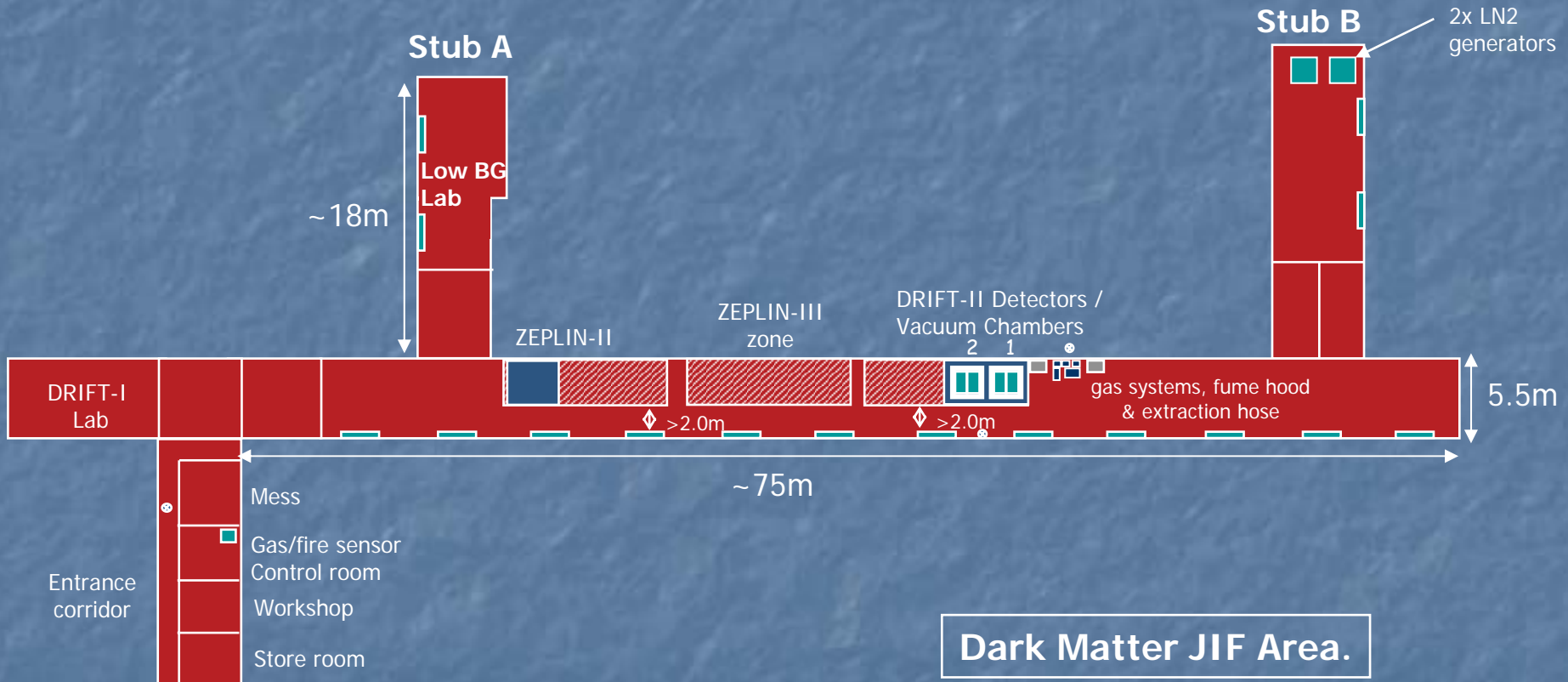
IAP, Paris, 14th February 2006

Overview of Boulby JIF Facility

- Low-b/g* salt-rock (*How low? – see later).
- >1500 m² floor area divided into main experimental hallway + 2 stubs; ancilliary rooms (workshop, store, mess,...).
- Cleanroom protocol for entry / exit; HEPA-filtered air.
- One stub has secondary air filtration – for use as ‘ultra-clean’ room (in-house low-b/g tests, detector commissioning, etc.)
- Crane facilities in experimental areas (x-y in Main hall).
- Air conditioning, telephone, 100Mbit/s optical link to surface.



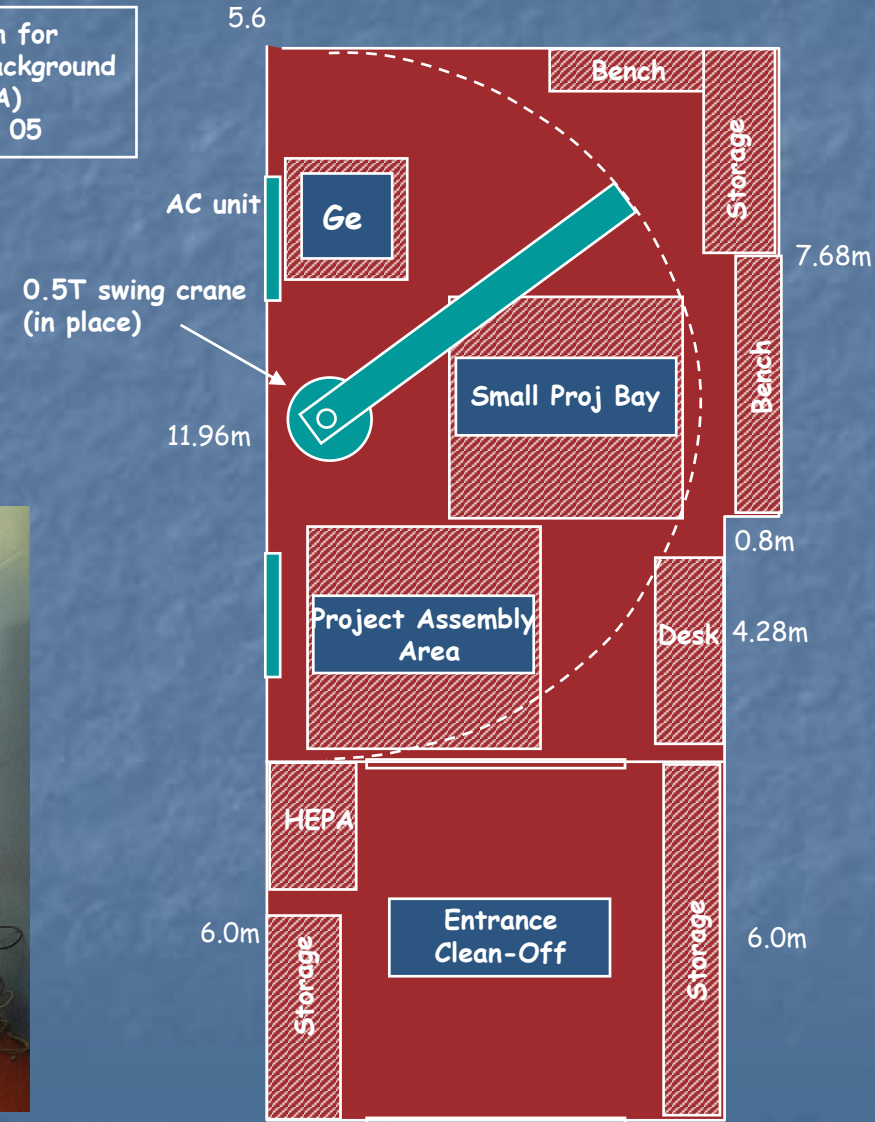
...Overview of JIF Facility



...Overview of JIF Facility: Low BG Lab

- Class 1000 clean room.
- Floor area ~70m².
- 0.5 tonne swing crane.
- HPGe detector operational (Pb/Cu castle under construction).
- NaI – based detector in place and operational.
- RAD-7 radon detector operational.

DRAFT Plan for
JIF Low Background
Lab (Stub A)
SMP - Nov 05



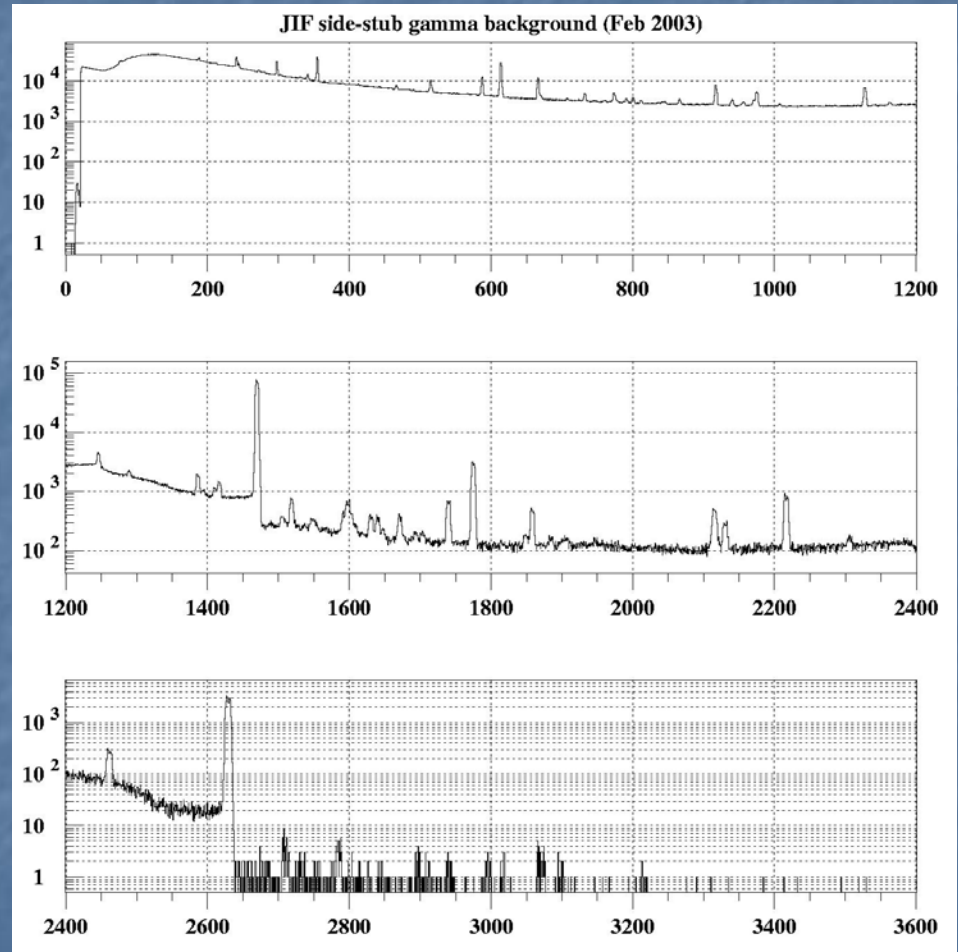
Previous Measurements @ Boulby

- Feb 2003: Unshielded 2kg Ge detector exposed to open cavern in JIF stub-2, obtaining average γ spectrum from all walls of the cavern (See ref [1].)
- 4 γ lines from U and 4 from Th compared to Monte Carlo.

Results:

- Calculated n-production from rock (NaCl): $\sim 3E-8 \text{ g}^{-1} \text{ s}^{-1}$.
- Neutron flux from rock: $3.0E-6 \text{ cm}^{-2} \text{ s}^{-1}$
- Neutron flux shielded by plasterboard wall: $2.7E-6 \text{ cm}^{-2} \text{ s}^{-1}$
- Neutron flux added by plasterboard: $6E-8 \text{ cm}^{-2} \text{ s}^{-1}$
- Net neutron flux: $2.76E-6 \text{ cm}^{-2} \text{ s}^{-1}$

Conclusion: plasterboard wall reduces neutron flux by $\sim 8\%$; main neutron background dominated by average U/Th concentration in rock.



...Recent Background Studies

- Recent measurements¹ with portable HPGe-detector and radon monitor at several test-points within / around JIF lab (see talk by Jan Keisel).
- ^{40}K (1460 keV) dominates γ -spectrum.
- ^{137}Cs (661 keV) line also present.
- Typical integrated γ counting rate: 20 – 24 counts $\text{kg}^{-1} \text{s}^{-1}$.
- Typical ^{222}Rn concentration in all tested locations: 2.5 ± 1.6 Bq/ m^3 . Similar results obtained with our own Rn detector (Burrige Rad-7).

[1] J.Keisel & J.Dorda (Inst. Phys., U. Silesia, Katowice, Poland), Aug 2005.

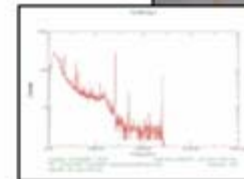


TARI funded inter-lab study of radon and gamma backgrounds

Boulby low background lab



Boulby Radon and NaI detectors



Boulby Ge detector - & early background spectrum



Gadolinium loaded scintillator neutron background measurement.



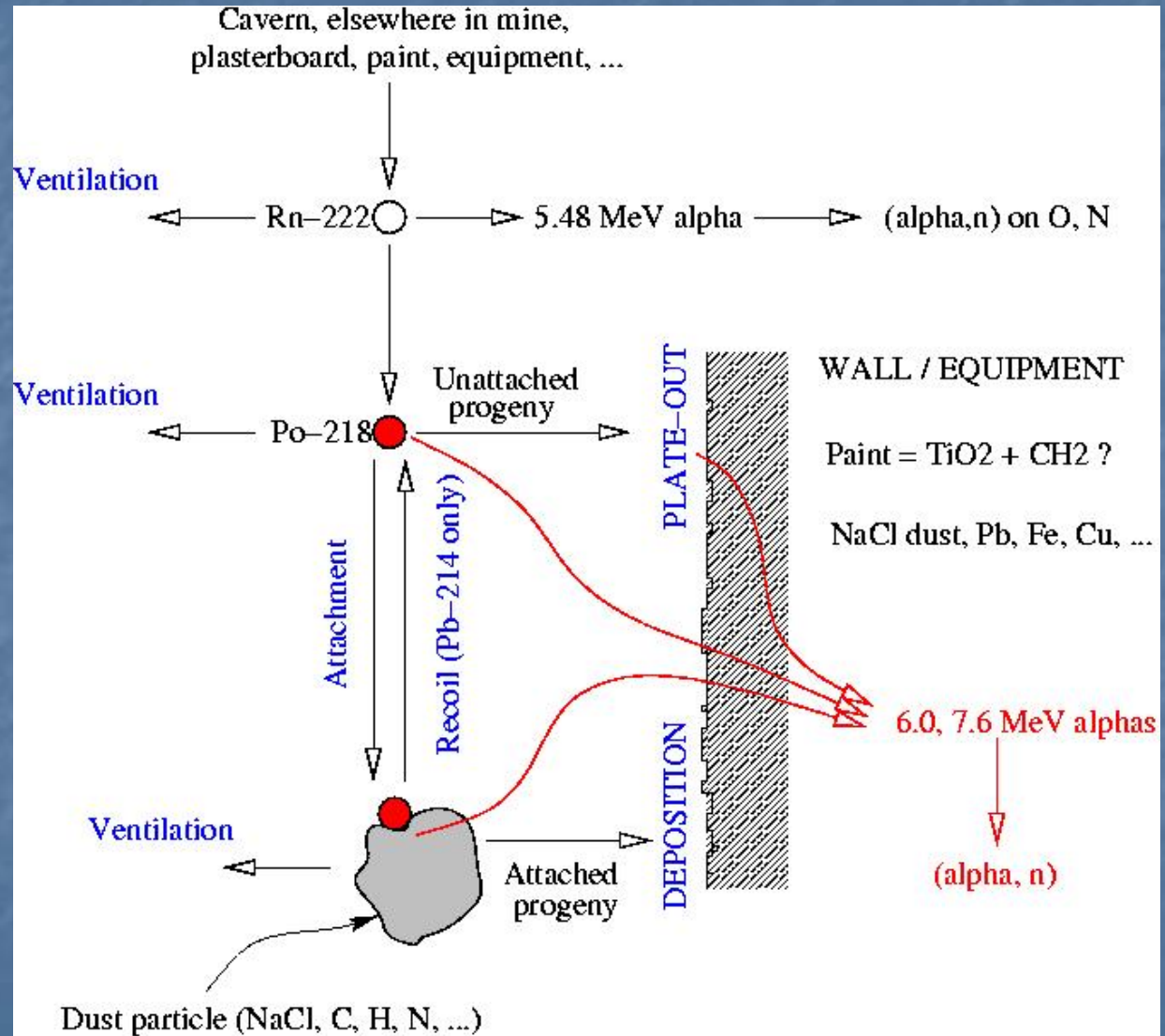
Boulby Radon and NaI detectors

Ongoing / Planned Background Studies

- NUTS: 6.5L Gd-loaded scintillator detector. Two-pulse signature (proton recoils followed by gammas from neutron capture) is used to distinguish n events. (see talk by E.Tziaferi).
- DRIFT-IIa: 1m³ (167g) low pressure CS₂, Negative Ion Drift TPC detector. Neutron-induced recoils produce distinctive high dE/dx tracks.
- ZEPLIN-II veto: Gd-lined liquid scintillator. Plans for a muon-induced neutron investigation are currently under consideration.
- Investigation of radon levels, radon-progeny plate-out / deposition and additional n-flux due to associated (α , n) reactions...

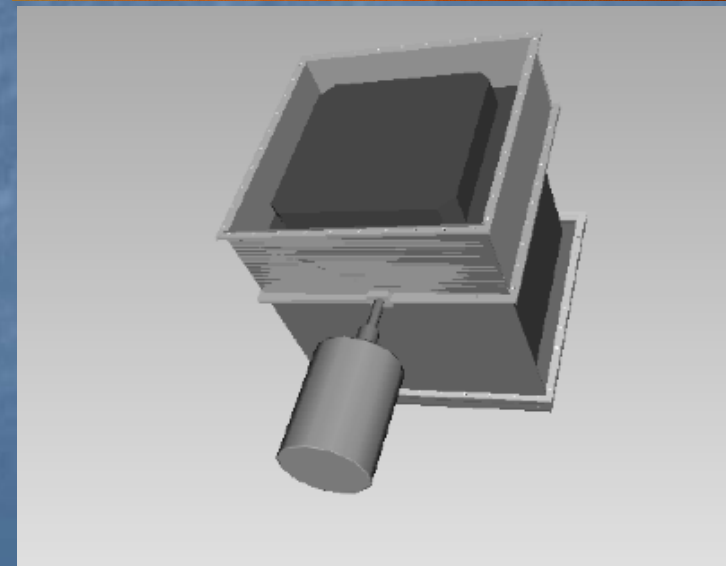
Is Radon a Problem?

- U-238 contamination on surfaces within and around lab.
- Resulting Rn can diffuse – resulting plate-out / deposition is not expected to match distribution of original contamination.
- Highest-energy α 's in U-238 decay chain produced by Rn – progeny.
- (α, n) cross-sections tend to increase with energy (typically 0.1-1 barn)

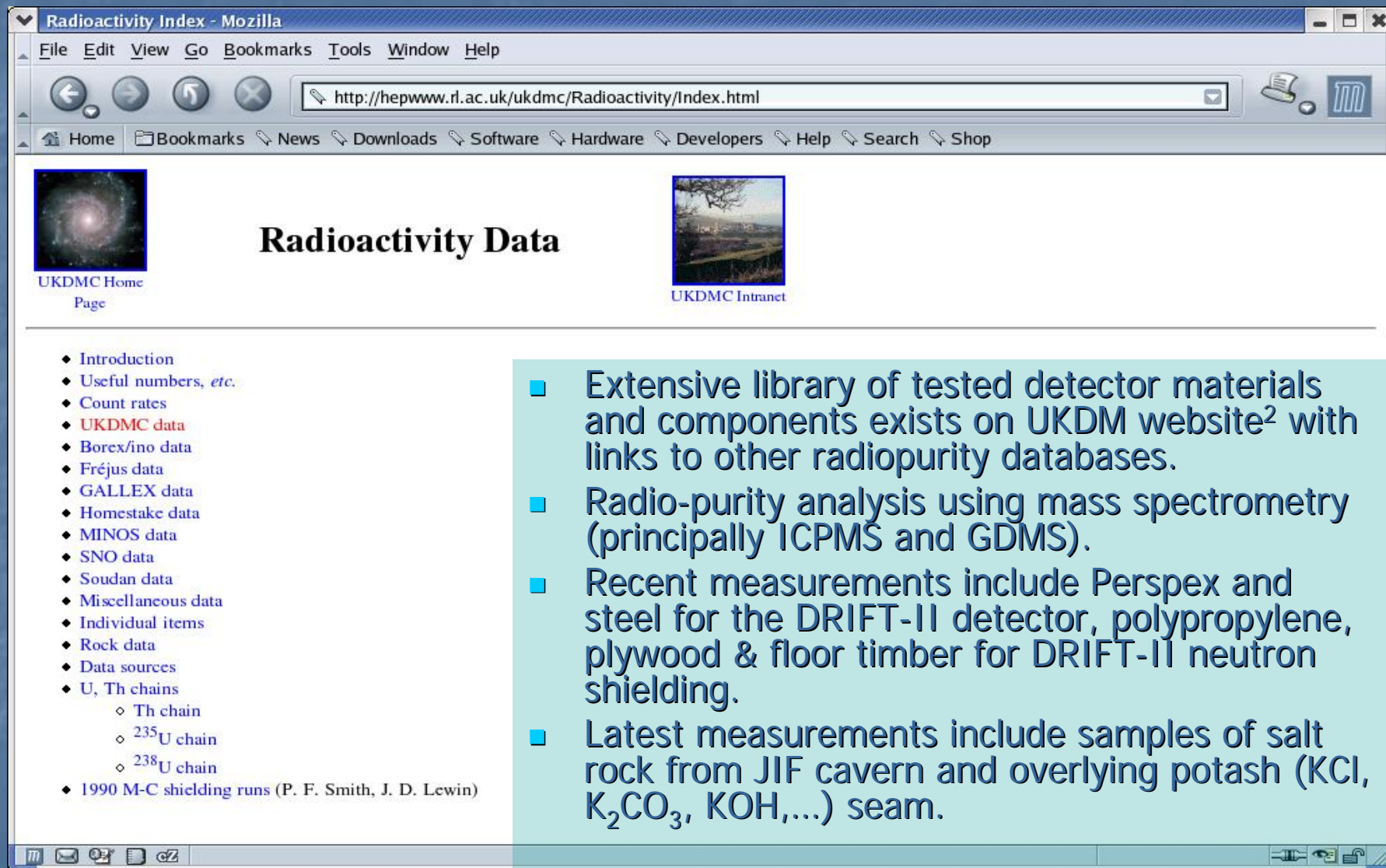


Low-B/G Facility: HPGe-detector

- Castle for HPGe detector currently under construction (8cm OFHC Cu, surrounded by 15 cm Pb).
- Ge-detector castle contained within Rn-'shroud' – box over-pressured with dry N₂ to displace Rn gas and reduce activity from Rn progeny.
- Estimated sensitivity: $\sim 1e-9$ g/g



Material Radiopurity Testing





Radioactivity Index - Mozilla

File Edit View Go Bookmarks Tools Window Help

http://hepwww.rl.ac.uk/ukdmc/Radioactivity/Index.html

Home Bookmarks News Downloads Software Hardware Developers Help Search Shop

 **Radioactivity Data** 

UKDMC Home Page

UKDMC Intranet

- ◆ Introduction
- ◆ Useful numbers, *etc.*
- ◆ Count rates
- ◆ UKDMC data
- ◆ Borex/ino data
- ◆ Fréjus data
- ◆ GALLEX data
- ◆ Homestake data
- ◆ MINOS data
- ◆ SNO data
- ◆ Soudan data
- ◆ Miscellaneous data
- ◆ Individual items
- ◆ Rock data
- ◆ Data sources
- ◆ U, Th chains
 - ◇ Th chain
 - ◇ ^{235}U chain
 - ◇ ^{238}U chain
- ◆ 1990 M-C shielding runs (P. F. Smith, J. D. Lewin)

- Extensive library of tested detector materials and components exists on UKDM website² with links to other radiopurity databases.
- Radio-purity analysis using mass spectrometry (principally ICPMS and GDMS).
- Recent measurements include Perspex and steel for the DRIFT-II detector, polypropylene, plywood & floor timber for DRIFT-II neutron shielding.
- Latest measurements include samples of salt rock from JIF cavern and overlying potash (KCl, K_2CO_3 , KOH,...) seam.

[2] <http://hepwww.rl.ac.uk/ukdmc/Radioactivity/Index.html>

...Material Radiopurity Testing



Raw rock samples crushed using geology dept. facilities at Sheffield



Samples sent for GDMS testing

Summary

Background studies:

- Repeats of earlier Ge-detector & Rn detector tests underway,
- N-b/g measurements with DRIFT-II,
- N-b/g measurements with NUTS,

Low B/G Lab:

- Shielding for Ge-detector under construction,
- Other infrastructure (crane, HEPA-filter,...) in place.

Radiopurity testing:

- Samples of cavern rock being tested.
- Large publicly-accessible database of results continually growing...