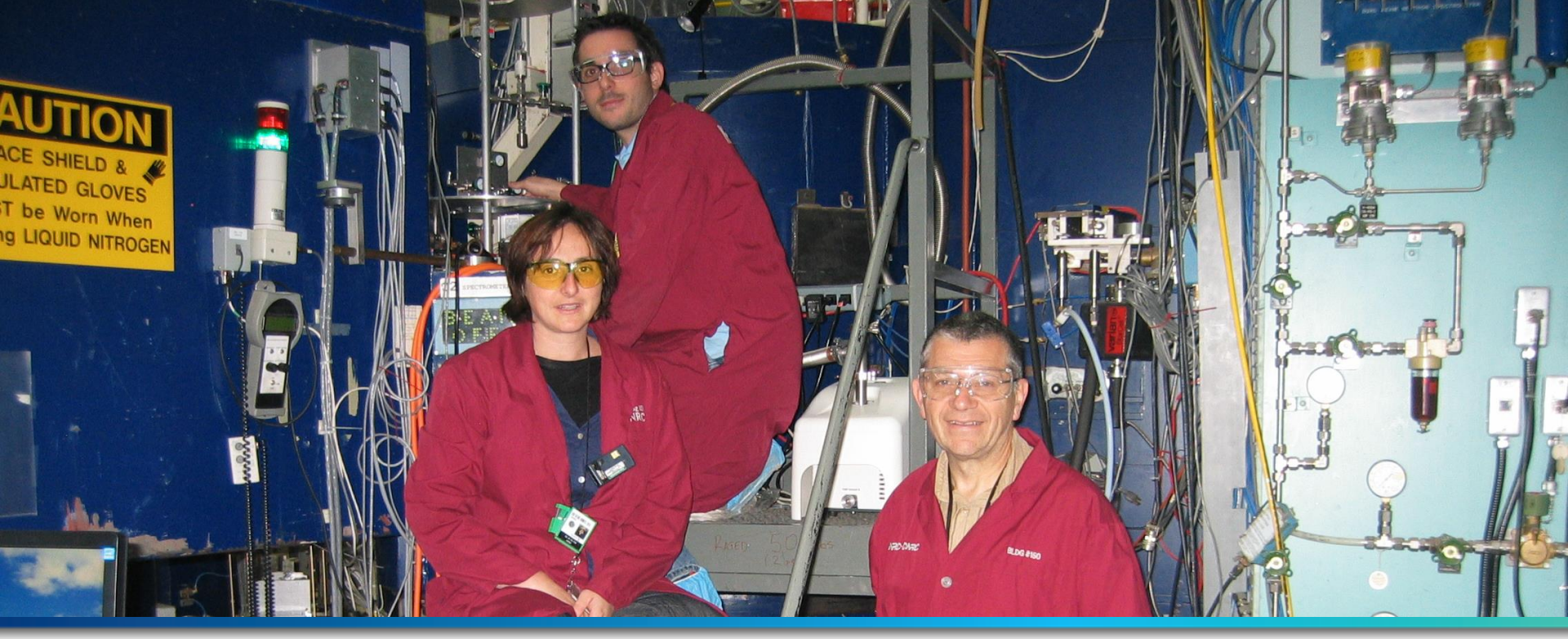

Managing Neutron Beam Scans at the Canadian Neutron Beam Centre

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Canadian Neutron Beam Centre

NRU: Canada's multipurpose research reactor

Six beam lines:

- Powder Diffractometer
- Polarized Beam
- Triple-Axis Spectrometers
- Reflectometer
- Stress-Scanning Diffractometer

Ancillary equipment:

- Cryostats
- Furnaces
- Monochromaters
- Filters
- etc.

http://www.cnl.ca/en/home/facilities-and-expertise/nru/default.aspx

Experiment Control

Sample space involves many independent variables:

- location, duration, magnetic fields, temperature, stress, background measurements, sample changes, beam focus, energy levels ....
- An experiment may involve scanning at thousands of points within the sample space.

During the experiment, scientists:

- Specify the points in sample space
- Sequence the points
- Run sequences of points
- Modify and rerun the sequences
- Organize the data into data sets for analysis

Experiment Control

Issues to address:

- Minimize the paradigm shift
  - There's 30 years of experience in the current system
- Identical software on all beam lines
  - Differences between beam lines addressed through configuration mechanisms
- Low learning curve for the basic functionality
  - Many visiting scientists come for days/weeks
  - Must be able to work independently

Managing the scans...

- Formalize the concept of 'scan' using a basic algebra:
  - Scans defined in terms of set theory
  - Set of operators for building scans (sequence, dot product, multiply, interleave, ...
  - e.g.,
    - `step(Q,...) | bg(...)`
    - `((step(PHI,...) ^ m_flip('up', 'down') ^ d_flip('up'))) * step(TEMP,...)`
- Repository:
  - templates of commonly used scan types (stepping, background, texture, polarized scans...)
  - User defined templates

Managing the scans

- User database
  - One per experiment
  - Each record defines a scan
  - Records are constructed by instantiating templates and combining using scan algebra
- Execution sequence
  - Expression to select and sequence records from the scan database
  - Basic operators for sequencing, repeating, e.g.:
    - (5-30), 99*10, (50-40)
  - Organize the acquired data for analysis

Managing the scans

Scan template repository
- Templates of scanning techniques
- Common + user defined
- Relatively stable

Scan database
- One db per experiment
- Instantiate and combine templates
- Frequently modified, even during experiment

Scan Sequence
- Expression to select and sequence records from the database
- Organize acquired data

Implementation

- EPICS Based control system
- Identical system deployed on all beam lines
- Scan algebra implemented in the Python language:
  - Python operators redefined as scan algebra operators
- Repository:
  - Templates are parameterized Python functions
  - Users can build their own templates
- Database
  - Usually quite simple, spreadsheet suffices
  - Ability to add Python scripting
- GUI for selecting and sequencing records from the database

- Thanks to:
  - Lee Cusick, Dave Dean, Ron Donaberger, Tim Whan

- Questions?
  - … and answers!