SpecTk: a displayer for NSCL SpecTcl

D. Bazin
National Superconducting Cycloton Laboratory
Michigan State University
East Lansing, MI 48823

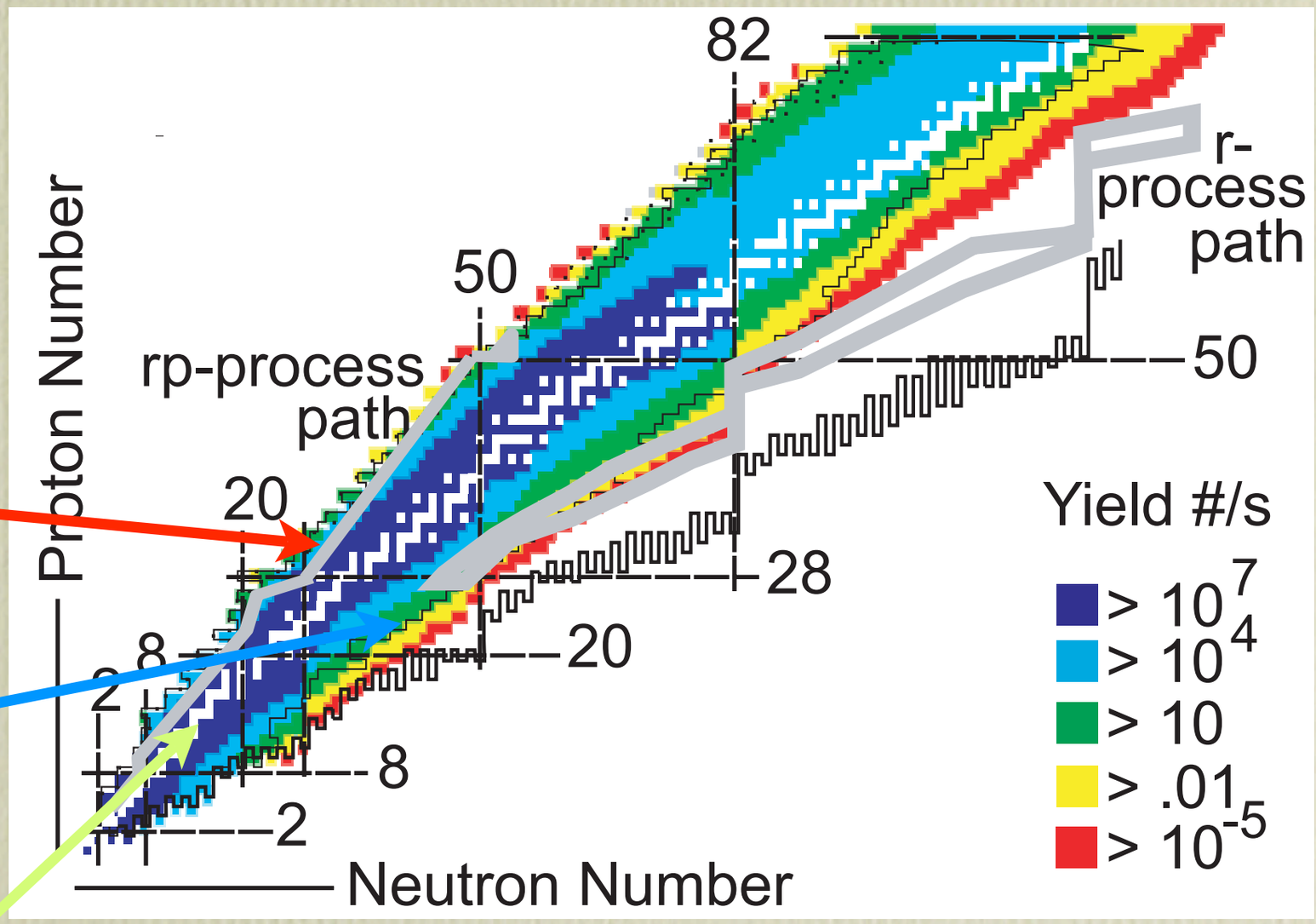
What do we study?

- Exotic nuclei
  - Stable nuclei found on earth are only a small fraction
  - Other nuclei with different number of protons and neutrons are unstable
- Isotopes
  - Same number of protons
  - Same chemical element

Proton-rich isotopes

Neutron-rich isotopes

Stable nuclei



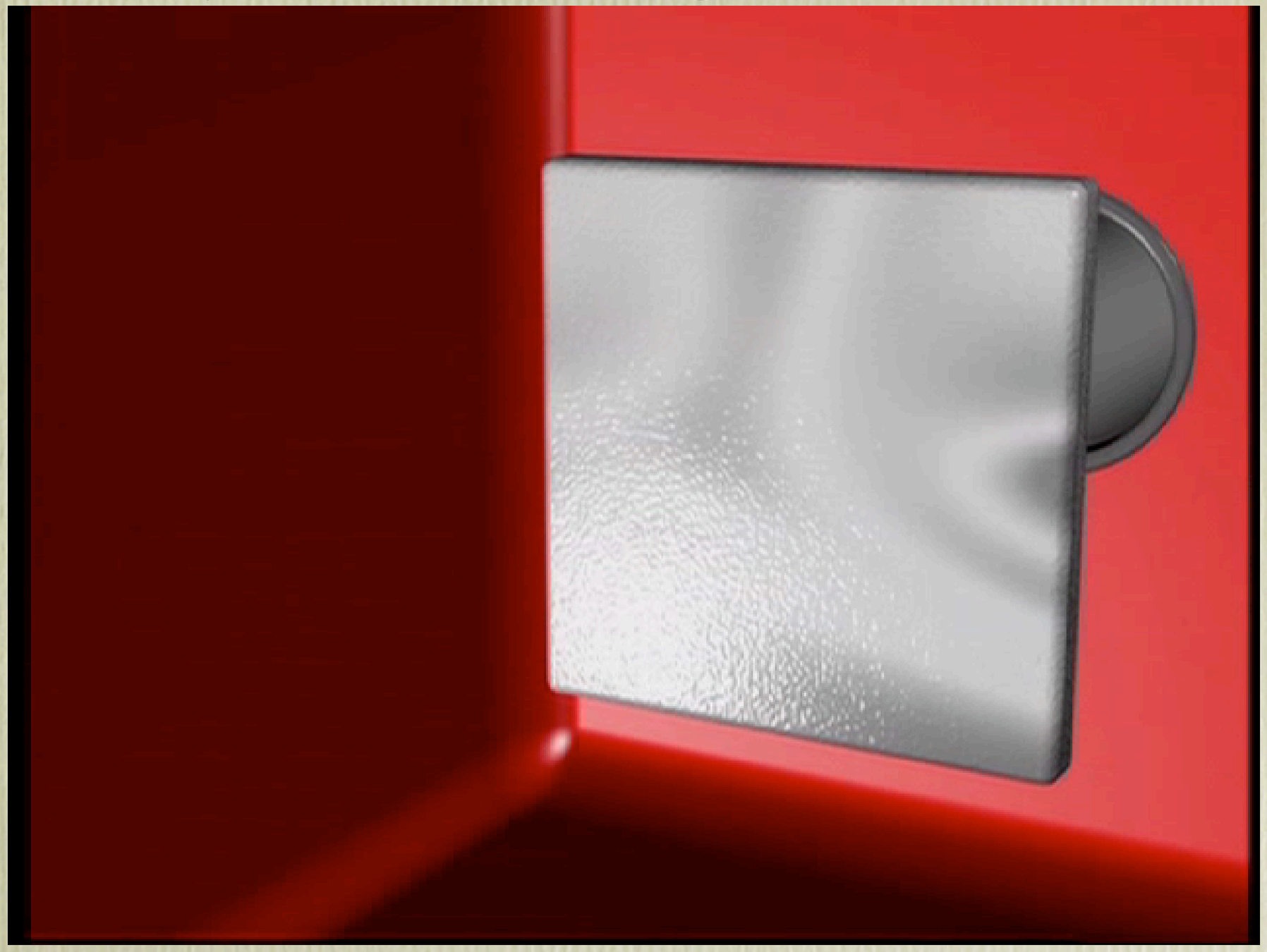
D. Bazin, Tcl 2005 conference, October 2005, Portland, OR

How do we make them?

- Nuclear reaction called Projectile Fragmentation
  - Accelerate stable nuclei to about ⅓ of the speed of light
  - Break off a piece randomly by smashing them on a fixed target
  - Collect the fragments
  - Filter out the uninteresting nuclei
  - Perform the experiment with them real quick!

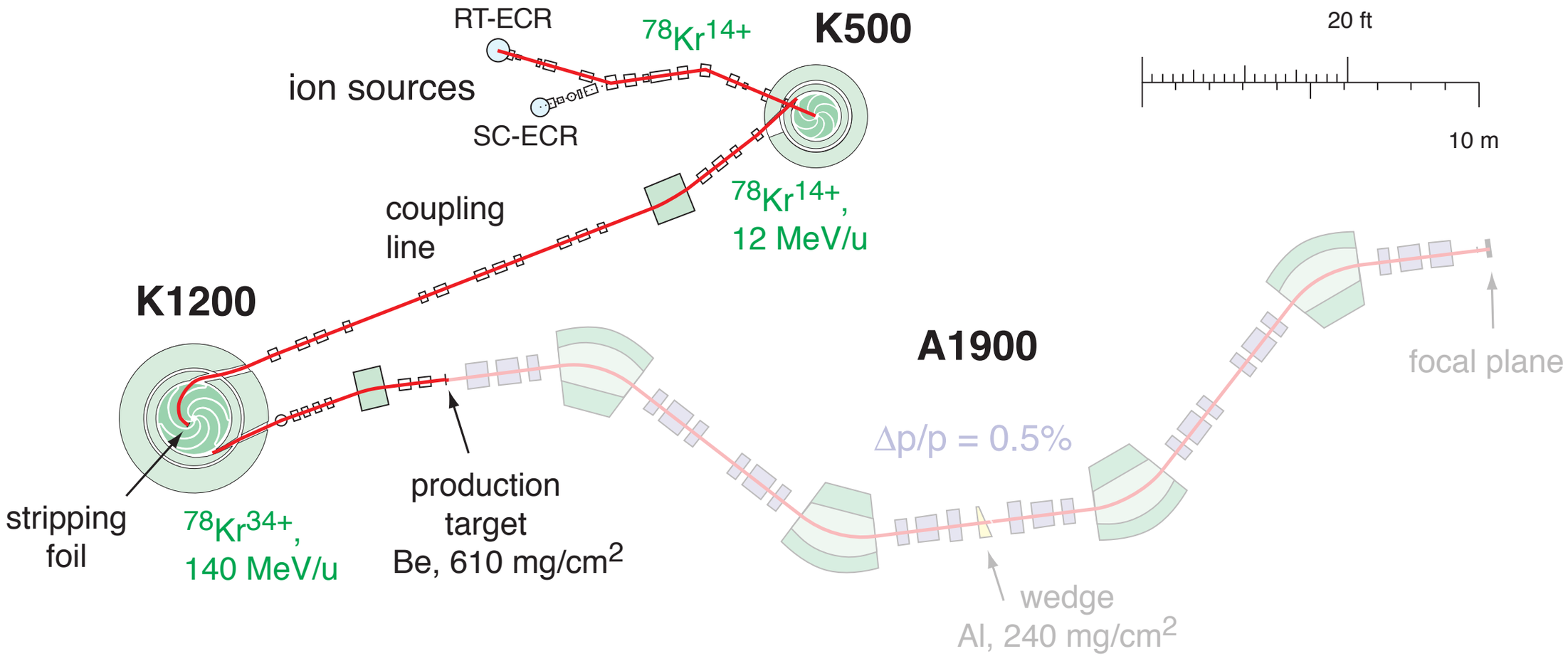
- Big machines for tiny particles
  - Cyclotrons accelerate the stable nuclei
  - Fragment Separator selects the good ones
  - Spectrograph measures their properties
  - All these machines require strong magnets
  - NSCL uses Superconducting magnets: more field for less current

Projectile Fragmentation

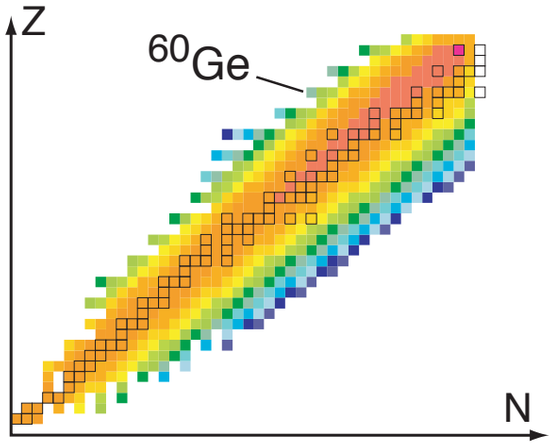


Excerpt from “Nucleus Factory” by W. Benenson and W. R. Richards, © 2004 Michigan State University

Experimental Setup at the NSCL

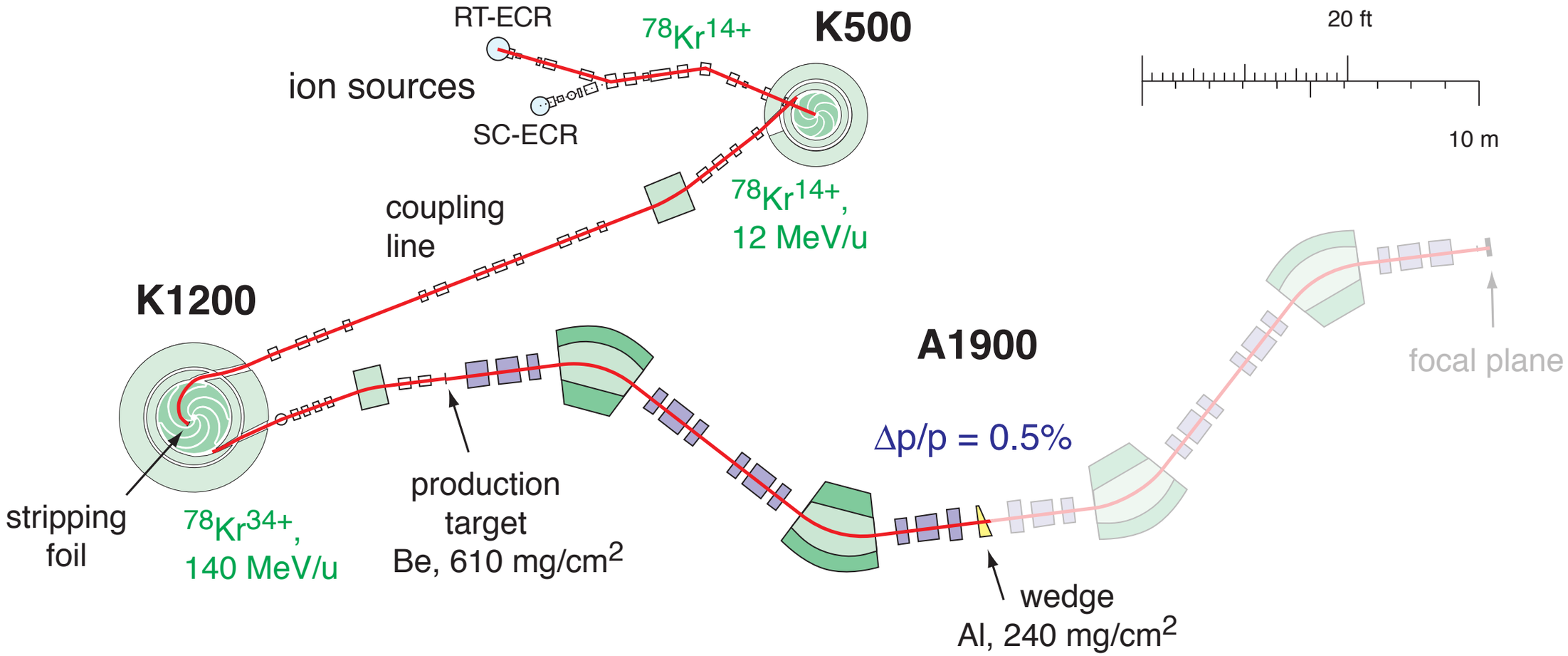


fragment yield after target

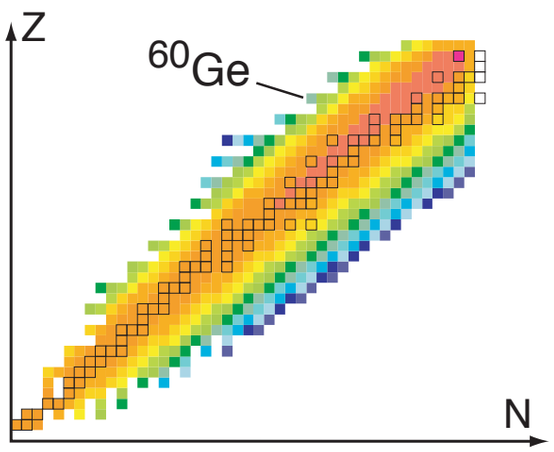


stolz@nscl.msu.edu 2005-01

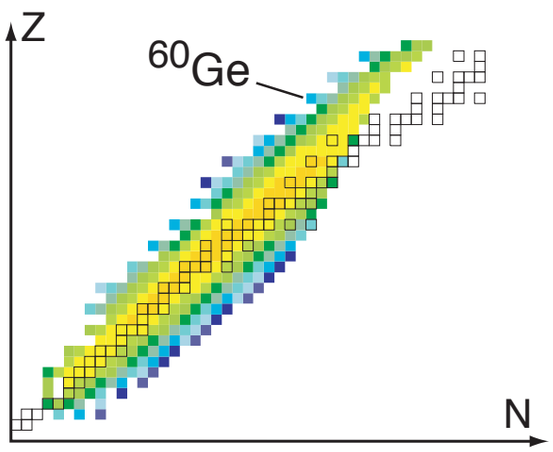
Experimental Setup at the NSCL



fragment yield after target

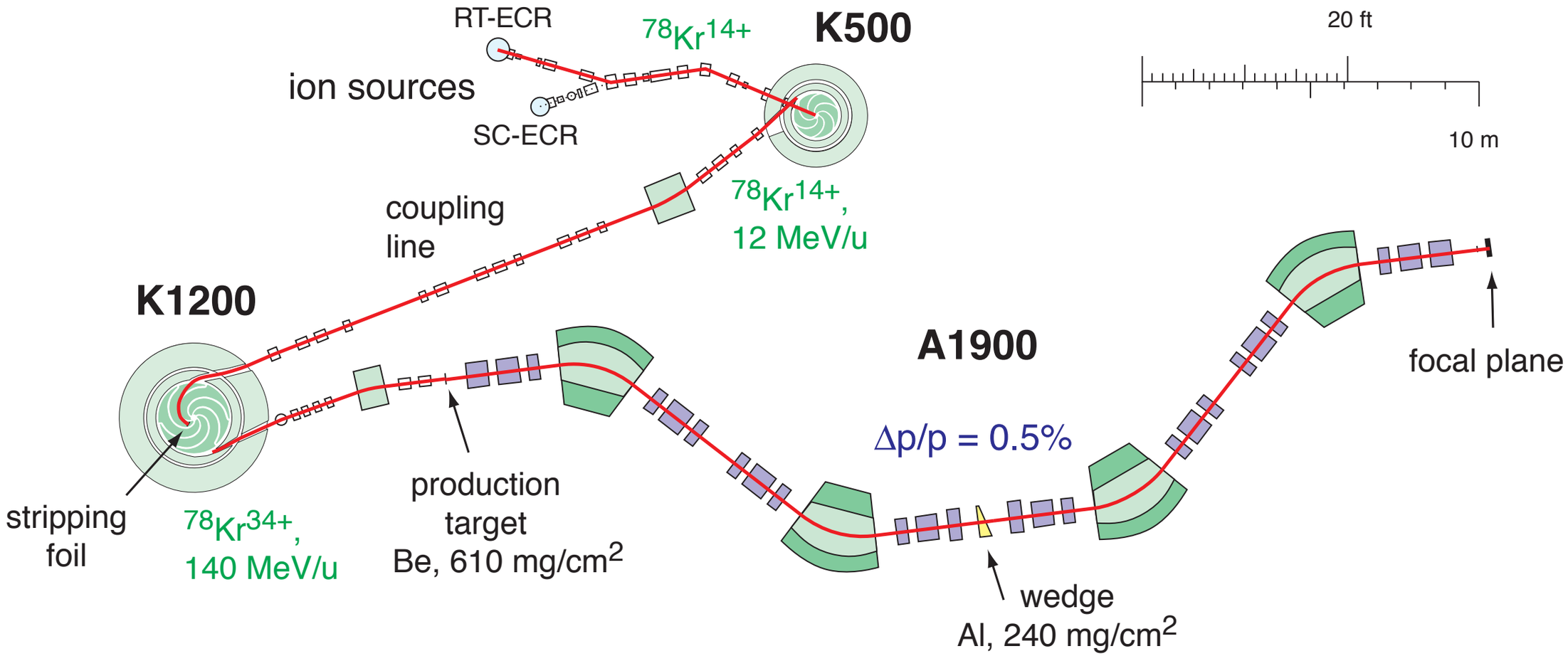


fragment yield after wedge

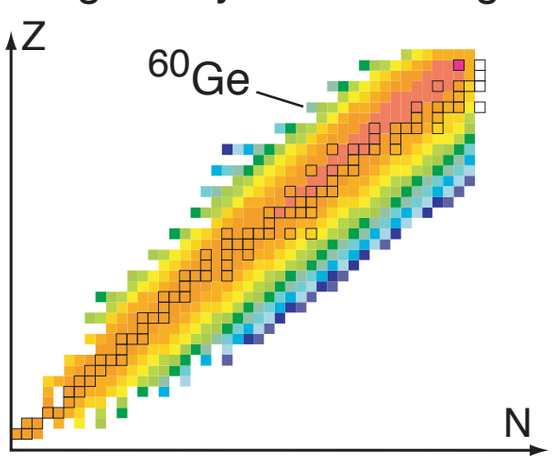


stolz@nscl.msu.edu 2005-01

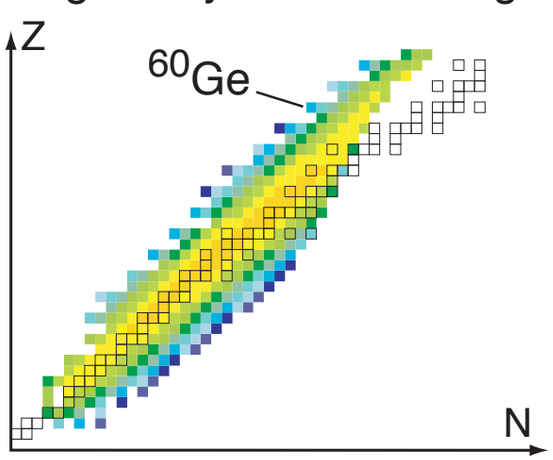
Experimental Setup at the NSCL



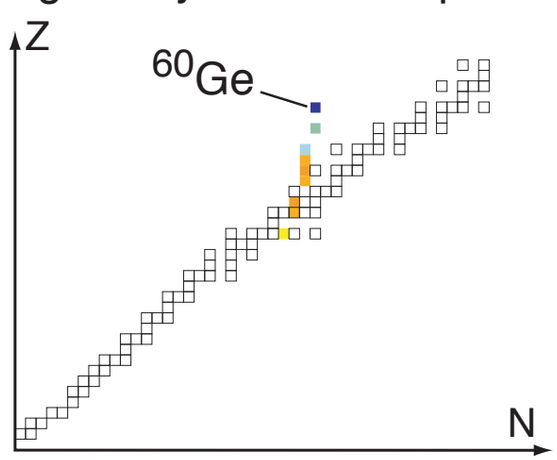
fragment yield after target



fragment yield after wedge



fragment yield at focal plane



stolz@nscl.msu.edu

Why is it so interesting?

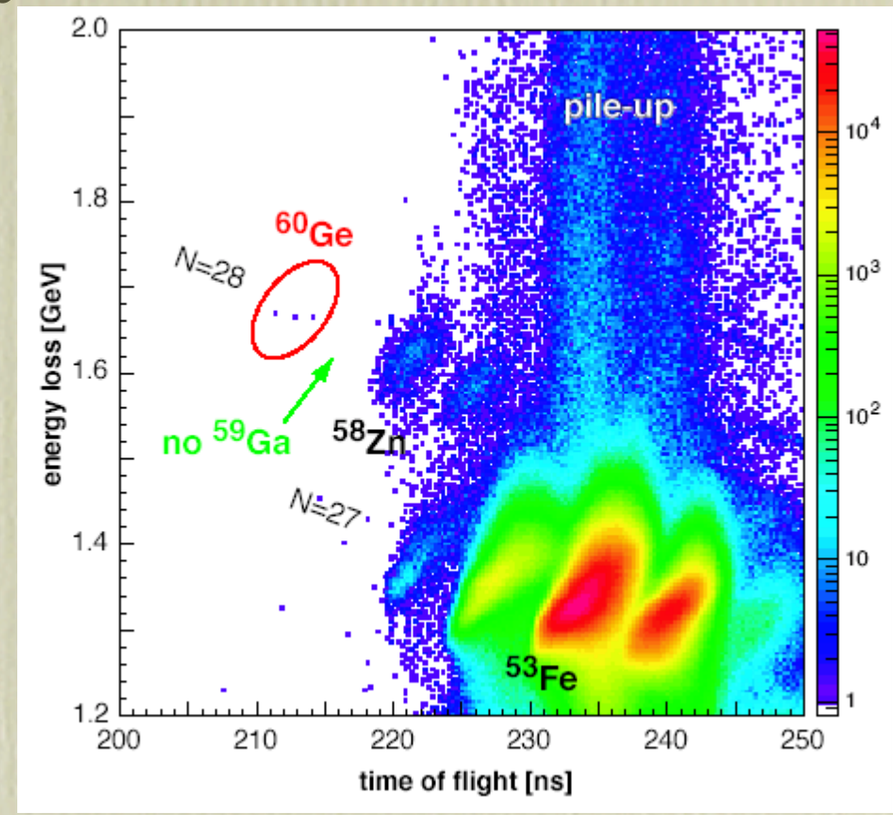
- Nucleo-synthesis in stars proceeds via exotic nuclei
  - How do stars make the elements we observe in the universe?
  - Nuclear reactions in stars or supernovae produce exotic nuclei which decay back to stability
  - Assembly of elementary particles in nuclei leads to complexity in the universe
  - Need for structure but also reaction mechanism knowledge
- Quantum many-body system governed by strong force
  - Many-body system governed by gravity: our solar system
  - Quantum many-body system governed by electromagnetic force: atoms
  - How do nuclear properties change when we vary the proportions of protons and neutrons?
  - Learn about fundamental interactions such as the weak and strong forces and their associated symmetries

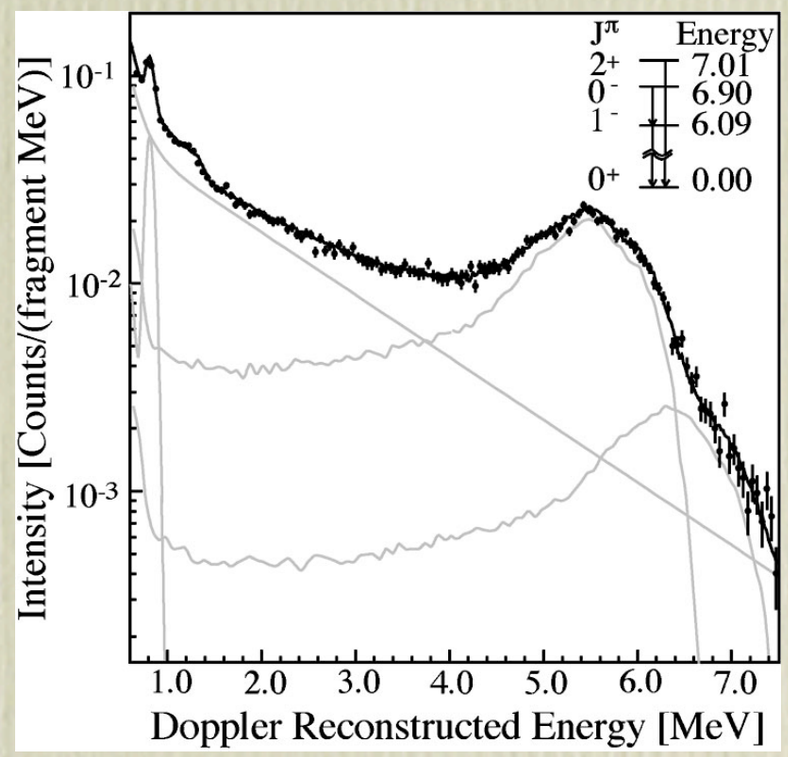
A typical experiment...

- Chain of observation
  - Phenomenon happens at the nuclear level
  - Some or all particles are registered by detectors
  - Signals from detectors are measured by electronics
  - Data from electronics is read and stored by a computer
  - Computer manipulates data and displays a representation
  - Physicist looks at display and tries to understand the phenomenon!
- The last link...
  - ... is critical
  - The displayer should accurately show the data in a representation that relates to the phenomenon as much as possible
  - In practice that means showing each event in representations based on physical units

Needles and Haystacks

- Accuracy of data representation is paramount
  - for analysis and interpretation of experiment
  - during data taking phase for proper diagnostic of experiment sanity
- At the NSCL:
  - NSCL SpecTcl is an analysis program which can sort, filter and accumulate data in histograms (written by R. Fox)
  - Histograms stored in memory need to be visualized and manipulated by physicists.
  - This is the purpose of SpecTk.
  - User-friendly not enough, need Physicist-friendly!





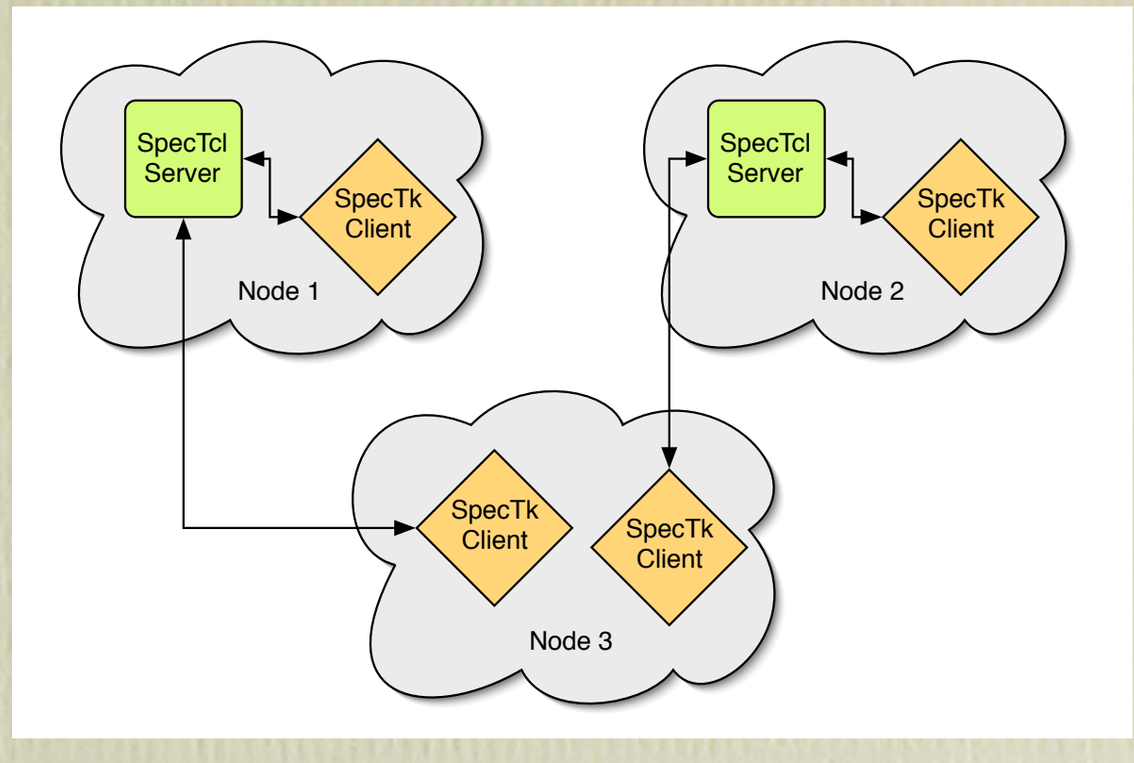
D. Bazin, Tcl 2005 conference, October 2005, Portland, OR

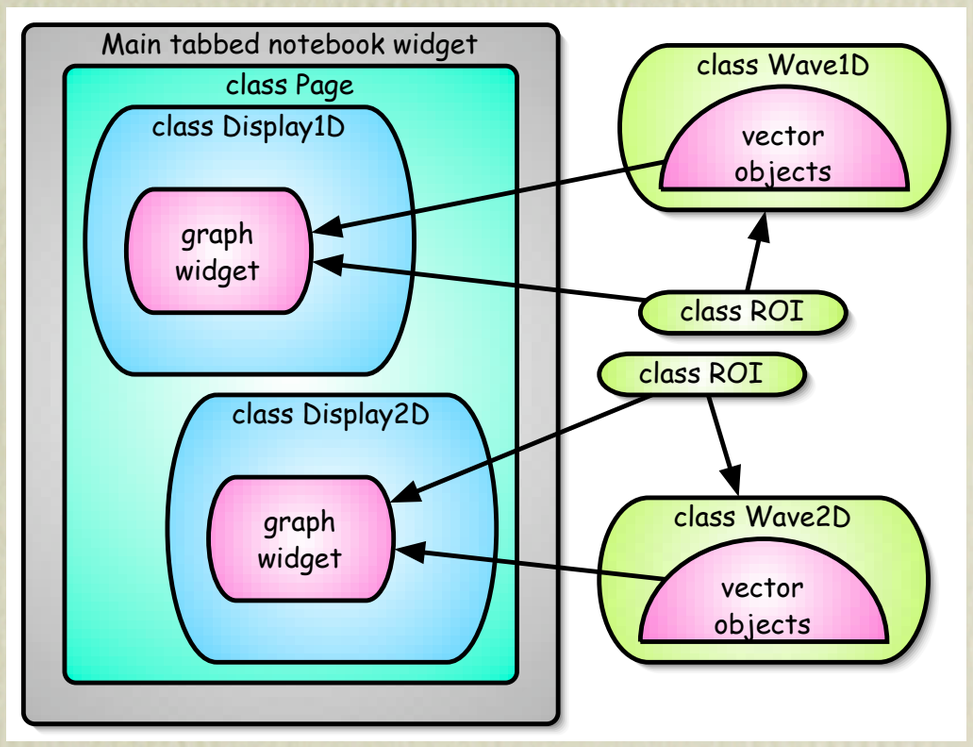
Praise for Tcl/Tk

- A language for other people...
  - ... than just programmers and computer specialists
  - SpecTk wouldn't have been created without Tcl/Tk and BLT
- Tcl/Tk framework
  - Client - Server network communications
  - Bindings - great for graphical user interaction
- Incr Tcl
  - Object oriented programming
  - Namespace encapsulation
- BLT package
  - Graphs provide almost all desired functionalities
  - Vectors are a powerful tool to store and manipulate data
  - Trees offer flexible and easy handling of large lists
  - Tabbed notebooks allow the most efficient use of real estate

Architecture of SpecTk

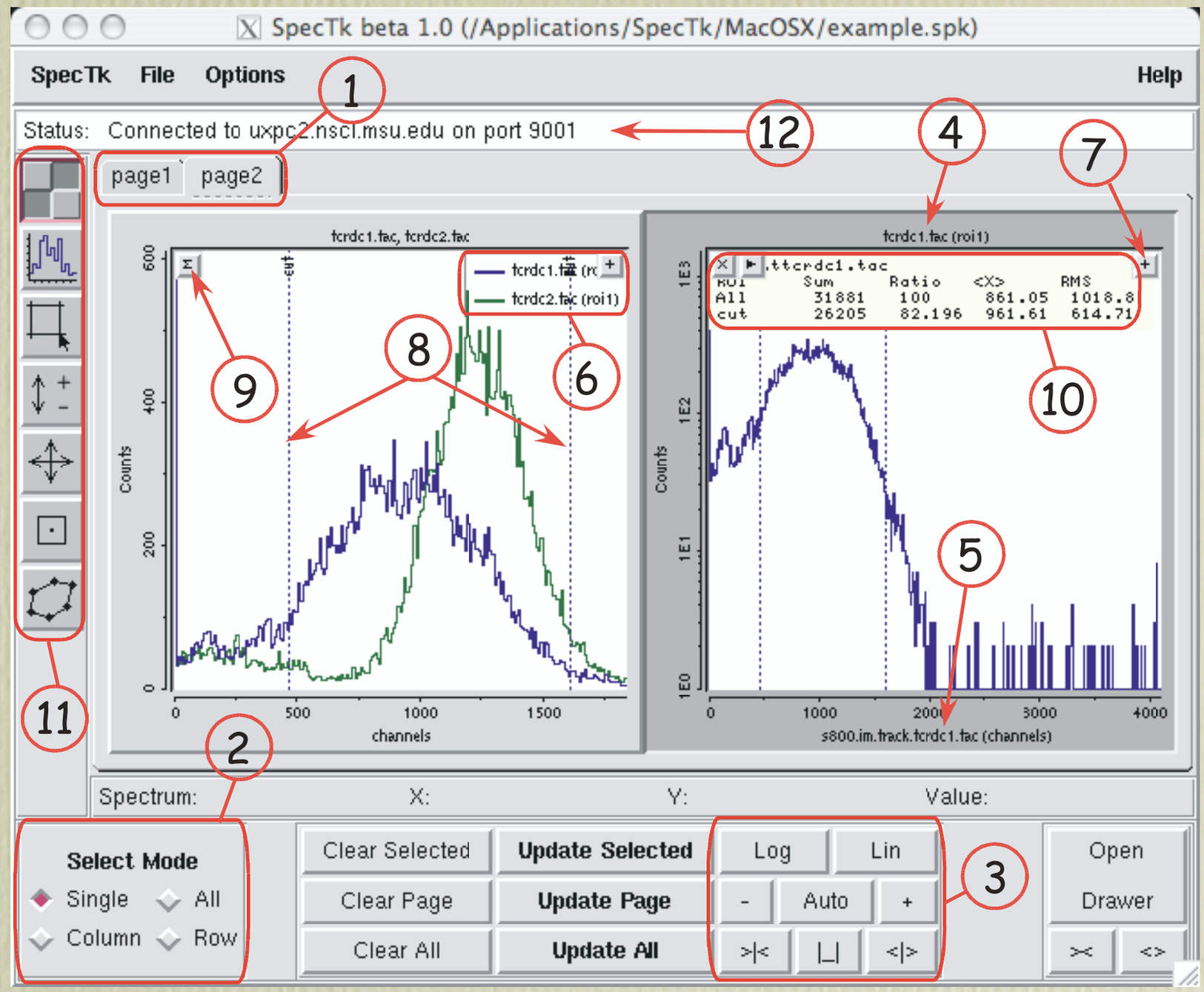
- Network architecture
  - Client of NSCL SpecTcl
  - Flexible configurations
  - Remote usability
  - SpecTcl commands captured in server and dispatched to clients
- Internal architecture
  - Histogram data contained in BLT vectors
  - Two-dimensional data in vectors rather than arrays
  - Graph widgets embedded in display classes
  - Region-of-interest (ROI) objects used by SpecTcl for filtering





A short aperçu...

1. Tabbed pages
2. Select mode
3. Inspect buttons
4. Histogram title
5. Parameter name
6. Multi view legend
7. Magnify button
8. ROI display
9. Statistics button
10. Statistics results
11. Tool bar
12. Status bar



A few last words...

- SpecTk mostly written in Tcl
  - A few new Tcl commands are implemented in C++
  - API from the BLT package allows direct manipulation of vectors
  - Implemented commands:
    - Create Tcl Photo Image from two-dimensional histogram data
    - Filter data inside polygon in subset vectors
    - Send histogram data in compressed binary format (SpecTcl server)
- Multi-platform portability
  - Originally developed on Mac OS X
  - Ported to Linux and Windows
- Foreseen improvements
  - Histogram data manipulation (binning, arithmetics, ...)
  - Custom fitting
  - User feedback!