



Operator vs. Automation

Lawrence Berkeley National Lab

88" Cyclotron Operations

August 7, 2012

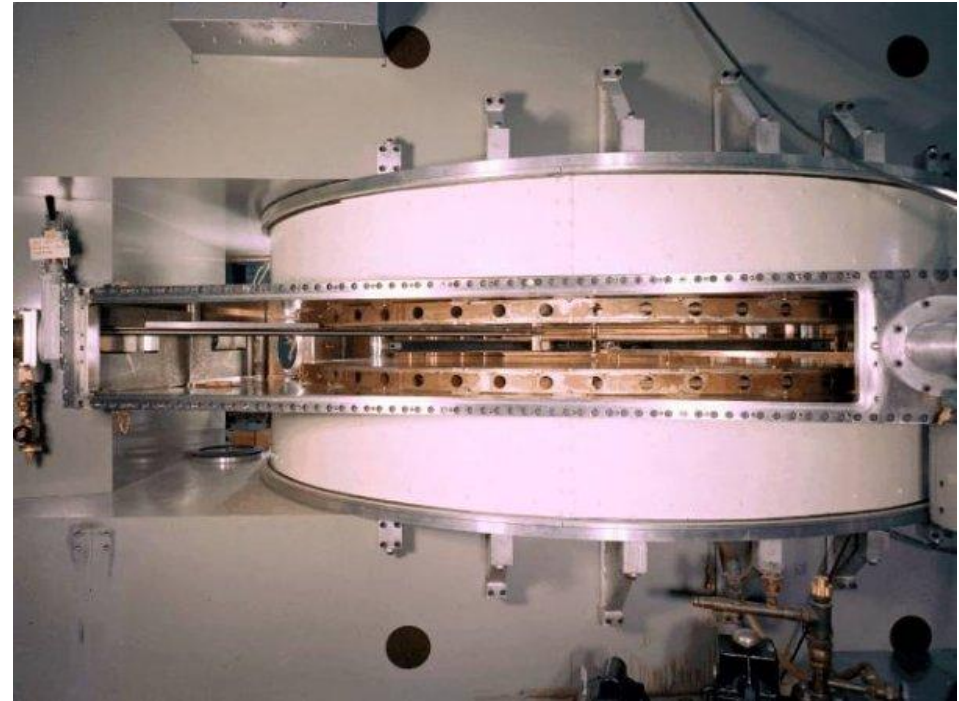
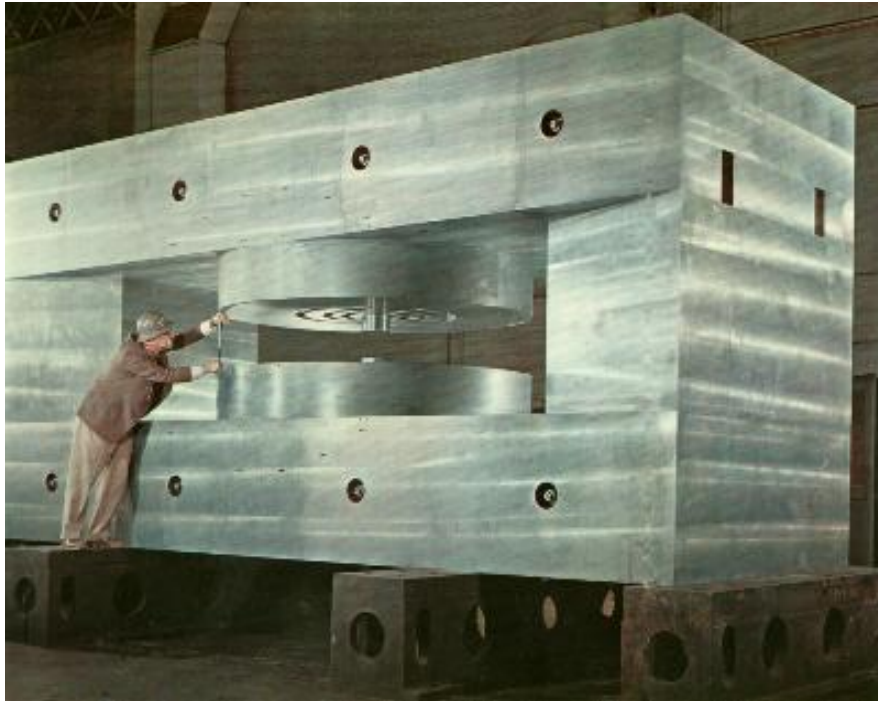
Navid Radnia



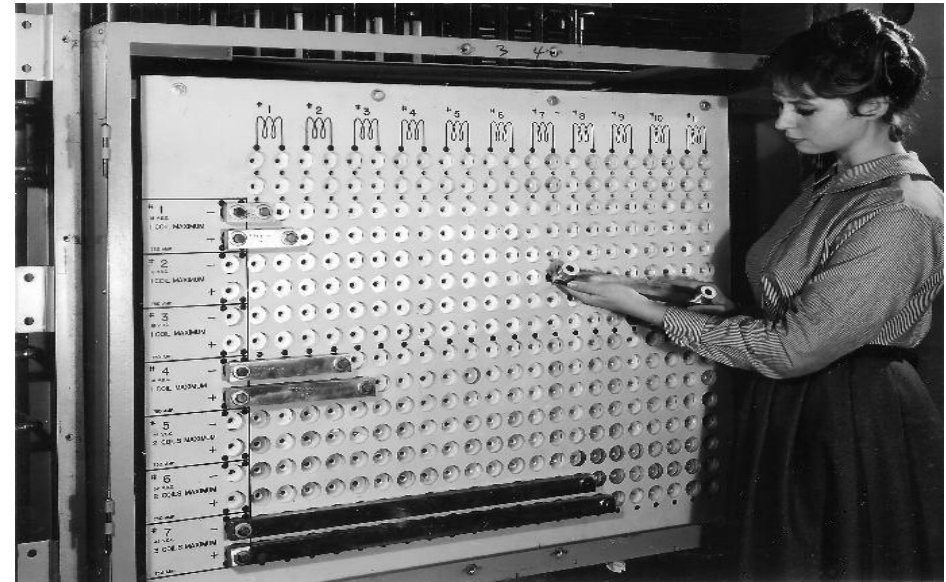
Glossary



- **History of the 88” Cyclotron**
- **History of Automation**
- **Why our facility has stayed analog?**
- **Current Automation Proposal**
- **Finding a Balance**
- **Possible Solution**
- **What do you propose?**



- K=140 sector-focused cyclotron
- Light- and heavy-ion capabilities
- Maximum energies: 55Mev(p), 65Mev(d), 170MeV(3He).
- Most heavy ions through uranium can be accelerated to maximum energies which vary with the mass and charge state.



- 1500 man-hours of work were necessary to assemble the trim coils which help regulate the strength and shape of the accelerator's magnetic field. (LEFT)
- Power supplies are patched in with bus bars on a patch panel. Setup is still used today. (RIGHT)



88" Cyclotron



- First internal beam on December 12, 1961. (LEFT)
- First external beam in May 1962. (RIGHT)



BGS

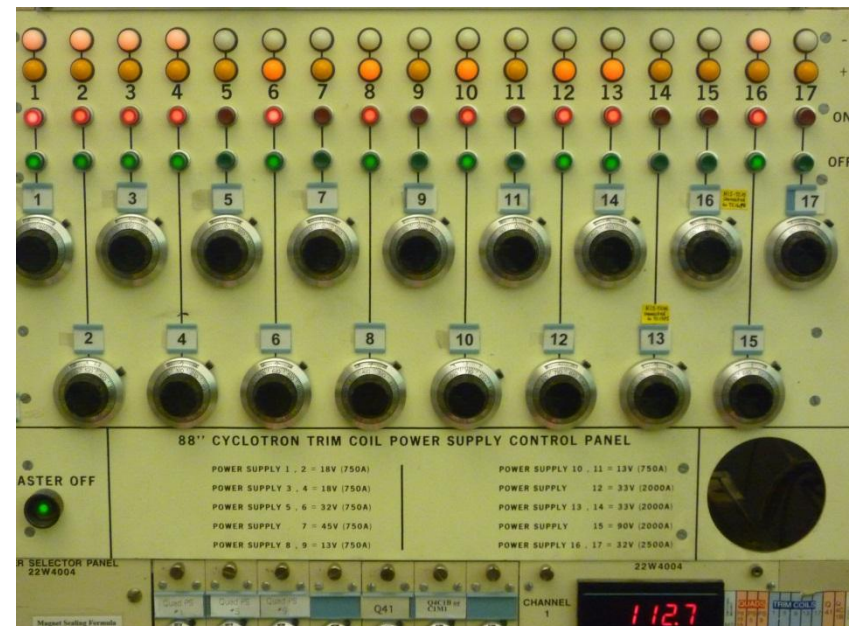


VENUS

- Major instrumentation at the 88-Inch Cyclotron includes the Berkeley Gas-filled Separator (BGS) and Versatile ECR ion source for Nuclear Science (VENUS), a third-generation superconducting ECR ion source and prototype for the Rare Isotope Accelerator (RIA).

Attempts over the years to integrate automated Trim Coil control.

- First attempt in 1960's
 - IBM Punch Cards
- 1980's to Present
 - Tech Boom



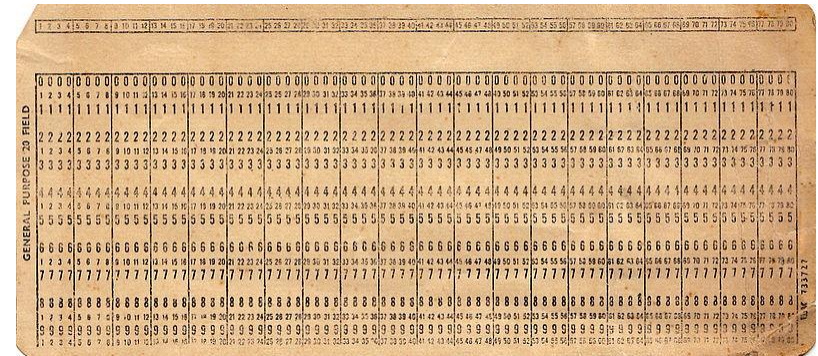


1960's



Goal of Proposal

- ✓ Monitor Set points.
- ✓ Decrease tune time to 20-25 minutes per shift.
- ✓ Annual Savings of about \$75,000



Failures

- ✓ Feedback Errors
- ✓ IBM Punch Card Errors
- ✓ More Time Consuming



1980's to Present



Software & Equipment Lost to Tech Boom

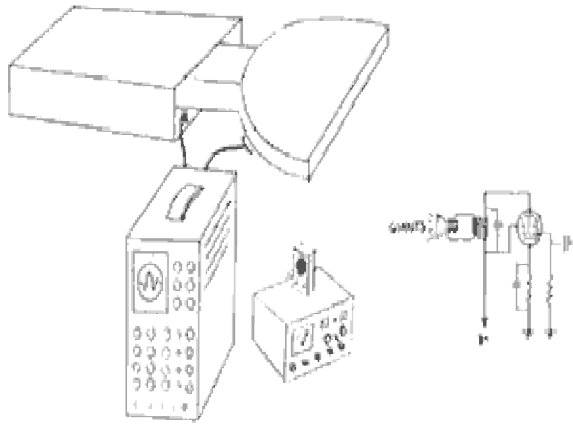
- FORTRAN
 - Cyclotron Development (CYDE)
 - ✓ Program used to calculate Trim Coil Solution.

- Outdated Equipment
 - ✓ Power Supplies
 - ✓ Variable Controllers

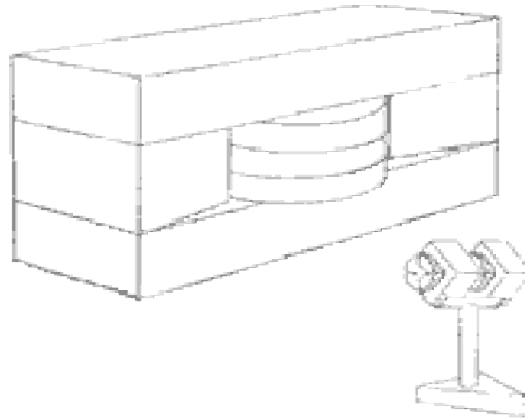




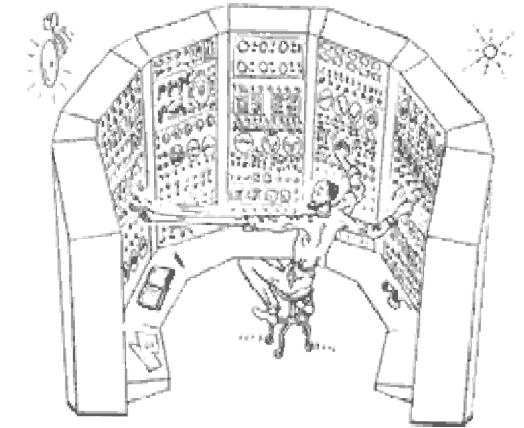
The Cyclotron, as seen by....



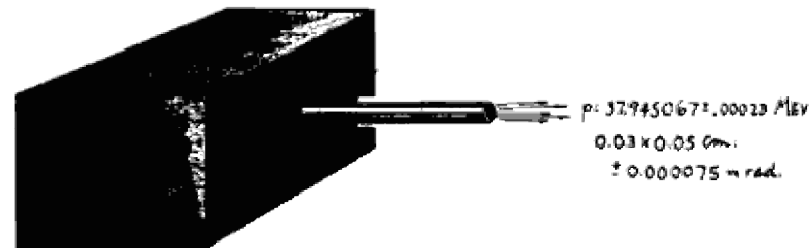
...the Electrical Engineer



...the Mechanical Engineer



...the Operator



...the Experimental Physicist



88" Cyclotron



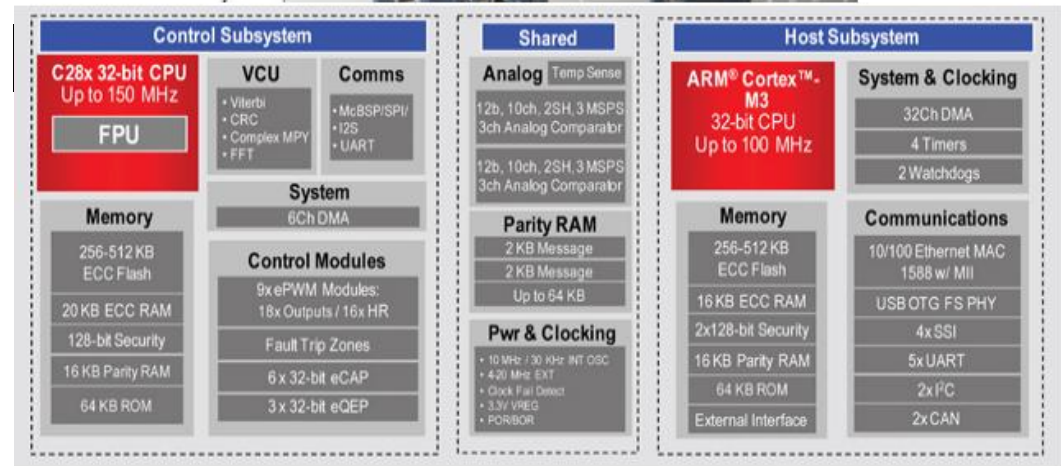
Why our facility has stayed analog?

- **Budget**
- **Operational Issues**

Why our facility has stayed analog?

➤ Budget

- Software Engineer
- Power Supplies
- Variable Control
- And many more



Why our facility has stayed analog?

➤ Operations

■ Automation Failures

- ✓ Optimizing beam intensity
- ✓ Not as simple as it looks.





Current Proposal



- Trim Coil Upgrade
 - Design
 - ✓ Digitally Controlled & Automated
 - ✓ Stored preset values for a particular product.
 - ✓ Algorithm that will optimize beam intensity.

- Not Considered



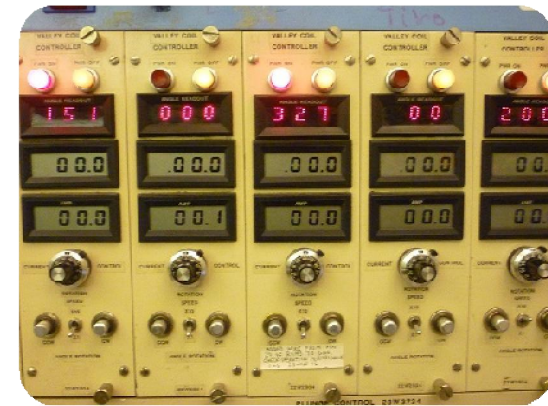
- ✓ Chassis configured with only one pot for all
What about weekly meetings and
work planning? failure.
- ✓ Two pots necessary for optimization upon
failure of automated system.

- Existing Design Flaws in Control Room

✓ Bunchers



✓ Valley Coils





Finding a Balance



- Key factors in determining a balance.
 - Machine Efficiency
 - Operator Knowledge
 - Problem Solving



Finding a Balance



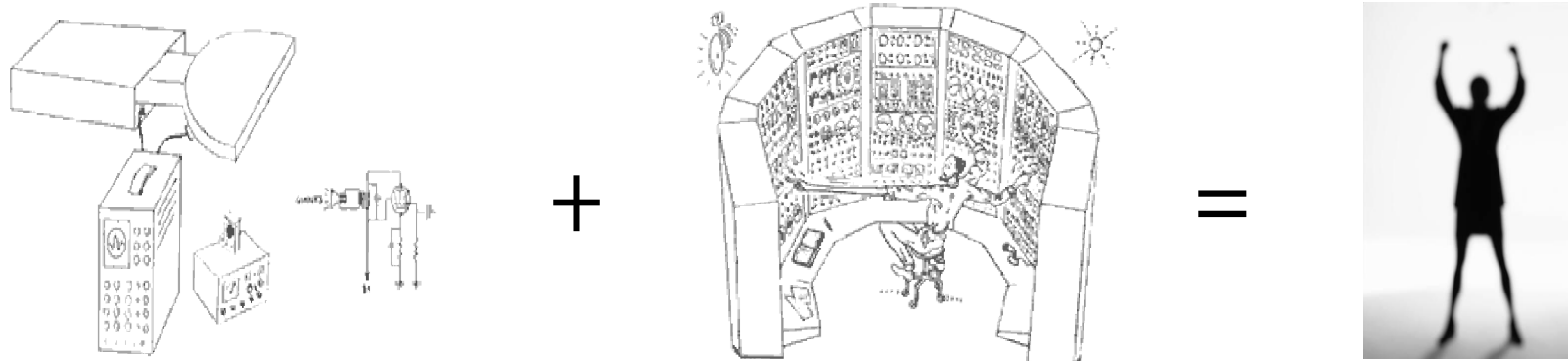
- Machine Efficiency
 - Operator
 - ✓ Involve operator in design
 - ✓ Parameters available to Operator.
 - ✓ Must be an appendage.
 - Automation
 - ✓ Software would have to evolve.



Finding a Balance



- Operator Knowledge & Problem Solving
 - Operator
 - ✓ Mechanical, Electrical & Infrastructure
 - ✓ Software knowledge
 - ✓ Checklists



- Get the right people more involved
 - Engineer
 - ✓ Control Room
 - ✓ Tuning Methods and Styles
 - ✓ Help bring more reality to theory



Questions?

