Potentially Relaxing

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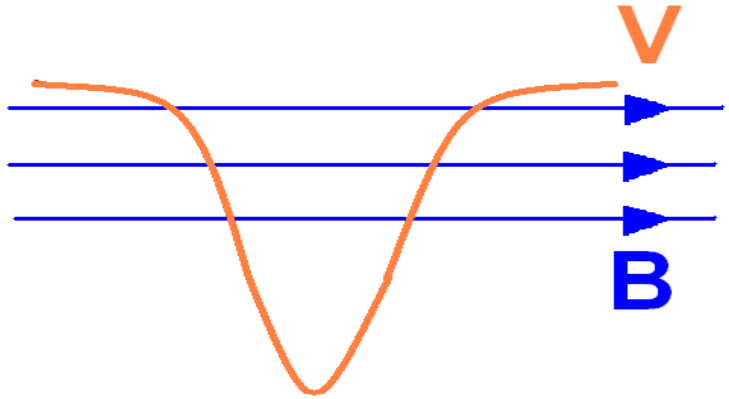
ATRAP: An Antimatter TRAP

- Hydrogen's antimatter twin

- Our group and our competitors have *made* antihydrogen, but no one has been able to *trap* it.
- The goal is to make and trap cold (not moving) antihydrogen, so that we can study its properties.
  - CPT Violation!

How Do You Trap Antimatter?

- Penning trap for charged particles.



F=q **v** x **B**

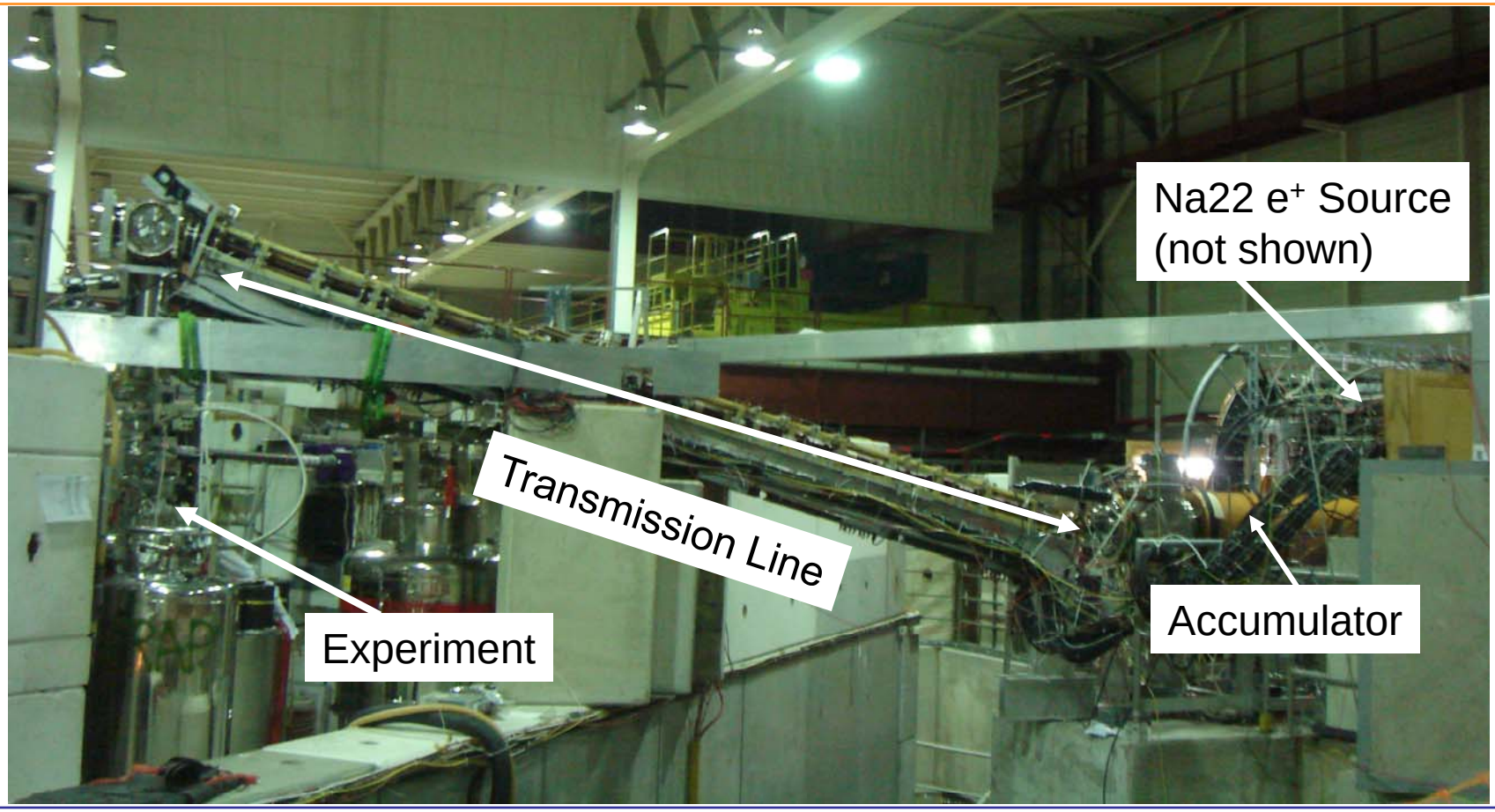
Potential Well

- Ioffe trap to capture neutral atoms.
- Big challenge: keeping track of magnetic fields with the nested trap.

What Have I Done and Why?

- Positrons are randomly emitted from Na22 source.
- Must collect e^+ and send to trap in a bunch.
  - Accumulator = another penning trap.
- Need to know potential *in* the trap, not just on the edges.
- Use LabVIEW and C++ to do a ‘relaxation calculation’.

Positron Transmission



Ahhh, Relaxation

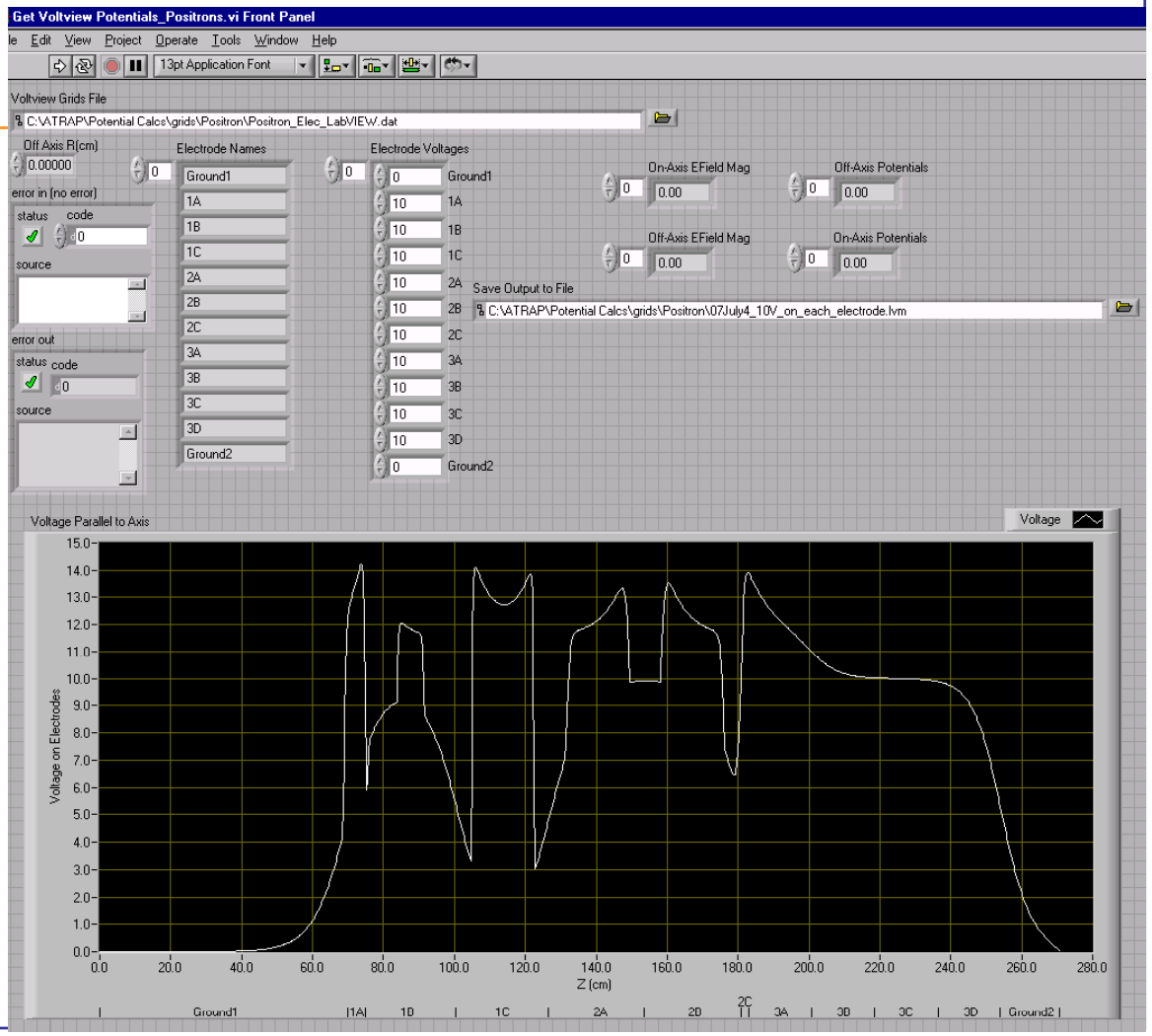
Boundary Conditions

10	10	10	10
0	2.05	3.13	0
0	1.03	1.94	0
0	0	0	0

- Approximate with a grid.
- In rectilinear coordinates, put average of nearest neighbors into point.
- Cylindrical coordinates adds a natural log correction.
- Do for each point in grid, iterate through grid several times to get ‘complete relaxation’.

LabVIEW Program

- Need to efficiently be able to calculate the potential at the center of the electrode ‘stack’.
- C++ code wasn’t working properly, so my LabVIEW program was giving non-physical outputs.
- Learned and read C++ code to debug the program.



What the Problems Might Have Been

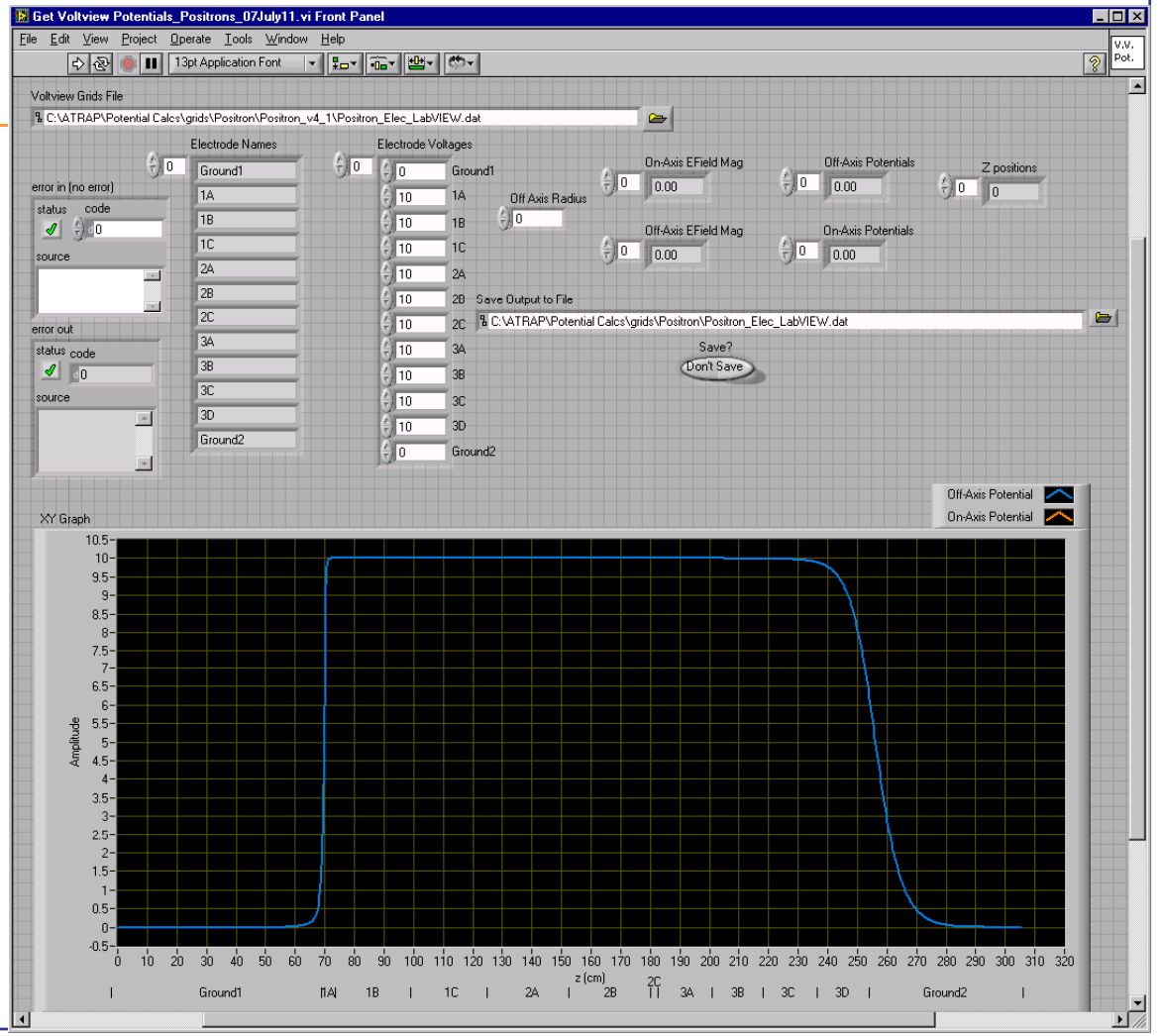
1	1	1	1	1	1	1			
0	0	0	0	0	0	0			
0	0	0	0	0	0	0	0		
0	0	0	0	0	0	0	0		
0	0	0	0	0	0	0	0		
0	0	0	0	0	0	0	0		
0	0	0	0	0	0	0	0		
0	0	0	0						
0	0	0	0						
0	0	0	0						

Inside electrode stack:
Do relaxation here

- Originally written for a simpler geometry.
- Program doesn't always handle diameter changes well.
- It may not be defining initial boundary conditions correctly.
  - Assume putting 1V on blue electrode, 0V on green electrodes.
  - Purple points *should* be 1, but they may not be defined, so default to 0.
- Assumes all electrodes ~same radii.
- Assumes not long and skinny.

LabVIEW Program

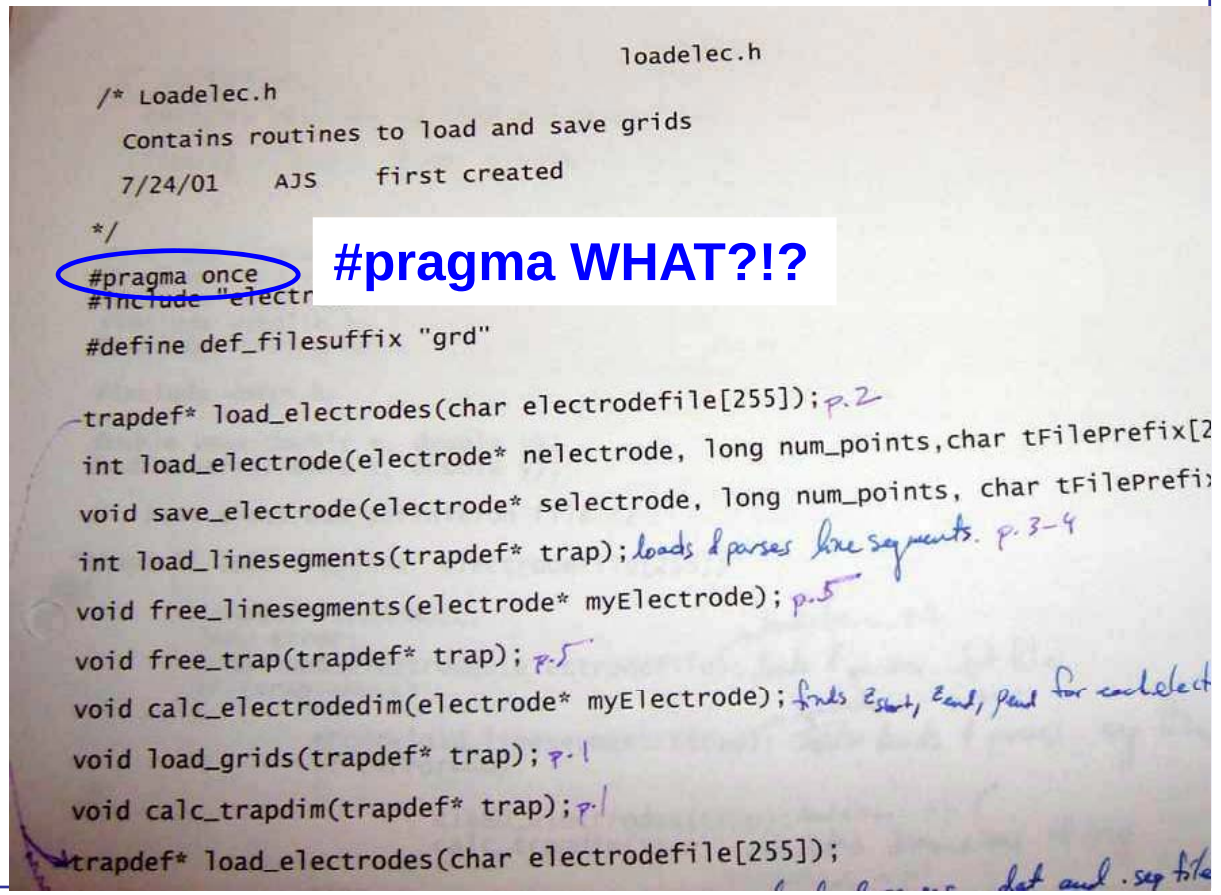
- Now it works!!!
- Input name of ‘relaxed’ grid files, voltages on electrodes.
- Output is on-axis potential.
- Fixes:
  - Better boundary handling
  - Length optimization
  - More flexible geometries accepted



- Thanks to Andrew Speck, original author,

Reading Some Code

- The relaxation wasn't working.
- Found problems in the C++ code.
- Convoluted structure of functions.
- Hard, since I learned C++ as I went.



Optimizing Pulse Generators

- Old system:
  - Ping Pulse Generator, ask it if it's gotten a pulse.

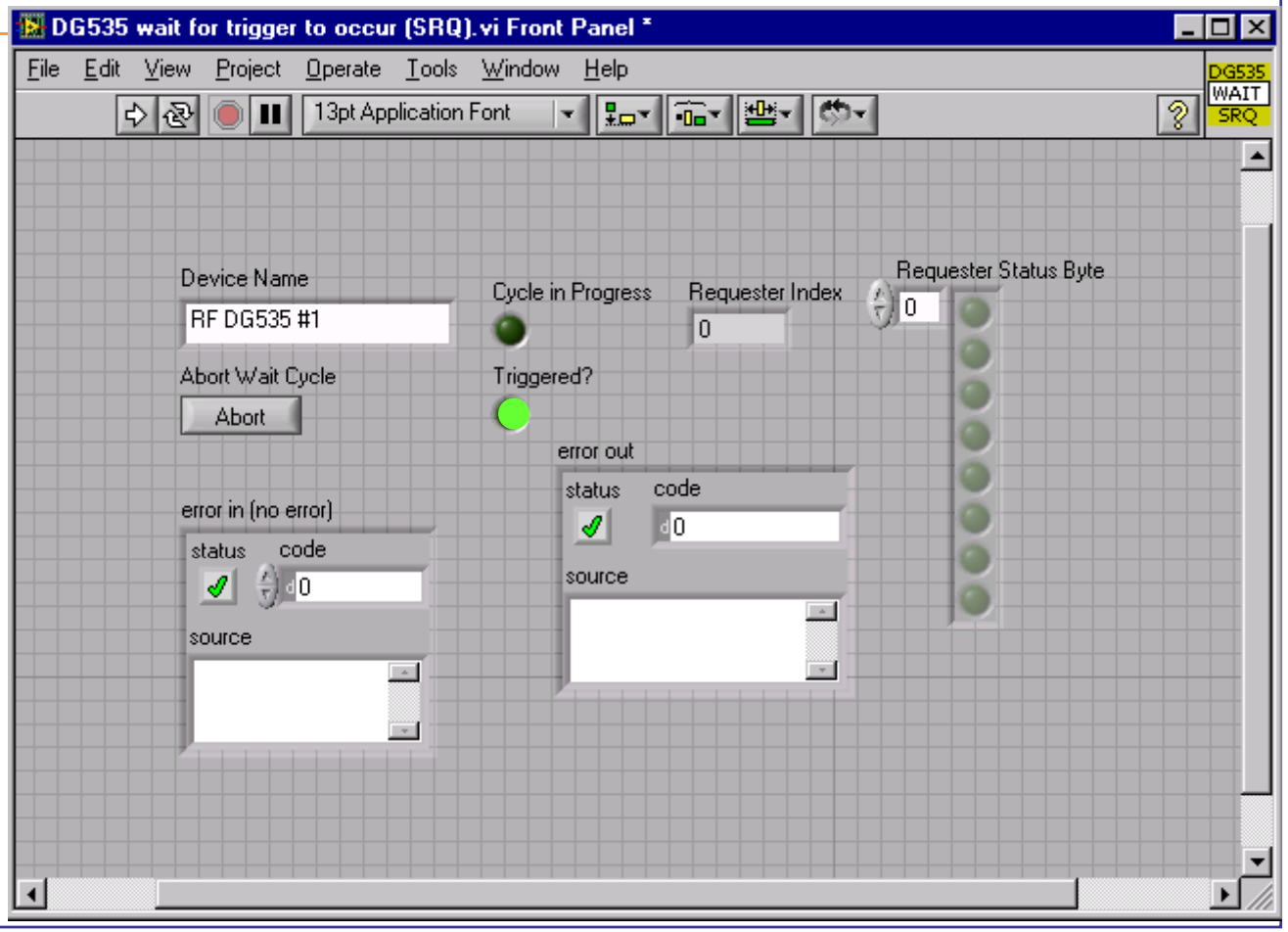
- Pulse Generators used for many applications, including injection of antiprotons.
  - Control room sends a pulse when they are about to eject.
  - Our Pulse Generators see this, and tell the rest of our hardware to get ready.
- Need software to be aware of the injection of antiprotons into the trap.

Hey!

- New system:
  - Have the Pulse Generator tell the computer when it has received a pulse.

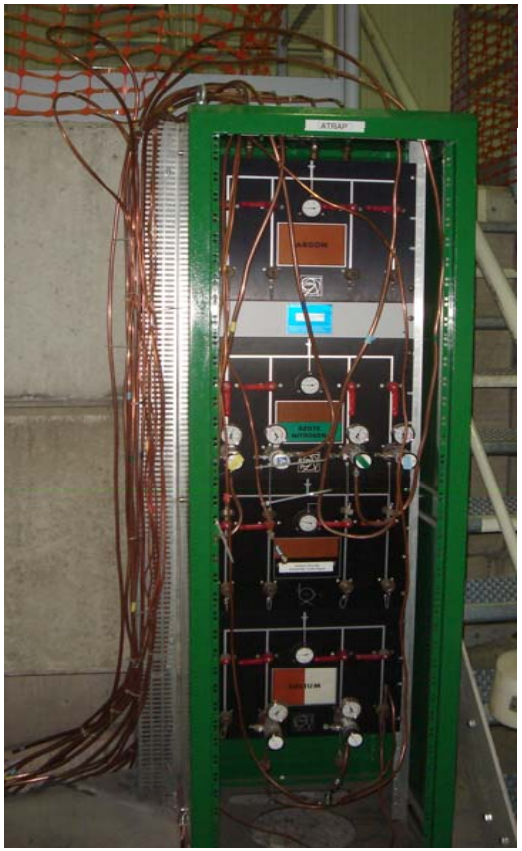
Optimizing Pulse Generators

- Give it a device name.
- Queries the database for the instrument's address.
- Tells instrument to generate a Service Request if it receives a trigger.
- Waits until receives SRQ or is Aborted.
- Checks which instrument requested service (desired instrument?)
- Checks that the request was for a trigger, and not an error.



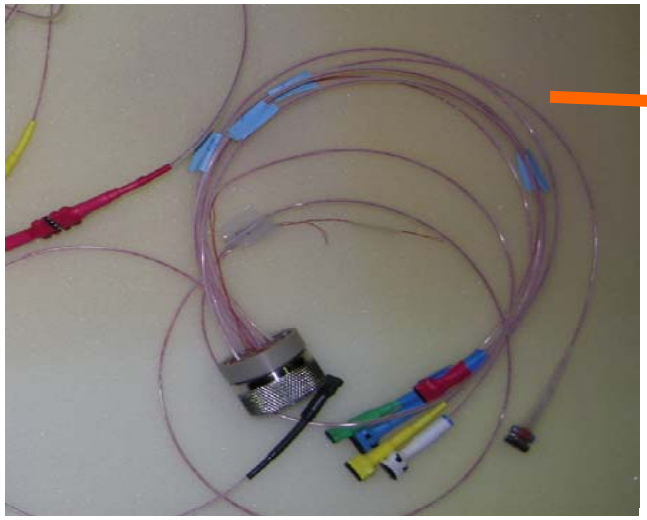
Cleaning House

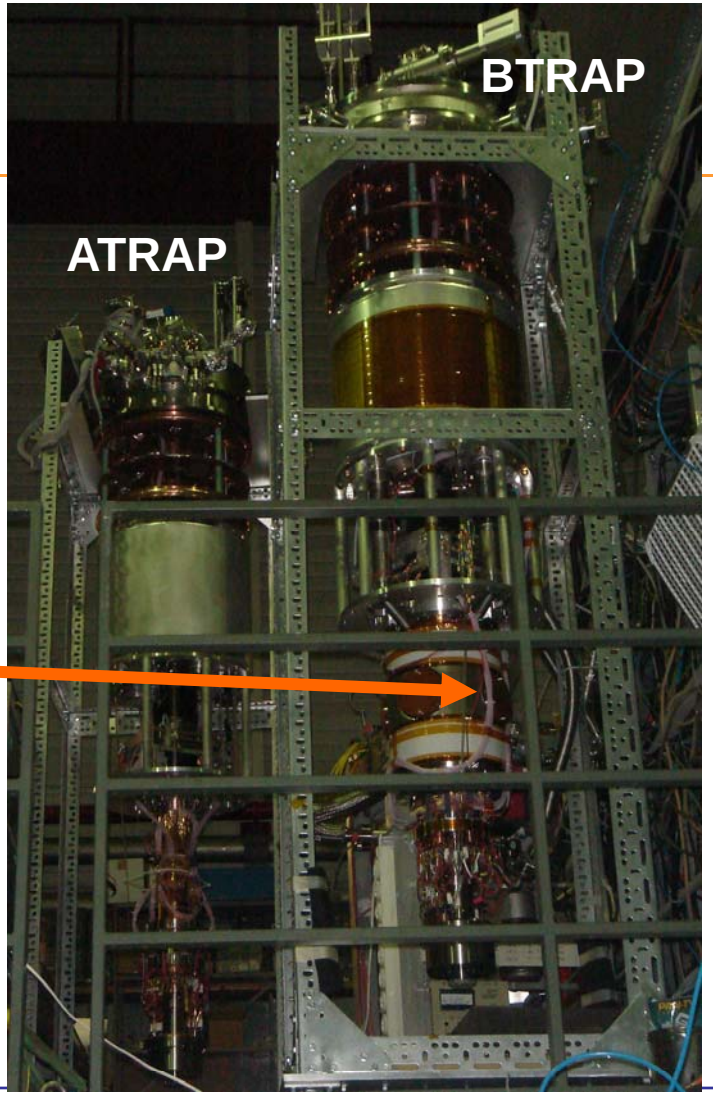
(Other Tasks Accomplished)



Temperature Sensor Connectors

- My 32-pin connector is now installed on BTRAP.
- BTRAP is an improved version of ATRAP.
- BTRAP includes a Ioffe trap to help trap the neutral antihydrogen.





Thank You

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Dr. Steven Goldfarb

Other Summer Students!

Obligatory Crazy Pictures

Being Freddie Mercury

Touching electric fences

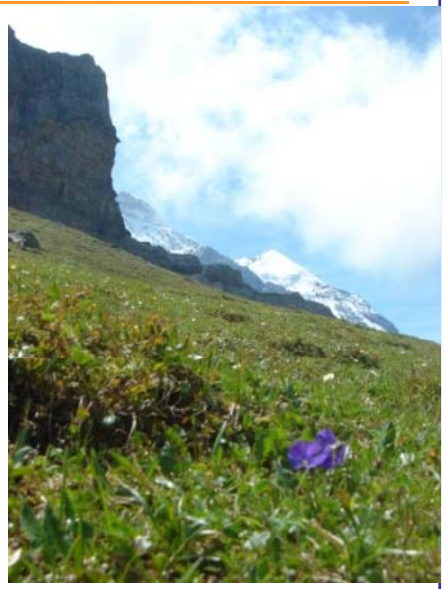
Trying to buy train tickets

It Turns Out I'm a Sucker for Artsy Flower Pictures…

Heidelberg

Paris

Krakow



Interlaken

Montreux