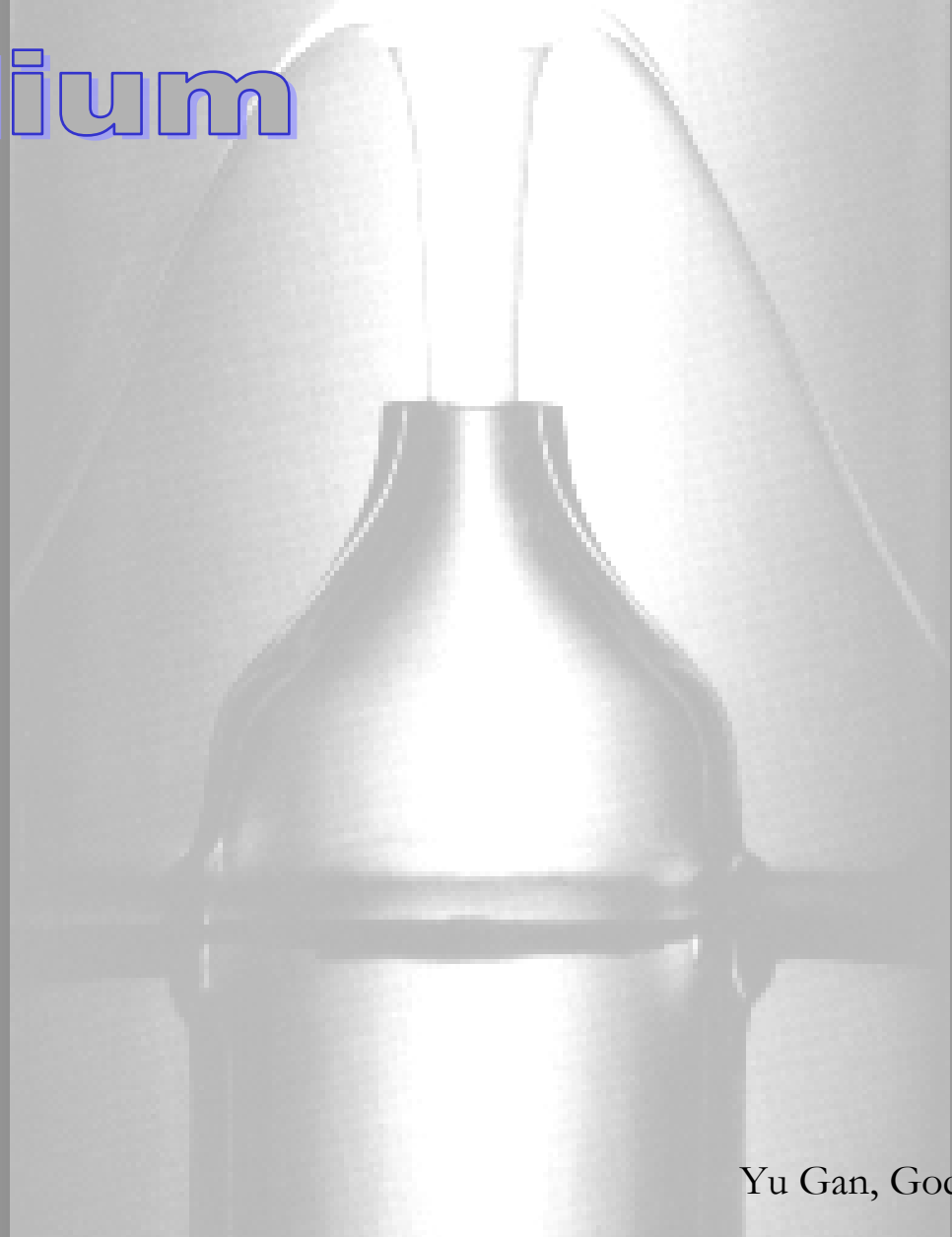
Superfluid Helium



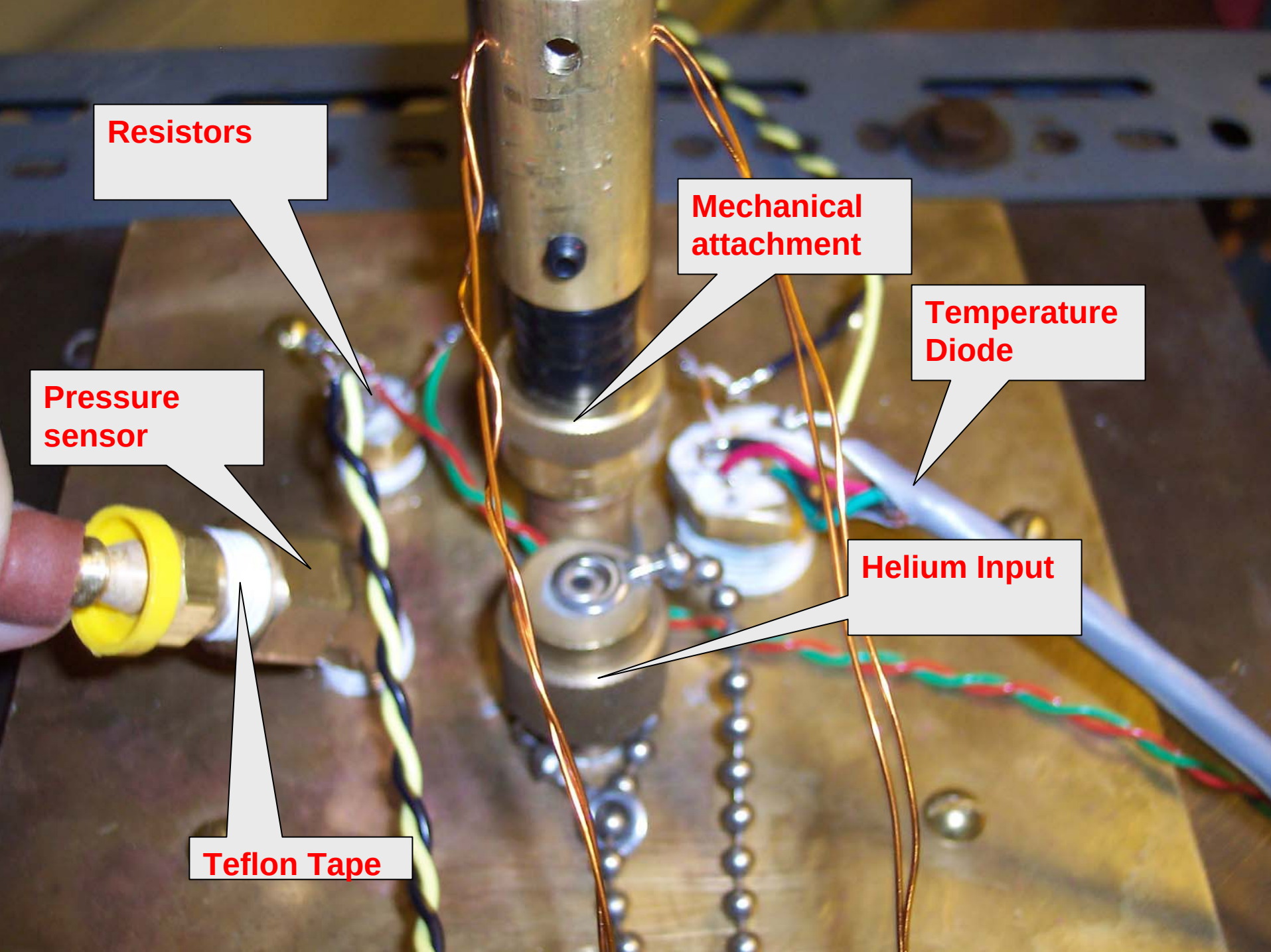
Yu Gan, Godfrey Miller, Carl Boettiger

Objectives

1. Reach Superfluid State
2. Basic observations
3. Observe Second Sound
4. Observe Angular Momentum Effects
5. Observe Fountain Effect

Prepwork: Instrument Plate Design

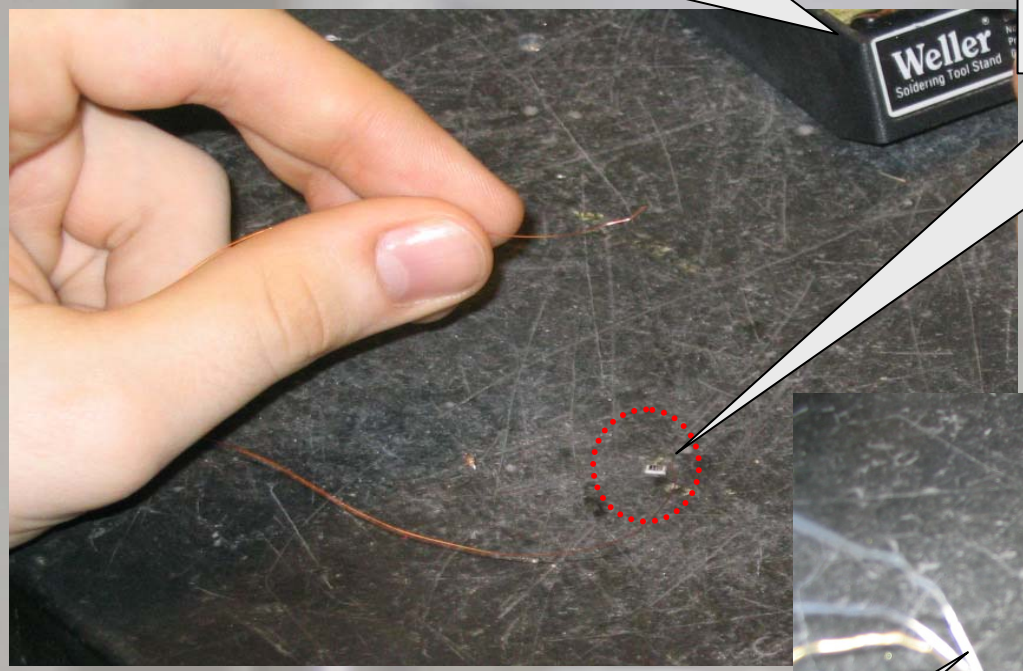
1. Design plate
2. Run wires through brass connectors and fill connectors with epoxy
3. Get Dan™ to go to the machine shop... a lot
4. Construct stirring rod
5. Screw plate down


Resistors
Mechanical attachment
Temperature Diode
Pressure sensor
Helium Input
Teflon Tape

Prepwork: Resistor Tube

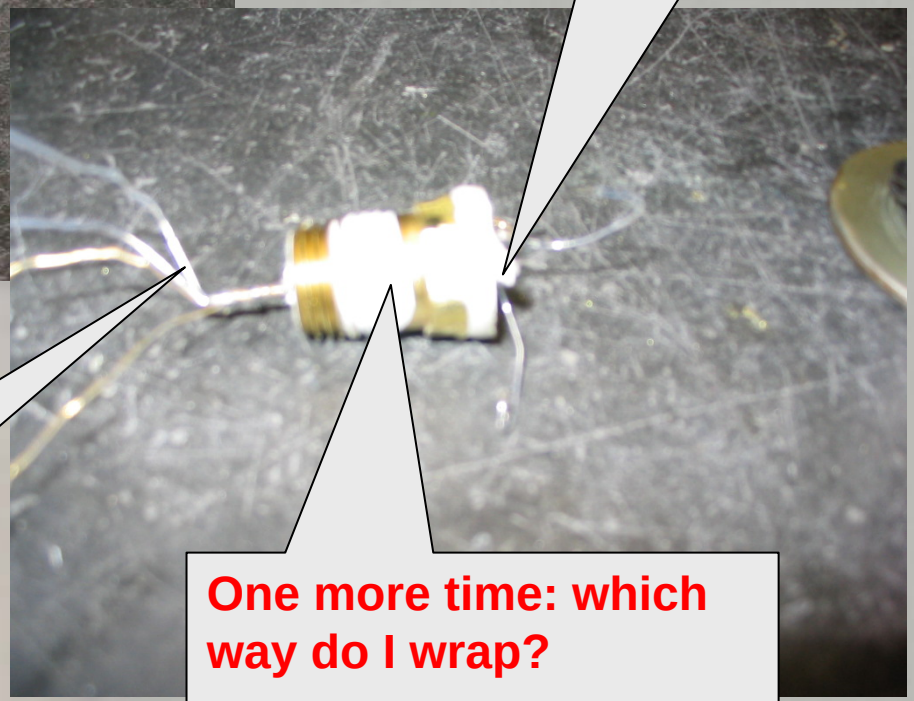
1. Beg women for rouge powder... get rejected... have Prof. Romalis© save day
2. Put resistor and wires into tube
3. Stuff KimWipe™ into tube
4. Put rouge/aluminum powder into tube (this filters the superfluid component from the normal fluid)
5. Stuff KimWipe™ into tube
6. Use Blu-Tack™ to attach tubes to stirring rod

Trade Suspicions: always leave the soldering iron on



Small Resistor

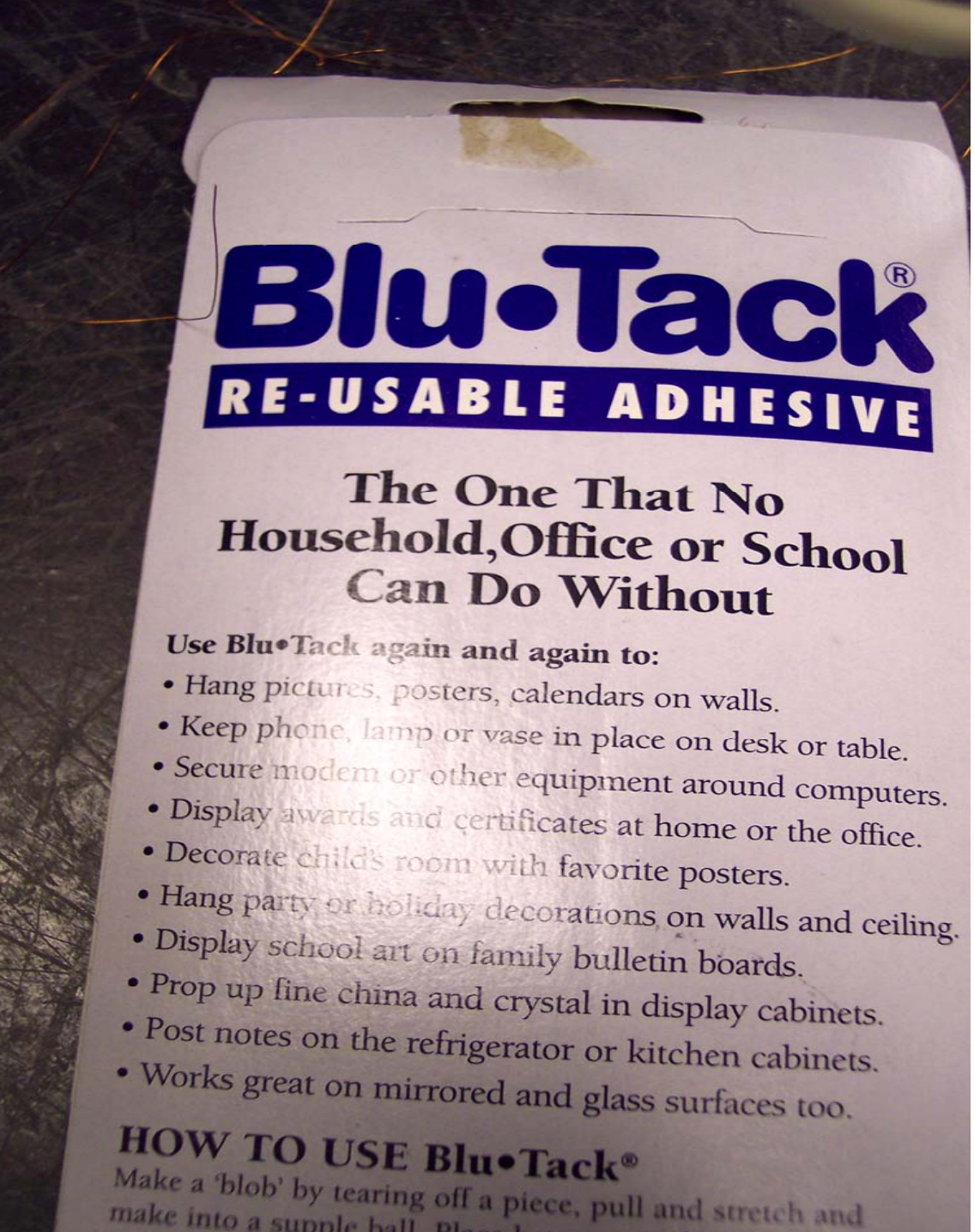
Wire Attachment hardware using Torr Seal™ epoxy



Thin Wires = fun for the whole family

Strip, twist and heat

One more time: which way do I wrap?

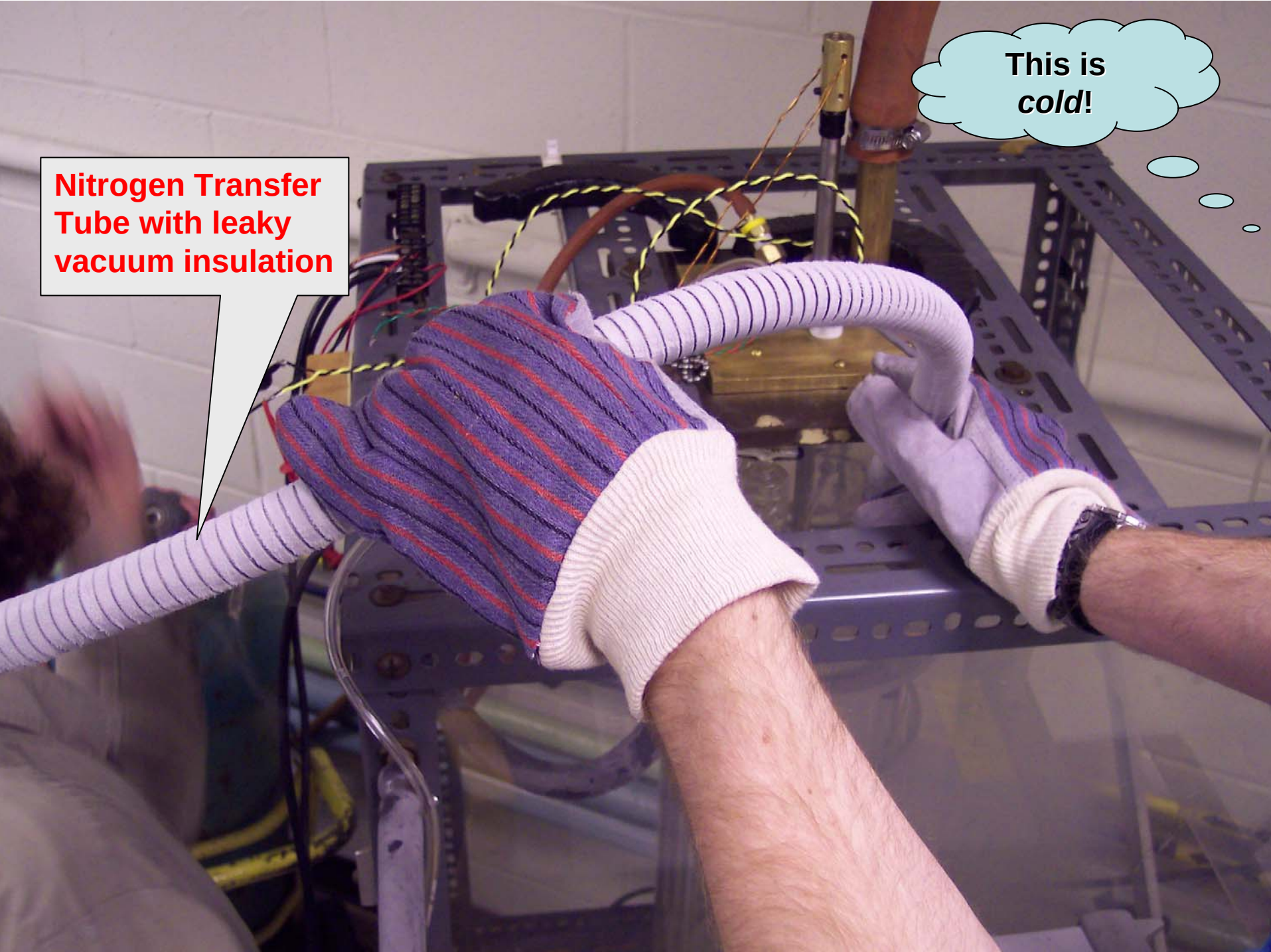


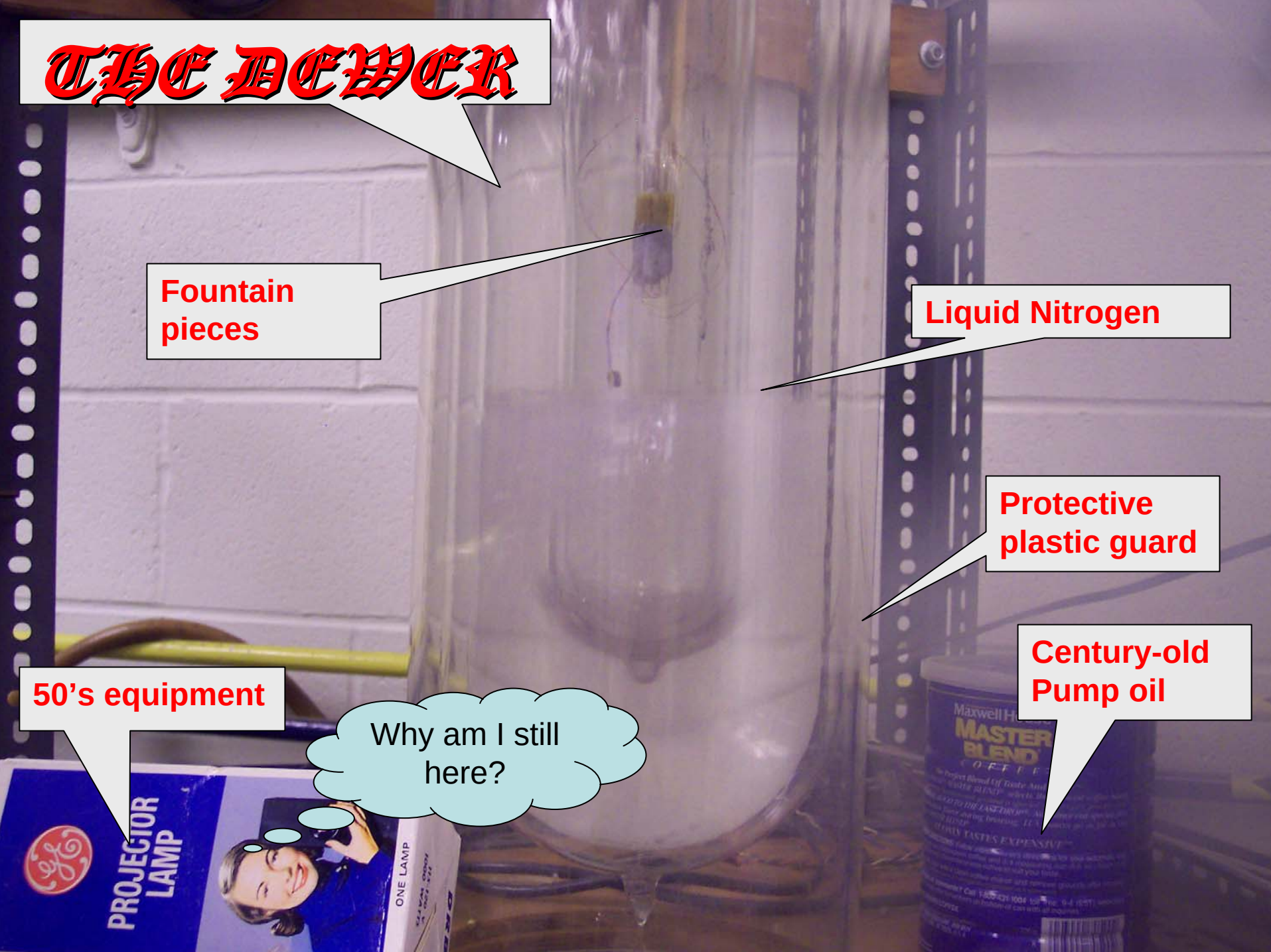
Remember the Blu-Tack™ rule: Press it on, but roll it off.

Cool-down Procedure

1. **Pump chamber with helium gas**
   (Actually, we only did this on cool-down 4)
2. **Turn on fans** (Actually, once we figured out how to do this on cooldown 2 the fans were never turned back off… 3 weeks later…
3. **Pump liquid nitrogen into outer chamber**
4. **Open blow-off valve!**
5. **Pump helium into inner chamber**
6. **Turn on vacuum pump**


Gas Galore
Yawwn. Watching Dan do everything is *hard work*
So many tanks… So confused…
DURA-LO
NITROGEN


Nitrogen Transfer Tube with leaky vacuum insulation
This is *cold*!

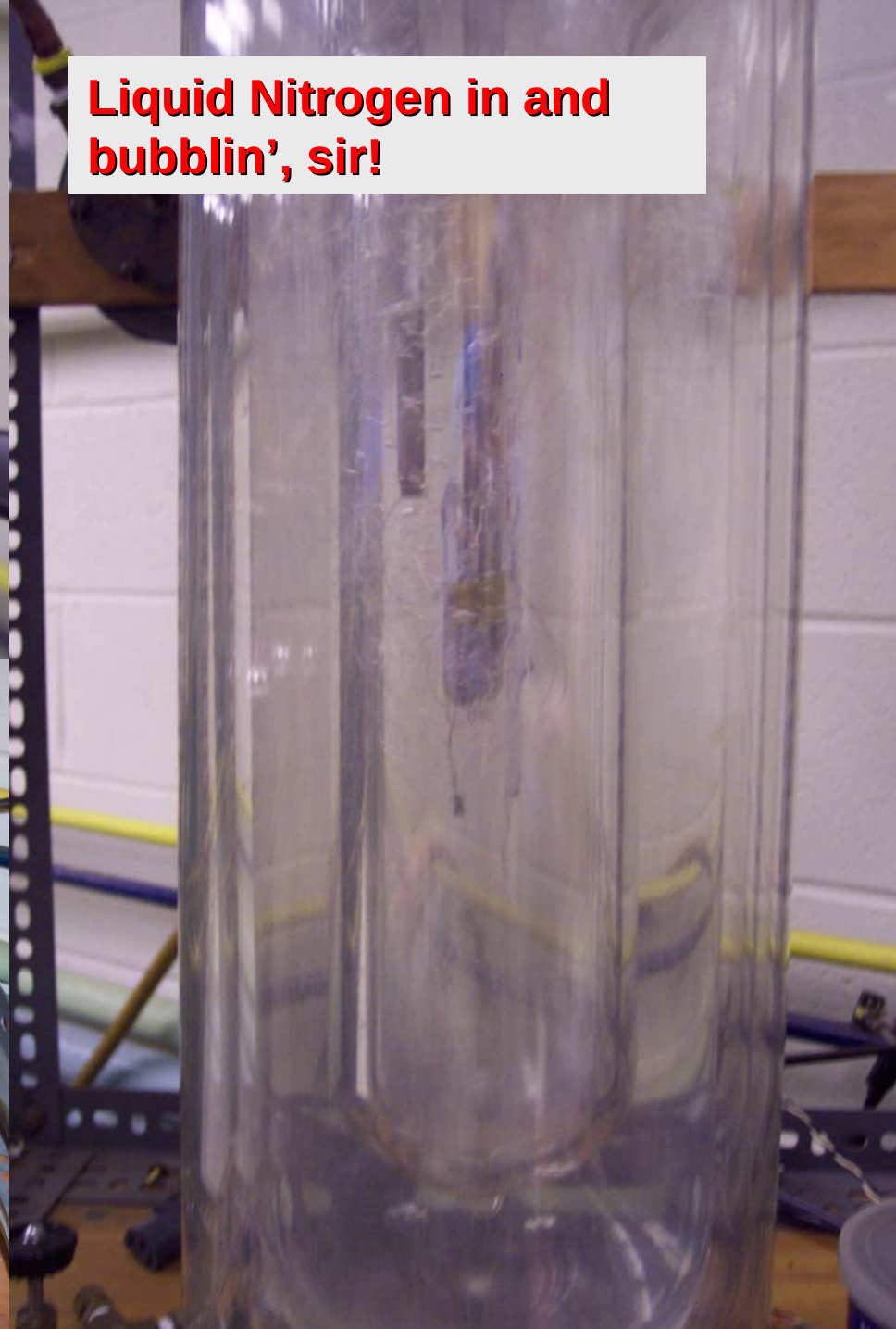

THE DEWER
Fountain pieces
Liquid Nitrogen
Protective plastic guard
Century-old Pump oil
50's equipment
Why am I still here?
PROJECTOR LAMP
ONE LAMP
Maxwell
MASTER BLEND


Two containers of liquid helium in as many weeks, at this rate I'll need another grant to fund this course!

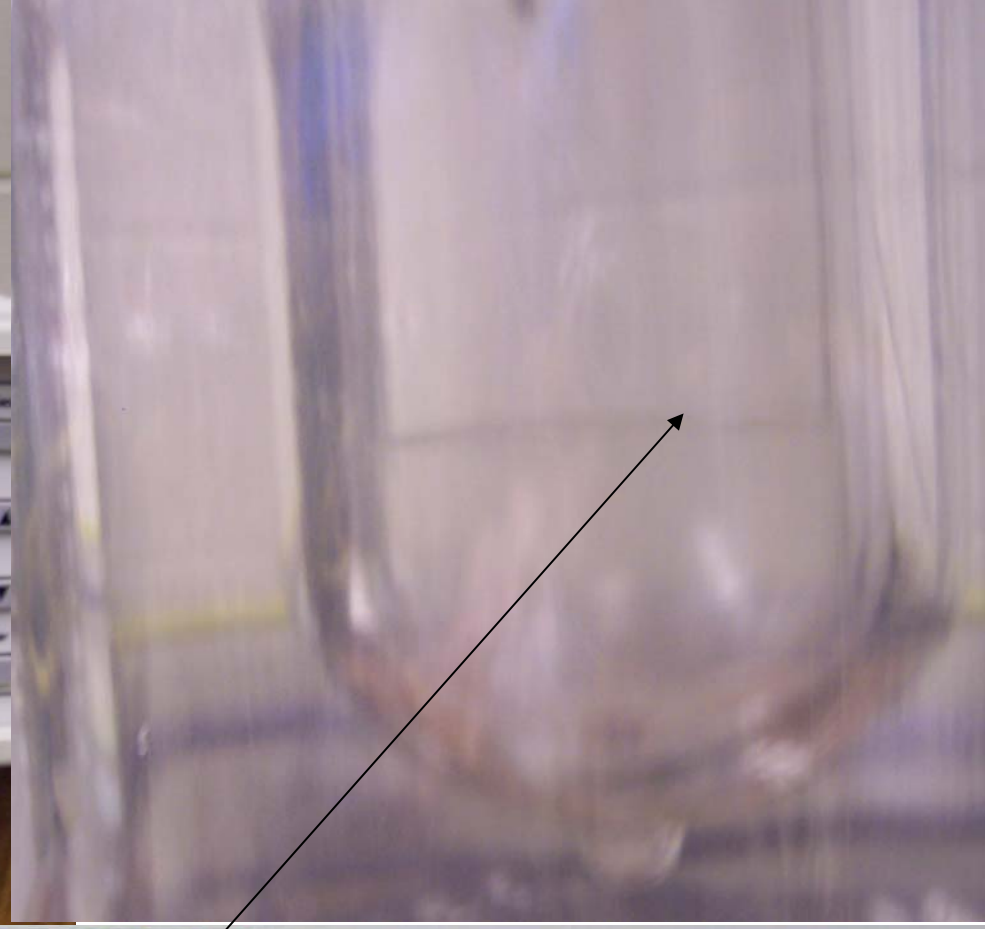

Why did I ever take this job?


Blow-Off Valve, Check


Fans on? Yeah, we never turn them off anyway
PROJECTOR LAMP
GE
MASTER BLEND


Liquid Nitrogen in and bubblin', sir!


Weller
Soldering Tool Stand
LakeShore
330 Autotuning
Temperature Controller
Sample
Heater %
63.77
Control
Er28




LakeShore
330 Autotuning
Temperature Controller
Sample
Heater %
100
80
60
Units
Baud
Address
7
8
9
Channel
Input Type
Curve
4
5
6
P
I
D
Control

Cool-Down #1

1. Almost blow up apparatus
2. Forget fans
3. Watch surface of helium become placid as soon as pumping begins
4. Read thermocouple temperature off Labview™
5. Pulse resistor voltage at various frequencies and amplitudes
6. Record second sound oscillation data

Cool-Down #2

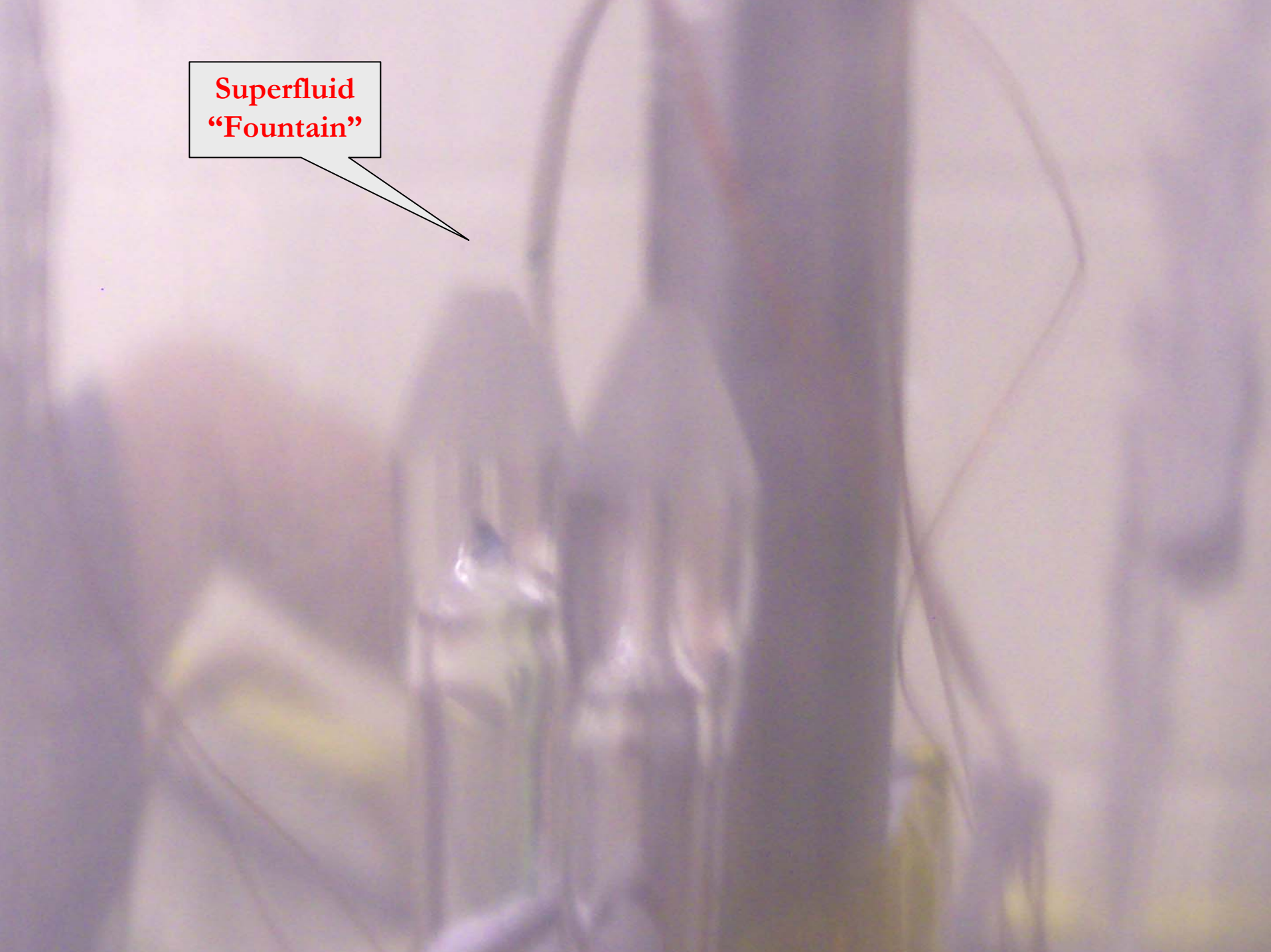
1. Attempt to stir helium before cooling
2. Almost blow up apparatus
3. Cool helium to superfluid temperatures
4. "Observe" quantized vortices?
5. Stir while superfluid
6. Observe that surface fails to spin except at high rotation rates

Cool-Down #3

1. Blu-Tack™ may work at low temperatures, but not when blasted with helium
2. Observe device slowly fall into ruin, resistor tube by resistor tube
3. Turn on resistor – watch submerged tubes fountain vigorously
4. Watch as resistors blow out one by one
5. Cry vigorously, blame Romalis©

Cool-Down #4

1. Use completely rebuilt and redesigned Dan™ apparatus for fountain experiment
2. Observe “fountains” of superfluid helium
3. Take many blurry photos of aforementioned “fountains”
4. Attempt to lower tubes into fluid; loosen seal, flooding chamber with condensation
5. Quit in disgust, write up pessimistic presentation


Superfluid
“Fountain”

Objectives Met

- ☑ Reach Superfluid State
- ☑ Basic observations
- ☒ Observe Second Sound
- ☒ Observe Angular Momentum Effects
- ☑ Observe Fountain Effect

Score: P ??

Lessons Learned

1. Become Math Major to avoid Core Lab
2. Barring that, become String Theorist to avoid contact with experiment
3. Barring that, leave apparatus to be fixed by elves (aka Dan™ & Romalis©)
4. Barring that, become I-Banker
5. Wires, like DNA, always come in double helices
6. Loosen valve securely before takeoff

¿¿Conclusions??

1. Superfluids are slick
2. Physics are phun
3. Superfluids behave more or less as one might expect (give or take experimental error)
4. Experiments are best left to experimentalists
5. Please give us a P!!!

Credits

1. Michael Romalis© (for late night emails, early morning lab meetings, and being elusive)
2. Daniel Hoffman™ (for locating, machining, and constructing everything Romalis didn't)
3. Carl Boettiger, Yu Gan, and God(frey) Miller (for putting together the PowerPoint presentation and taking pictures)

Questions?