

Maintenance Log

Nov 17th 09 • Removed laser head cover, checked black circulatory fan motor for rotation. The motor seemed to turn fine w/o hesitation.

Nov 18th 09 • Brought HV power supply, vacuum pump, & hoses down to Dr. Barry Wells' lab.
* Need to buy 6" exhaust end for Dr. Eyles, also need new compressor fittings. ← ALL SET!

What Needs to be Replaced/Fixed?

- Vacuum pump oil - replaced? ✓
- Halogen filter - replaced?
- Air inlet filter - replaced? ✓
- Thyatron cooling oil - replaced?

Nov 26th 09 • Excimer was lowered onto reinforced table using the 5 ton crane in Dr. Wells' lab.
• Main exhaust was hooked up to vacuum line.
• H.V. power supply was reconnected to the laser.
• Air filter on laser head was replaced.
• ~~Excimer~~ Vacuum line installed to laser head.

What else needs to be installed.

- Vacuum pump needs oil ✓
- Vacuum pump exhaust line needs to be installed ✓
- Extension cord for H.V. ✓
- Compressor fittings for gas lines ✓
- Water Supply?

Dec 1st 09 • Filled vacuum pump with oil from metal can with part number 906788. Filled to 3/4 mark on sight glass as specified in instruction manual.

Dec 8th 09 • Installed gas cylinder mount near excimer & brought down 2 bottles Xenon, 1 bottle HCl. Have also found a loaner for Nelson (Quefery)

Dec 11th 09 • Received Swagelok fittings, all but PFA nuts

- Parts list for swagelok fittings
 - SS-400-NFSET - stainless steel complete set (nut, part & back part)
 - PFA-423-1 - Front Ferrule
 - PFA-424-1 - Back Ferrule
 - PFA-422-1 Nut 1/4" - not the right one,
 - B-400-3 - Brass T of compression nuts & fittings

Dec 11th 2009

• Finished connecting laser HV to power supply L-15-250V 20A 3φ connectors
• Filled w/ 2,500 mbar He @ 3:37pm, will check for leaks the following day

Dec 15th 09

• Checked @ 11:30 (20 hrs) Pressure @ 2,000 mbar
→ 500 mbar / 20 hrs = 25 mbar / hour.
the accepted leak rate is 5 mbar / hour so we have some work to do. My plan is as follows.

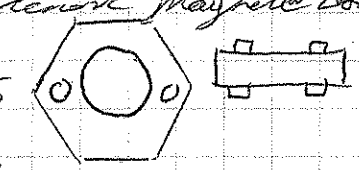
Dec 16th 09

- First check all other solenoids for operation
- Check if pressure is coming back thru solenoids
- Take cover off, (charge system 2500 mbar) & check for leaks in obvious places first. (Make sure to ground caps!)

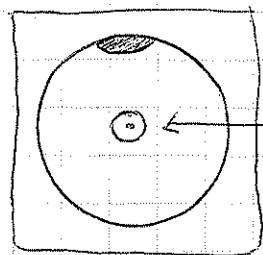
• Tested solenoids for gas through part. Yellow solenoid (Noble gas) did not let gas through. Surprisingly, the Red solenoid did! (Halogen)

• Replaced ~~red~~ solenoid (yellow) w/ replacement part # 903113 (Honeywell Lucifer O.S.A) V5-60-5053
• solenoid body has following specs
→ Valve # V5 MLSK 892A, 220/250V, 175 Bnz, Ser# AHP orifice 1.2 (Honeywell Skinner valve)

- To replace internals of solenoid do as follows:
 - 1) remove laser head cover; ground out caps!
 - 2) remove electrical connectors from solenoid body
 - 3) Remove nut from solenoid & remove magnet body.
 - 4) Place ring of the two plugs over shaft; align plugs into corresponding holes & loosen using a 7/8" socket w/ extension.
 - 5) Be sure all pressure is evacuated or



After replacing solenoid I tested the throughput of helium @ 3 bar & there was no pressure. So, I took it apart again & noticed a tiny ripple that looked like a gas outlet. It appeared to be clogged so I turned on the gas (2 bar) to help push anything out & used a thin piece of wire to unclog the hole. All of a sudden POOF! I was blasted w/ 10 year old crust! At least the valve works now. I left the new replacement stems in there just to be sure, so the old one was probably still good. This is what it looks like in case this happens again



this was clogged!

Top View

Checked (w/ soapy water) most of the connections for leaks & found none. Maybe the gas is passing back thru the solenoid valves overnight.

I will connect all the lines to a dead end; re-charge it to see if that is true

Charged to 2,500 mbar @ 4:30 12/16/09

Dec 17th 09

Pressure dropped to 1,900 mbar in 18.5 hrs = 32.4 mbar/hour which is worse (could be exponential & so just less likely)

Probably not too safe.

Taking patterned metal shield off of capacitors to check for corrosion = possible leak sites.

No apparent leak sites, to remove Cap. cover simply loosen the machine screws; pull out shield

Need to speak of Lambda Physik rep. Jeff Edberg to see where to go next. Maybe he can shed some light.

Just got off the phone of Amy from Coherent. She recommends the following:

- Check window seals (usually 1st to go)
- Check pins coming into laser tube w/ He meter.
- Removed front laser window cover, plan to review window & attenuation procedures & check seals soon. Possibly a good time to switch out the optics? Will bring it up in today's meeting.

Dec 21st 09

Thought about the idea of changing the optics out. Then realized that I don't have any other mirrors lying around. Then remembered the test data sheet performed by X Physik for XeCl (308nm) & ArF (192nm). Both tests were performed using the same front & rear mirrors! Meaning we probably won't have to do any optics switching at all! Types of mirrors are below

front: CaF₂ 36.0mm x 5mm

rear: Al-MgF₂ 36.0mm x 5mm

- New plan is to remove & clean mirrors, reseal (of queue) o-rings; re-tighten. Then pressurize; check for pressure drop.
- Tightened 6 allen bolts on laser window output & rear. They turned a 1/4 more before stopping. Maybe they were just a little too loose, but I doubt it. Anyways, recharged the system to 2,500 mbar @ 2:15pm. Will check again tomorrow.

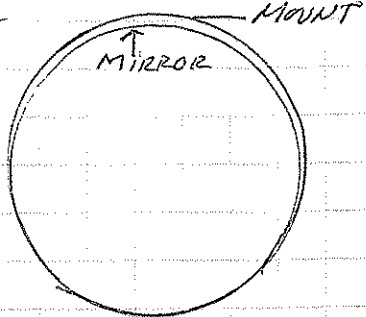
Pressure dropped ~ 400 mbar before 3 hrs! Brought system down to 1,000 mbar, then put ~ 100 mbar He. removed end mirror as in directions. Mirror looked very dirty w/ powder like spotting. Needs to be cleaned. looked like this →



O-ring also looked dried out needs replacement. Titled

• Also seemed that mirror was not seated "nicely" in mount, it looked like it was sagging down off center

• O-ring has the following specs: $\phi 32 \times 2$ Viton



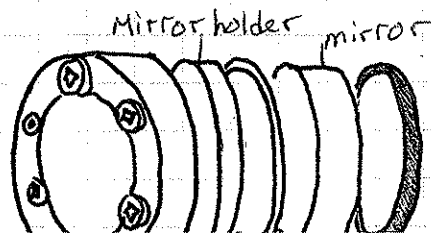
* Note: When new o-rings arrive & the system is opened up again, double check that mylar ~~ring~~ ring is in place.

Jan 4th 10

Welcome back & happy New Year! Anyways I've been trying to find out if the Halocarbon grease is the same as fluorocarbon grease which I was told by Amy would help w/ the O-ring leak. Turns out, you are not to use grease on any of the o-rings! It can ruin the laser tube if any grease gets in there.

Problem is, according to the past records the grease (fluorocarbon) was used. So, this may pose some trouble. For now, I must acquire new o-rings. Trouble is, Coherent has zero parts for EMGs. Looking at the packers list, I've found the following dimensions for o-rings
2x O-rings 32x2mm ✓
5x O-rings 6x1.5mm

• Found a missing mylar ring, maybe I forgot it after the first install or maybe that was the problem the whole time. Charged system to >2500 mbar @ 3:15 pm today.
• This is how the window assembly goes



O-Ring dimensions are 32x2mm

• Just remembered that there was a lot of corrosion on the o-ring groove. This could lead to improper sealing of the windows. Once the helium arrives I'll plan to clean out the gaffe w/ Q-Tips & Ethanol (low moisture) & replace the o-ring w/ the one that's been cleaned w/ rubber rejuvenator.

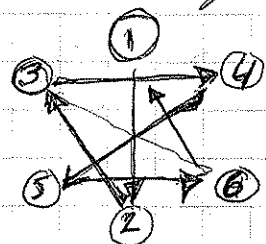
Jan 7th 2010

• Helium arrived last Friday, today (Monday) I will clean the o-ring groove of acetone, blow off the mirror w/ compressed air (electronics grade) & replace old o-ring w/ "new o-ring" also will charge system to 2500 mbar for tomorrow's leak check w/ Di-Hex.

Jan 18th 2010

* Regulator reads - 2600 psi 1/18/10

• Filled system to 2100 mbar after doing the following ← 1:00pm
→ Cleaned window mount (on laser) w/ acetone
→ Replaced o-rings w/ "new" o-rings
→ ~~Replaced~~ Dusted off mirror w/ compressed air
→ Re-sealed mount w/ following pattern



• Depending on the leak rate I might attempt to clean off the port hose tomorrow.

• 12:00 pm, gauge reads 1500 mbar, a 600 mbar drop in 23 hours
= 26 mbar/hour

Jan 19th 2010

This is at least a decrease from the 45 mbar/hr ~~was~~ seen previously. Now I plan on taking the port window off & cleaning the o-ring bore.

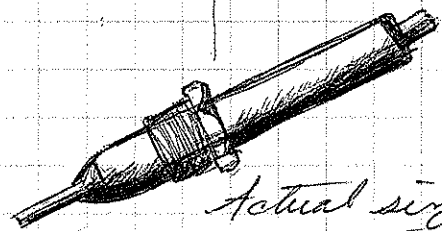
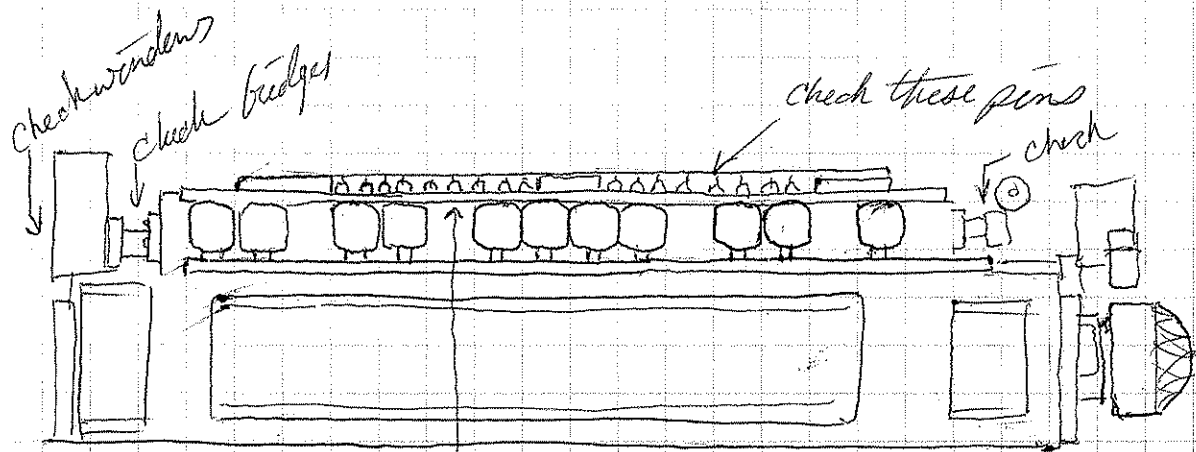
Cleaned most of it out by creating pressure & then removing the ~~plug~~ Cork-Puff!

• Re-pressurized the system again to 2100 mbar @ 12:15 pm. Kept original o-ring in because it didn't look so bad once washed w/ warm water.

Jan 20th 2010

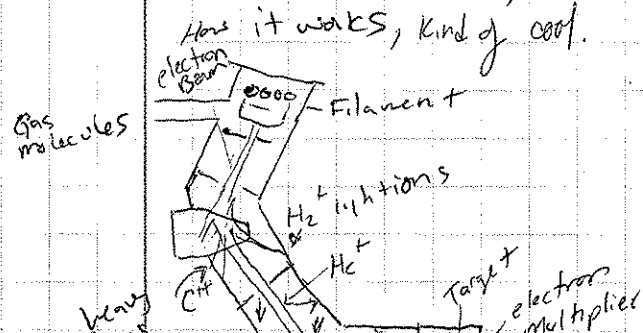
• Gauge reads 1500 mbar after 25 hrs = 24 mbar/hr → pretty much the same.

• Today we (Dr. Hines & I) are supposed to leak check in the following places.



Actual size drawing of one of the pins

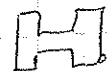
• Dr. Hines is here, we are going to check the leaks



Leak Rates

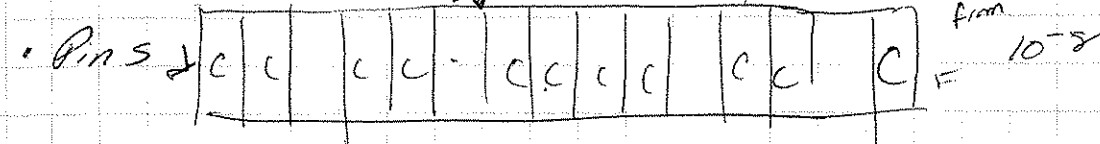
- Rear window mount ≈ 1 cc/sec $\times 10^{-8}$ Scale
- Front window mount ≈ 1.5 cc/sec $\times 10^{-8}$
- $\approx 10 \times$ rear window $> 1 \times 10^{-8}$

• Rear Tube bridge (white) — X



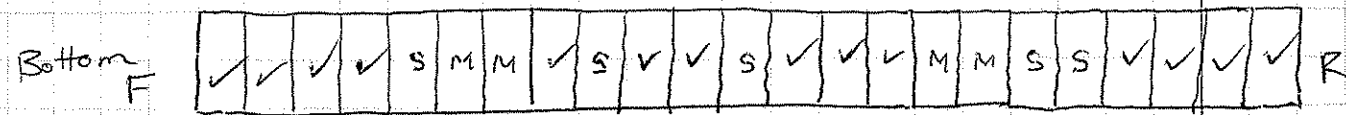
• Front Tube bridge — X

← cover (marked) $\approx 4 \times 10^{-8}$
Corroded plug $< 5 \times 10^{-8}$
 $\approx 2 \times 10^{-8}$
30% ← from 10^{-8}



• Near tubes to laser gas processor — X

• Front " — X



Top - 6th From Rear - major leak.

• After testing the system it was clear we had some potential causes. My plan is as follows

- 1) Get New o-rings, re-seal

Jan 22nd 2010

• Removed front window, "rejuvenated" the
o-ring, looked brand new, replaced.
Charged system to 72100 m bar @ 1:30pm.

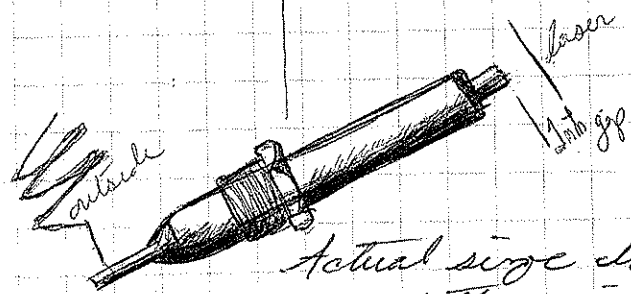
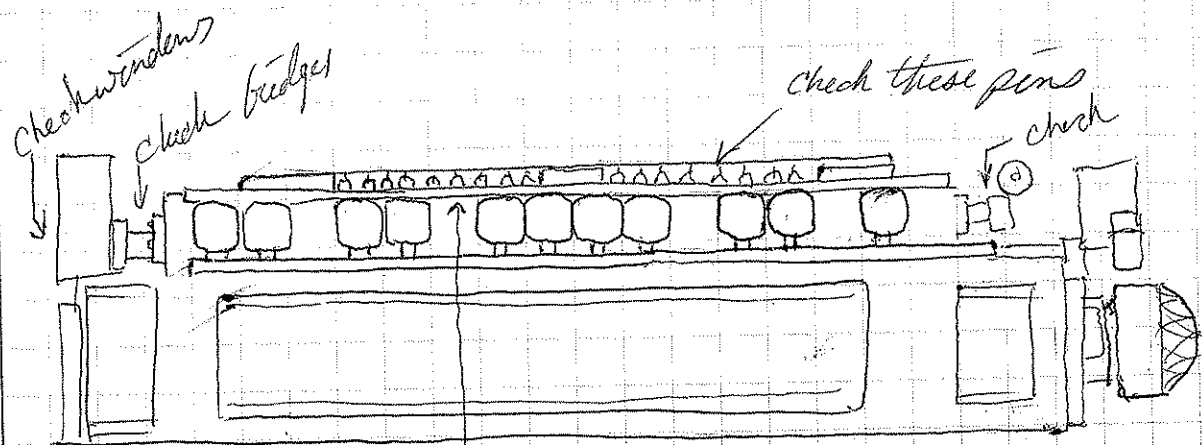
Cleaned most of it out by creating pressure & then removing the ~~plug~~ cork - Puff!

Re-pressurized the system again to 2100 mbar @ 12:15 pm. Kept original o-ring in because it didn't look so bad once washed w/ warm water.

20th 2010

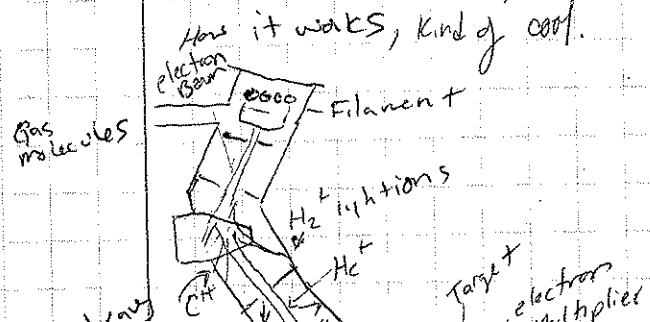
Gauge reads 1500 mbar after 25 hrs = 24 mbar/hr → pretty much the same.

Today we (Dr. Hines & I) are supposed to leak check in the following places.



Actual size drawing of one of the pins

Dr. Hines is here, we are going to check the leaks

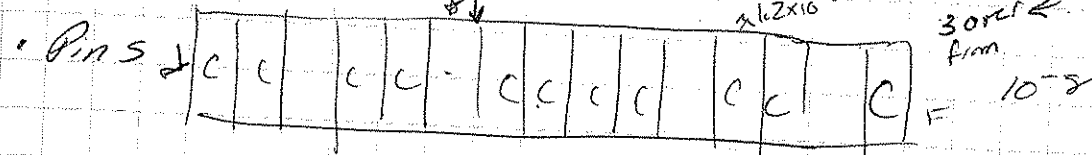


Leak Rates

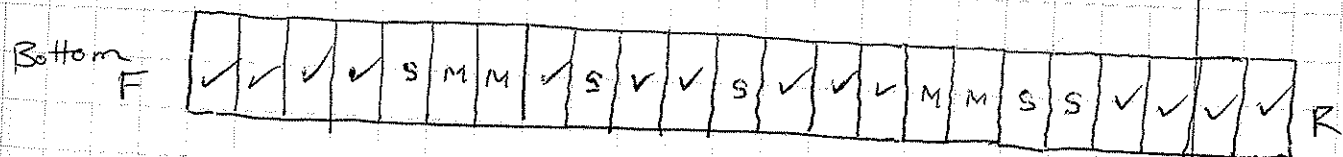
- Rear window mount ≈ 1 cc/sec Scale × 10⁻⁸
- Front window mount ≈ 1.5 cc/sec × 10⁻⁸
- 10X rear window > 1 × 10⁻⁸

• Rear Tube bridge (white) — X

• Front Tube bridge — X
 ← 4th hole
 ← Corroded plug < 5 × 10⁻⁸
 ← 2 × 10⁻⁸
 ← 30 mbar from



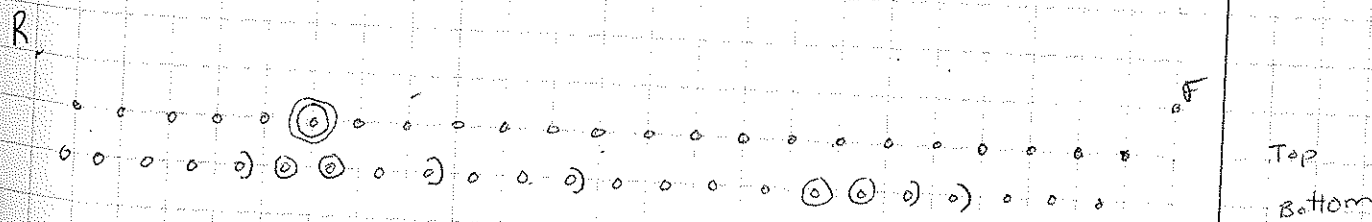
• Near tubes to laser gas processor — X
 • Front " — X



Top - 6th From Rear - major leak.

After testing the system it was clear we had some potential causes. My plan is as follows

- 1) Get New o-rings, re-seal

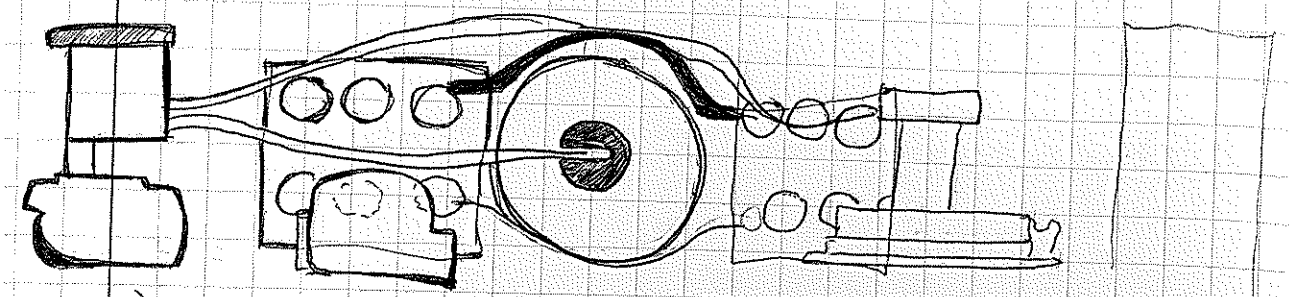
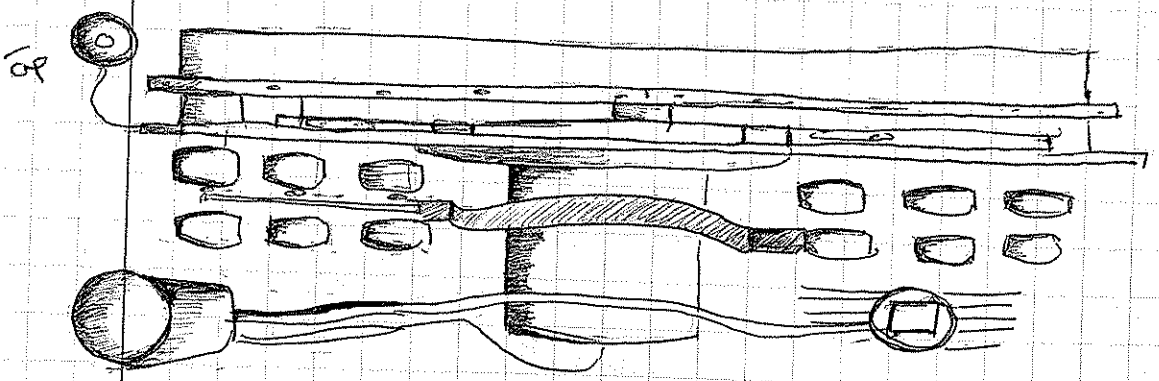


Key
 ⊙ - Large
 ⊙ - Medium

2nd 2010 • Removed front window, "regenerated" the o-ring, looked brand new, replaced. Charged system to 72100 mbar @ 1:30 pm.

4th 2010 • Back to just above atmosphere ~1200 mbar. retightened front window (loose) & rear window. Cracked & tightened problem pins. Charged to 72100 mbar @ 1:45 pm.

• Going to check pressure tomorrow & decide then if I should order the o-rings. This is a break down of how to get to the pins.

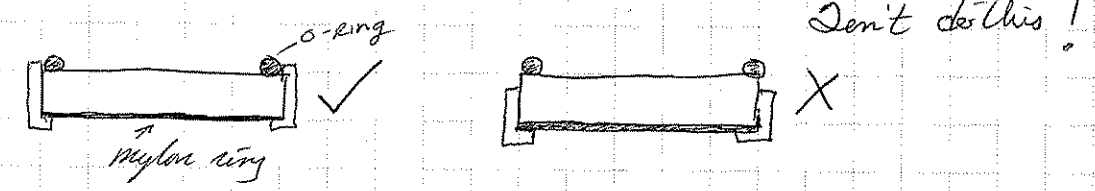


- 1) Remove Thyatron Fan, disconnect oil lines, remove shielding from caps.
- 2) Disconnect black caps, lift up, disconnect red wires

Received new o-rings (12x32x2m, 40x6x1.5m) for window mounts & spark plugs. Installed in the rear window & in the front. repressurized to 2100 mbar. Feb 3rd 2010

Disaster! Returned early in the morning to discover the front window has cracked! Not sure if this occurred once I pressurized the system or not. Feb 4th 2010

I now think that I made a mistake when re-installing the lens. The lens sits in the window mount which is adjustable, I believe that I screwed the lens too far out past the edge of the window mount. After re-reading the manual it details that the lens should be inside the mount as shown below. Feb 5th 2010



Now I am searching for a new CaF₂ lens of the following specs:
 CaF₂ lens
 36x5mm (diameter x thickness)
 10-5 scratch-Dig
 λ/10 - surface flatness

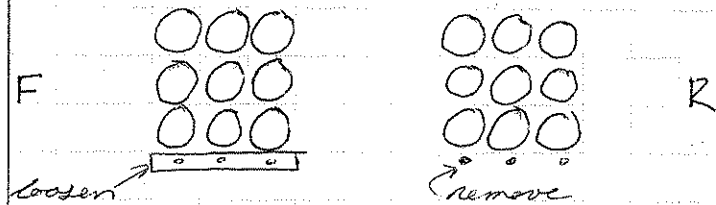
Also, I am going to check the voltages of the thyatron (LP-189)

Reservoir voltage:	$U_R =$	7.04 V _{ac} (measured)	7.0 V _{ac} (test data sheet)
Heater Voltage:	$U_H =$	7.39	7.4 V _{ac}
Bias Voltage	$U_K =$		160 V _{dc}

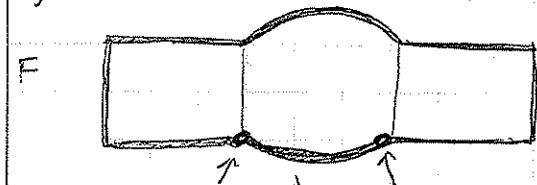
2010

Instructions on Accessing Speech Plugs

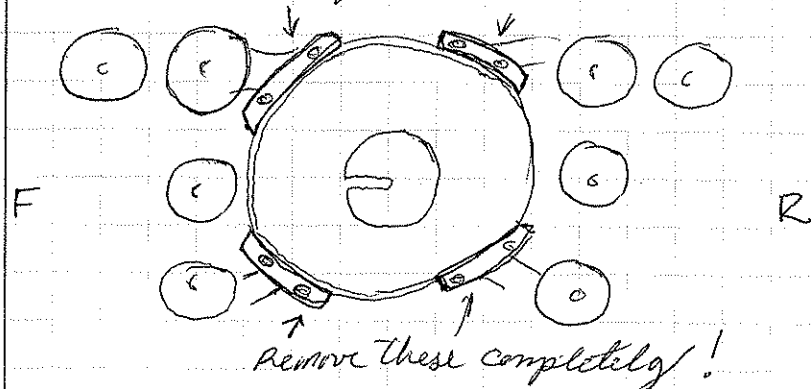
1) Loosen machine head screws (3mm) that hold the cover on black capacitors



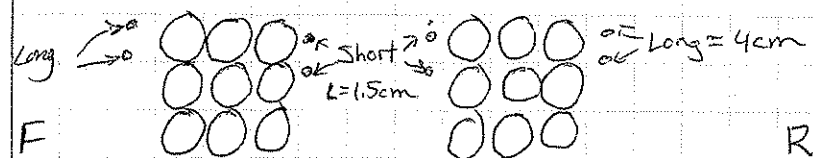
2) Remove bottom bracket from black capacitor array.



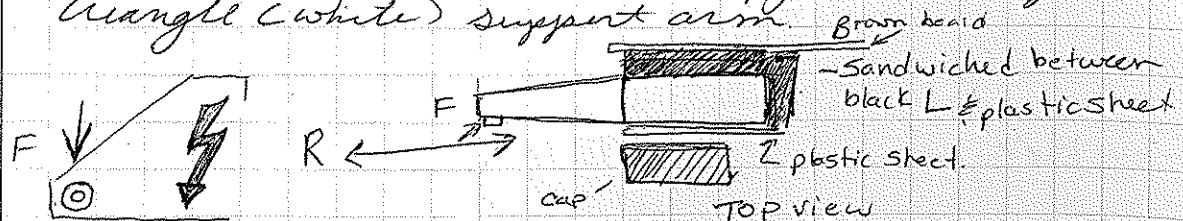
3) Loosen 8 (3mm) machine head screws that connect the black capacitors to the MSC.



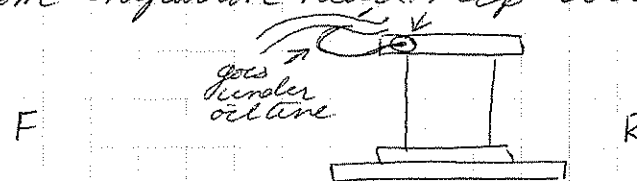
4) Loosen & remove 8 (4mm) machine head screws which bolt the black capacitors array to chassis



5) Remove the machine head screw of flat washer from triangle (white) support arm



6) Removed thick, copper wire (covered in clear plastic) from thyatron head. Keep bolt on threads for safe keeping.

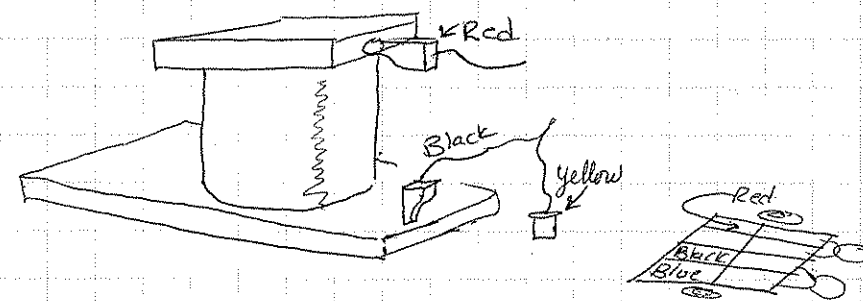


7) Moving of Thyatron

a) disconnect the 4 short black wires that connect to the red caps.



b) Remove electrical connections



c) Gently remove 4 plastic screws (4.5m)

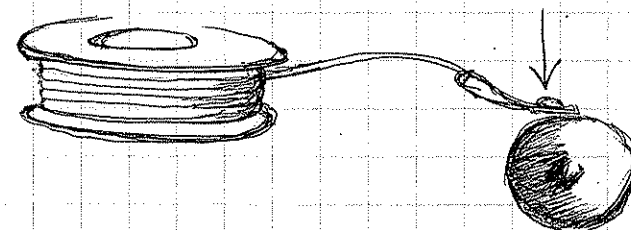


d) Gently lift out thyatron & remove the 4 (Length = 0.5cm) Flat headed screws (3mm) which secure the thyatron base to the chassis.

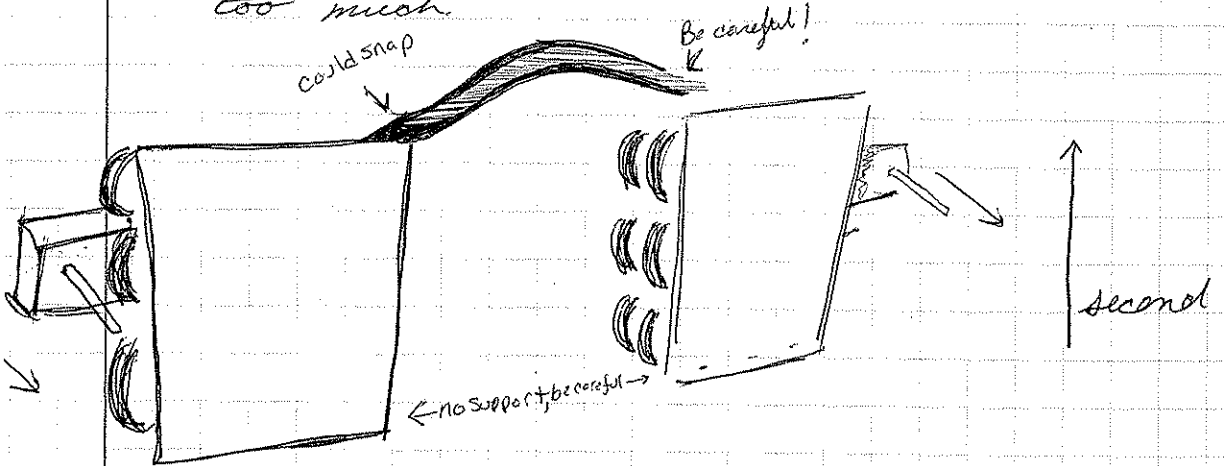


e) Remove 3 bolts below the base that were previously loosened in step 1 if you haven't done so already

8) ~~Back~~ Remove Red line from capacitors (3mm)

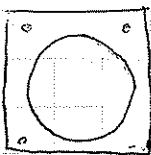


10) Gently lift capacitor array out towards your body, clearing the support rails. Then slowly lift up & out. Careful not to let them bend too much.

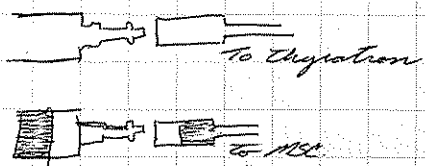


11) Remove MSC from laser. To do this...

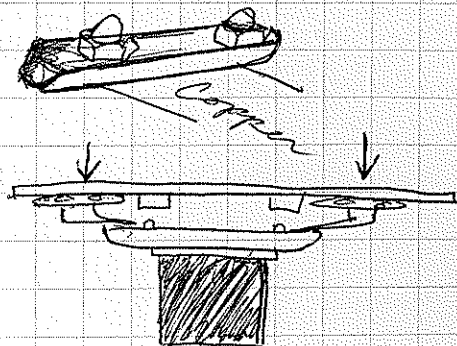
a) Remove the 4 machine head screws



b) Then, remove the quick disconnected fittings on oil line



c) Remove 4 rounded nuts that clamp down on copper foil which connects MSC to spark plug. Top & bottom.

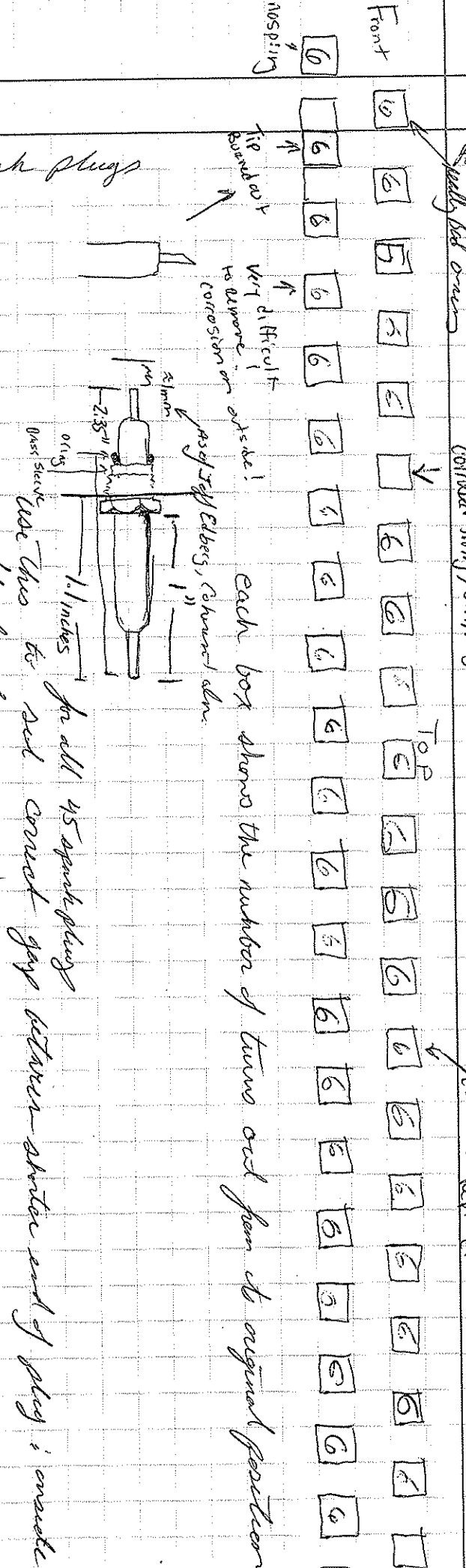
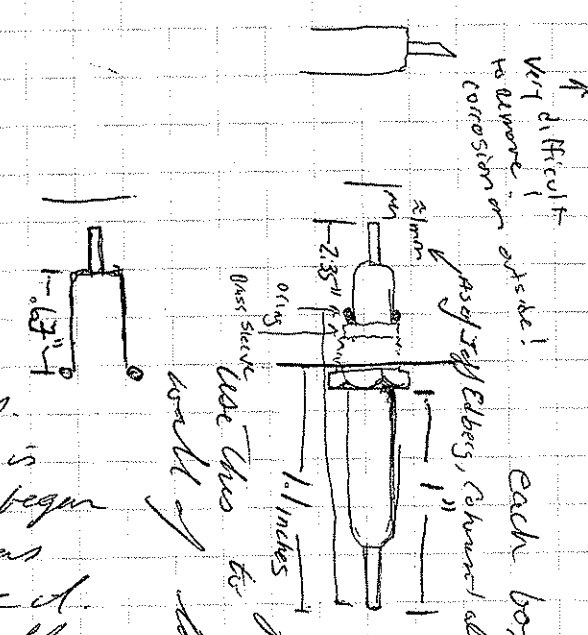


d) Remove heavy MSC that is still attached to the thyatron & amp are all set!

Feb-16th 2010

Replacing O-rings on spark plugs

Notes:
I was able to change all, but one of the o-rings. The reason being is that the nut began to slip as I was trying to remove it. Instead of possibly snagging the entire piece I decided to leave it. I don't believe this was a trouble leak source, but I will double check it once the helium detector is back.



Leak Test

2010

- used Veeco Helium leak detector w/ Dr. Hines.
- Proceeded to check leak rates of ~~each~~ spark plug or newly installed O-rings
- The following produced leaks during the first round of testing

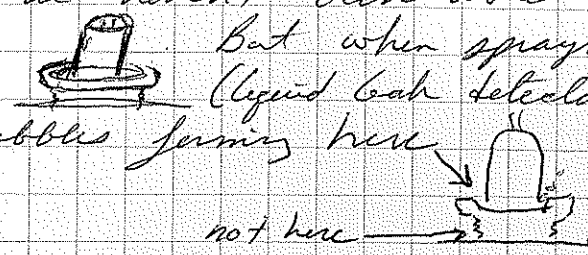
TOP ROW:

- 2nd from the Front - big leak - Fixed!
- 6th from Front - stripped bolt, only not replaced, medium leak
- 10th from Rear, small leak - Fixed!
- 6th from Rear - big leak - Fixed!

Bottom Row:

- 2nd from front - small leak - Fixed!
- 11th from front - small leak - Fixed!
- 16th from front - big leak - Fixed!
- 17th from front - big leak - Fixed!
- 2nd from Rear - medium leak - Fixed!

→ Only leaking plug that remains is on the top row, 6th from the front. The nut is stripped & we haven't been able to loosen it at all.



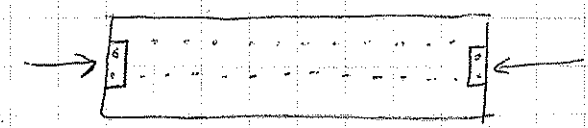
After bringing system to 2200 mbar (operating pressure) the leak rate was found to be 10⁻¹⁰ mbar/l/s which is a huge improvement, but still not good enough.

March 5th 2010

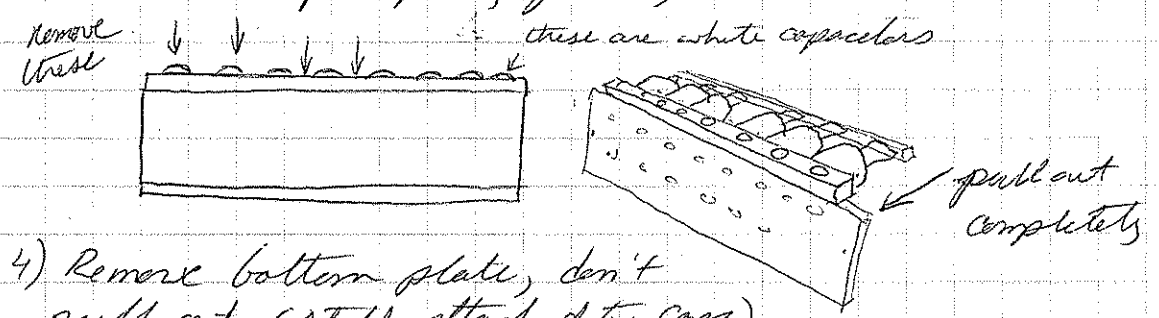
- Could not remove spark plug (top, 6th from front), bolt is stripped. Currently still leaking.
- We decided to take off the plate in order to get it out.
- This is how its done.

Removing Spark Plug Array

- 1) Remove MSC, Thyatron, & capacitors like stated Jan 25th
- 2) remove the two white mounting blocks from array



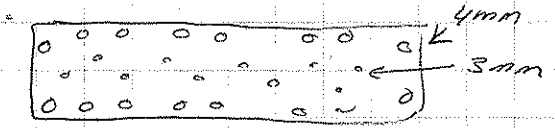
- 3) Remove top spring plate, these are white capacitors



- 4) Remove bottom plate, don't pull out (still attached to caps)
trick: - start to loosen bolts w/ allen key, then use this tool which comes w/ the laser tool kit.

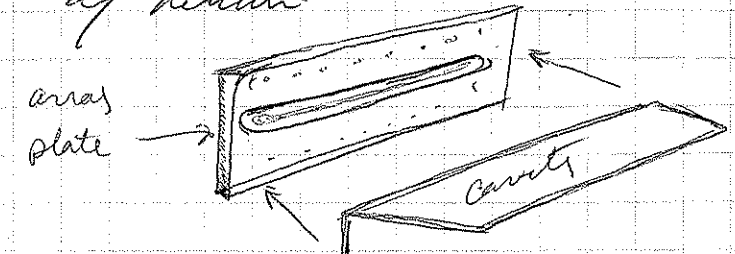


- 5) Now loosen & remove all the 4mm allen bolts & the 3mm allen bolts security the array to laser cavity.



- 6) Jimmy the plate carefully to create a little space between the plate array plate & cavity. Now use a flat metal shim (in the tool kit) to pry between the plate until it "pops" open.

- 7) Pull out plate, cover interior cavity & puff w/ helium



2010

- Completed another (3rd) leak test using the same Veeco helium leak detector
 - Found one leak, Top, 12th from front.
 - The o-ring had a little "nick" in it so I replaced it; cranked it down → No Leak.

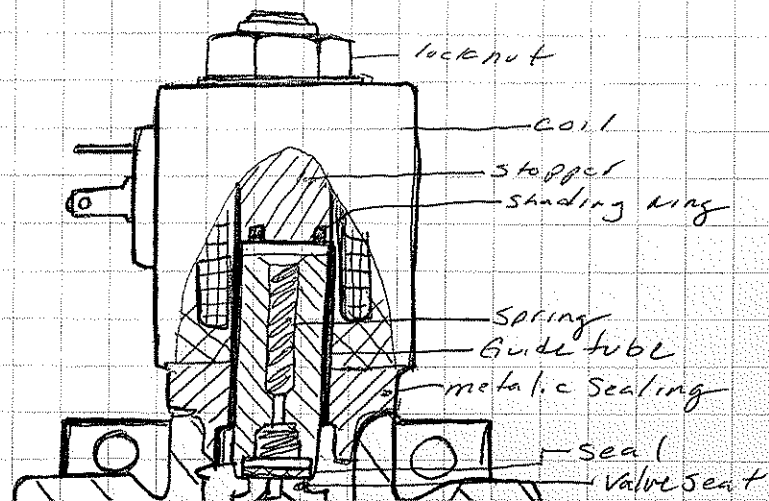
As of today, none of the plugs are leaking when the sniffer spends 10 seconds on them. Even increasing the sensitivity from 10^{-8} to 10^{-9} produced 0 readings.

- Charged the system to 2200 mbar & will check in the morning. Hopefully it will hold pressure & we can continue.

2010

- Still leaking! (2200 mbar/hr) Decided to check for leaks in the vacuum line. Discovered large reading. Thought it maybe from residual helium left in line. Positioned "sniffer" head onto exhaust inlet; set scale until I obtained a "steady" reading. Then I pressurized the system & the detector skyrocketed! Meaning this is a true leak source.

- Took apart solenoid & it was very corroded. tried to clean away debris; used replacement kit, but still leaked. I think the fluid body has holes for the gas to leak through.



- Using the leak detector I was finally able to seal off the vacuum pump solenoid. Pressurized system to 2200 mbar @ 3:00 pm.

March 17th 2010March 18th 2010

- System still leaking! Worse than before (220 mbar/hr) Decided to check the inlet solenoids for gas leaks even though I tied the halogen; Noble lines together.

- Huge leak coming from the joint of where the halogen line & noble line connect. The solenoids must be leaking; using leak detector I tightened everything up so no gas was leaking thru. Pressurized system to 2200 mbar @ 5:30 pm.

March 19th 2010

- Success! Pressure holding at 2200 mbar for greater than 24 hrs. This is outstanding! Now I will clean out inlet solenoids & put the system (entire system) back together today. Finally!

- Cleaned Noble solenoid valve (dirt) that was previously replaced (stem kit V5-60-8053) & replaced halogen stem + o-ring.