Introduction to Mass Analyzers:

Helium Leak Detector to Mass Spectrometer

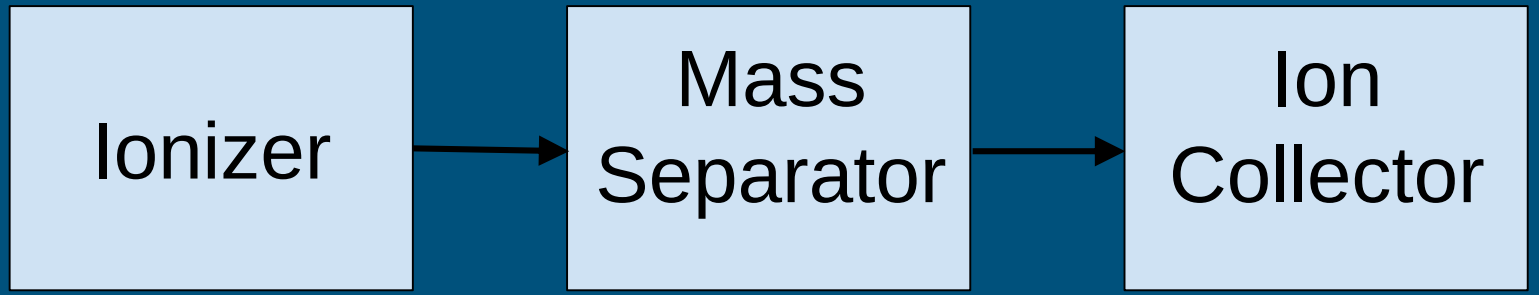
Grayson Perez, Erik Sánchez, and Nano-Development Lab at PSU

Nano SIMS 50

- Spatial resolution of 50 nm
- Seven masses at once
- Electrically insulated samples

Cameca. *Nano SIMS 50*. N.d. *Cameca.com*. Web. 10 Aug. 2017.

Sections of a Mass Spectrometer

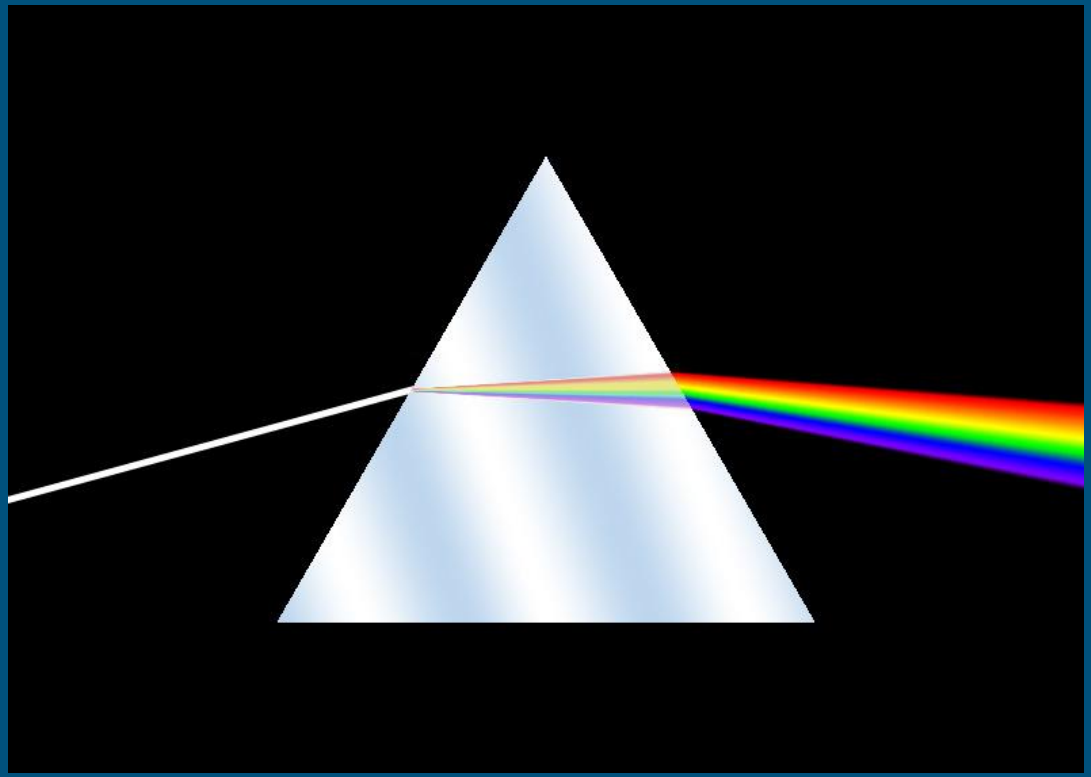


- Electron impact
- Chemical
- Photoionization

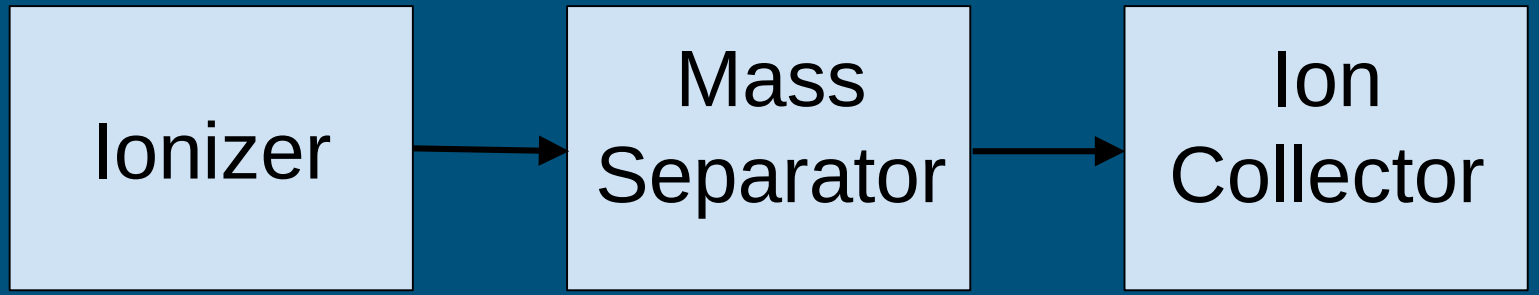
- Quadrupole
- Ion-Trap
- Magnetic Sector

- Faraday Cup
- Electron Multipliers
- Photomultiplier

Goal of a Mass analyzer



Sections of a Mass Spectrometer



- Electron impact
- Chemical
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- Quadrupole
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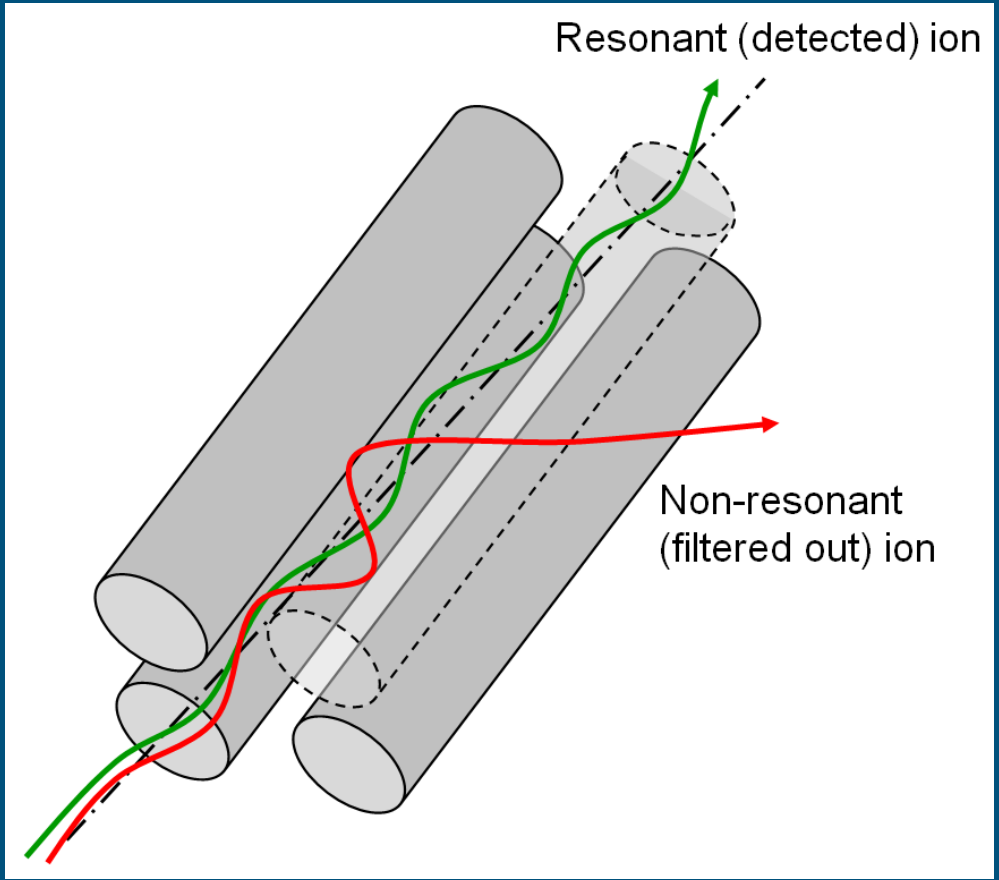
Type: Quadrupole

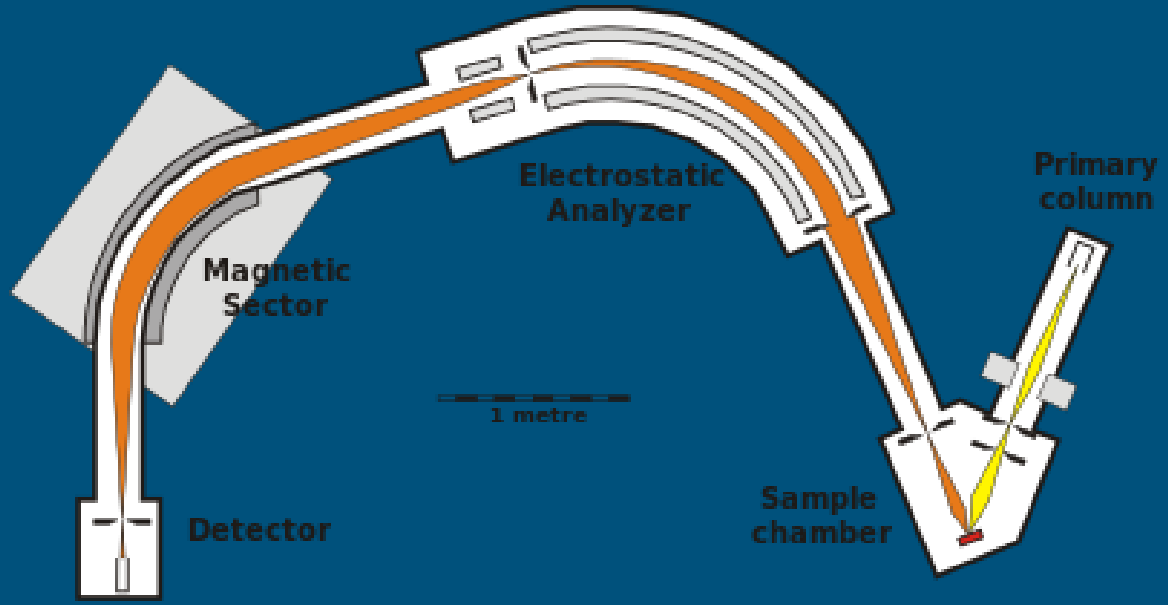
Benefits:

- Low cost
- Mechanically simple
- Works at higher pressures



A quadrupole. N.d. *Chem.Libretexts.org*. Web. 10 Aug. 2017.

Type: Magnetic Sector



Williams, I.S. (1998), "U-Th-Pb geochronology by ion microprobe", in McKibben, M.A.; Shanks III, W.C.; Ridley, W.I., *Applications of microanalytical techniques to understanding mineralizing processes*, Reviews in Economic Geology, **7**, pp. 1–35, doi:10.5382/Rev.07.01

Benefits:

- High Resolution
- Low mass region

Criticism:

- Exorbitant cost
- Limited methods

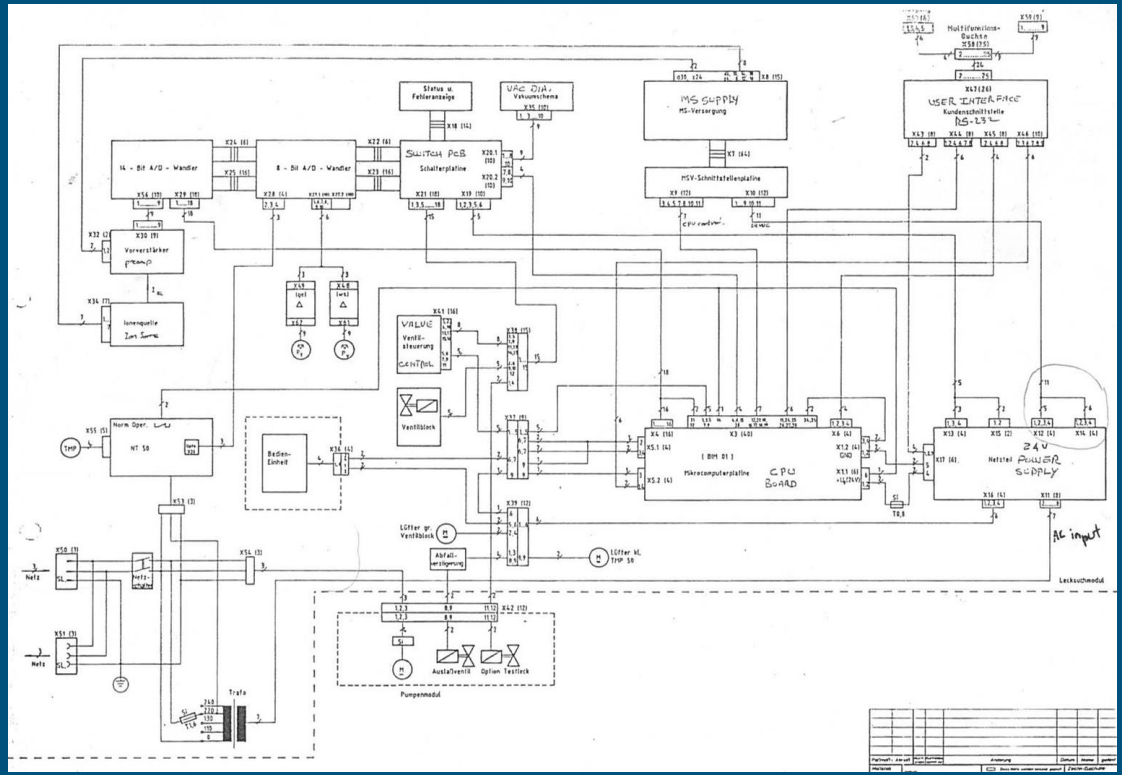
Project: Alternative

- The primary issue is price
- Instead convert helium leak detector
- Reduce cost from $100,000 to $1,000

Leybold. *UL 100 plus*. N.d. Cologne, Germany. *www.atecorp.com*. Web. 10 Aug. 2017.

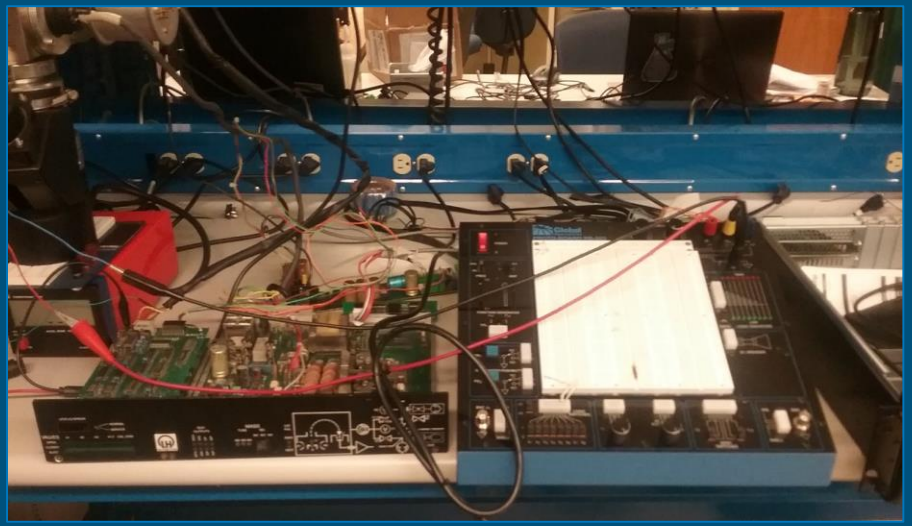
Problems

- Much of the electronics are associated with auxiliary systems
- Want Spectrum, only gives three mass values



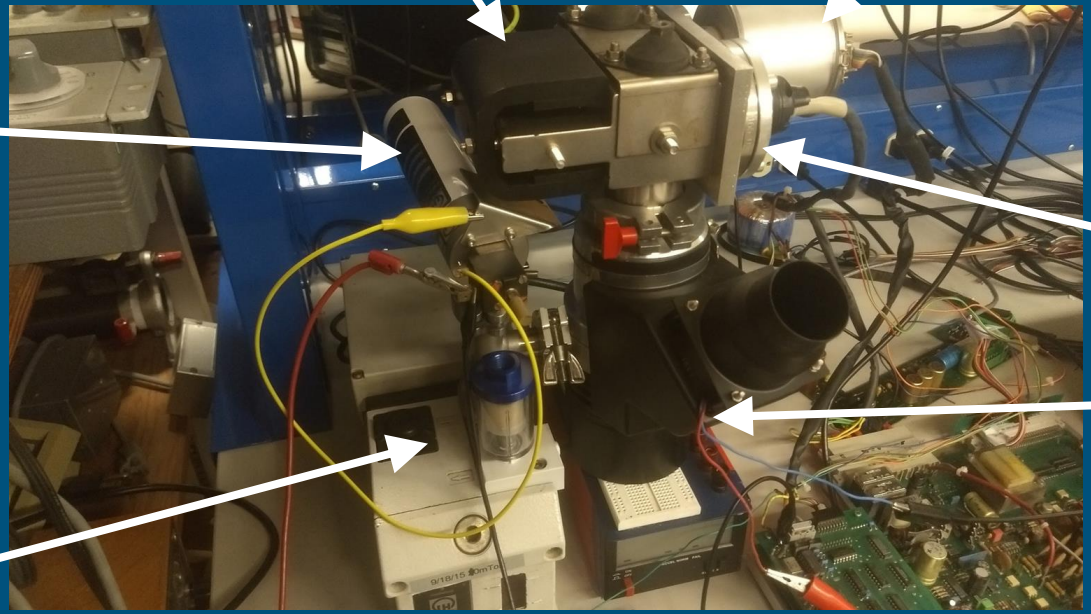
Auxiliary Electronics

- Eliminate Valve control, CPU Board, and User Interface
- Supply Signals manually and control using an arduino



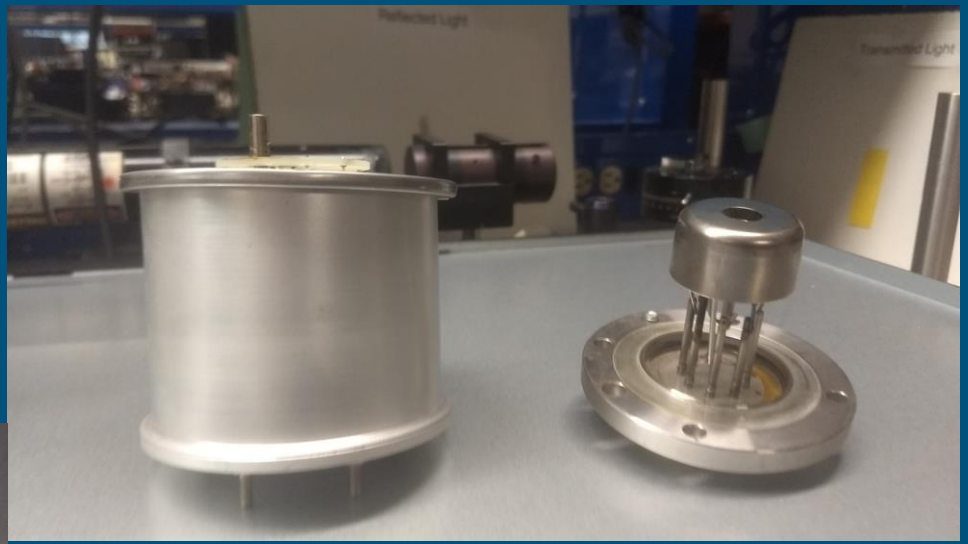
Testing apparatus. Photo by Tianna Coburn

Test Set-Up

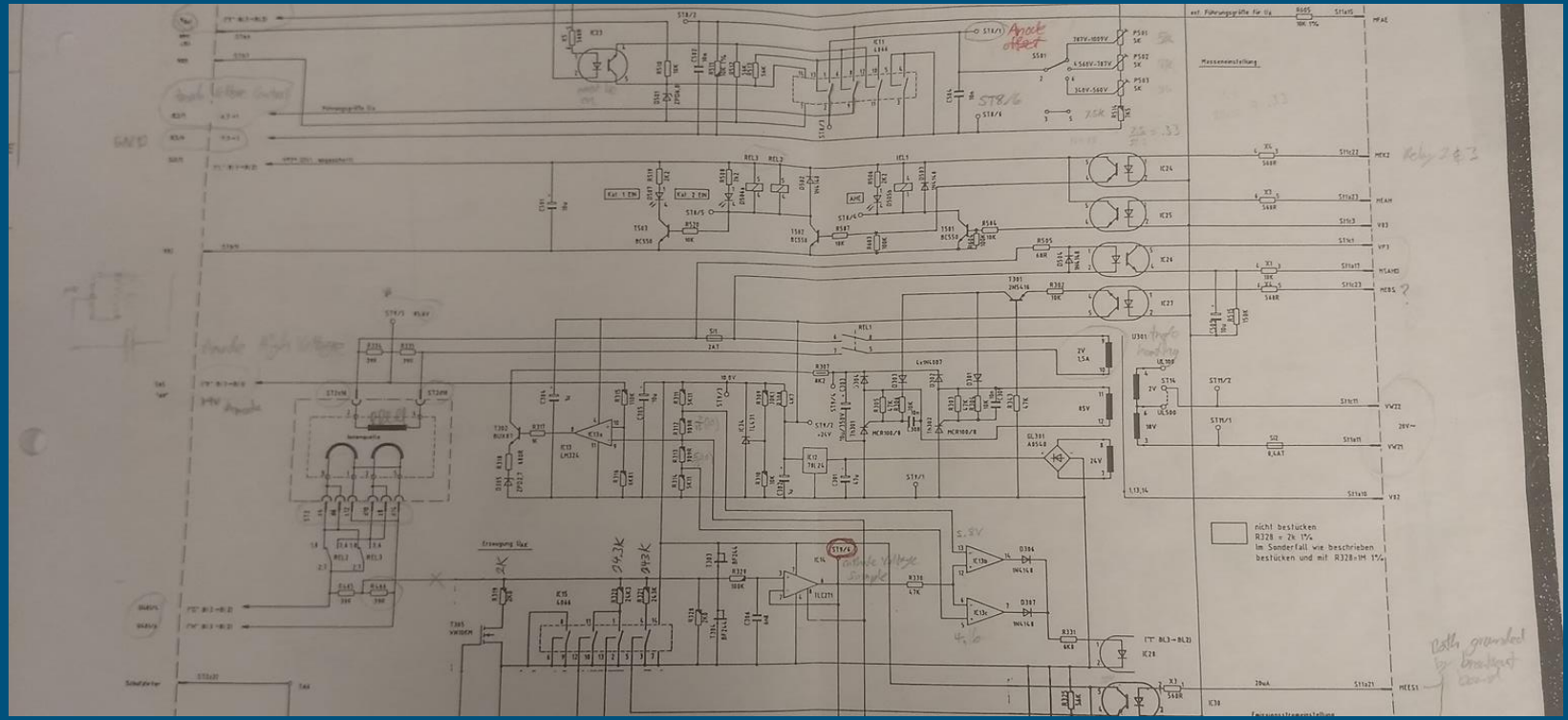


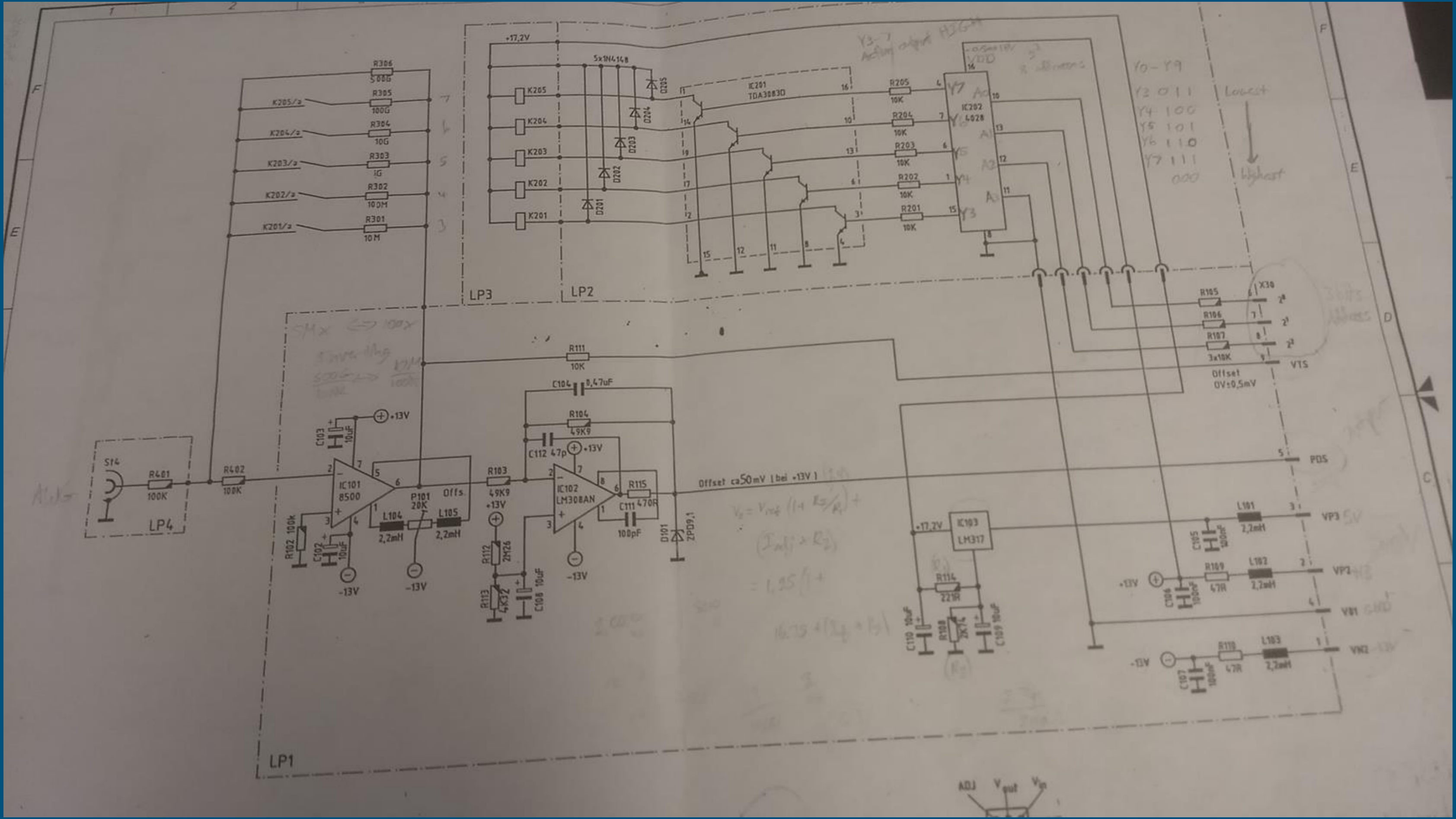
Vacuum setup. Photo by Tianna Coburn

Ion Collector Pre-Amp



Left: Pre-Amp Right: Ion gun





+17,2V
5x1N4148
R306 500G
R305 100G
R304 10G
R303 1G
R302 100M
R301 10M
K205/a
K204/a
K203/a
K202/a
K201/a
K205
K204
K203
K202
K201
D201
D202
D203
D204
D205
IC201 TDA3083D
R205 10K
R204 10K
R203 10K
R202 10K
R201 10K
IC202 4028
Y7
Y6
Y5
Y4
Y3
A0
A1
A2
A3
LP3
LP2
LP1
LP4
X30
R105
R106
R107
3x10K
VTS
Offset 0V±0,5mV
R111 10K
C104 0,47uF
R104 49K9
C112 47p
+13V
-13V
St4
R401 100K
R402 100K
IC101 8500
C103 10uF
R102 100k
C102 10uF
L104 2,2mH
P101 20K
Offs.
L105 2,2mH
R103 49K9
R112 2M26
R113 4K32
C108 10uF
IC102 LM308AN
R115 470R
C111 100pF
D101 ZPD9,1
Offset ca50mV (bei +13V)
PDS
IC103 LM317
R114 221R
R108 2K74
C110 10uF
C109 10uF
C105 100nF
L101 2,2mH
VP3
C106 100nF
R109 47R
L102 2,2mH
VP2
VB1
C107 100nF
R110 47R
L103 2,2mH
VN2
ADJ

Next Steps

- Finish modifying Circuit board, optimizing, and recording characteristics
- Connect signals to Arduino and make Nice UI
- Create Final container design for reduced system

Acknowledgments

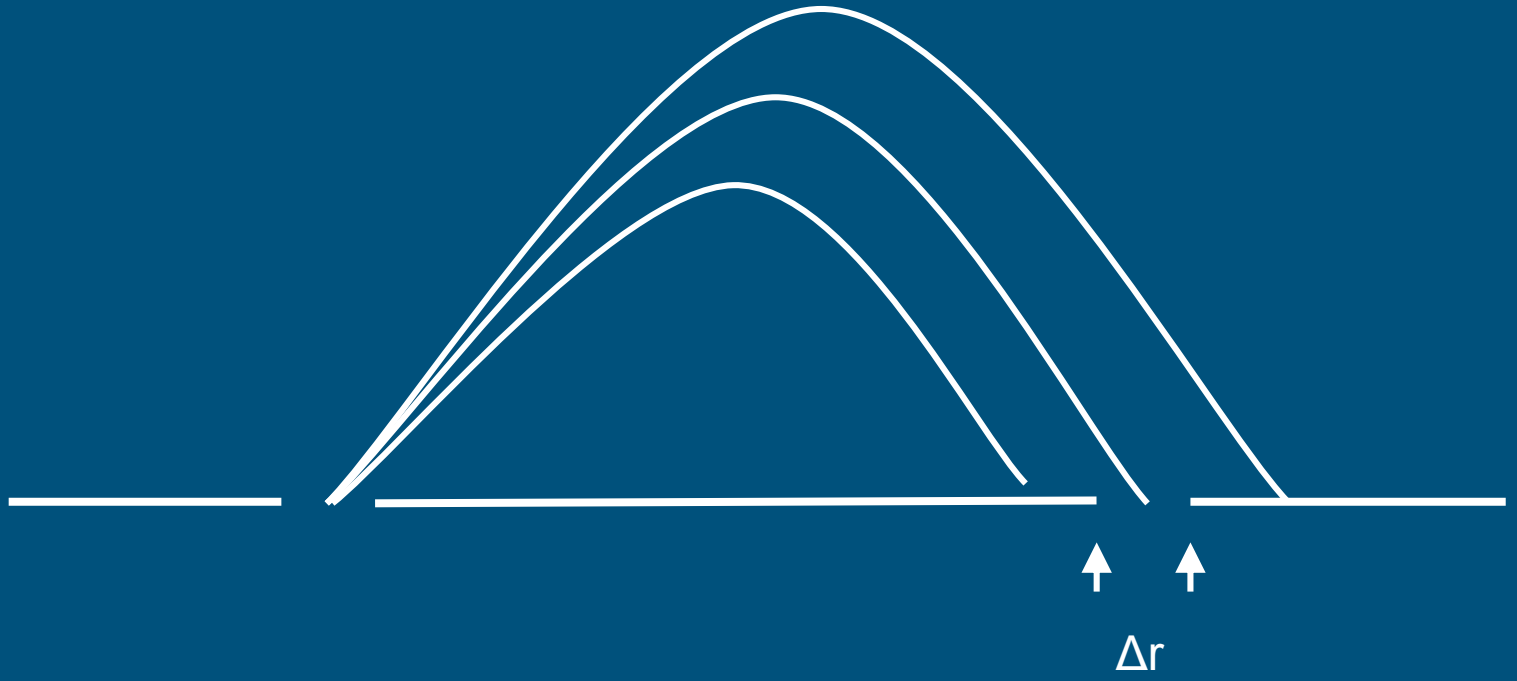
Thanks to Dr. Erik Sánchez, Dr. Jun Jiao, Hillary Louth, Tianna Coburn, Jeff Black, Alex Smith and to everyone else who helped me

Questions?

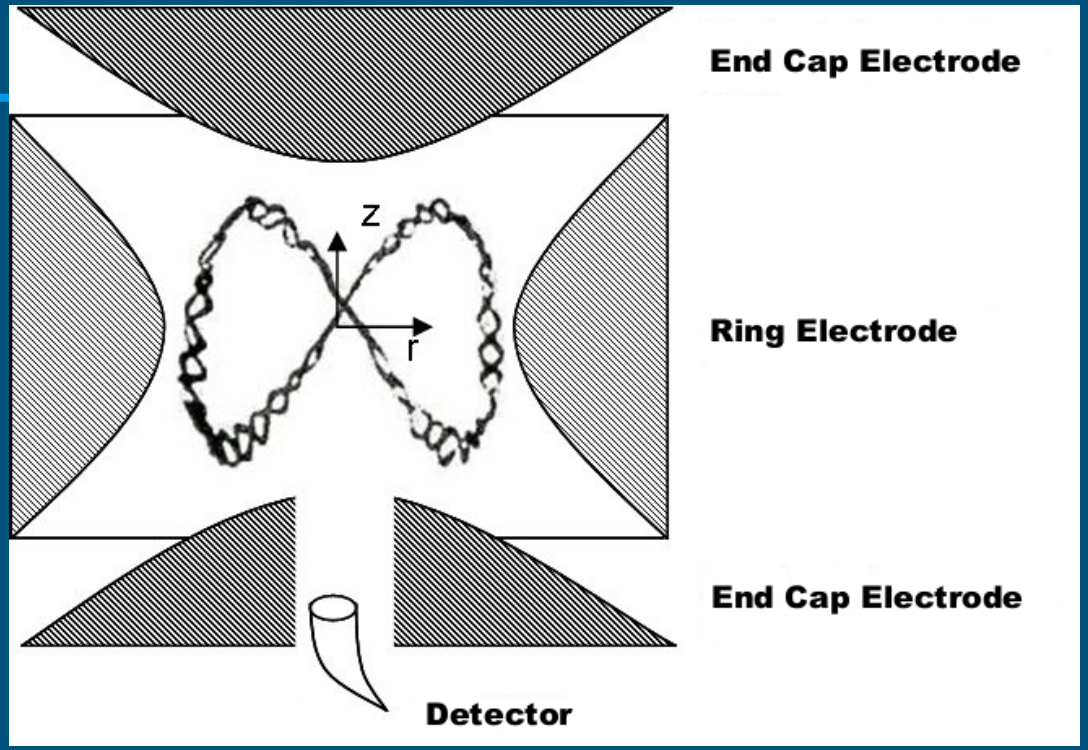
References:

1. *A quadrupole*. N.d. *Chem.Libretexts.org*. Web. 10 Aug. 2017.
2. Dass, Chhabil. *Fundamentals of contemporary mass spectrometry*. Hoboken, N.J: Wiley, 2007. Print.
3. Duckworth, Henry Edmison. *Mass spectroscopy*. Cambridge: Cambridge U Press, 1960. Print.
4. Cameca. *Nano SIMS 50*. N.d. *Cameca.com*. Web. 10 Aug. 2017.
5. Robinson, James W., Skelly Frame Eileen M., and George M. Frame. *Undergraduate instrumental analysis*. Boca Raton, Fla.: CRC Press, 2014. Print.
6. *Trap Diagram*. N.d. *Doping.chuv.ch*. Web. 10 Aug. 2017.
7. Williams, I.S. (1998), "U-Th-Pb geochronology by ion microprobe", in McKibben, M.A.; Shanks III, W.C.; Ridley, W.I., *Applications of microanalytical techniques to understanding mineralizing processes*, Reviews in Economic Geology, **7**, pp. 1–35, doi:10.5382/Rev.07.01
8. Leybold. *UL 100 plus*. N.d. Cologne, Germany. *www.atecorp.com*. Web. 10 Aug. 2017.
9. Leybold. *ULTRATEST UL 100 PLUS* . Cologne, Germany: n.p., n.d. Print. User Manual

Resolution



Type: Quadrupole Ion-Trap



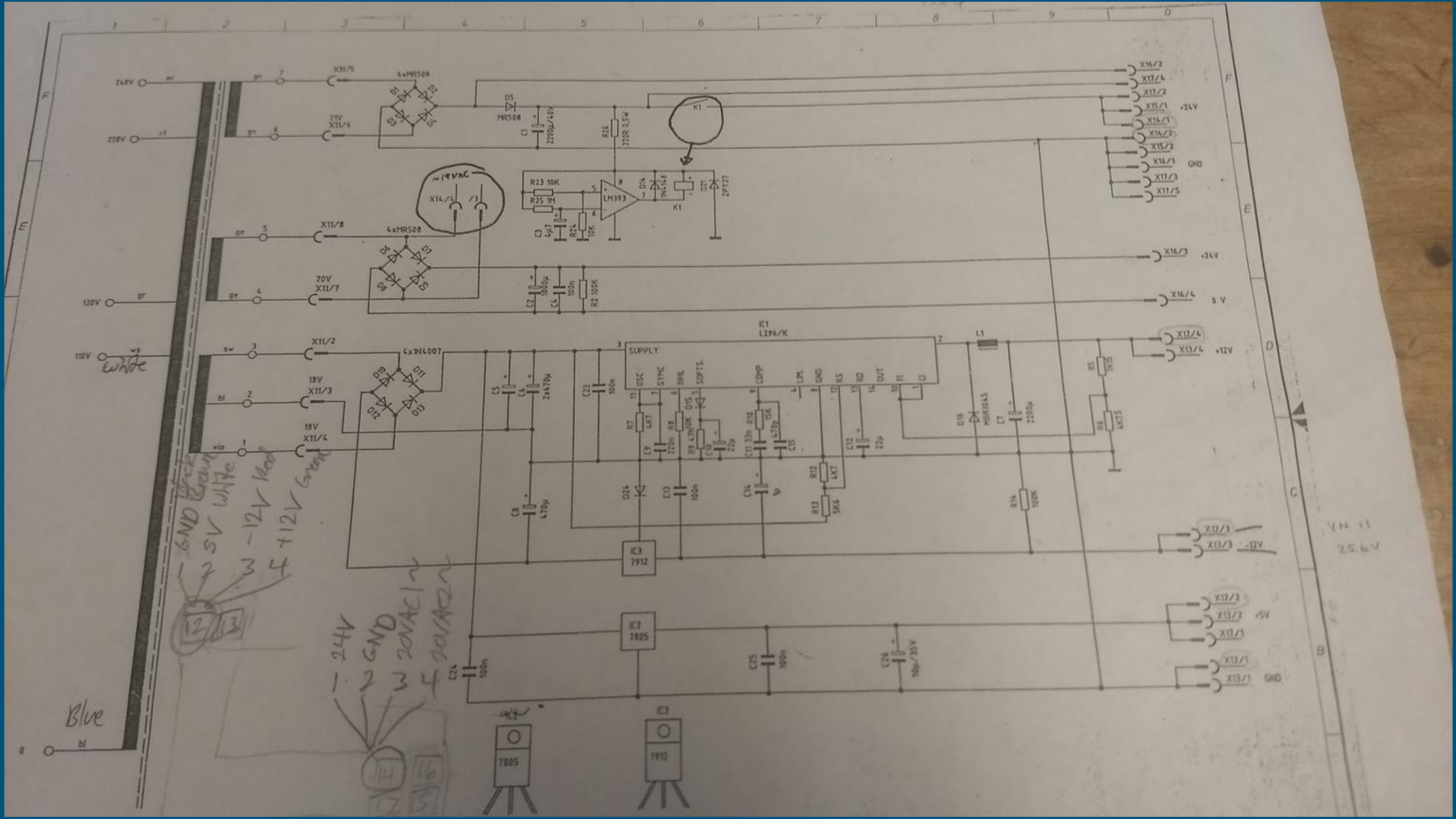
Trap Diagram. N.d. *Doping.chuv.ch*. Web. 10 Aug. 2017.

Benefits:

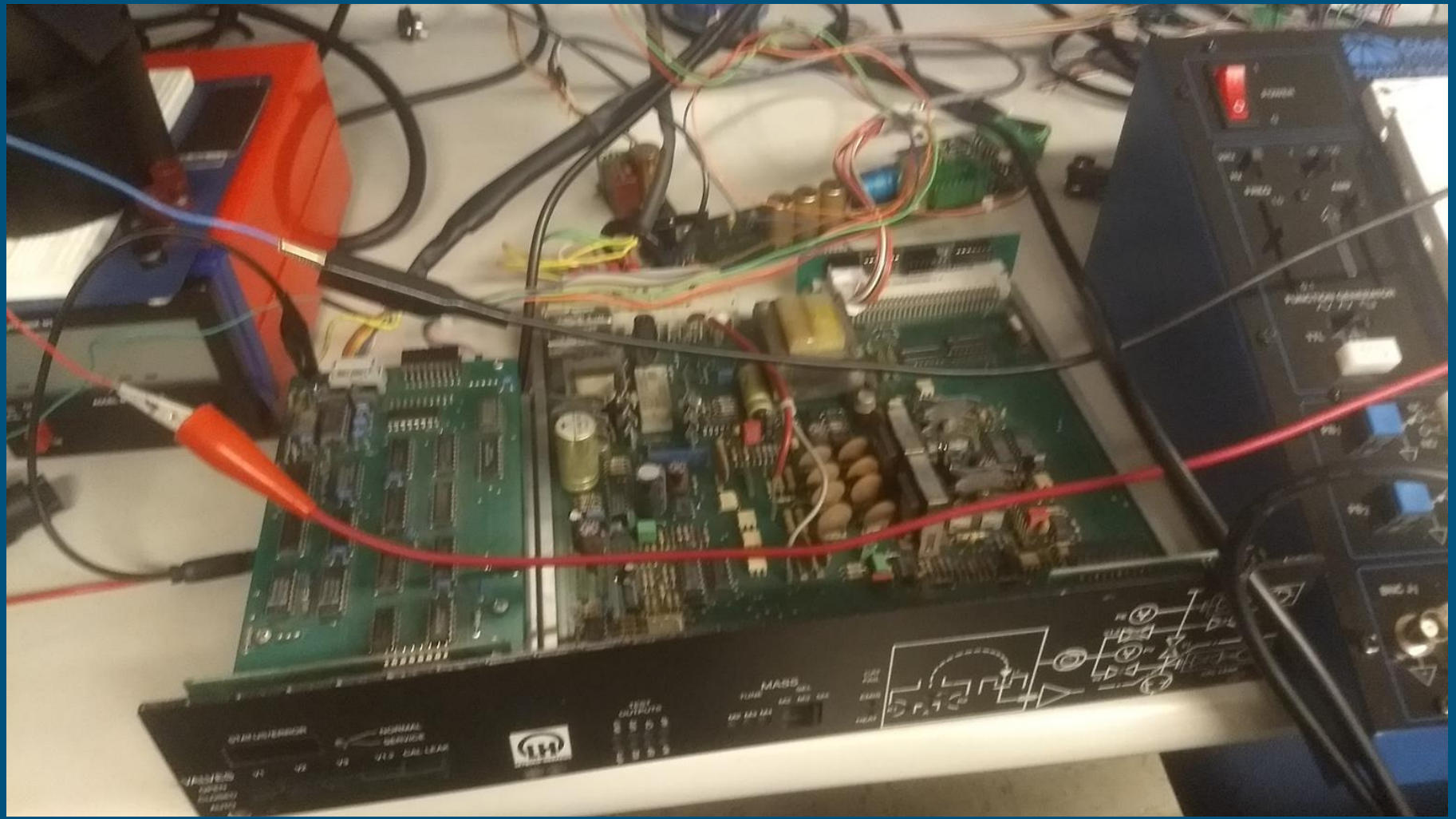
- High efficiency and sensitivity
- Compact

Criticism:

- Space-Charge Build-Up



240V
220V
130V
110V
White
Blue
4xMR508
X11/5
21V
X11/6
D5
MR508
C1
2200µ/40V
R26
220R 0,5W
K1
R23 10K
R25 1M
LM393
D14
1N4148
D21
ZPY27
C3
4µ7
R24
10K
~19VAC
X14/5
/3
X11/8
20V
X11/7
C2
1000µ
C4
100n
R2 100K
X16/2
X17/4
X17/2
X15/1
+24V
X14/1
X14/2
X15/2
X16/1
GND
X17/3
X17/5
X16/3
X16/4
0 V
IC1
L296/K
SUPPLY
X11/2
4x1N4007
18V
X11/3
X11/4
C5
C6
2x470µ
C23
100n
OSC
SYNC
INHI
SOFTS.
COMP
LIM.
GND
RS
RO
OUT
FI
CI
L1
D18
MBR1045
C7
2200µ
R5
R6
X12/4
X13/4
+12V
R7
4K7
R8
R9
C9
220n
C10
22µ
C11 33n
R10
15K
C15
4n7
C12
22µ
R12
4K7
R13
5K6
D24
C13
100n
C14
1µ
C8
470µ
R14
100K
IC3
7912
X17/3
X13/3
-12V
IC2
7805
C25
100n
C26
10µ/35V
C24
100n
X12/2
X13/2
+5V
X11/1
X12/1
X13/1
GND
7805
7912
1 GND
2 5V
3 -12V
4 +12V
12
13
1 24V
2 GND
3 20VAC1
4 20VAC2
14
16


MASS