Physics 3880

NOTEBOOK EXAMPLE

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Spring, 2012

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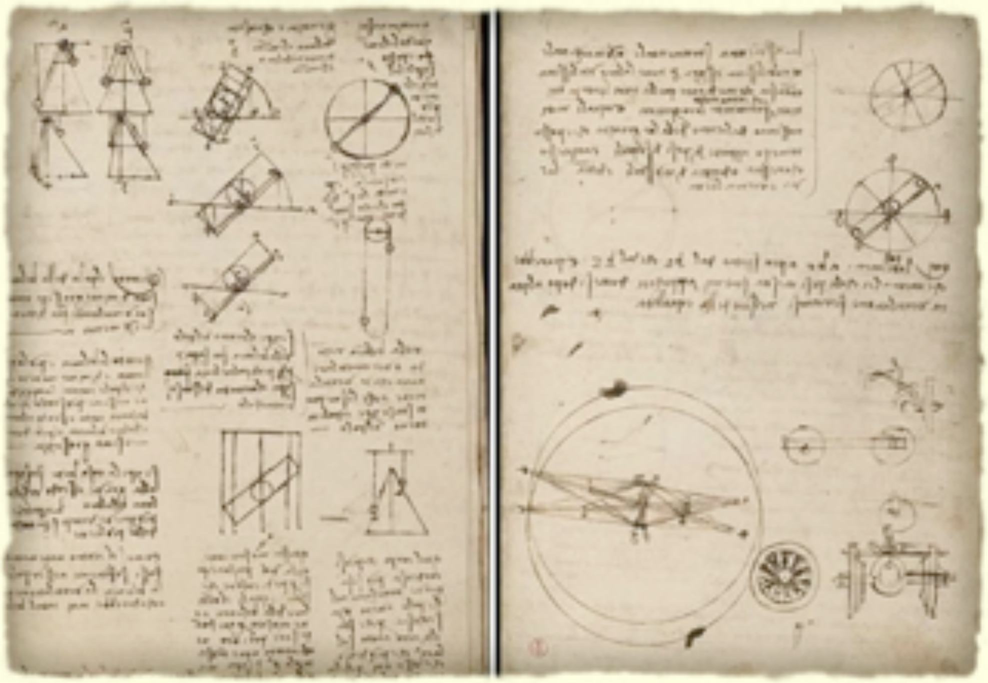
Notes on a Lab blook …

Lab books have a glorious history. They can be works of art (Leonardo comes to mind) …



but most of all the science of our world is built on them That's right: science is built on good notes. Consequently, learning how to keep a useful, meaningful lab book is an essential.

A lab book is not just a place to write down meausrements here and there. A better way to think of a lab book, is as a journal.

It's a place to jot down thoughts as you have them …

It's a place to record discussions with other scientists …

It's a place to outline an experiment plan …

Notes on a Lab blook (cont'd) ...

It's a place to record notes on equipment malfunctions – what is going wrong, what you've done to troubleshoot, what you've found, what you've eliminated, and ultimately how it got fixed. ...

It's certainly a place to record measurements ...

It's a place to do analysis ...

Notes in a lab book should be reasonably neat – this because they serve a number of purposes:

1. They serve to remind you what you've already done, tried, thought of, tested, discounted, etc...

   It might sound unbelievable, but in a longer-term project, one can often forget what measurements you've done, what you've tried in troubleshooting equimpment problems, etc.

2. They serve to communicate what you've done to other researchers.

   Often, work in a lab continues, even after you have gone. Lab books serve as a record to others about what you've done, how you did it, what troubles you encountered, and how you solved them.

3. They can serve as an official record of your work. This can be important if it comes to questions of patents or "who got there first?"

A common error first-timer lab book keepers make, is to try to cram everything into a small space. A key to keeping a useful lab book is to

SPREAD THINGS OUT !!

Notes on a Lab blook (cont'd) ...

In addition to making for ease of reading, keeping things spread out allows you to come back later and make further notes, based on results as the work continues.

Put dates at the tops of pages

Put headings at the tops of pages, to help you find things

Refer to information on other pages (see p. 8)

Keep a running table of contents

Do calculations

EXAMPLE: I need to heat my sample to 95 deg C; what size heater (1W, 10W, 100W) am I going to need...

BOX IN IMPORTANT RESULTS

Record the occasional piece of physics humor ...

"How many theoretical physicists does it take to split the lunch check???" — nobody knows, it's never been done!! "

10/22

- Took chamber assembly off feedthru and removed mag shield and top plate for re-alignment.

- RD was out of alignment. Realigned and re-assembled.

- Also constructed tool for removing and replacing primary samples. Seems to work well.

Magnetic Testing of Chamber Apparatus

10/23/96

- Can is assembled. Want to check magnetic field strength inside the mag. shield. Will do this using F.W. Bell Model 640 Gaussmeter, and a 1X * two-axis probe (cylindrical, ~.4 cm dia x 5 cm long)

- The probe can be used throughout the meter's full range of settings, .1G thru 30KG. On the .1G range setting, the scale is marked in .001G increments.

- Accuracy of the instrument is ± 0.25% of full scale plus ± 0.02G, and internal calibration accuracy is ± 0.3% of reading.

Zeroing

- I zeroed probe down to the .1G range setting for each probe orientation w/which a measurement was performed. Zeros at 1G and .3G ranges were very stable; zeros at .1G were a bit jumpy, varying by about ± .005G

Results for various probe orientations are as follows.

ORIENTATION	AMBIENT $\lvert\vec{B}\rvert$	INTERNAL $\lvert\vec{B}\rvert$
1 (Hor. ~E-W)	0.145G	0.003G ± .002G
2 (Diag. ~E-W ; 45° down)	0.40 G	0.025 ± .005G
3 (Hor. ~N-S)	0.1 G	0.01 G ± .005G

*Note: It is difficult to check every location in the can, due to size of probe. However, from moving probe around in can as much as possible, while maintaining roughly the same probe orientation, it appears that $\vec{B}$ inside the can is roughly uniform, w/ no obvious magnetic sources →

Since overall accuracy of instr. is only .02 G, it is difficult to say what absolute value of $\vec{B}$ is inside the can. The can was designed for about ~ 1mG interior field strength. However, based on my measurements, it appears the interior field strength may be on the order of ~ <u>10 mG</u>.

Does this shoot down my angular measurements?

- Need to calculate a deflection over the path length of electron

$$\Delta d = \frac{1}{2} e B \sin\theta \, d_t^2 \sqrt{\frac{1}{2 E m_e}}$$

assume
$d_t = 6.35$ cm
$B = 10$ mG $= 10^{-6}$ T
$E = 1$ eV $= 1.6\times10^{-19}$ J
$\theta = 90°$

$\Rightarrow \Delta d \cong 600\,\mu m = \underline{.6\ mm}$

For my detector aperture of 1.6 mm, this shd be considered significant, though not disastrous.
However, if $\vec{B}$ inside can is ~ 0.02 or 0.03 G, then we've got a problem

- Trials w/ 1X 1-axis probe confirm max $\vec{B}$ inside can of ~ .03 - .04 G. Fields of such strength are definitely a problem to angle-resolved. SE yields, though not for angle resolved BSE yields.

~~Once the can is in the chamber, I will check the can fields once again.~~

* Can is magnetized - need to de-Gauss it

MAGNETIC SHIELDING (cont'd)... 10/24/96

- Spoke w/ Jack White at Magnetic Shield Corp. / Perfection Mica Co. : (630) 766-7800.

- After describing my design to him, he sez he would believe that I'm only getting an attenuation of 20-30:1. Even though my calculation (see LB I p. 16) of an attenuation of 300:1 is basically correct, Jack sez this is theoretical and very tough to achieve. He sez two things in particular are hurting me:

(i) stress annealed rather than oven annealed
(ii) my spot-welded seam.

His suggestion is to take 3-4" strip of material and cover up the seam and see how that does, or to have them build the shield for us. He sez it sounds like ~$300 job, and could get into the 1-2 mG range.

- Also, he suggests that if we could replace the spot welding w/ TIG weld it would help.

- He sez doesn't not believe de-gaussing will help much.

- Also sez we could send them the shield for annealing, but fact that there is .030" netic top plate could complicate matters.

* Also gave de-gaussing procedure:

102 turns of 14 gauge wire.

Run coil up to 5A, then decrease to zero at rate of 1A every 4 sec.

PLAN OF ~~ATTACK~~:

1. Remove spot-welded .030" netic top plate.

2. Have Reed Nielson TIG weld the can seem.

3. Punch center hole in .014" Co netic top plate, using .030" Netic top plate as template

4. Have Reed TIG weld the .014" top plate to the can

5. Send whole assembly off to Mag. Shield corp. for annealing.

6. Be Happy w/ results.

10/24 PM

- Faxed request for quote to Jack White @ Mag Shield Corp.

E-Gun Testing

10/25/96

- Pulled gun to determine cause of low (~6 MΩ) resistance between filament pins (4 & 5) and extractor cup (6) [see p. 8].

  - Discovered ceramic insulator which holds filament pins in filament assembly was dirty. Cleaned w/ slurry of 240 grit alumina powder and nylon toothbrush. Repeated approx 10 times, each time wiping the excess alumina powder off w/ chemwipe & methanol.

  - Resistance increased to ~1 GΩ (as measured w/ 616)

- Replaced gun on chamber, re-tested all pins, everything looks good.

CONCLUSION:

- Based on first order calculations - experiment is doable.

5 JUNE 91

FIRST GUESS DETECTOR DESIGN:

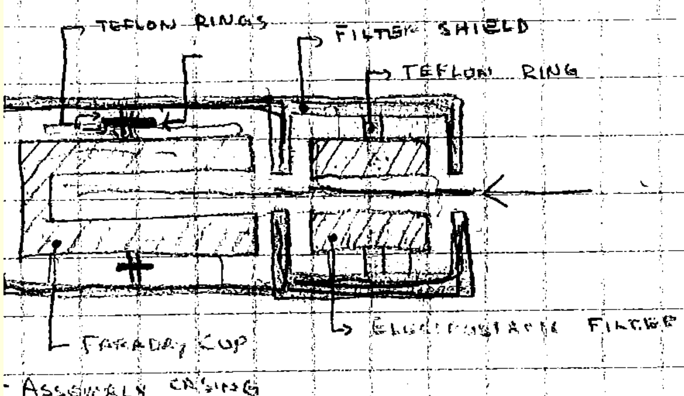


FIG 1

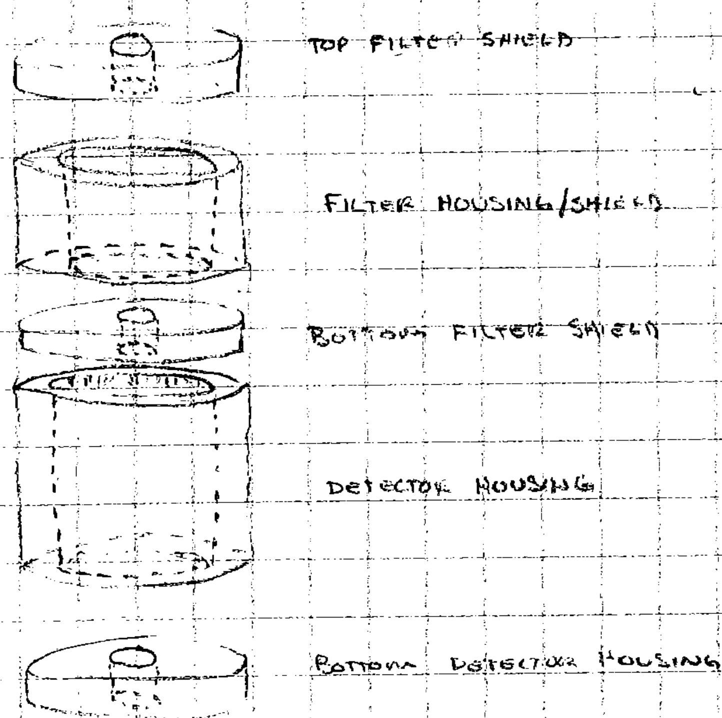


FIG 2

OUTER ASSEMBLY

DETECTOR ASSEMBLY
- Not to scale

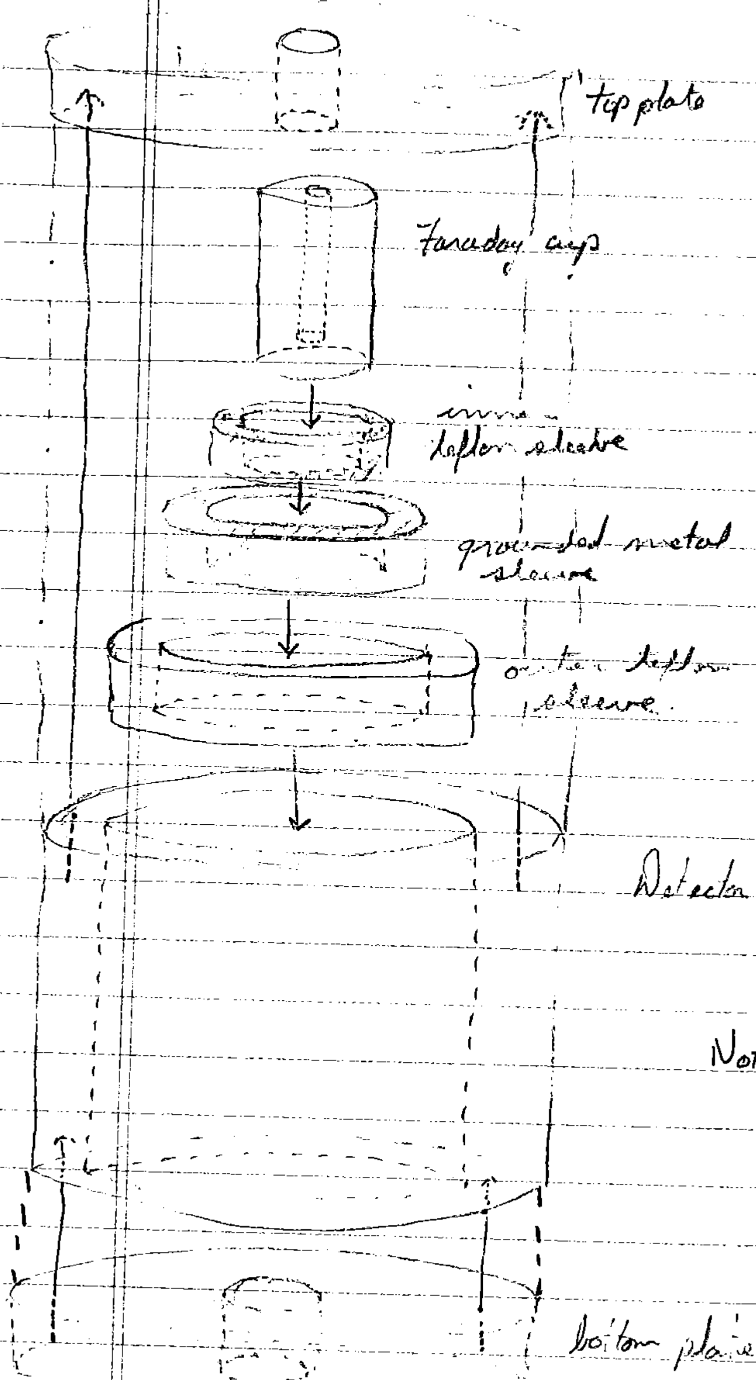
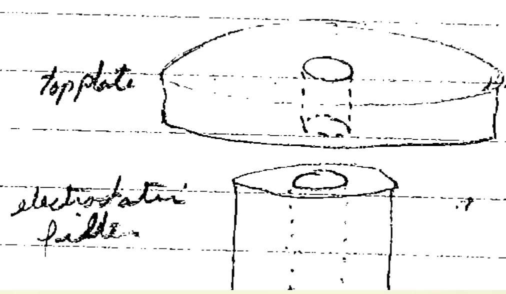


FIG 3

NOTE: Ground / measurement leads not shown

FILTER ASSEMBLY
- Not to scale



- NOTE: Filter assembly is mounted on top of Detector assembly as show

NEXT:

- 1) Nail down dimensions
  - use computer

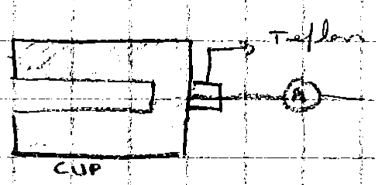
2) Discuss arcing problems w/ 30KV on filter

3) Find equipment to generate/measure 30 KV on filter

- Need a high Voltage vacuum feed thru
  - Kurt J. Lesker Company part 10-49
    p. 10-15, 16 1991 Catalog

[illegible] TO DESIGN:

- Negatively biasing the Faraday cup itself [illegible] one possibility - rather than use of [el]ectrostatic shield.
  - Shown to be not viable in this case, however, for following reason



Assume a cup to be biased to (−) 20kV. If a good isolator is used - w/ impedance of 10 G ohm,

- applying ohm's laws $V = IR$

$$I = \frac{V}{R}$$

$$= \frac{20{,}000\,V}{1\times10^{10}\,ohm} = 2\times10^{-6}\ amps$$

- Material for filter: not brass? check
  - Al, Cu
- Need penetration depth of 30keV electron in aluminum

TRIAL DIMENSIONS

Faraday Cup: - Material: Al

Aperture diam: .0625" (1/16)

depth: .625" (5/8)

Trap diam: .25" (1/4) (3/16" thick)

Trap length: .75" (3/4)

Inner teflon sleeve: inner diam: .25"

outer diam: .375" (1/8" thick)

length: .5"

Grounded metal sleeve: inner diam: .375"

outer diam: .5" (1/8" thick)

length: .5"

outer teflon sleeve: inner diam: .5"

outer diam: .625" (1/8" thick

length: .5"

Detector housing: inner diam: .625"

outer diam: .75"

Electrostatic filter:

Filter: aperture diam:

total diam:

length:

Tues., 16 Feb 91 –

Time to start final design...

Important points:

1) - Make sure components - ie front shield, filter, back shield, detector all line up exactly.

- Maybe design so they all fit together, then drill the holes.

2) Design so components are interchangeable - ie, for several different size filters

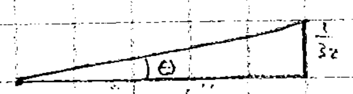
3) Design for rigidity

4) Coat inside of filter, detector w/ carbon to minimize production of secondaries w/in the device.

5) design aiming system, built in

How electron "line" from point source...

assume 1" from target



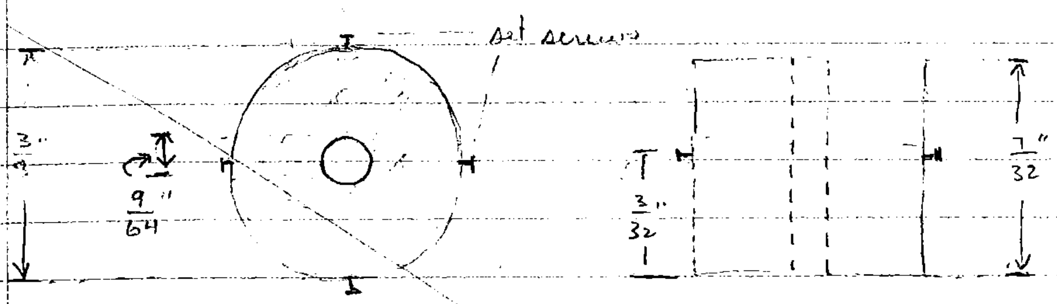
$\tan\theta = \frac{\frac{1}{32}"}{1"}$ ∴ $\theta = .0312$ rad

Program starts electrons $\frac{1}{4}$" from filter...

FILTER & ASSEMBLY . . . NOT TO SCALE

pin 1/64 1/32

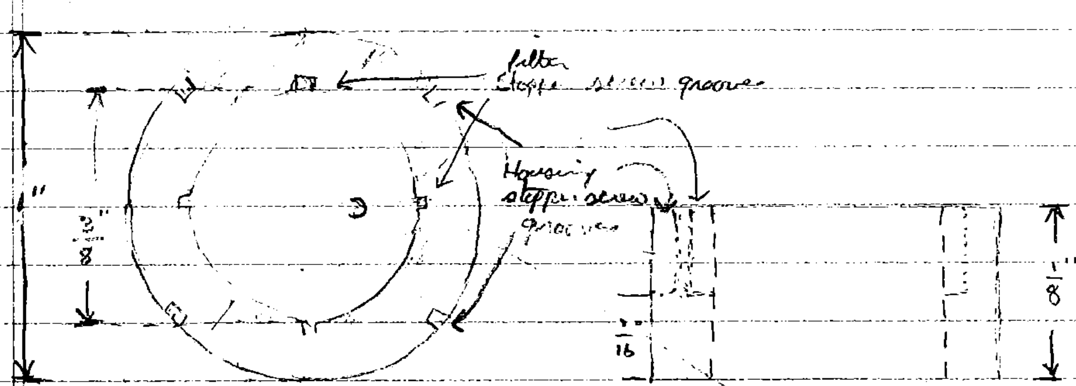
FILTER



TOP VIEW SIDE VIEW

Material: aluminum w/ carbon coating on inside tunnel sfc.

INSULATING RING Bottom

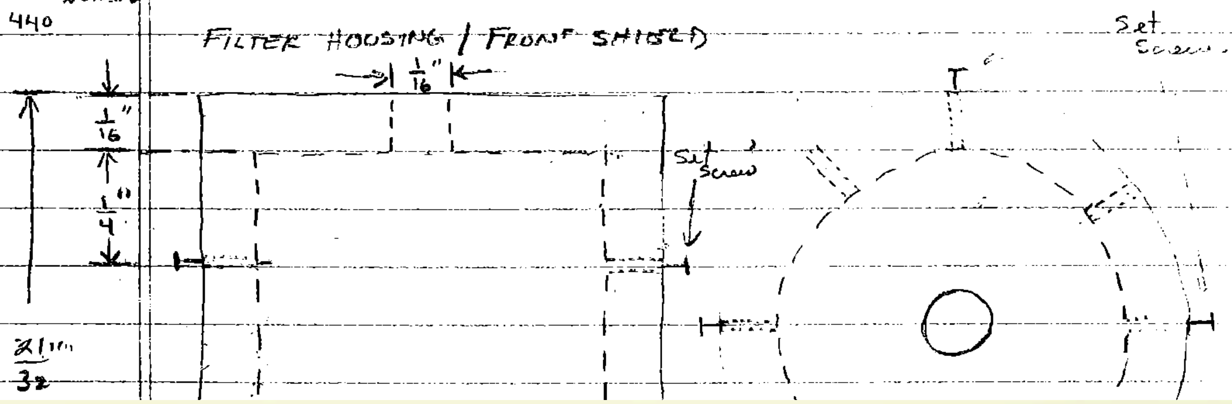


TOP VIEW SIDE VIEW

.060 ~~add 90's~~ 980's screws 440

Material: Teflon

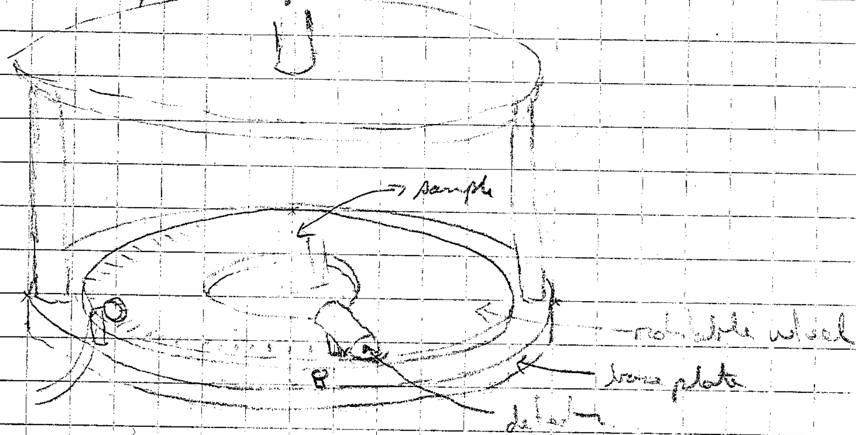
FILTER HOUSING / FRONT SHIELD



10/27/92

- Working on detector mounting assembly to fit in J.R.'s Vacuum chamber

- Initial design concept:



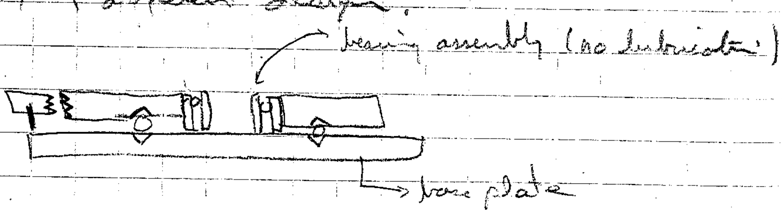
- detector mounted on rotatable wheel. Wheel sits on four gears mounted to base plate.

- Sample is mounted to base plate at center of rotation.

- entire assembly can be wrapped in μ-metal for E, M field shielding.

Conversation w/ J.R. ...

- Possibly go to slightly different design:



- Spot weld bearing assembly to base plate, rotating ring to bearing.

- Groove base plate, rotating plate to accept ball bearings.

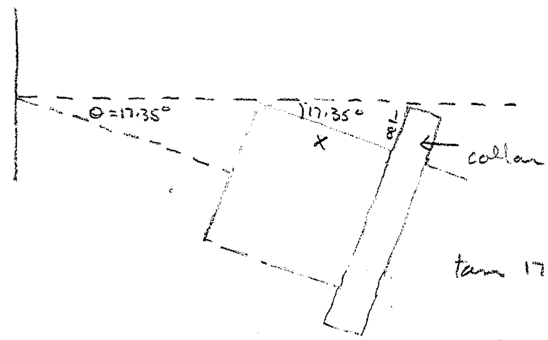
* Note: check detector collar - $\frac{1}{8}$" thick → can this be mounted w/out ~~[struck out]~~ increasing θ

↓

10/29

Also note: Mounting collar is $\frac{1}{8}$" thick. How far back must it be placed so as not to interfere w/beam?...

Top View

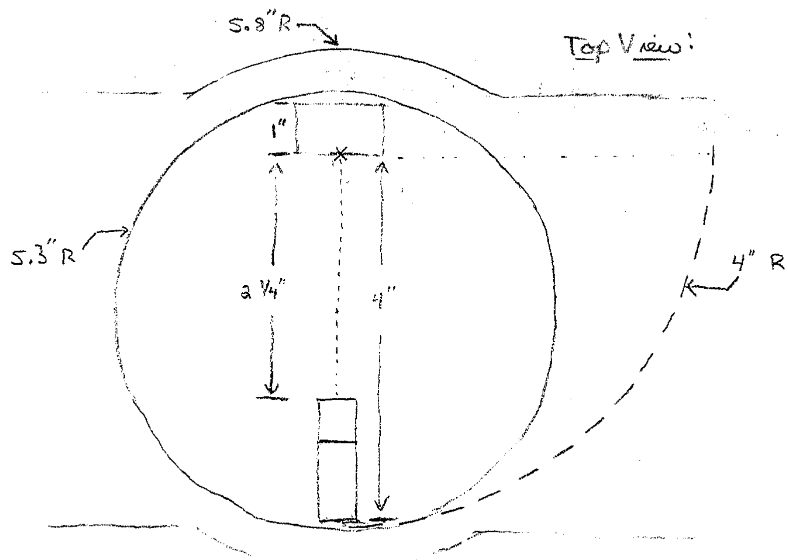


$$\tan 17.35 = \frac{\frac{1}{8}}{x}$$

$$\Rightarrow x = \frac{\frac{1}{8}}{\tan 17.35} = .4''$$

2nd Alternative:

- Can maintain horizontal configuration if we move sample from center of chamber...



x - marks axis of rotation

- This gives target / detector dist of 2.25" which converts to

$\theta_{min} \approx 15.5°$

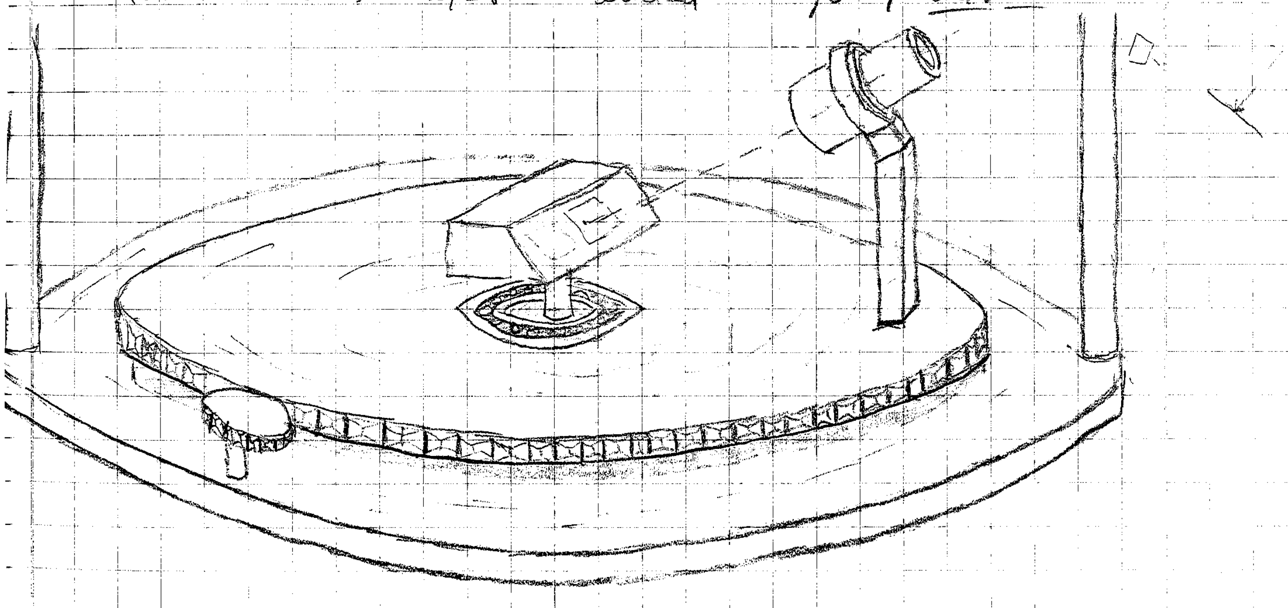
- Possible snags:

1) - requires bring electron gun in from main cross port - need a special flange for the fit

2) - Maintaining optimum 3.5" max. gun-sample dist.

3) Maintaining magnetic shielding

* Talked to J.P. - 10/28 - elected to go w/ alt. #1



- gives target dist. of 2" or just under, $\theta_{min} = 17.35°$

* NOTE: Will have to accept minimum gun-target dist. of 3.75" (2" target/detector dist. + 1.75" detector length)