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# Sketch of the X-Ray Spectrometer for the BNL Nonlinear Compton Scattering Experiment

This note discusses some preliminary plans for the Bragg-scattering x-ray spectrometer proposed for the nonlinear Compton scattering experiment to be conducted at the BNL Accelerator Test Facility. We wish to determine any incompatiblities of this design with installation at the ATF, so that we can begin construction soon.

Figure 1 (AutoCad) shows a plan view of the experiment. The 50-MeV electron beam enters from the right and collides head on with the $CO_2$ laser pulse in the scattering chamber. The electron beam is deflected downwards into the dump by the bend magnet. The backscattered x-rays continue along the initial electron direction through the magnet and scatter in the graphite crystal as soon after the magnet as possible. The x-rays take on an energy-angle correlation in the scattering process, and are detected in the Ge detector at a given angle. Ideally the distance from the $e$-laser collision point to the Bragg crystal should be the same as the distance from the Bragg crystal to the Ge detector.

The mechanics are complicated by the presence of the deflected electron beamline, which lies below the x-ray spectrometer. Figure 2 shows an elevation view of the spectrometer and electron beamline. Figures 3 and 4 shows the plan and elevations views of the spectrometer only.

The x-rays exit the ATF vacuum chamber through a thin (5 mil, 1″-diameter) beryllium window mounted on a $2\frac{3}{4}''$ Conflat flange, and enter an atmospheric-pressure helium box in which the Bragg crystal is mounted. [In an earliet concept, the crystal was in a vacuum box.] The Bragg crystal (1″ high and 4″ long) is suspended from above through a rotary feedthrough from a (used) GE $\theta$-$2\theta$ goniometer. We will try to achieve a mounting so that the Bragg crystal can be pulled completely out of the beam as well, to permit commissioning studies of the full x-ray beam.

A long arm connects the $2\theta$ motion of the goniometer to the housing of the germanium detector. Although it was originally foreseen that the detector and house could move in $\theta$ under motor control, it is probably sufficient to adjust the angle manually.

A major issue is the lead shielding of the Ge detector. It is desirable to have a background of zero x-rays per pulse from the ATF electron beam. Since the detector is located only about 2′ above the electron beam dump, we need considerable shielding. H. Kirk advises us that we can use some of the lead recovered from a sunken Roman ship to build a box around the detector. We will likely need additional shielding of more ordinary lead around the inner low-radioactivity lead shield.

The inner dimensions of the lead shield box are $10'' \times 12'' \times 17.5''$. If the shield of good lead is 1″ thick, we require about 500 lbs; or about 1100 lbs if the shield is 2″ thick, *etc.* We anticipate that at least an additional 2″ of lead should be placed underneath the shield

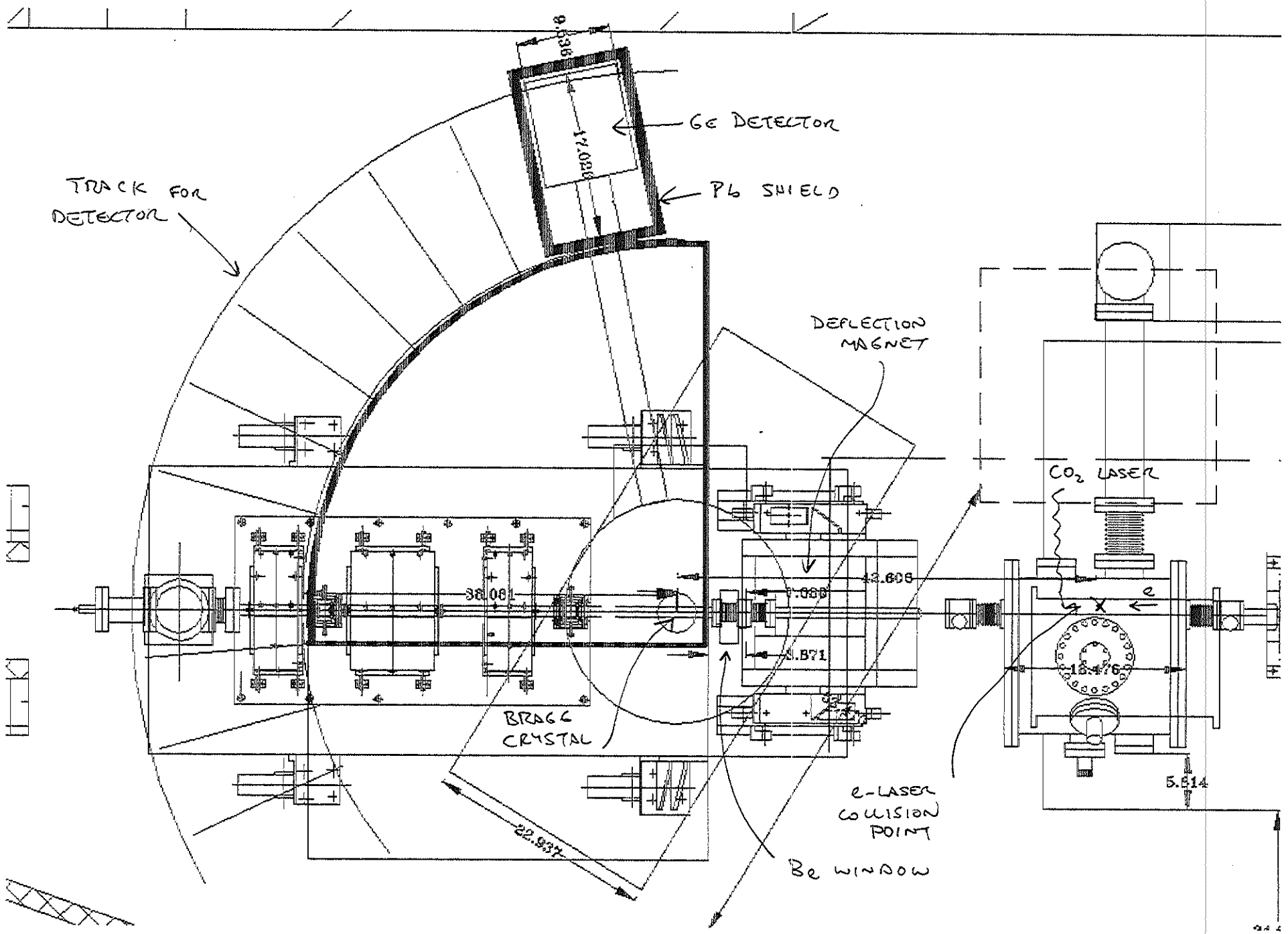
of good lead, requiring 300 lbs of lead bricks (*i.e.*, 12 bricks). It would be preferable if this base could be cast as a unit without vertical cracks.

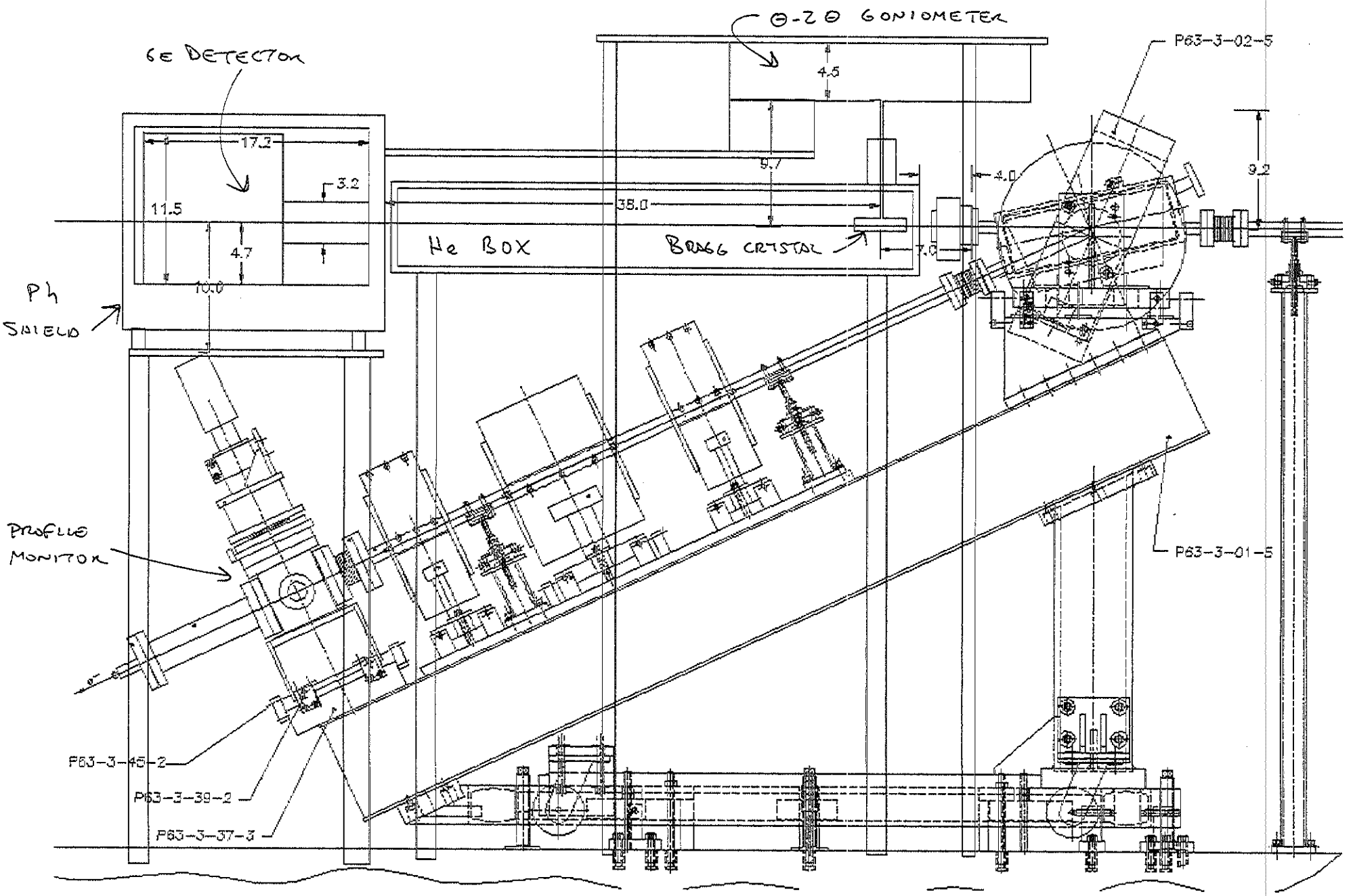
The detector must be replenished with liquid nitrogen about once a day during operation. It may be simplest just to lift off the lid of the lead shield box for this.

The shield + detector unit must roll on a horizontal, circular arc over a range of nearly 90°. For this unit to clear the east concrete wall of the ATF experimental area, the detector must be a few inches closer to the Bragg crystal than optimum. Figure 5 shows the expected relative energy resolution (in units of 0.1%) of the x-ray spectrometer for several energies and angles for the ideal radius 43″, and the more practical radius 38″. The entrance slit through the lead shield is $T = 0.1''$ in all cases. The 38″ radius causes only slight broadening of the detector resolution, which we consider acceptable.

The horizontal surface on which the detector rolls comes extremely close to the camera for the beam profile monitor just upstream of the dump. We wish to explore the merits of rotating that monitor so the optical axis is horizontal.

The detector system weighs close to one ton, and must be supported on a stand that engulfs the existing deflected-electron beamline. We need to understand any restrictions on placement of legs for the detector stand.


TRACK FOR DETECTOR
GE DETECTOR
Pb SHIELD
DEFLECTION MAGNET
$CO_2$ LASER
BRAGG CRYSTAL
e-LASER COLLISION POINT
Be WINDOW
38.081
22.937
5.814


θ-2θ GONIOMETER
6E DETECTOR
P63-3-02-5
17.2
11.5
3.2
4.7
10.0
4.5
5.7
38.0
4.0
9.2
7.0
He BOX
BRAGG CRYSTAL
Ph
SHIELD
PROFILE
MONITOR
P63-3-01-5
P63-3-45-2
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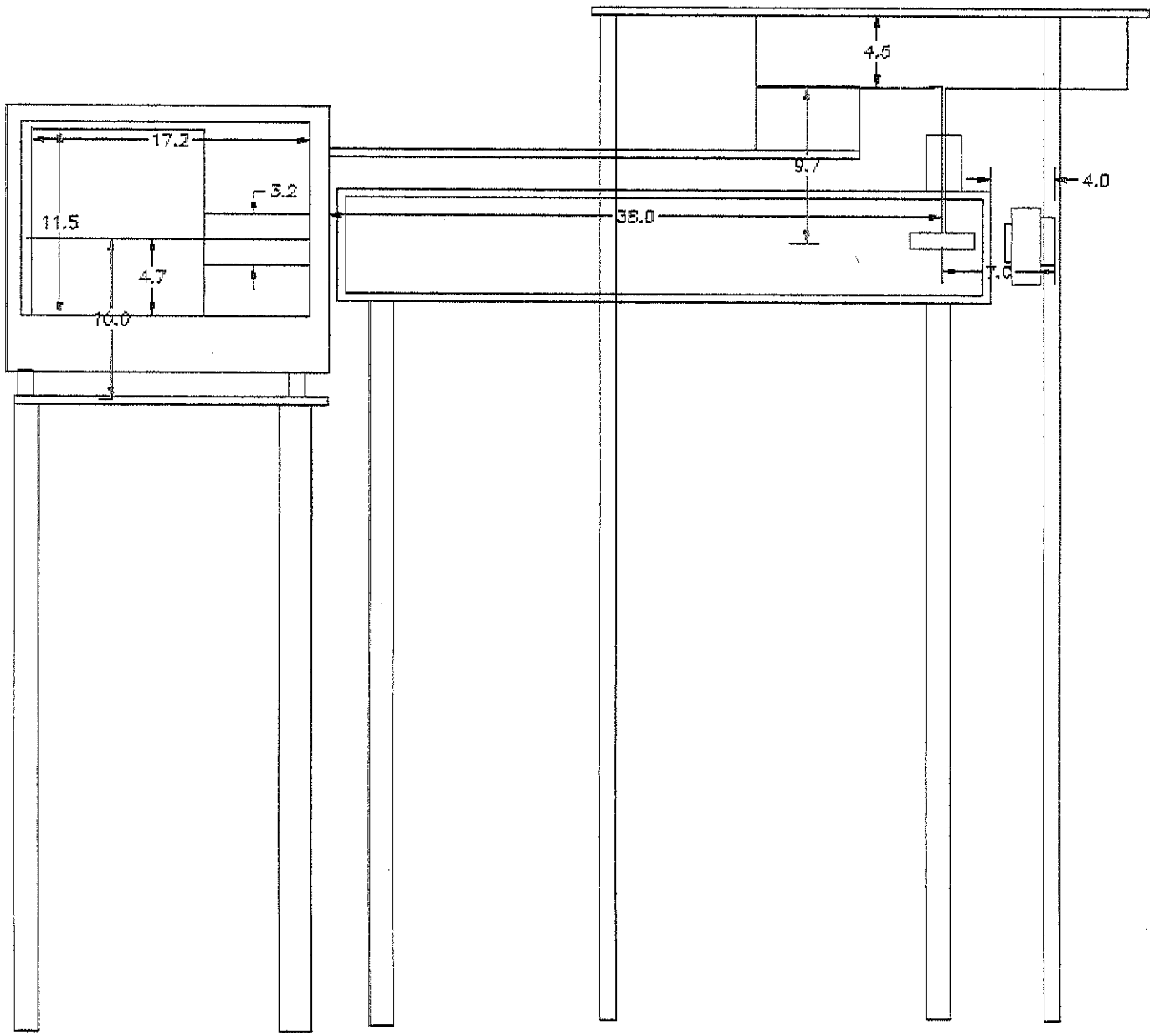
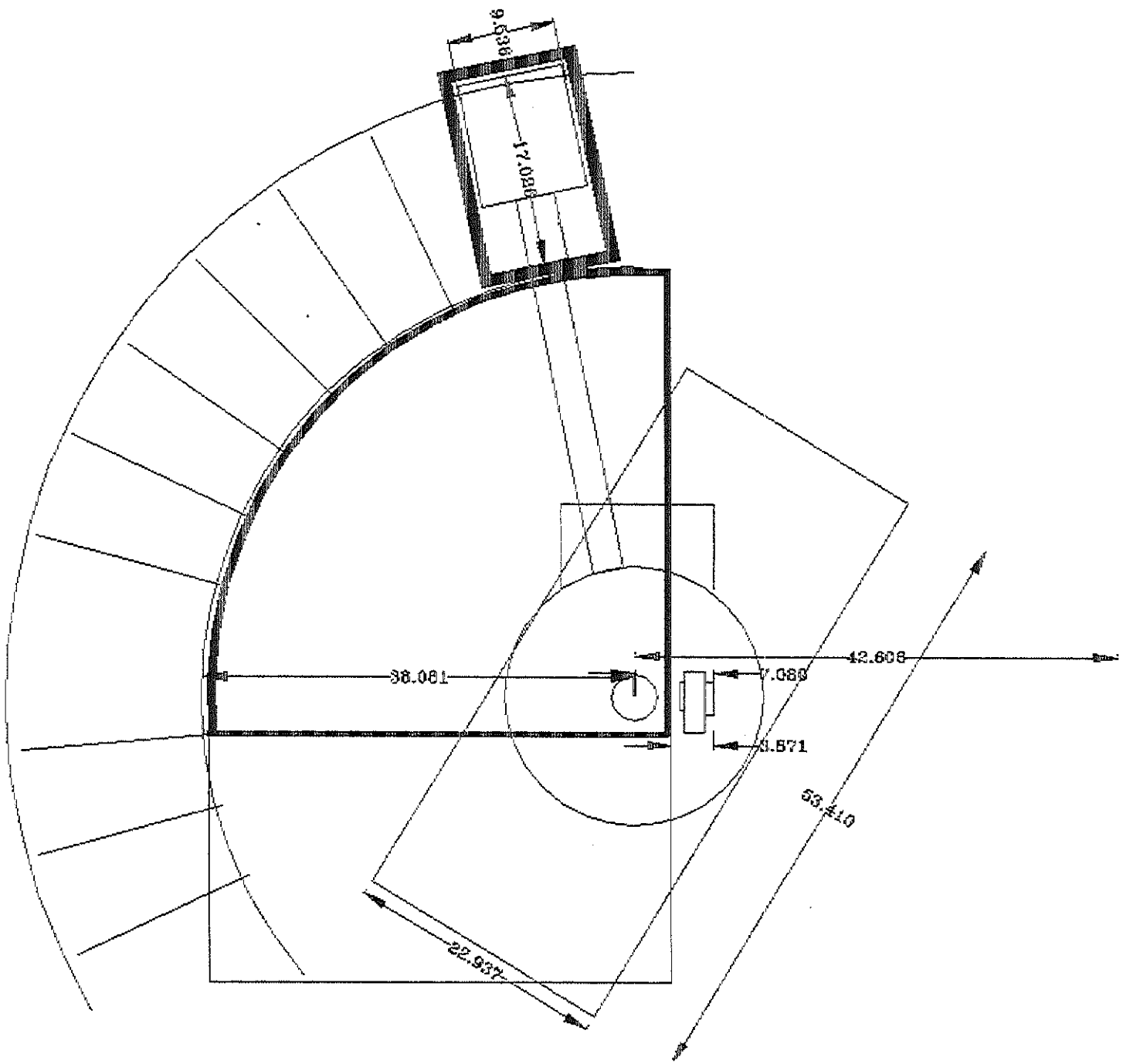
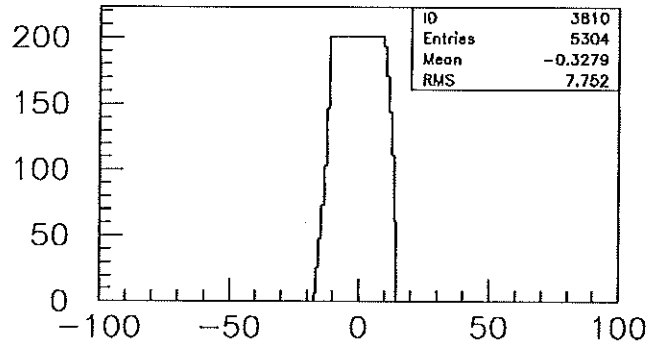
P63-3-37-3

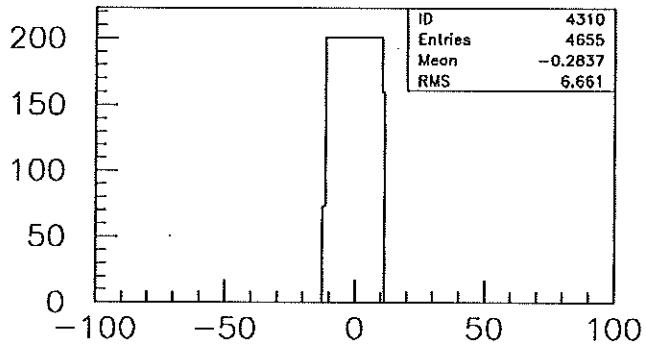

4.5
17.2
3.2
11.5
4.7
10.0
9.7
38.0
4.0
4.0
9.2


9.436
17.036
38.081
42.606
7.089
3.571
53.410
22.937

Photon Number vs. (E−Eo)/Eo




R=38 W=.1 T=.1 E=18.48

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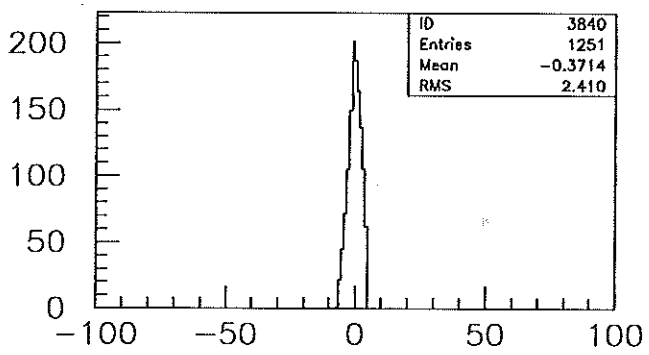


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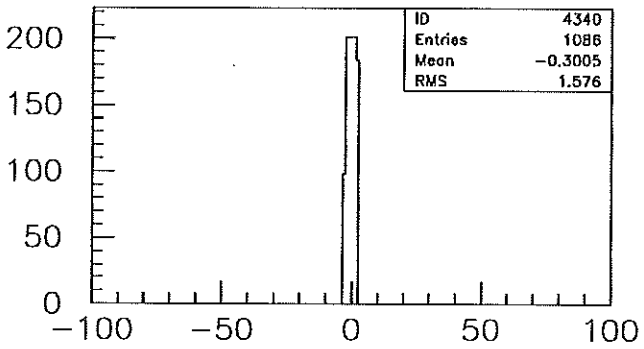
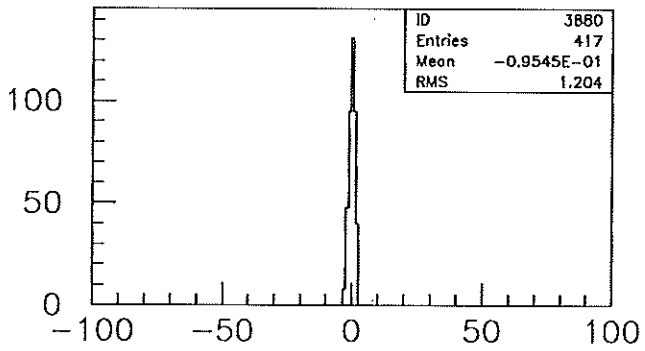



R=43 W=.1 T=.4 E=4.73

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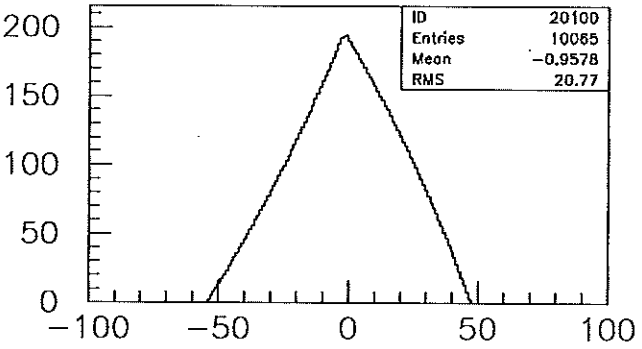


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