Aerosol Phase Function Monitoring "II"

Auger Collaboration Meeting

Malargue, Argentina

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1. Air Cherenkov Correction to Fluorescence Signal
2. Aerosol Phase Function Measurement ... Concept
3. Dedicated APF Light Source:
   - Design
   - Test at HiRes
   - Status of Coihueco Installation
4. ~~Summary~~ "THREE" issues:
   i) APF glancing shot DAQ implications
   ii) "TRIPLE POINT" vertical lasers
   iii) Dedicated "flat field" N_2 lasers.

Simulations (and event reconstruction):

a) $\gamma_{\text{fluorescence}}(\lambda)$ $\qquad + \; T^m T^a$

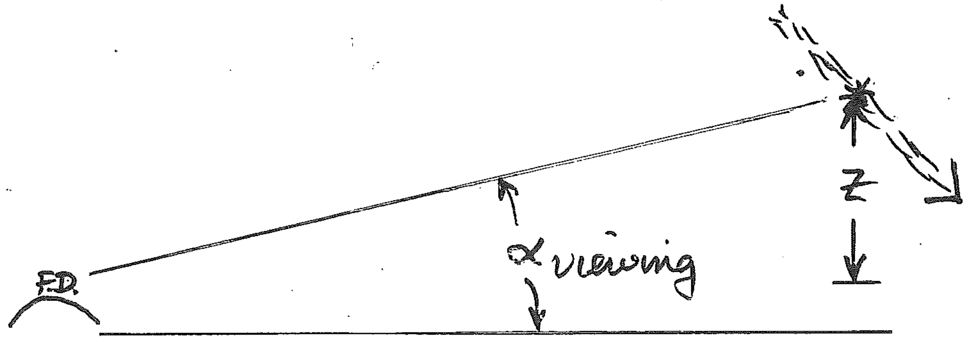
b) $\gamma_c(\lambda, \theta)$ $\quad + \;$ single scatter (into F.D. F.O.V.) $\quad + \; T^m T^a$

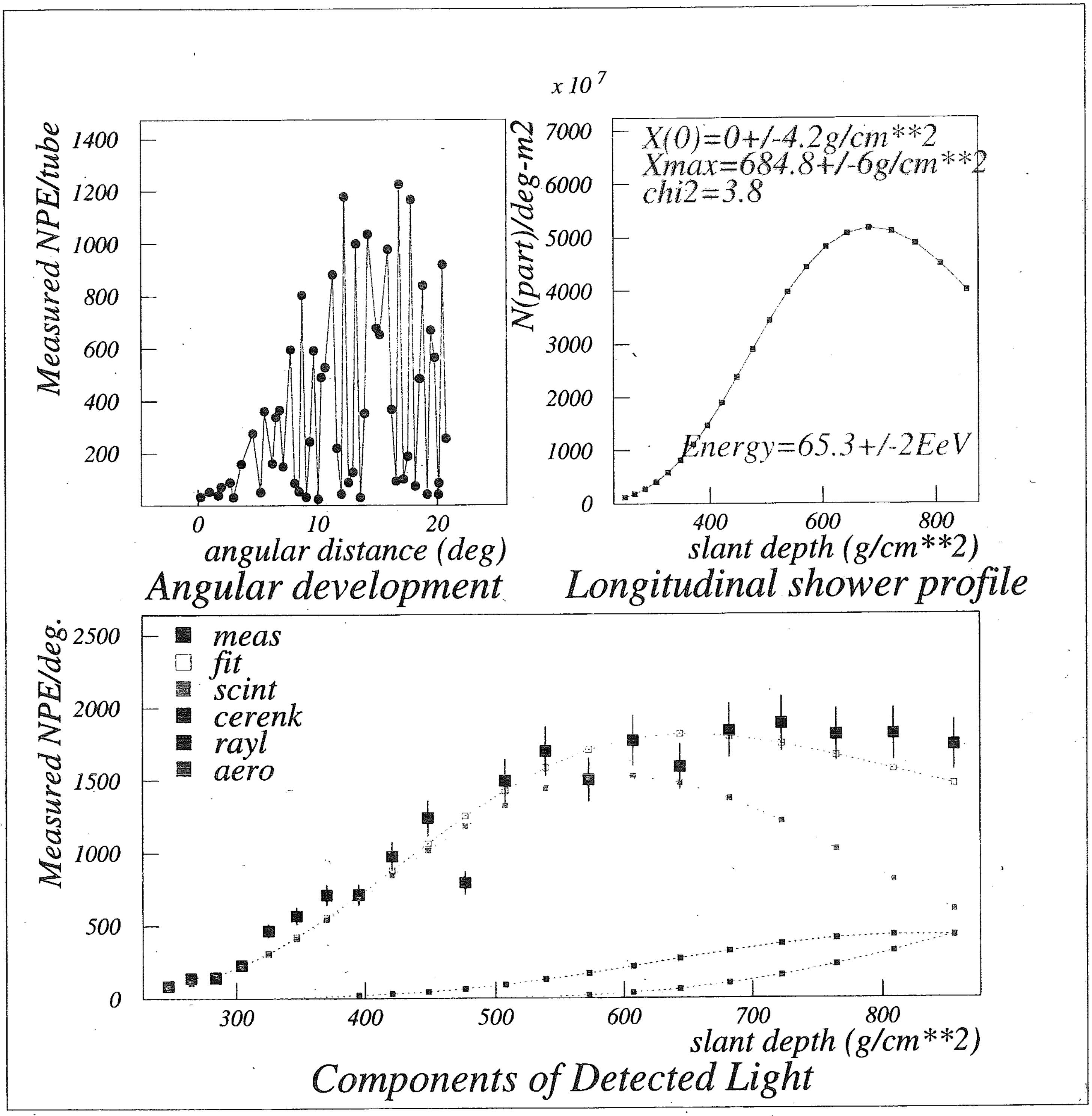
- θ: with respect to the shower axes
- single scatter: need $\Lambda(z,\lambda)$ and $\frac{1}{\sigma}\frac{d\sigma}{d\Omega}$
- $T^m T^a$: need $\Lambda(z,\lambda)$

$m \equiv$ molecular/Rayleigh
$a \equiv$ aerosol/Mie

where: $$T(z,\lambda,\alpha_{\text{viewing}}) = e^{-\tau(z,\lambda)/\sin\alpha_{\text{viewing}}}$$

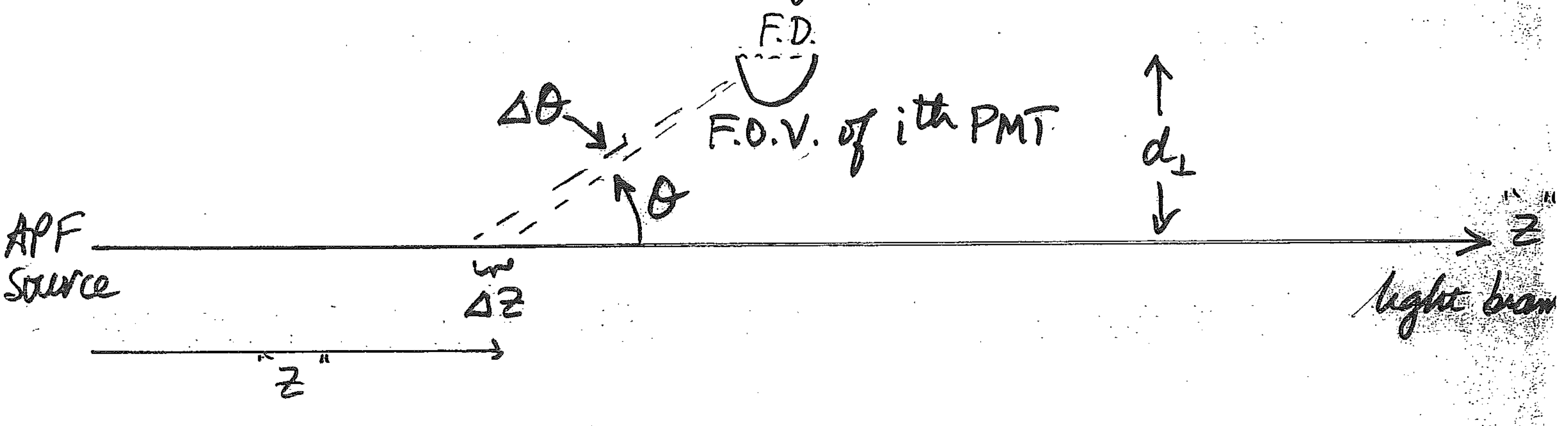
$$\tau(z,\lambda) = \int_0^z \frac{dz}{\Lambda(z,\lambda)}$$





x 10^7
Measured NPE/tube
1400
1200
1000
800
600
400
200
0
10
20
angular distance (deg)
Angular development
N(part)/deg-m2
7000
6000
5000
4000
3000
2000
1000
0
X(0)=0+/-4.2g/cm**2
Xmax=684.8+/-6g/cm**2
chi2=3.8
Energy=65.3+/-2EeV
400
600
800
slant depth (g/cm**2)
Longitudinal shower profile
Measured NPE/deg.
2500
2000
1500
1000
500
0
meas
fit
scint
cerenk
rayl
aero
300
400
500
600
700
800
slant depth (g/cm**2)
Components of Detected Light

"A.P.F. light source geometry"



$$\text{Signal}_i = I \times \frac{\Delta z}{\Lambda^m} \times \left(\left(\frac{1}{\sigma}\frac{d\sigma}{d\Omega} \right)^m + \frac{\Lambda^m}{\Lambda^a} \left(\frac{1}{\sigma}\frac{d\sigma}{d\Omega} \right)^a \right) \Delta\Omega_i \varepsilon_i$$

where: $\Delta z = \dfrac{d^2 \Delta\theta}{d_\perp}$

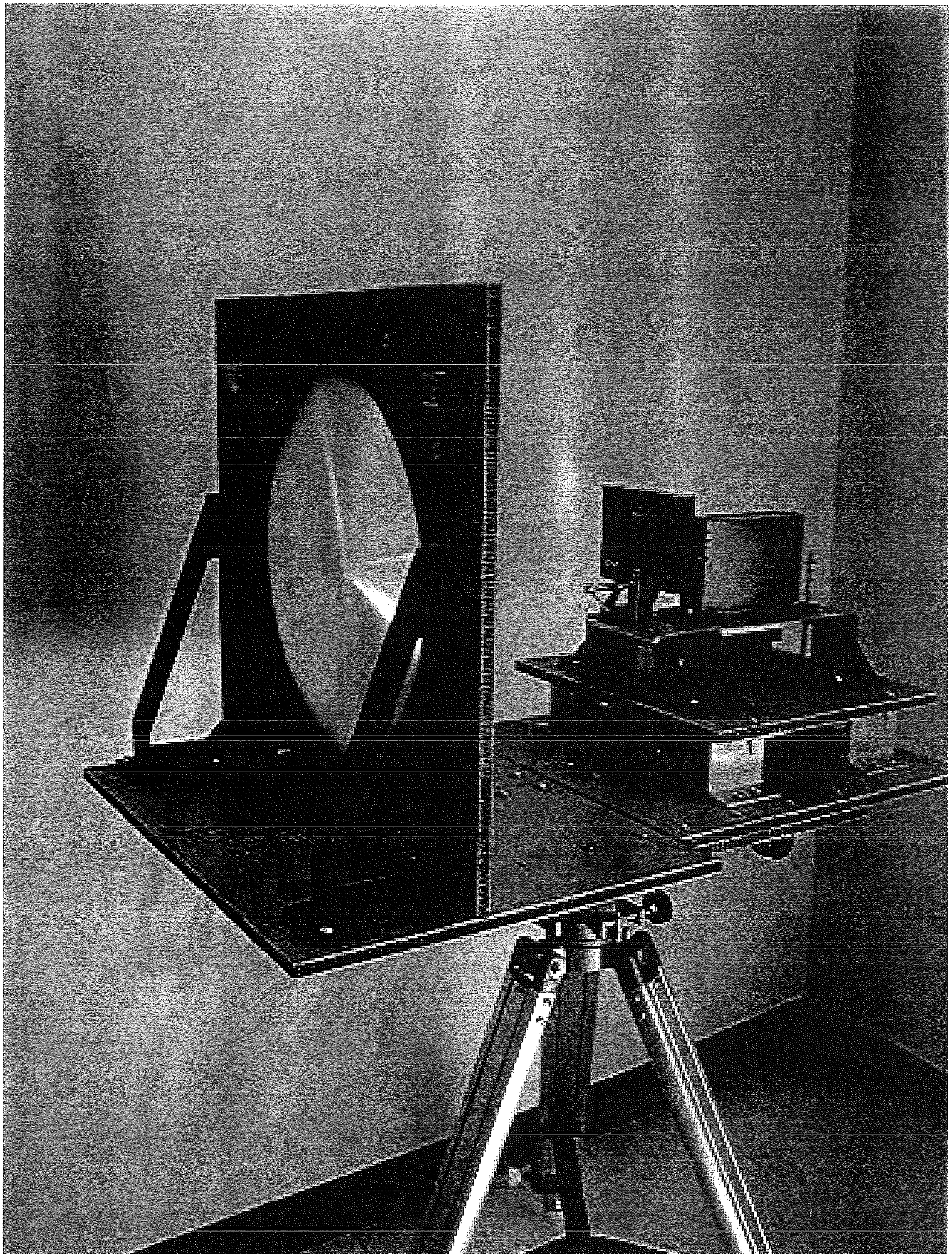
$$\Delta\Omega_i \doteq \frac{\text{Area (Telescope Aperture)}}{d^2}$$

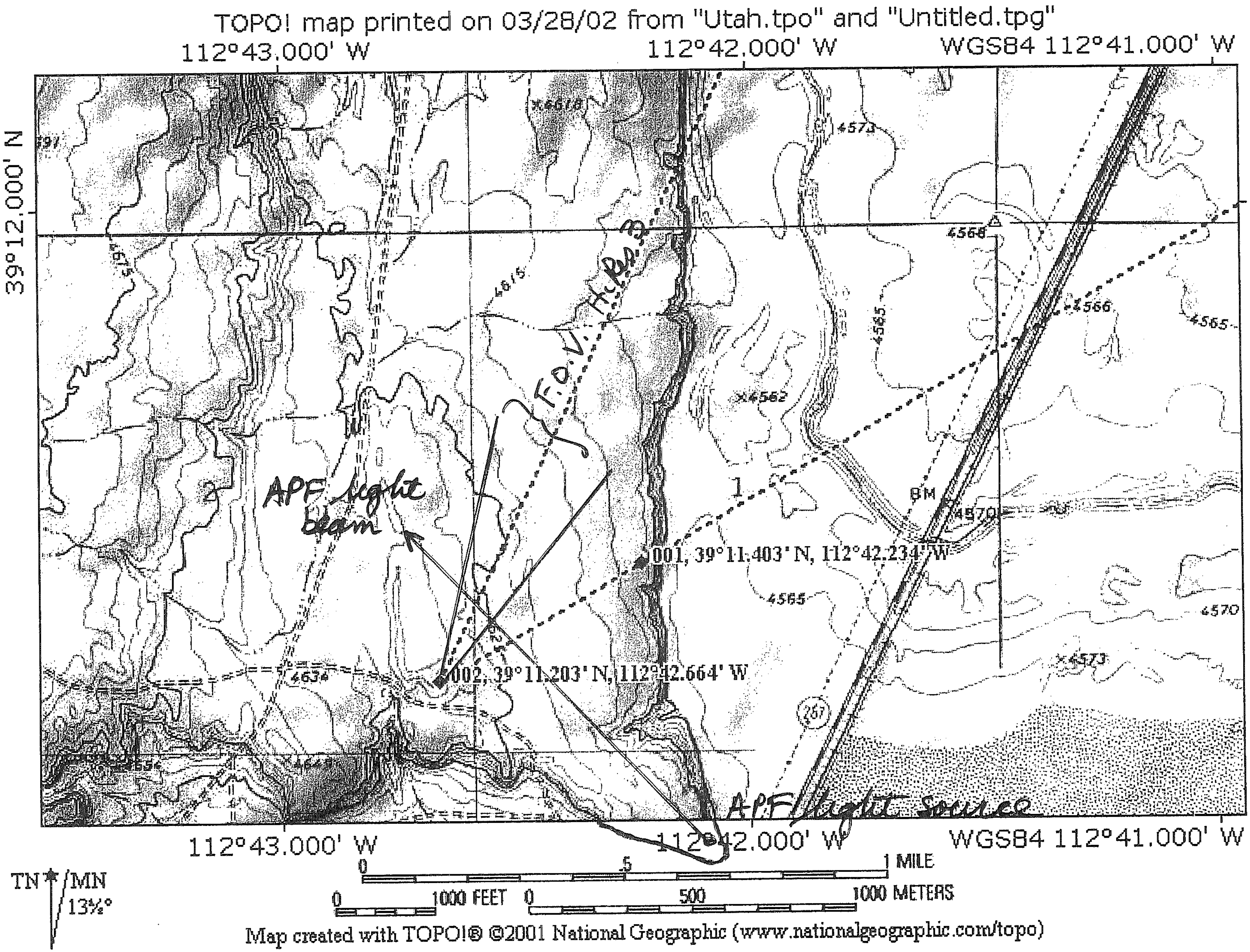
$$I = I_{source}\, e^{-z/\Lambda_{TOT}} \approx I_{source} \text{ for } z \ll \Lambda_{TOT}$$

$\dfrac{\Lambda^m}{\Lambda^a} \simeq 1$ (typically) and measured by H.A.M.'s

$$\therefore \text{Signal}_i \approx \frac{\text{Area}}{d_\perp} \underbrace{\left(\left(\frac{1}{\sigma}\frac{d\sigma}{d\Omega} \right)^m + \frac{\Lambda^m}{\Lambda^a} \left(\frac{1}{\sigma}\frac{d\sigma}{d\Omega} \right)^a \right)} \Delta\theta\, I_{source}\, \varepsilon_i$$

"sum" of molecular (Rayleigh) and aerosol phase functions.




TOPO! map printed on 03/28/02 from "Utah.tpo" and "Untitled.tpg"
112°43.000' W
112°42.000' W
WGS84 112°41.000' W
39°12.000' N
4618
4573
4568
4566
4565
4615
4562
BM
4570
001, 39°11.403' N, 112°42.234' W
002, 39°11.203' N, 112°42.664' W
4634
4573
257
APF light beam
F.O.V. H.R.B
APF light source
0
.5
1 MILE
0
1000 FEET
0
500
1000 METERS
TN
MN
13½°
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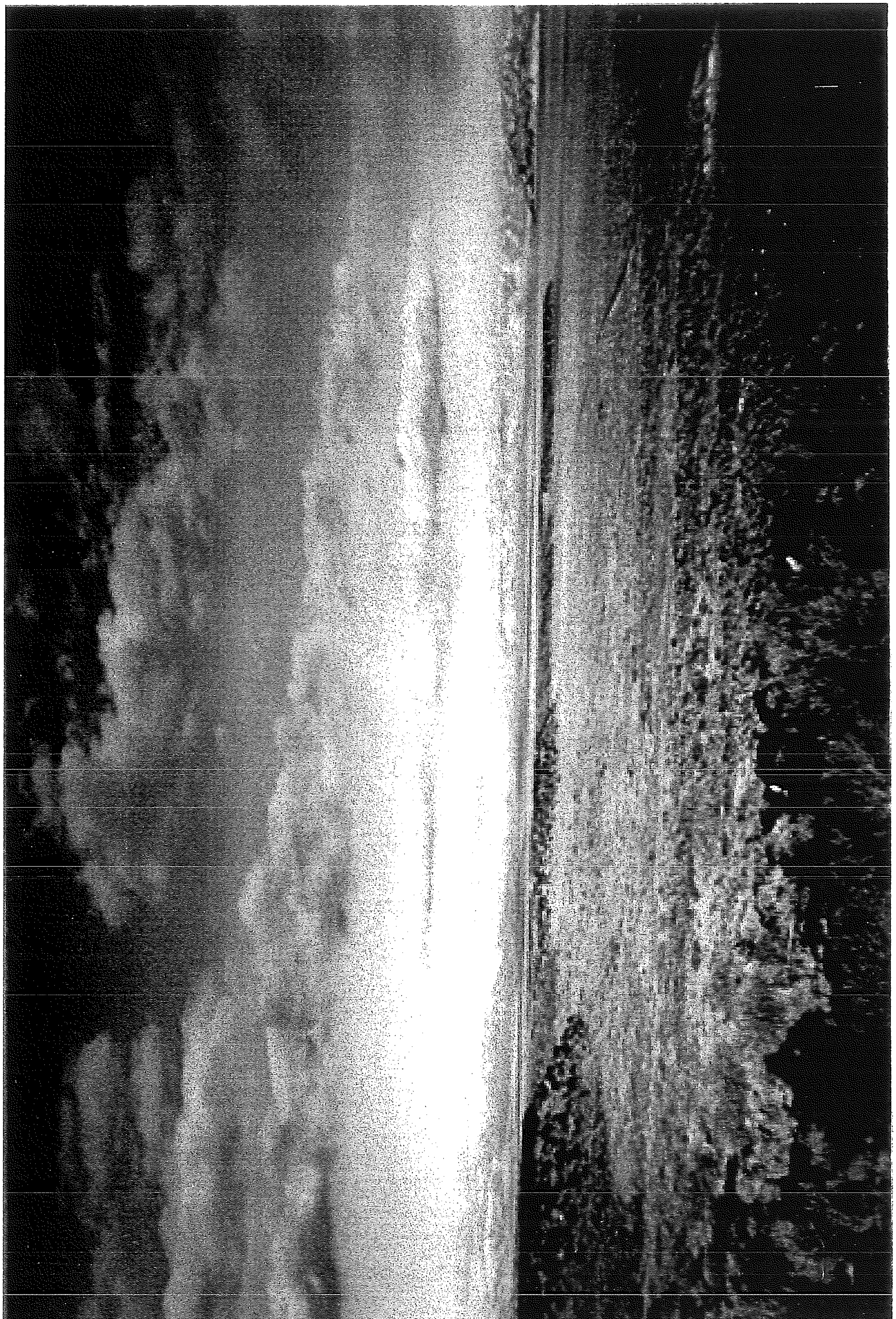
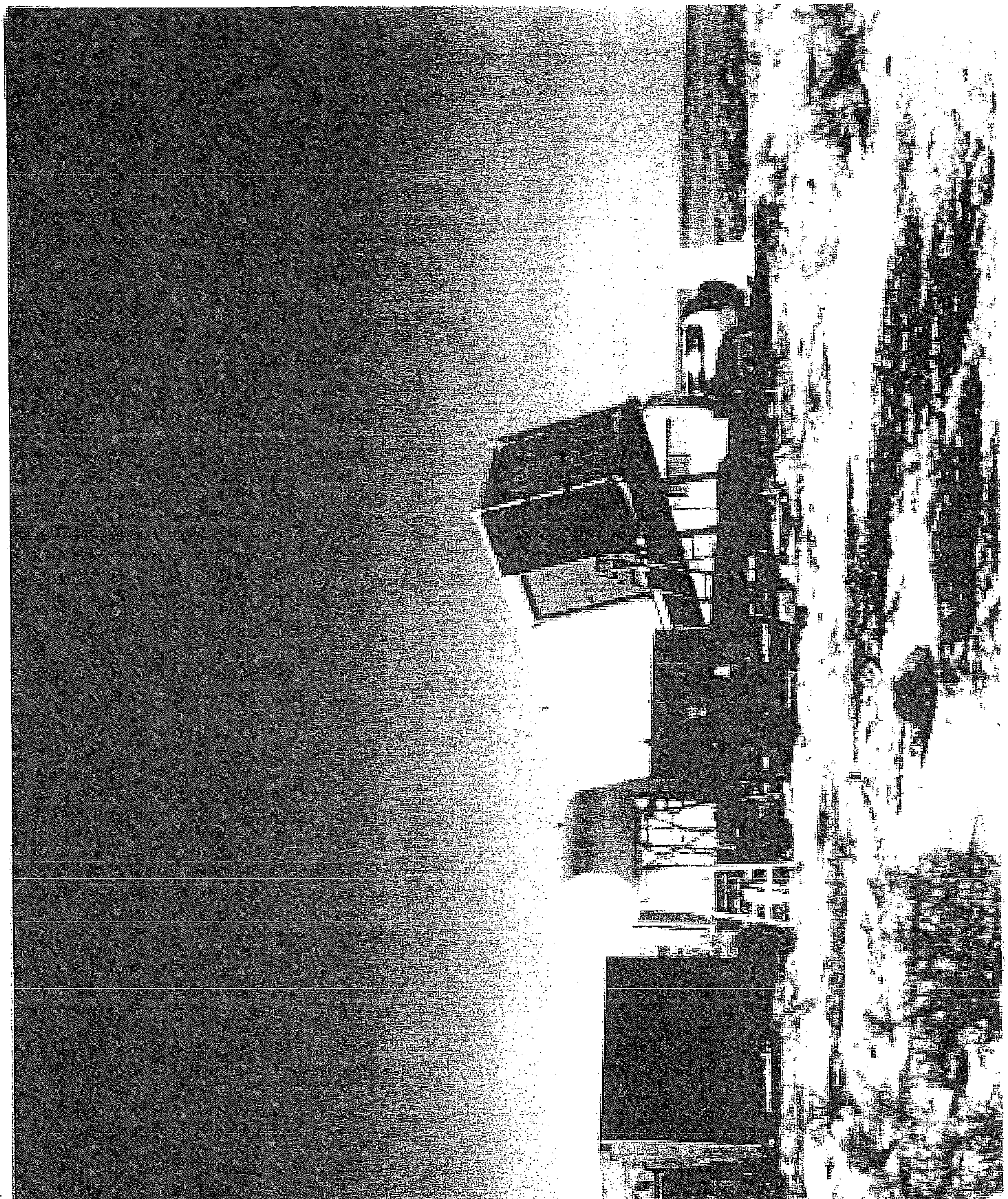
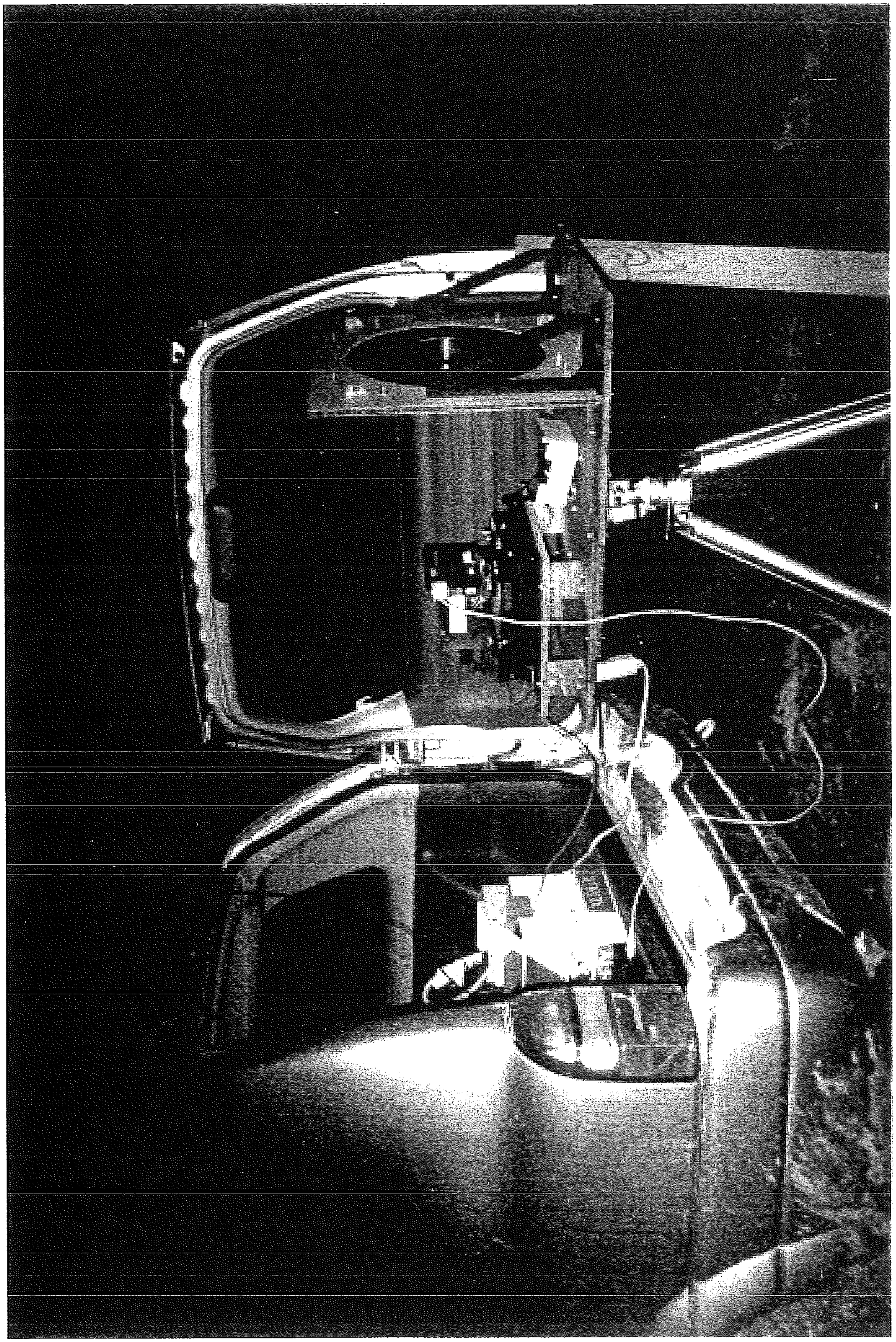
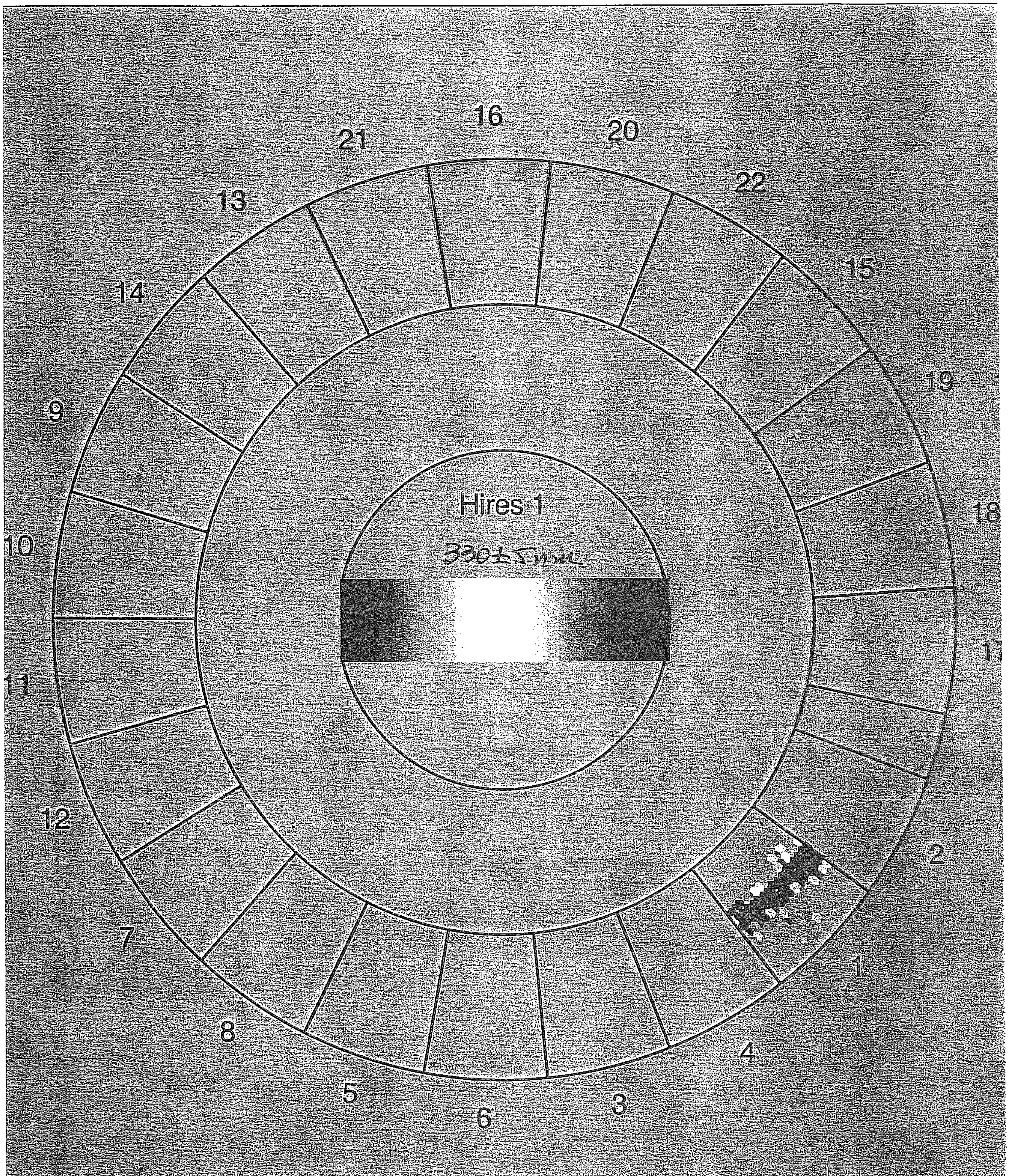
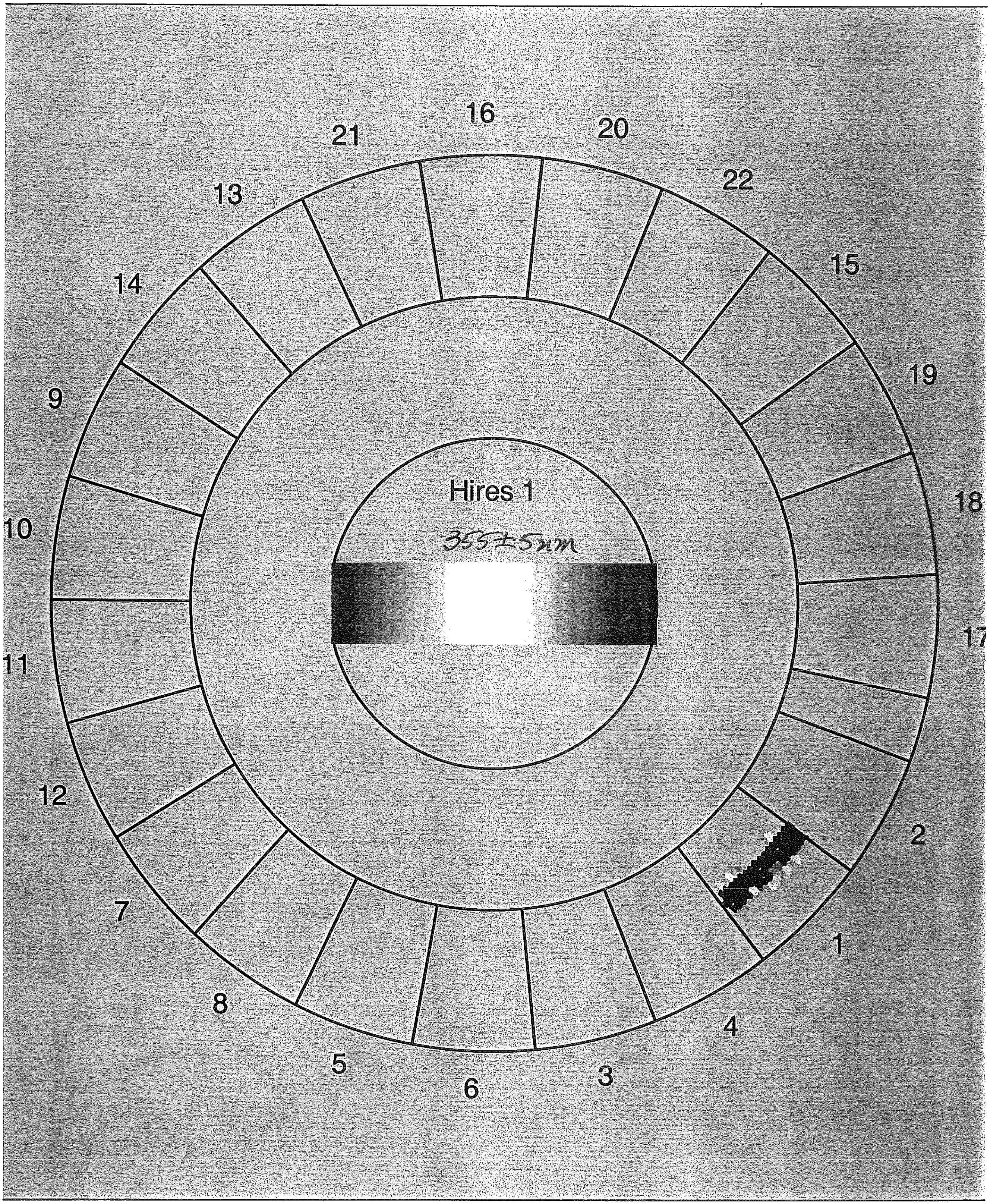




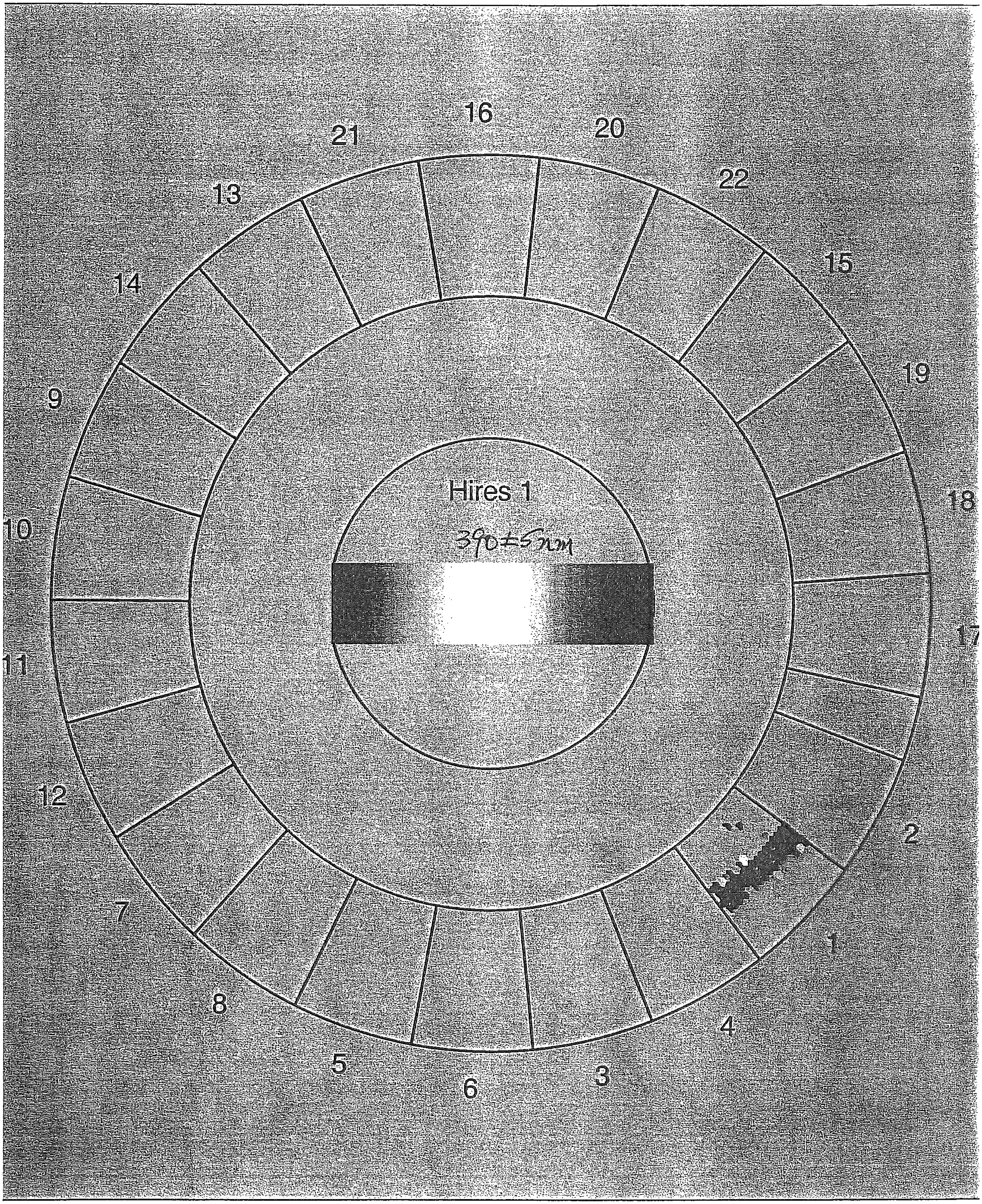




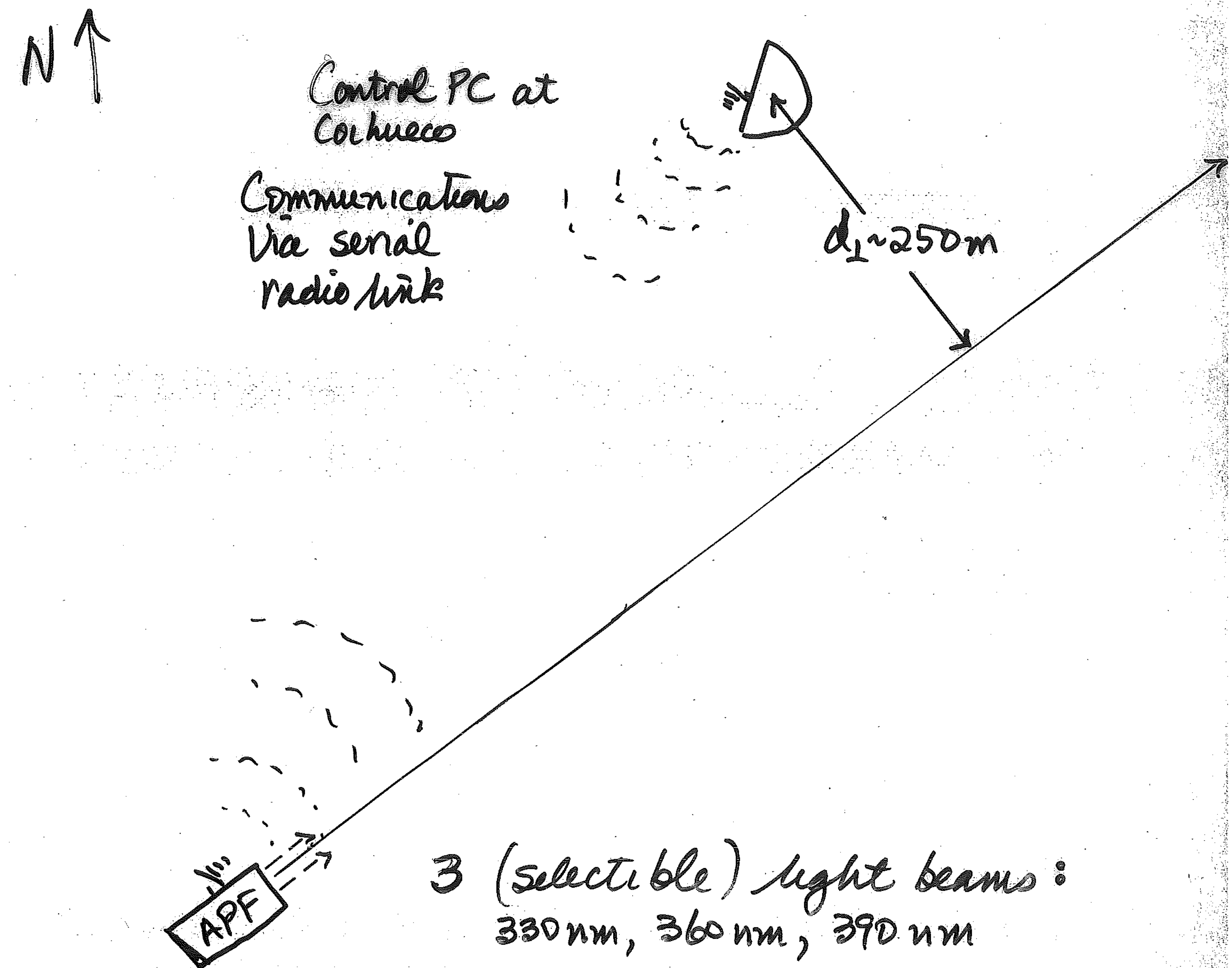
16
20
21
22
13
15
14
19
9
18
10
17
11
12
2
7
1
8
4
5
3
6
Hires 1
330±5nm



16
21
20
22
13
15
14
19
9
18
10
17
11
Hires 1
355±5nm
12
2
7
1
8
4
5
3
6


16
20
21
22
13
15
14
19
9
18
Hires 1
390±5nm
10
17
11
12
2
7
1
8
4
5
3
6

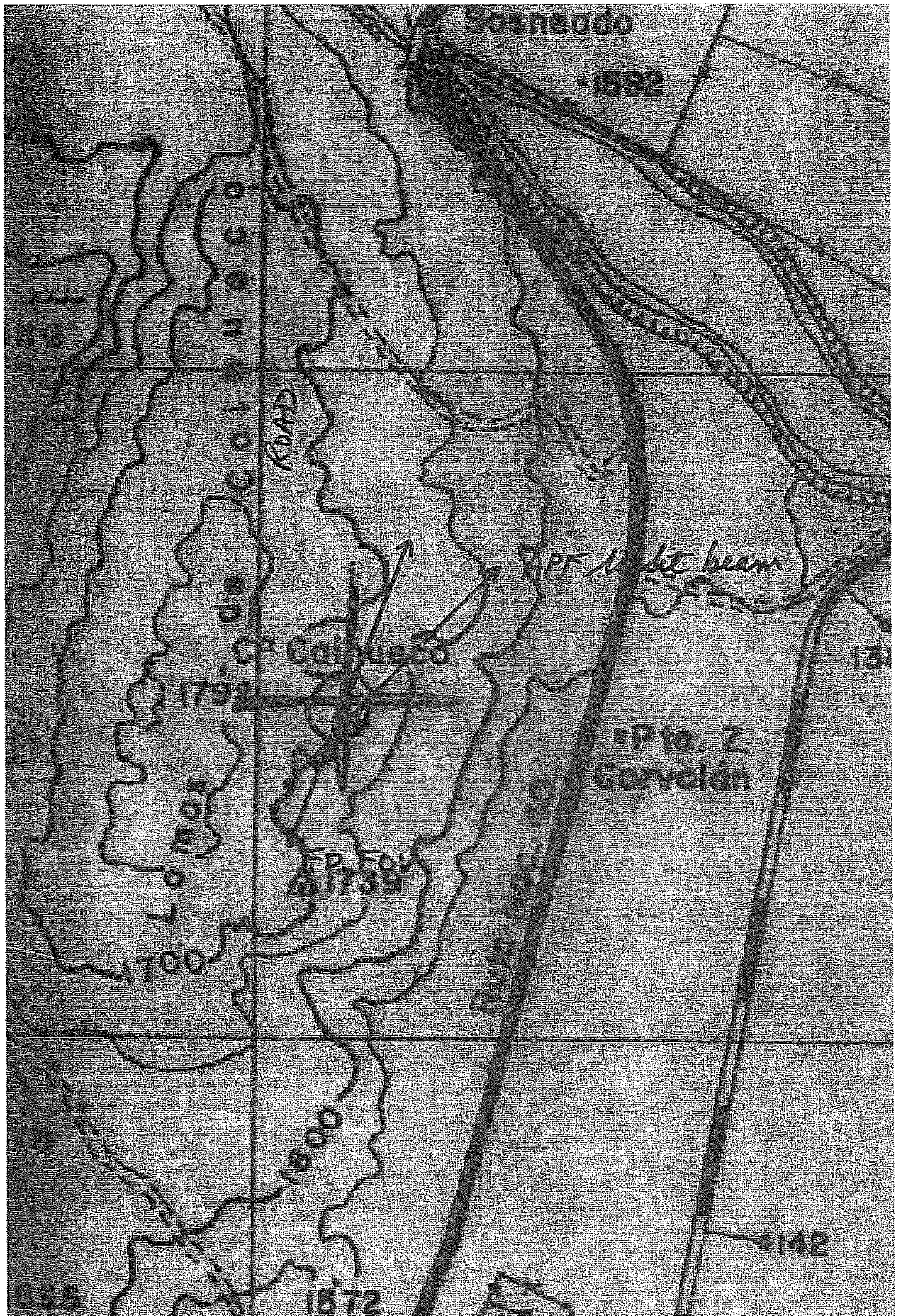
APF Source at Coihueco

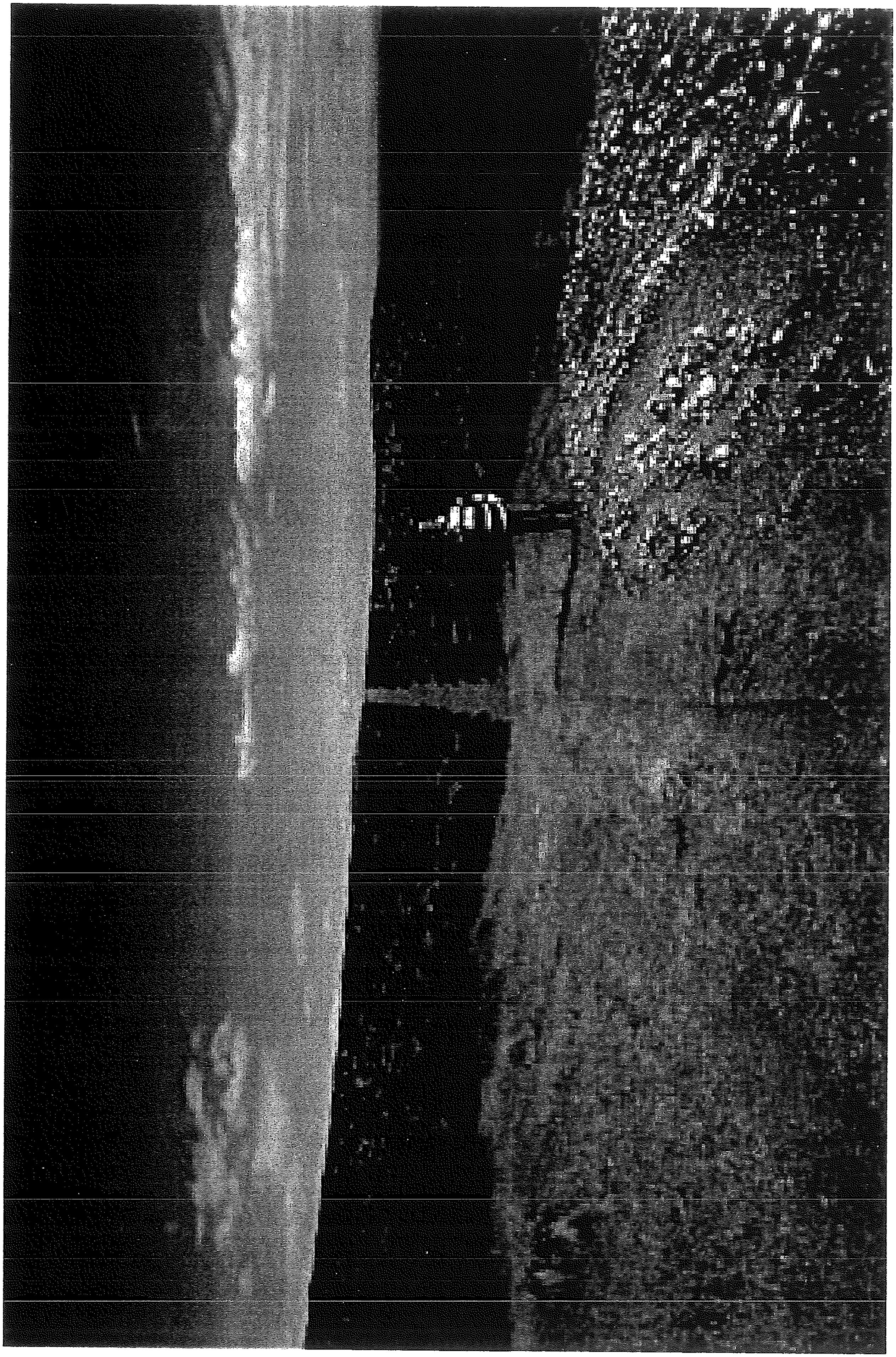


3 (selectible) light beams:
330 nm, 360 nm, 390 nm

Triggered on "GPS second" + fixed offset

<u>NO</u> moving parts (other than relays)


Sosneado
1592
ROAD
APF light beam
Cº Coihueco
1792
Lomas de Coihueco
Pto. Z. Corvalán
1759
1700
1800
1572
142
Eo. Coihueco



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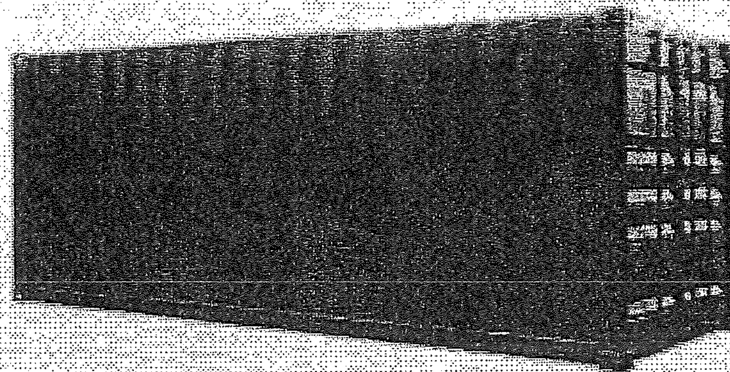


DOUBLE DOORS ONE END (TYPE 1)
20' DRY FREIGHT ISO CARGO CONTAINER

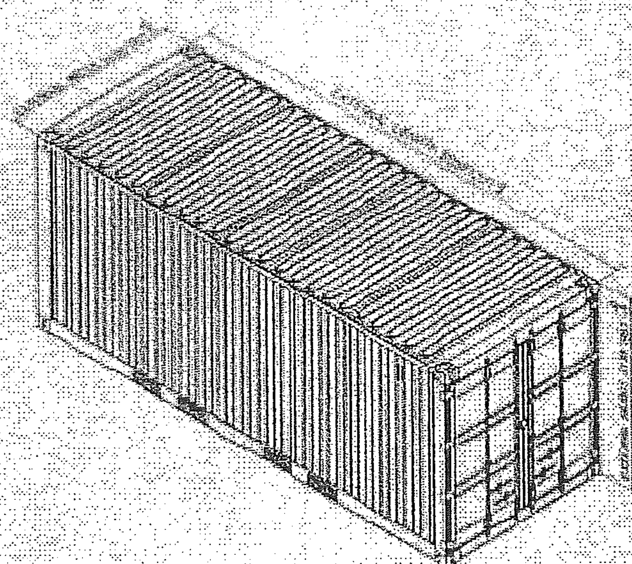
20' DOUBLE DOOR ONE END	Length		Height		Width		Door Opening	
	Exterior	Interior	Exterior	Interior	Exterior	Interior	Height	Width
FEET / INCHES	19' 10 1/2"	19' 2 5/64"	8' 0"	7' 4 5/64"	8' 0"	7' 8 1/2"	6' 11 1/4"	7' 8 1/8"
METRIC	6,058	5,844	2,438	2,237	2,438	2,350	2,125	2,340

20' DOUBLE DOOR ONE END	Tare Weight	Payload	Gross Weight	Cubic Capacity
LBS.	4,960	47,950	52,910	1,096 CU.FT.
KG	2,250	21,750	24,000	31 CU.M.

ALL NEW CONTAINERS ARE MANUFACTURED TO THE LATEST ISO STANDARDS.

— STANDARD FEATURES —
- Corrugated steel sides, and roof
- 14 gauge locking steel double end swing doors
- 1 1/8" thick marine wood floors, forklift tested to 16,000 lbs per 44 square inches
- Tie down steel lashing rings, 4400 lbs. cap. each
- (2) way laden fork lift pockets
- Vents, (2) each

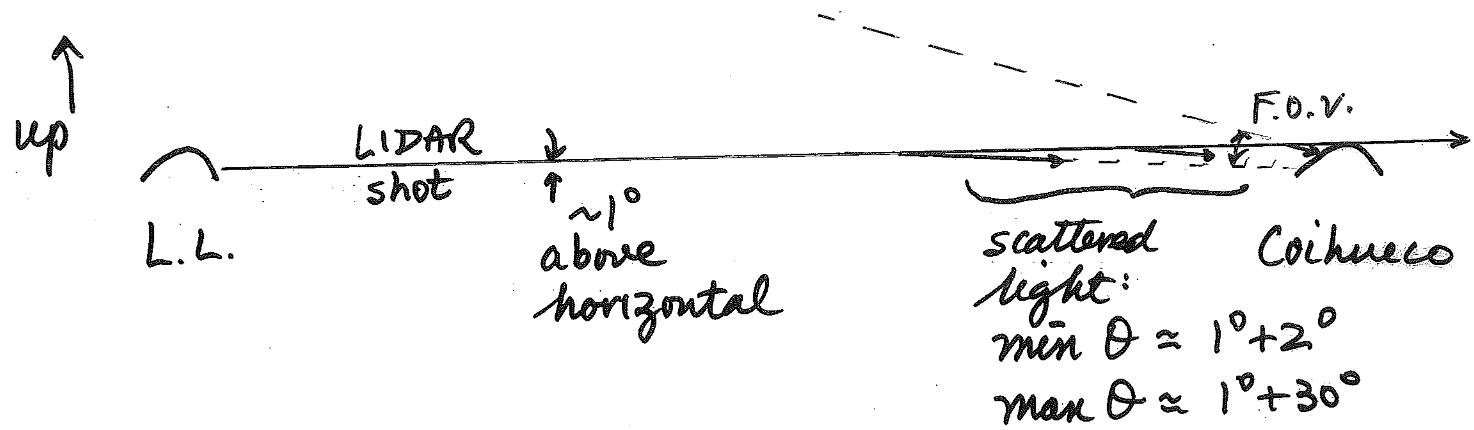
— OPTIONAL FEATURES —
- 2nd set of (2) way unladen fork lift pockets
- Manifest box (2) each
- Adjustable shelving brackets (6) sets
- Decking and shoring beams (18) each



PART # SB861

F.D. camera readout for "glancing shots" (to measure APF at small scattering angles)

1. What is the "geometry"?



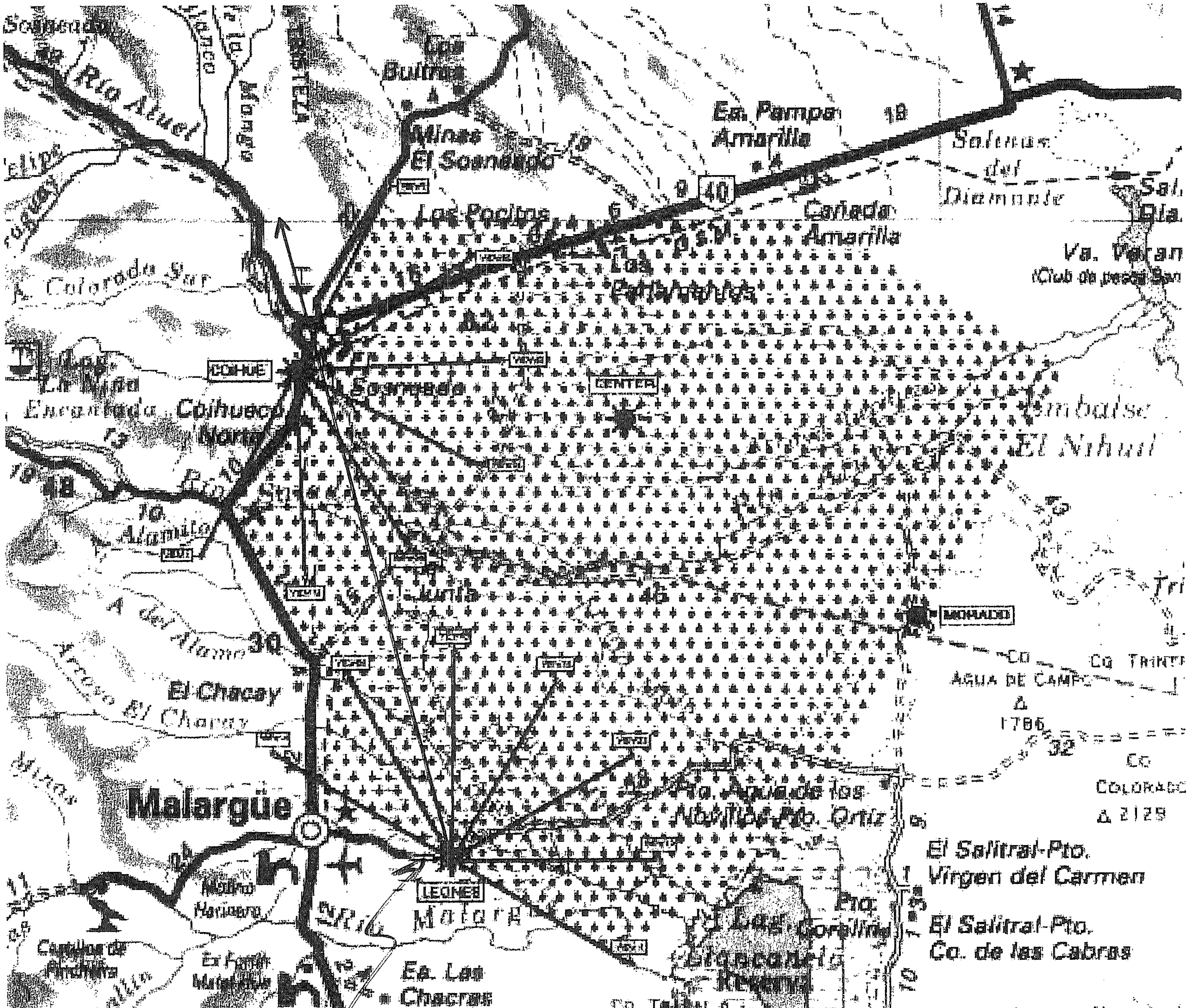
✓ Need good (precision) LIDAR pointing
✓ Need to minimize (then vary) height where atmosphere is "monitored".
At "1°" the height difference ≤ 45 km × tan 1° = 0.79 km

2. For subtraction of multiple scattered light:

a) need to read out most of camera, ie many pixels on either side of "track"

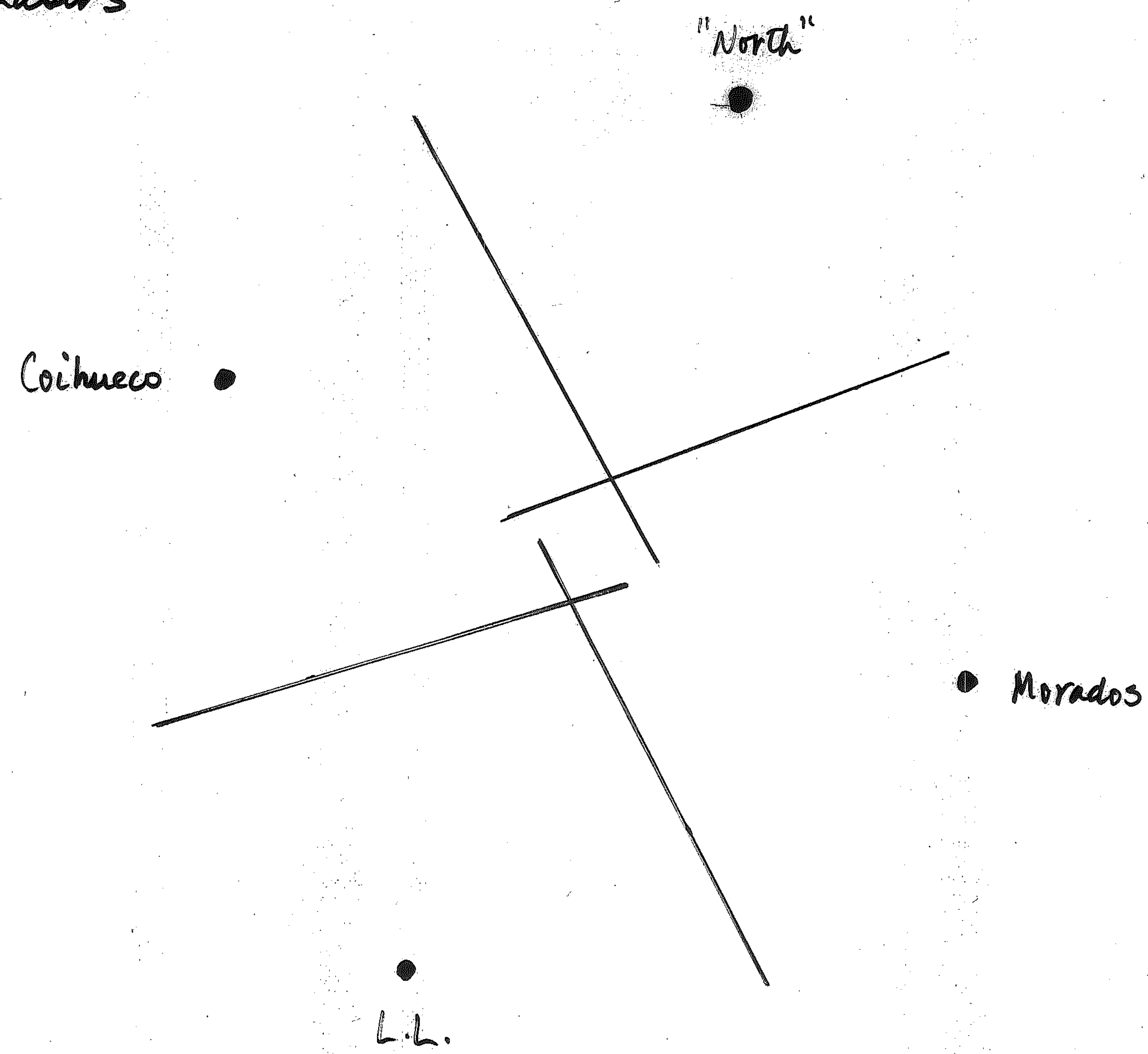
b) need to read out many more time bins "than usual"

This monitors M.S. light to allow subtraction w/o simulation



Example of "near grazing" LIDAR shot.

"Triple Point"
Vertical Lasers



Fixed, Low Power, N_2 lasers "behind" each F.D.

IF with additional experience we find that vertical (laser) shots (from the F.D. center) provide a useful "flat field" illumination ...

THEN we should consider installing an inexpensive N_2 laser at each F.D.

Then on uniform, clear nights (as seen by the LIDAR(s)) perhaps 10 ~ 100 vertical N_2 laser shots would be fired to monitor the *individual* **AND** *telescope to telescope* relative performance.