New Mexico Hardware Responsibilities

US Auger Collaboration Meeting

Colorado State Univeristy

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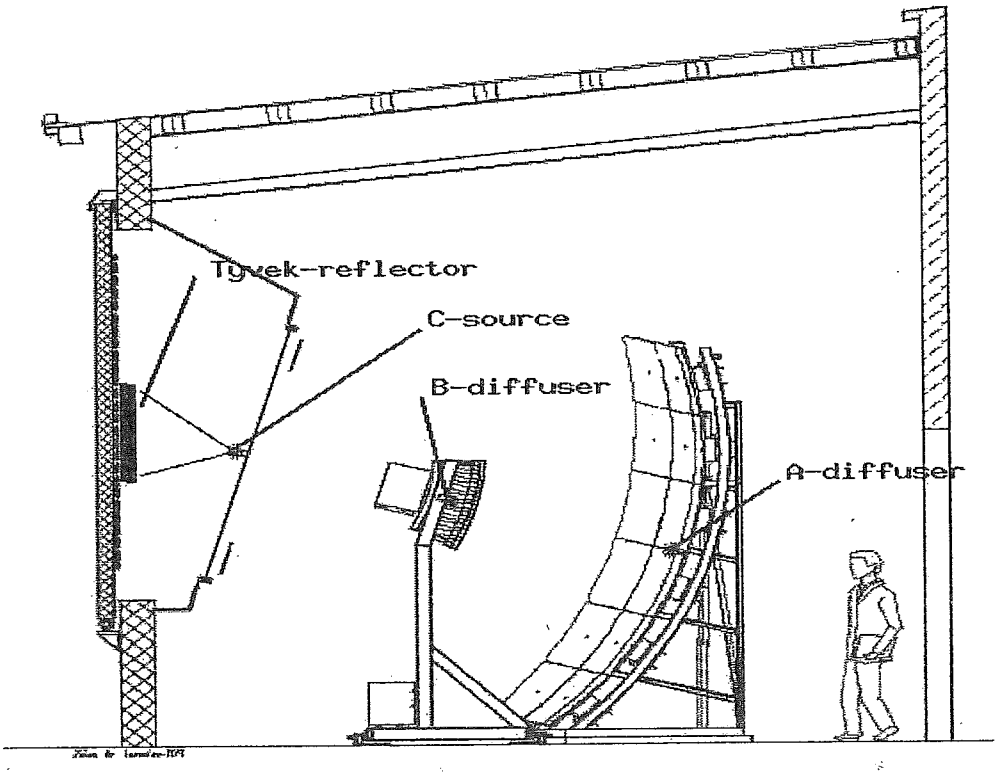
February 28, 2003

1. FD relative optical calibration systems (w/ Catania)
2. APF (aerosol phase function) light sources
3. **New** *central* laser facility (w/ Utah)
4. Other collaborative projects (P. Sommers' talk)
   (a) Roving laser/LIDAR(s) and FD absolute calibration
   (b) Fixed LIDARs (near each FD) site

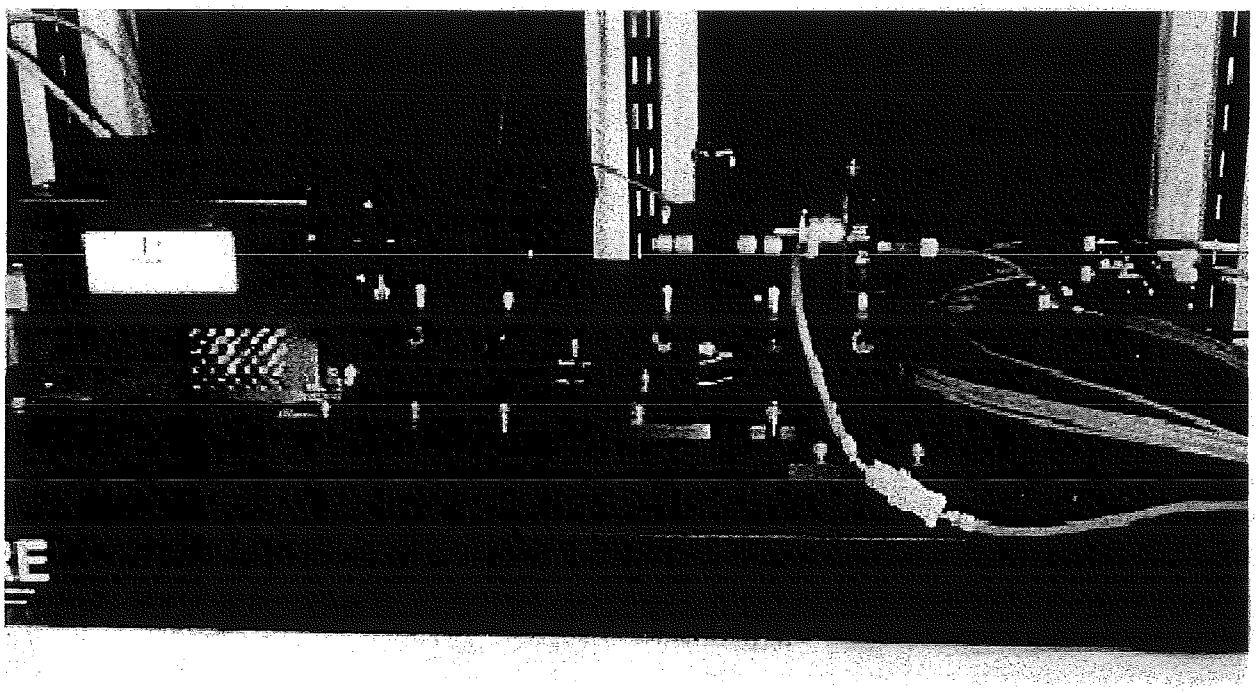
4. Relative optical calibration



Schematic of Auger fluorescence telescopes showing *relative calibration* diffusers.

- **The relative optical calibration system was used to monitor time variations in the telescope calibration between absolute calibrations.**
  - This was done with three xenon flash lamp light sources coupled to optical fibers to distribute light signals to three different destinations (denoted A, B and C) on each telescope.

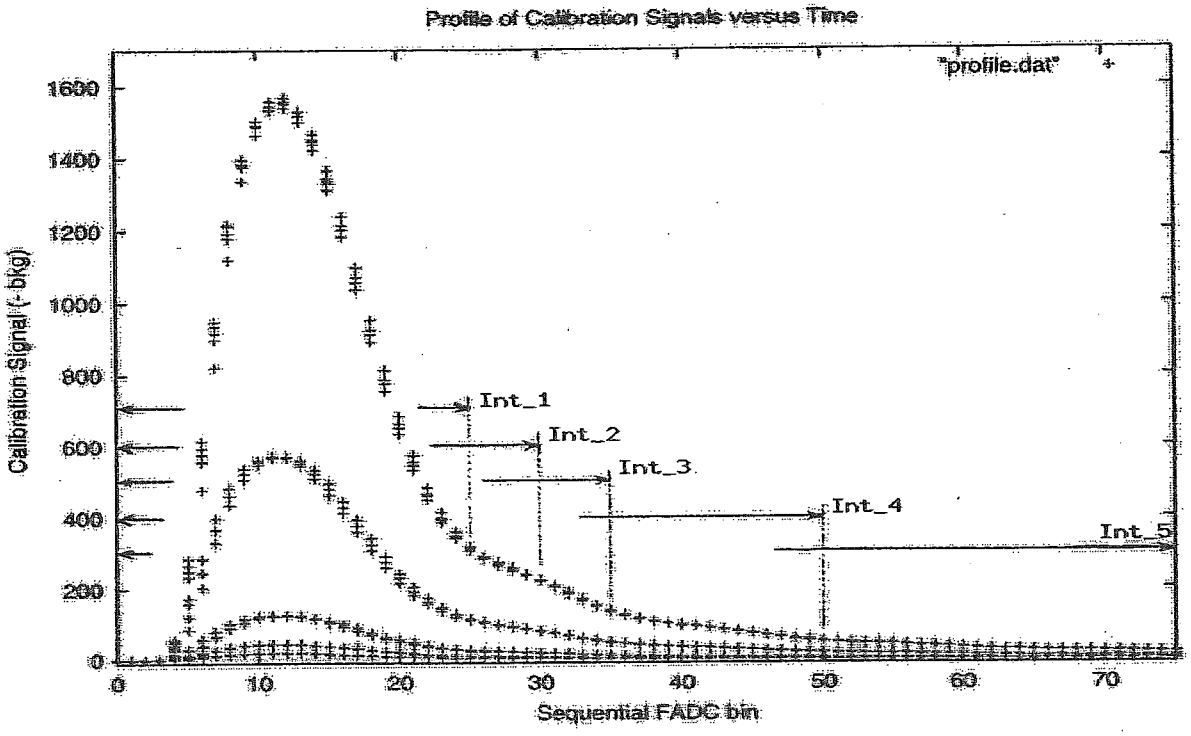
4. Relative optical calibration (con't)



Photograph of one of the three optical calibration light sources at each fluorescence detector site.

- Each calibration light source included a xenon flash lamp at the focus of a f/1.5 lens, quartz beam splitter (to a monitoring fiber), filter wheel and f/2.4 lens focusing onto a 1:7 optical fiber splitter.
- Quartz optics were used through-out.
- The optical calibration light sources mount on a 18" × 30" optical bread-board which are in-turn supported on simple wall-mounted shelves.

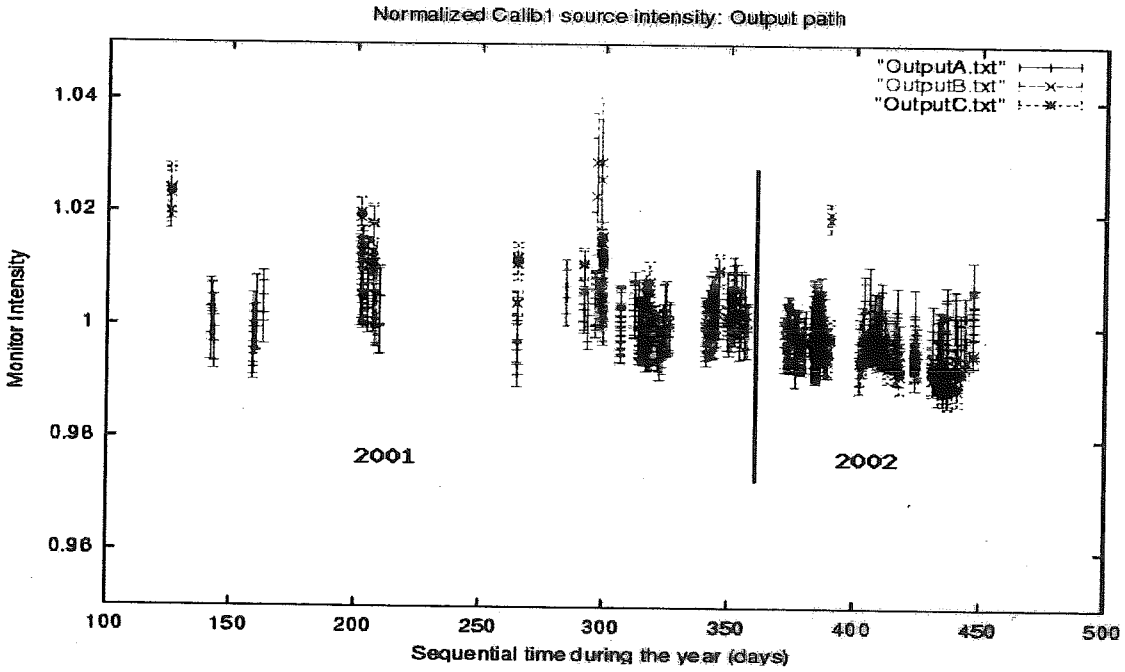
4. Relative optical calibration (con't)



Typical light pulses from the "A"-source.
Each time bin is 100nsec. The *arrows* show different integration times used to monitor the observed signal.

- The A-source included a Johnson-U filter that approximated the wavelength acceptance of the fluorescence telescopes and a filter wheel with 5 different neutral density filters that provided a dynamic range of ~ 100.

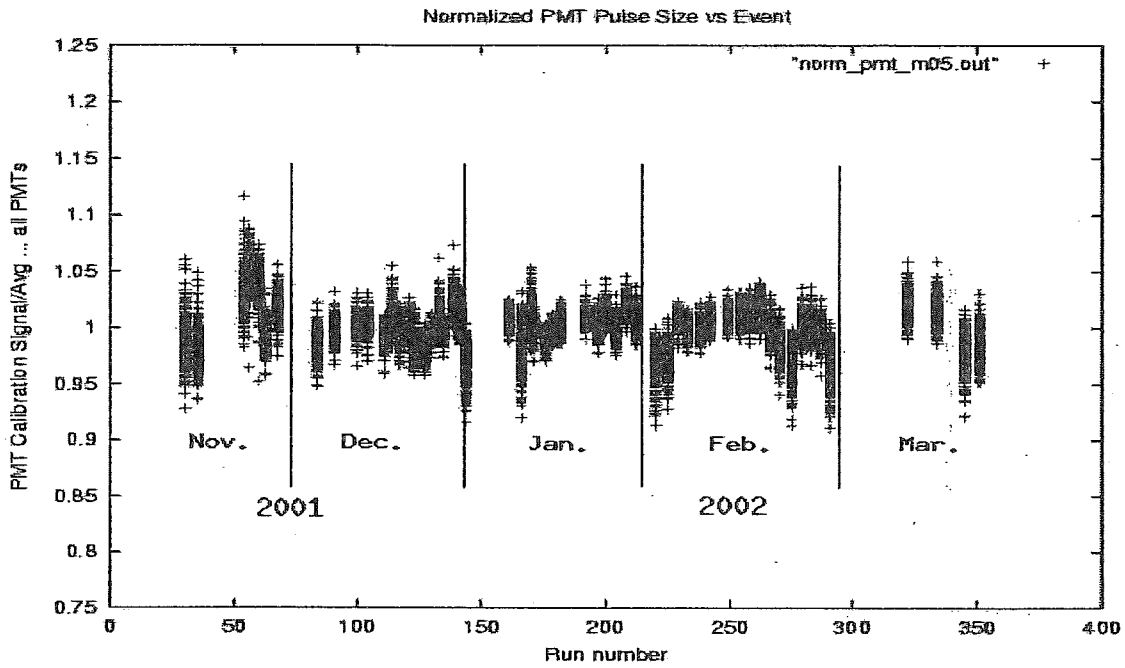
4. Relative optical calibration (con't)



Optical calibration sources' intensity during the last year. The plot shows the light pulse intensities (average $\pm$ RMS) *versus* sequential day since January 1, 2001. The intensities are normalized to the average intensity for the entire time period.

- The xenon light pulses were very stable with an RMS/average-pulse-intensity of $\sim 0.5\%$ for typical 50-pulse calibrations.
- **Over many months of operation the xenon calibration pulses varied by $\sim 1\%$.**

4. Relative optical calibration (con't)



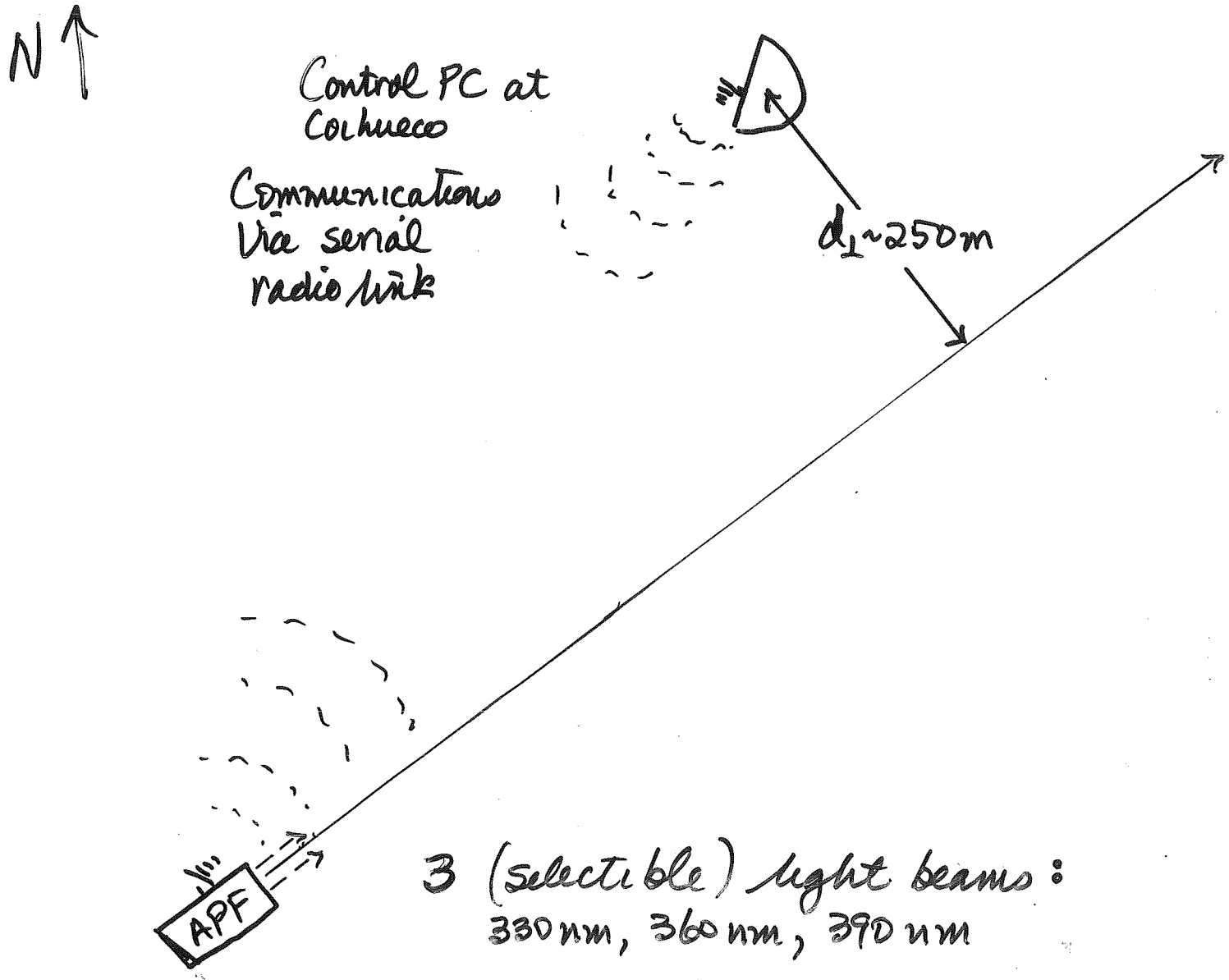
Time history of the *normalized* A-source calibration signals. All 440 pixels (PMTs) of telescope-5 are shown.

The vertical axis records each pixel's observed signal *normalized* by the average of that pixel's signal during the 5-month period. The horizontal axis is the sequential calibration *run* number.

- The vertical *smear* for each calibration run shows that the gains of individual pixels changed in time in comparison to the average (coherent) pixel trends.
- The vertical motion of the centroid of each *smear* shows that there were some coherent time variations of the pixel gains.

⊙ **The relative pixel to pixel variations with time, and the coherent variations with time, were typically $< 5\%$.**

APF Source at Cerro Tololo

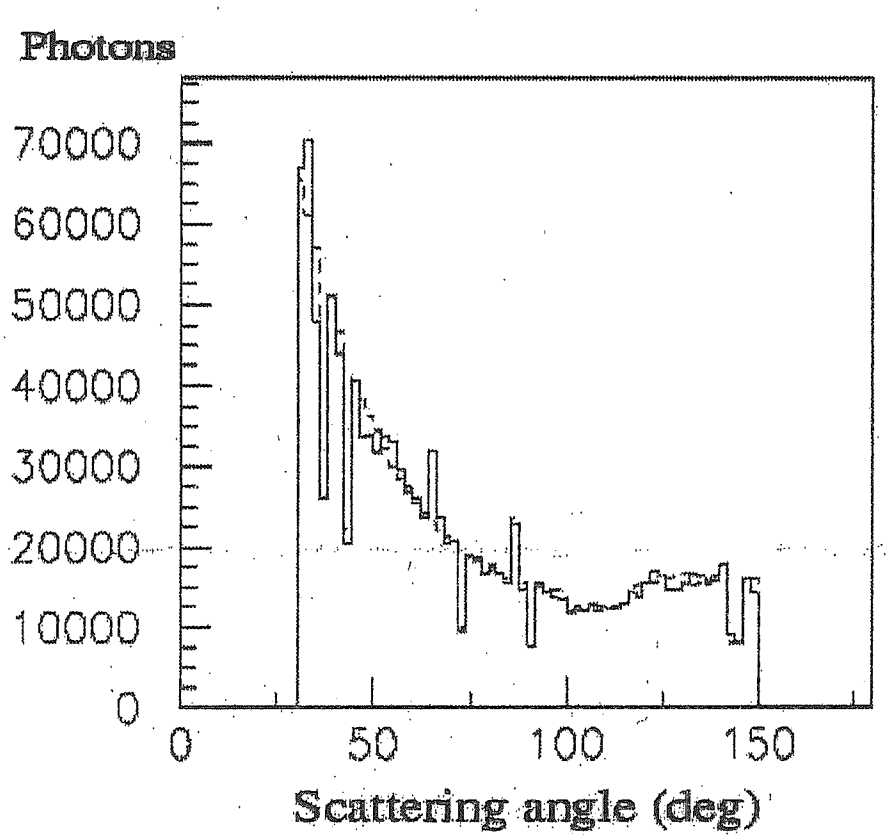


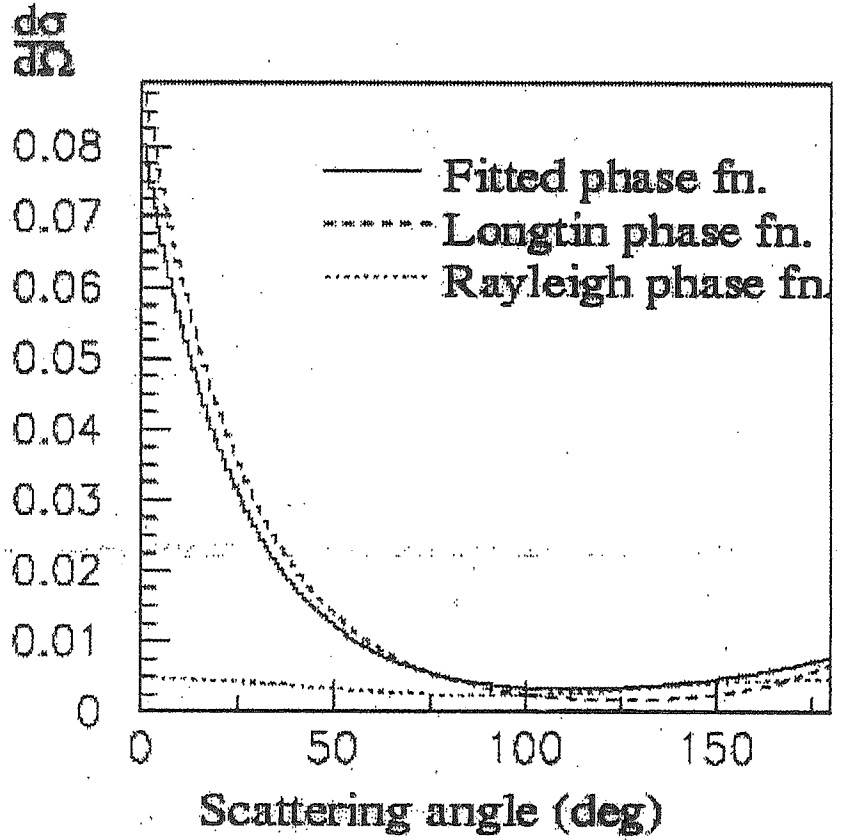
3 (selectible) light beams:
330 nm, 360 nm, 390 nm

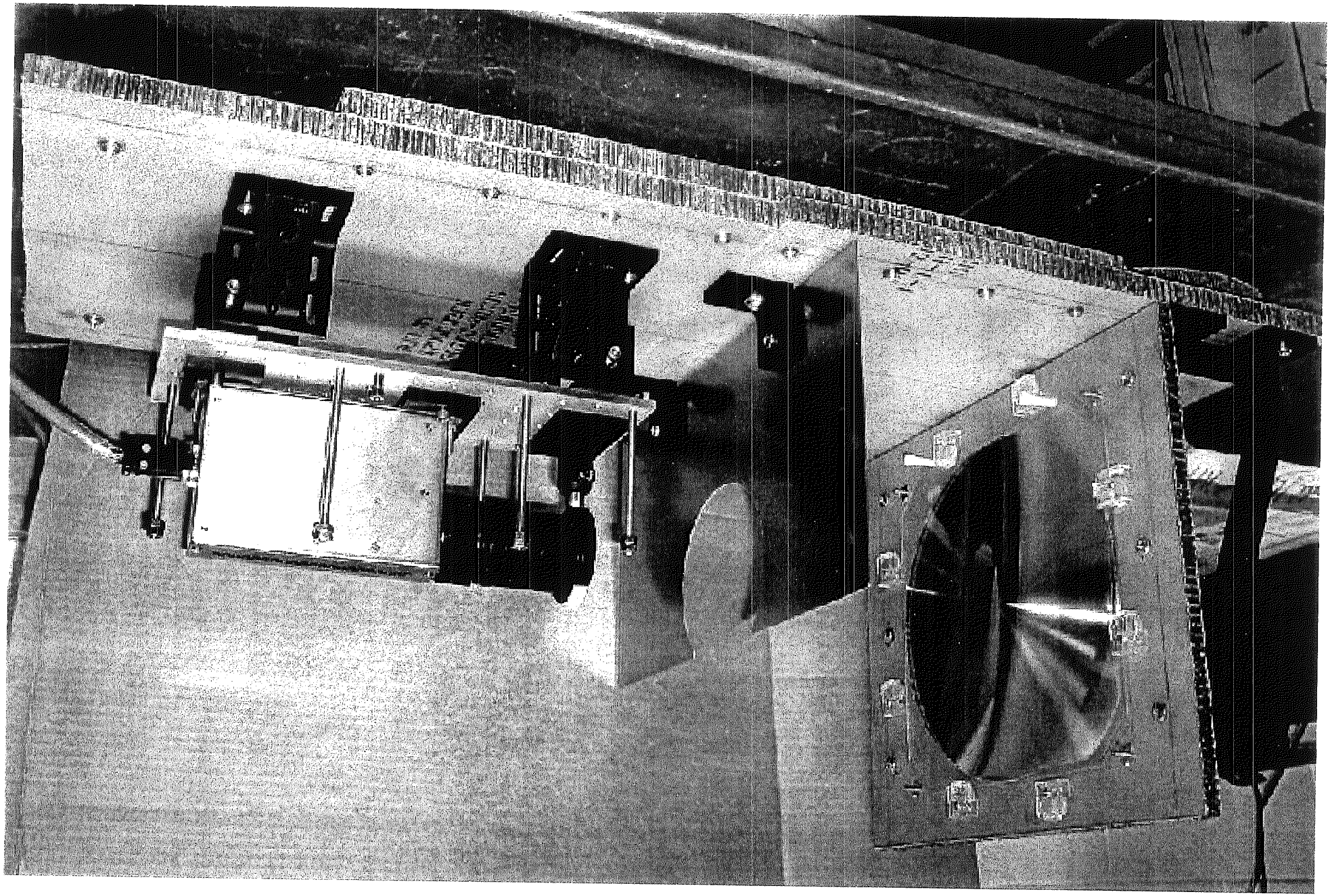
Triggered on "GPS second" + fixed offset

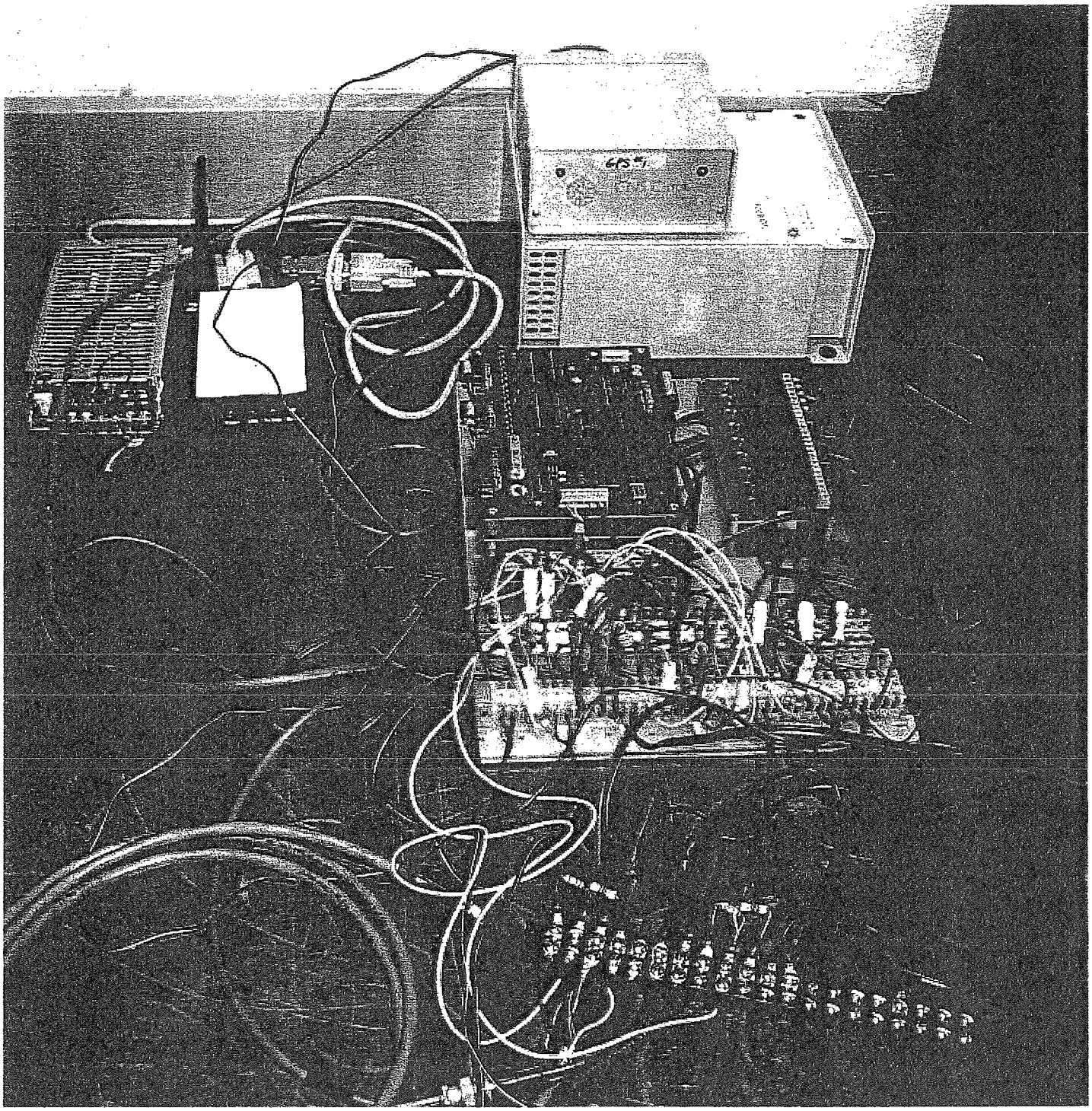
NO moving parts (other than relay)

Light source ~1.3 km from Cerro Tololo


Photons
70000
60000
50000
40000
30000
20000
10000
0
0
50
100
150
Scattering angle (deg)


dσ/dΩ
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
Fitted phase fn.
Longtin phase fn.
Rayleigh phase fn.
0
50
100
150
Scattering angle (deg)



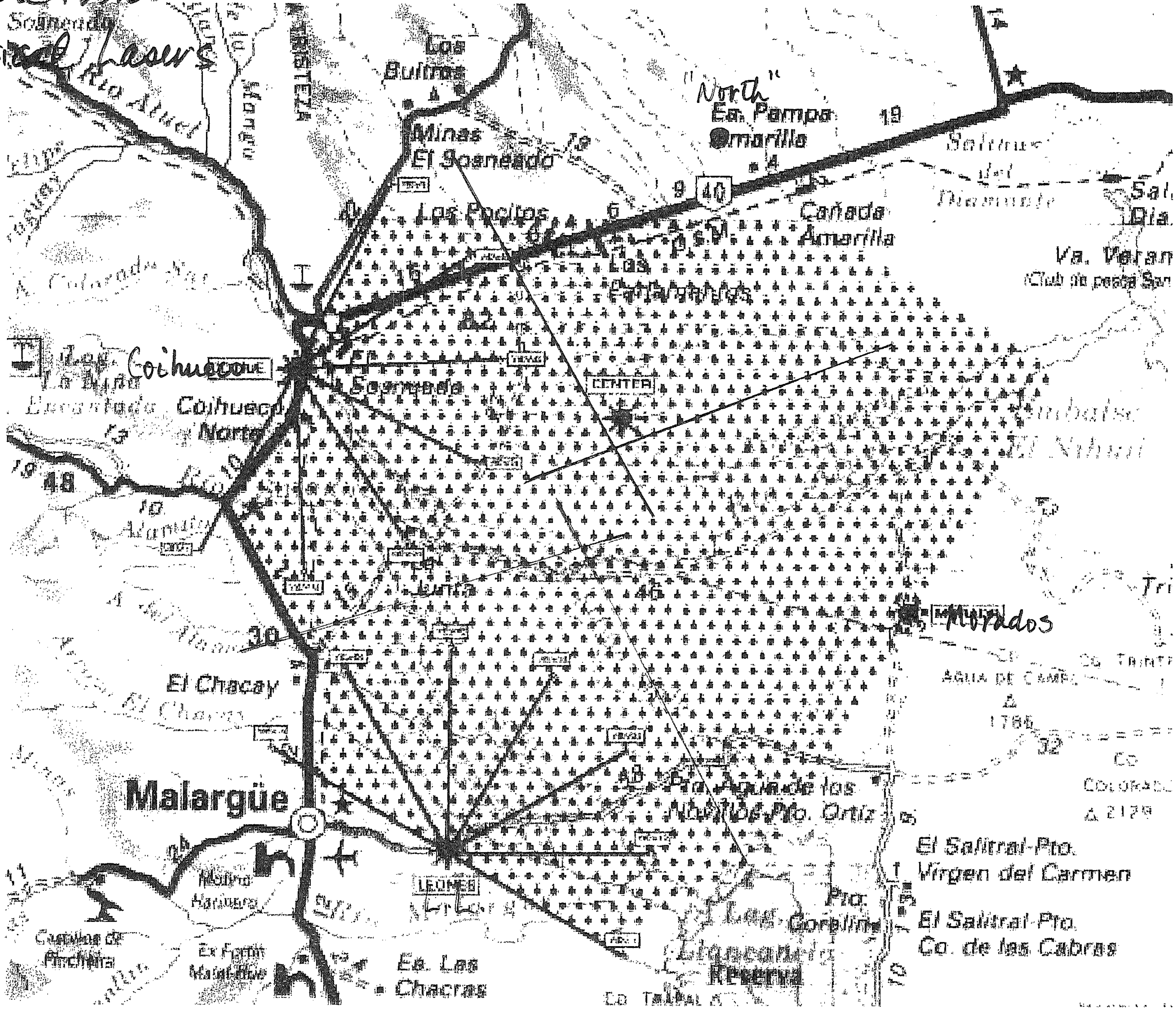


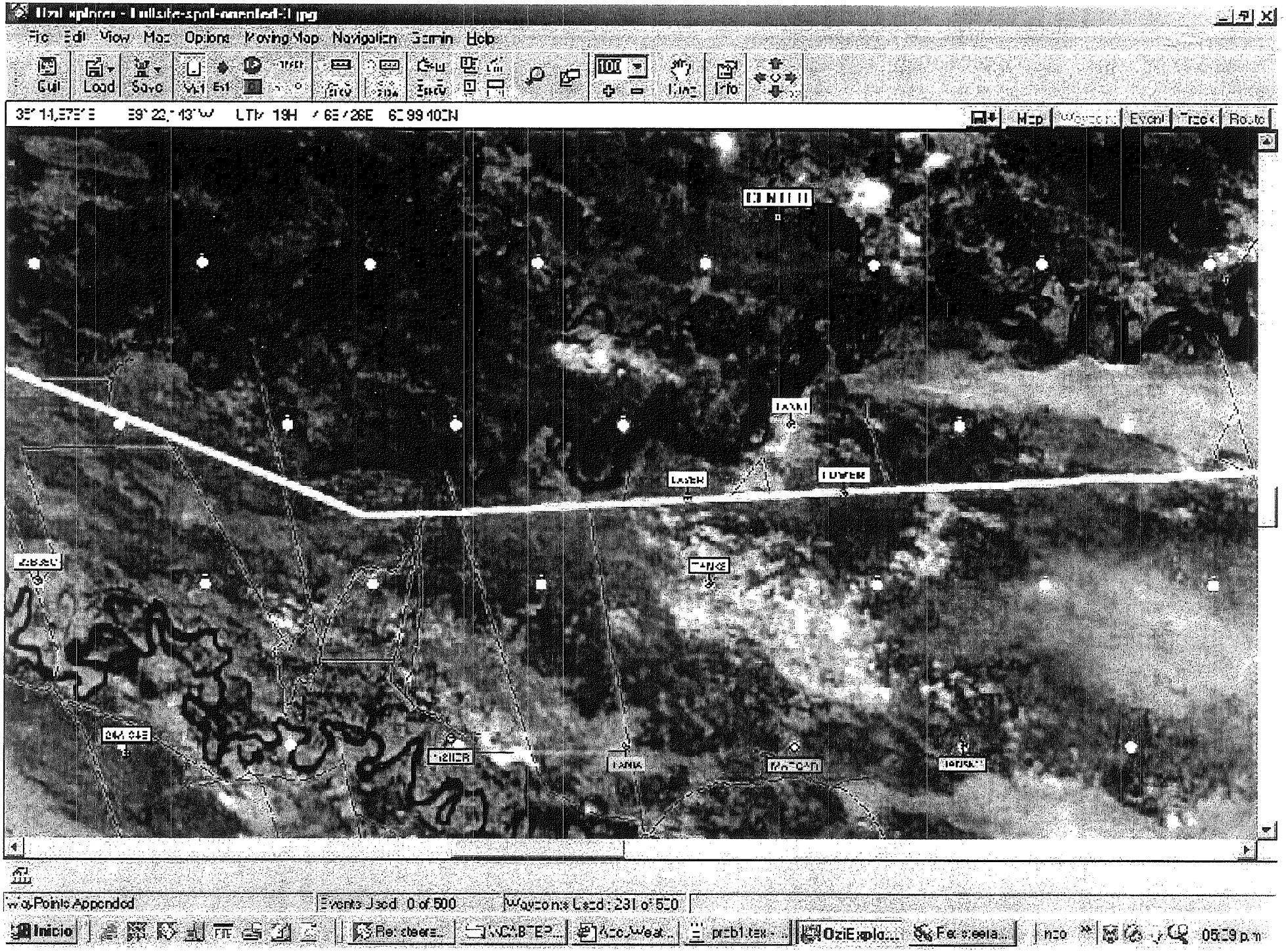
Q. Do we need a "central" facility?

↗ ie point ~ equidistant from all FDs

- Weather station ... there already
- Vertical laser:
  - i) $\tau^a(z)$
  - ii) check triggering of FDs ← best w/ variable brightness laser beam
  - iii) " timing (relative) of FDs
  - iv) " "Escale" (relative) of FDs ... best if at or near = distant site(s)
  - v) " Timing (relative) of FDs and GA ↗ needs injection of light into GA tank when laser fires
- Steerible laser:
  - i) "features" of roving LIDAR but available every night on demand
  - ii) test beam ... to confirm (?) that atmospheric parameters match what we observe (ie scattered laser light)

"Triple Point Vertical Lasers"

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Quit
Load
Save
Info
Map
Event
Track
Route
Points Appended
Events Used: 0 of 500
Waycons Used: 231 of 520
Inicio
OziExplo...
05:39 p.m.