Possibility of the Near Earth objects distance measurement with laser ranging device

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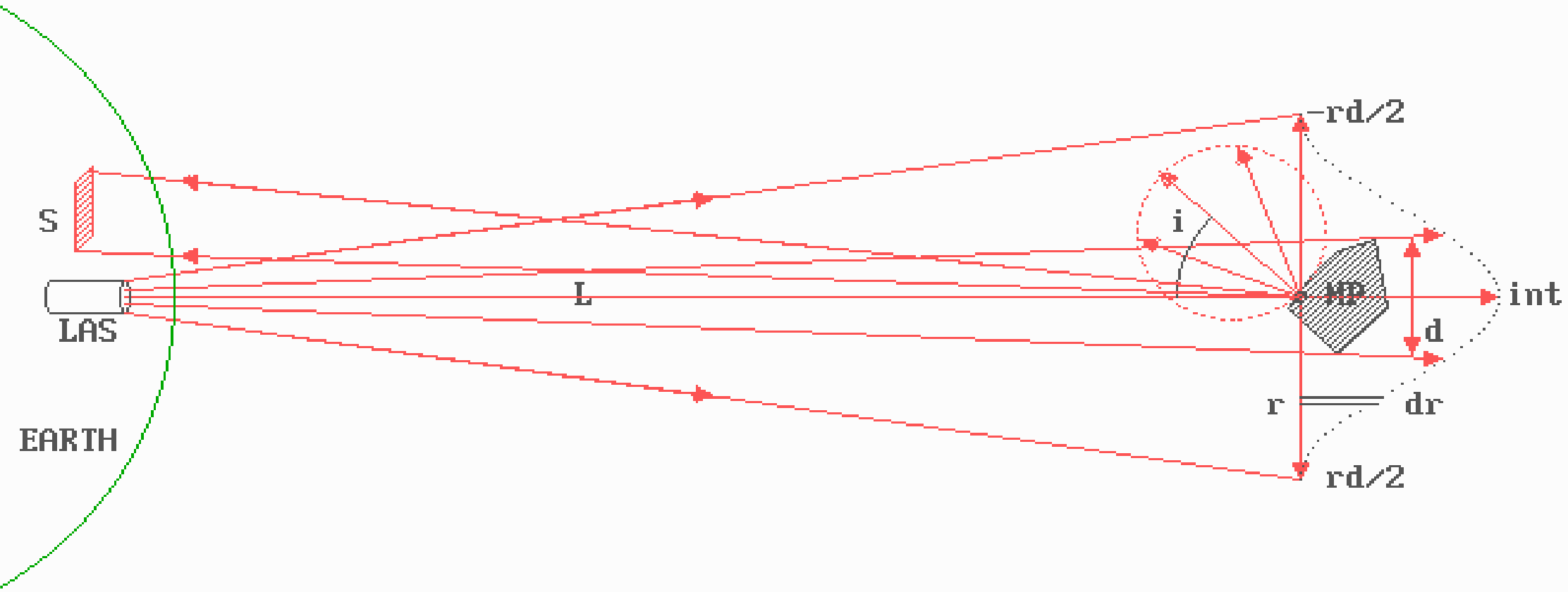

Fig. 1. Measurments of minor planets with laser ranging device

$$d_{la} = 2 \cdot L \cdot \mathrm{tg}\, r_d \qquad (1)$$

where r_d is the diffraction, the angle radius $r_d = 1.2197\ \lambda/dt$

As the energy li diffraction image is irregular, the energy radiated in the direction of the minor planet Eep can be calculated using formula:

$$E_{ep} = E_{las} \cdot c_{at} \cdot c_{op} \quad \frac{\int_{t}^{d/2} l_i(r) \cdot r \cdot dr}{\int_{0}^{r_d} l_i(r) \cdot r \cdot dr} \qquad (2)$$

E_{las} – laser emanated energy;
c_{at} – light transmissivity of the atmosphere;
c_{op} – light transmissivity of the optical system;
d – diameter of the minor planet

The surface of the minor planet is matted and its each element reflects the light in accordance with the Lambert Law. Area S on the Earth receives radiated energy E_e:

$$E_e = E_p \cdot c_{at} \cdot a \cdot \cos i \cdot S/\pi L \quad (3)$$

i – mean surface normal angle turned in the direction of the Earth;
a – reflection coefficient (albedo).

As Ee is very weak, the reflected energy can be described with the number of photons per unit of area $n_f = E_e/E_{fot}$, where E_{fot} – photon energy:

$$E_{fot} = h \cdot \nu \quad (4)$$

h – Planck's constant (h = 6.622 ·10-34 J ·s);
ν – frequency of light wavelength.

laser energ.= 10 J
laser wavelength= .694 mkm
laser beem divergence= .5819907 ’’ (2 r difr)
atmospher transmitance= .8
qantum effect.= 50 %
planets albedo= 10 % (black)

	minor planets diameter m				
	50	100	200	400	800
range km	reflected photons on 1 km^2				
50000	1.953181E+7	6.593346E+7	1.413264E+8	1.583503E+8	1.631335E+8
100000	1275306	4882952	1.648337E+7	3.53316E+7	3.958758E+7
200000	80588	318826	1220738	4120841	8832901
400000	5052	20147	79706	305184	1030210
800000	316	1263	5036	19926	76296
1600000	19	79	315	1259	4981

Table 1. Reflected photons from minor planet.

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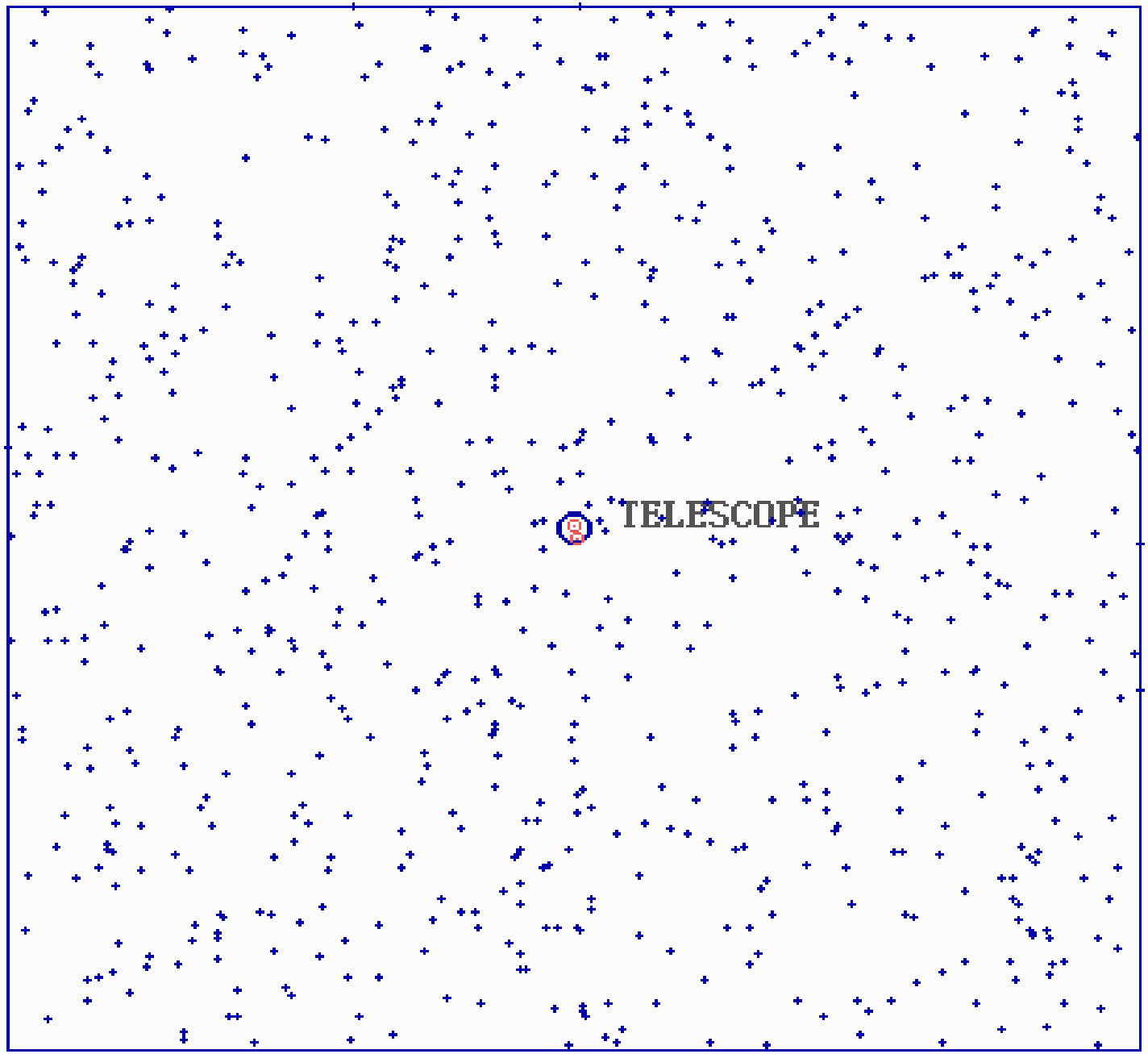

Fig. 2. Photons rain on Earth surface

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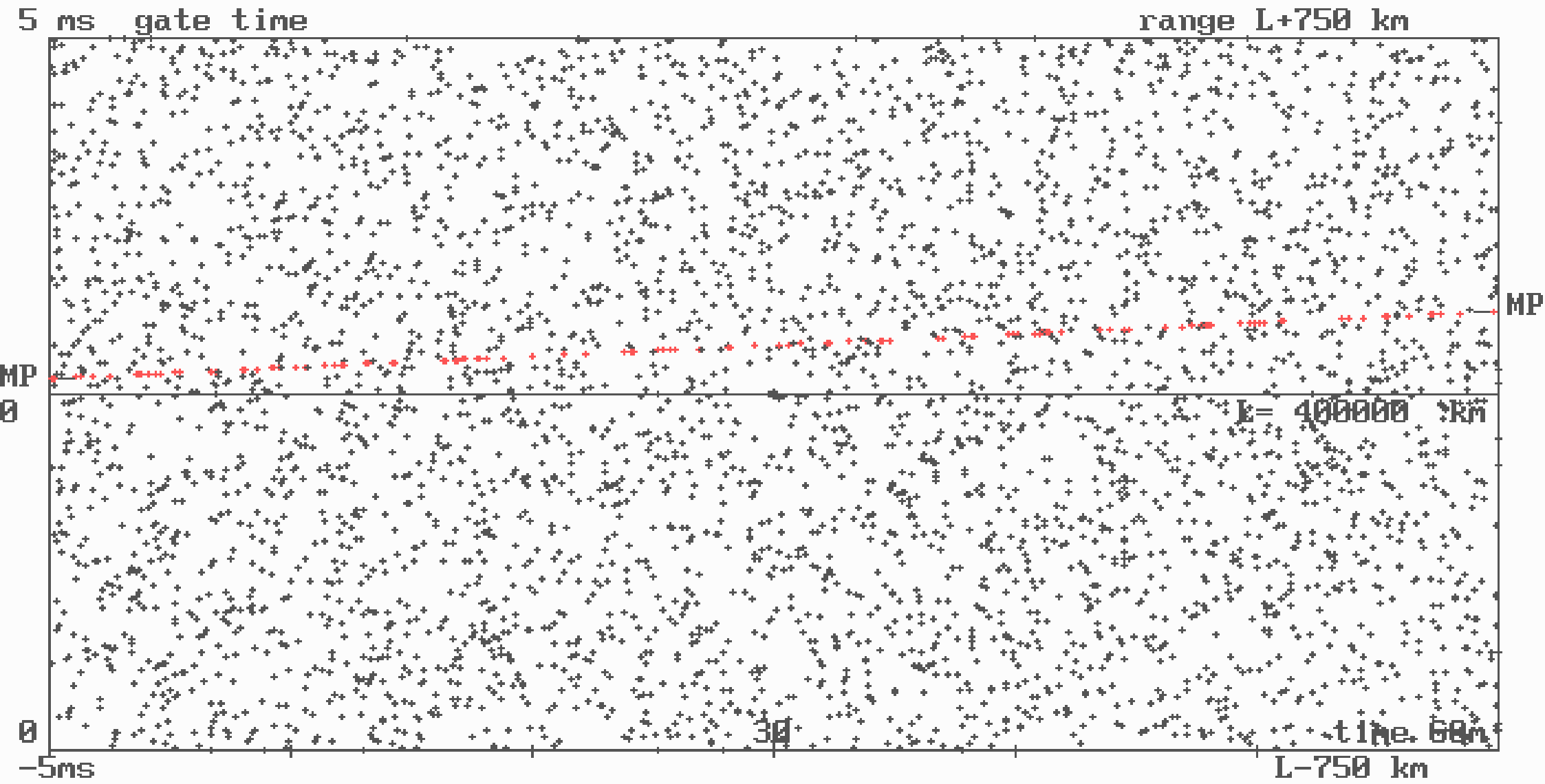

D tel= 2.6 m Planets diameter= .2 km
79706 photons on 1 km^2 qantum effic.=50% noise freq.= 659 HZ
117 measurments from 600 laser starts

Fig.3. Reflected laser pulses and noise from minor planet

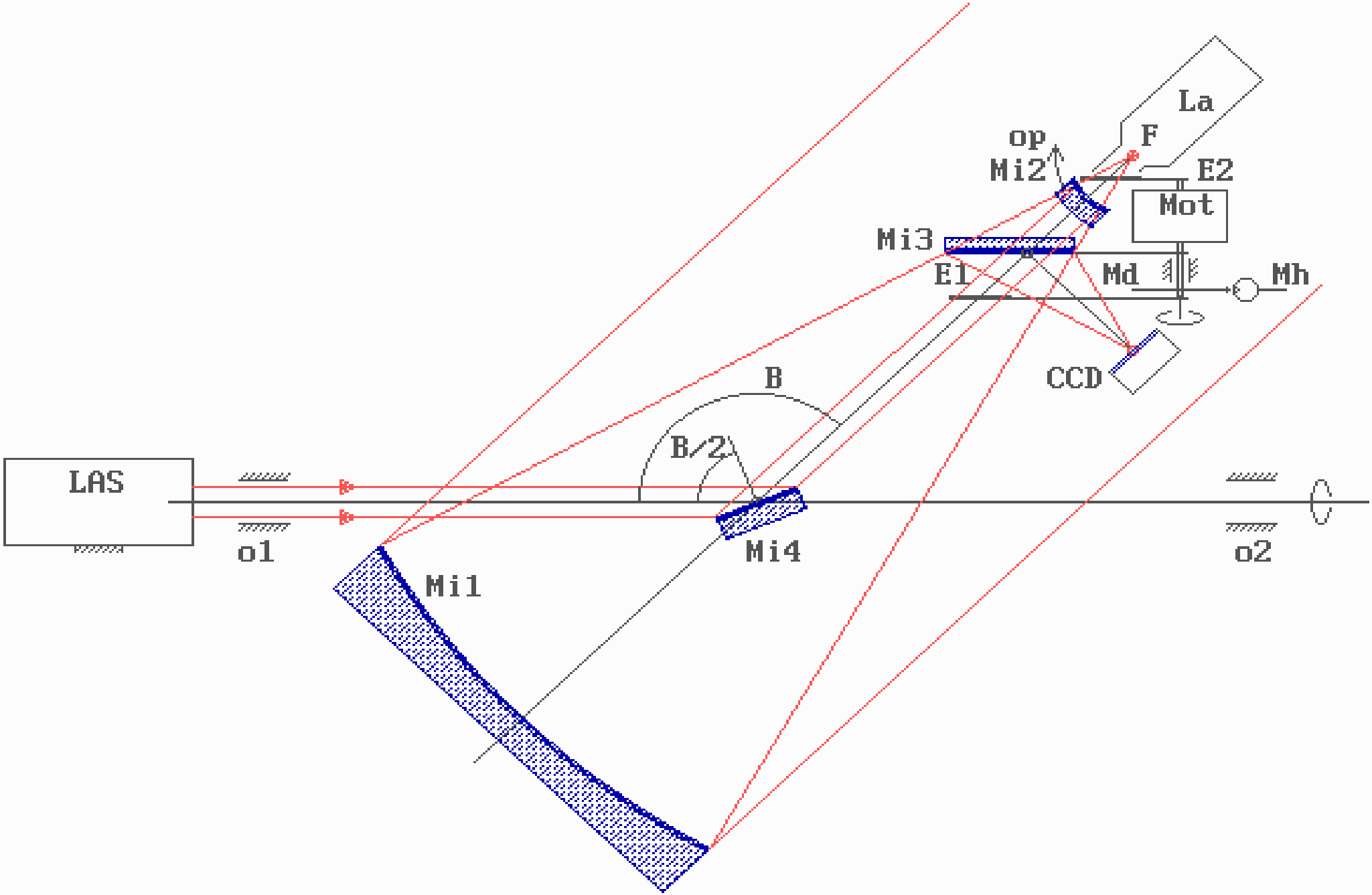

Fig. 4. The laser arangement relative to the telescope

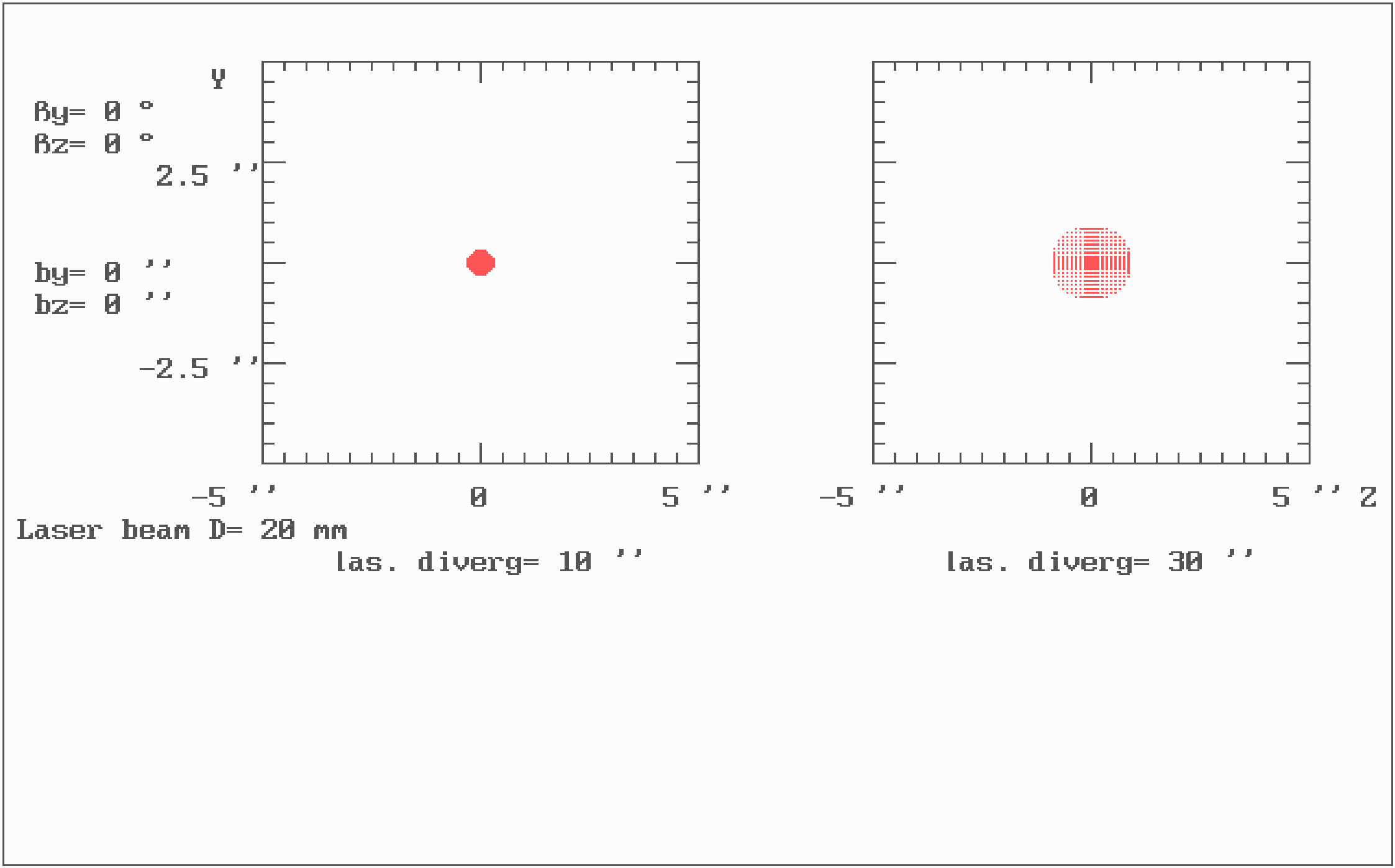

Fig. 6. Real laser energy distribution in the far zone

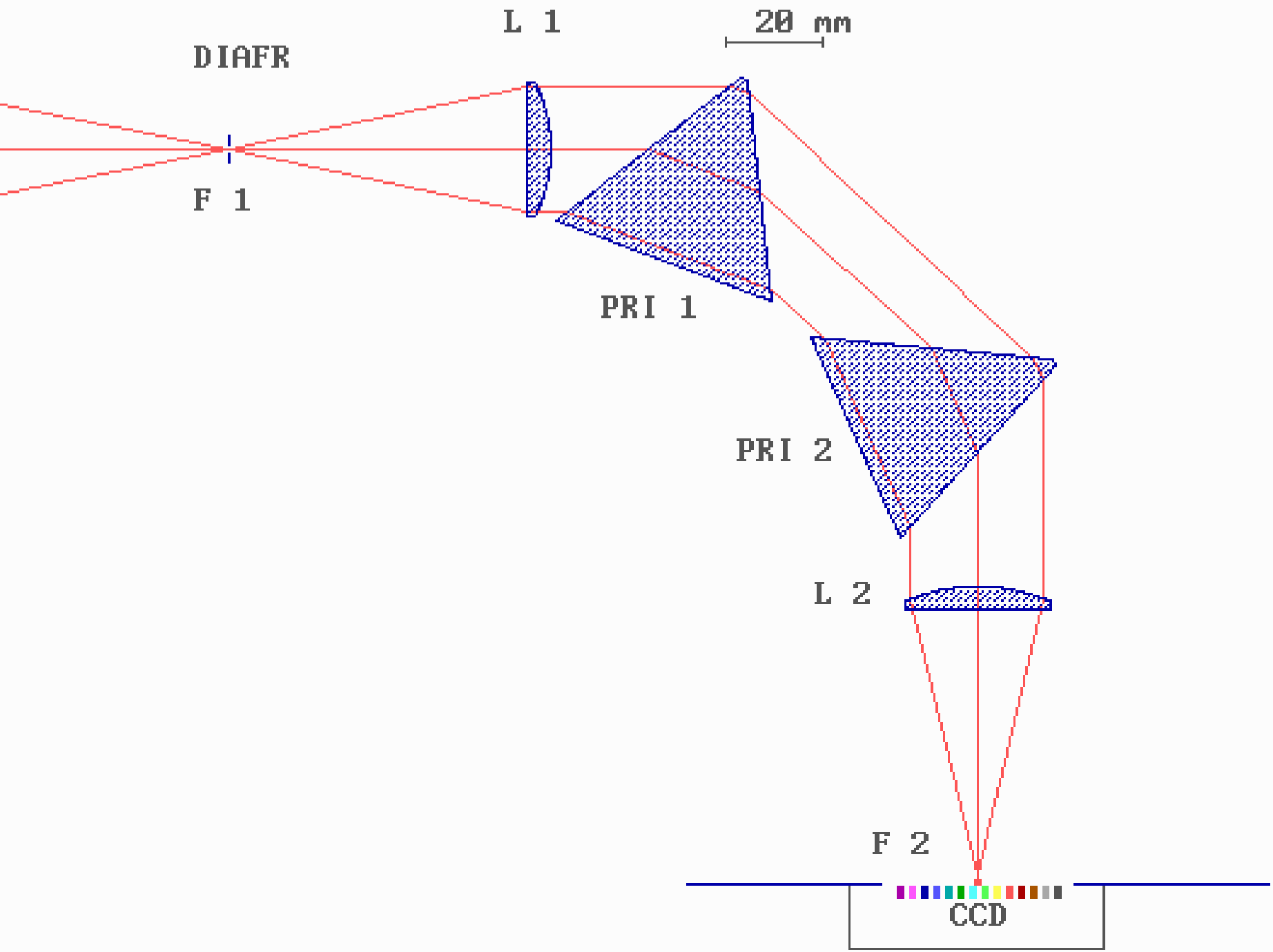

Fig. 9. Spectrogaph for recieving laser pulses

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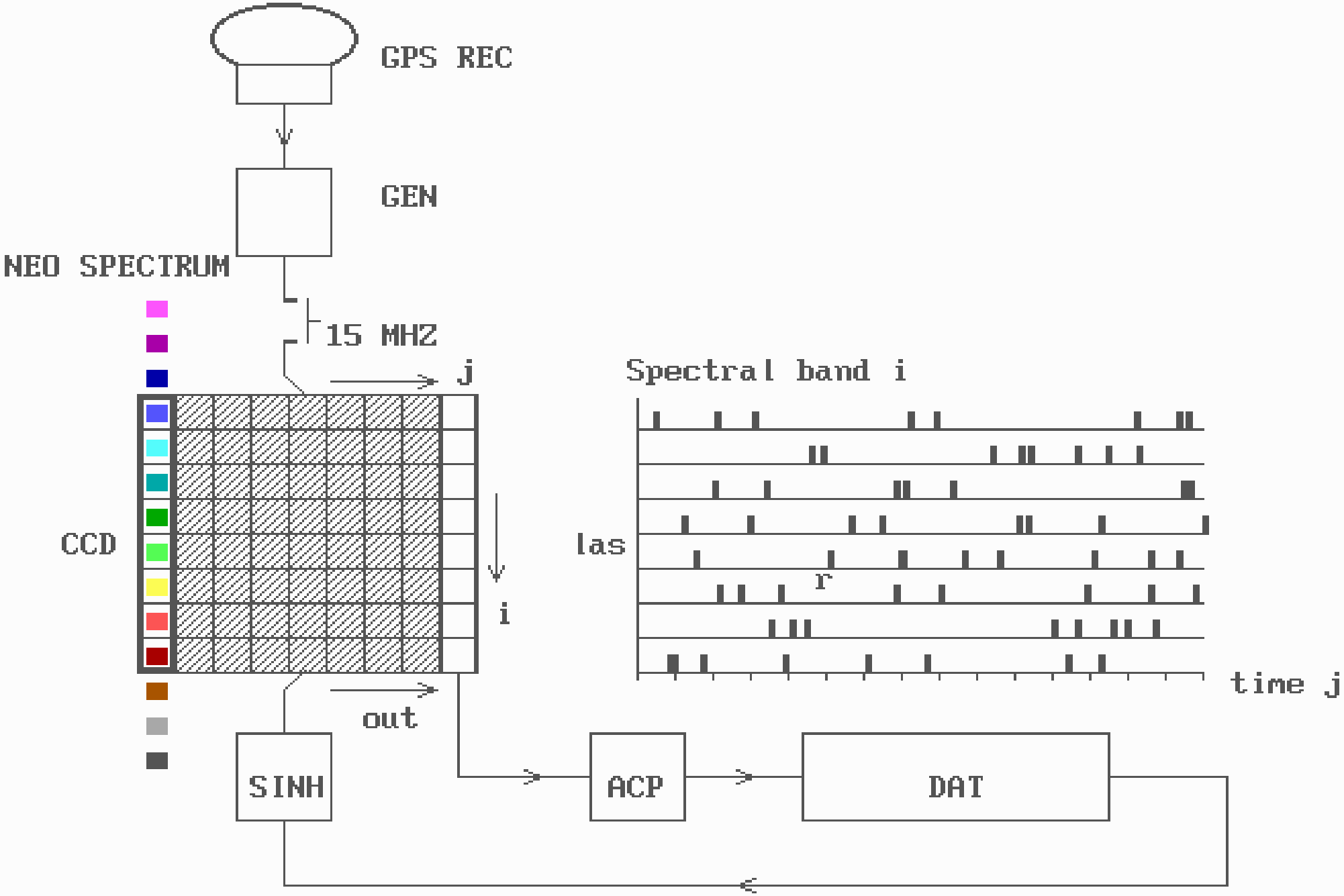
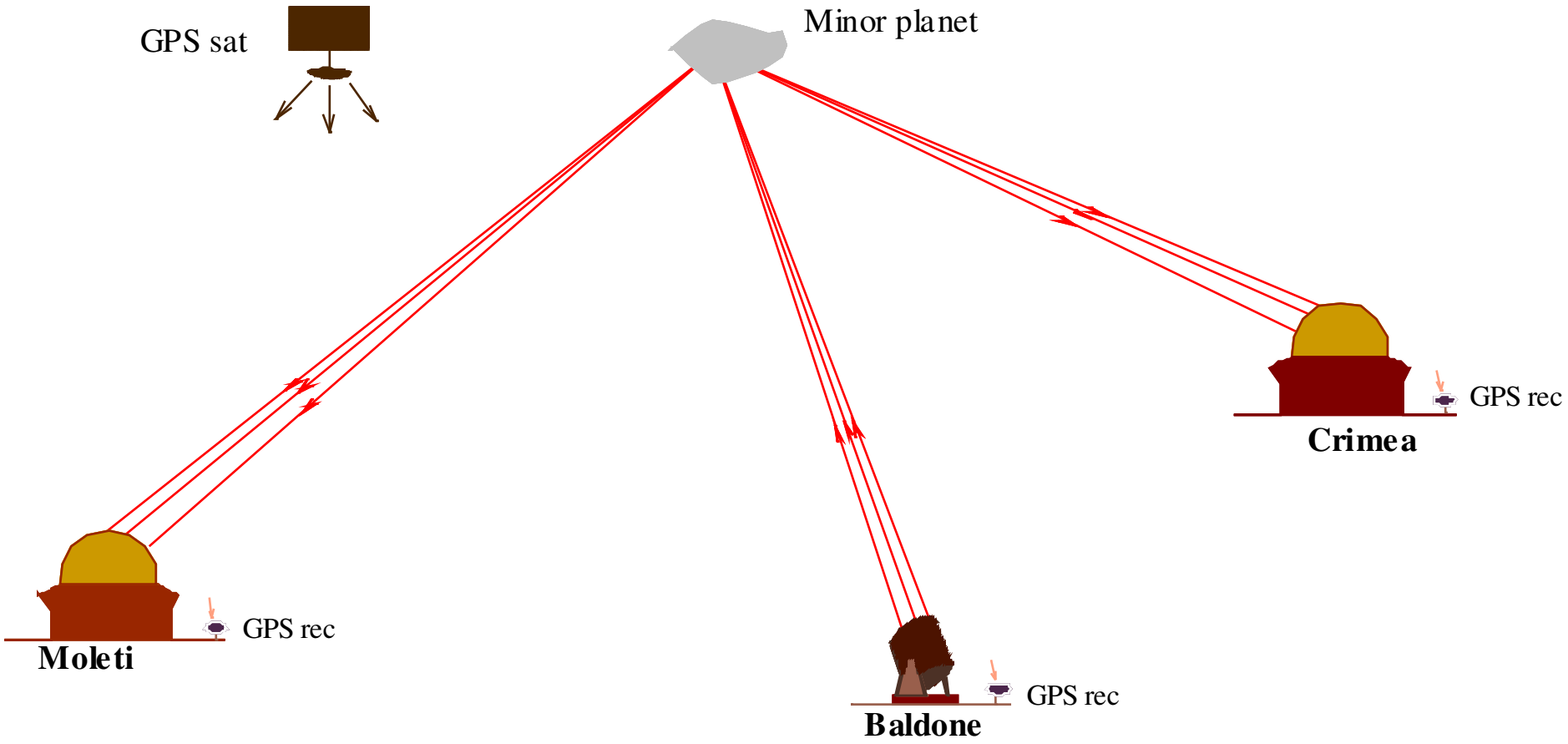


Fig. 11. Spectrograph for reflected pulses measurment

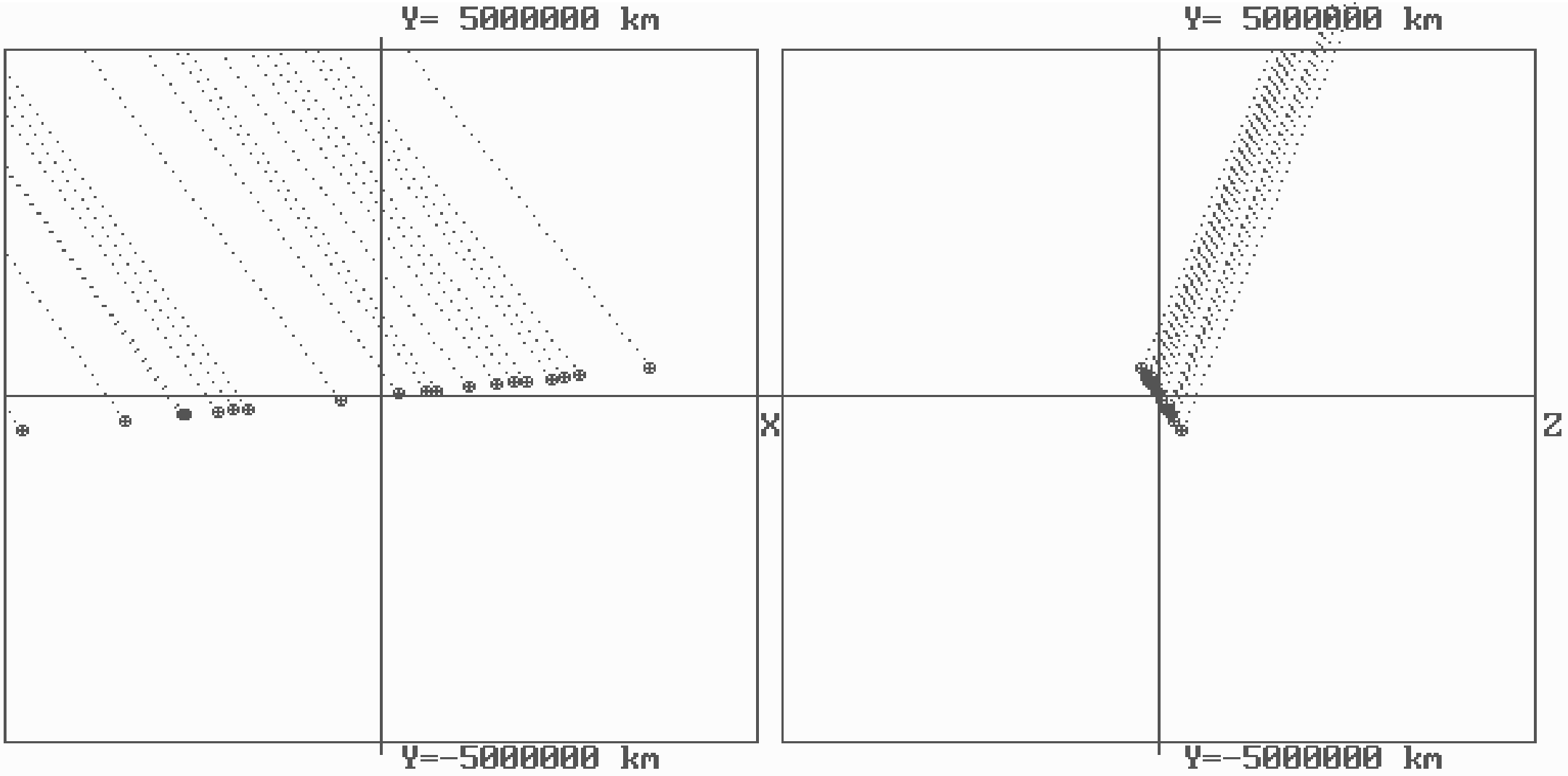
A possible arrangement of transmitting and receiving telescopes for NEO distance measurements



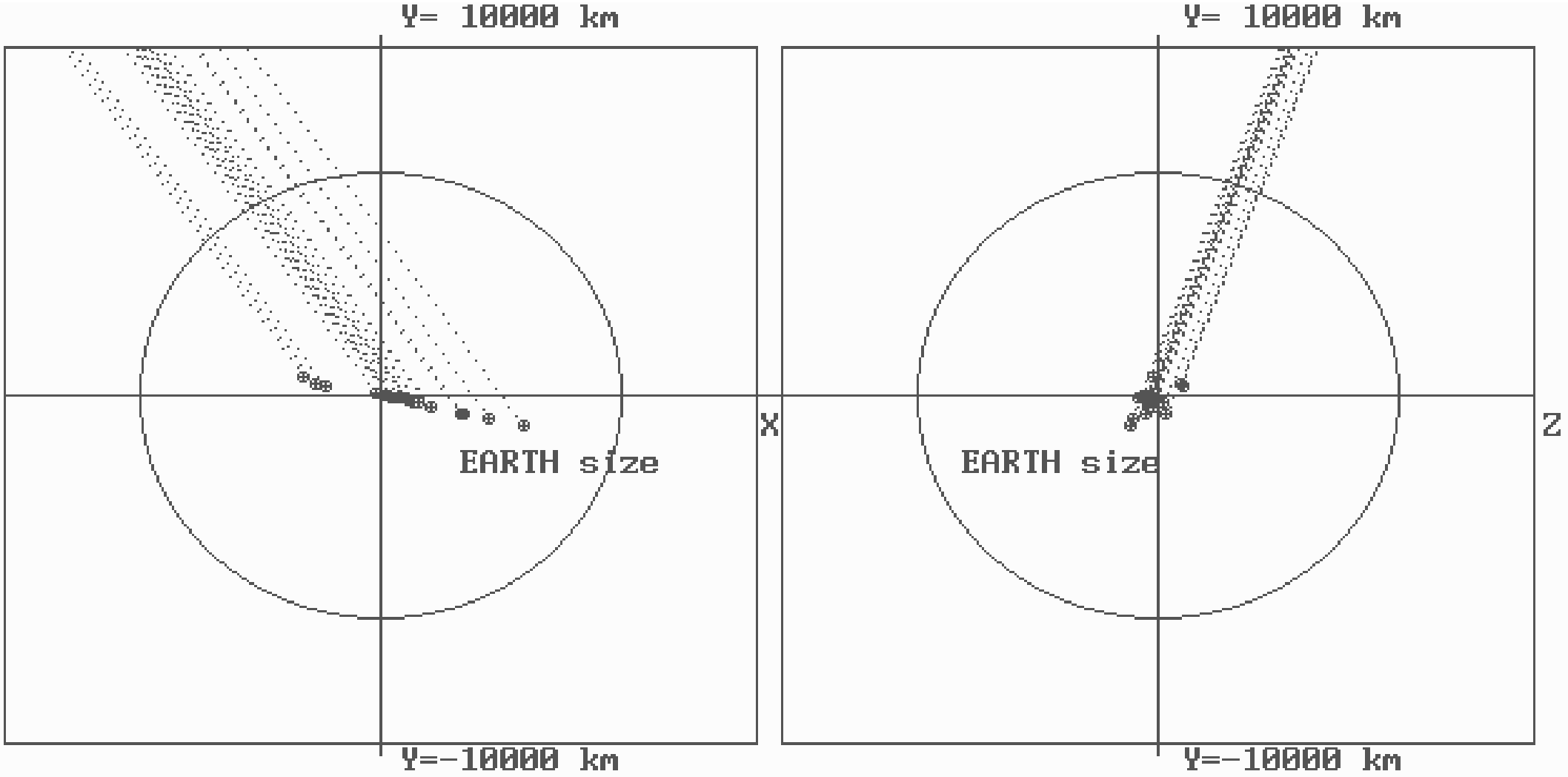
630 mm paraboloid mirror

The telescope model

Forecasted trajectories of asteroid 500 days after observation



angular coordinates error= .5 ''
no range measurments
no velocity measurments
Planets rectangular coordinates error after 500 days
eps X= 2612101 km
eps Y= 280573.3 km
eps Z= 164294.8 km



angular coordinates error= .5 ''
range measurments error= 10 m
no velocity measurments
Planets rectangular coordinates error after 500 days
eps X= 1596.051 km
eps Y= 366.4737 km
eps Z= 385.6769 km

This project can be carried out in co-operation with other astronomers of the Baltic States. Its implementation would enable scientists to improve significantly the orbital elements of the minor planets that present danger to the Earth and to forecast their motion in the future.


Thank You
for attention