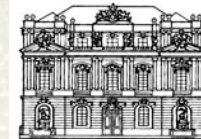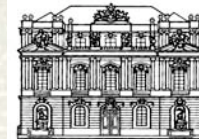# Identifying Single Retro Tracks With A 2 kHz SLR System:

Simulations and Actual Results

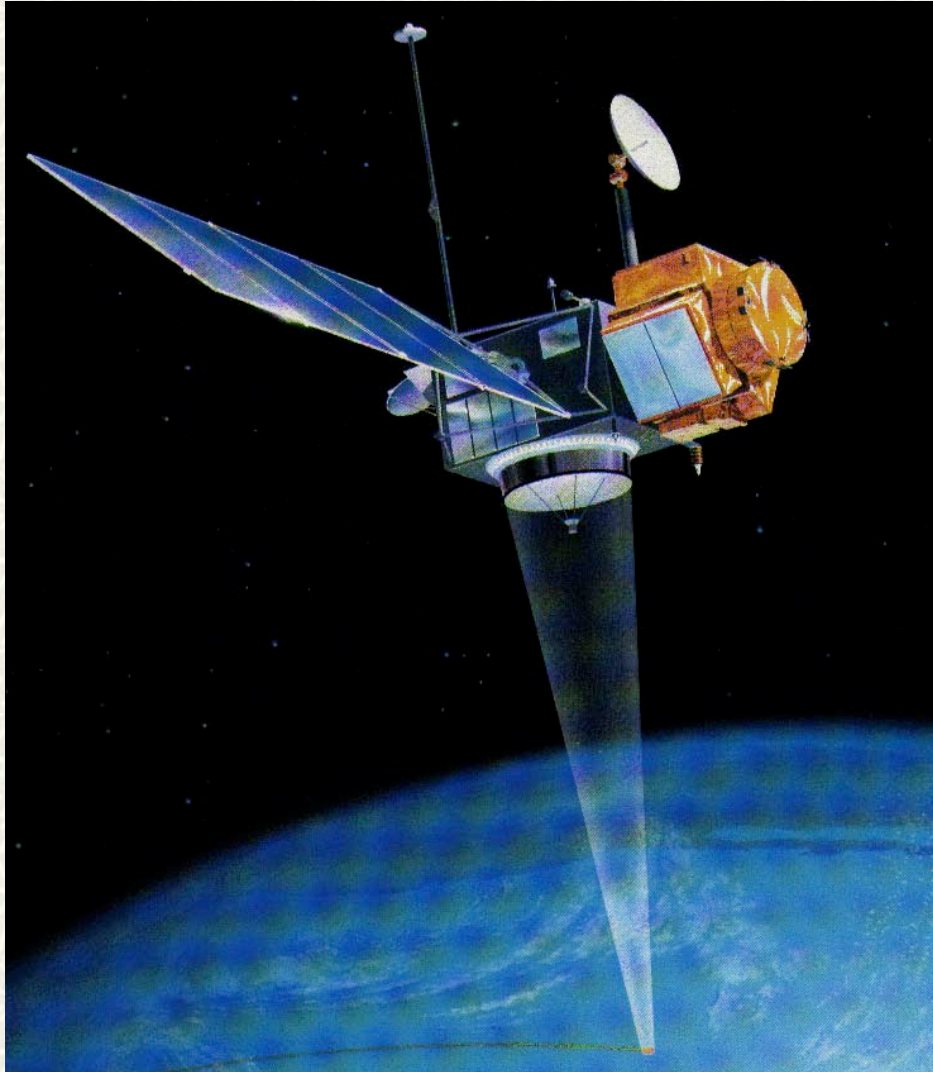**D. Arnold, G. Kirchner, F. Koidl**

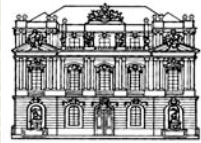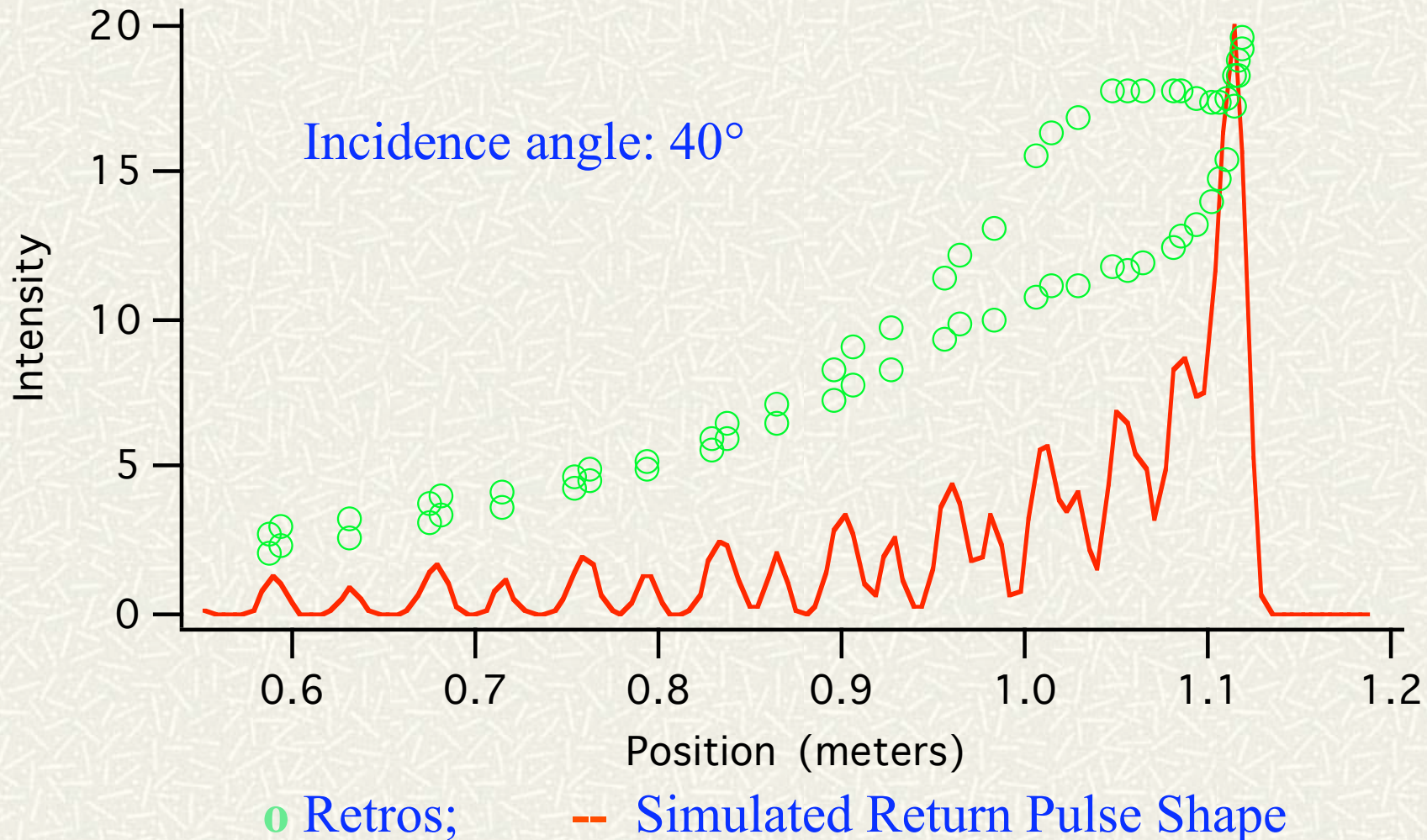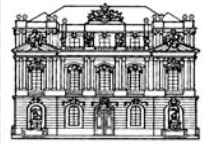San Fernando, June 2004

General

- **Most satellites have more than 1 retro;**
- **Most times more than 1 retro is seen;**
- **LAGEOS gives Single Photon-Electrons (max. return rate most times < 15 %)**
- **LEOs usually give Multi-PE, BUT:**
  - ➢ **Big Fluctuations in Return Energy;**
  - ➢ **Always considerable amount of SPEs;**

- ➢ Big ring of retros:

  - ➢ Always multiple retros visible;

- ➢ Satellite is stabilized; so:
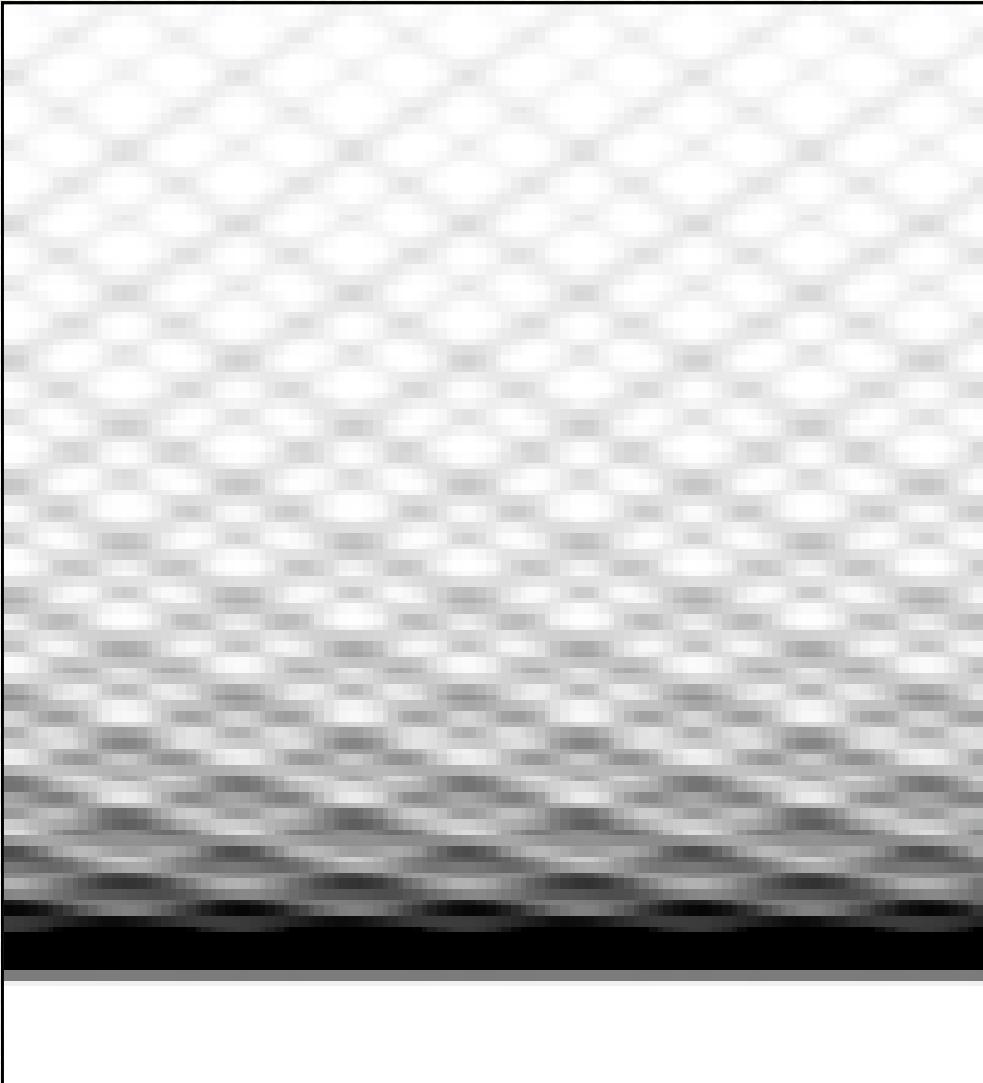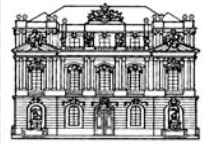
  - ➢ Slow changes of visible retros;

San Fernando, June 2004

Topex: Return Pulse Shapes (simulated) and Retros

Incidence angle: 40°

Intensity

Position (meters)

o Retros; -- Simulated Return Pulse Shape

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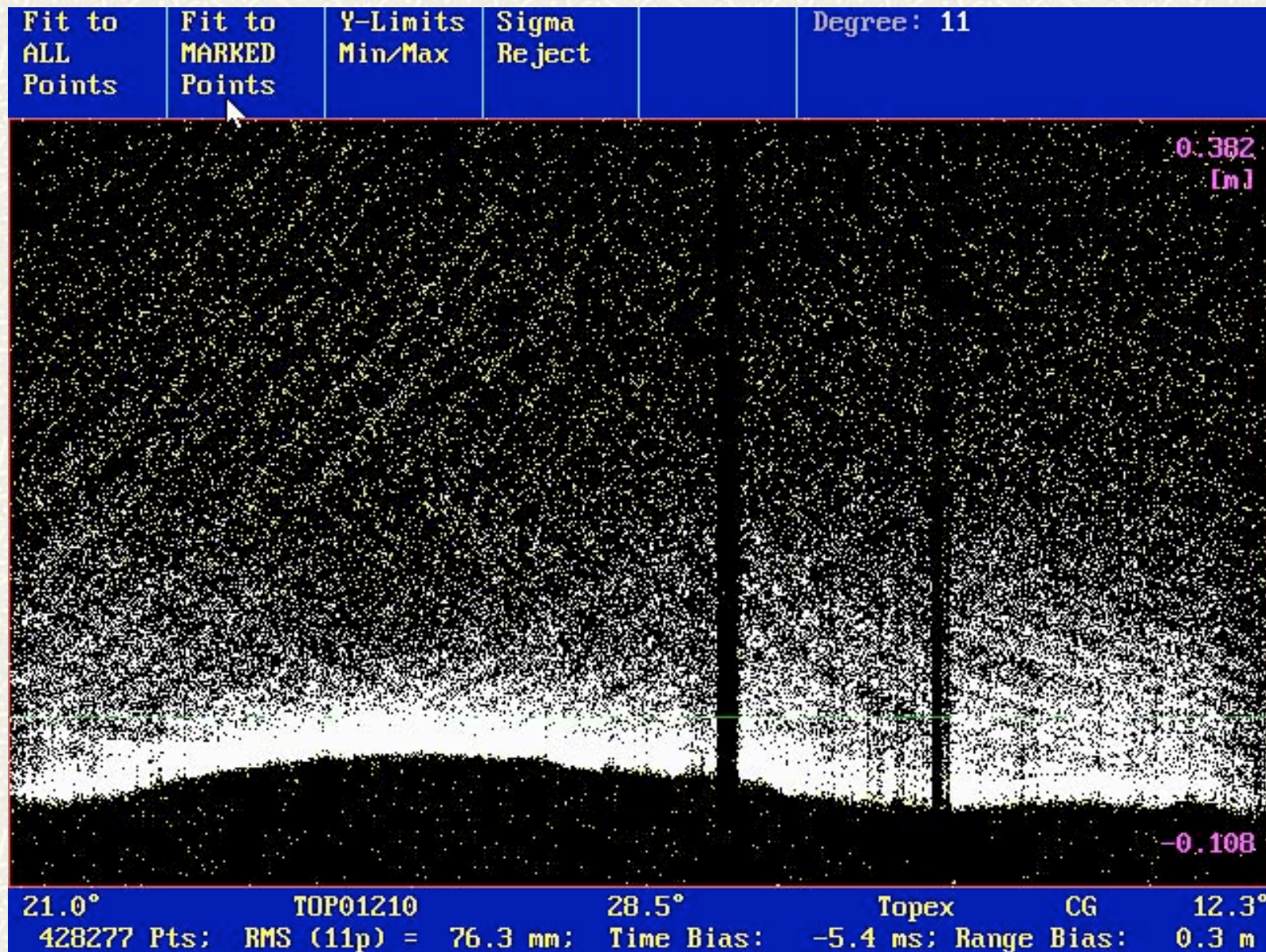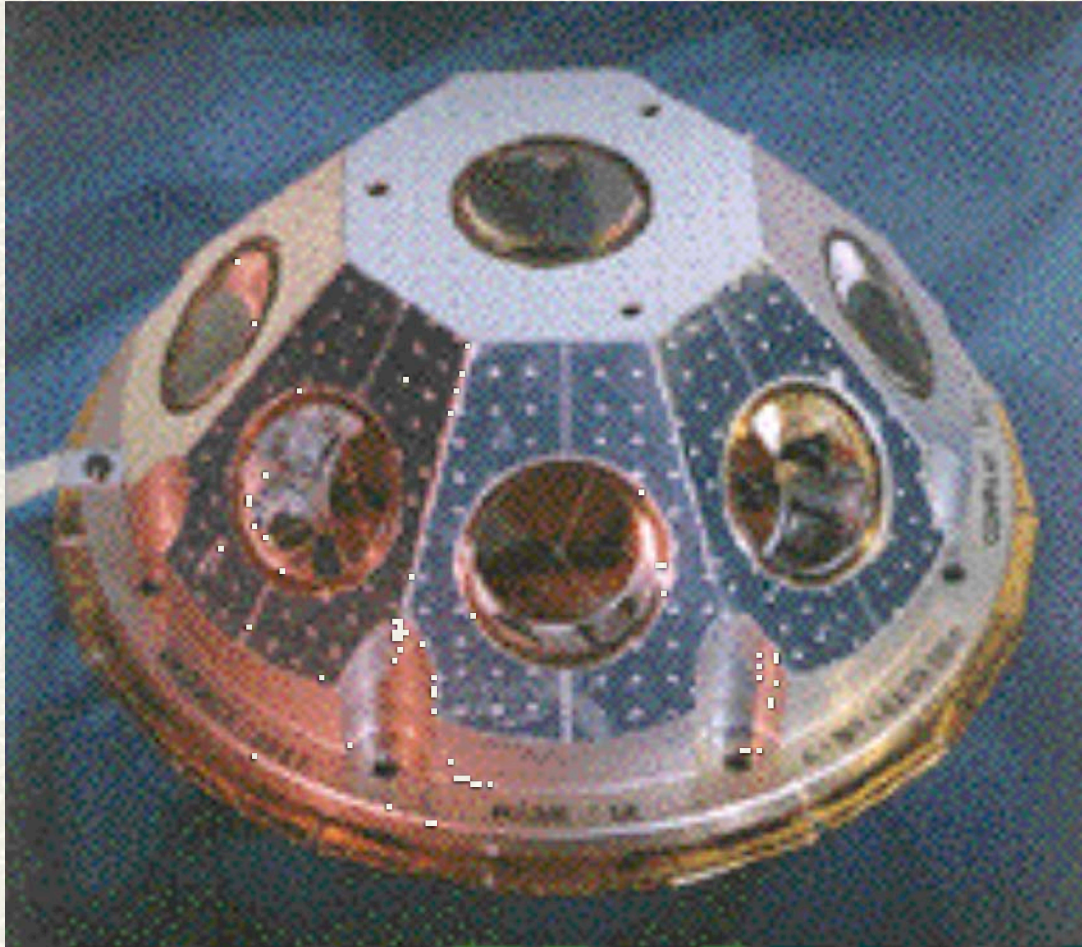
➢ Vertical axis: 550 to 1188 mm (two-way);

➢ Laser Pulse: 10 ps, but:

   ➢ 40 ps FWHM assumed to simulate receiver noise;

➢ 24° rotation of the satellite about the symmetry axis;
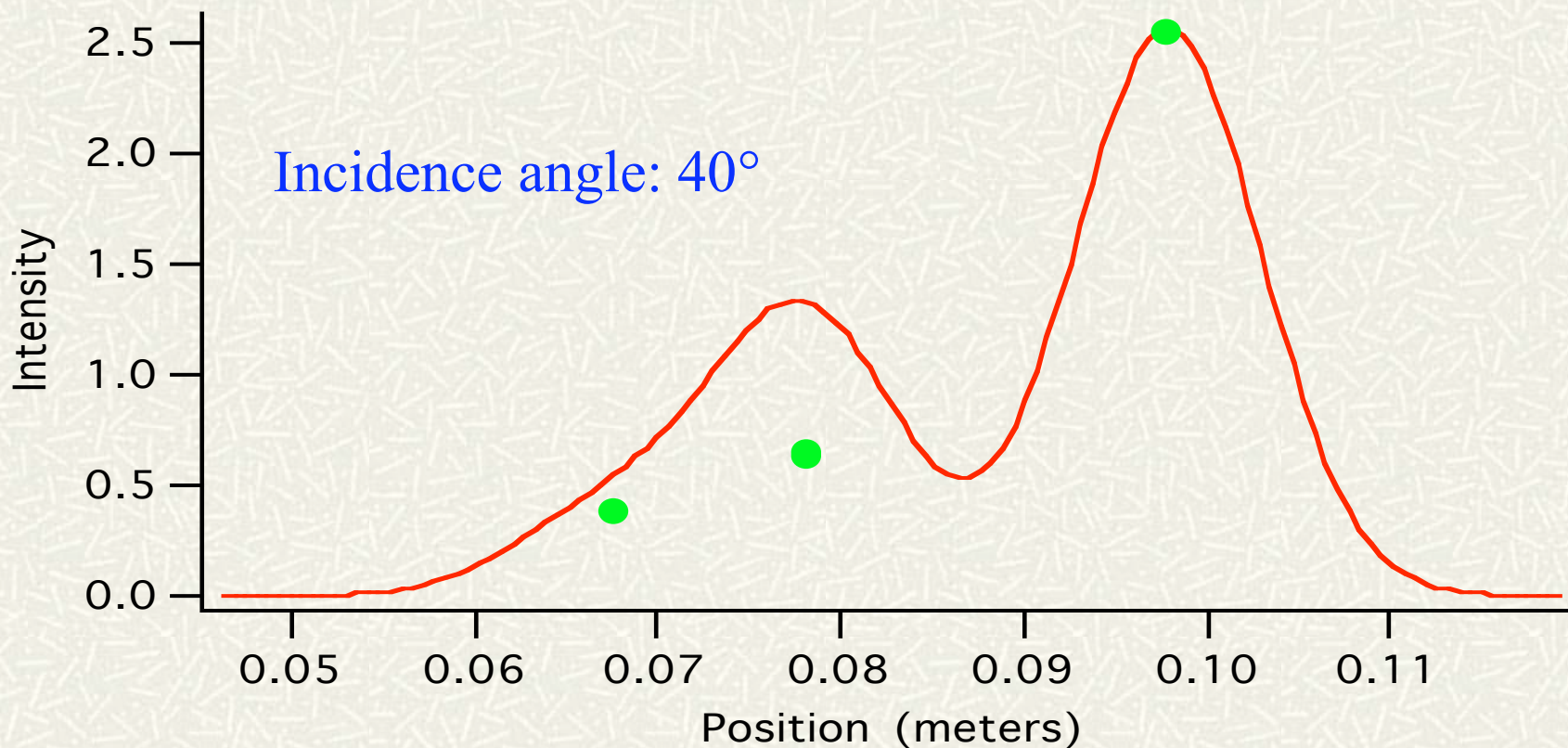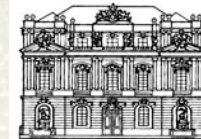
San Fernando, June 2004

Topex: Graz Data
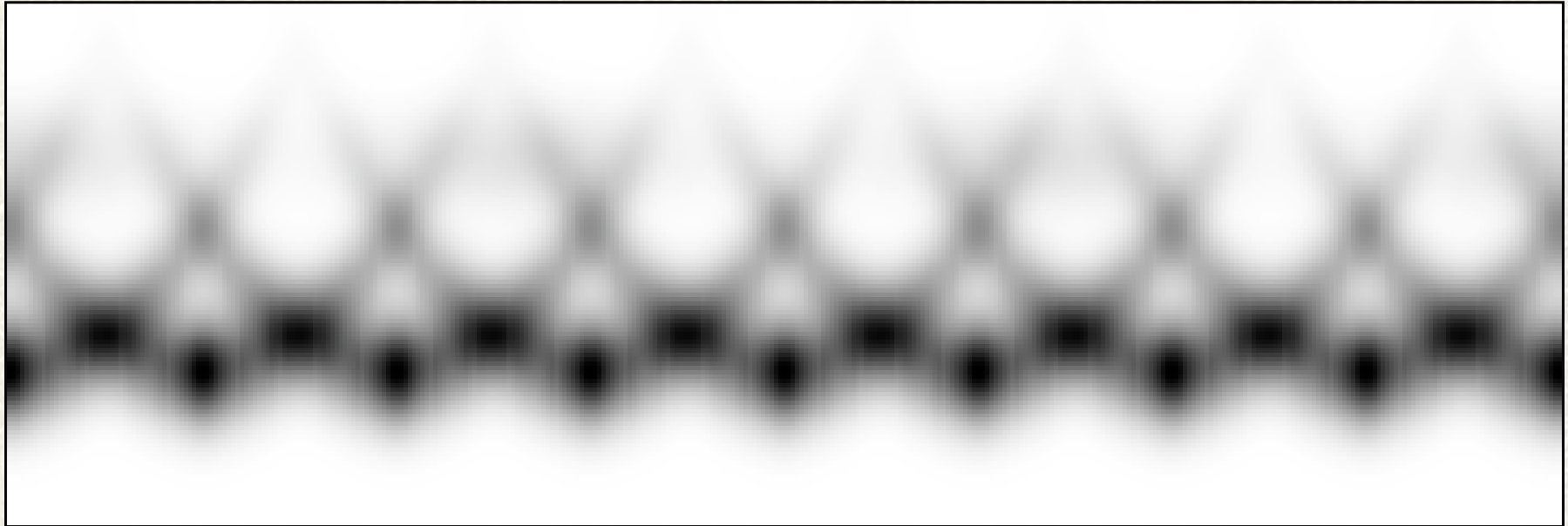
- Satellites are stabilized;

- Slow changes of visible retros;

- ERS and ENVISAT: Identical arrays

- Always 2 retros visible at least;

San Fernando, June 2004

ERS-2, Envisat: Simul. Return Pulse Shapes

Incidence angle: 40°

o Retros; Middle dot is actually 2 retros at same distance;
-- Simulated Return Pulse Shape

San Fernando, June 2004

- Horizontal axis is from 0° to 360 ° => one full revolution;

- We usually see only a fraction of this full revolution;

- Vertical axis is from 46 to 119 mm (73 mm);

- At the mm-level: CoM correction is **NOT CONSTANT !!!**

San Fernando, June 2004
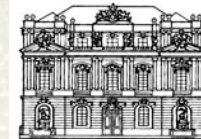
Envisat: 300 k Returns
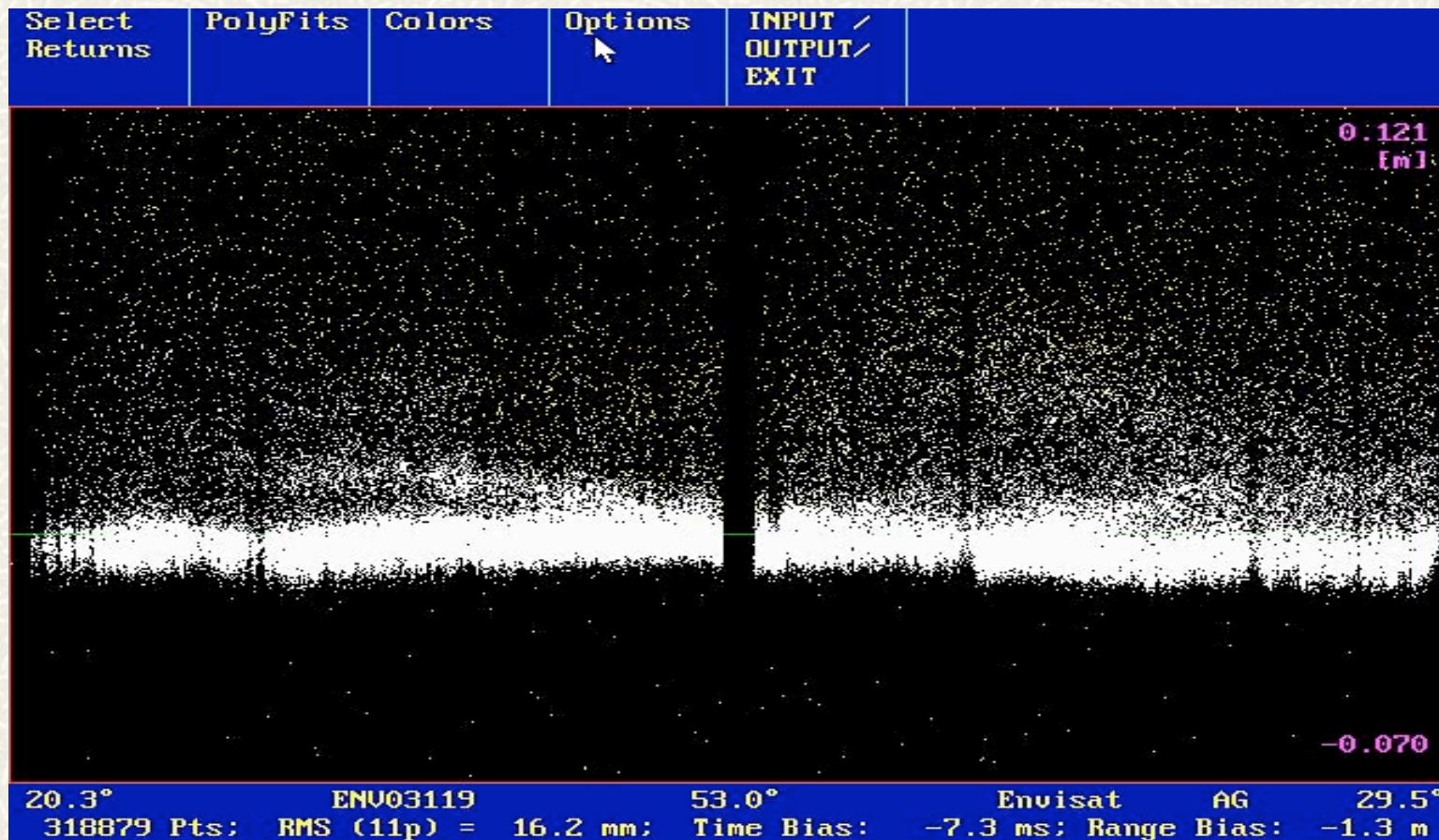
- ~ 1/8 of simulated full revolution (as in previous image)
- 2nd Track: shows max. offset of up to ~ 2 cm
- For NP generation: 2nd track returns omitted

San Fernando, June 2004
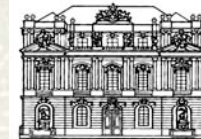
LAGEOS

- **Lageos 1:**
  - VERY slow rotation only;
  - Slow changes of retro visibility;
  - Allows detection of tracks of different retro clusters;
- **Lageos 2:**
  - Rotates significantly faster;
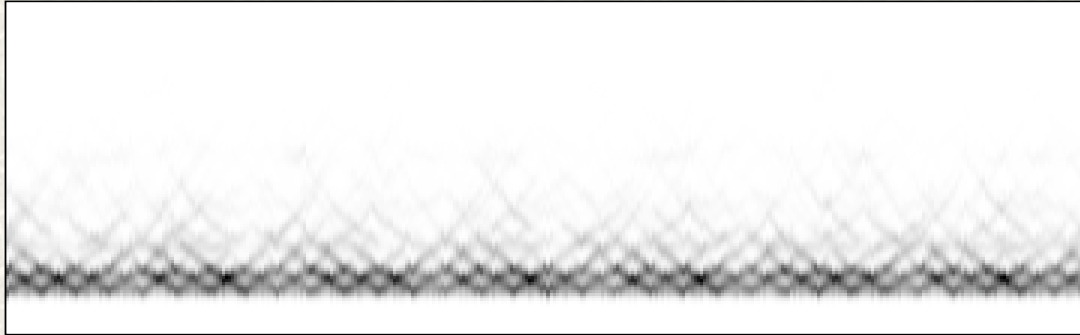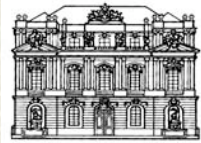 - Not easy to detect tracks of single retros or retro clusters

San Fernando, June 2004

LAGEOS: Retro Visibility, Sim. Return Pulse Shapes
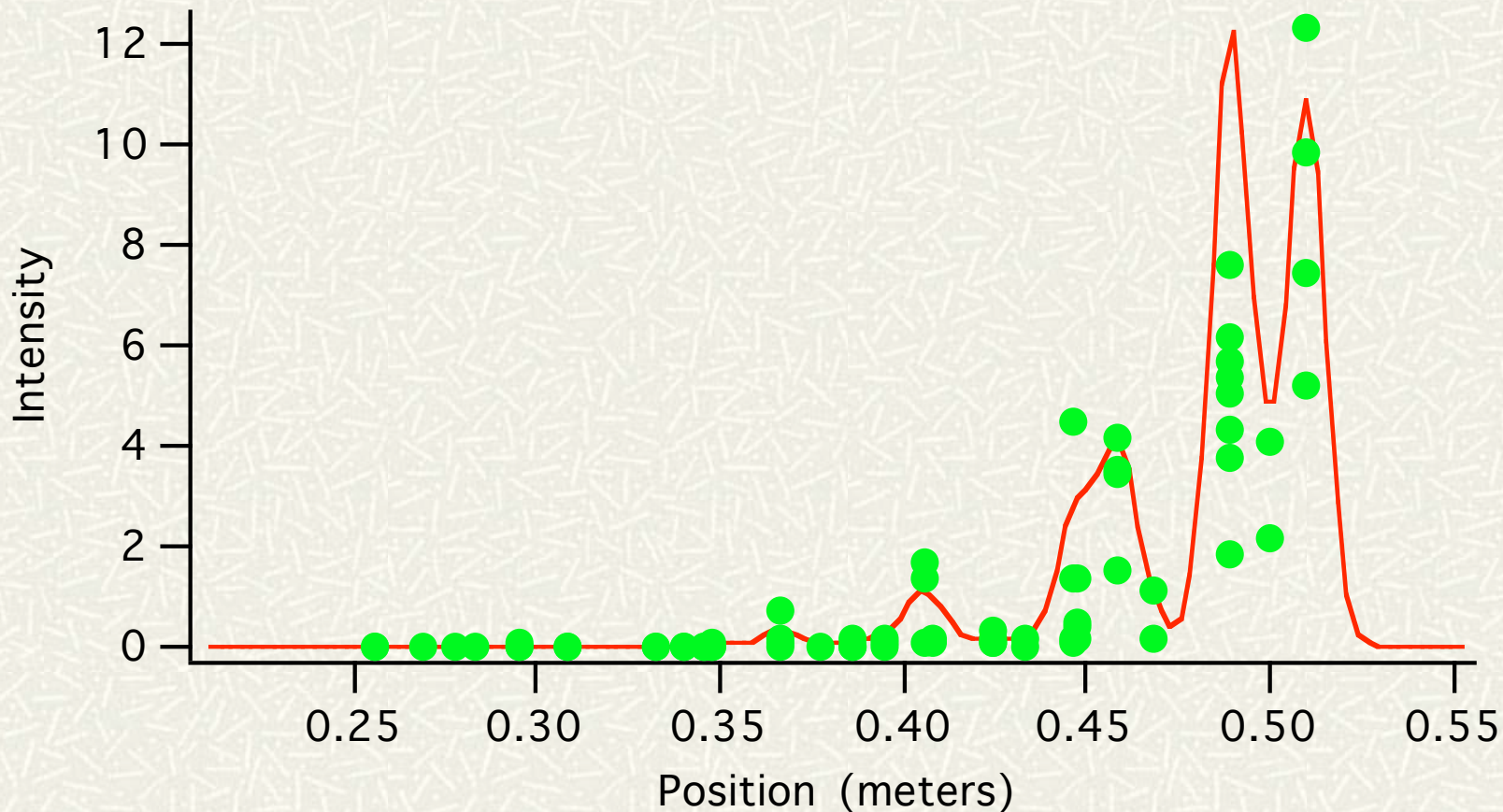
o Retros;   -- Simulated Return Pulse Shape

San Fernando, June 2004

- 90° angle with spin axis
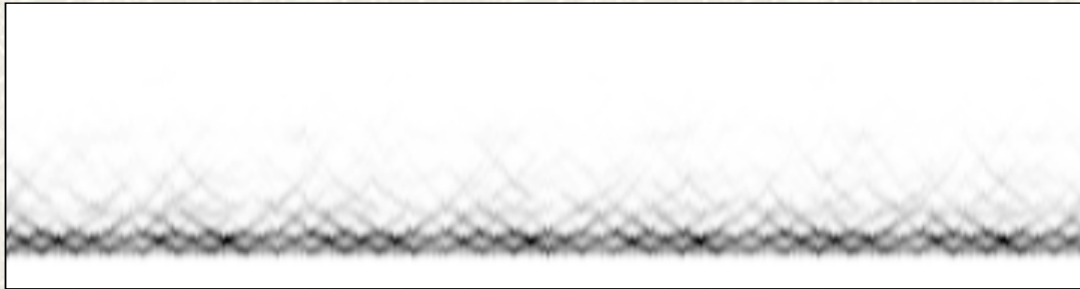
- 30° angle with spin axis

- 0° angle with spin axis
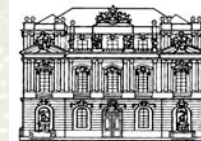
- Horizontal: 1 complete revolution (360°)
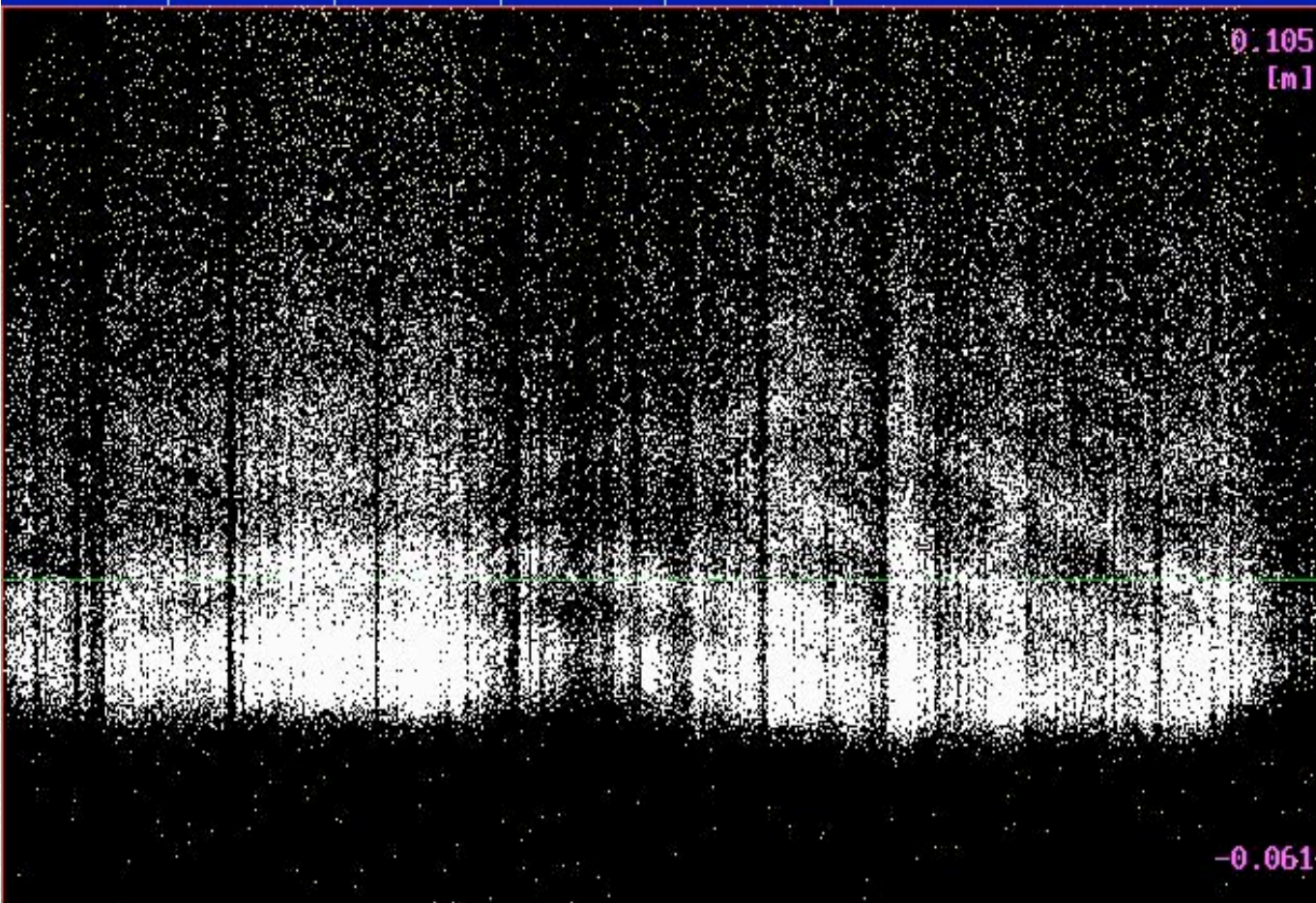
- Vertical: 280 to 550 mm (two-way).

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Lageos 1: Multiple tracks

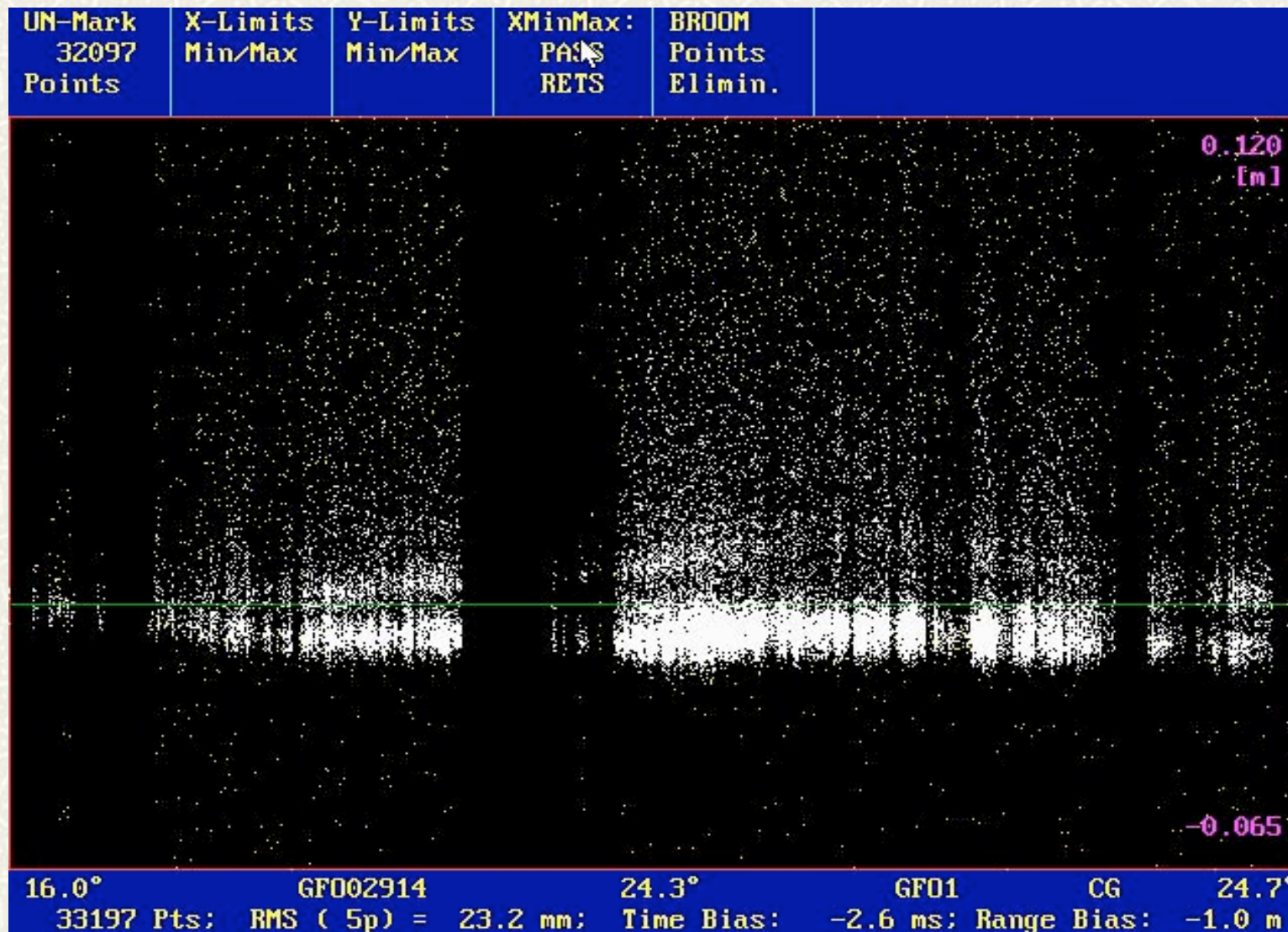
- Lageos-1 Pass
- Night time
- ~ 500 k Returns
- Slow rotation
- ~ 160 mm vertical
- Several tracks
- NP: Track 1 only
- 400 k remaining

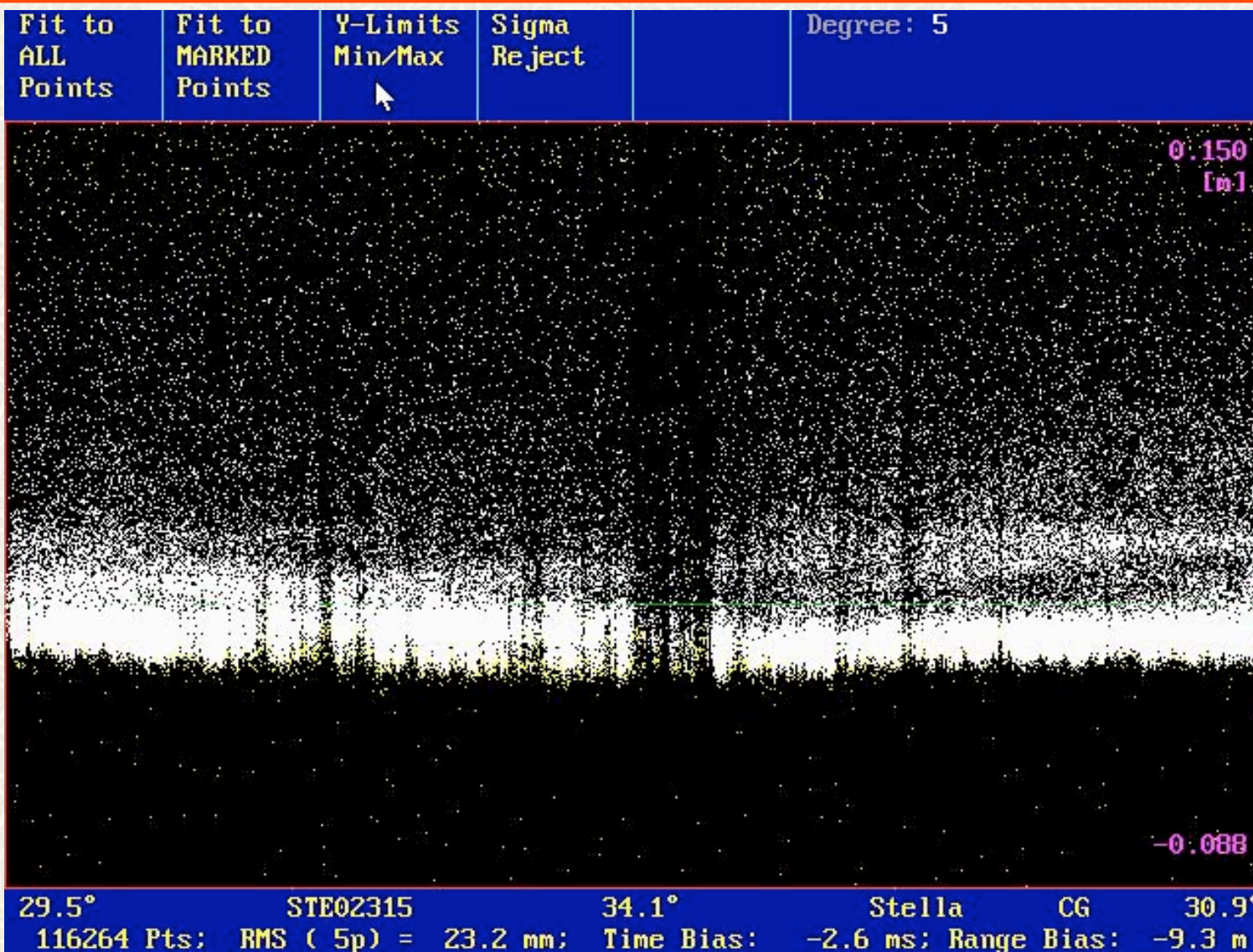San Fernando, June 2004

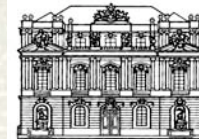# Other Satellites: GFO

Other Satellites: Jason-1
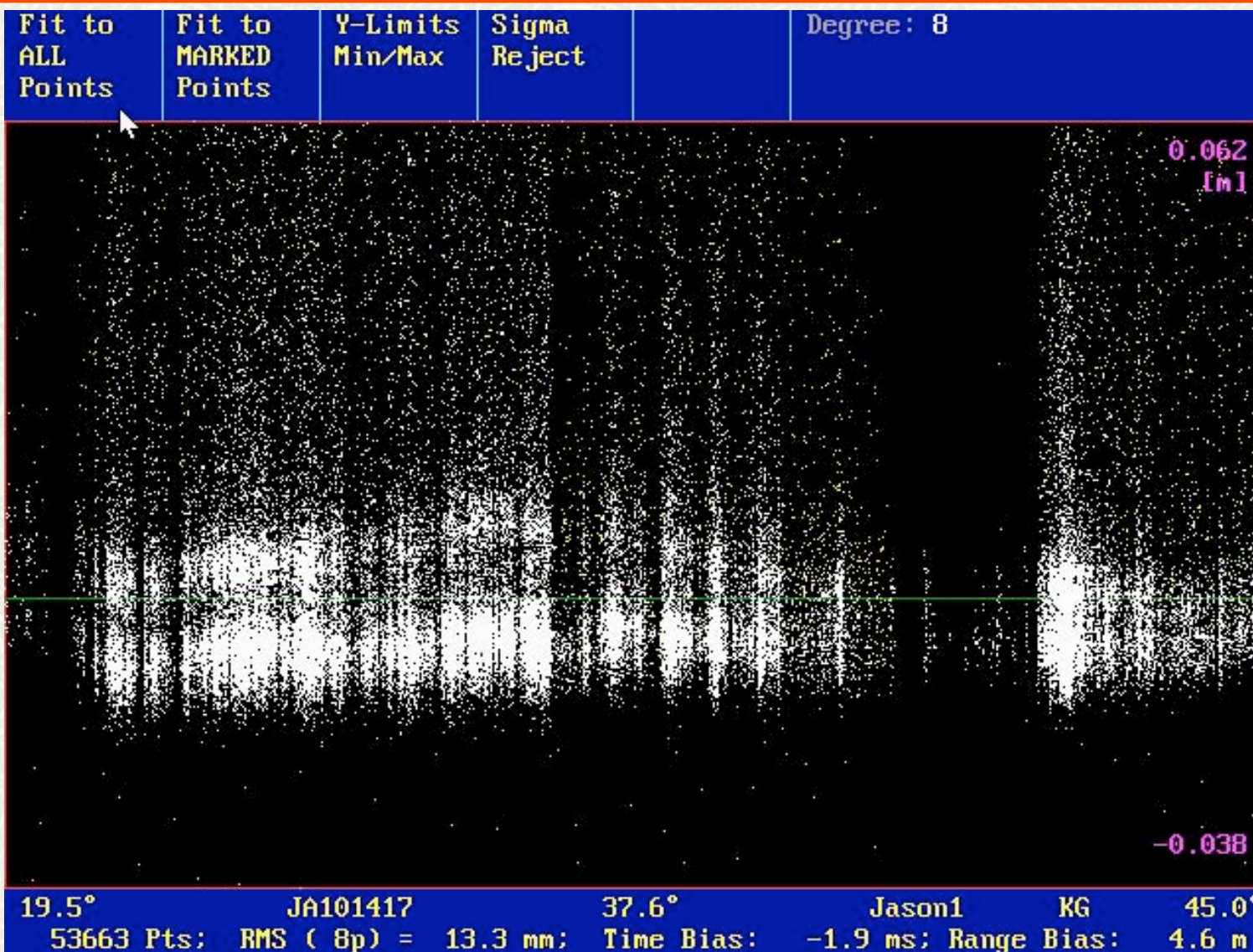
Even Stella shows it ...

San Fernando, June 2004

Conclusions
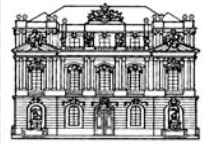
- The Graz 2 kHz SLR system resolves:
  - single retro tracks;
  - and / or tracks of retro clusters on most satellites;
  - Exceptions: LaRetC, Champ (?), Panels only on Glonass sats;
- Lageos: Single PE returns only, due to low energy (400 µJ/shot);
- LEOs: Multi-PEs, but also significant fraction of SPEs;
- NP Generation: Secondary tracks omitted, only nearest retro used;
- Consequence for CoM corrections at mm-level:
  - Even with secondary tracks removed:
  - CoM correction: **NOT ALWAYS CONSTANT !**
- For stabilized satellites: Chance to increase SLR accuracy !

San Fernando, June 2004

Be aware …

… of these things also in YOUR system:

- With kHz   => We now can show it;

- With 10 Hz   => You just don't know it ….

☺