Grazing Occultations of Stars by the Moon – Why do we still observe ?

Dr. Eberhard Riedel, IOTA-ES, Munich, Germany

Grazing Occultations of Stars by the Moon

1. The scientific purpose:

- The purpose did change over the decades
  - Improving stellar positions until HIPPARCOS
  - Improving the lunar limb profile data until Kaguya
- And now: Still improving lunar limb data ??
  - Precise limb needed for solar diameter measurements
  - Finding errors in HIPPARCOS proper motions
  - Measuring stellar diameters
- Training observational skills:
  - Prepare for different occultation observations
  - Total control over the equipment
  - Gaining experience in group observation organization

Grazing Occultations of Stars by the Moon

1. The scientific purose:

- Grazing occultations reveal the mechanics of the solar system

  - Occultation timings reveal errors in stellar proper motions in the Hipparcos Catalogue

  - Overall rotational errors of the Hipparcos reference frame are assumed

  - The ‚Gaia' project of the ESA starting 2012 will measure 1 billion stars down to 1 μ" !!

Grazing Occultations of Stars by the Moon

1. The scientific purpose: Why do we observe?

- Baily‘s Beads reveal a variable solar diameter

1. The scientific purpose: Why do we observe?

- Baily‘s Beads reveal a variable solar diameter

- Reductions of Baily‘s Beads suggest a variable solar diameter of +/- 400 km

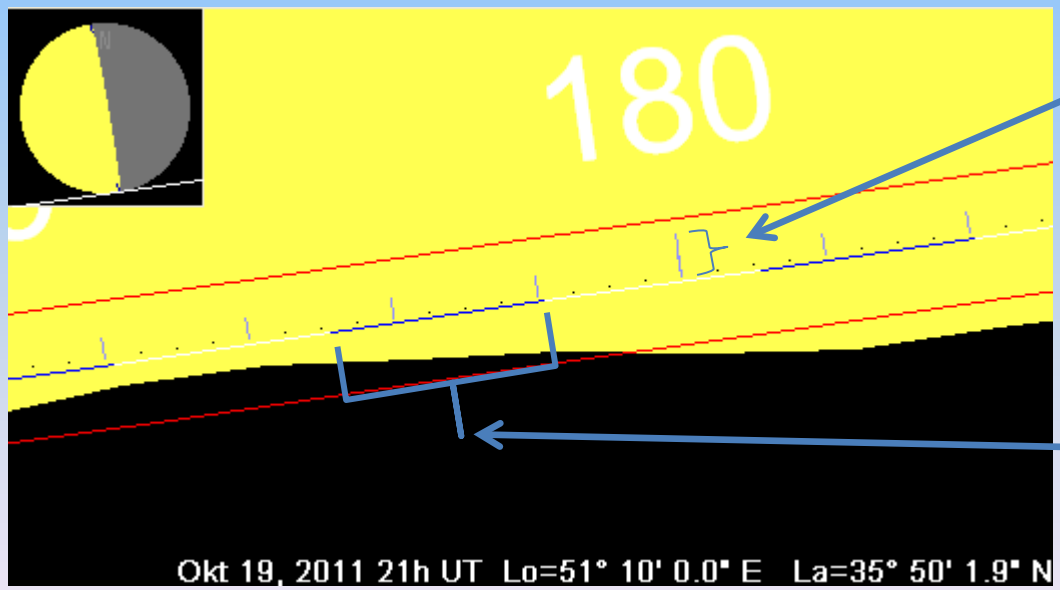
- More ‚grazing occultation‘ observations of the sun are needed

Grazing Occultations of Stars by the Moon

Grazing Occultations of Stars by the Moon

2. Limb data improvement? Kaguya vs. Earthbound

- How precise can earthbound observations be ?
  - Kaguya Laser Ranging Precision 5 to 200 meters
  - Average lunar velocity: 0.55“ (1,03 km) in 1 second



1“
<> 1.9 km

10 sec
<> 10.3 km

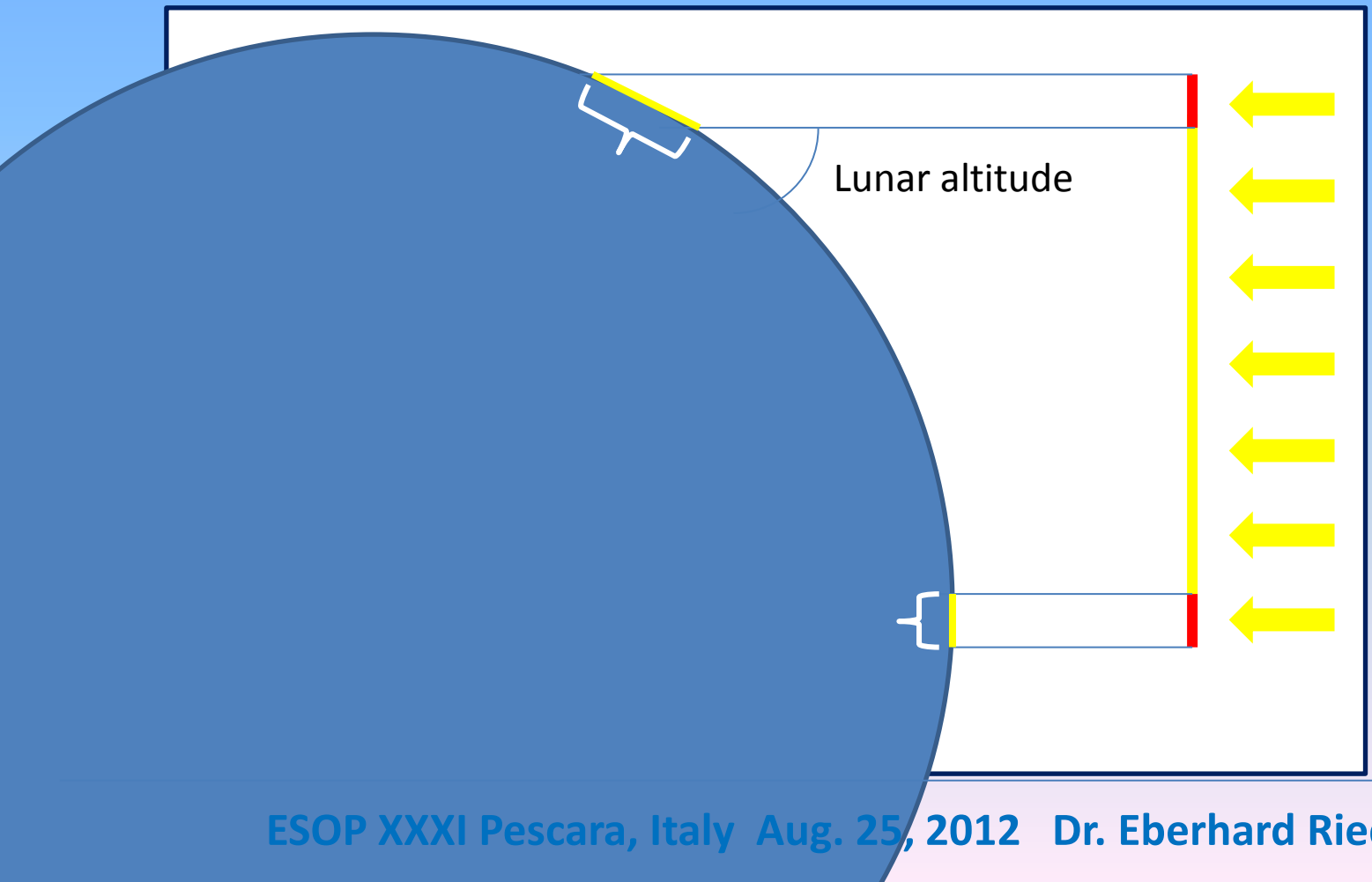
2. Limb data improvement? Kaguya vs. Earthbound

- How precise can earthbound observations be ?
  - The moon moves 1 km per second
  - Timing down to 0.1 sec. gives a horizontal resolution of 100 m
  - To achieve a 5 m accuracy we would need a timing precision of 5 msec.
  - This is not possible, even with video means (1/25)
  - BUT: We can compete in the vertical axis!

Grazing Occultations of Stars by the Moon

2. Limb data improvement? Kaguya vs. Earthbound

- How precise can earthbound observations be ?



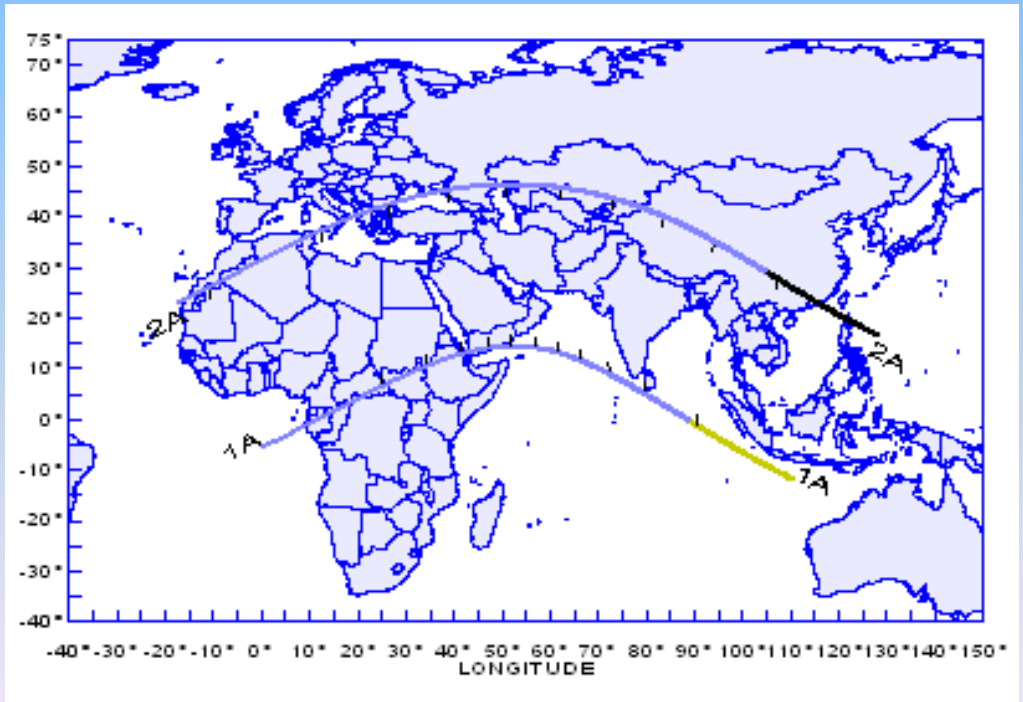
2. Limb data improvement? Kaguya vs. Earthbound

- How precise can earthbound observations be ?

The stretching of lunar limb features
is a function of the lunar alitude !

2. Limb data improvement? Kaguya vs. Earthbound

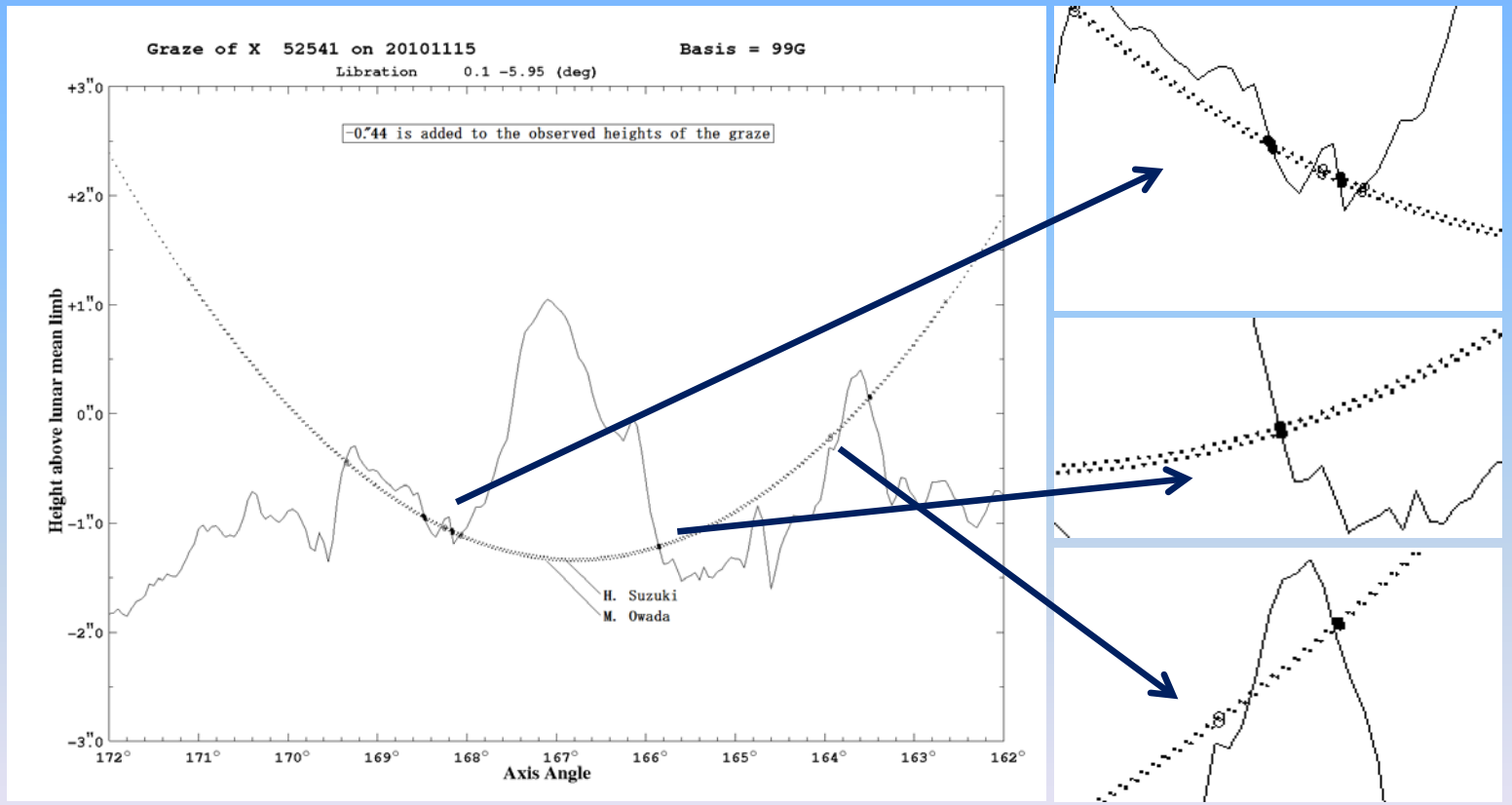
- How precise can earthbound observations be ?
  - The polar regions heights are projected at least 1:1
  - Earthbound height measurements are limited by the posi-tioning precision !
  - GPS is sometimes less accurate
  - Good maps (GE)are sometimes better.



Grazing Occultations of Stars by the Moon

2. Limb data improvement? Kaguya vs. Earthbound

- How precise can earthbound observations be ?



Reduction by Mitsuru Soma, National Astronomical Observatory of Japan

2. Limb data improvement? Kaguya vs. Earthbound

- How precise can earthbound observations be ?

Conclusion:

- Kaguya heights can be improved by earthbound observations , when positioning and timing are precise!
- Many nearby observing stations can detect high precision details of the lunar limb !

2. Limb data improvement? Kaguya vs. Earthbound

- How precise can earthbound observations be ?

Precision necessities:

For video timings:

- Timing precision (typically) 0,03 sec.
- Positioning accuracy (Long, Lat, Elev): 15 meters (0.5“)

For visual timings:

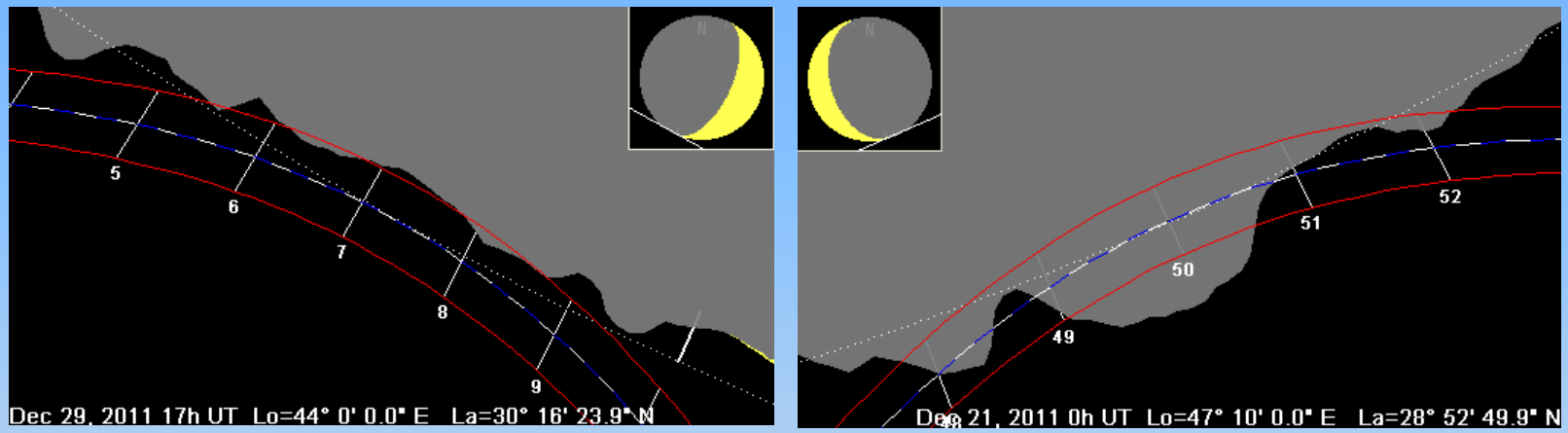
- Timing precision (best possible) 0,3 sec.
- Useful positioning accuracy : 150 meters

With Google Earth the position can be known to around 3 meters (0.1 arcsec !)

Grazing Occultations of Stars by the Moon

3. Selecting the station coordinates relative to the profile

- Judging the extent of the lunar limb profile

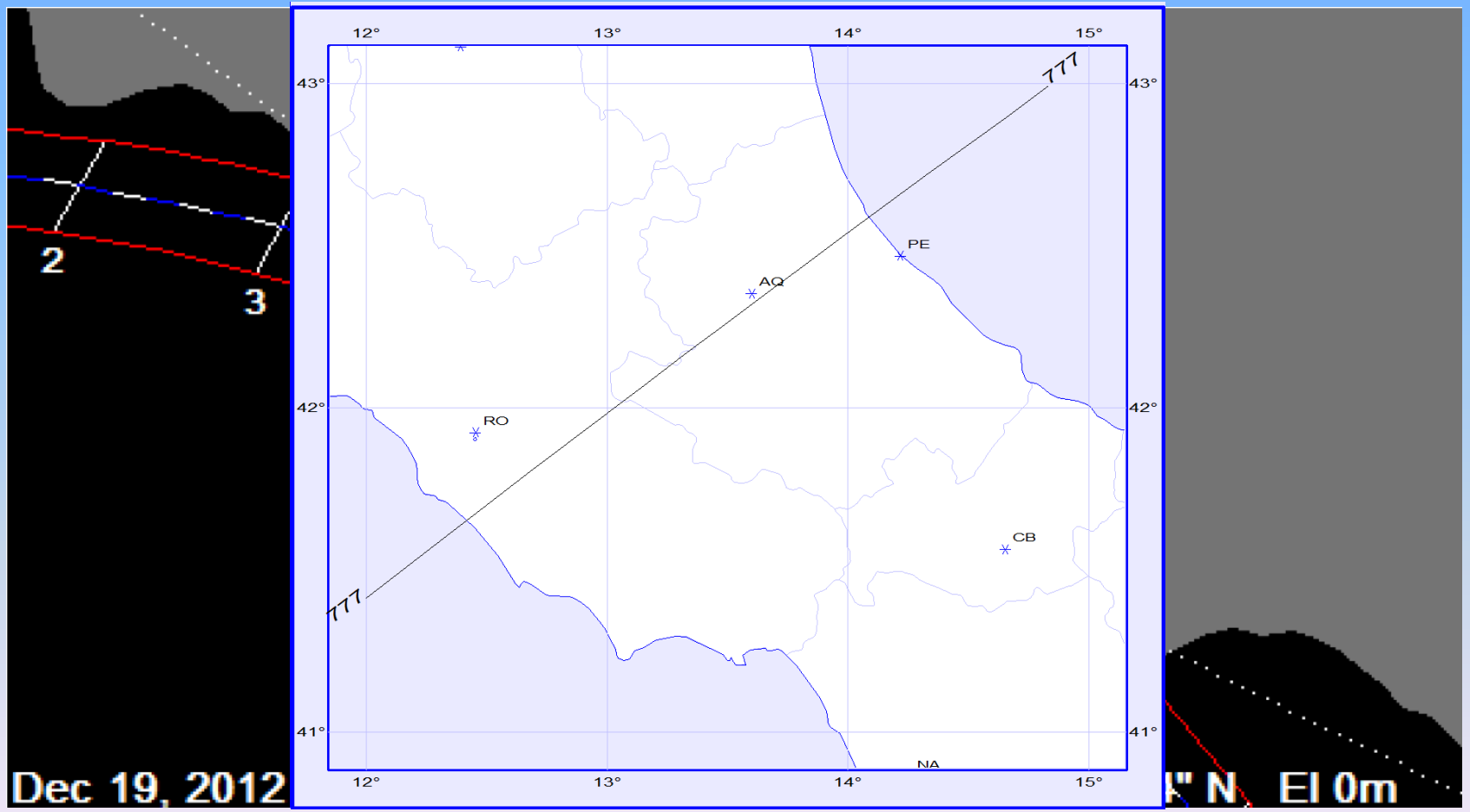


- Selecting and positioning the observing teams
  - according to equipment (video equipment to critical positions)
  - according to experience (beginners in the middle)

Grazing Occultations of Stars by the Moon

3. Selecting the station coordinates relative to the profile

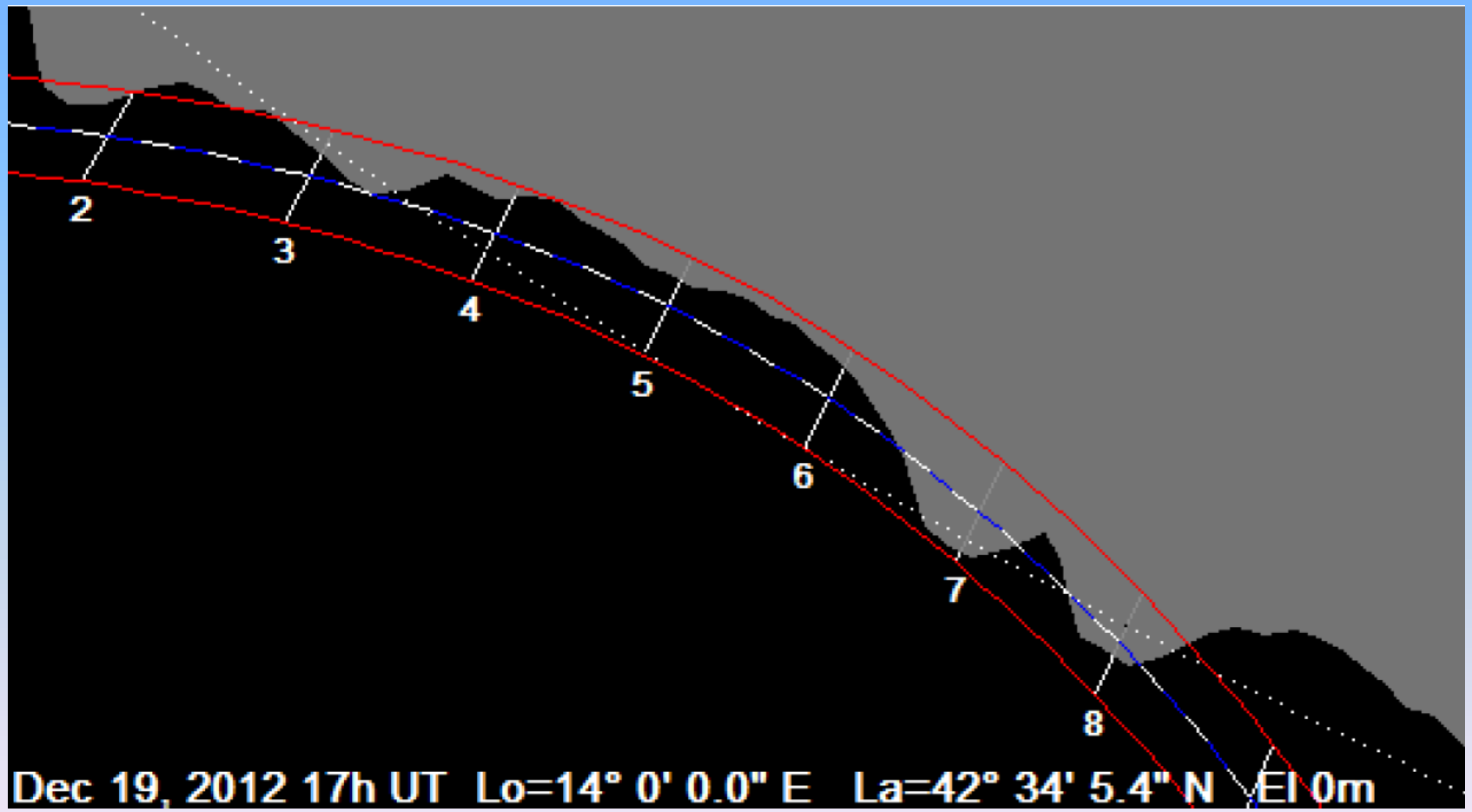
- The data precision we have now allows to explore the edges



Grazing Occultations of Stars by the Moon

3. Selecting the station coordinates relative to the profile

- The data precision we have now allows to explore the edges



Grazing Occultations of Stars by the Moon

3. Selecting the station coordinates relative to the profile

- The data precision we have now allows to explore the edges