Simulation of optical response for next-generation single-reflector LLR targets

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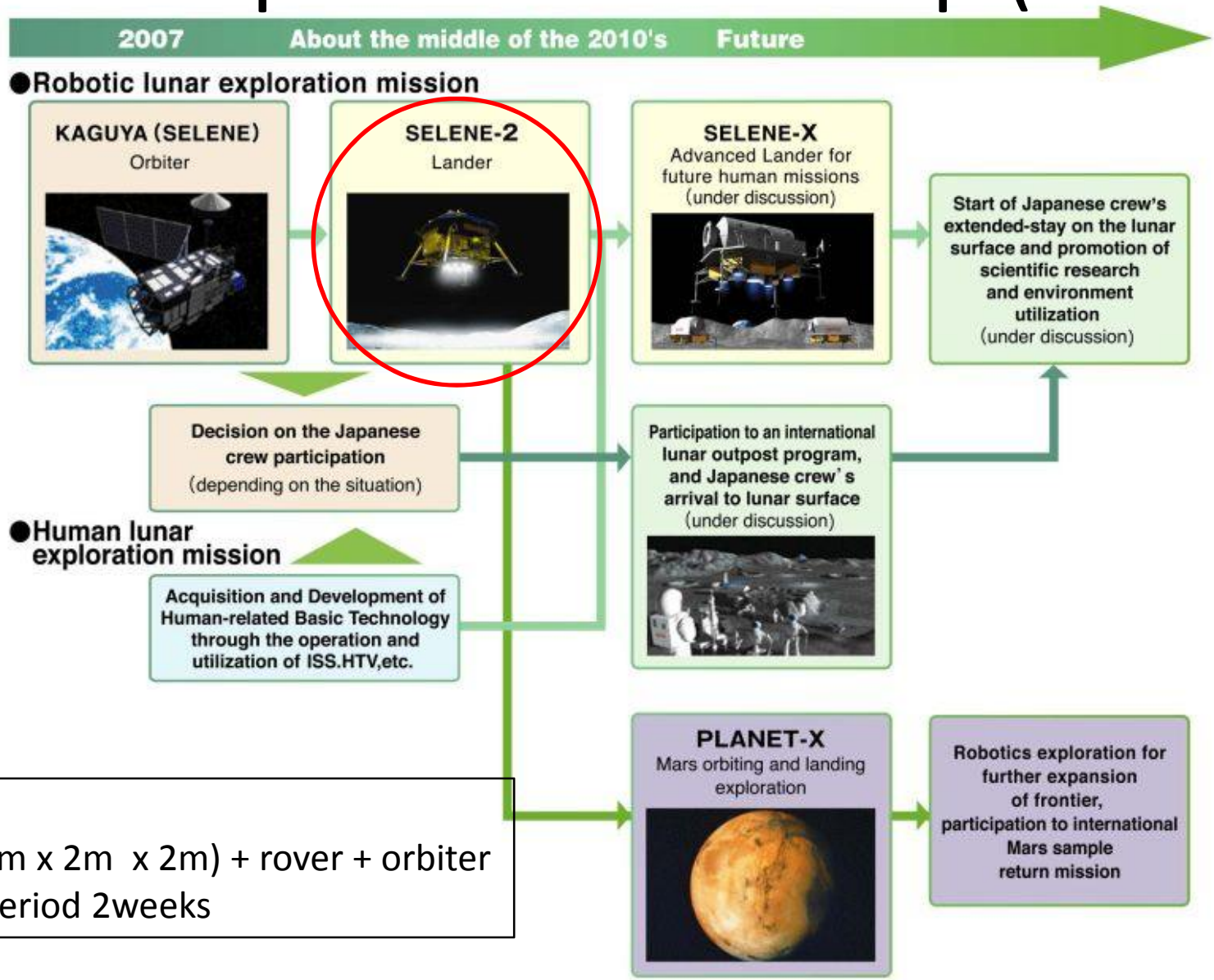
17th International Workshop on Laser Ranging, 16-20 May, 2011.

(http://www.jspec.jaxa.jp/e/enterprise/moon.html)

Lunar exploration roadmap (JAXA)



SELENE-2
Lander (4m x 2m x 2m) + rover + orbiter
Mission period 2weeks

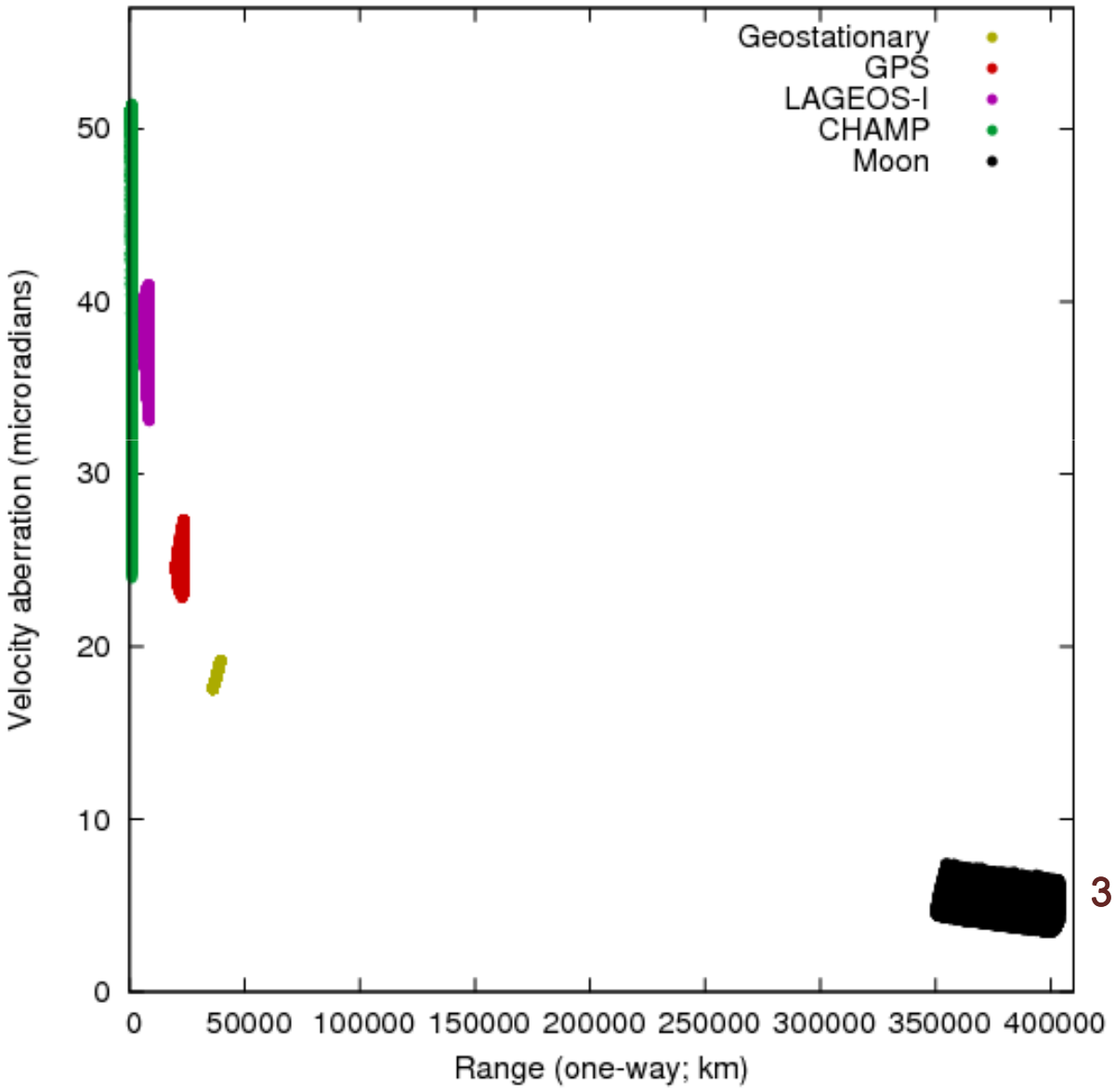
SELENE2 status

- Mission for landing demonstration + sciences
- pre-project phase
  - 2008 call for payloads
  - 2010-11
    - Selection of model payloads
    - Selection of landing site(s) candidates
  - FY2011 proposal to be a project

  …
  - FY2016? Launch

Velocity Aberration from SLR to LLR

From 18.6 Year's data for the Moon



3.5 to 7 microrad

Velocity Aberration in LLR

Velocity Aberration

$= 2\, v \sin \phi / c$

Motion of the Moon

~ 1 km/s

V. A. Maximised

~ 7 microrad

V. A. Minimised

~ 3.5 microrad

Earth Rotation

< 0.5 km/s

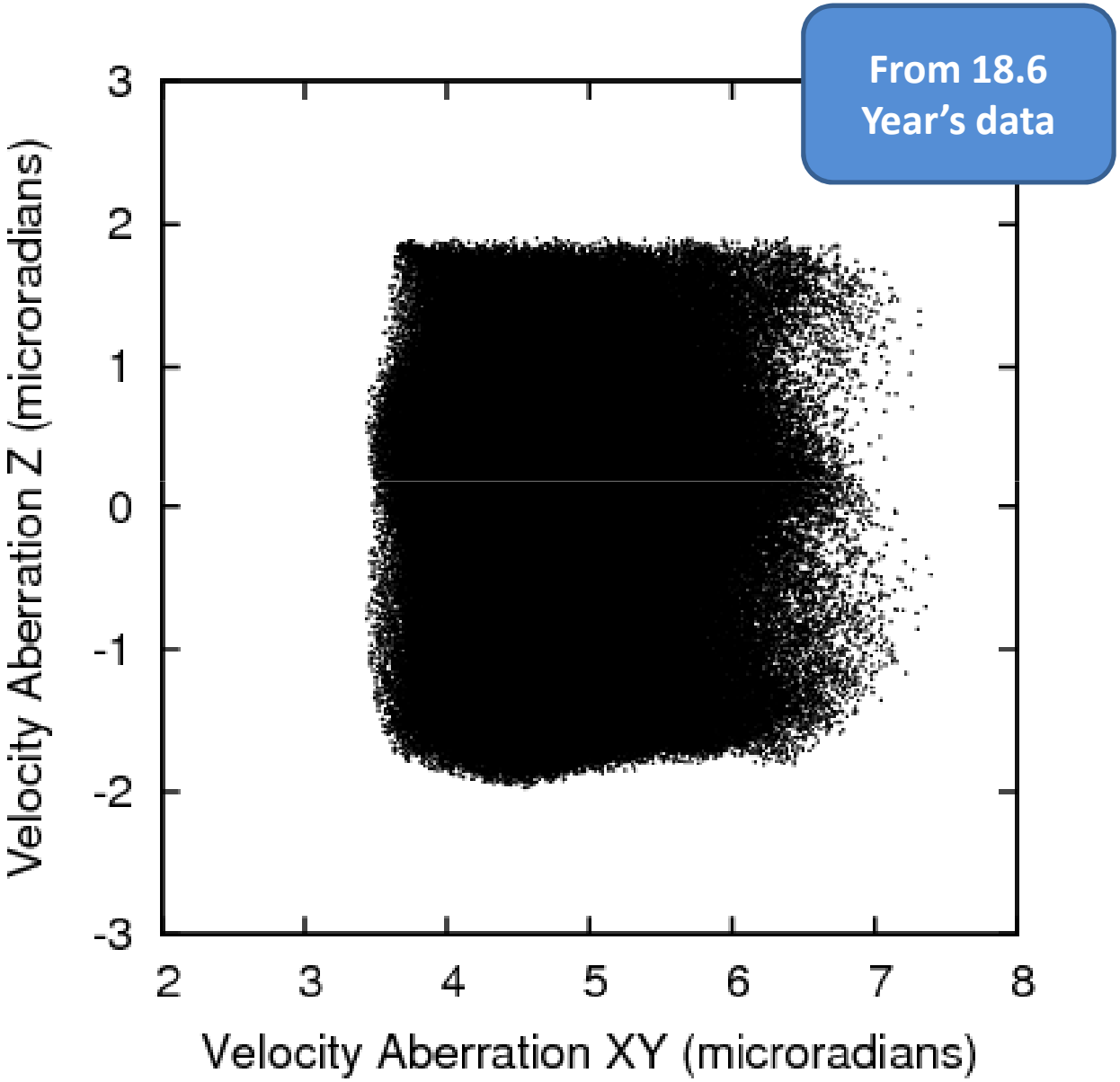
V. A. Maximised

~ 7 microrad

Velocity Aberration from Lunar LRA

2-D graph

Z = parallel to Moon's z axis



Velocity Aberration from Lunar LRA

2-D graph

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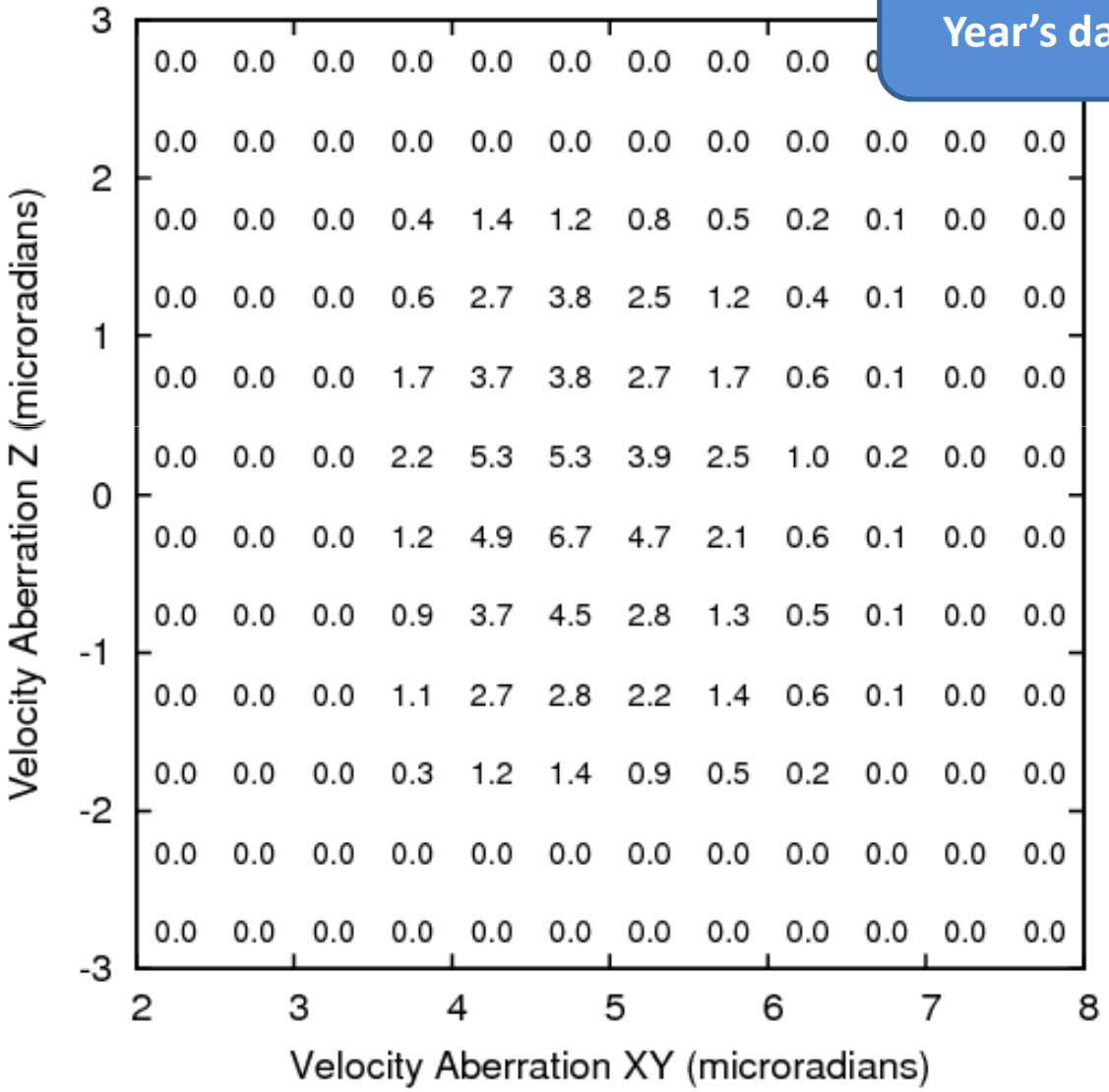
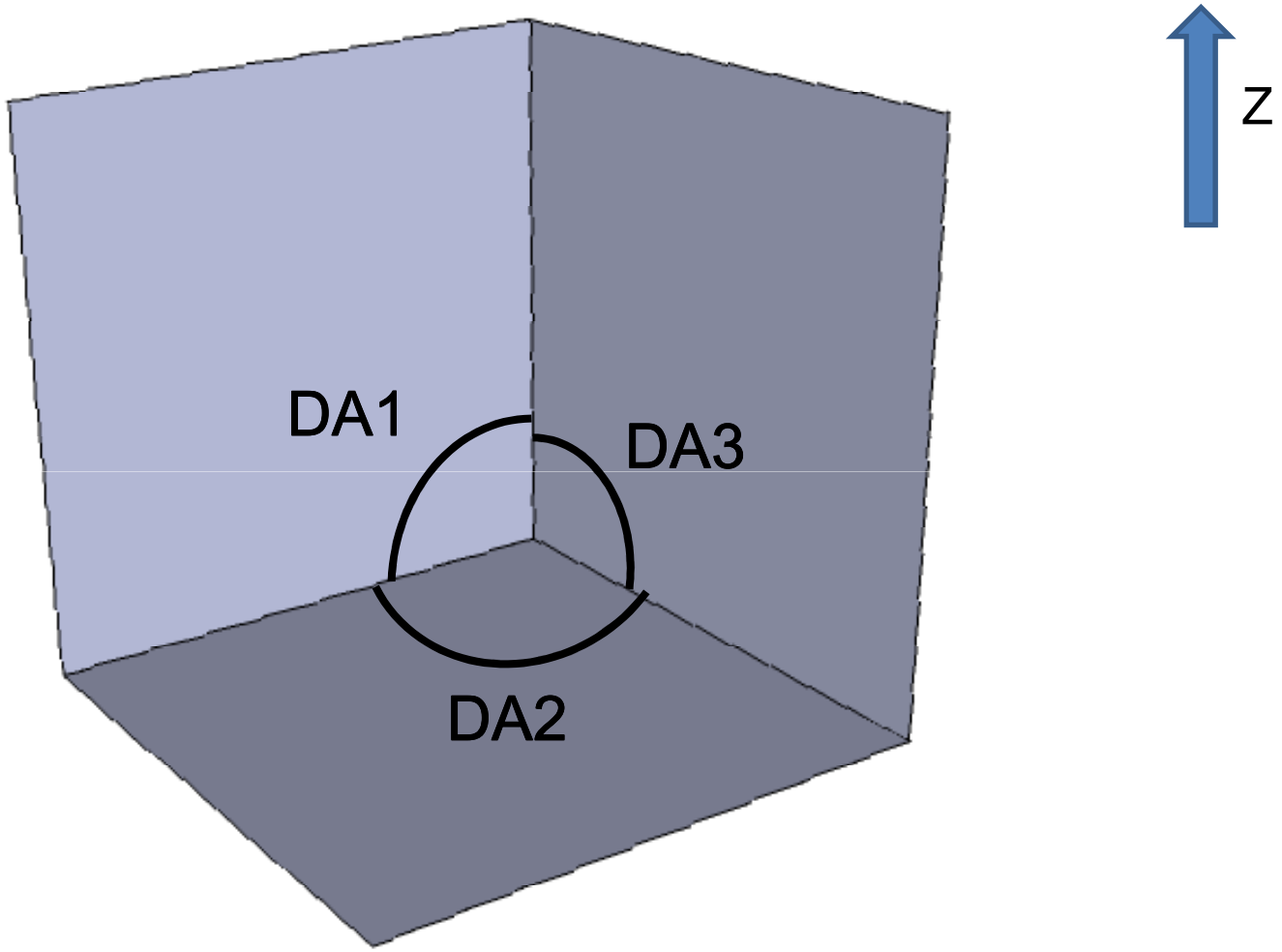


Use this percentage for weighting

Dihedral Angle 1-2-3: Definition



Case 1: DA1 = DA2 = DA3

Case 2: (DA1 = DA3) ≠ DA2

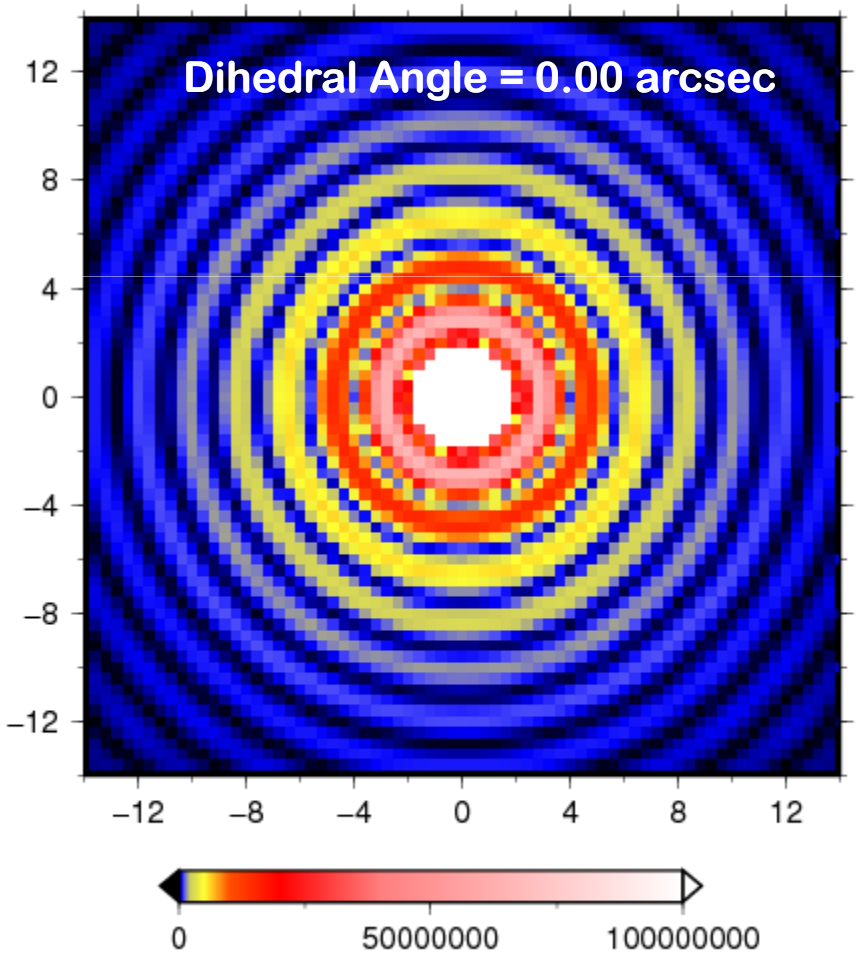
Far-field diffraction pattern: Case-1

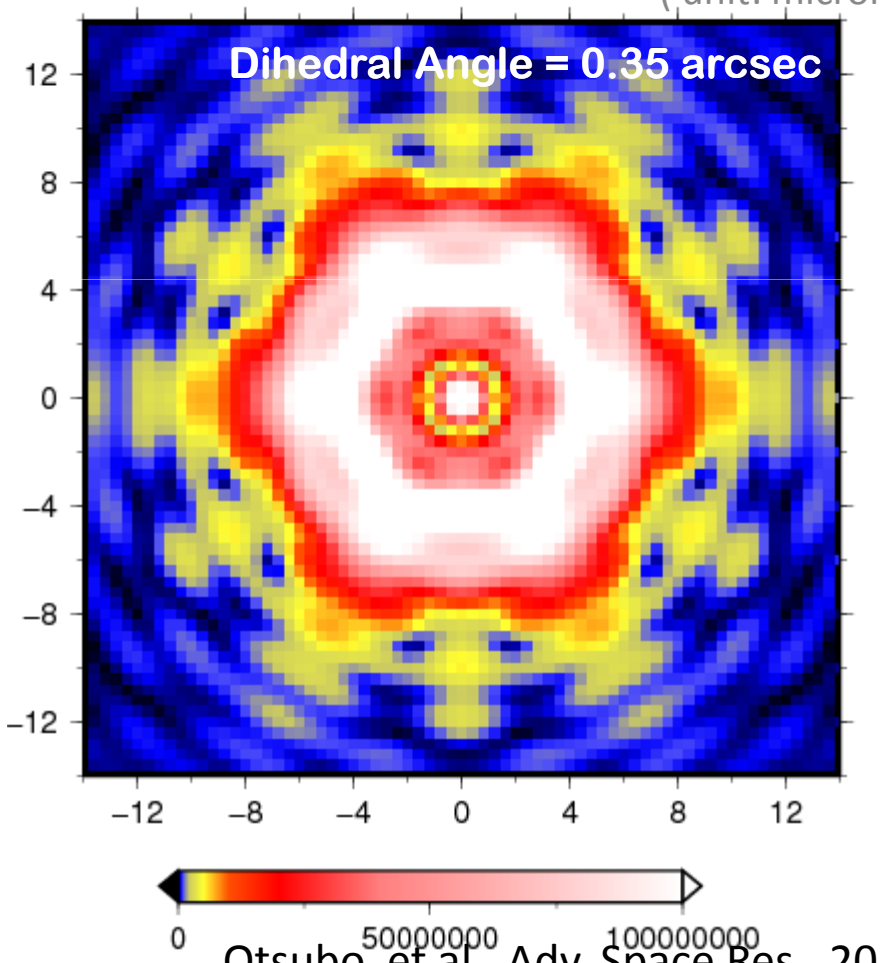
Possible LLR retroreflector (Circular front face 200 mm , Hollow type)

V. A. for LLR = 3.5 to 7 microrad

Wavelength = 532 nm, Linear polarization, Angle of incidence = 0

(unit: microrad)





Otsubo, et al., Adv. Space Res., 2010.

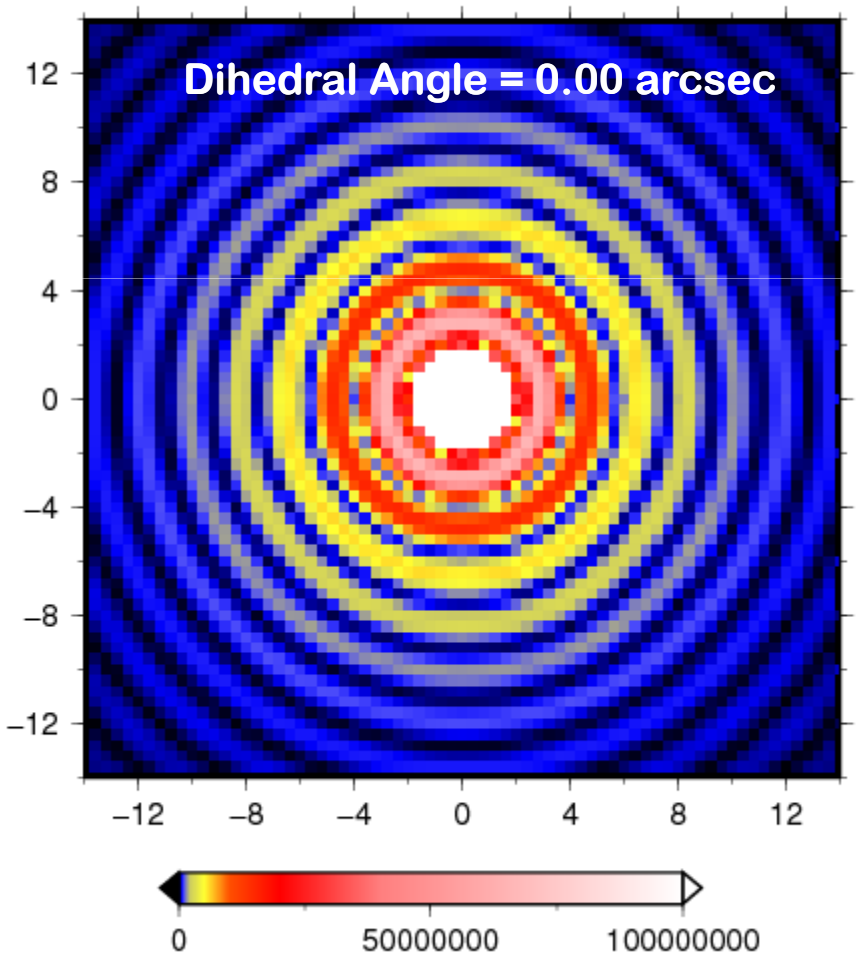
Far-field diffraction pattern: Case-2

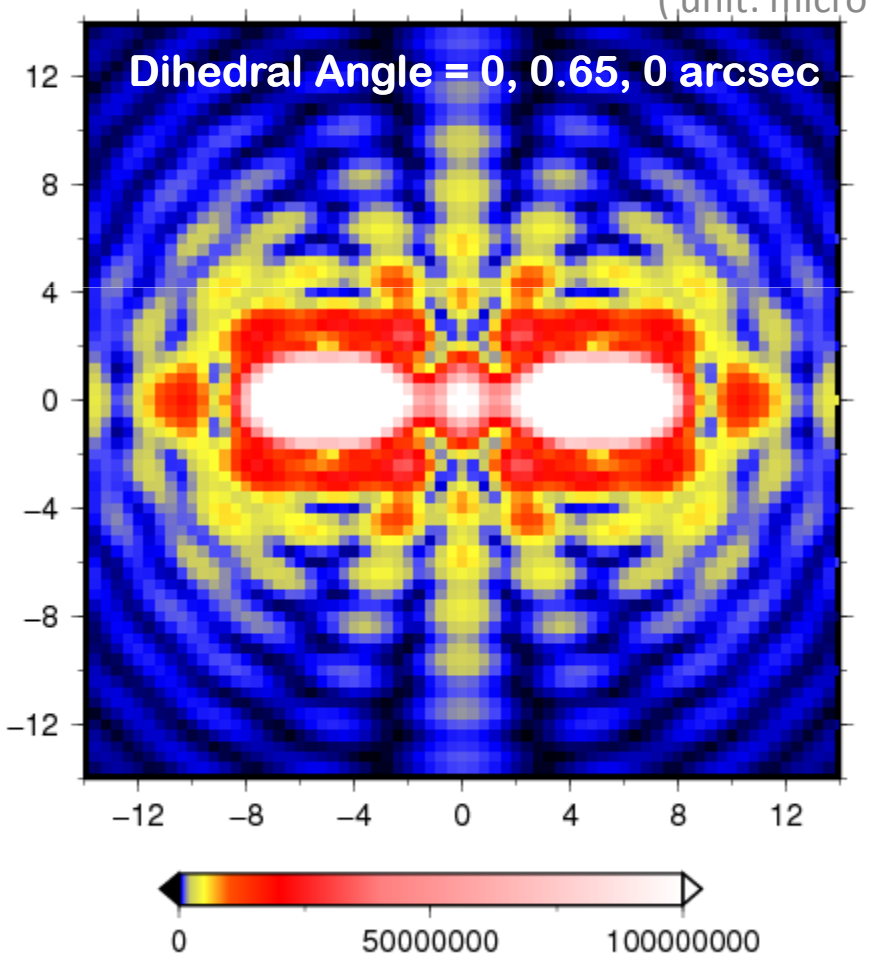
Possible LLR retroreflector (Circular front face 200 mm , Hollow type)

V. A. for LLR = 3.5 to 7 microrad

Wavelength = 532 nm, Linear polarization, Angle of incidence = 0

(unit: microrad)





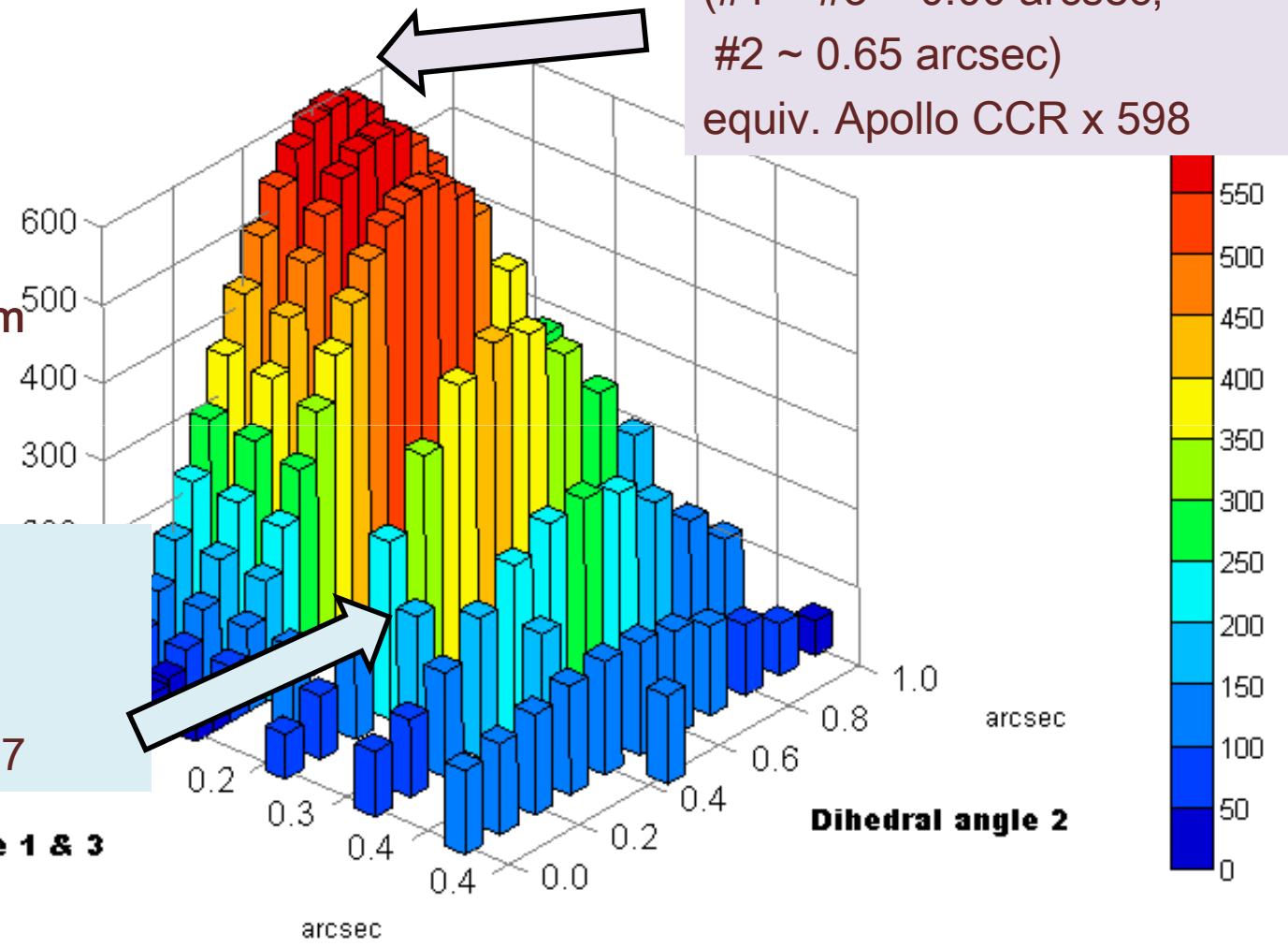
Best dihedral angle? D = 200 mm

Search for the best dihedral angle

Circular front face
Hollow type
Diameter = 200 mm
Wavelength = 532 nm

Case 2 Best (tentative)
(#1 = #3 = 0.00 arcsec,
#2 ~ 0.65 arcsec)
equiv. Apollo CCR x 598

Case 1 Best
(#1 = #2 = #3
~ 0.30 arcsec)
equiv. Apollo CCR x 177



Summary & Future studies

LLR Retroreflector: asymmetric dihedral angle performs best

- Angle of incidence (2D) x Velocity aberration (2D)
- Dihedral angle = [0.0, approx 0.6-0.7, 0.0] arcsec works best for large retros
- Approx. 4 times stronger than the best symmetric dihedral angle [0.3, 0.3, 0.3]

Computer simulation vs Reality

- Critical esp for large retros
- Manufacturing error
- Severe environment on the Moon