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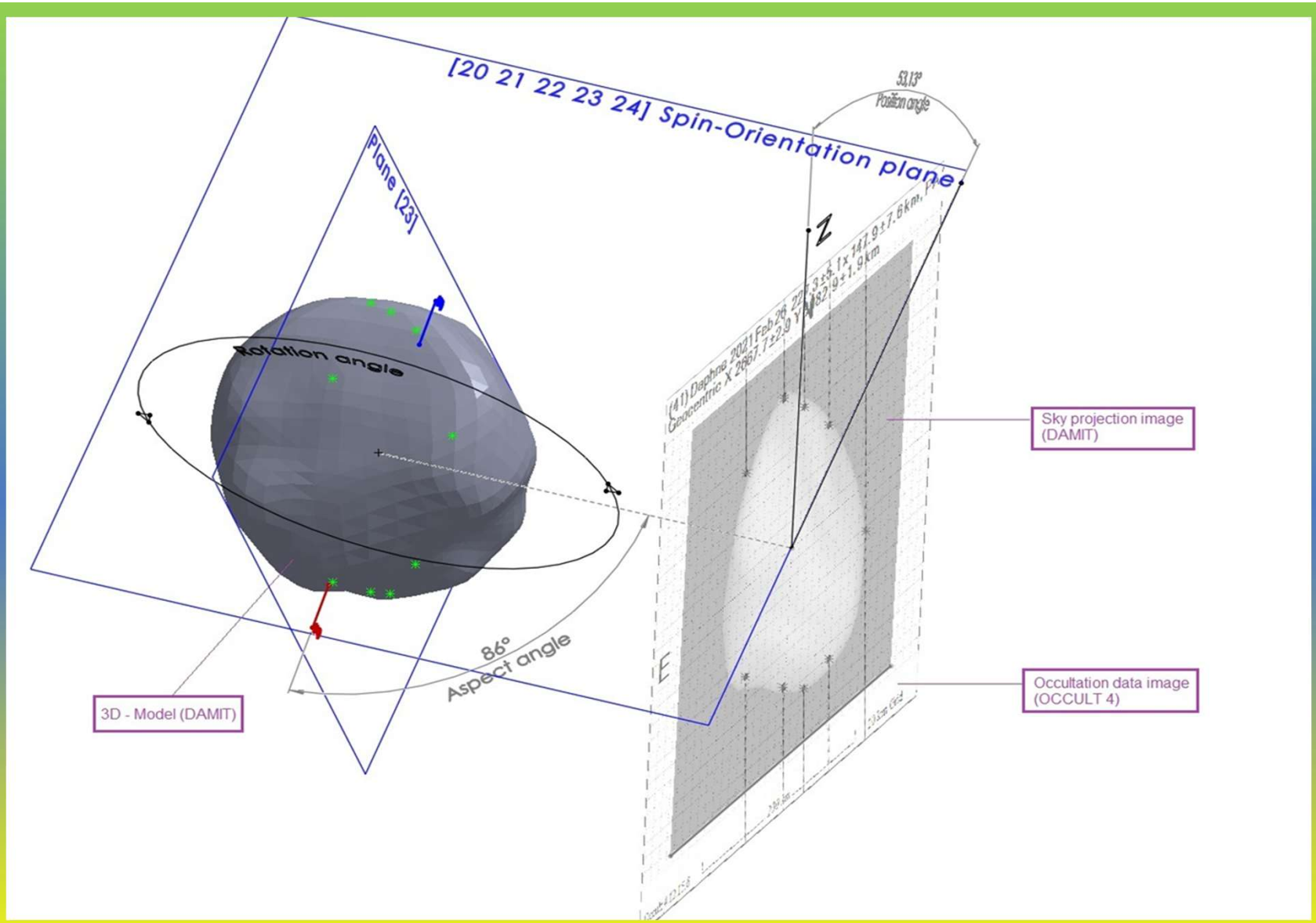
Improvement in VAMOR process

VAMOR – validation of asteroid modells by occulation results

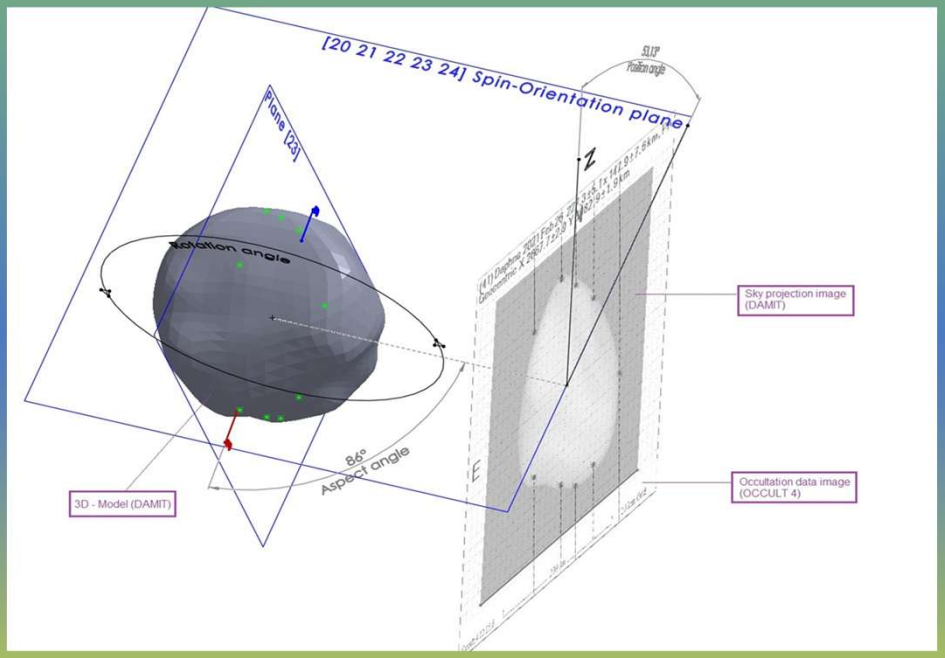
how VAMOR works:



how VAMOR works:

Both 2D-images and the 3D-model in the same virtuel space.

The 3D body is in a precise viewing position (by rotating and tilting the spin axis) "behind" the 2D-images in same scale.

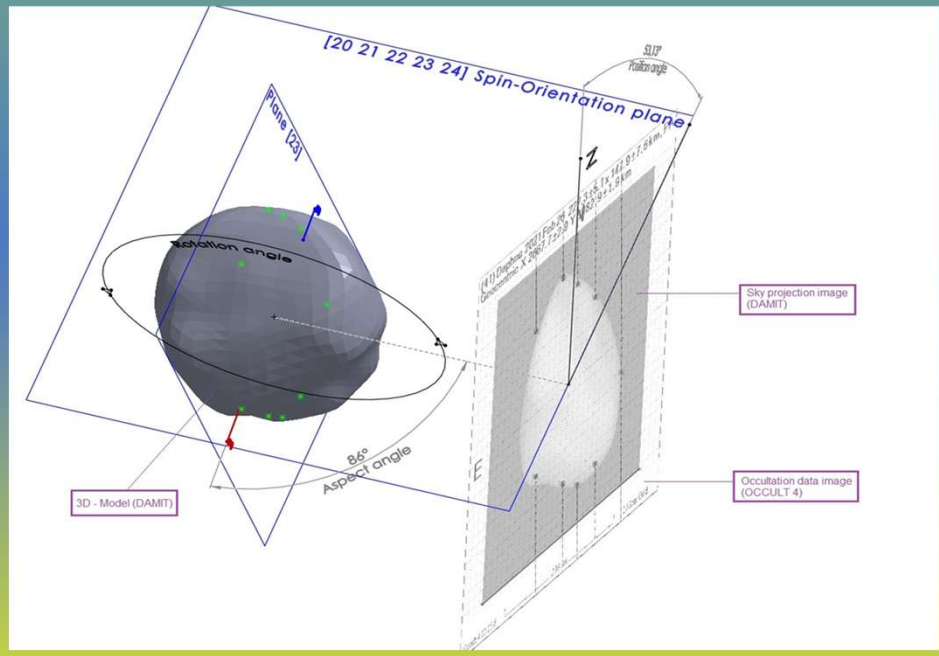


Parallel shifting of the measuring points from the plane of the 2D-image to the center plane of the body.

how VAMOR works:

<u>Present method:</u>

Parallel shifting of the measuring points to a plane that passes through the center of the body is only correct for near spherical shapes (more regular bodies).

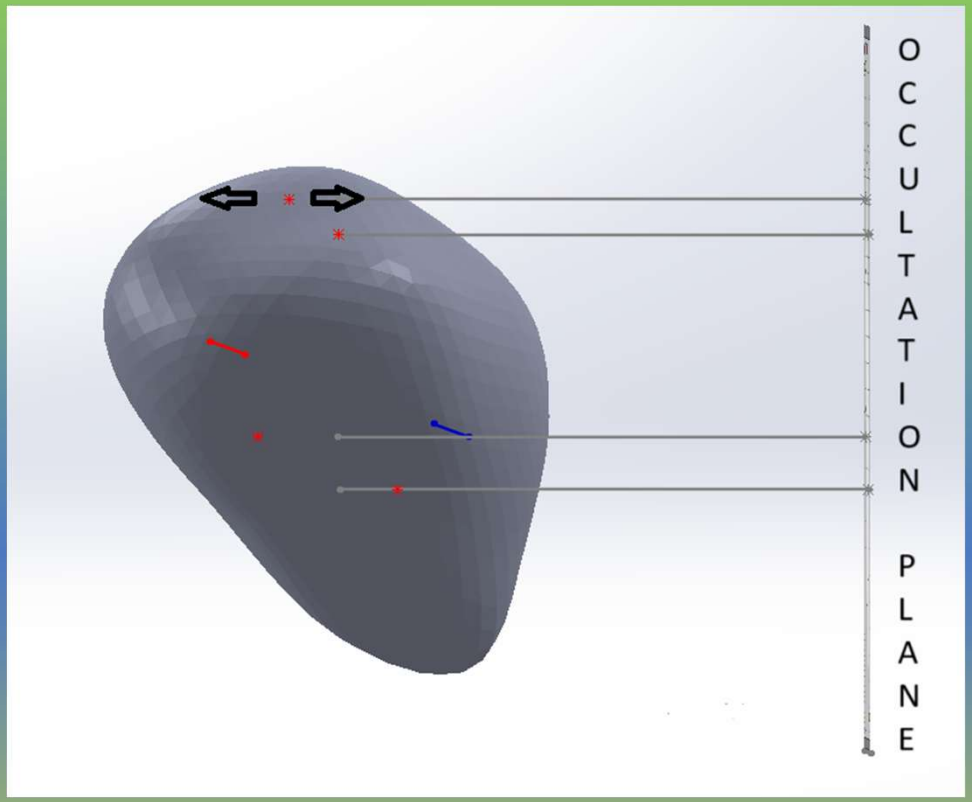


how VAMOR works:

<u>Further developed method (VAMOR +):</u>

The measuring points are free positioned up to the closest distance from the body.

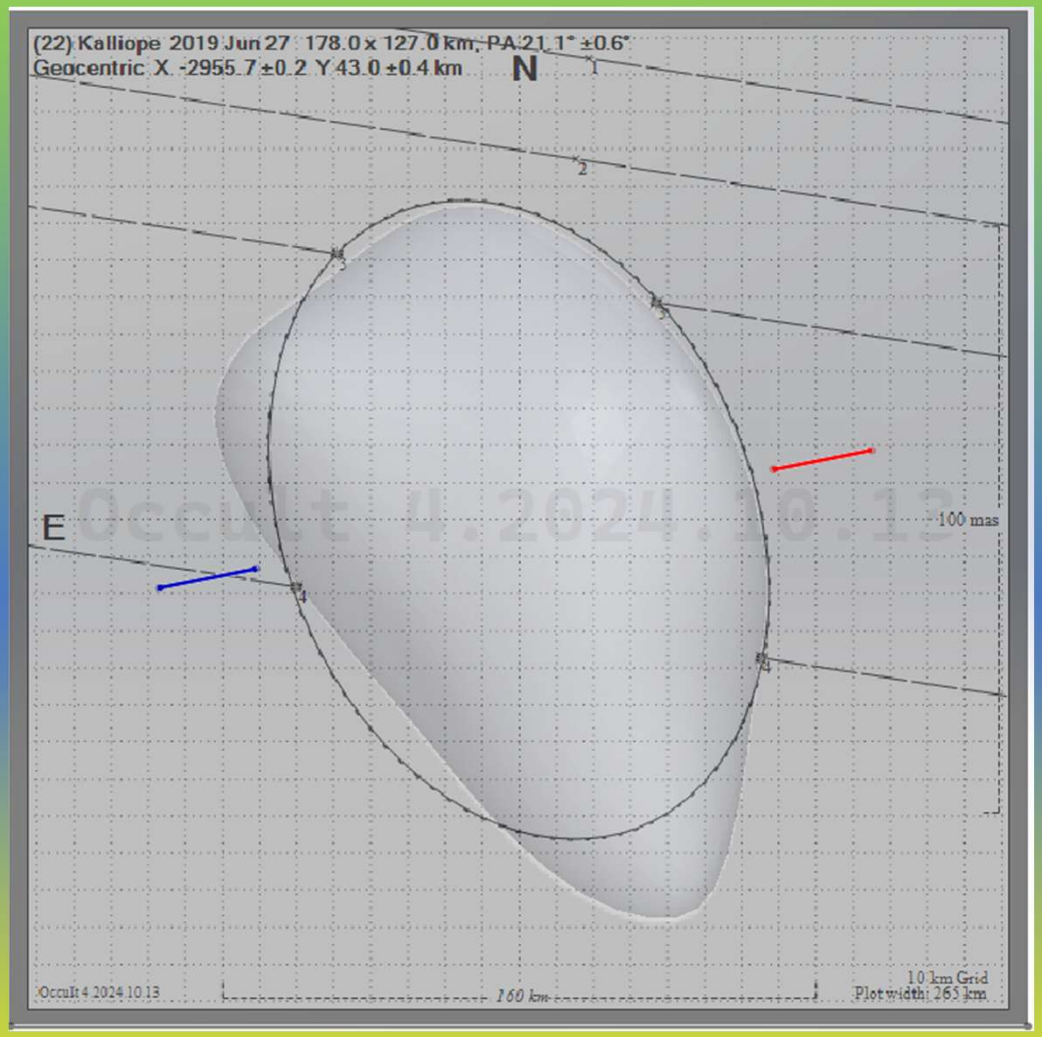
This allows the data point to be positioned on the body where the event was most likely measured.



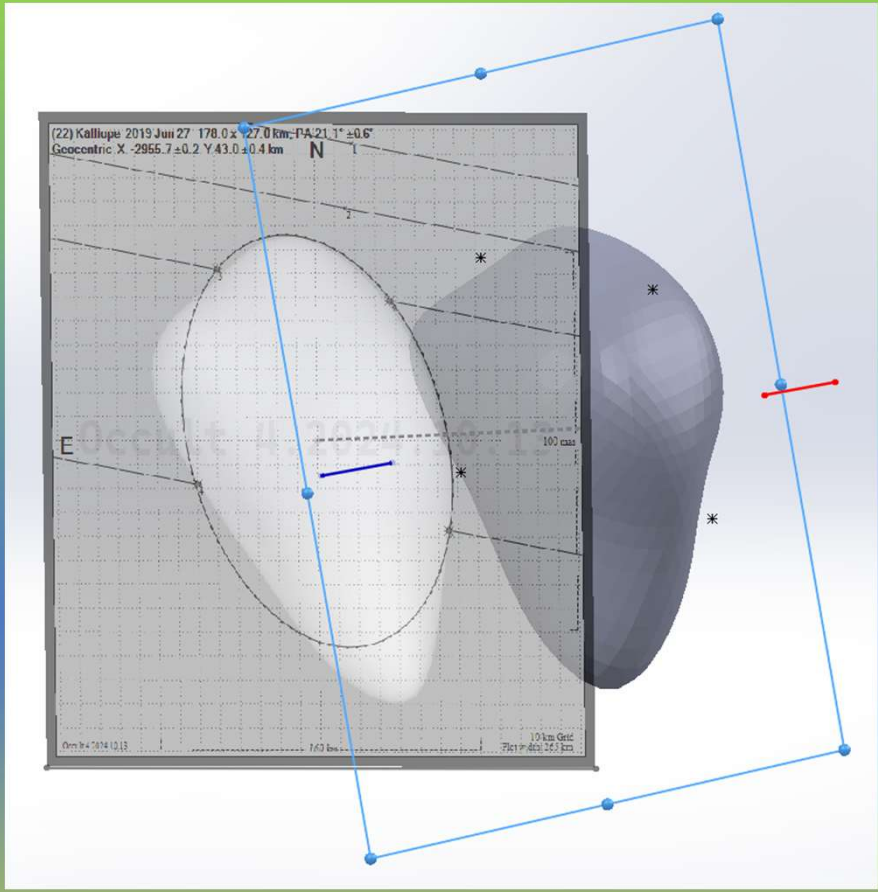
The data points are not positioned on the center plane anymore but can be freely positioned up to the closest distance.

changing:

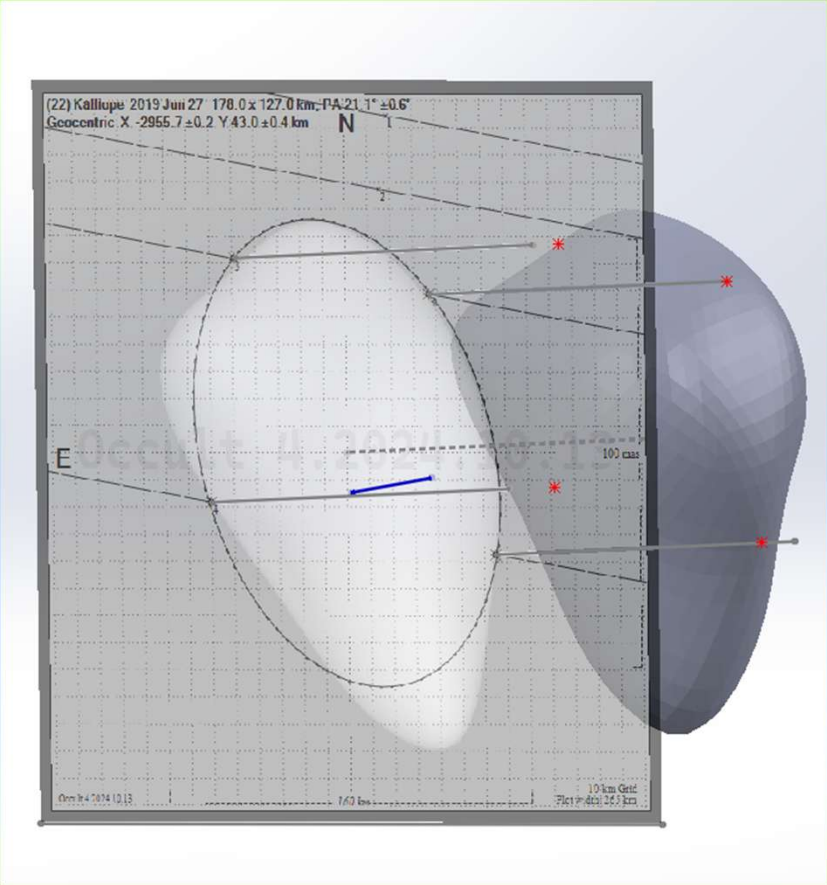
Event 9, Observer John Broughton (AU) (4 station), observation points fits well the modell



changing:



VAMOR: Distance points to body:
6,18 km, 4,74 km, 5,92 km and 2,55 km
mean: 4,85 km
RMS: 5,05 km
scale: 100% (DAMIT)



VAMOR+: Distance points to body:
4,07 km, 2,55 km, 0,91 km and 0,37 km
mean: 1,98 km
RMS: 2,45 km
scale: 100% (DAMIT)

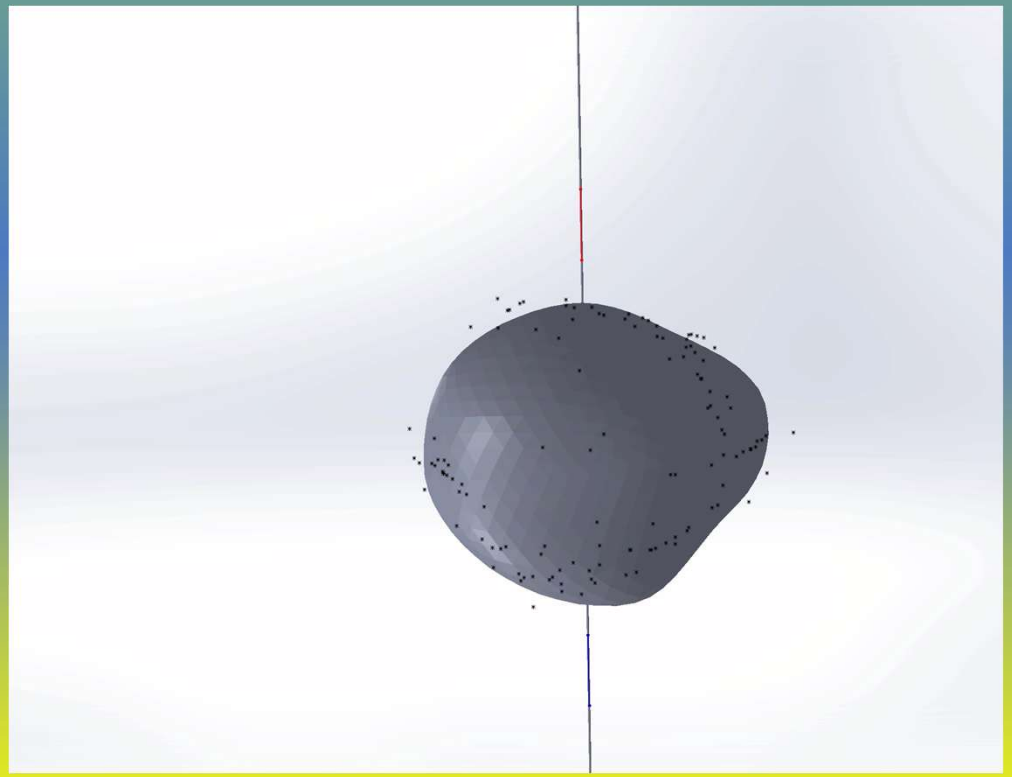
To test the method we select a long elongated planet with a well known 3D model: (22) Kalliope

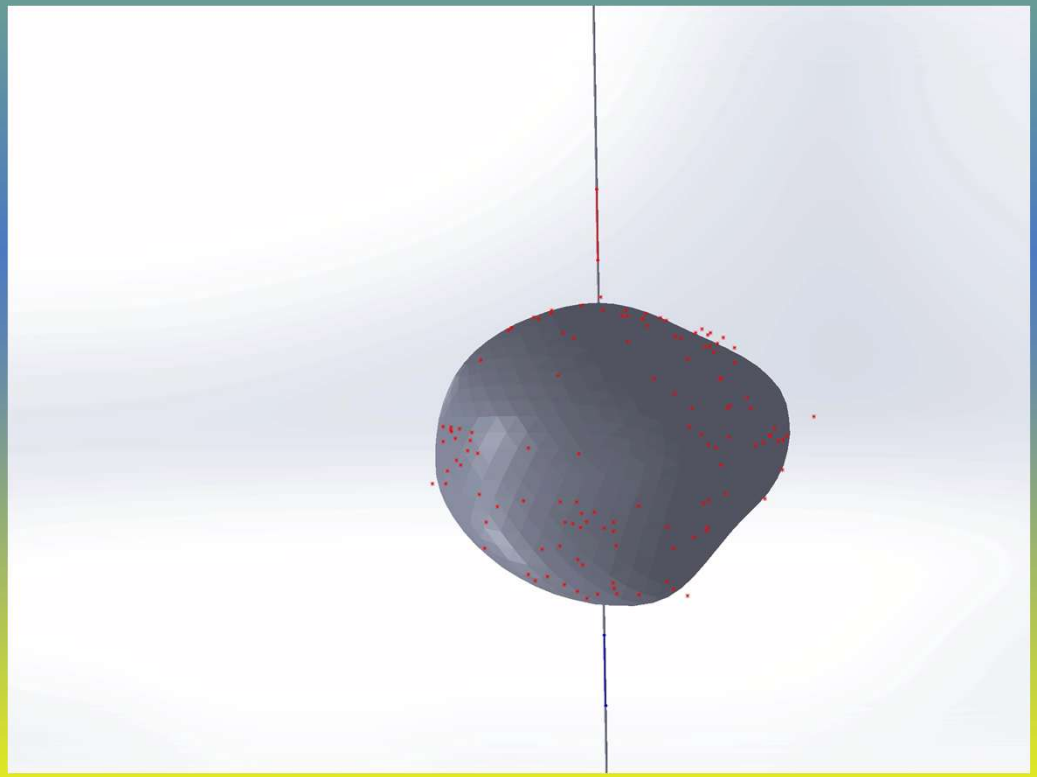
128 contacts (data points) average distance to body

VAMOR: 4,19 km **VAMOR+:** 2,89 km
(scaling 100% both)

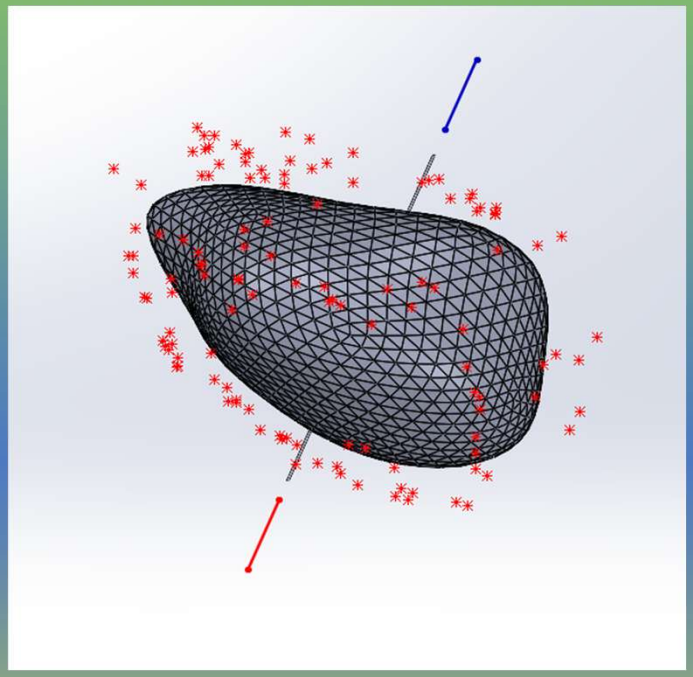
To test the method we select a long elongated planet with a well known 3D model: (22) Kalliope

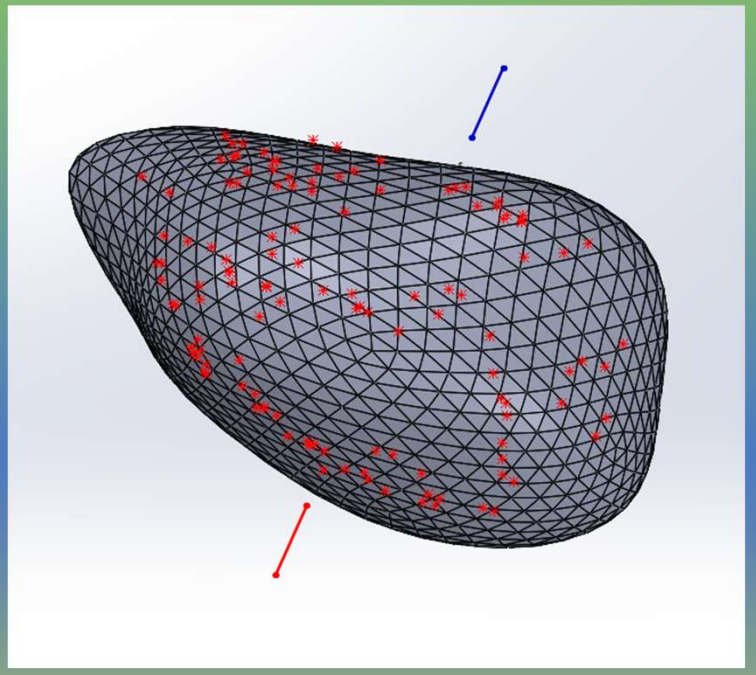
128 contacts (data points) on body





tool VAMOR



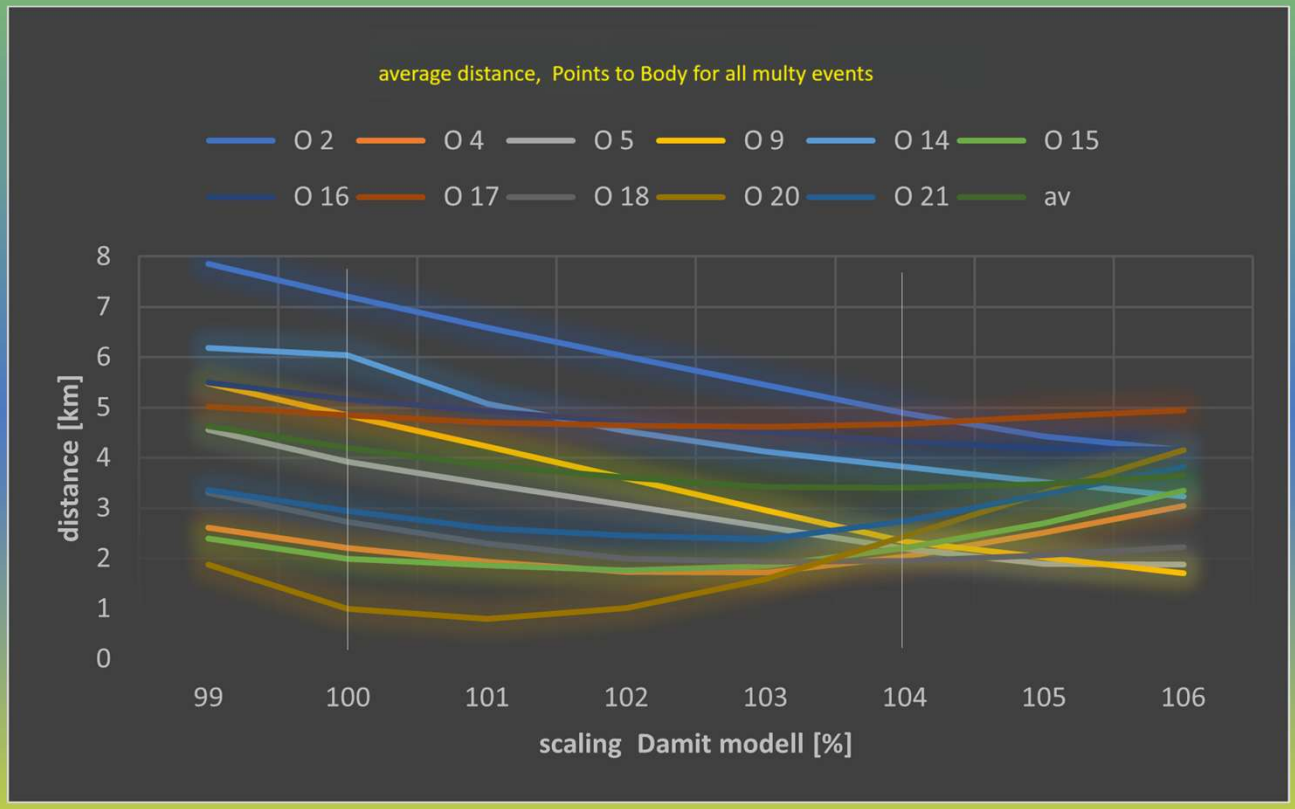


(22) Kalliope (16282) scaled with 80% and 120%. Data points remain in their position in the coordinate system

The body model can be scaled within the 3D graphic.

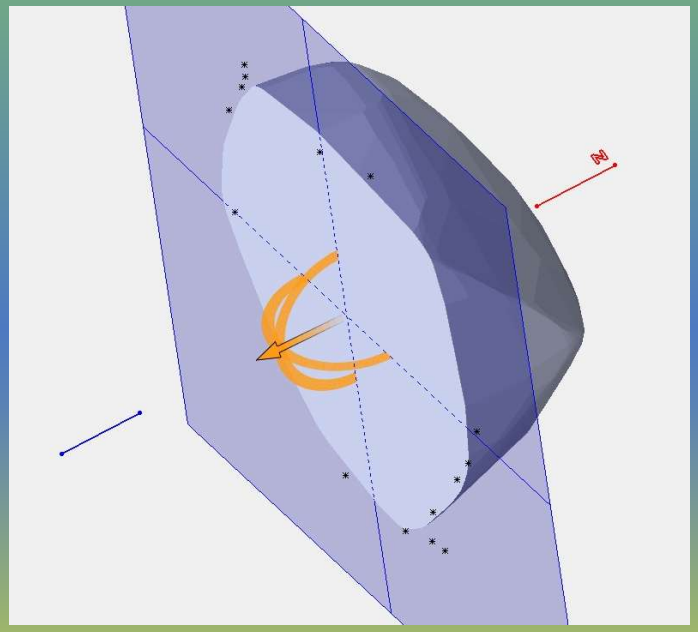
To test the method we select a long elongated planet with a well known 3D model: (22) Kalliope

Scaling of (22) Kalliope:
Diameter by best fit:
104%

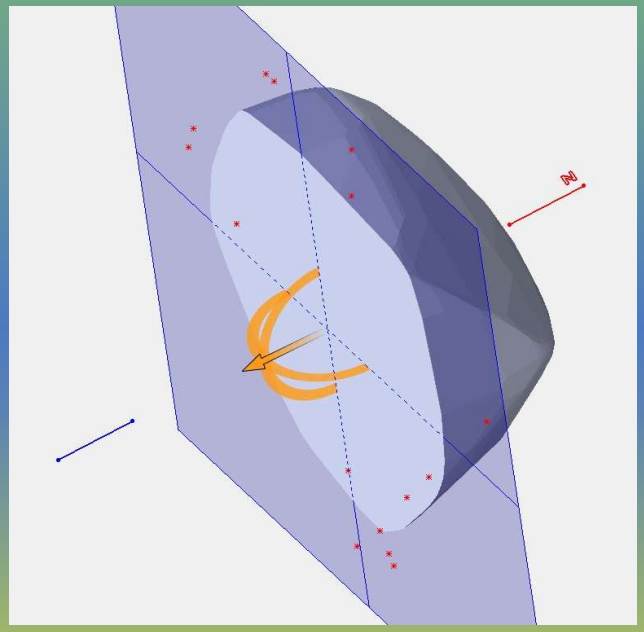


minimum@ scaling 104% → D_{vol}= 157.5 km (Damit 151.4 km; Neowise 167.5 km)

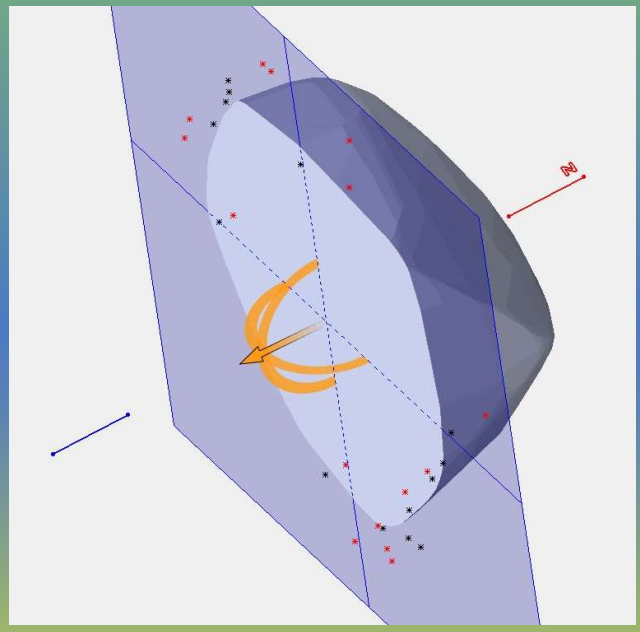
How is the difference of both methods for not long elongated bodies?
Example (357 Ninia):



Event 3 VAMOR present

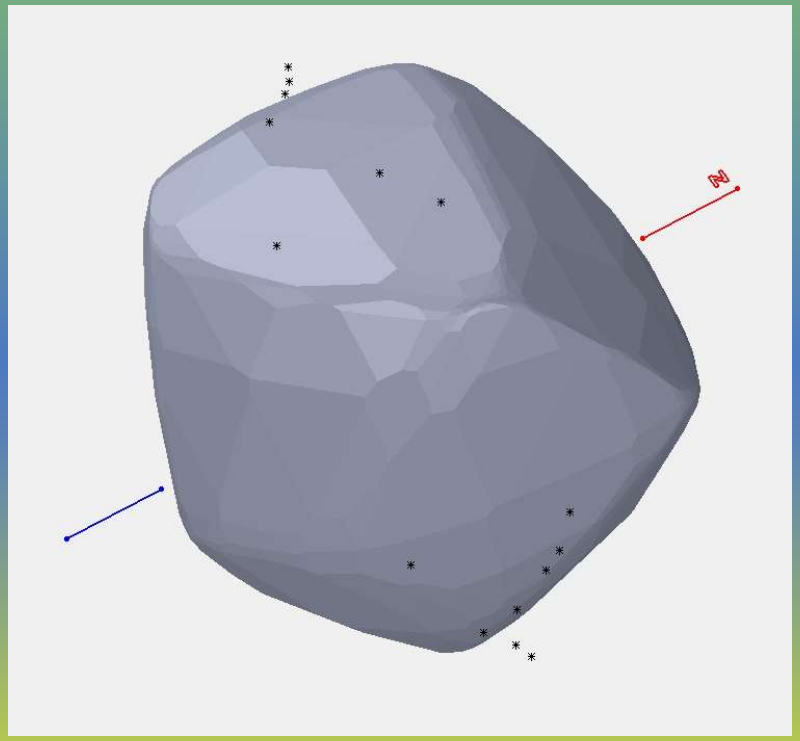


Event 3 VAMOR+ improved

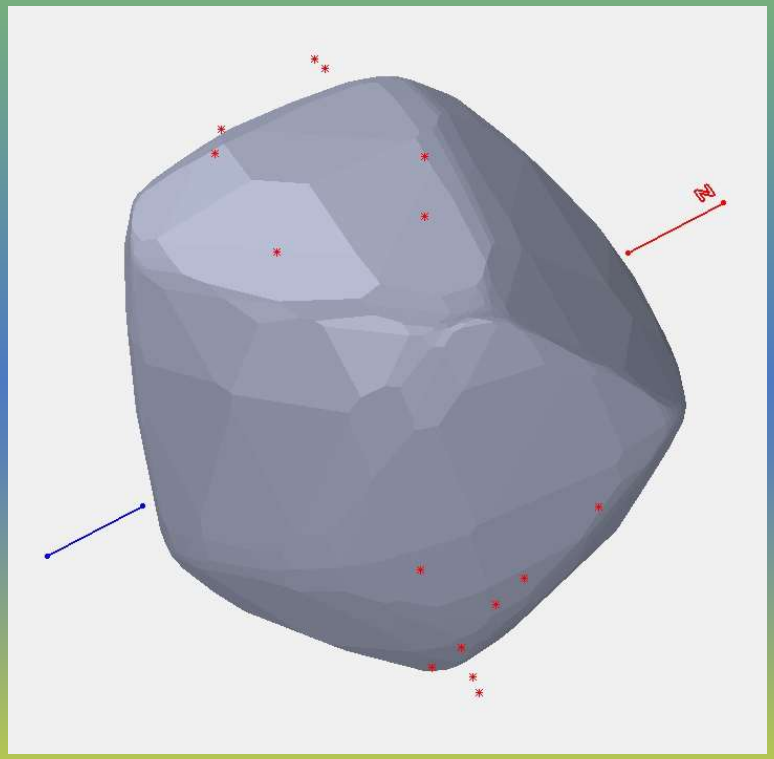


Event 3 both methodes

How is the difference of both methodes for not long elongated bodies?
Example (357 Ninia):

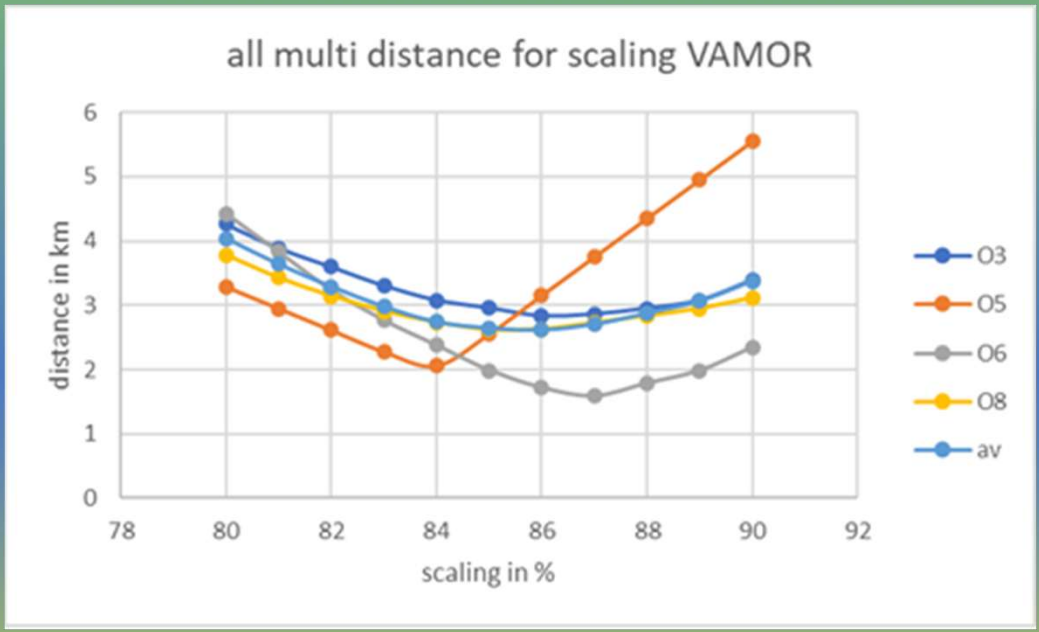


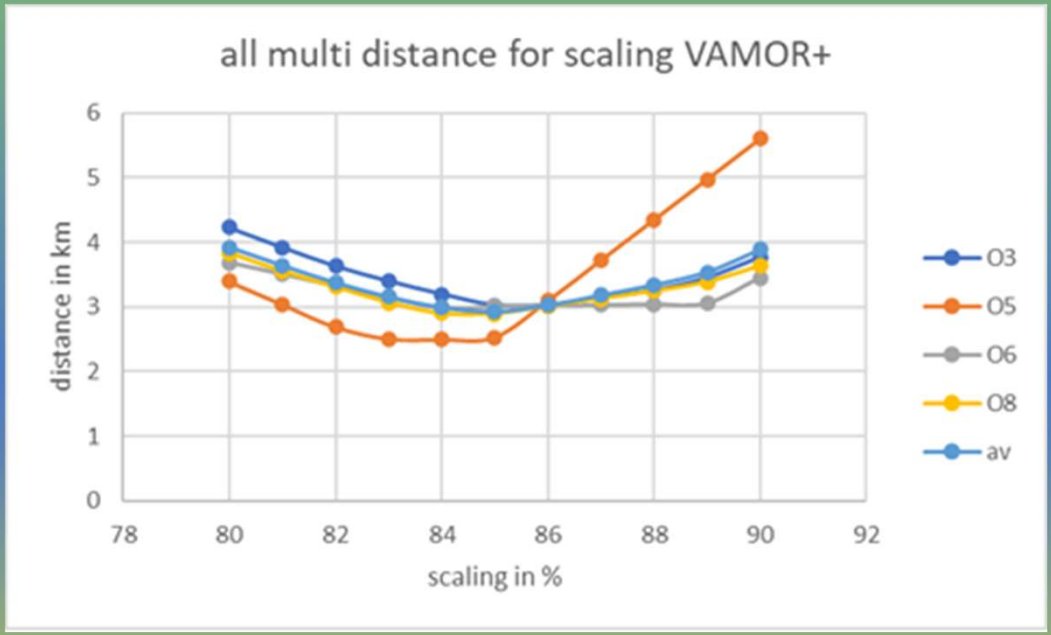
Event 3 VAMOR



Event 3 VAMOR+

How is the difference of both methodes for not long elongated bodies? Example (357) Ninia:

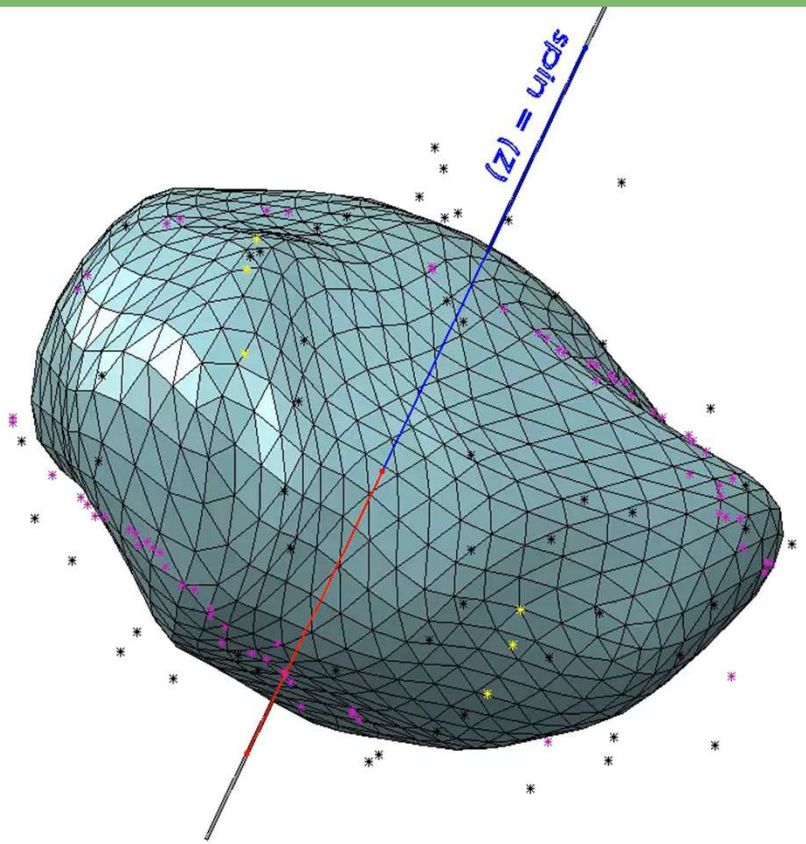




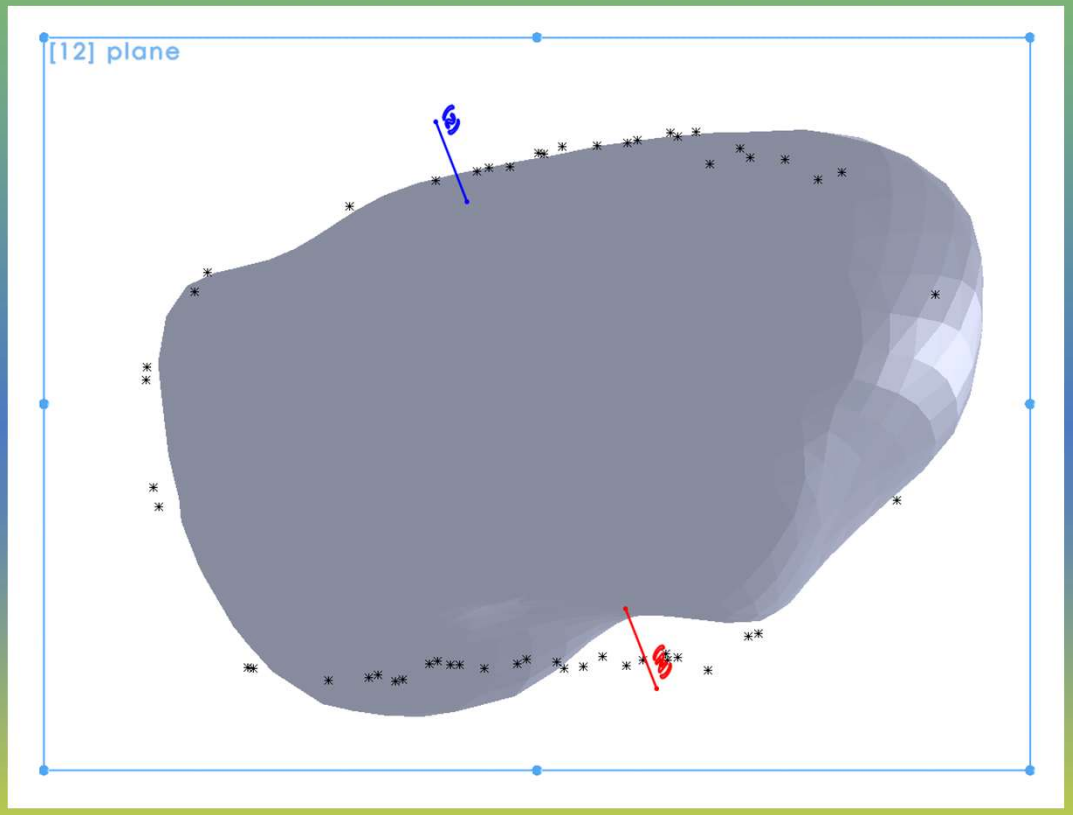
best fit 86%, value 2,61 km RMS 3.36

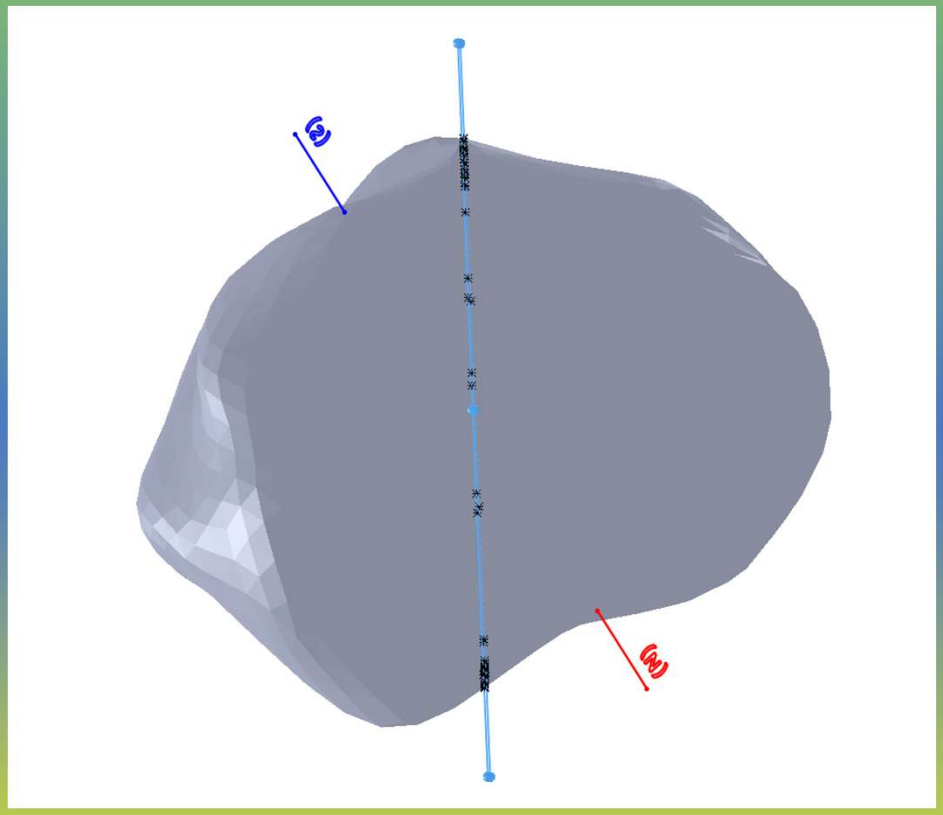
best fit 85%, value 2.92 km RMS 3.64

Body can be exported as a motion study (430) Elektra:



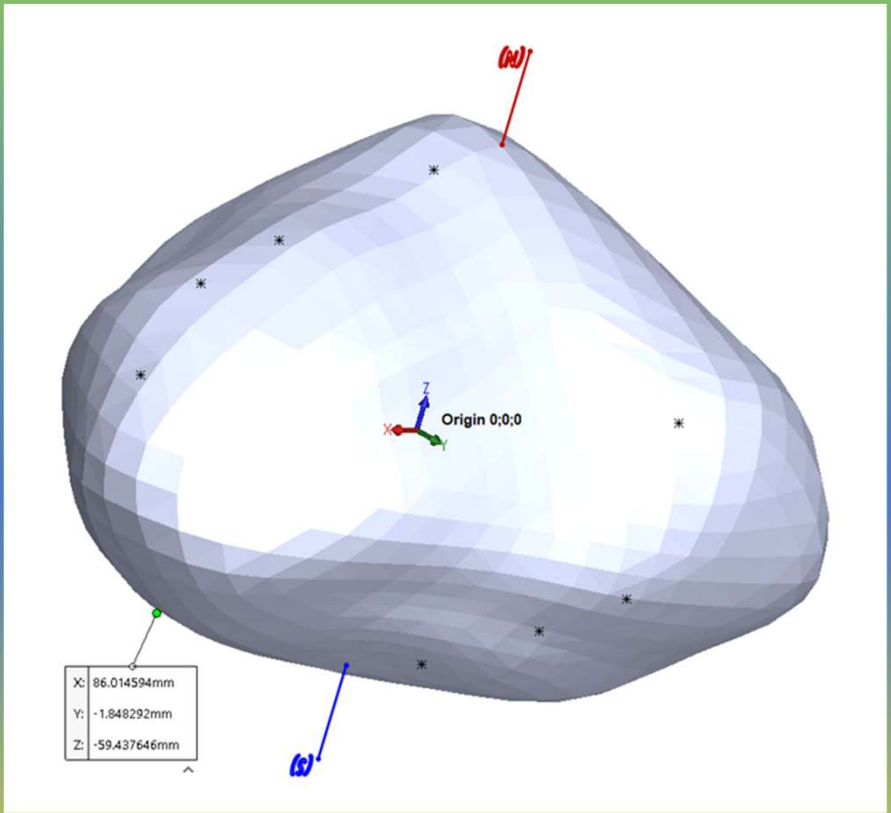
Inconsistency with model:





(130) Elektra; DAMIT 1856 date: 2017-09-21; Observation of 30 chords 2018-04-21

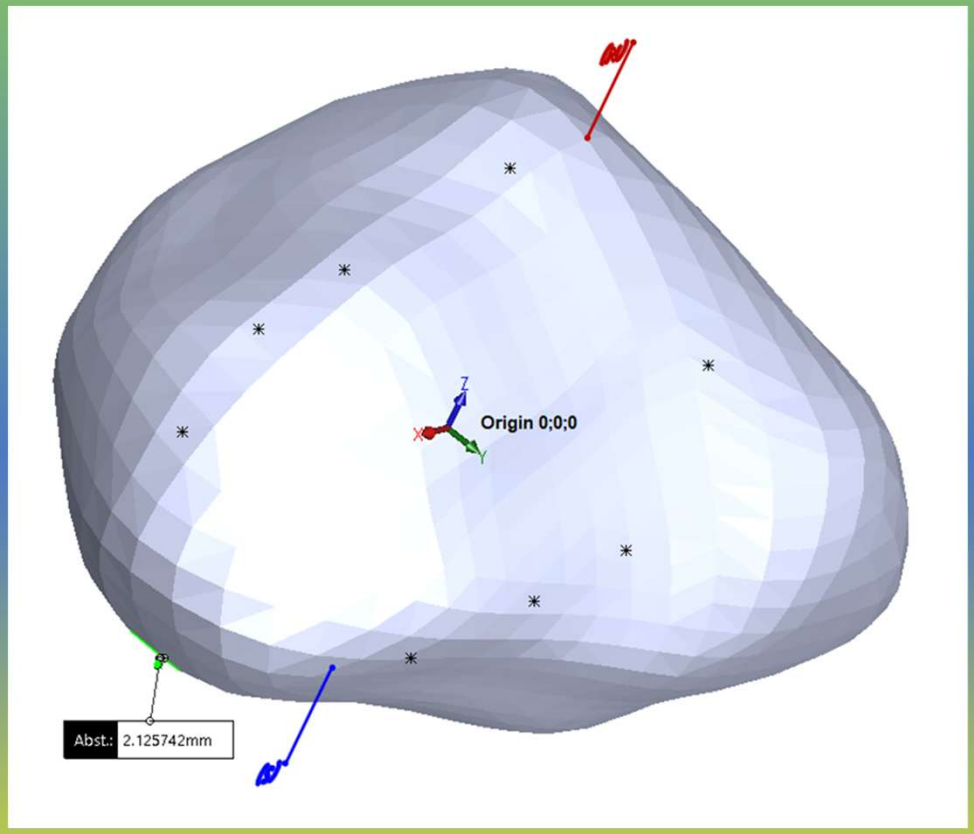
output VAMOR




```
     -80.171767     -51.95379     -39.166028
     -79.425206     -50.658477     -46.39952
     -71.496528     -44.173534     -55.137239
     -61.780727     -38.343839     -46.023505
     -0.641995      8.37518      -82.625319
[22]
     25.096243      -13.671377     -79.571131
     -23.783906      13.118514      79.681621
[23]
     115.429171      -9.017937      13.500377
     100.399287      -9.999298      42.493565
     73.248925      -9.093863      56.661013
     18.014199      -6.873734      80.089207
     -103.854871      6.883995      5.395978
     -100.001539      10.458471     -49.440834
     -68.406833      9.022418      -60.472092
     -24.656796      6.77154      -72.004911
     86.014594      -1.848292      -59.437646
[24]
     51.155329      67.845459      -16.675148
     -50.466704      -66.953868      16.603428
```

The X,Y,Z coordinates can be determined for each transformed measuring point

output VAMOR




```
#[22] *2*
                5,781255
                1,959543
                                3,870399
                                                4,316406
#[23] *9*
                5,613474
                0,204266
                2,533058
                5,444009
                8,588125
                1,463298
                1,691404
                1,306431
                2,125742
                                3,218868
                                                4,117577
#[24] *2*
                1,065445
                9,303801
                                5,184623
                                                6,621778
#  ____________________________________________________________

# Total:                       8,798387        12,579059

                                mean values     RMS
```

The distance to the body surface can be determined for each transformed measuring point.

output VAMOR

```
# (41) Daphne (1793)

# Number of vertices: 902
# Number of faces: 1800
# Number of edges: 2700
# Calculation of Euler's polyhydron theorem = 2  (when 2 then in accordance with the theorem)

# Diameter (volume-based): 187,295 km
# Diameter (surface-based): 193,289 km

 -0,000073                10,775237                 86,923035
 10,752237                0,012047                 88,737221
 -0,000073                0,012047                 90,591125
 -0,000073                -10,927783                 92,601799
 -10,980663                0,012047                 89,148842
 14,960337                -14,230153                 89,421906
```

The volume-based and surface-based diameter of the body model can be calculated.

output VAMOR

- Non-scaled 3D models can thus be scaled with an assumed starting value
- In the case of two models, the variance of all measuring points provides an indication which model is preferred
- The values of the distance measuring point to the surface (error) are displayed graphically via the scaling factor
- The minimum shows the best match

Thanks!

further reading JOA 2/2023

https://www.iota-es.de/JOA/JOA2023_2.pdf seite 16

Presentation during ESOP 2023:

https://s3.eu-west-1.wasabisys.com/armagh.space/site/wp-content/uploads/2023/02/19132153/Schaffer_VAMOR.pdf

Presentation during ESOP 2024: