Archeops Optical Configuration for Trapani 1999 flight

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July 4th 1999 v2.1 Correct mistakes on plate scale and focal ratio
July 30 1999, v2.2 add real flight configuration
(April 22st, 1999 v1.1)

From various document (and contributions from Bertrand Gautier, Fred Gannaway, Peter Ade, Bruno Maffei, Ravinder Bhatia and Alain Benoit), here is a summary of the optical configuration of telescope+ photometer that is planned for Trapani Test flight in July 1999 (and Kiruna 2001).

The telescope, as shipped to Grenoble by Shaul Hanany, should have the following characteristics (version 7):
off-axis gregorian telescope with a parabolic primary and ellipsoid concave secondary, satisfying the Dragone condition.
Overall size: 1500 by 2420 by 1160 mm
Primary apparent diameter: 1500 mm (real projected diameter is 1780 on a tangent to the outside rim)
Off-axis angle is about 60 deg.
Primary focal length: 1112 (from primary mirror center to focus) (parabola focal length is 800)

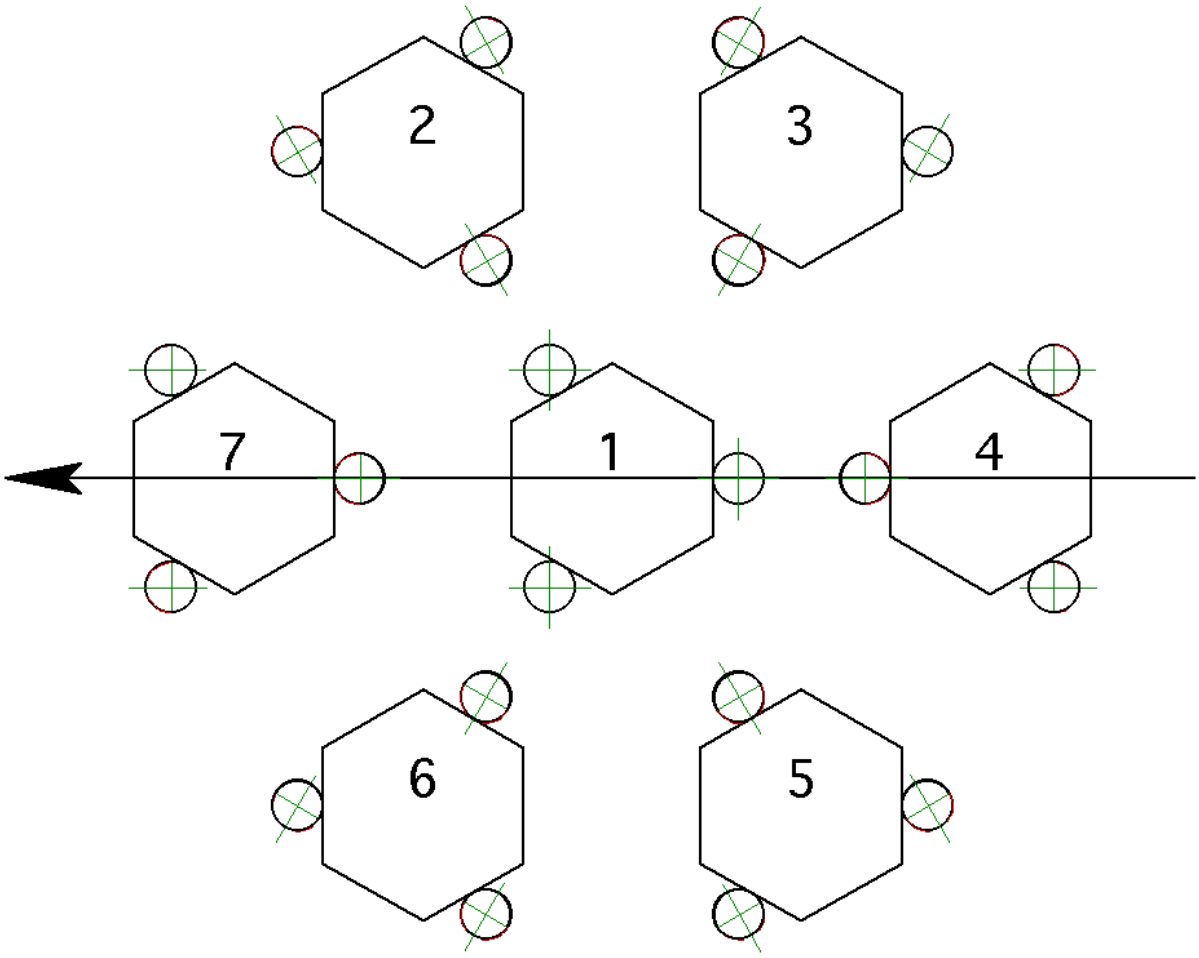
Secondary projected diameter is 800 mm (oversized with respect to the 23 degrees (30 dB limit) given by the horns which project to 650 on the secondary).
The Secondary conjugates the primary focus onto the focal surface (which is not a really a plane): distance as measured with the chief ray from secondary to the focal surface is 815 mm away, distance from primary focus to secondary is 490.
The Primary center is imaged by the secondary at a distance of 440 from the focal surface. This point is aimed at by all the horns to minimise sidelobes.
The focal plane itself is a surface of a sphere with a radius of curvature of 1010 mm. it is concave toward the incoming beam (so the center of the sphere is toward the secondary).

Wrong[The focal length of equivalent telescope is 800, so the f number is 800/1500= 0.5333. Hence the focal surface scale is 13.96 mm/ deg on the sky.]
The focal length of equivalent telescope is 2100, so the f number is 1.75. The effective primary diameter is 1200. Hence the focal surface scale is 36 mm/ deg on the sky.

At Trapani, on the focal surface, the radius from the center bolometer axis to the ring bolometer axis is 28.6 (by construction); that's a separation of 0.78 degrees = 47 arcmin on the sky.
The Kiruna hexagonal compact configuration will give 28 arcmin between nearby bolometers.

The used distance between the back-to-back horn mouth to the focal phase center is taken as 12 mm (although it actually depends on the wavelength 5 at 2 mm and 18 at 1.2 mm).

Fig1: Trapani 1999 configuration: the arrow is scan drift direction
The bolometer base is shown (it is not the focal surface). One hexagon is the imprint of one bolometer (20 mm side). On the sky nearby bolometers are separated by 47 arcmin.
The four nominal bolometers could be placed as:
143 Ghz in position 1 and 6
217 Ghz in position 4 and 5



During the Trapani17 July 1999 flight, 6 bolometers were present. The previous drawing can be viewed on the sky with elevation going up and cross-elevation going horizontally, then :
Bolo 1 (143 GHz) on position 1
Bolo 2 (143 GHz) on position 3
Bolo 3 (143 GHz) on position 5
Bolo 4 (217 GHz) on position 2
Bolo 5 (217 GHz) on position 4
Bolo 6 (350 GHz) on position 7

Fig. 2: Kiruna configuration: scan drift direction is horizontal
The bolometer base is shown (it is not the focal surface). One hexagon is the imprint of one bolometer (20 mm side, 1mm spacing). On the sky nearby bolometers are separated by 28 arcmin.

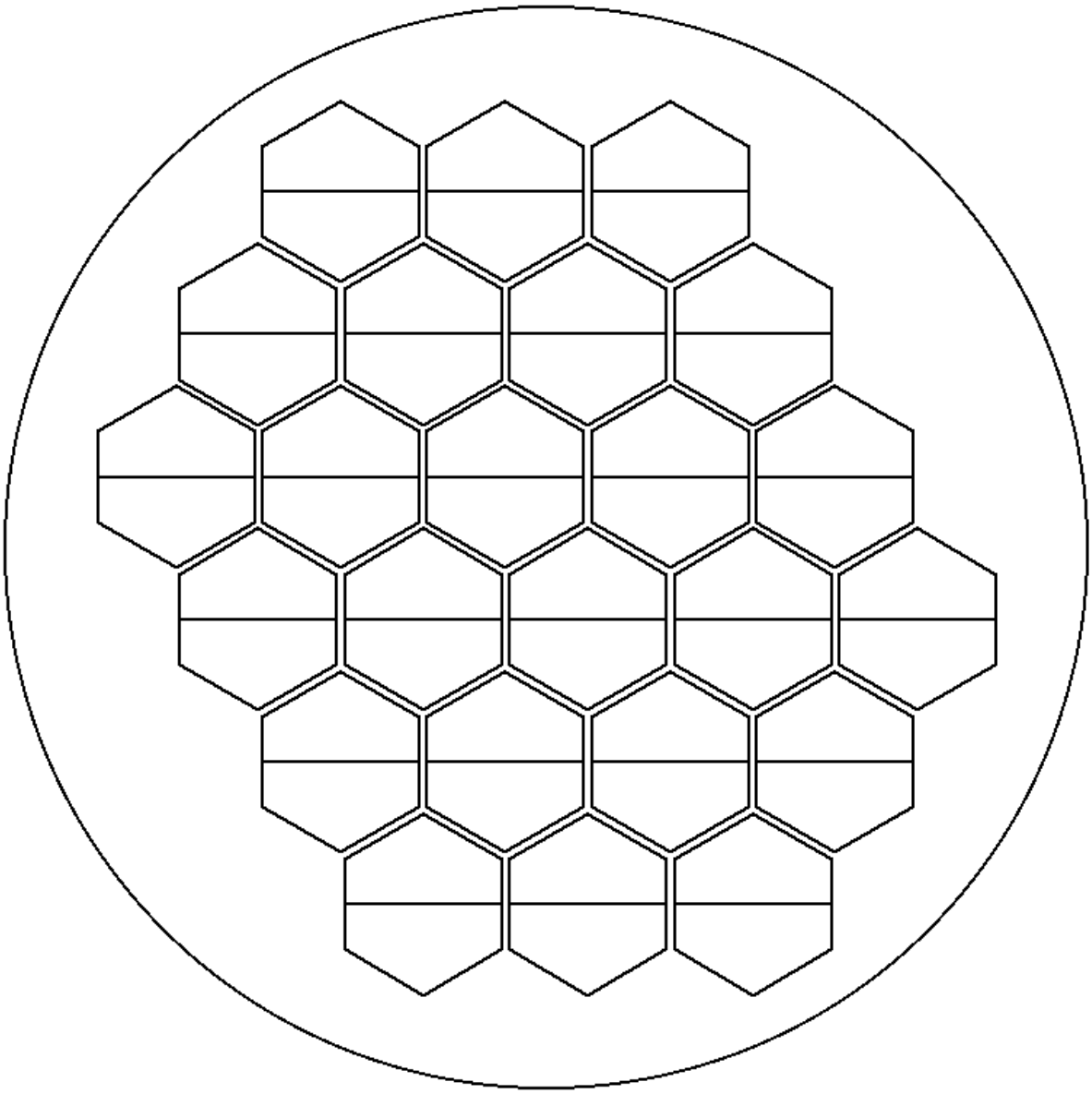
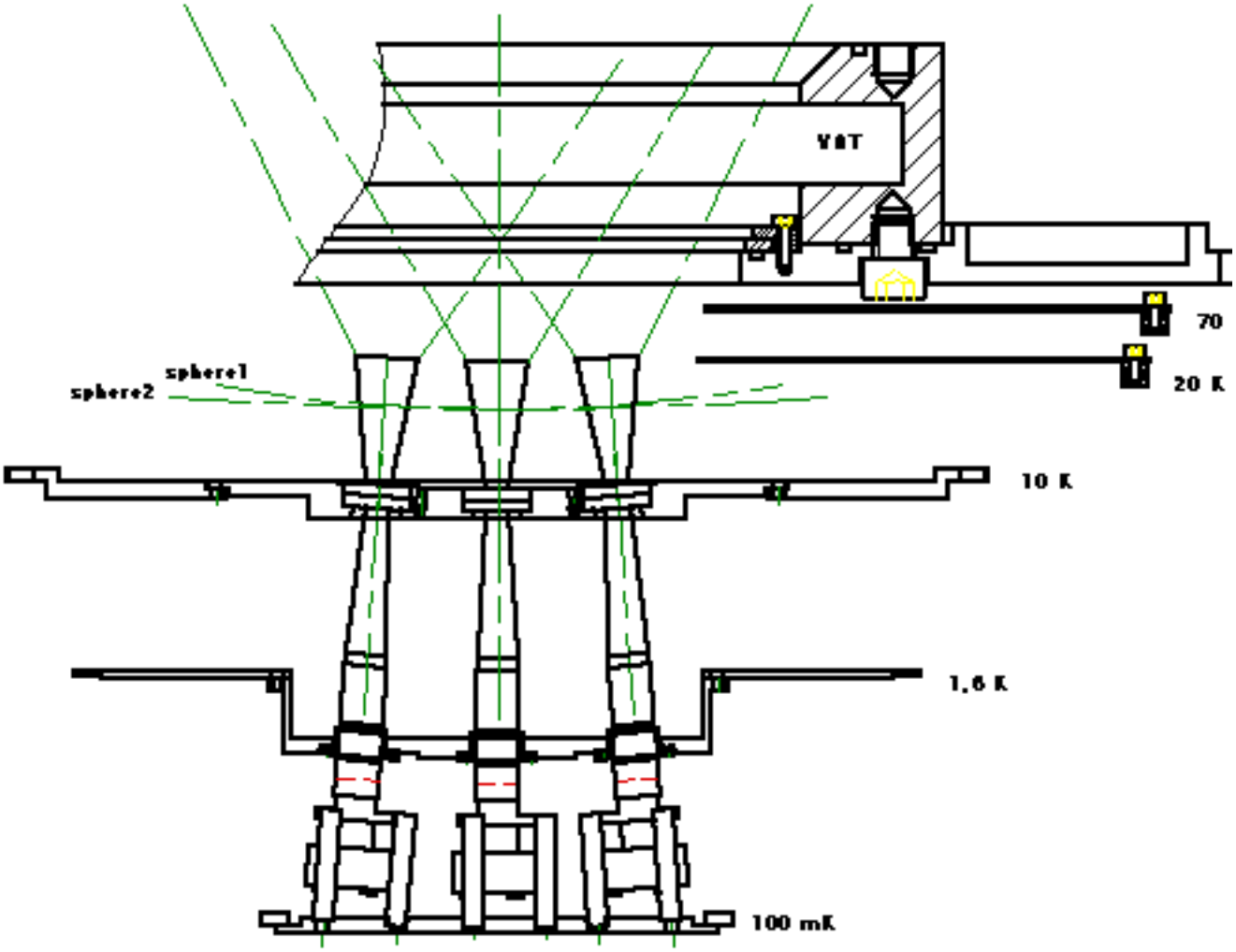



Fig. 3: Cold optics for Trapani flight: Sphere 1 is centered on the image of the primary mirror center through the secondary mirror. The back-to-back horns are aiming at that point. The focal phase center is on the Sphere 2. For the chief ray this is inside the horns at the nominal 12mm distance. (there is a slight displacement of 0.5 mm between sphere 1 and 2 for off-center bolometers)