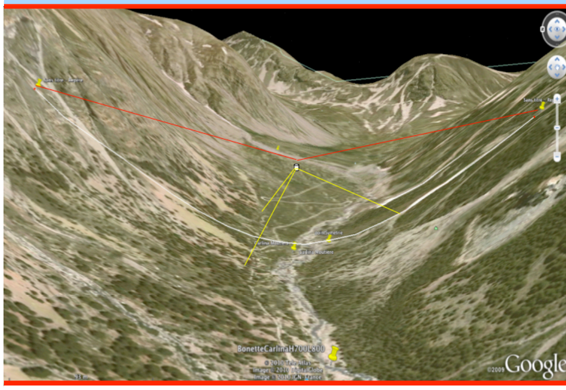
Preliminary testing of "Ubaye Hypertelescope", a prototype direct imaging interferometer in the southern Alpes, France.

F. Allouche[a], F. Bolgar[b], J. Maillot, A. Rondi, D. Mourard[c], J.-P. Rochaix[a], R. Prud'homme, M. Roussel, A. Surya[d], A. Labeyrie[a]

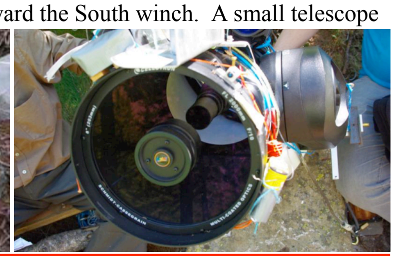
[a] Collège de France, chaire Astrophysique Observationnelle, 11, place Marcelin Berthelot 75231 Paris.
[b] Ecole Normale Supérieure, 45, rue d'Ulm / 29, rue d'Ulm F-75230 Paris - France.
[c] UNS, CNRS, OCA, UMR 6525 H. Fizeau, Boulevard de l'Observatoire, B.P. 4229 06304 Nice - France.
[d] Indian Institute of Astrophysics, Bangalore - India.

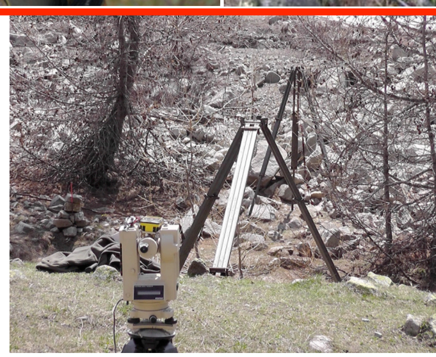
Hypertelescopes, multi-aperture interferometric arrays combining hundreds ofapertures, may be the next generation of high-resolution instruments for direct imaging at sub-milli-arc second resolution. Their theoretical imaging performance, calculated and simulated (5,6), is expected to exceed that of first-generation interferometers using few apertures. We began assembling and testing a version designed somewhat like the Areciboradio-telescope, although in diluted form and intended for direct imaging in the optical range. The prototype instrument, with global aperture spanning initially 57m and later perhaps 200m at the same site, exploits the smoothly curved topography of a high south-alpine valley. The current testing involves minimal hardware, with only two apertures for producing interference fringes on a camera suspended 100m above the ground mirrors and tracking the star's image. A speckle interferometry mode will be used initially(3), pending adaptive phasing. We present the current prototype state and conclude on the scientific potential of the instrument, and of possible larger versions for apertures up to perhaps 1500 m.

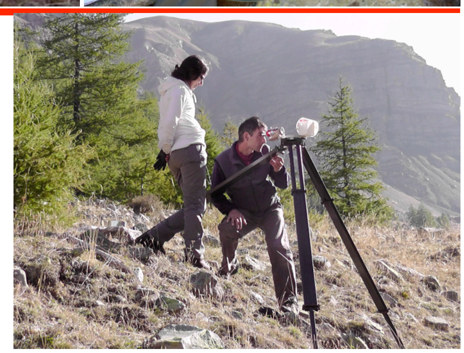


Left: Google Earth view of the Moutière valley where the prototype of the Carlina hypertelescope is under construction.
The focal gondola, ***(right)*** will be suspended above the valley from a cable (red) attached to the South and North cliffs. The variable position and attitude of the gondola for tracking the star are controlled by 3 sets of motorized guy wires (yellow).

Pending an upgraded gondola simplified observations can be made with a passive gondola, motor driven ***(left)*** from the ground by six wires, under computer control. (***middle***). The gondola is equipped with a coudé folding mirror feeding the star light toward the South winch. A small telescope (***right***) equatorially tracking the gondola motion, captures the beam, as well as returning laser light retro-reflected from the gondola. The laser source, attached to the telescope tube, is a telemeter laser also serving for measuring the gondola's distance .

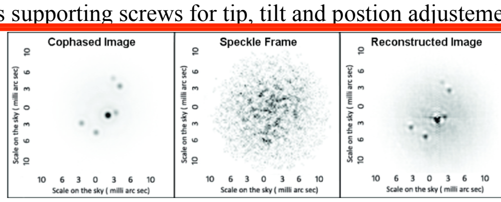






Middle: 2 tripods with 16 m baseline, part of an effective diluted aperture 57 m in diameter on the ground, are located on a sphere 200 meters in radius. The gondola is 100 m above the valley, at the focus surface later. ***Right:*** Aligning the miror on its segment. ***left:*** A close view on the tripod's head showing the mirror's supporting screws for tip, tilt and postion adjustement.

Exoplanet transit cross resolved star, as imaged by a 20 mirror cophased hypertelescope with a 100 m baseline. The star disk is 27 resels while the planet is 3 resels. (Courtesy Surya (4) .



Numerical simulations from (3). Photon limited speckle masking results of a group of 6 stars from turbulent degraded interferograms with 50 mirrors apertuer with aperture rotation through night for 8 hours.

(1) Le Coroller et al. 2011, A&A, submitted
(2) Borkowski et al, A&A 429, 747-753 (2005)
(3) Surya et al 2011, Mon. Not. R. Astron Soc, in prep.
(4) Private discussion.
(5)Lardière et al., Mon. Not. R. Astron. Soc. **375,** 977−988 (2007)
(6)Partru et al. Mon. Not. R. Astron. Soc. **395,** 2363−2372 (2009)

For hundreds of sub-apertures, Carlina designs do not use delay lines . The primary mirrors are co-spherized, using for example the white laser scheme developed by Le Coroller et al (1), accurate within a few microns. Because of the discontinuity of the wavefront new AO techniques have been developped: Borkowski et al (2) discussed a method for determining the piston error from multi-spectral speckle pattern. For faint sources, a modified Laser Guide Star system is also considered and currently under study by one of us. On the other hand, simulations by Surya et al. (3) have demonstrated that hypertelescopes, in the absence of adaptive phasing, can be used for imaging, in the speckle imaging mode. And in a later discussion (4) their simulations showed the capabilities of hypertelescopes to image exo-planets crossing the disk of well resolved parent star.