Engineering a whole sky one meter class telescope: MezzoCielo as a patrol of transients

Roberto Ragazzoni[1,2,3]
Silvio Di Rosa[1,3]
Paolo Spanò[4]
Demetrio Magrin[1,2]
Carmelo Arcidiacono[1,2]
Marco Dima[1,2]
Jacopo Farinato[1,2]
Davide Greggio[1,2]
Luigi Lessio[1,2]
Paolo Cerpelloni[1,2]
Elisa Portaluri[1,5]
Mohamed Y. Bournane[3]
Simone Zaggia[2]

1: ADONI – Laboratorio Nazionale Ottiche Adattive
2: INAF – Osservatorio Astronomico di Padova
3: Dip.to di Fisica & Astronomia, Università di Padova
4: Spano Optical Design – Consultancy Firm
5: INAF – Osservatorio Astronomico d'Abruzzo

Concept

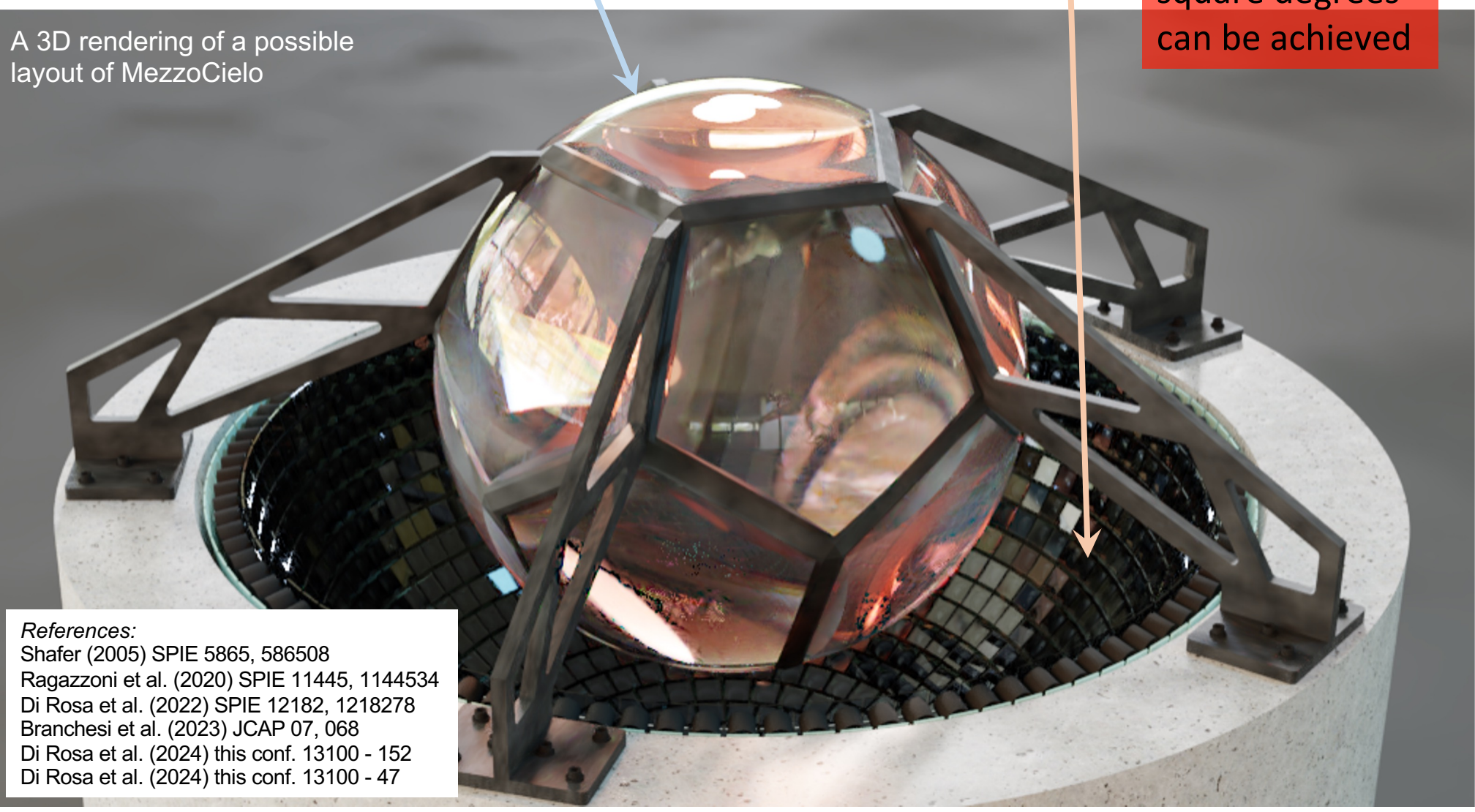
A monocentric spherical envelope made up by 800mm class meniscus forming a hollow sphere filled with low refractive Index, high transparency liquid, makes half of the celestial sphere reimaged onto an hemispherical surface with high spherical and chromatic aberrations…

An array of individual, mass produced, cameras compensates such aberrations and provides onto CMOS-like detectors seeing limited images of a small portion of the sky with a slight overlap, the same size of the monocentric system aberration

In this way a FoV exceedings 10^4 square degrees can be achieved



You can see a dummy model at stand #321

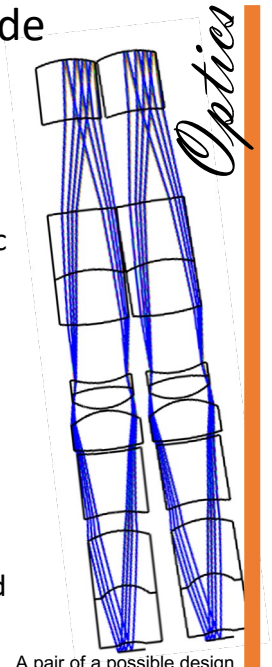


References:
Shafer (2005) SPIE 5865, 586508
Ragazzoni et al. (2020) SPIE 11445, 1144534
Di Rosa et al. (2022) SPIE 12182, 1218278
Branchesi et al. (2023) JCAP 07, 068
Di Rosa et al. (2024) this conf. 13100 - 152
Di Rosa et al. (2024) this conf. 13100 - 47

Optics

Design options include among the others:

- Compensation of large spherical aberration through the use of aspheric surface on reimaged pupil;
- Use of liquid within the optical corrector itself;
- Adoption of two glasses meniscus option to diminish monocentric aberrations;
- Trade off between large individual Field of View and numerosity of compensator;
- Use of typical CMOS format and pixel size.



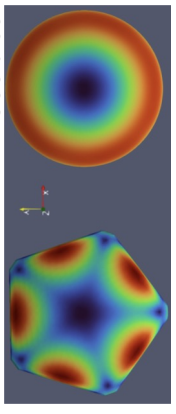
A pair of a possible design of the optical compensator. The field lenses are on top While the detector is on the bottom.

Mechanics

Optimization of the structure does consider the following:

- Interface between meniscus and structure in order to be fluid tight;
- Deformation of meniscus due to gravity and hydraulic loads so to design them in order to assume the proper shape when under static loads;
- Calculation of birefringence effects due to stress onto the meniscus, considering the worst-case scenario of both thermal and gravitational loads acting;
- Tolerancing into spherical tiles to be compliant with optical performances;
- Stability under wind and thermal uneven loads.

See also: 13100-47
13100-152



Deformations computed through FEA of meniscus in different configurations..

Science

Definition of scientific aims as patrolling whole sky telescope

- NEO (Near Earth Objects) and SSA (Space Situational Awareness) applications are obvious niches.
- Optical counterparts of GW can be accomplished with significant gain in terms of accurate source pinpointing for further observations.
- Unknown parameters space is rather wide

Expected afterglows of a GW-related optical phenomenon with (yellow) the threshold sensitivity of MezzoCielo in comparison with other instruments.

