# SST Progress Report

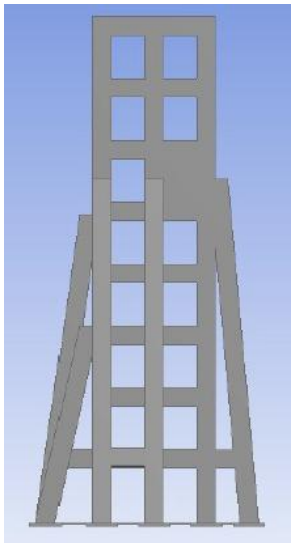
Tim Greenshaw for SST group

- Davies-Cotton SST.
  - 7 m structure.
  - 4 m design.
- Progress with Dual Mirror designs:
  - SST-GATE.
  - ASTRI.
- Camera developments:
  - ASTRI camera and SiPMs.
- Calibration and pointing.
- Schedule.
- Summary.

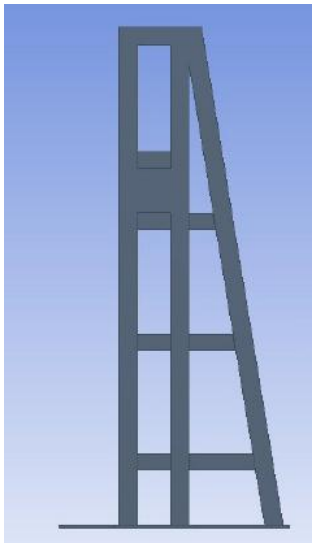
# Davies-Cotton SST – 7 m structure

Jacek Niemiec

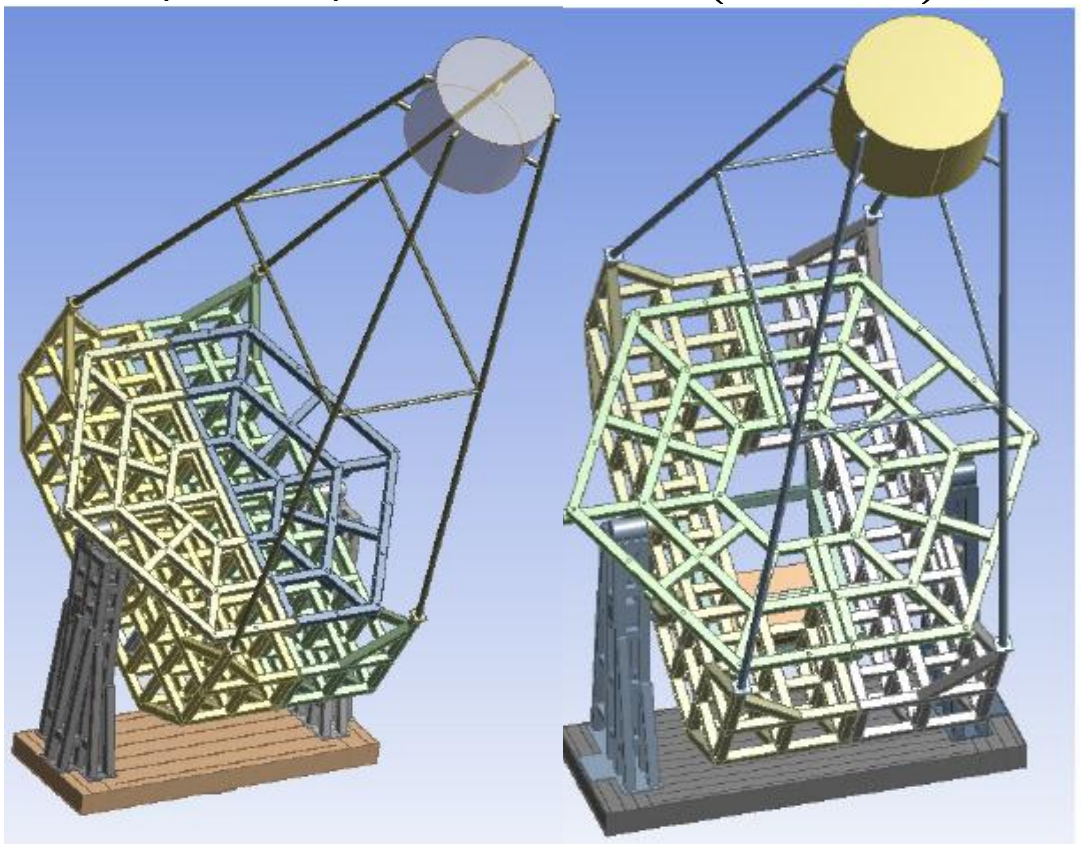
- Recommendation of SST review was that IFJ-PAN steel structure be simplified.
- Done for dish support structure, counterweight, dish and columns:
- Before:



After:



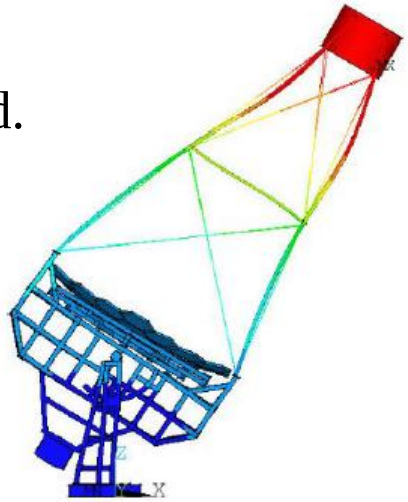
- Telescope:
- Before (27 tons): After (24.4 tons):



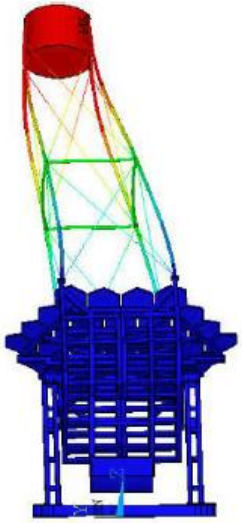
- Costs of material and welding reduced.

# DC SST – 7 m structure

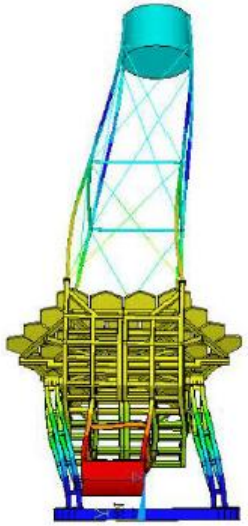
- FEA of optimised structure completed.
- Lowest frequency oscillations 2.5 Hz at elevation of 60°:



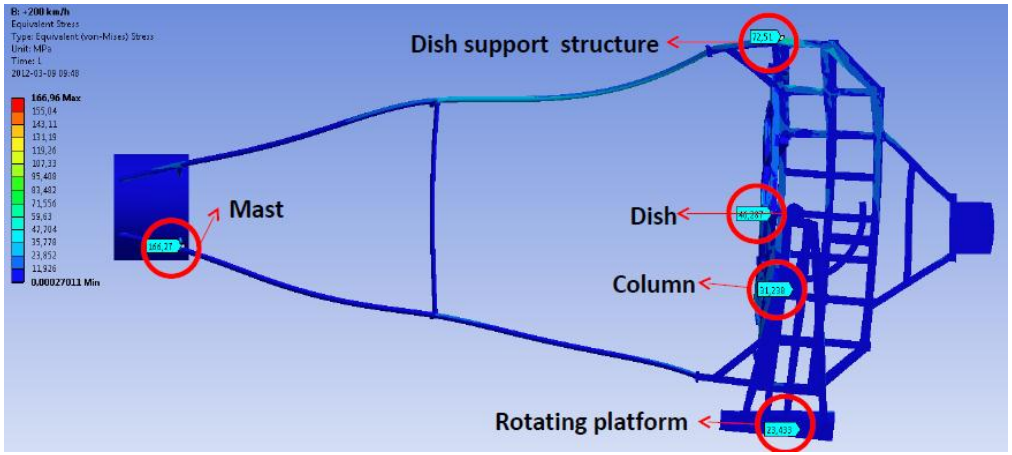
- Next modes:
- f > 3 Hz



f > 5 Hz



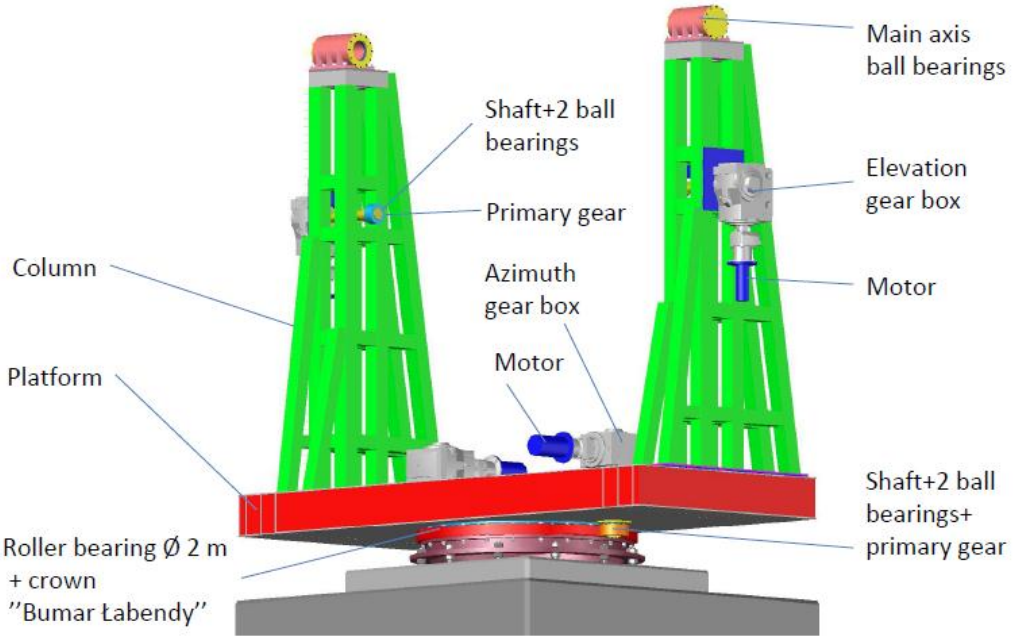
- Max. camera displacement under gravitational and 50 km/h wind load is 15 mm at an elevation of 30°.
- Less than $^1/_3$ pixel size.
- Stresses under 200 km/h wind load in parking position are largest in dish support structure, 73 MPa:




- Steel yield strength 250 MPa.

# DC SST – 7 m structure

- Detailed design of drive system performed:

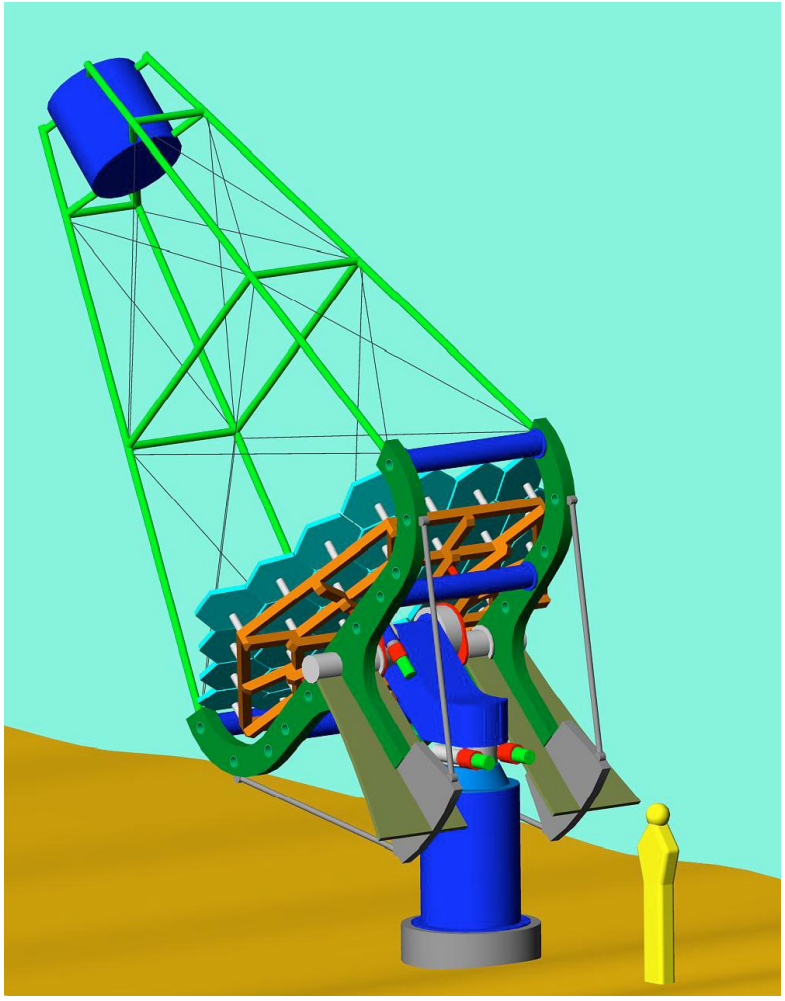



- Gear boxes, motors... chosen.
- Suppliers same as for MST in many cases.

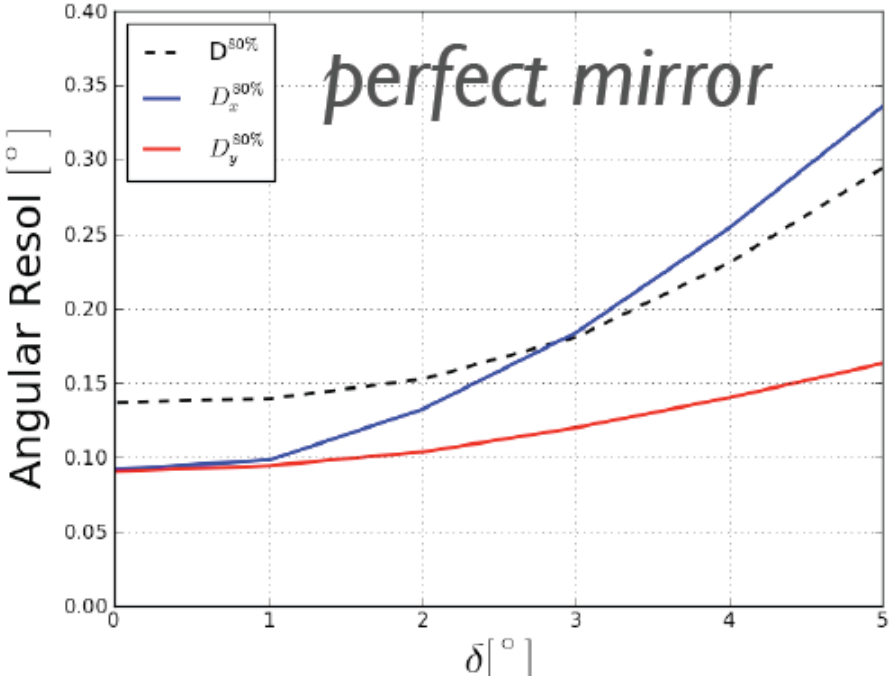
- Design now considered complete enough to be shelved.
- Polish groups starting work on 4 m DC structure for which Swiss developing SiPM-based camera.

# 4 m DC SST – structure and mirrors

Teresa Montaruli, Jacek Niemiec

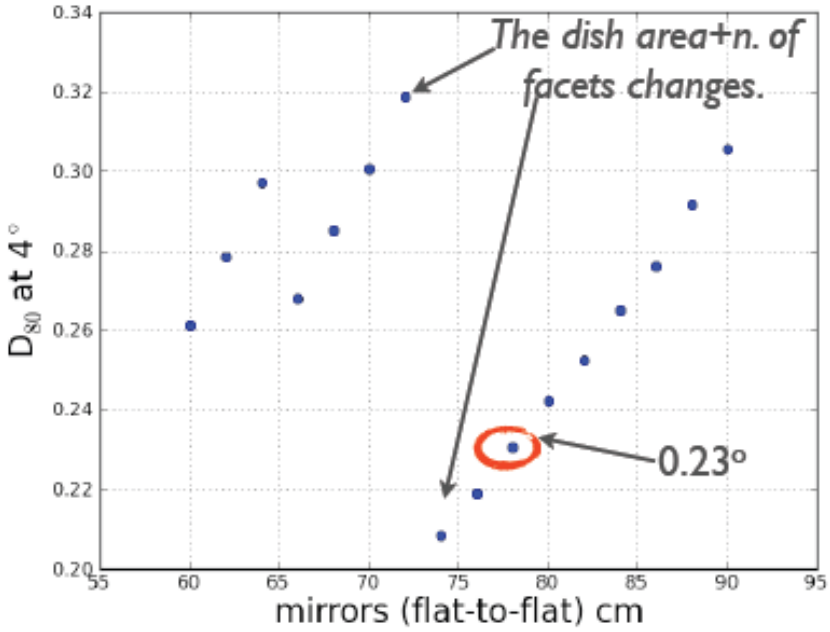


- Design DC telescope that has D ~ 4 m, focal ~ 5.6 m and 9° FoV.
- C.f. FACT, refurbished HEGRA CT3 telescope, D ~ 3.5 m, f ~ 5 m.
- Hexagonal mirrors of flat-to-flat size 78 cm give required PSF:



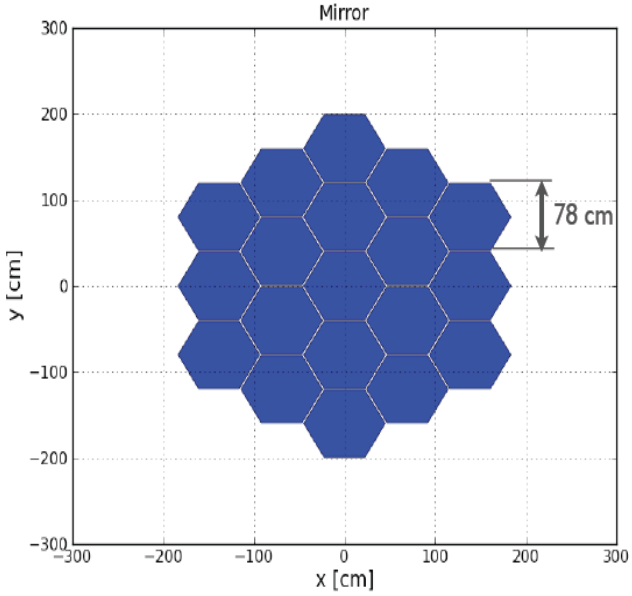
# 4 m DC SST – structure and mirrors

- Facet sizes which give mirrors extending beyond D ~ 4 m result in poor PSF:




- Optimum facet size 78 cm flat-to-flat.

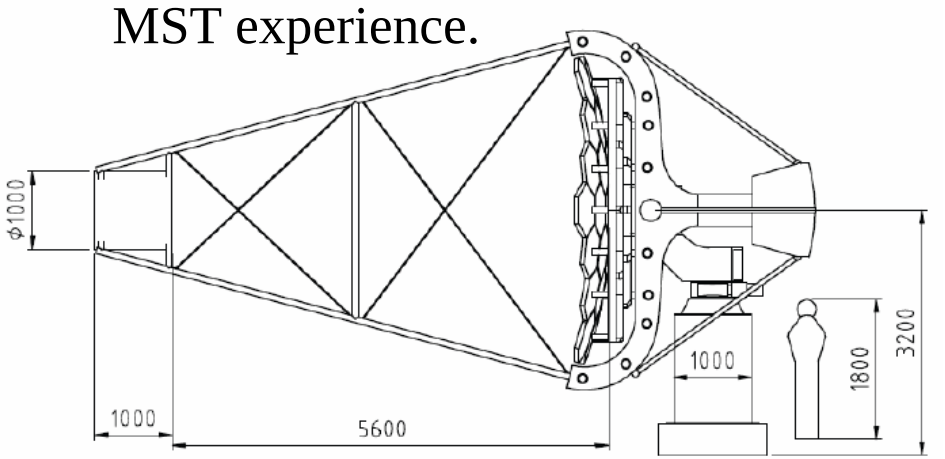
- Resulting primary:

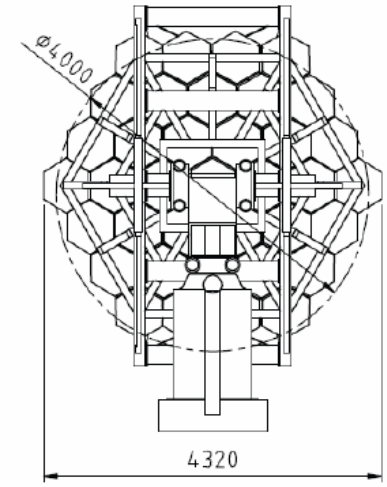



- Baseline: HESS mirror design.
- Galaktica (Armenia) can produce mirror for prototype at cost of €1700 for each of ~ 10 facets.
- Also looking at composite mirrors.

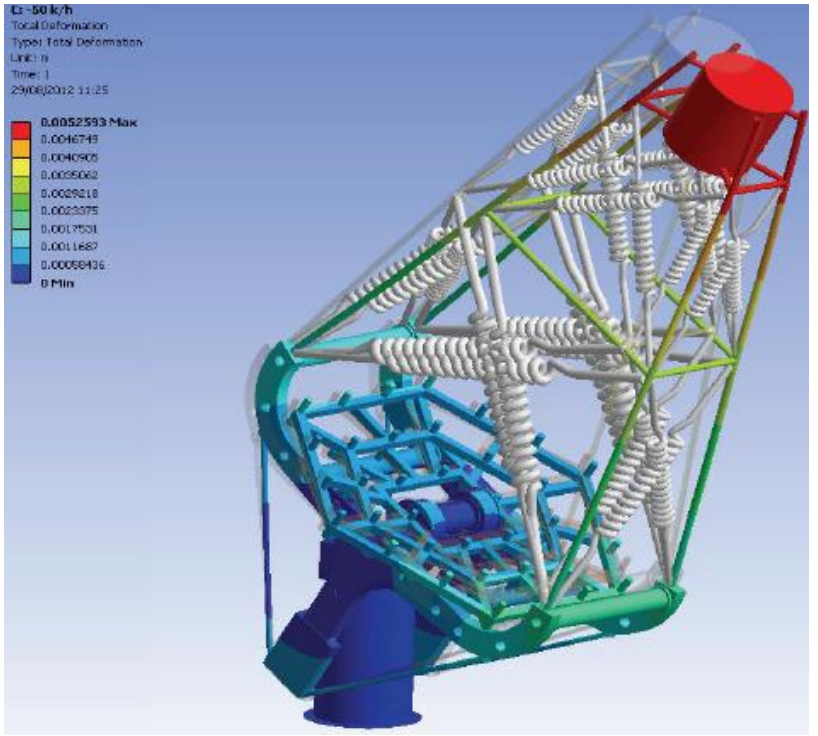
# 4 m DC SST – structure and mirrors

- Structure design based on 7 m and MST experience.



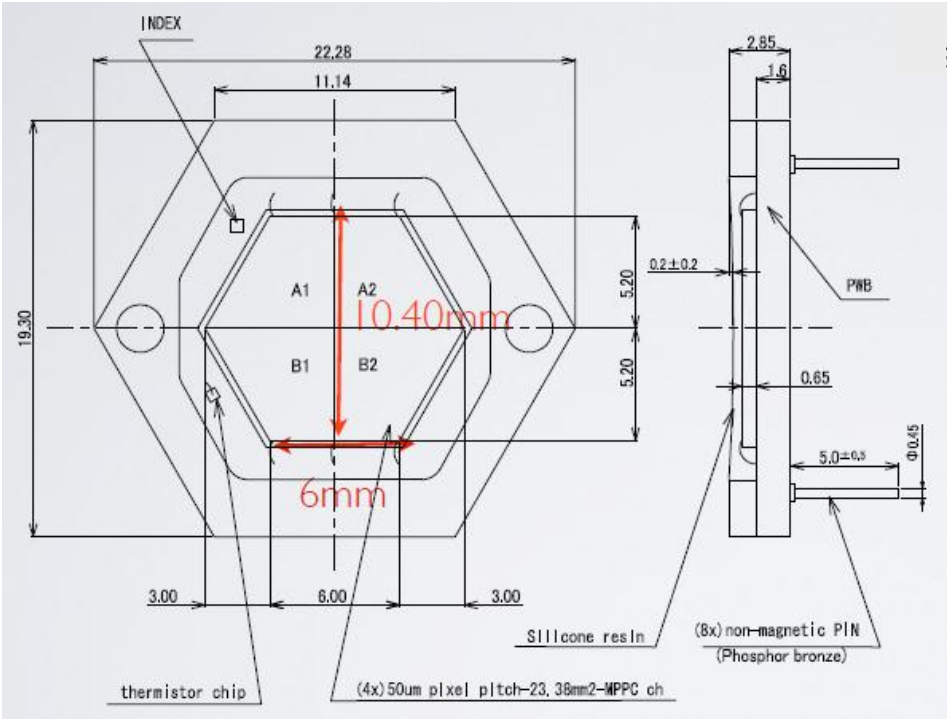

- Gravitational deformation plus effects of 50 km/h wind acceptable:




- Lowest mode of oscillation ~ 6.5 Hz.

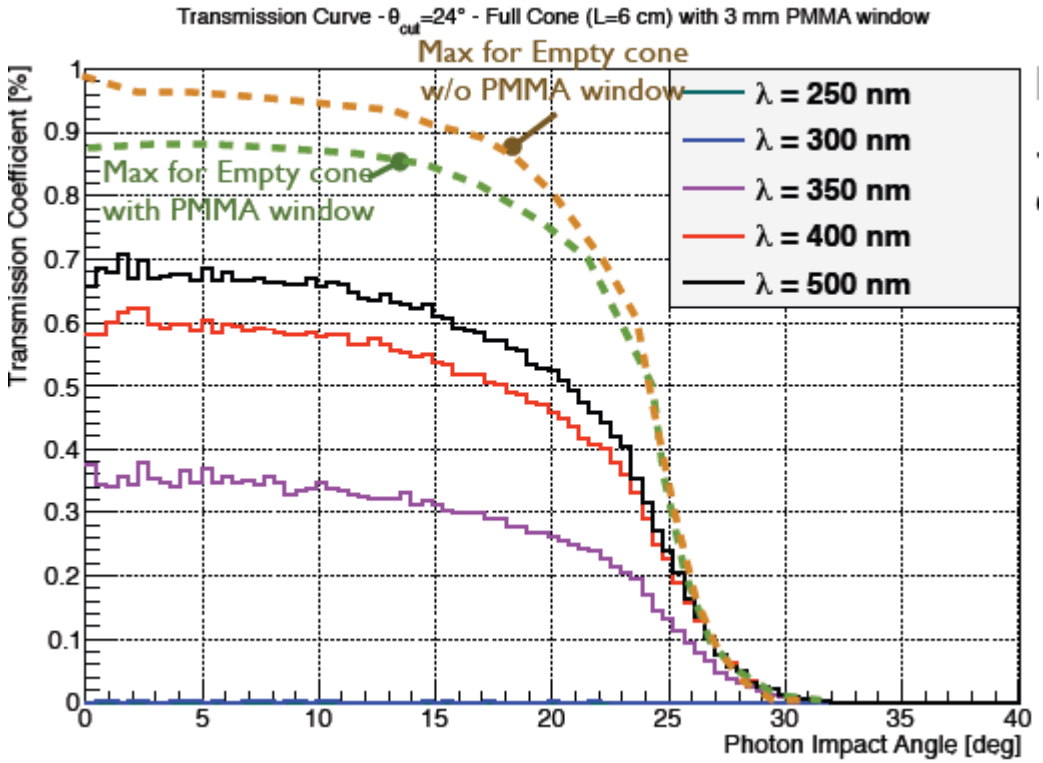
# 4 m DC SST – camera

- SiPM development with Hamamatsu.



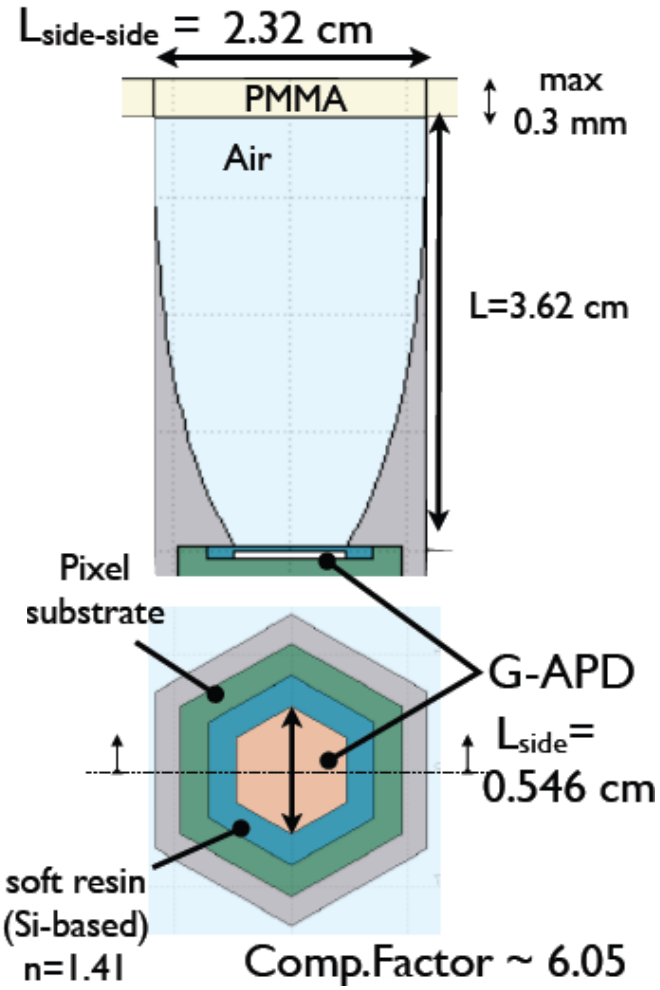

- Pixel is hexagonal, consists of 4 channels of area 23.4 mm$^2$.
- Cells 50 × 50 μm$^2$, fill factor ~ 60%.

- Cost of (small numbers) of these SiPMs high, but price per mm$^2$ reasonable for large numbers.
- Use open Winston cone to limit absorption:

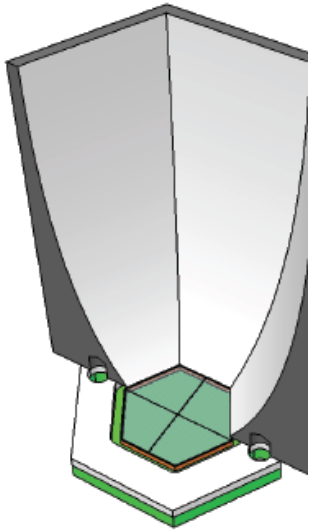


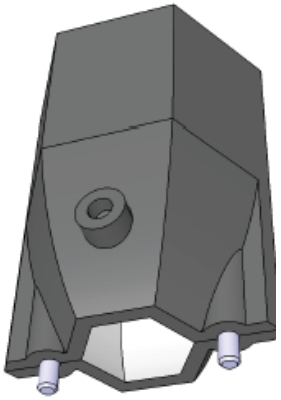
# 4 m DC SST – camera

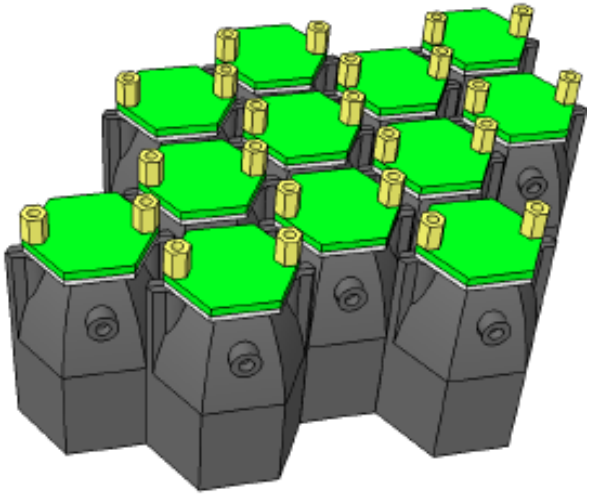
- Pixel design:

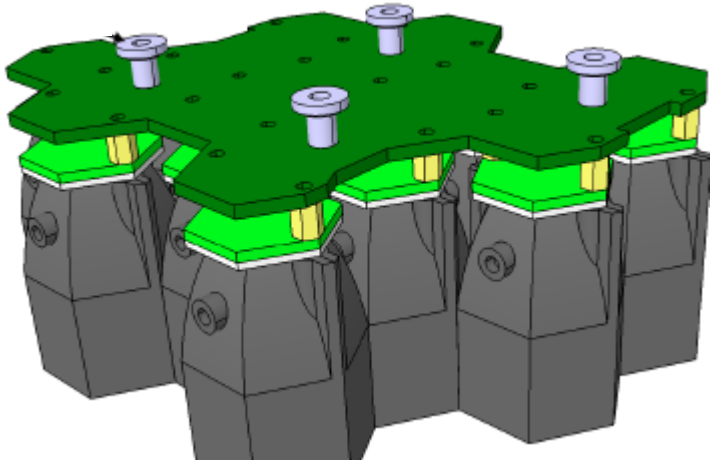



- Working on manufacturing methods:



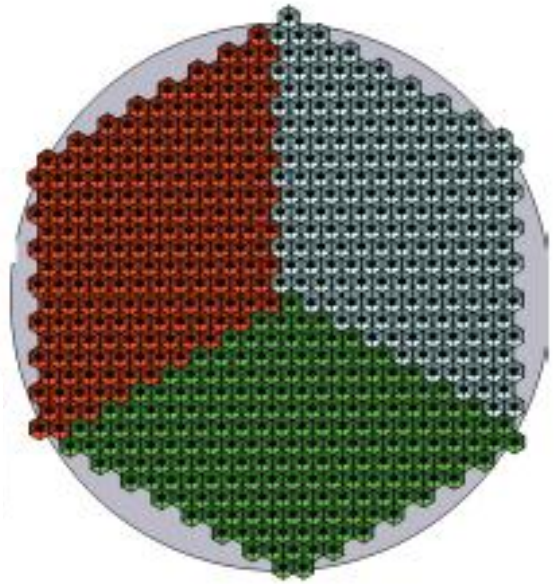


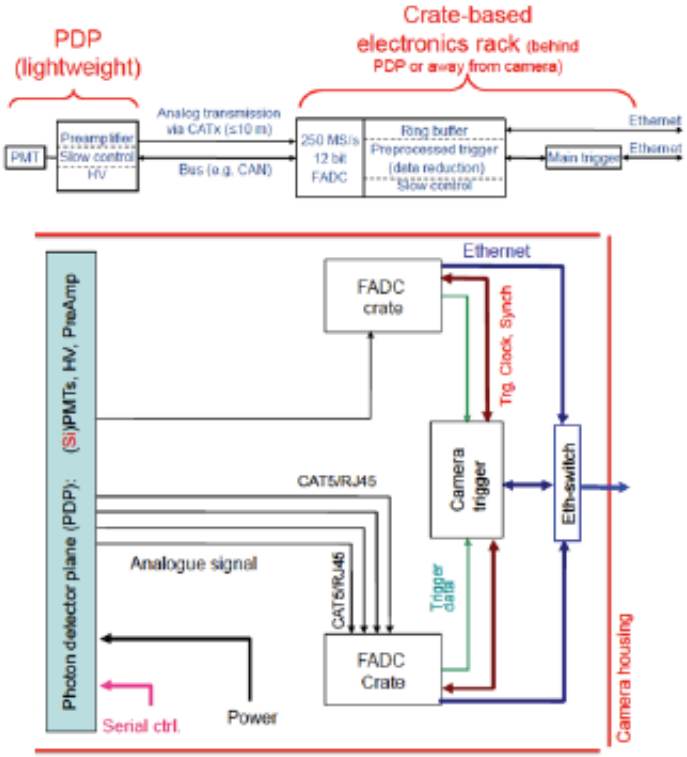




# 4 m DC SST – camera

- DPNC proposal is to develop prototype of detector plane using 12 pixel units.
- Preamps and front end electronics will be developed with ETHZ.
- Will be matched to FlashCam...



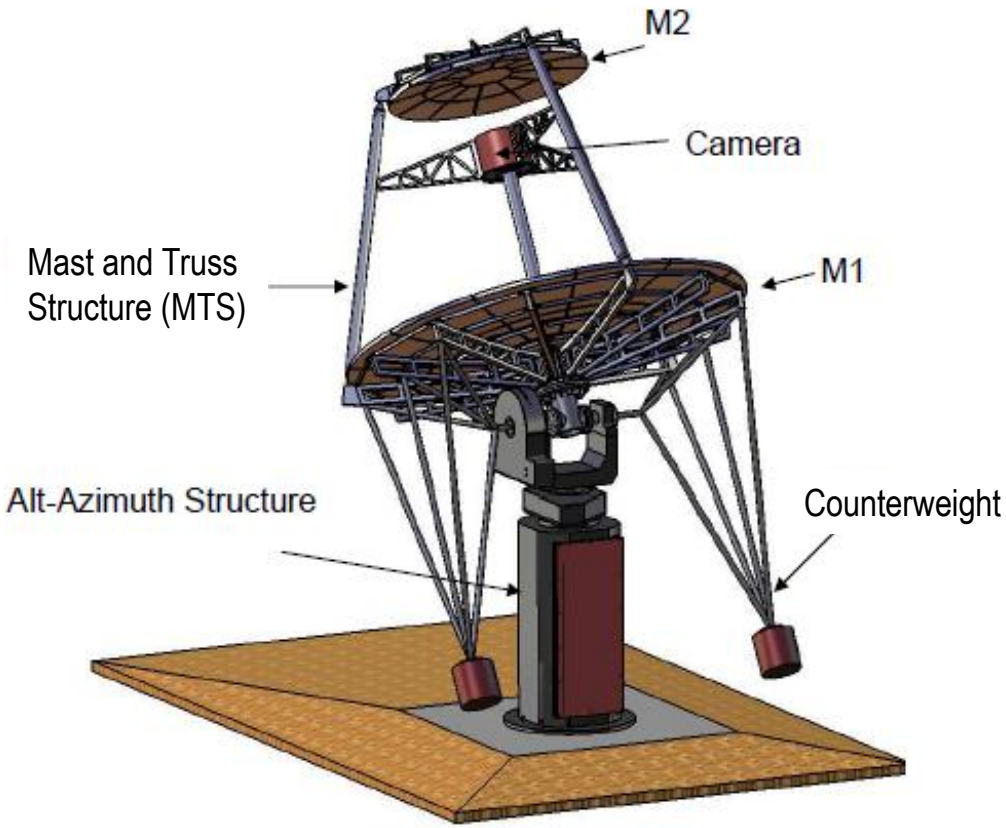



- ...but will also investigate e.g. EASIROC-based readout.
- Look at use of commercial cooling system.

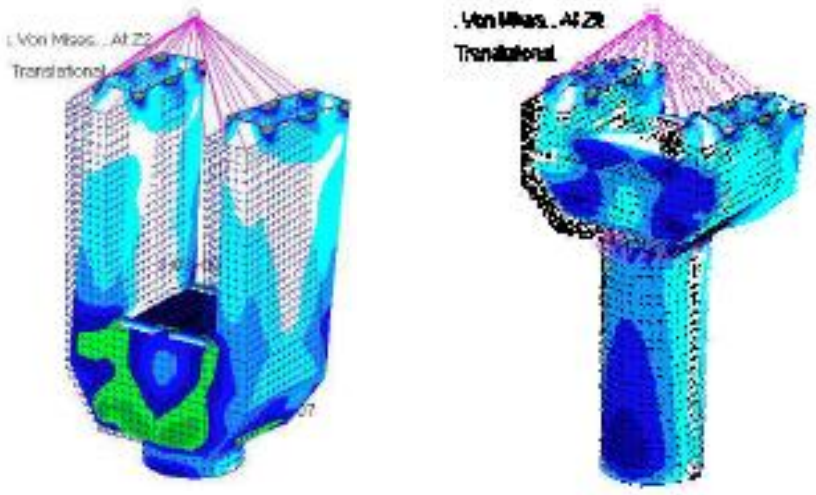
# Progress with SST-GATE

Delphine Dumas

- Structure design evolving:




- Now use “short” fork as opposed to long design originally intended to accommodate camera electronics.



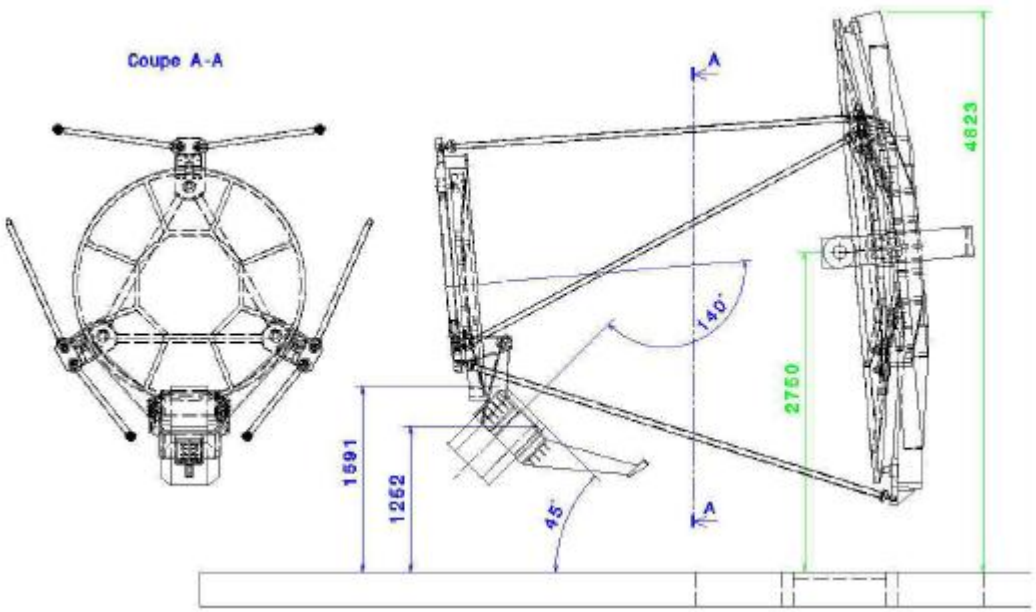
- Improves stiffness and reduces mass from 1.9 to 1.0 tons.
- Steel chosen for MTS.
- Support from technical division of INSU for drives.

# Progress with SST-GATE

- Three arm Serrurier support for secondary mirror and camera under study:

- Significantly stiffer than previous design.

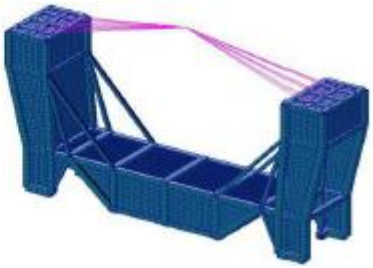
- Camera removal using rotating support:



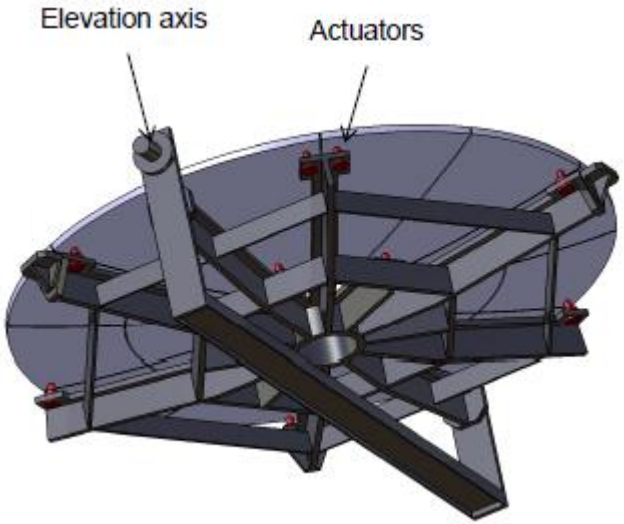

- FEA indicates need to increase stiffness of dish.

# Progress with SST-GATE

- Back up solution, wide fork…



- …which carries dish at outer extremes:

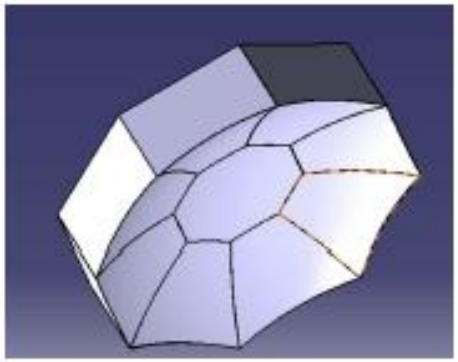



- Shelter will be used, provided by Losberger.

- Planning permission sought for erection of shelter in Meudon.
- Procurement planned for November.

# Progress with SST-GATE

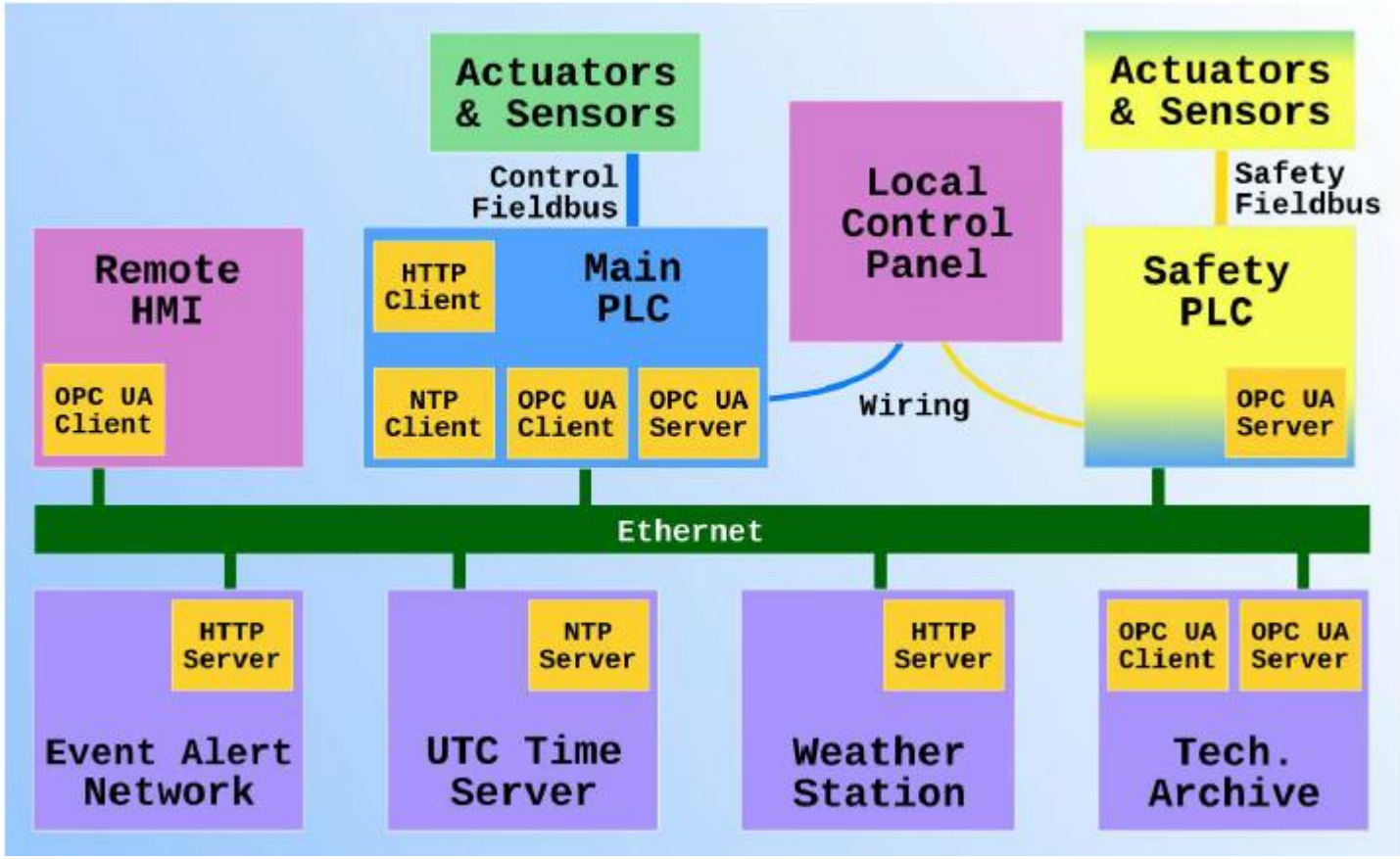
- Secondary mirror will be constructed by CEA IRFU.
- Feasibility demonstrated.
- Mould purchased.
- First panel expected December 2012.
- Complete mirror summer 2013.

- July 2012, talking to several possible suppliers of primary mirror.
  - Optic Technium (Wales).
  - Schott (Germany).
  - LZOS (Russia).
  - LAM (France).
- Developing collaboration with Nexeya for actuators.

# Progress with SST-GATE

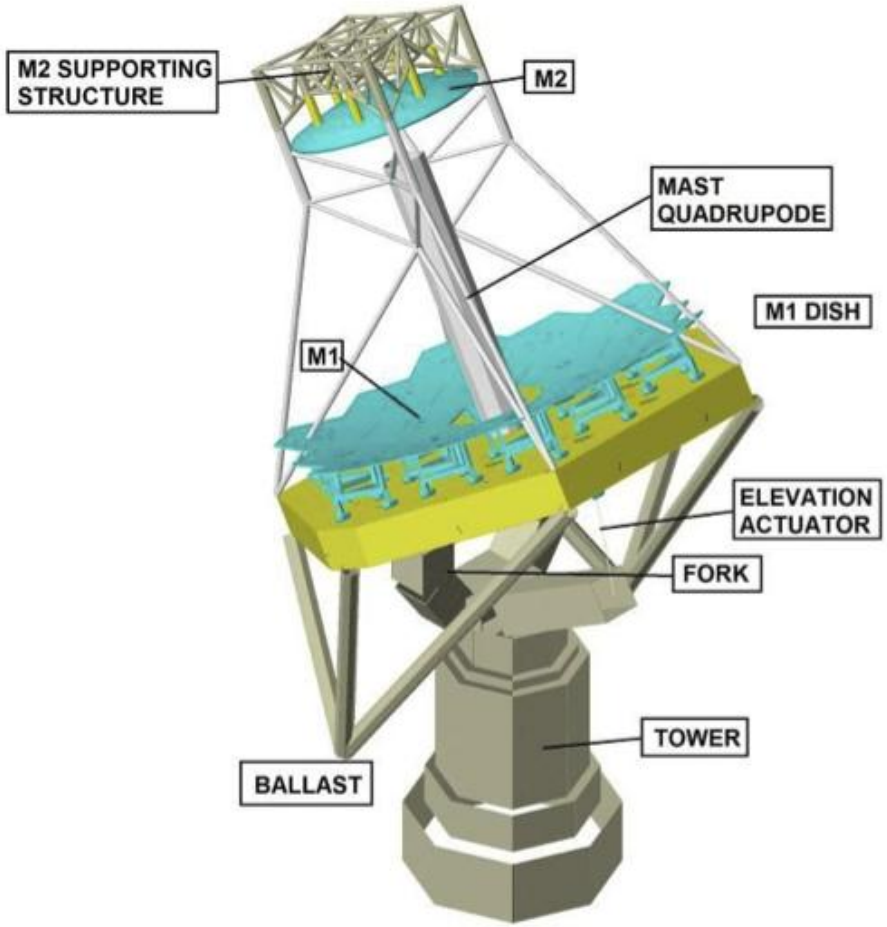
- Software and communication layout being designed.
- Main and safety Programmable Logic Controllers probably Siemens.



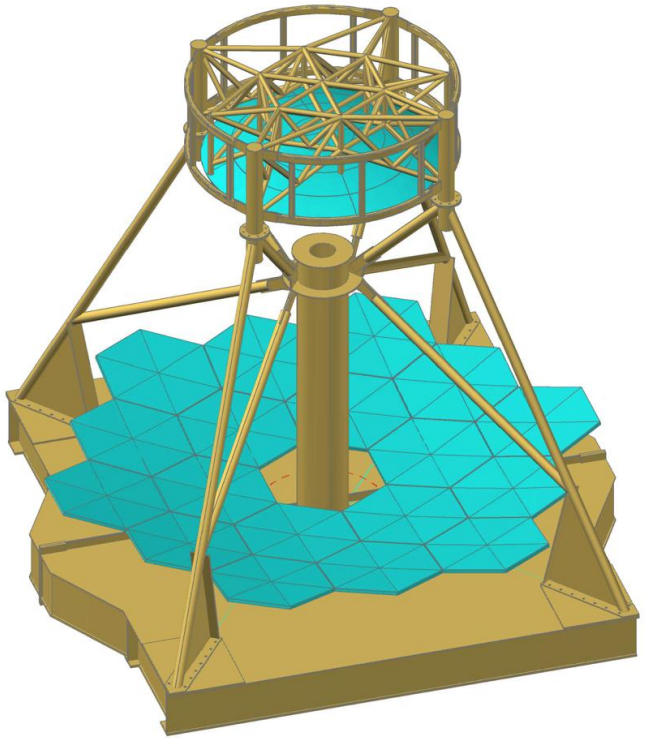
# Progress with ASTRI

Rodolfo Canestrari, Giovanni Pareschi

- Structural design essentially complete:

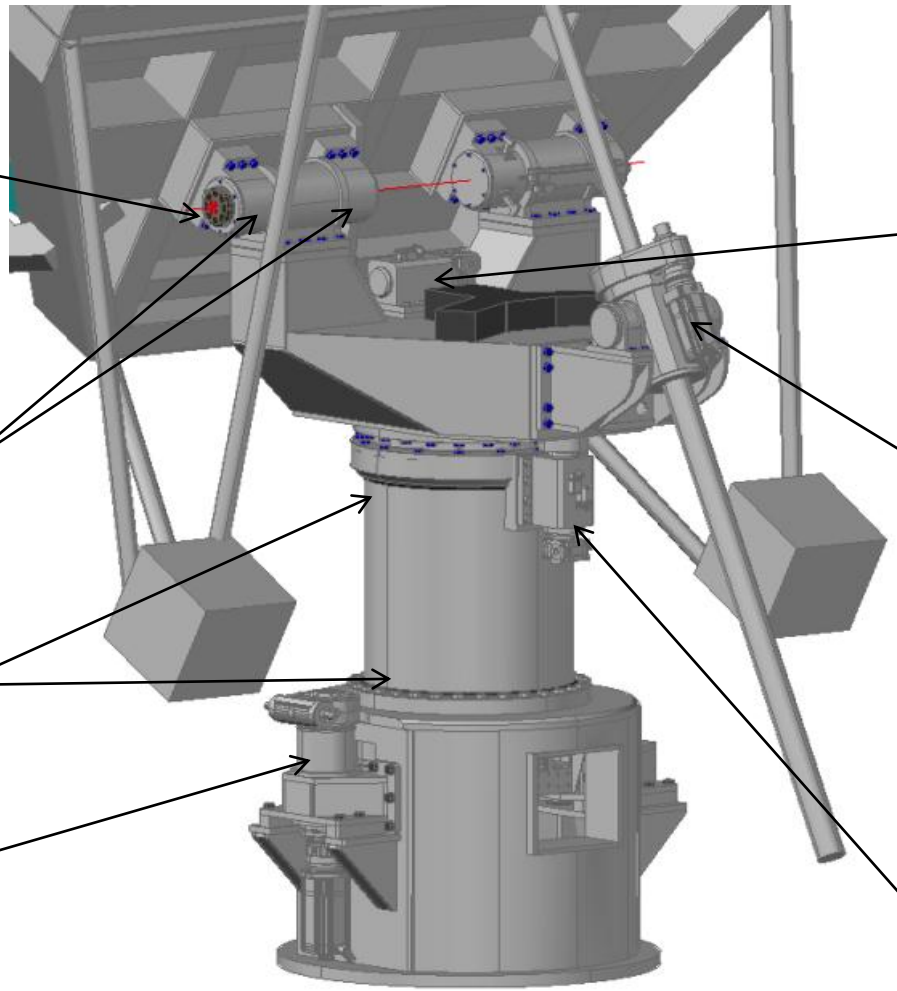



- Quadrupod/tube for secondary and camera support:



- Legs counteract lateral deformation.
- Tube increases torsional stiffness.

# Progress with ASTRI



Measuring system of the altitude axis

Preloaded bearings of the altitude axis

Preloaded bearings of the azimuth axis

Emergency drive system of the azimuth axis

Driving system of the azimuth axis

Emergency drive system of the altitude axis

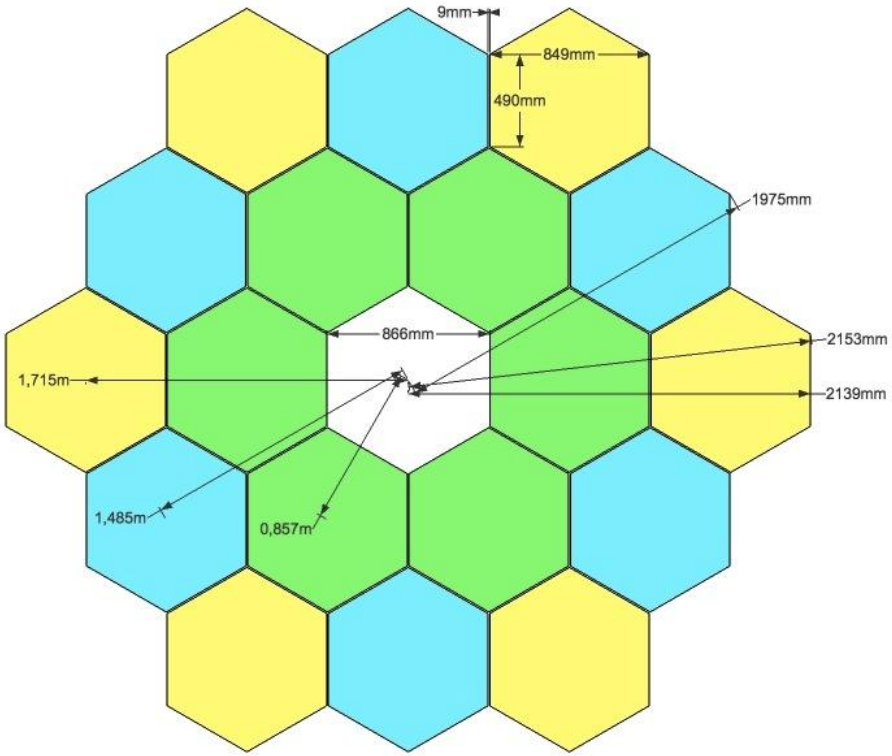
Locking system of the altitude axis

Driving system of the altitude axis

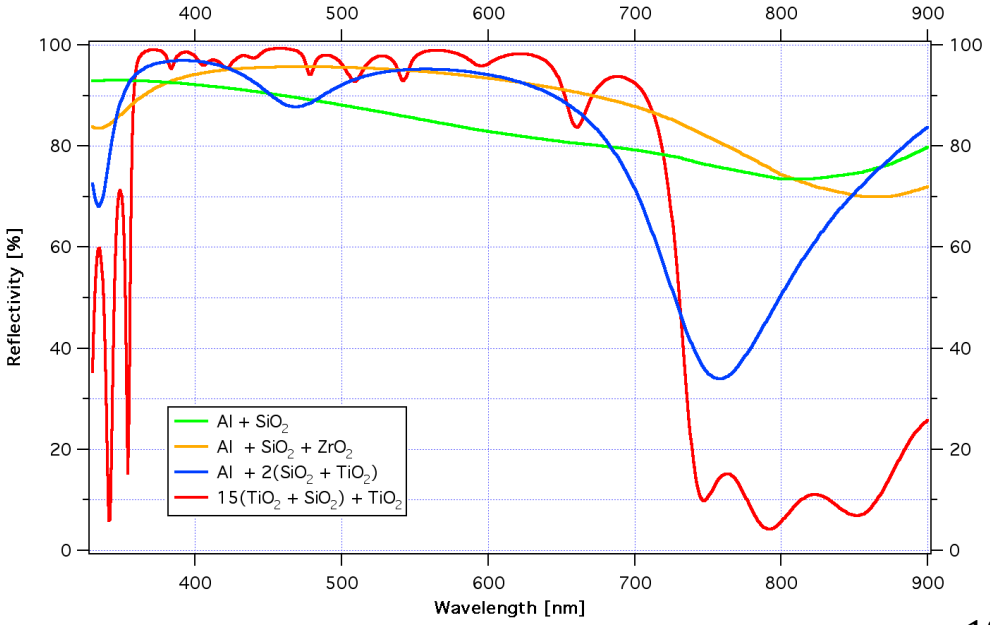
Locking system of the azimuth axis

# Progress with ASTRI

- Primary mirror:

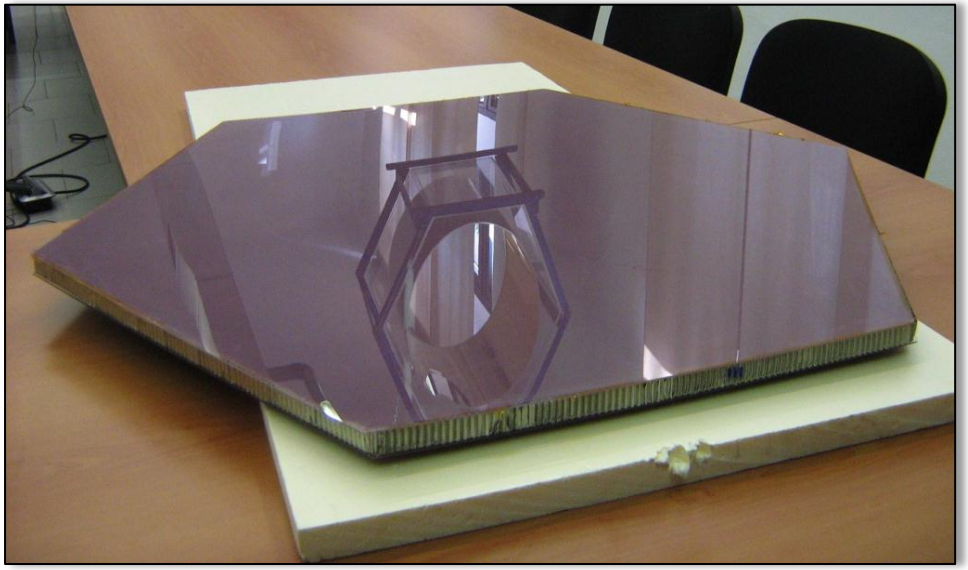


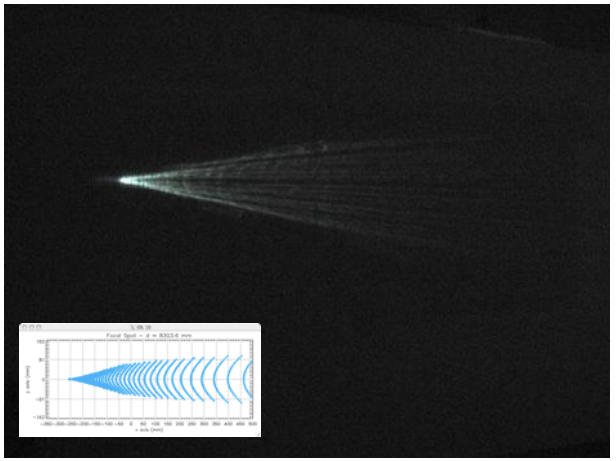

- Solution one, sandwich structure using thin (2 mm) hot slumped glass.
- Solution two, thick (10 mm) hot slumped glass.
- Dielectric coating procedure developed.



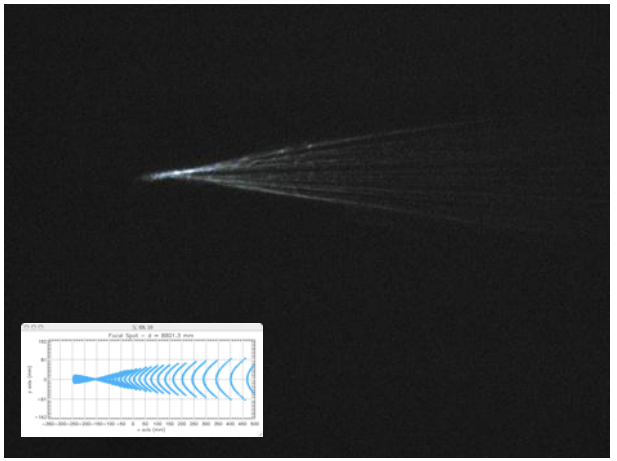
# Progress with ASTRI

- First “yellow” hexagonal primary mirror panel delivered.
- Dimensions 850 mm flat-to-flat.
- Thickness 2 mm.
- Radius of curvature ~ 9.4 m.
- Aspherical profile.
- “Almost within specification”





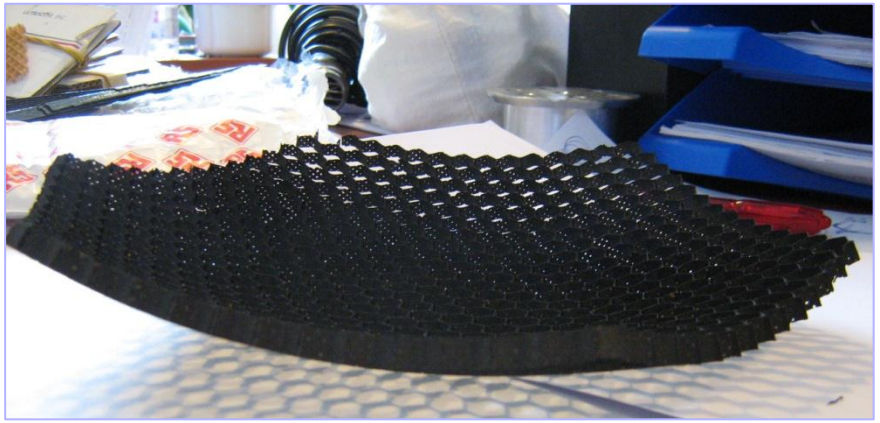
PSF, 0 mm off axis



PSF, 500 mm off axis

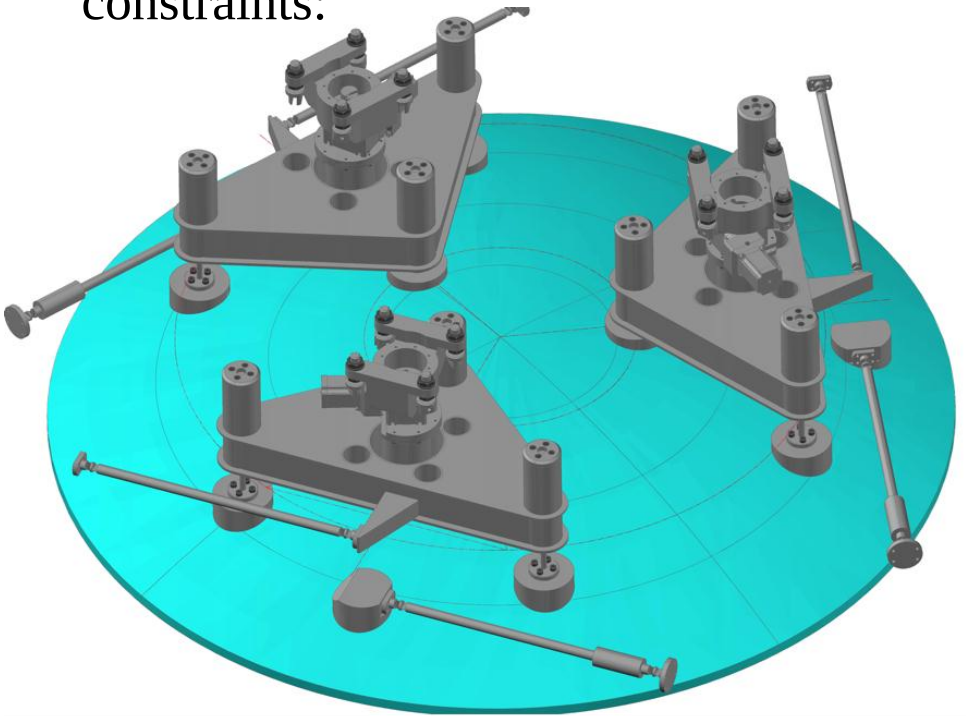
# Progress with ASTRI

- Secondary mirror.
- Monolithic.
- Will use pre-shaped honeycomb:



- Optimization of design now underway with US manufacturer.
- Reduces stresses in structure which tend to cause astigmatism.
- Glass, developments with FLABEG.

- Secondary support structure will include three actuators and lateral constraints:

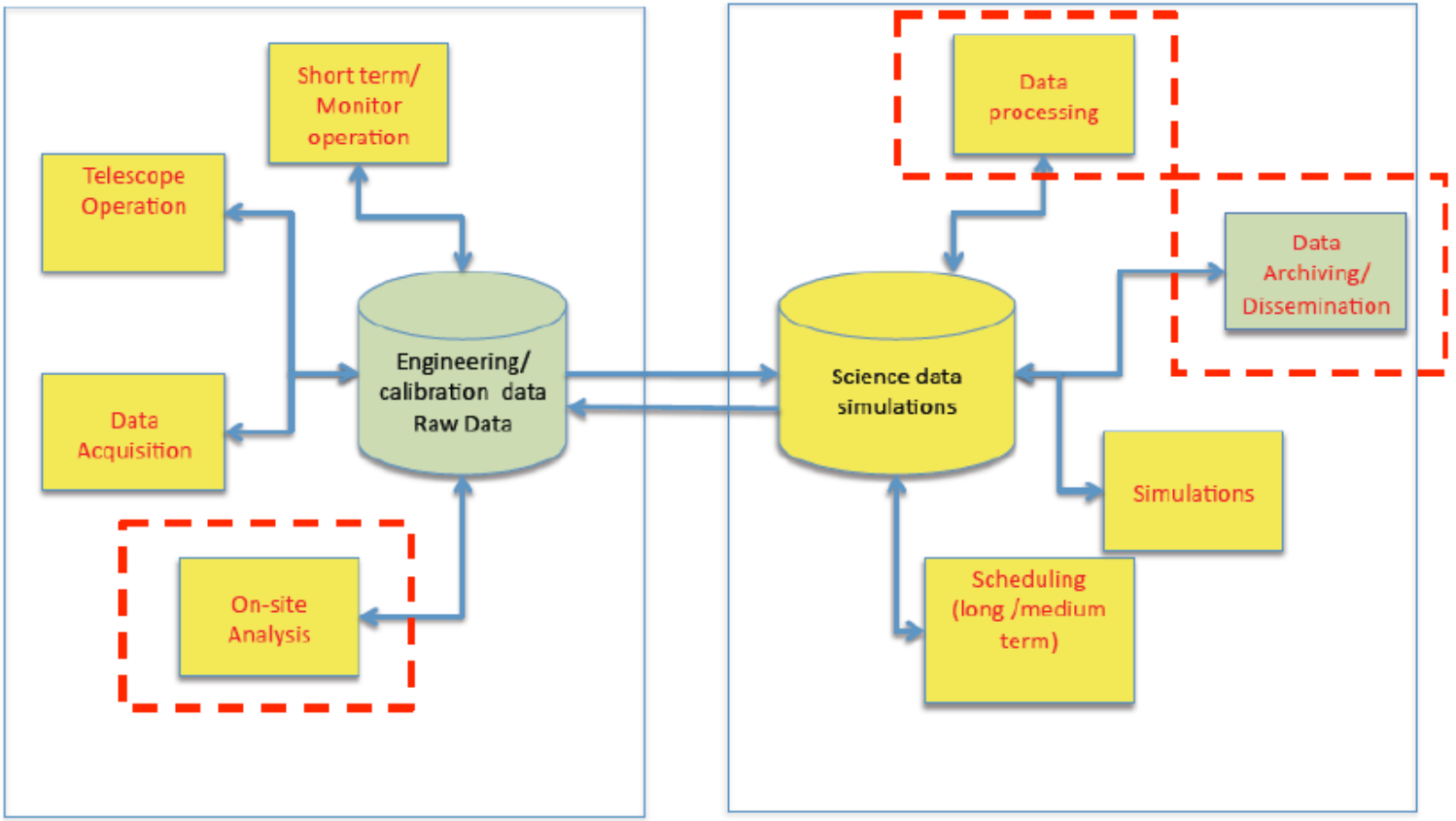


- Actuators will be connected via whiffletrees to spread load.

# Progress with ASTRI

Massimo Trifoglio, Angelo Antonelli

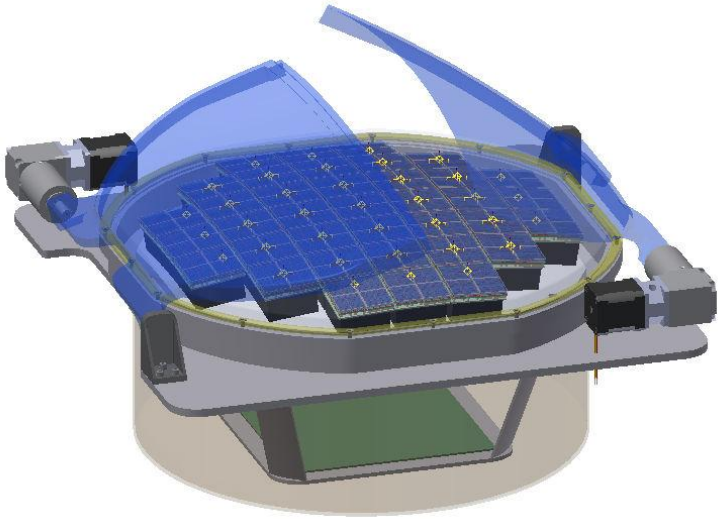
- Control framework, use ALMA Common Software (ACS).
- Data handling and archiving under development.



# Camera development – ASTRI

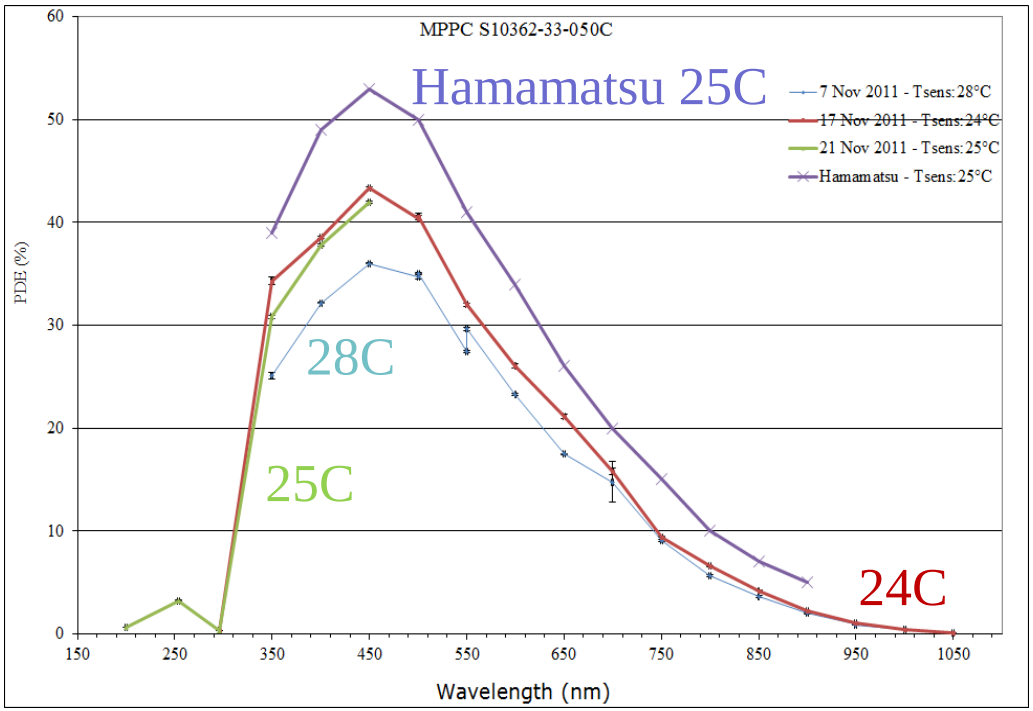
Giovanni La Rosa, Giovanni Bonanno

- Camera based on Hamamatsu SiPMs.
- Readout using EASIROC chip.
- Mechanical and electronic design progressing.



- Camera mass about 25 kg.

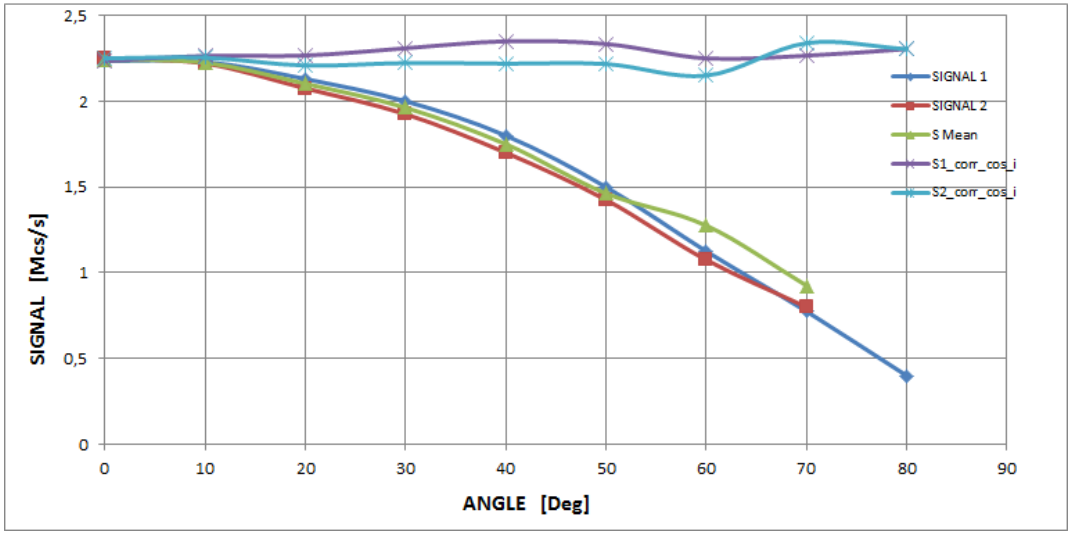
- Characterizing SiPMs, e.g. PDE:




- Catania measurements corrected for cross talk.
- Peak PDE at ~ 450 nm of ~ 40%.

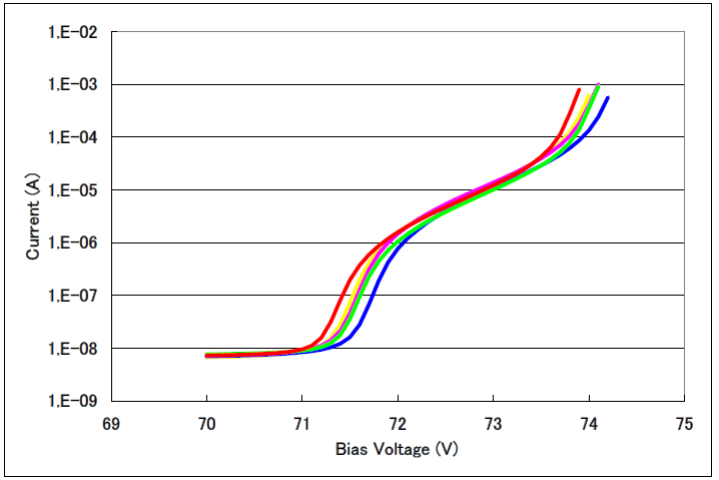
# Camera development – ASTRI

- Signal as func. of incidence angle of light on SiPM:




- Signal decreases with cos θ, i.e. in proportion to light hitting sensor, to angles of incidence of (at least) 80°.

- ASTRI consortium has received 530 SiPM.
- I-V tests at Hamamatsu being repeated in Catania.




- Establishing quality control procedures for camera construction.

# Pointing

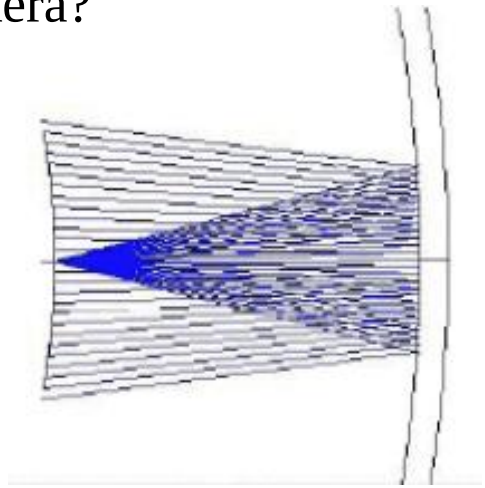
Jacco Vink

- Dutch contribution to CTA.
- Determine position of images to high accuracy.
- E.g. by imaging stars during observations.
- Use camera?
  - Saturation?
  - How many stars/field needed?
- Alter camera?
  - Replace one module/pixel by CCD camera?
  - Use light guides between modules?
- Funding sought.

# Calibration

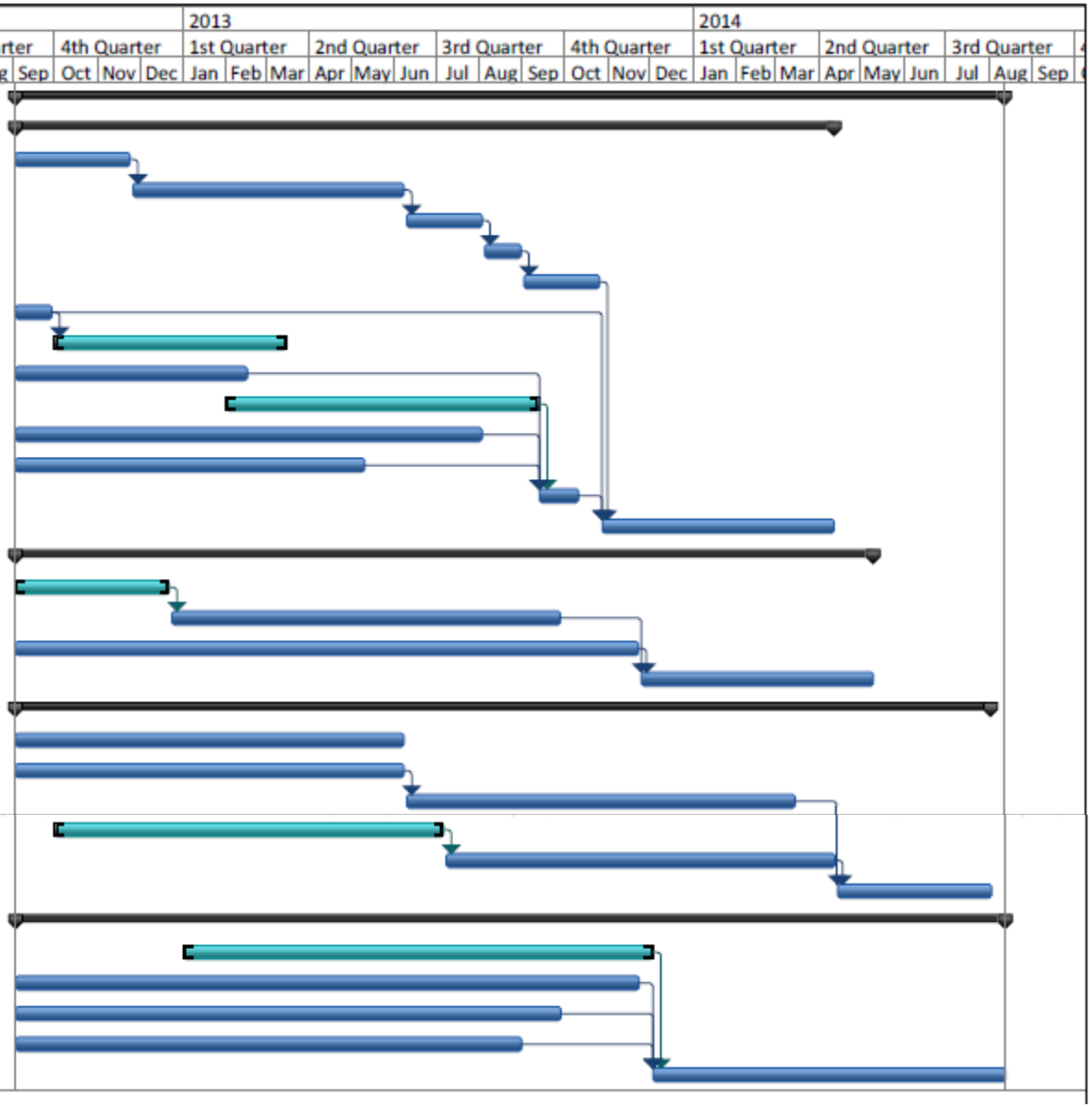
Alberto Segreto, Michael Daniel

- Use “photon statistics”: variance of NSB images.
- Verified with UVscope at Auger.
- Use calibration system; need flat, uniform, fast pulse at right wavelength.
- Look e.g. at LEDs with suitable driver circuit.
- With monolithic secondary, can mount on camera?



# Developing overall SST project planning

| ID | Task Name | Duration |
|---|---|---|
| 1 | **SST Prep Phase** | **506 days** |
| 2 | **ASTRI prototype** | **420 days** |
| 3 | STR design | 3 mons |
| 4 | STR prod | 7 mons |
| 5 | STR assembly | 2 mons |
| 6 | STR test | 1 mon |
| 7 | STR site assembly | 2 mons |
| 8 | MIR test | 1 mon |
| 9 | MIR manufacture | 6 mons |
| 10 | CAM front end | 6 mons |
| 11 | CAM back end | 8 mons |
| 12 | CAM software | 12 mons |
| 13 | CAM mechanics | 9 mons |
| 14 | CAM test | 1 mon |
| 15 | Site test | 6 mons |
| 16 | **SST-GATE prototype** | **440 days** |
| 17 | STR design | 4 mons |
| 18 | STR build | 10 mons |
| 19 | MIR build | 16 mons |
| 20 | TEL test | 6 mons |
| 21 | **DPNC camera** | **500 days** |
| 22 | Pixel design/test | 10 mons |
| 23 | Electronics design | 10 mons |
| 24 | Electronics prod | 10 mons |
| 25 | Mechanics design | 10 mons |
| 26 | Mechanics prod | 10 mons |
| 27 | Test | 4 mons |
| 28 | **CHEC camera** | **506 days** |
| 29 | Back end electronics | 12 mons |
| 30 | Front end elect | 16 mons |
| 31 | Mechanics | 14 mons |
| 32 | Calib/test system | 13 mons |
| 33 | Test | 9 mons |



# Summary

- We have a 7 m DC SST structure “ready to go”.
- Ideas on how to mass produce a SiPM-based camera for a Davies-Cotton telescope are being developing.
- Funding is being sort to pursue this option and build a prototype device.
- A first design of a telescope of 4 m diameter has been produced to match this camera.
- Dual Mirror prototypes suitable for MAPM-based and SiPM-based cameras are progressing well.
- The design and prototyping of the mirrors for these telescopes is going well.
- The design of cameras for the DM prototypes is progressing.
- Calibration and pointing concepts are being developed.
- Much will be known at the end of 2013 that will allow the writing of the SST section of the Technical Design Report for CTA.