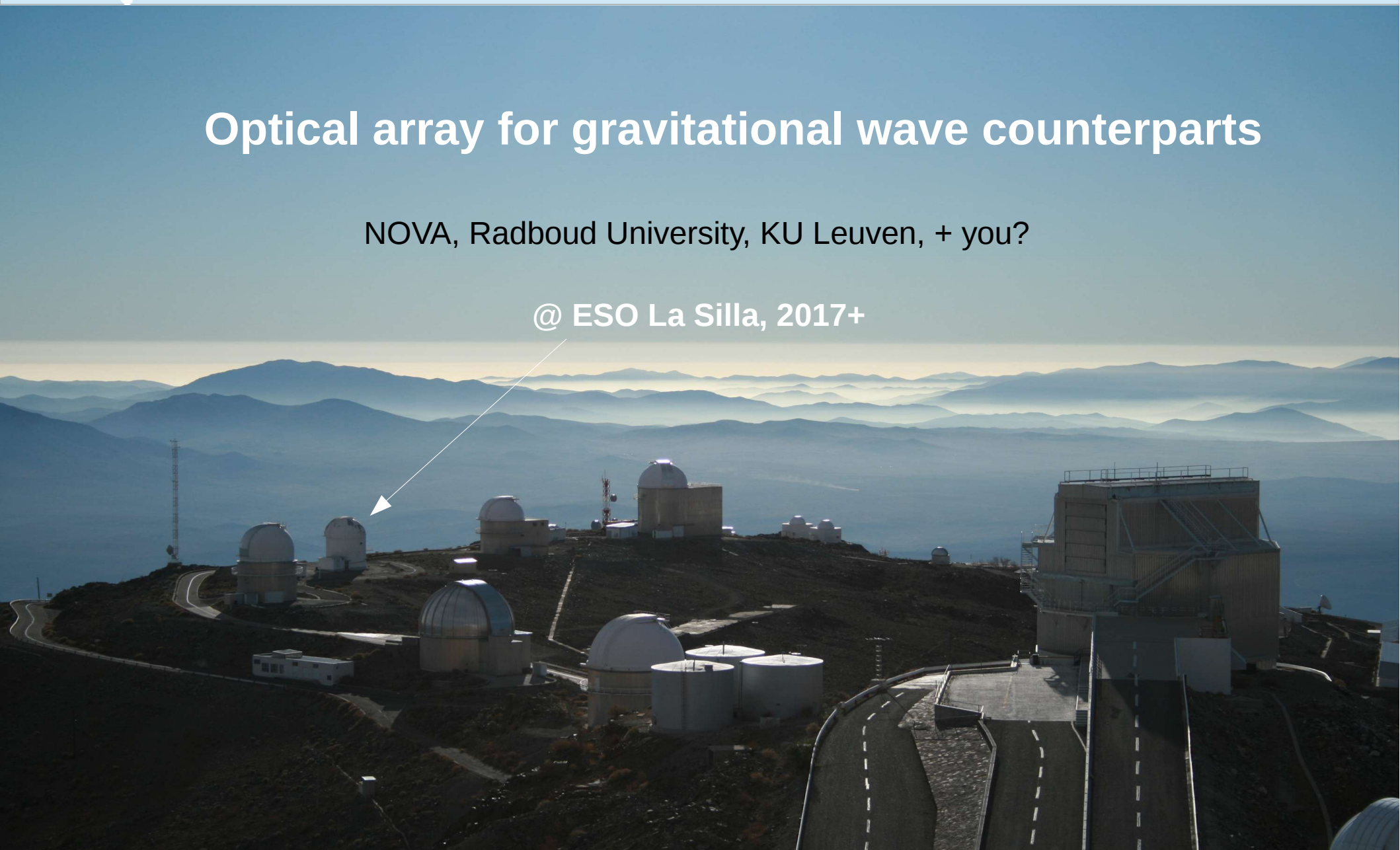
BlackGEM

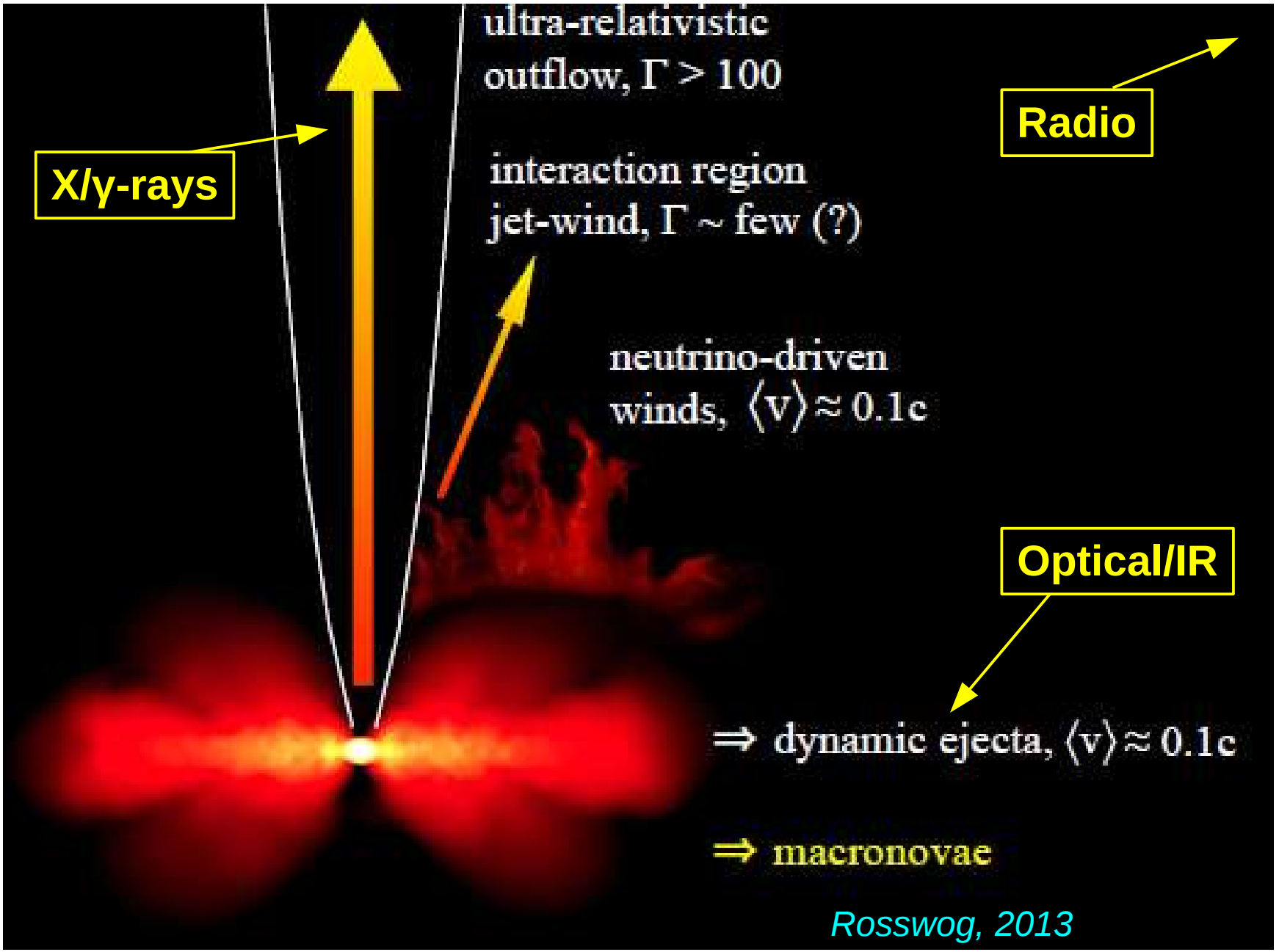
Optical array for gravitational wave counterparts

NOVA, Radboud University, KU Leuven, + you?

@ ESO La Silla, 2017+



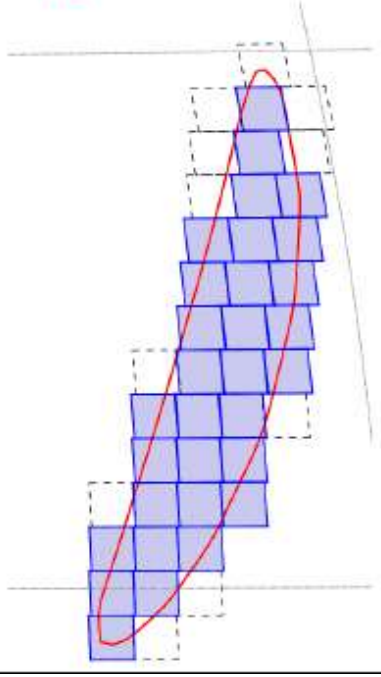
Which type of EM?

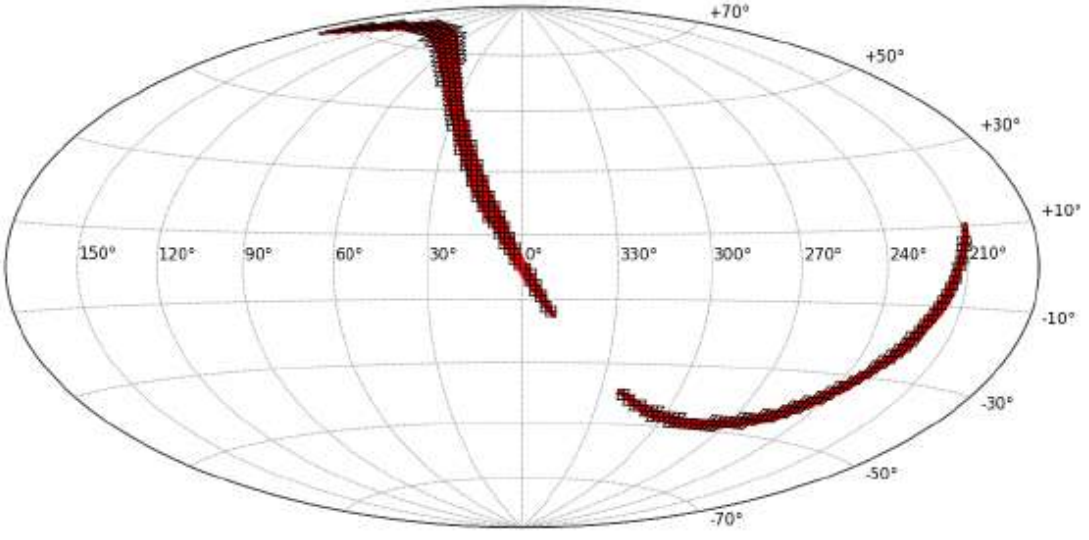


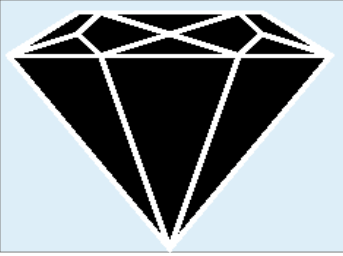
BlackGEM: GW Counterparts

+ Optical counterparts

- Challenges:
  - Poor sky localization (~100 sqd)
  - Faint (21st-22nd mag at 200 Mpc)
  - False positives
  - Gone in hours/days
- What do we need?
  - Large field of view
  - Sensitivity
  - Colour information
  - Dedicated facility for rates







BlackGEM Array

Dedicated, optical telescope array for GW events.

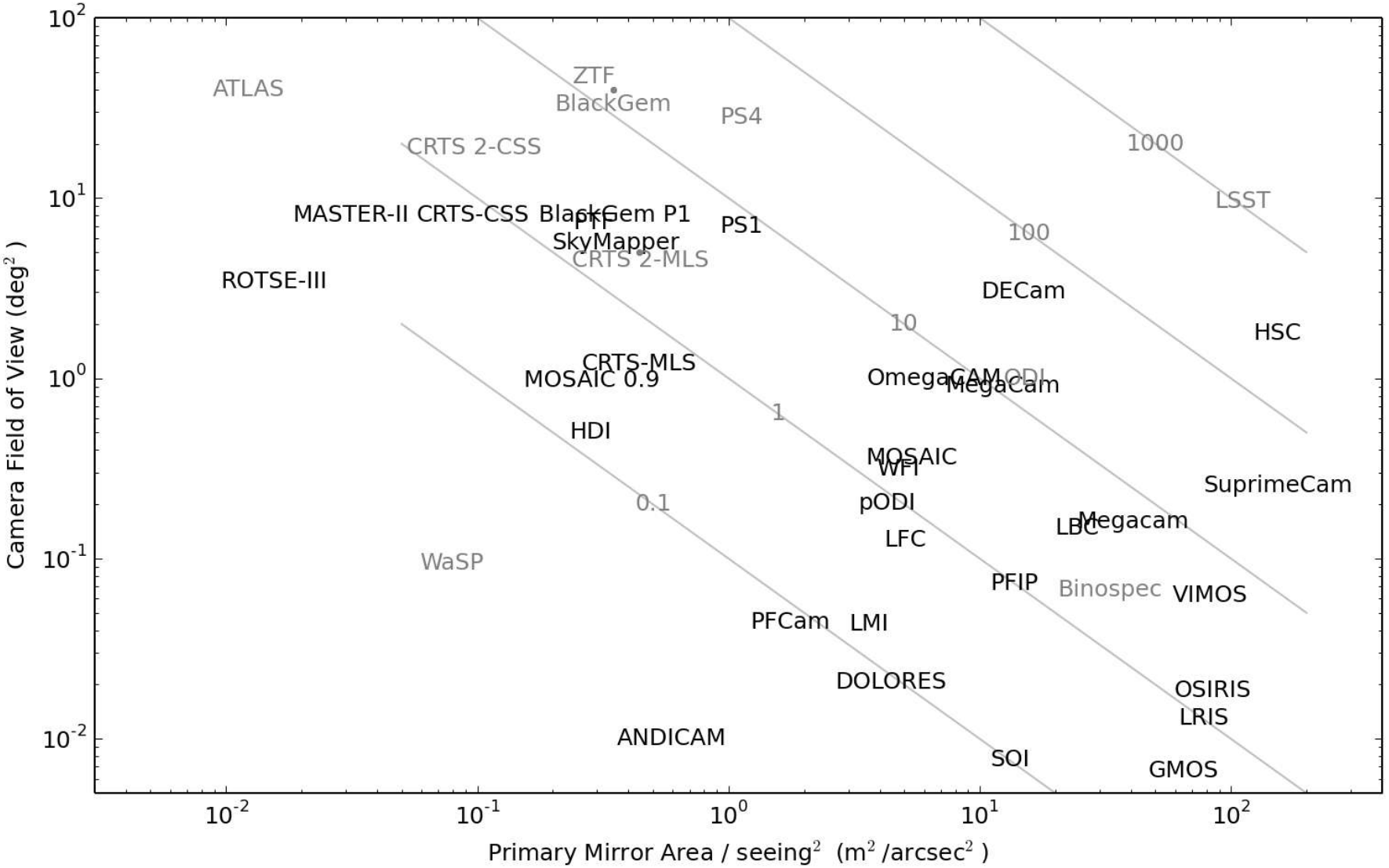
- 15 telescopes with 65cm diameter mirrors
- Field of view per telescope: 2.7 square degrees
- Total field of view: 40 square degrees
- Spatial resolution: 0.57″ / pixel (i.e. seeing limited)

- Flexible: fish-eye, combi-mode, full zoom
- Location: La Silla observatory of ESO
- Robotically, remote-controlled, triggered by Virgo/LIGO
- *Dedicated to GW events!*

Phase1 = 3 telescopes has now started *(NOVA, RU, FOM, NWO)*

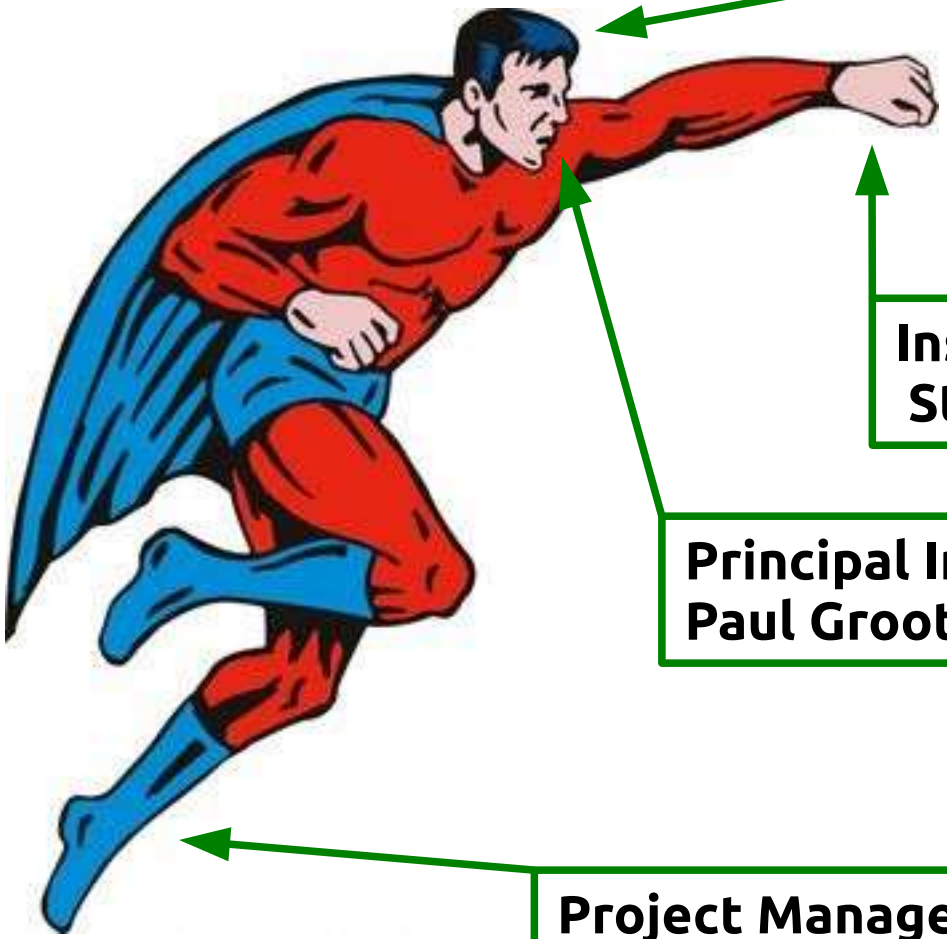
www.blackgem.eu and **@BlackGEM_Array**

BlackGEM Array



BlackGEM Array Team

Project Scientist ('brains'): Gijs Nelemans



Instrument Scientist ('golden hands'): Steven Bloemen

Principal Investigator ('mouth'): Paul Groot

Project Manager ('kicking feet'): Marc Klein Wolt

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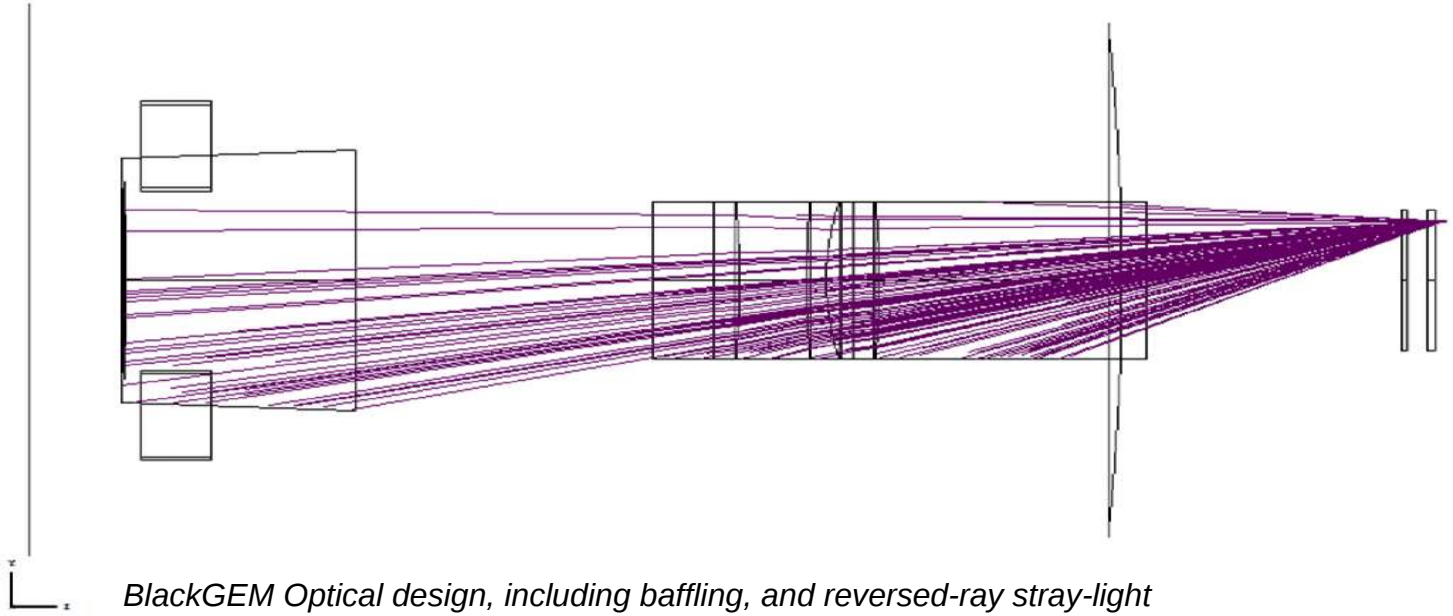
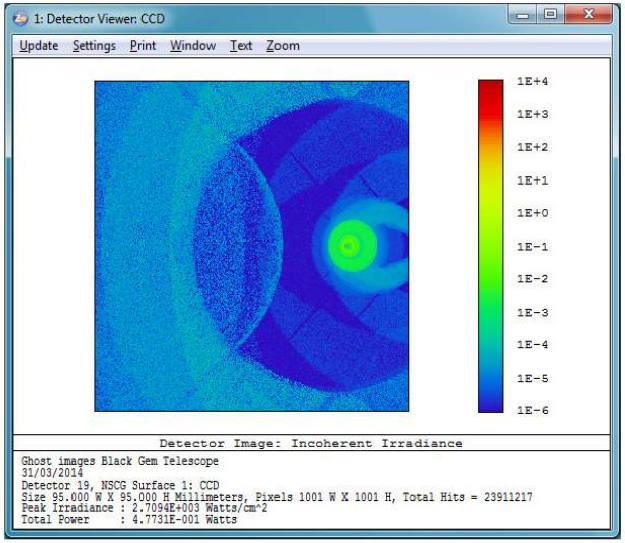
Optical design

- F/5.5, Wynn-Harper design, 65cm parabolic M1, 23cm spherical M2, triple corrector
- 9.5cm x 9.5cm flat focal plane, plate scale: 16 µ/asec: 0.562 ”/pix

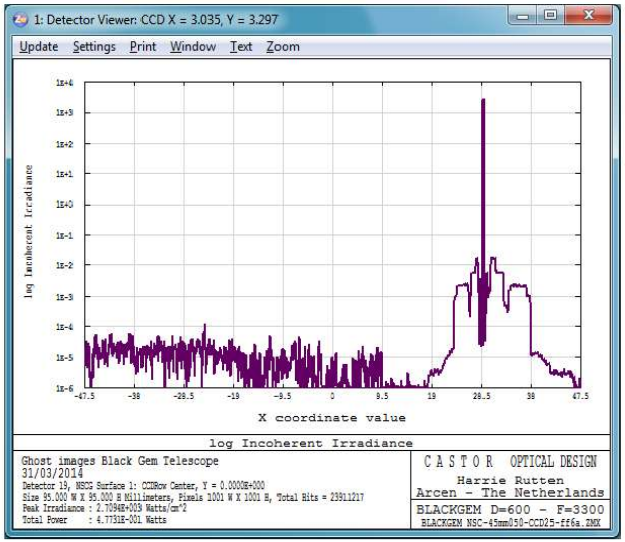
- Design: CasToR Optical Design (Harrie Rutten)
- Status: ***Finalized***, first optics ordered



BlackGEM Optical design, including baffling, and reversed-ray stray-light Analyses. Sky is on left, CCD is on right.



Ghost 0.50°, Reflectivity CCD 25%.



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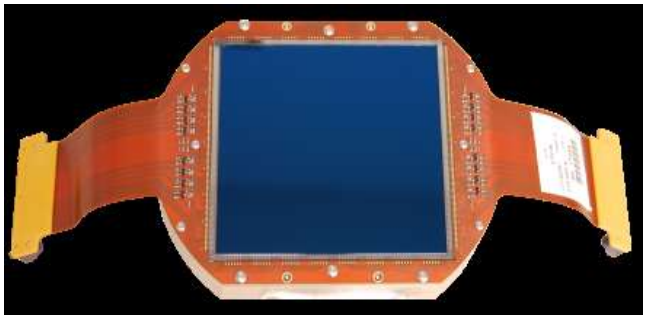
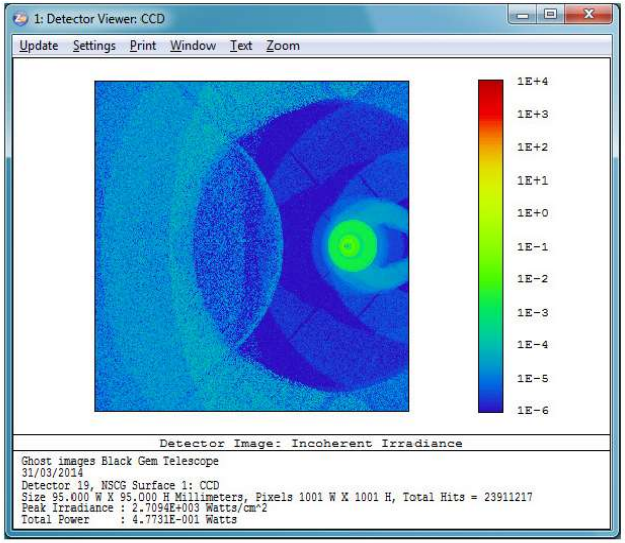
Ghosting analyses, here for Off-axis star (0.5d, with high CCD reflectivity): Strongest ghost is at level of 15 magnitudes.

CCD & Filters

- STA1600, 10.5k x 10.5k CCD, 9 µ pixel.
- Scale on sky: 0.562”/pix, total field of view: 2.7 sqd/telescope

- Manufacturer: STA, USA
- Status: ***Final***





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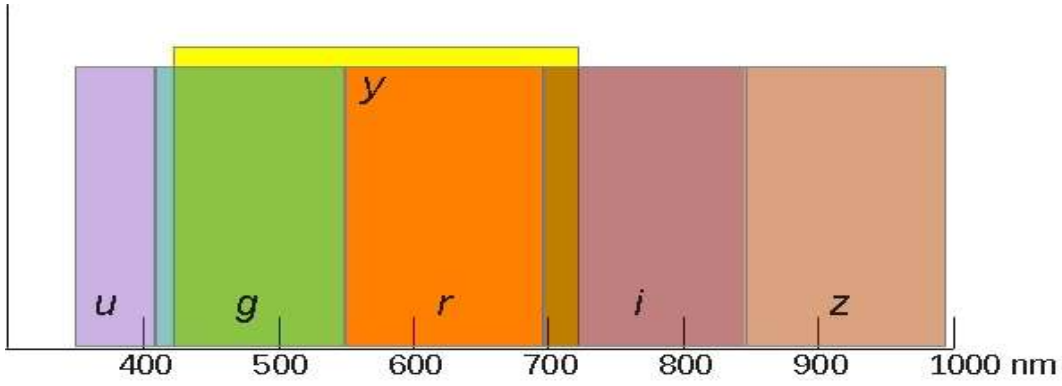
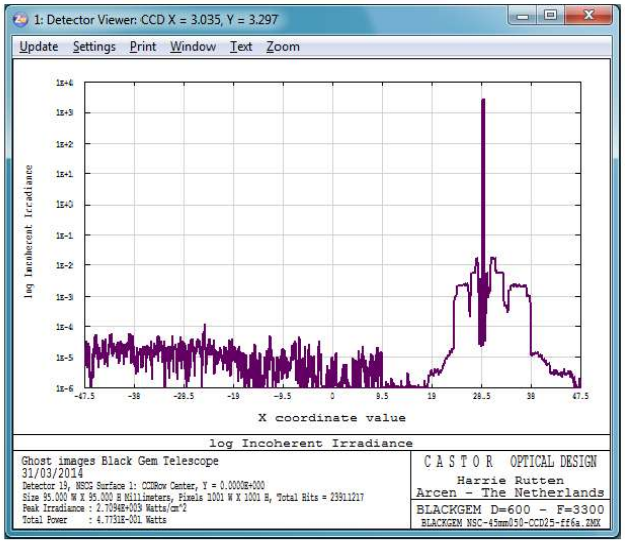
Filters:

Sloan u,g,r,i,z filters plus broad-band y (yellow, 440-720nm)





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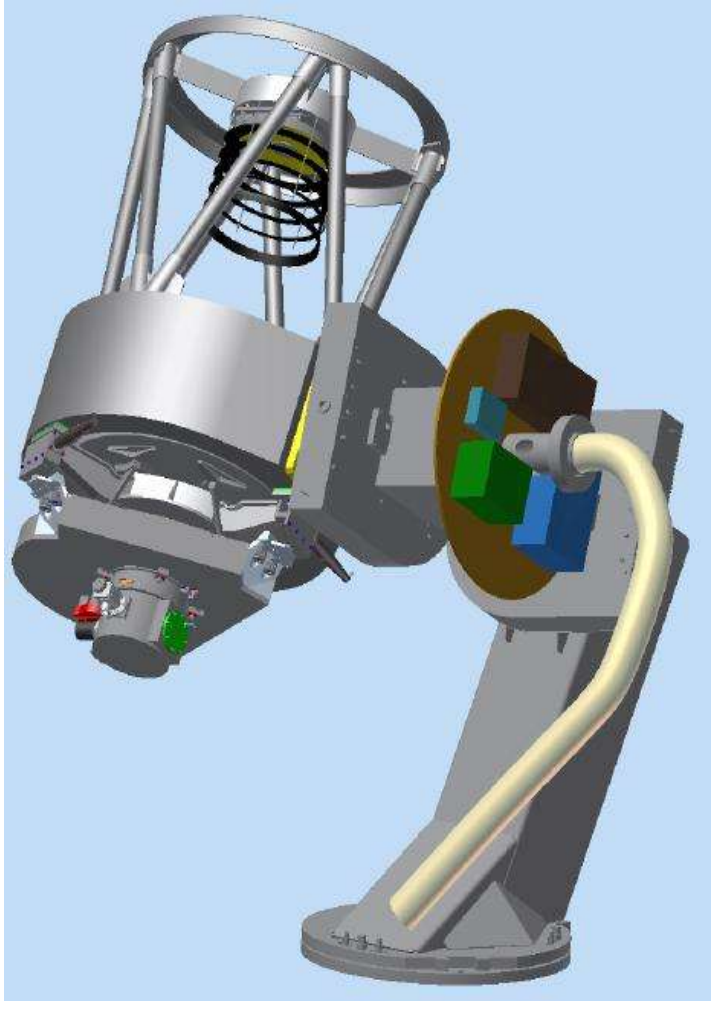
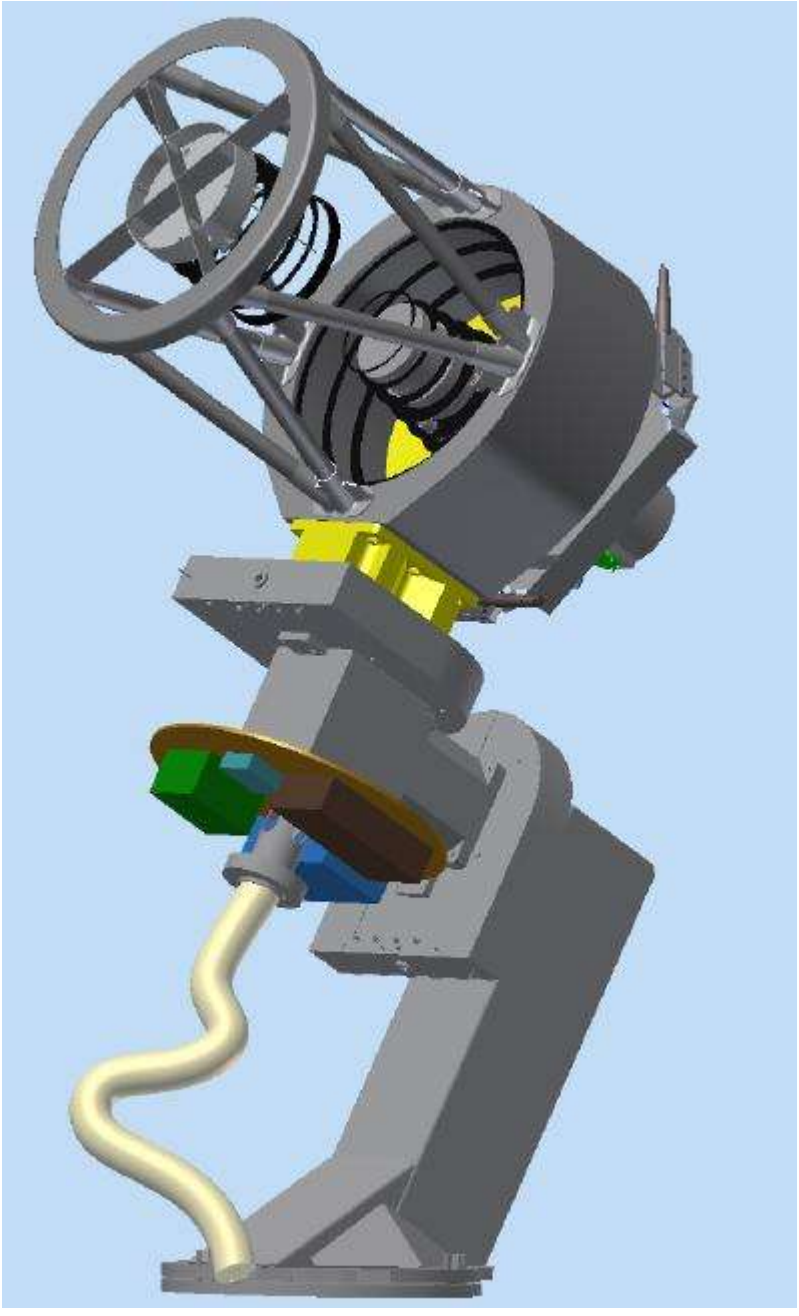
Mechanical design telescope

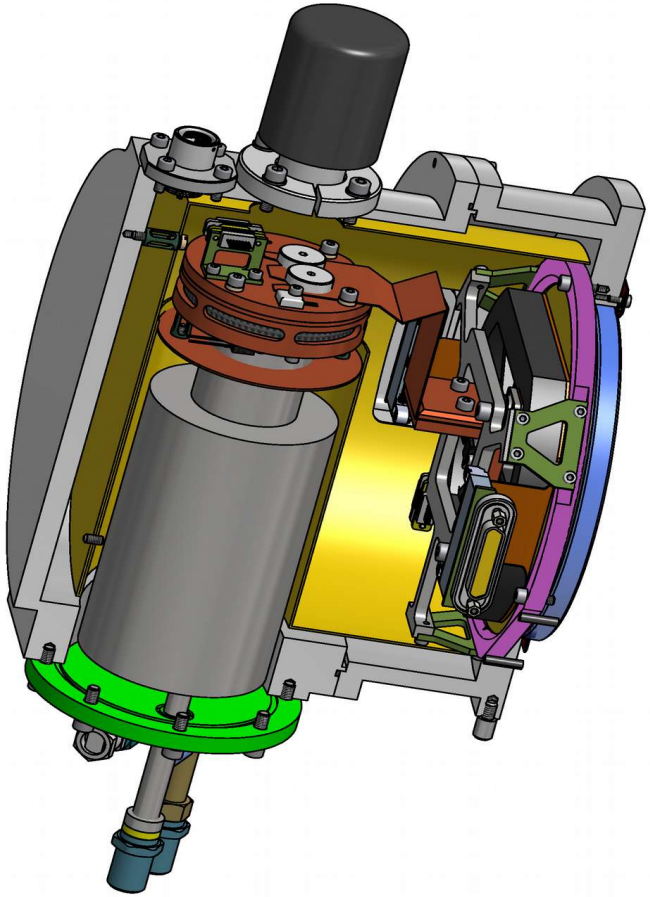
- Carbon-fibre structure
- Design: NOVA OIR, Mount Fornax 200 (co-designed)
- Final design & Manufacturing: Airborne Composites.
- Total mass: 150 kg.
- Status: ***In FDR, Airborne ongoing***

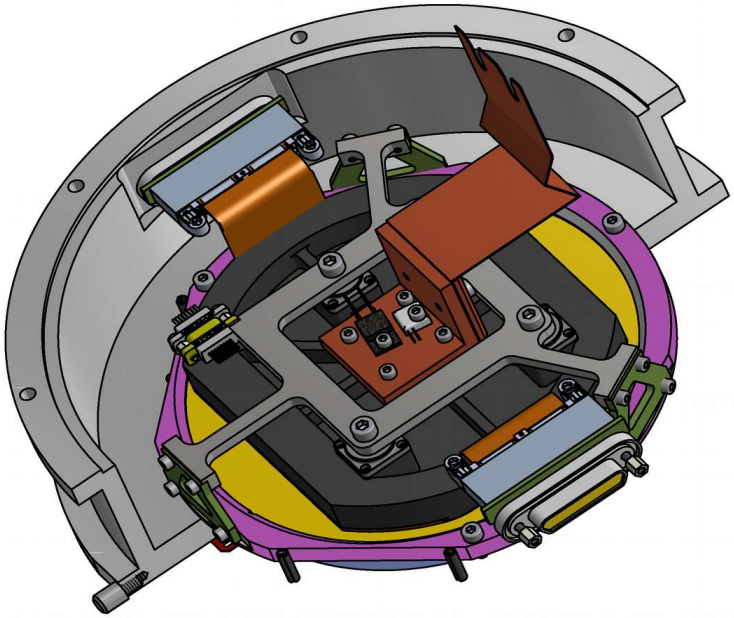


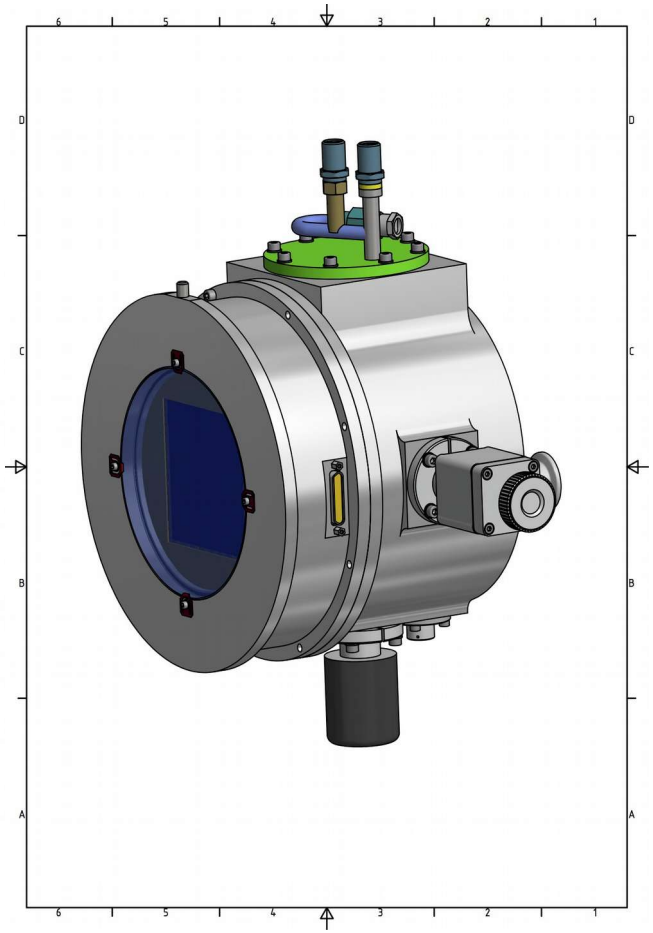


Cryostat

- Adapted version of Maia and Merope cryostats for Mercator telescope
- Joule-Thompson cooling, with compressor >10m away.
- Design & Manufacturing: KU Leuven
- Status: ***In FDR***

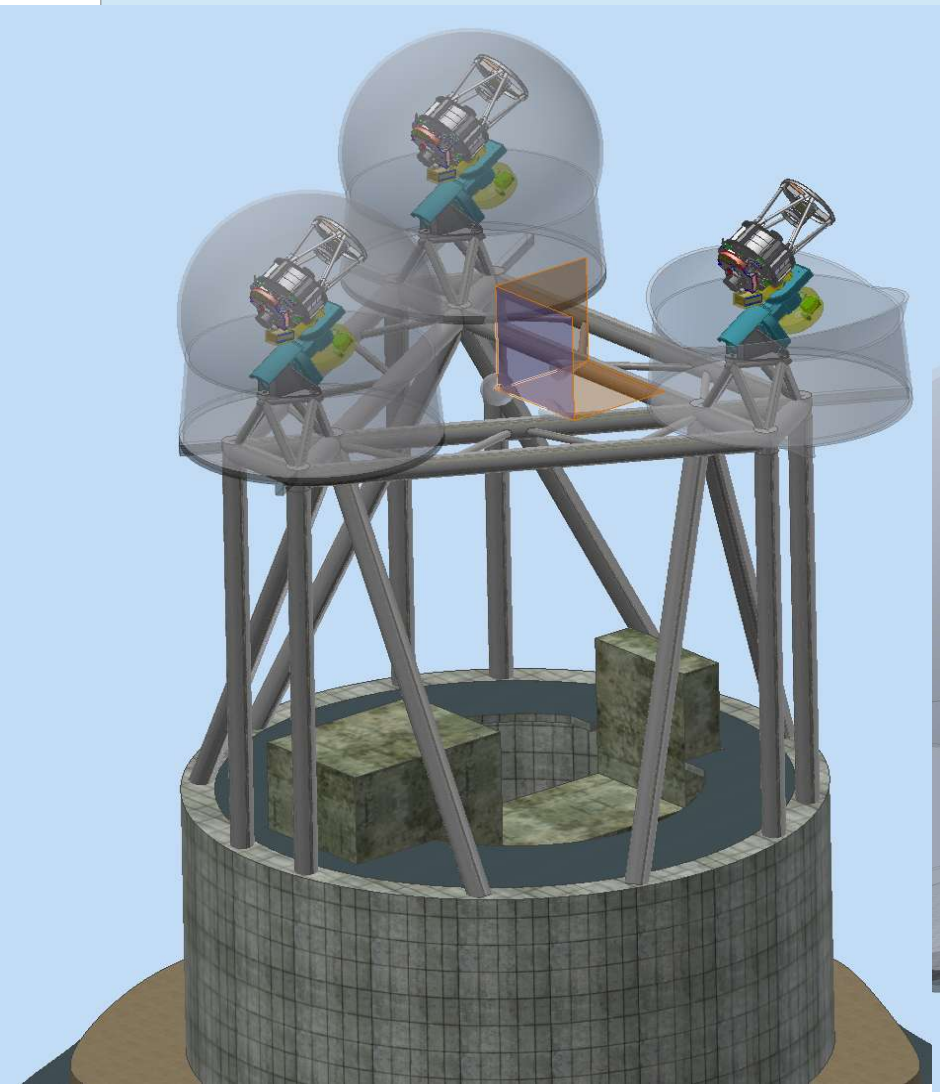


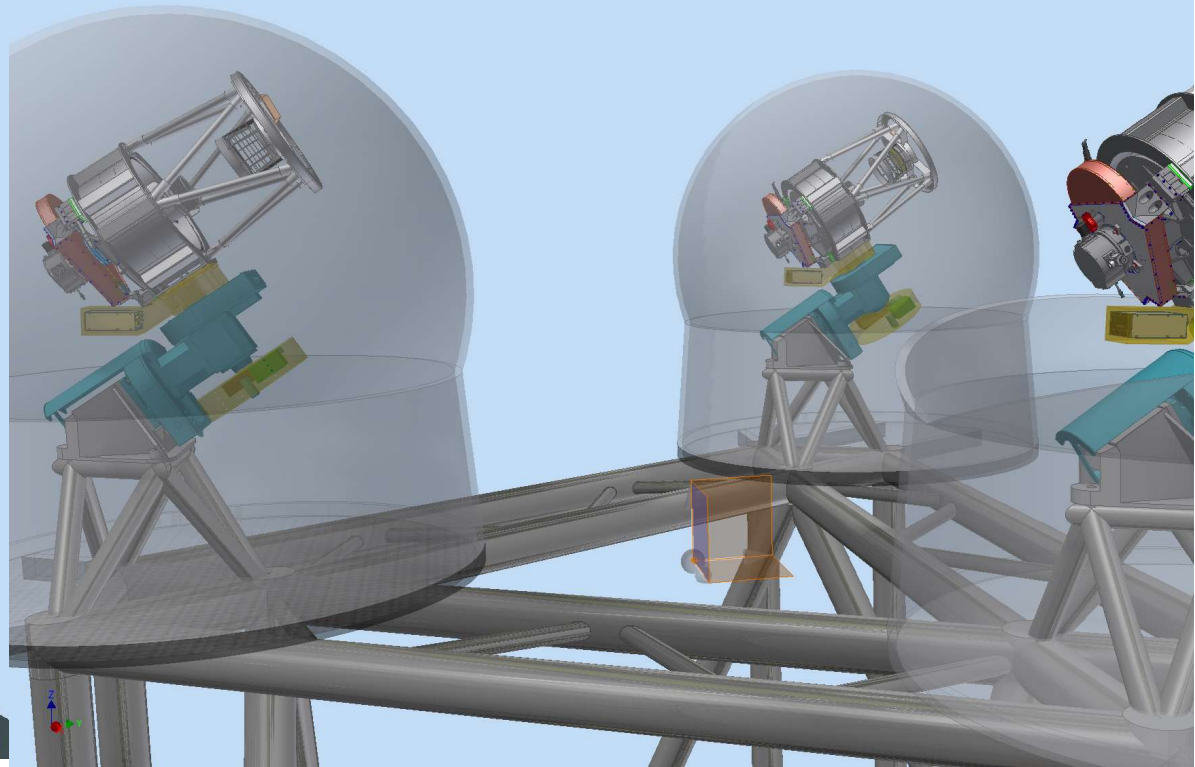




Dome

- MeerLICHT dome into current SAAO 20-inch building. Automated
- BlackGEM on GPO building. One Baader AllSky 3.5m per telescope. 3 domes on building
- Design: Radboud U. TechnoCenter.
- Status: in FDR





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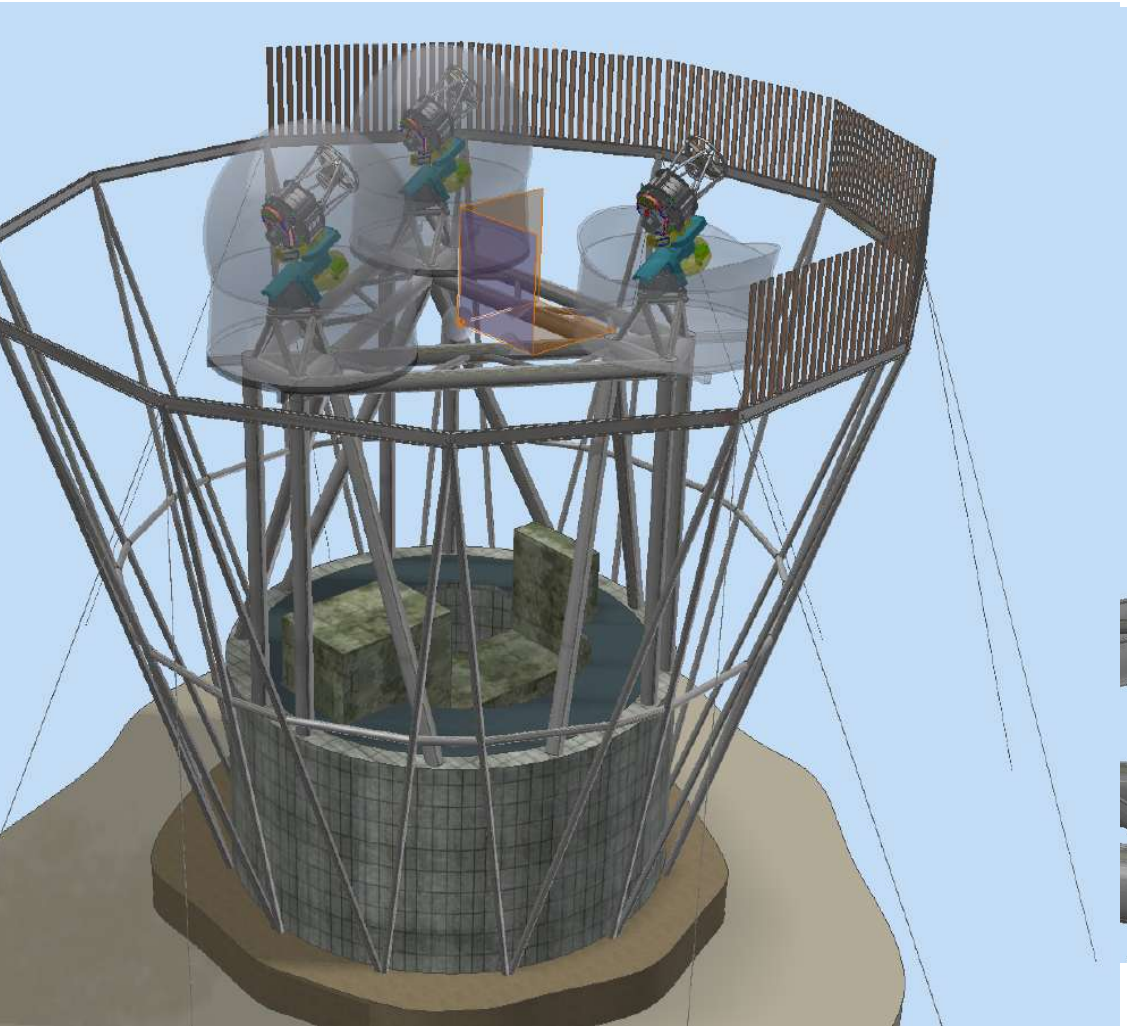
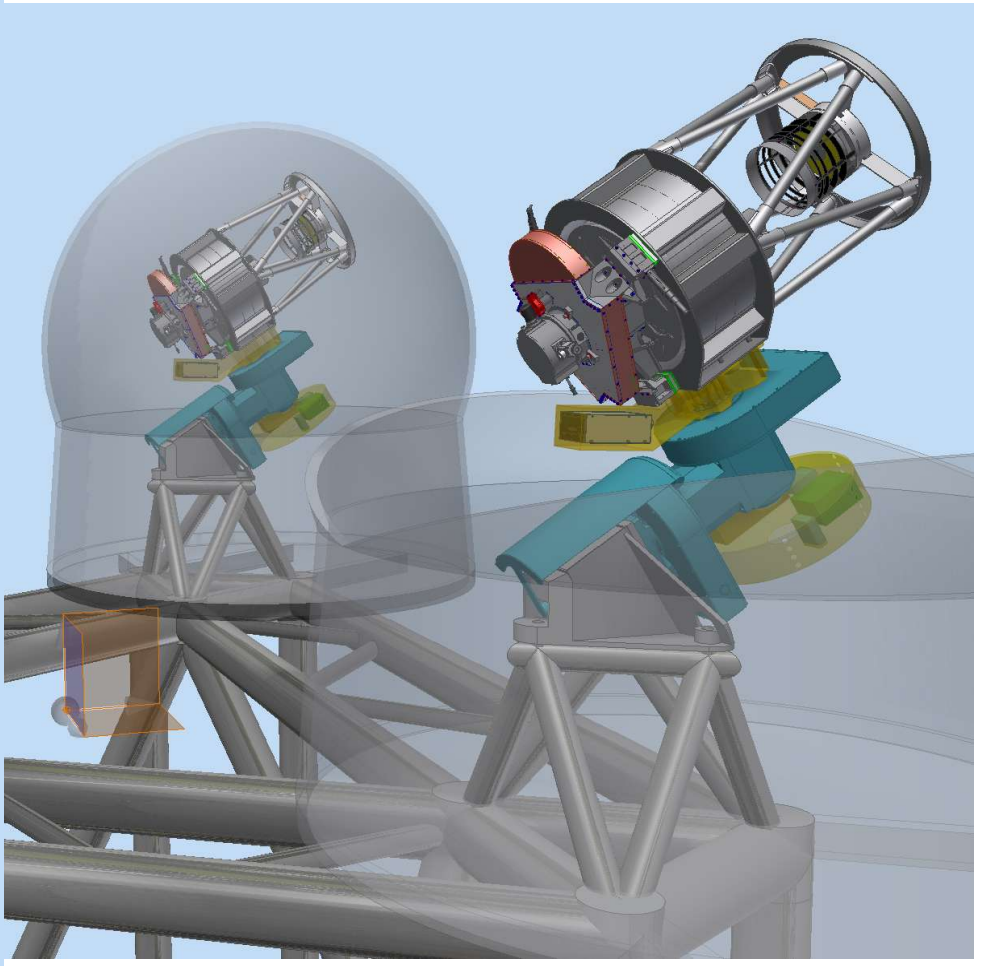




BlackGEM

Phase	*Time*
PDR	March 2014
FDR	Nov 2015
Commissioning MeerLICHT	June 2015
Commissioning BlackGEM	October 2016
Operations BlackGEM	Jan 2017 – Jan 2022

MeerLICHT: Pre-cursor telescope, installed at SAAO (South Africa).
To work in tandem with MeerKAT radio array.

Collaboration: Radboud U., Univ. Cape Town, NWO, NRF, Oxford

PIs: Woudt & Groot

First 'always-on' optical-radio synoptic/transient facility

Aim and Schedules

BG-SASS: (8 sqd, 2017)

Southern All Sky Survey

50% of time, dark time

Full Southern Sky in u,g,BV,r,i,z down to ~22nd mag

BG-FSS: (8 sqd, 2017) **Survey Phase**

50% of time, bright time

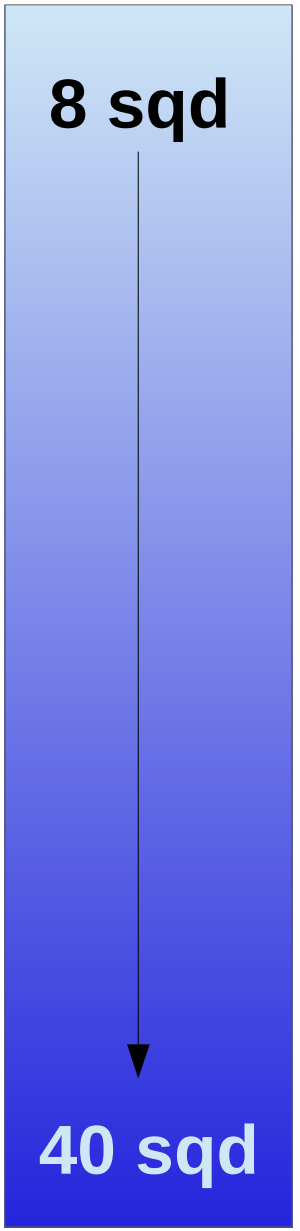
Rates : $N_{candidates}(l,b,\tau,mag,colour)$ $(degr^{-2}\,hr^{-1}\,mag^{-1})$

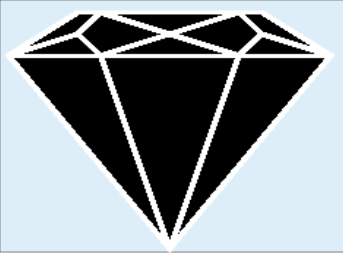
- Number of fiducial fields: ~200 square degrees
- Cadence: once every minute, in 2 bands (BV,r)
- Time per sqd: 7-14 nights

BG-TSM: (8-40 sqd, 2018+) **Trigger Phase**

GW events

- Follow-up on Virgo/LIGO detections
- Cover the error boxes in a tiling pattern (Fly's Eye Mode)
- Follow late-term afterglows (Zoom Mode)





Join us...?

Your input needed now:

- You can become a consortium member (5 yrs)

  → BlackGEM PI Level (you and your students): 100 kEuro
  → BlackGEM Institute level (your institute): 650 kEuro
  → MeerLICHT (your institute): 100 kEuro

- Expected to lead science case (e.g. SNIa, TDEs, RR Lyrae)

- Welcome if no conflicting interest with current members

Contact Paul Groot (p.groot@astro.ru.nl)

Twitter: @BlackGEM_Array Website: www.blackgem.eu (next week new site!)