

BlackGEM Team & Consortium

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Consortium Partners in Phase 1:



Radboud Universiteit





PI Contributions from:

Weizmann, Tel Aviv, Hebrew University, Potsdam, Manchester, DTU Copenhagen, UC Davis, Texas Tech University, UC Dublin, Valparaiso



BlackGEM Telescopes

BlackGEM @ ESO La Silla 3 telescopes installed early 2020 Each telescope 2.7 square degrees f.o.v. 110 Mpix camera @ 0.56"/pix Six filters: *u,g,q,r,i,z*



Data Policy

- All data is fully reduced on the fly. At T+15 min all products are available through database:
 - Reduced, background subtracted images
 - Full-source catalogs with point-source measurements of all objects in every image
 - Transient catalog with transient candidates from difference imaging
- Transients will be announced publicly (TNS, Brokers) as soon as they are validated
- Within the consortium: all data is accessible to all partners immediately.
- For the general public:
 - 1) Transient Alerts immediately announced
 - 2) Deep Sky Survey (images+catalogs) via ESO Archive
 - 3) Time-dependent data: in Data Releases (not a requirement, but an aim)



BlackGEM Surveys

- BlackGEM Trigger Mode: 'Transients Galore'
 - \rightarrow GW error box coverage in multiple colours (q,u,i, possibly +grz)
 - → 100s of sqd in multiple times over ~week time scale down to q=23 (also TDEs, SN of all types, Dwarf Novae, SN .Ia, SN Iax, etc.)

BlackGEM Southern All-Sky Survey: (BG-SASS) 'Southern Sloan' (1st year only)

- \rightarrow 30 000 sqd down to 22nd mag in *u*,*g*,*q*,*r*,*i*,*z* at 1" median seeing
- → By itself a fantastic resource for all kinds of science: (galactic streams/structure, dwarf galaxies, stellar populations, 'gems', quasars, weak lensing, high-z galaxies, etc.)
- \rightarrow First year only; MeerLICHT Sky survey will form starting point.

BlackGEM Fast Synoptic Survey (BG-FSS): 'Kepler on steroids'

- \rightarrow High cadence (5 min), multi-colour (*u*,*q*,*i*: simultaneous), wide-field
- \rightarrow Kepler Short Cadence-type sampling on millions of objects
- \rightarrow Deep drilling fields: thousands of exposures over weeks time-scale
- → Flexibility for experiments: continuous read-out, six filters, etc. (fast transients, asteroids, KBOs, early SN, interacting binaries, eclipses etc.)

• BlackGEM Local Transients program (BG-LT): 'Fast and Early'

- → Survey local mass concentrations (<100 Mpc) for young/fast transients every three hours in u,q,i; repeat same fields every night given visibility.
- \rightarrow Note that for all pointings except MW Galaxy and Magellanic Clouds: 80% pixels is cosmological

• BlackGEM Q-Scan survey (BG-Q): 'Wide Monochrome'

→ wide field survey every 3 nights (1st yr) and 1 nights (yr 2 and on) of 1000/2000 square degrees in q-band only

Survey Planning per Telescope

In case of GW Trigger: All three telescopes participate to cover error box for ~1 week timespan or until definitive counterpart is found.	
Telescope 1 :	 * BG-LT, every 180 minutes for a 90 minute slot 50 sqd in u,q,i every 3hrs * BG-Q, every 180 minutes for 3x90 minute slots per night 162 sqd per 90 minute slot, i.e. ~500 sqd per night Two sets of 500 sqd fields on 2 nights, repeated on nights 3/4, 5/6,7/8 etc.
Telescope 2:	 * 1st year: BG-SASS-qscan combi Southern sky (δ<+30d) Each field covered in four exposure sets, combining filters: (q, qur, qgi, qz)
	* 2 nd + years: BG-Q - 1000 sqd per night, repeated every night
Telescope 3:	 * 1st year: BG-SASS-qscan combi (on dark nights) Southern sky (δ<+30d) Each field covered in four exposure sets, combining filters: (q, qur, qgi, qz) * 1st year: BG-FSS (on bright nights) Continuous observations in u,q,i on single field (2.7 sqd) for 2 weeks
	* 2 nd + years: BG-FSS (always)

- Continuous observations in u,q,i on single field (2.7 sqd) for 4 weeks



Survey Planning 1st year

One-month view Telescope by Row

Pink = BG-SASS Yellow = BG-FSS Green = BG-Q Blue = BG-LT





Survey Planning 2nd+ year

One-month view Telescope by Row

Pink = BG-SASS Yellow = BG-FSS Green = BG-Q Blue = BG-LT



BG GW Trigger mode

- After LIGO/Virgo/KAGRA trigger: Rank tile 95% of error box, down to q=23 every 2 hours
- If size allows: three filter follow-up: *u*,*q*,*i*. Use all 3 telescopes
- Continue for a week, or until definitive counterpart is found



Example:

GW190814 with MeerLICHT in u,q,i for a week. (De Wet et al., submitted)

BG Southern All Sky Survey

- Sky south of Dec < +30d, down to 22^{nd} mag in g,q,r 21^{st} mag in u,i,z
- Full coverage in all six bands: *u*,*g*,*q*,*r*,*i*,*z*. 5x60s exposures per filter
- Deeper/sharper version of MeerLICHT Southern All Sky Survey, currently underway

MeerLICHT Southern All Sky Survey, status Dec 2020









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BlackGEM Local Transient Survey

- Every 3hrs a 90min window
- In this window: 18 fields (2.7 sqd each) in three bands: *u*, *q* and *i*
- Nearby Universe galaxies/clusters, incl. Gal.Cen., MCs, Cen A, Fornax, Virgo, Norma, Centaurus Clusters



Points: d< 30 Mpc & B<14 mag; green: 120 brightest, blue 30 brightest

BlackGEM Fast Synoptic Survey

High Cadence survey to characterize fast transient phase space: *"What goes 'bang'- 'bang' in the night?"*

 \rightarrow 60s integrations, 3 bands (*uqi* alternating), continuous for 2-4 weeks i.e. 900 (*uqi*) observations per week, 270s effective cadence on 2.7 square degrees.



- Fast transients
- Short-period variables
- Fast-moving objects

Outbursting AM CVn system; Levitan et al. 2012





BlackGEM Q-Scan Survey

- Single filter (q), large area survey for slower/rarer transients
- First year on 1 telescope only: 1000 square degrees over 2 nights, repeated every 3rd/4th night.
- Second year on 2 telescopes: one as above, + 1000 square degrees every night
- Possibility for wider/shallower with decreased integration time, e.g. 30s instead of 60s
- Geared towards SN Ia, TDE, SLSNe
- · Colours to come from follow-up telescopes after discovery in particular LCOGT
- 'Rolling' area with time.

