GW EM identification

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Science Drivers

- ALIGO/AVIRGO developments of course

- Transient sky (as highlighted in the USA decadal survey, LSST 2020+)

Science Requirements

- Our interprepretation of GWEM requirements:
  Fov > 50 square degree's
  Limiting mag V=20.0-21.0 within a few minutes
  Ability to construct potentially complex shaped fov's
  colours?
  Large pixels so serious sky contribution especially in the IR => optical
- Detection implication => nightly whole sky survey needed.

Practical Considerations 1

- Little funding available at the moment – needs to be cheap
- To have any chance of funding must be clear UK leadership. But GW physics one of the top priorities of most major funding agencies.
- Upgraded interferometers start in 2015, expect to take a few years (?) to reach potential.
- SuperWASP experience (most successful ground based exoplanet survey) – cheap and fast

Practical Considerations 2

- Complex field shapes implies multiple units
- Relatively rapid deployment needed => reusing existing technology if possible.
- Availability of large classical telescopes nearby implies candidate identification priority
- Further implication of this is rapid reduction system and communication.

Why La Palma?

- Area of maximum localization accuracy for the 3 interferometers - but x2 lower sensitivity than mainland USA

- Already have infrastructure/local knowledge/contact etc on La Palma (both in the SWASP and ING/IAC contexts)

Gravitational-wave Optical Transient Observer - GOTO

A dedicated GWEM observatory

- Two optical designs based 25cm or 20cm customized astrographs
- White light (colours possible but will have survey speed implications)
- GPU based real time reductions
- On La Palma nearby telescopes for detailed examination of transient source – 2m LT, 4m LT2 (?), 4m WHT, 8m GTC

Ball park hardware costs

- Optics: 20cm - £8k, 25cm - £12K
- Detectors: £10K (Kodak interline 29 Megapixel 40-50% QE from 400-680nm)
- Mount: £40K (10x20cm or 8x25cm)
- Enclosure: £50K (+£10K site prep).
- On-site computing: £20K

- Doesn't include UK based computing or staff

Simulation results

	25cm f2.8	20cm f2.8
Pixel scale (arcsec/pix)	1.7	2.0
Fov / telescope	6.63	9.0
$T_{20.0}$ (sec)	3x18	3x37
$N_{20.0}$ Tel. (10hr survey)	~8	~10
$C_{20.0}$ (£K)	296	300
$T_{20.5}$ (sec)	3x43	3x95
$N_{20.5}$ Tel. (10hr survey)	~14	~21
$C_{20.5}$ (£K)	448	528
$T_{21.0}$ (sec)	3x105	3x230
$N_{21.0}$ Tel. (10hr survey)	~30	~50
$C_{21.0}$ (£K)	900	1200

Implications from simulations

- Whole sky survey speed driving the cost
- Contributing factor – low detector QE

- To go fainter than the sky => much smaller pixels (eg BlackGem). Very Important when considering limiting magnitude during bright moon.

- Modular design

- Whole sky per night at V=20.5 possible. Whole sky at V=21 possible with increase in detector QE (40 -> 60%).

Other points

- Other detector options available eg CCD 4x4K with 60-70% QE for £20K
- Have not included volume discounts which could be significant (maybe 10-20%)

- Independent control of individual telescopes => mimic error ellipses/boxes
- Rapid deployment: 1.5 yr from cash to sky (limited operations)
- Yearly running costs low

Summary

- Nightly whole sky survey to V=20.5 certainly feasible now with on-site hardware costs around £0.5M.
- Extension to V=21 possible with improved CCD QE
- Modular telescope design allows mimicing interferometer detection fields

- On-site hardware costs ~£0.5M running costs (including spares ~£25k/year). Staff costs excluded.