## **LSST:UK Science and DAC plans**

S.J. Smartt (Queen's University Belfast) and Bob Mann, George Beckett (University of Edinburgh) on behalf of LSST:UK Consortium





LSST:UK Consortium

https://www.lsst.ac.uk/



Photo credit : Owen McBrien

## LSST:UK

- MoA signed in 2015 (STFC and LSST)
- UK (through STFC) is funding 100 PI positions
- Each PI has 4 "junior associate" positions grad students or postdocs
- Benefits equivalent to US scientists : "full access to LSST survey data and data products"
- LSST:UK decide the 500 positions in competitive application process : currently 90 of the 100 PI positions filled
- LSST:UK Phase A : 2015 2019 (funded)
- LSST:UK Phase B: 2019 2023 (submitted, under review)





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#### **UK involvement in the** Large Synoptic Survey Telescope: Phase B

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STFC



# UK Data Access Centre

### (Project Lead : Bob Mann)

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#### •We plan a DAC to meet UK science requirements

- Curate and support analysis of LSST Data Releases
- IntegrateUK-held multi-wavelength datasets & support follow-up
- Hosting and operating the LASAIR transient broker
- Facilitating UK contributions to Science Collaboration computation

#### Operate as a node in a coordinated international DAC network

- Full functionality of the LSST Science Platform
- *IRIS:* a new national computing infrastructure for STFC-funded science





# UK Data Access Centre

#### • Proto-typing relevant technologies :

- Implementing UKIDSS DB in qserv
- Comparing qserv performance on bare-metal DB nodes
- Processing ZTF alert stream with developing LASAIR broker
- Trialing DESC simulation runs on GridPP (UK LHC grid)
- Running Jupyter Notebooks under Kubernetes on OpenStack
- Goal: proto-DAC running on IRIS by end of Phase A (March 2019), then hardened for production in time for start of Commissioning

Technical discussions underway with IN2P3 colleagues; keen to broaden discussion to include other International Contributors (esp. in Europe)

Contact Bob Mann (rgm@roe.ac.uk): LSST:UK Project Leader & DAC lead

## LSST:UK Phase B (under review)

#### Four year programme of work 2019 - 2023

WP	Title	DI S.Y.
1	Management	4
2.1	DAC Management	1
2.2	Data Ingestion and Publication	3.5
2.3	Alert Handling Infrastructure	1.5
2.4	Provision of DAC Platform	2
2.5	Science Support	5
3.1	UK Solar System Science Server Software	4
3.2	LASAIR: UK transient broker for LSST	4
3.3	Transient Classification & Spectroscopic Follow-up	4
3.4	UK Variability Broker for LSST	4
3.5	LSST & Near-Infrared Data Fusion	6
3.6	3D LSST: Photometric Redshifts	4
3.7	Morphology & Low-surface-brightness Science	4.5
3.8	Strong Lens Discovery System	1.9
3.9	PSF and Sensor Characterisation & Modelling	4
3.10	UK's Contribution to DESC Operations	1.9
3.11	Cross-Matching Catalogues at LSST Depths	2
	Total	57.3

Data Access Centre (DAC)

> Level 3 data products:

Science Development (DEV)

Table 1 The Phase B Work Packages and their DI staff requirements

### LSST + near-IR data fusion





discovered z~6.8 quasar, combining optical DES and near-infrared VISTA Hemisphere Survey data. The deep "iband drop out" provides the redshift identification.

- Combined LSST ugrizy + VISTA YJHK
- Catalogue level queries and image level re-analysis
- Capability to re-process IR and LSST pixel data (matched phot algorithms)
- Basis : LSST software stack + additional modules
- Extension to EUCLID

UK leads: M. Banerji, R. McMahon

### LSST + near-IR data critical combination

### Depth vs. wavelength Evolving L\* red-sequence galaxy



Figure from : Harry Ferguson (STScI) Obscured QSO hosts z ~ 2-3 Figure from : Manda Banerji (Cambridge)

UK workshop on "LSST multi-wavelength data fusion"



# 3D LSST : photometric redshifts and error models



Figure 9.4 Simulated LSST Gold Sample and recovery with ANNz2. Histogram : true distribution; red: using point estimates of photo-z; blue: stacking photo-z posteriors (J. Soo, UCL), While ANNz2 has one of the best performances among current codes, the differences between the truth and the two photo-z methods are significant, necessitating further development and accurate error propagation.



ANNz2 : photometric redshift and probability distribution function estimation using Machine Learning (Sade, Abdalla, Lahav 2016)

#### UK DAC will provide :

- Galaxy catalogue with reliable photo-z and errors
- Propagate these to the DESC "Joint Probes" Cosmo pipeline
- Covariance modelling code integrated into DESC
- Extension to include NIR data

UK leads: B. Joachimi W. Hartley

## Galaxy Morpholog, strong lenses from UK lea Machine learning A. Ve

UK leads: S. Kaviraj A. Verma ++



Figure 9.5 H18 implemented on HST data produces clean morphological classes, without training sets, which can be labelled into standard morphological types e.g. ellipticals (col 7, 8) red spirals (col 2) etc.

- Catalogues of galaxy morphology classifications : (Hocking et al. 2018 code)
- Benchmarked with Galaxy Zoo and HST



- Pipeline to deliver optimised sky-subtraction on any scale to preserve LSB structures
- Algorithms to mitigate shredding by LSST software stack de-blenders
- Strong lens finders machine learning techniques

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Table 1 The Phase B Work Packages and their DI staff requirements

## Lasair - The UK: LSST Transient Server

[\* Pronounced LAH-sir. Scots and Irish Gaelic for *flash*, *flame*]

UK DAC will :

- Be a broker for the full LSST transient alert stream
- Ingest all LSST alerts in UK database
- Provide user access and value added (Level 3) data products



UK leads: S. Smartt, K. Smith, D. Young (QUB) R. Williams, A. Lawrence (Edinb.) M. Sullivan (Soton), I. Hook (Lanc.)





alert

## LSST Alert format example diaSource

### diaObject

"namespace": "lsst". "type": "record", "name": "alert". "doc": "sample avro alert schema v1.0", "fields": [ {"name": "alertID", "type": "long", "doc": "add {"name": "l1dbID", "type": "long"}, {"name": "diaSource", "type": "lsst.alert.diaSou {"name": "prevDiaSources", "type": [{ "type": "array", "items": "lsst.alert.diaSource"} {"name": "diaObject", "type": ["lsst.diaObject", {"name": "ssObject", "type": ["lsst.ssObject", ' {"name": "diaObjectL2", "type": ["lsst.diaObject "items": "lsst.alert.diaSource"} "namespace": "lsst.alert", "name": "diaSource". "type": "record", "fields": [ {"name": "diaSourceId", "type": "long"}, {"name": "ccdVisitId", "type": "long"},
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https://github.com/lsst-sims/sims\_alertsim



## Science products - kilonova ! Multi-wavelength and multi-messenger transient astronomy on tap



#### PS17egl

#### 13:09:48.08 -23:22:53.2 (197.45034 -23.38147)

#### See also: AT2017gfo ATel 11037 GW170817-NGC4993 SN2017gfo

Local Name: 7H3Gkpu Flag Date: Aug. 18, 2017 Survey: RING Processing Flags: nondets the targetfinders reffinders stamps locationmap eph ghost brightstar PS1 Name: PS17egl Number of Detections: 50 Object List: good Spectral Type: Internal Followup ID: 3254428 Internal ID: 1130948080232253200 Contextual Classification: sn Galactic (I,b): (308.37939,39.29597)

#### Aug. 18, 2017, 7:54 a.m. (ken.smith): Excellent detection

Context info: The transient is possibly associated with NGC 4993; a 13.32 mag galaxy found in the NED catalogue. It's located 8.80" S, 5.30" W (2.0 Kpc) from the galaxy centre. A host z=0.010 implies a transient M = -15.91. Possible GW Events Association: GW170817 (80% contour)



## Lasair Spectroscopic follow-up at ESO

UK DAC will :

- Provide targets immediately for ESO follow-up (classified by ML)
- ESO's NTT : SOXS (son of xshooter)
- ESO's 4MOST : 4 sq degrees + 2400 fibres
- VLT + xshooter
- Ingest data and classifications/redshifts back into Lasair



TiDES :Time Domain Extragalactic Survey 250,000 Fibre hours (Sullivan, Hook, Nichol et al.



SOXS GTO (PI: S. Campana) 50% of telescope GTO for transients (2021-2026)

## Summary

- I. Major investment by the UK in LSST
- 2. Proposal to build a UK Data Access Centre (DAC) at University of Edinburgh
- 3. Build and exploit UK expertise and heritage distributed through UK
  - Massive multi-wavelength archives and data
  - Galaxy photometry and photo-z
  - Image analysis, lensing (weak and strong)
  - Star/galaxy separation
  - Processing and discovery of transients
  - Solar system science
- 4. Major funding proposal to STFC under review aim is to work with international collaborators in LSST to deliver data products and access