Computational synergies between LSST and SKA

Bob Mann
University of Edinburgh
*LSST:UK Project Leader*

[Image of LSST:UK telescope and SKA array]
Synergies between LSST & SKA

- Scientific synergies
  - Bacon et al (arXiv: 1501.03977) summarise synergies from cosmology, galaxy evolution, transients
  - UK in unique position to exploit the combination of SKA and LSST (and Euclid)

- Computational synergies (& complementarities)
  - Both technical and political/financial
  - Now is the time to start discussing details
LSST Basics

- Large optical survey telescope to be located in Chile
  - annular primary 6.5m effective; 9.6 sq. deg FOV
- Ten year survey from ~2022
- US-led: NSF + DoE (camera) plus foreign partners

- Four science themes
  - Probing dark energy and dark matter
  - Mapping the Milky Way
  - Exploring the transient optical sky
  - Taking an inventory of the solar system

system design: Ivezic et al (arXiv:0805.2366)
# High-level survey requirements

<table>
<thead>
<tr>
<th>Survey Property</th>
<th>Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Survey Area</td>
<td>18000 sq. deg.</td>
</tr>
<tr>
<td>Total visits per sky patch</td>
<td>825</td>
</tr>
<tr>
<td>Filter set</td>
<td>6 filters (ugrizy) from 320 to 1050nm</td>
</tr>
<tr>
<td>Single visit</td>
<td>2 x 15 second exposures</td>
</tr>
<tr>
<td>Single Visit Limiting Magnitude (5σ point source, AB)</td>
<td>$u = 23.9; g = 25.0; r = 24.7; i = 24.0; z = 23.3; y = 22.1$</td>
</tr>
<tr>
<td>Integrated limiting mag (5σ ps, AB)</td>
<td>$u = 26.3; g = 27.5; r = 27.7; i = 27.0; z = 26.2; y = 24.9$</td>
</tr>
<tr>
<td>Photometric calibration</td>
<td>&lt; 2% absolute, &lt; 0.5% repeatability &amp; colors</td>
</tr>
<tr>
<td>Median delivered image quality</td>
<td>~ 0.7 arcsec. FWHM</td>
</tr>
<tr>
<td>Transient processing latency</td>
<td>&lt; 60 sec after last visit exposure</td>
</tr>
<tr>
<td>Data release</td>
<td>Full reprocessing of survey data annually</td>
</tr>
</tbody>
</table>
Data Products: Level 1 – nightly processing

10^6 alerts per night: need “event broker” at NCSA to filter these

Archive Site
Difference Imaging Alerts within < 60 sec Solar System orbits < 24h

Summit Site

Base Site
Data Products: Level 2 – annual data release*

All extant data included:
• per-visit images
• per-visit catalogues
• co-add images
• co-add catalogues
• Per-visit forced photom.

* Twice in Year 1
Beyond requirements of LSST project delivery:
• needed for much science
• mainly coordinated through Science Collaborations
• may be incorporated into L2
UK participation in LSST

LSST:UK Consortium

Defines the programme of work for...

Works on behalf of...

LSST:UK Science Centre (LUSC)
1 August 2014: start of construction project

October 2019: telescope First Light

October 2022: start of main survey operations

September 2032: end of main survey
Phase A funding from PPRP

- £15M set aside for operations contribution
- Phase A programme (July 2015 – March 2019)
  - LUSC-DAC (Data Access Centre prep): 6 staff-years
    - DAC testbed, Data Challenges, supporting LUSC-DEV (Edin)
  - LUSC-DEV (Level 3 prep/development): 16 staff-years
    - Weak lensing: sims., PSF, deblending, Euclid synergy (Man/Oxf/UCL)
    - Milky Way: star/galaxy separation, tidal stream detection (Cam)
    - Transients: alert handling, classification, cadence (QUB/UCL/Soton)
    - Solar System: postage stamps, lightcurves (QUB)
    - Sensor characterisation: image analysis systematics (Oxf)
UK Data Access Centre

- Supporting UK community’s use of LSST data
  - Provide access to Level 1 and 2 data products
    - Generated in the US and France
  - Ingest and serve ancillary datasets
  - Support running of Level 3 data analysis
    - Providing LSST software stack & environment
    - Providing compute and storage facilities
    - Operating helpdesk, etc
  - Likely to be a coordinated network of DACs
    - Details unclear as yet...
DACs similar to the SKA Regional Centres
  - But with smaller computational requirements

Expectations:
  - Database: ~2PB in 2022 growing to ~31PB in 2032
  - Images*: ~30-50PB flat file storage
  - Compute*: ~20 TFlops in 2022 ➔ ~140 TFlops in 2032

*Very uncertain: depend on science goals and degree of coordination between DAC network
UK LSST/SKA synergies

- Scientific pull
  - Joint analyses: e.g. weak lensing, transients

- Political/financial push
  - STFC want common computing infrastructure across the PPAN area
    - Extension of GridPP?...or something cloudy?
  - Both projects need to understand how well they could fit a generic model and whether they share specific requirements – e.g. multi-PB databases
UK LSST/SKA complementarities

- Focus on different computational challenges
  - SKA: bulk processing, data transport
  - LSST: large databases, high transient rates

- Can we share expertise?

- Can we coordinate astro requirements for proposed STFC computing infrastructure?
Summary

- **Strong scientific synergies**
  - Key contacts: Sarah Bridle (LSST:UK PS), David Bacon (LSST:UK SKA Liaison)

- **Potential for technical collaboration**
  - Key contacts: Bob Mann (LSST:UK PL), George Beckett (LSST:UK PM)

- **Now is time to start discussing details**
  - Plans for DACs and Regional Centres are taking shape
  - Future of STFC computing under discussion