The DIA Science Unit (Transients & Variables)

Eric Bellm
DIA Science Unit Lead

Rubin Project & Community Workshop | 8 August 2023

Session Outline

- This talk:
  - Brief overview of the commissioning Science Units and their charge
  - Membership and current activities of the DIA Science Unit
  - Short summary of the assigned requirements

- Bruno Sanchez (Project DIA Update)

- Shu Liu (DIA Algorithms)

- Michael Wood-Vasey & ECB: next steps, group planning, & open discussion

Charge to Science Units

- Develop **methods/algorithms for evaluating science performance of the as-built system**, including identifying needs for on-sky observations and external reference datasets, for a set of formal requirements from the OSS and LSR (see charge for details)
- Assist Science Pipelines to **implement and test software to generate diagnostic metrics and plots**; develop additional code for specialized analyses
- **Suggest, prioritize, and perform ad hoc and science validation investigations** using on-sky commissioning data; report issues and recommend potential solutions and/or further studies
- **Document the results** in the form of tech notes and (sections of) Construction Papers

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Science Units

- **Throughput for focused light** – Merlin Fisher-Levine
- **Delivered image quality and PSF modeling** – Josh Meyers
- **Instrument signature removal / detector characterization** – Chris Waters and Yousuke Utsumi
- **Sky background / low surface brightness / ghosts and scattered light** – Lee Kelvin
- **Photometric calibration** – Jeff Carlin
- **Astrometric calibration / proper motions** – Clare Saunders
- **Survey performance / survey strategy optimization** – Lynne Jones and Leanne Guy
- **Object detection, quality flags, V&V sample production, survey property maps** – Peter Ferguson
- **Difference image analysis – transient and variable objects** – Eric Bellm
- **Difference image analysis – Solar System objects** – Mario Juric
- **Galaxy photometry / photo-z** – Dan Taranu and Melissa Graham
- **Weak lensing shear** – Arun Kannawadi
- **Crowded stellar fields** – Ian Sullivan
- **Eyeball squad / beautiful images**

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Science Unit Deliverables

- For system-level requirements, document science methodology to evaluate performance in dedicated technote linked from Jira LVV system
  - Target audience includes Systems Engineers, developers, and general LSST science users
  - Contains algorithmic description at the level of pseudo-code, including mathematical procedures as well as pass / fail criteria
  - Rubin Science Performance Metrics (RTN-038) – placeholder at the moment
- Implementation of science performance analyses as software
  - Science Pipelines (e.g., ComputeExposureSummaryStatsTask, analysis_tools, cp_verify)
    - Recommended default for analyses that touch calibration, image, or catalog-level data products directly
  - Stand-alone analyses
    - Utilities / scripts / notebooks residing in separate (Project-controlled) code repos?
- "Narrative" documentation
  - Technotes to describe detailed analyses
  - Sections of relevant construction papers
  - Additional infrastructure papers on specific topics

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Who we are

Science Unit Lead: Eric Bellm
US/Chile-11: Michael Wood-Vasey, Shu Liu, Bruno Sánchez, Gautham Narayan, Amanda Wasserman, Rick Kessler, Bob Armstrong, Saurabh Jha, Federica Bianco, Tatiana Acero Cuellar, Benjamin Racine, Dominique Fouchez, Rob Knop, Maya Guy
UKD-UKD-S13: Graham Smith, Dan Ryczanowski
US/Chile-10: Markus Rabus
US/Chile-09: Simon Birrer, Paul Schechter, Tansu Daylan
plus institutational contributors including Adrian Shestakov, David Wang

See https://sitcomtn-050.lsst.io/

Charged requirements

Difference image analysis – transient and variable objects

Notes	
Lead	@Eric Bellm
Normative requirements	• LSR-REQ-0043: Data Products for Dark Energy/Matter Science • LSR-REQ-0045: Data Products for the Transient Sky • OSS-REQ-0160: Level 1 Difference Source - Difference Object Association Quality • OSS-REQ-0351: Difference Source Spurious Probability Metric • OSS-REQ-0352: Difference Source Sample Completeness • OSS-REQ-0353: Difference Source Spuriousness Threshold - Transients • OSS-REQ-0339: Level 2 Source-Object Association Quality • OSS-REQ-0158: Coaddition for Templates for Subtraction • OSS-REQ-0164: Catalog Completeness and Reliability

https://confluence.lsstcorp.org/display/LSSTCOM/SIT-Com+Science+Units+Charge

These requirements fall largely in a few buckets.

completeness — do we find the sources we're supposed to?

purity — do we reject artifacts and junk?

spuriousness/reliability scoring — can we quantify that tradeoff?

source association — do we produce lightcurves for astrophysical objects?

validating each of these will rely heavily on injected sources.

The Science Unit is active and busy.

some current activities:

- building familiarity with DM code and processing in the USDF
- testing DIA performance around galaxy clusters for strong lensing
- theoretical work on DIA algorithms

future plans:

- ongoing algorithms work
- more rigorous strong lensing tests
- tests on larger precursor datasets
- develop more useful injection catalogs for the new source_injection package
- work with AuxTel DIA products
- refine plans for verifying assigned requirements

VERA C. RUBIN

OBSERVATORY