Report to AAAC on Euclid/LSST/WFIRST Coordination

Jason Rhodes (JPL)

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What is the TAG?

Euclid: ESA-led with NASA and Canadian contribution
LSST: DOE and NSF funded, plus international contributors
WFIRST: NASA with potential international partners

- Tri-Agency: DOE/NASA/NSF
- Tri-Project: Euclid/LSST/WFIRST
- Meet to discuss commonalities, coordination, optimization of data, simulations, software
- Three aspects to TAG:
    1. the agency program managers talking to each other, often as part of wider program communication
    2. the agencies plus project leads (what we usually mean by TAG)
    3. the project leads gathering input from their collaborations, e.g. informal “task forces”
- Informal group started in ~2012
- Discuss coordination on these three projects, primarily for dark energy
    - Other science areas are considered, but haven’t driven discussions
- Telecons every ~2 months
- Facilitates open communication about issues that affect all the projects and require joint or coordinated efforts of the agencies

Who is the TAG (new since January in bold)

- HQ Reps
  - Eric Linder and Kathy Turner (DOE)
  - Dominic Benford and **Eric Tollestrup** (NASA)
  - Nigel Sharp (NSF)
- Project Reps
  - Jason Rhodes (Euclid and **WFIRST** Project)
  - Steve Kahn (LSST Project)
  - **Phil Marshall** (LSST Dark Energy Science Collaboration/DESC Spokesperson)
  - David Spergel (WFIRST Formulation Science Working Group)

Philosophies

- The best dark energy constraints in ~2030 will come from a combination of Euclid/LSST/WFIRST data
- The teams that are processing those data best understand the data and should be involved in that combination
- We should maintain US leadership or co-leadership in dark energy science using these combined data sets
- Coordinating the cadences and survey footprints can increase science output
- The optimal combination of the data sets may need to be done at the 'pixel' rather than 'catalog' level
  - This requires coordination and goes beyond the scope of the projects
  - This needs to be done with forethought in order to be done correctly
- Simulations of the universe are computationally intensive and should be used by multiple groups where possible

LSST/Euclid coordination

TAG-informed activity, but done at project level

- Requires international agreements and careful examination of data rights
- Requires agreement of Euclid Consortium, LSST Project and LSST DESC
- In 2015, the TAG endorsed an effort at defining the scientific and technical benefits of coordination
  - Euclid Consortium, LSST DESC, LSST Project produced a joint charge that led to an in-person meeting of key scientists in July 2016
  - LSST/Euclid Synergy paper complete and under peer review
- Euclid/LSST Letter of Intent (LOI) is being drafted, completion expected this fall; will be followed by MOU for early data sharing by next summer

LSST/Euclid Synergy Paper

TAG-informed activity, but done at project level

Draft version September 18, 2017
Typeset using LaTeX default style in AASTeX61

SCIENTIFIC SYNERGY BETWEEN LSST AND EUCLID

Jason Rhodes,[1,2] Robert C. Nichol,[3] Éric Aubourg,[4] Rachel Bean,[5] Dominique Boutigny,[6] Malcolm N. Bremer,[7] Peter Capak,[8] Vincenzo Cardone,[9] Benoît Carry,[10] Christopher J. Conselice,[11] Andrew J. Connolly,[12] Jean-Charles Cuillandre,[13,14] N. A. Hatch,[11] George Helou,[8] Shoubaneh Hemmati,[8] Hendrik Hildebrandt,[15] Renée Hložek,[16] Lynne Jones,[12] Steven Kahn,[17] Alina Kiessling,[1] Thomas Kitching,[18] Robert Lupton,[19] Rachel Mandelbaum,[20] Katarina Markovic,[3] Phil Marshall,[17] Richard Massey,[21] Ben J. Maughan,[7] Peter Melchior,[19] Yannick Mellier,[22] Jeffrey A. Newman,[23] Brant Robertson,[24] Marc Sauvage,[13] Tim Schrabback,[15] Graham Smith,[25] Michael A. Strauss,[19] Andy Taylor,[26] and Anja Von Der Linden[27]

- Submitted to ApJS in August; responded to benign referee report
- Presented to Euclid and DESC consortia, LSST project, Euclid Board, ESA Euclid Science Team, LSST DESC leadership- all in favor
- Provides some quantitative rigor and depth versus previous work
- Meant to guide a future LSST/Euclid MOU

Paper covers:

1. Cosmology
   A. Shape
   B. Photoz
   C. Object detection/deblending
   D. Transients
   E. High performance computing
   F. Cluster masses
   G. Spectroscopic training sets
2. General astrophysics
   A. Clusters and dark matter
   B. Solar system science
   C. Internal analysis of galaxies
   D. Galaxy morphology
3. Survey coordination
   A. Cadence
   B. Overlap

Overall focus is on pixel level, rather than catalog level coordination and survey coordination that would not happen naturally

LSST/Euclid LOI & MOU

- Steve Kahn (LSST project) met Yannick Mellier (Euclid Consortium lead) in September 2017
- LOI started
- Under revision in US/Europe (Rhodes is in the loop)
- Will involve Euclid Consortium Board, LSST DESC leadership, and LSST Project
- Focus will be on data sharing for early cosmology, especially photo-z
- Full MOU on data sharing and survey coordination is expected to follow

LSST/WFIRST Coordination (1)

TAG-informed activity, but done at project level

- Primarily requires agency and inter-team discussions
- WFIRST data has no proprietary period; simplifies data rights issues
- First steps of coordination are cosmology-based but other science areas considered
- Strong overlap between WFIRST Science Investigation Teams and LSST science groups
- Jason Kalirai gave a WFIRST talk at LSST meeting in August

LSST/WFIRST Coordination (2)

TAG-informed activity, but done at project level

- WFIRST (coordinated by Rhodes) contributed 3 sections (wide survey, supernova, microlensing) to LSST observing strategy white paper (https://arxiv.org/abs/1708.04058)

- This paper and its Github repository will be the mechanism for for requesting new simulations of LSST observing strategy

- Will inform future TAG activities

Science-Driven Optimization of the LSST Observing Strategy

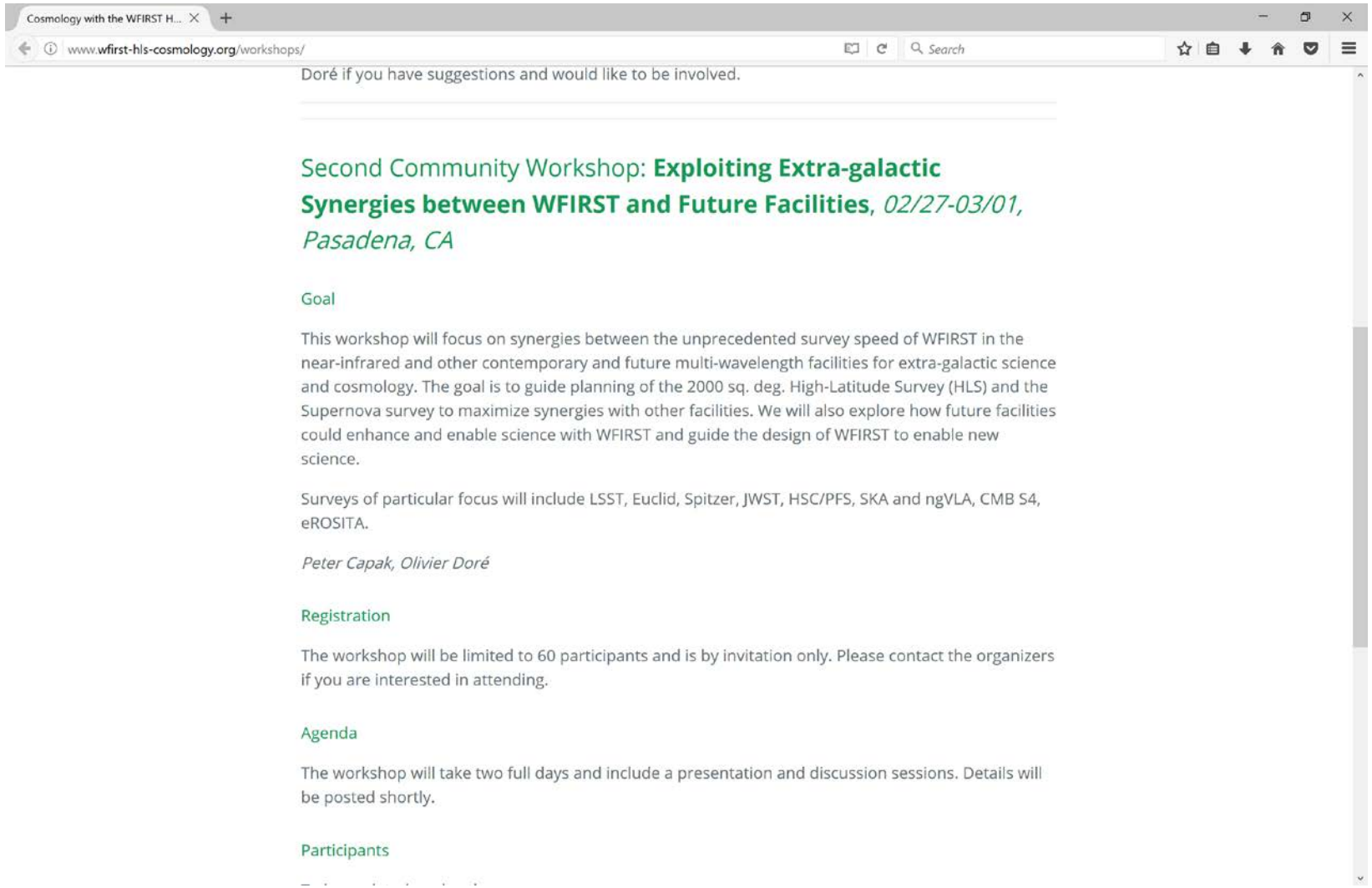
LSST Science Collaborations: Phil Marshall, Timo Anguita, Federica B. Bianco, Eric C. Bellm, Niel Brandt, Will Clarkson, Andy Connolly, Eric Gawiser, Zeljko Ivezic, Lynne Jones, Michelle Lochner, Michael B. Lund, Ashish Mahabal, David Nidever, Knut Olsen, Stephen Ridgway, Jason Rhodes, Ohad Shemmer, David Trilling, Kathy Vivas, Lucianne Walkowicz, Beth Willman, Peter Yoachim, Scott Anderson, Pierre Antilogus, Ruth Angus, Iair Arcavi, Humna Awan, Rahul Biswas, Keaton J. Bell, David Bennett, Chris Britt, Derek Buzasi, Dana I. Casetti-Dinescu, Laura Chomiuk, Chuck Claver, Kem Cook, James Davenport, Victor Debattista, Seth Digel, Zoheyr Doctor, R. E. Firth, Ryan Foley, Wen-fai Fong, Lluis Galbany, Mark Giampapa, John E. Gizis, Melissa L. Graham, Carl Grillmair, Phillipe Gris, Zoltan Haiman, Patrick Hartigan, et al. (52 additional authors not shown)

(Submitted on 14 Aug 2017)

The Large Synoptic Survey Telescope is designed to provide an unprecedented optical imaging dataset that will support investigations of our Solar System, Galaxy and Universe, across half the sky and over ten years of repeated observation. However, exactly how the LSST observations will be taken (the observing strategy or "cadence") is not yet finalized. In this dynamically-evolving community white paper, we explore how the detailed performance of the anticipated science investigations is expected to depend on small changes to the LSST observing strategy. Using realistic simulations of the LSST schedule and observation properties, we design and compute diagnostic metrics and Figures of Merit that provide quantitative evaluations of different observing strategies, analyzing their impact on a wide range of proposed science projects. This is work in progress: we are using this white paper to communicate to each other the relative merits of the observing strategy choices that could be made, in an effort to maximize the scientific value of the survey. The investigation of some science cases leads to suggestions for new strategies that could be simulated and potentially adopted. Notably, we find motivation for exploring departures from a spatially uniform annual tiling of the sky: focusing instead on different parts of the survey area in different years in a "rolling cadence" is likely to have significant benefits for a number of time domain and moving object astronomy projects. The communal assembly of a suite of quantified and homogeneously coded metrics is the vital first step towards an automated, systematic, science-based assessment of any given cadence simulation, that will enable the scheduling of the LSST to be as well-informed as possible.

LSST/WFIRST Coordination (3)

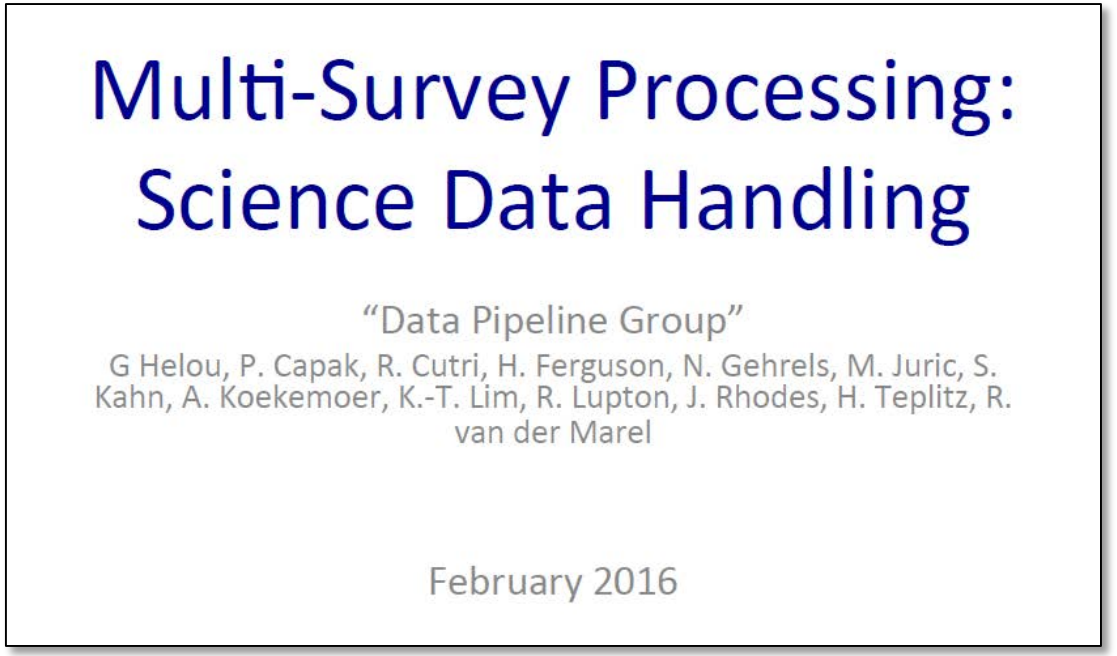
TAG-informed activity, but done at project level



Slides from George Helou

Joint Processing: Recap and Status (1)

- TAG commissioned a report on how joint pixel-level data processing could be done in the US and what work is needed to make that happen
- George Helou (IPAC) coordinated a report recommending a 4-stage approach, and that the next step be a scoping study of work needed to fulfill joint processing (Phase 2)
- Agencies made resources available
- Work on Phase 2 started July 2017



Joint Processing: Recap and Status (2)

- Three types of tasks in Phase 2: Requirements, Algorithms, System architecture. Based on these, effort is scoped for Phases 3 + 4
- Team has been assembled, leads/co-leads of tasks volunteered, work organization agreed and plans made to produce report
- Note participation by DOE, NASA, NSF communities

Task	a.i	a.ii	a.iii	a.iv	b.i	b.ii	b.iii	c.i	c.ii	c.iii	c.iv	c.v
	Requirements				Algorithms			Infrastructure, networking, hardware, interface				
Topics	Best phot-z for 3D WL, Breaking z-degeneracies	Time domain astronomy/SN /AGN transients/rapid response	Galactic, Solar System, Stellar Streams, Reionization	Microlensing, time baselines for SSOs	LSST Deconfusion, optimal photometry for phot-z, cross-mission color selection, dust corrections			Infrastructure, networking, hardware, interface				
Lead(s)	Newman (Upitt.)	Chary (IPAC)	Paladini (IPAC)	Helou (IPAC), Dawson (LLNL)	Lupton (Princeton) & Ferguson (STScI)	Lupton & Ferguson	Melchior (Princeton)	Dawson & A. Smith (STScI)	Dawson & A. Smith	Rusholme (IPAC)	Appleton (IPAC)	Teplitz (IPAC)
Members	Momcheva, Ferguson, Schneider, Prakash, Chary, Capak	Ferguson, Juric, Momcheva, Prakash, Capak, Armus, Wood-vasey	Ferguson, Momcheva, Wachter, Kirkpatrick, Chary, Grillmair	van der Marel, Carey, Grillmair	Dawson, Melchior, Schneider, Schulz, B. Lee, Appleton	Dawson, Melchior, Ferguson, Schneider, B. Lee, Grillmair, Armus	Dawson, Ferguson, Koekemoer, Lupton, Schulz	Schneider, Fox, Groom, Ebert	Fox, Flynn, Ebert	Smith, Fox, Groom, Berriman	Smith, Fox, Wachter, B. Lee, Rusholme, Berriman	Smith, Fox, Wachter, Groom, Rusholme, Berriman

Joint Processing: Recap and Status (3)

- Goal is to deliver final Phase 2 report to agencies by June 2019
- If Phase 3 starts in Sep 2019 and lasts 3 years, the system will be ready in Sep 2022, just in time for LSST and Euclid first data releases

- Near-term: a comprehensive list of use cases and requirements is targeted for end Nov 2017

- Will engage European colleagues as appropriate and when coordination makes sense; Euclid Consortium and ESA already briefed on this activity by Rhodes/Helou

Slides from Alina Kiessling and Katrin Heitmann

TACS

- The Tri-Agency Tri-Project Cosmological Simulations task force (TACS) was formed in May 2017.
- Katrin Heitmann (ANL) and Alina Kiessling (JPL) co-lead TACS.
- Representation from US and Europe, members of Euclid, WFIRST, and LSST.
- The TACS charge has 6 tasks for investigation
  - —Common Supercomputing Infrastructure
  - —Flagship Numerical Simulations
  - —Simulation Suites
  - —Synthetic Sky Maps
  - —Systematic Effects
  - —Advanced Statistical Methods
- All tasks are being investigated in parallel
- Bi-weekly telecons to share progress and updates
- First task report expected in March 2018

TACS Membership:
Nick Battaglia (Princeton, Baryons/Hydro)
Andrew Benson (Carnegie, Mock catalogs)
Tim Eifler (JPL, Analysis)
Andrew Hearin (ANL, Mock catalogs)
Stefan Hilbert (MPA, Probes)
Shirley Ho (LBNL, Probes)
Zarija Lukic (LBNL, Simulations)
Michael Schneider (LLNL, Probes)
Elena Sellentin (Geneva, Analysis)
Joachim Stadel (Zurich, Simulations)

TACS Advisory:
Pablo Fosalba (ICE)
Salman Habib (ANL)
Rachel Mandelbaum (CMU)
Peter Nugent (LBNL)
Brant Robertson (UCSC)
Romain Teyssier (Zurich)

TACS

- Common Supercomputing Infrastructure task is relevant to any science area that uses numerical simulations.
- The areas for investigation are:
  1. How would a common infrastructure work? E.g. What facilities are running, analyzing, hosting and serving the simulation data products?
  2. What simulation products should be hosted and stored? What magnitude of storage will be required as a function of time?
  3. How will the data be served? Are there on-site analysis capabilities possible?
  4. Which facilities could act as the data center? What are the costs associated with any necessary upgrades? What is the annual cost to be the data center?
  5. Are there common data formats that could be encouraged? How can we best enable the community to use the simulation data (e.g. provide test software and reduced size datasets for users to become familiar with the data).
- Ideally:
  - Euclid, WFIRST, and LSST will all share simulation outputs.
  - NASA, DOE, and NSF facilities are utilized in the common supercomputing infrastructure

Survey Coordination

- TAG has identified possible need for third working group in ‘Survey Coordination’
  - Identification of deep fields
  - Overlap regions
  - Cadence
- Phil Marshall and Jason Rhodes will set this up in coming weeks
  - Will focus on Euclid and WFIRST w/ LSST
  - Will engage WFIRST SITs and Euclid Consortium
- Will go beyond cosmology
- Will be informed by the LSST Observing Strategy White paper

Beyond Cosmology

- TAG has been focused primarily on cosmology (DOE focus is just DE cosmology)
- TAG, agencies, and consortia recognize that there are larger communities
- We are making efforts to engage those communities

Conclusions

- LSST/Euclid synergy paper under peer review; will form basis of MOU
- LSST/WFIRST coordination has progressed
- TACS- progress on HPC
- Joint Processing Phase 2 progress
- Survey coordination task will be started
- Recognition that cosmology is not the only science case to benefit