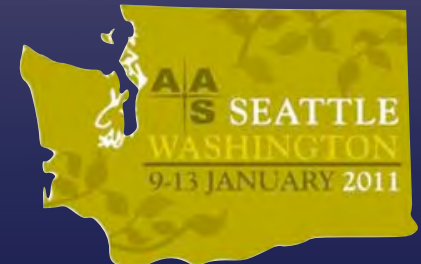
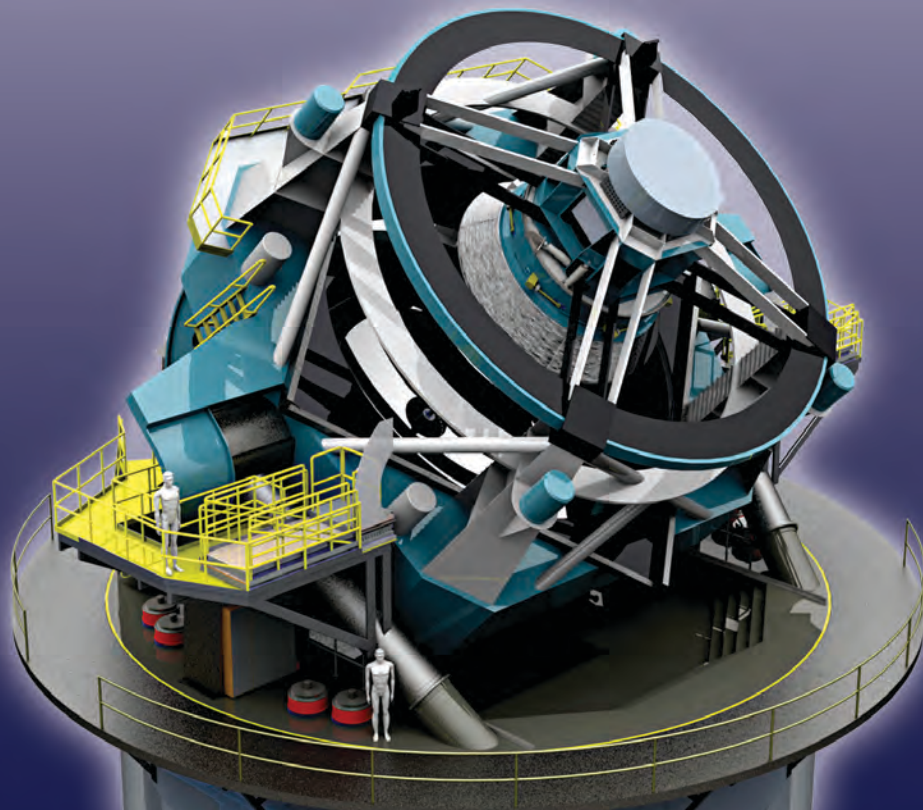


Transient and Variable Star Science with LSST

Lucianne M. Walkowicz
University of California, Berkeley



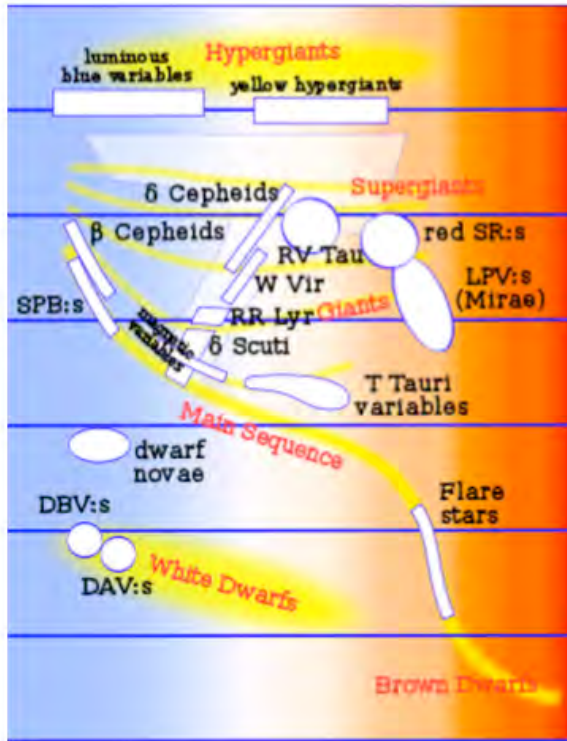
Chairs: Lucianne Walkowicz & Josh Bloom

Ghaleb Abdulla • LLNL
Eric Agol • UW
Marcel Agueros • Columbia
Scott Anderson • UW
David Arnett • U of A
Charles Bailyn • Yale
Andrew Becker • UW
Edo Berger • CFA
Josh Bloom • UC Berkeley
Howard Bond • STScI
Tim Brown • LCOGT
Mark Claire • UW
Kem Cook • LLNL
Nick Cowan • UW
Victor Debattista •
Rosanne DiStefano • CfA
Jeremy Drake • CFA
Derek Fox • Penn State
Chris Fryer • U of A
Suvi Gezari • Johns Hopkins

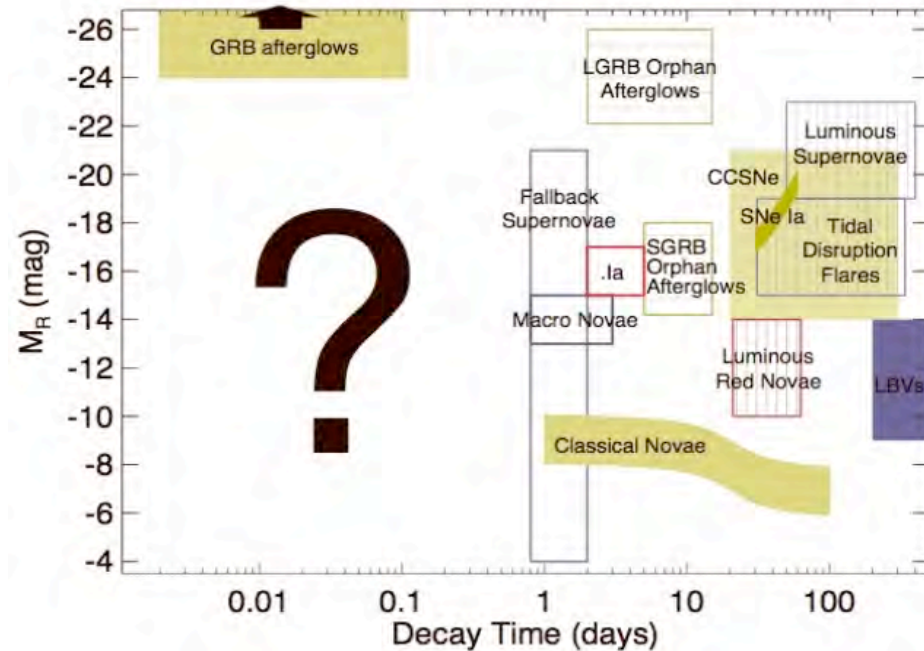
Josh Grindlay • Harvard
Zoltan Haiman • Columbia
Suzanne Hawley • UW
Arne Henden • AAVSO
Eric Hilton • UW
Steve Howell • NOAO
Mark Huber • LLNL
Zeljko Ivezic • UW
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Knox S. Long • STScI
Julie Lutz • UW
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Ashish Mahabal • Caltech
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Hakeem Oluseyi • FIT
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James E. Rhoads • ASU
Mercedes Richards • Penn State
Stephen Ridgway • NOAO
Roger Romani • Stanford
Wayne Rosing • LCOGT
Abi Saha • NOAO
Masao Sako • UPen
Dimitar Sasselov • CfA
Allen W. Shafter • SDSU
Chris Smith • NOAO/CTIO
Nathan Smith • U of A
Paula Szkody • UW
James P. Theiler • LANL
Virginia Trimble • UC Irvine
Tom Vestrand • LANL
Alistair Walker • NOAO
Lucianne Walkowicz • UC Berkeley
Przemyslaw Wozniak • LANL
Marc Moniez – LAL

Incredible Diversity



*Also: microlensing,
transiting planets...*



LSST Science Book:
<http://www.lsst.org/lsst/science/scibook>



Discovery Space of Transients

Filled: Well observed

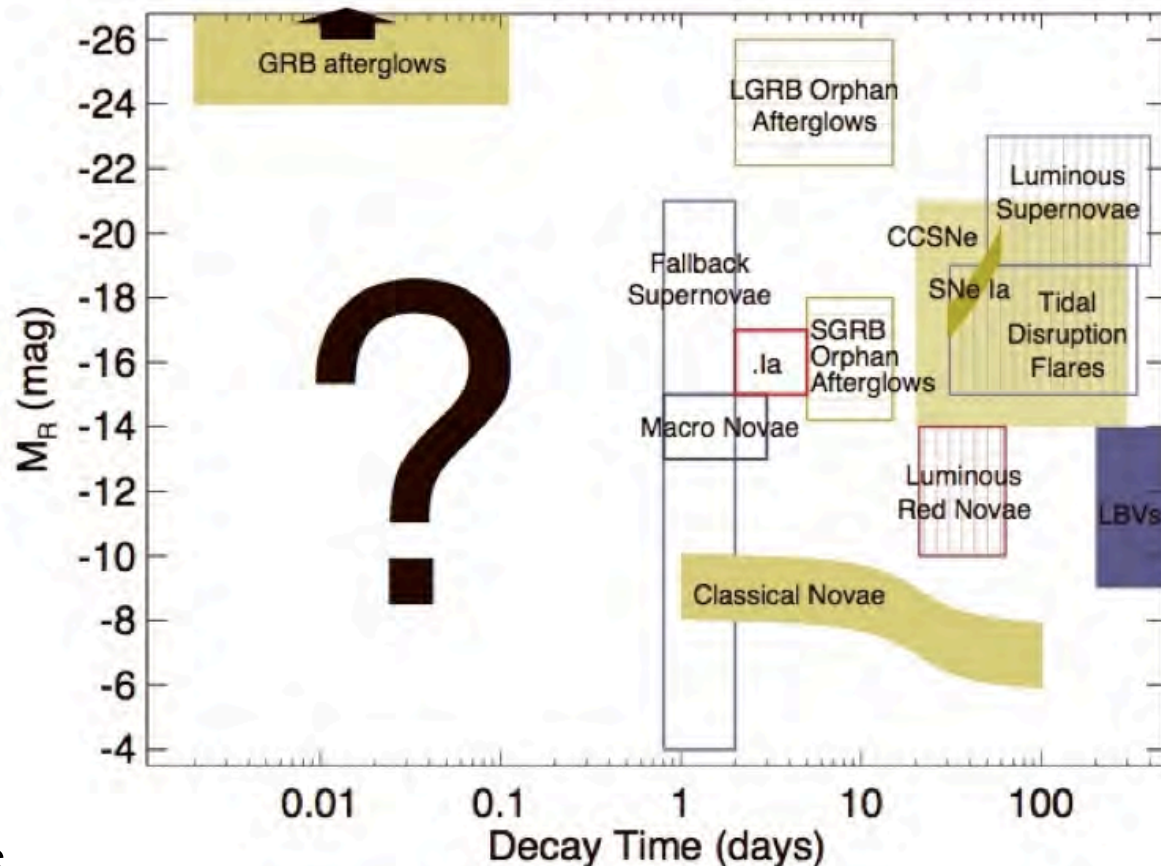
Vertical Stripe: Rare

Horizontal Stripe: Not yet detected

Unfilled: Theoretical

- *Contemporaneous GRB optical counterparts*
- *Giant pulses from pulsars*
- *Flares from anomalous X ray pulsars*

...the unknown!

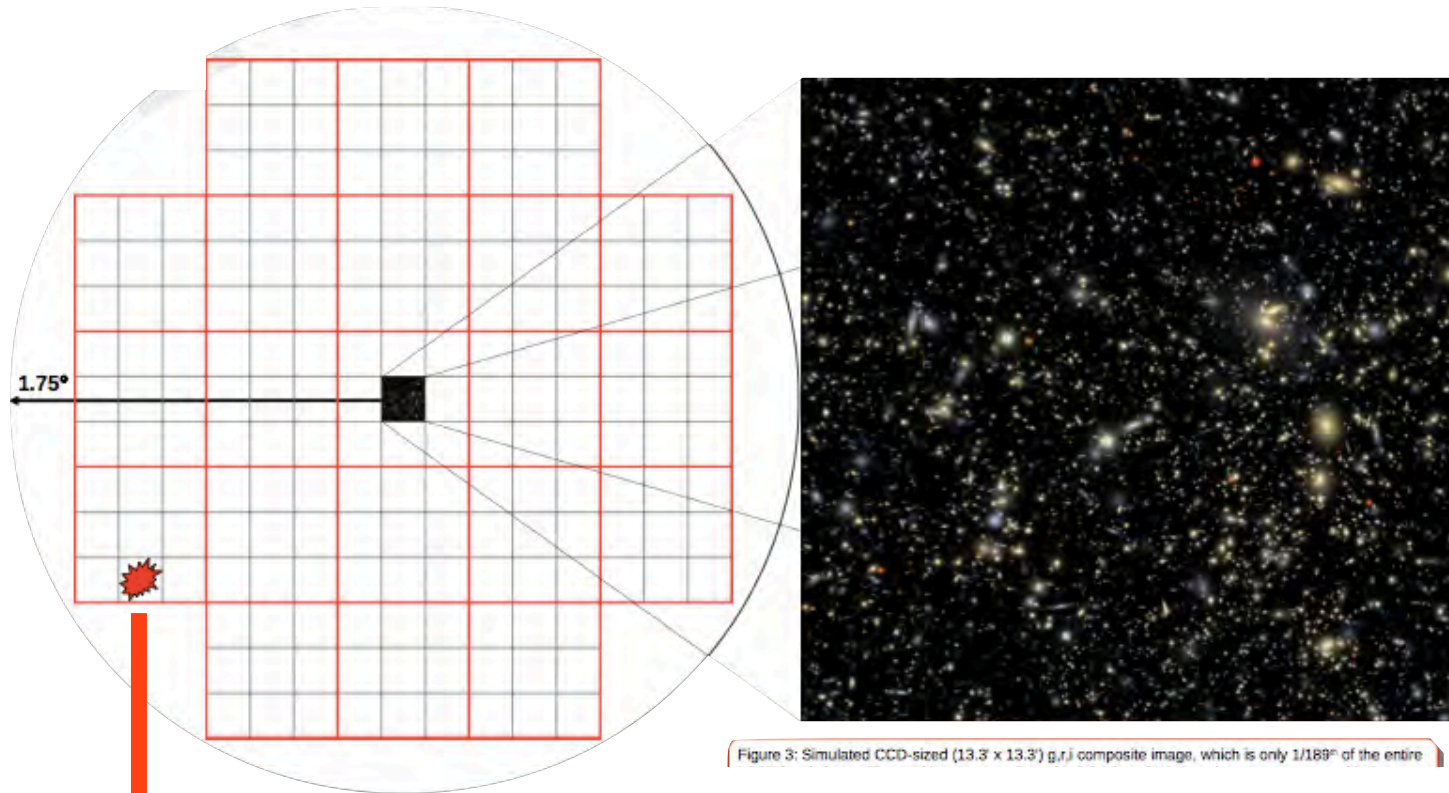


adapted from Rau et al. 2008

Expected Rate of Transients

Class	Mag	t (days)	Universal Rate	LSST Rate
Luminous SNe	-19...-23	50 - 400	$10^{-7} \text{ Mpc}^{-3} \text{ yr}^{-1}$	20000
Orphan Afterglows SHB	-14...-18	5 - 15	$3 \times 10^{-7...-9} \text{ Mpc}^{-3} \text{ yr}^{-1}$	~10 - 100
Orphan Afterglows LSB	-22...-26	2 - 15	$3 \times 10^{-10...-11} \text{ Mpc}^{-3} \text{ yr}^{-1}$	1000
On-axis GRB afterglows	...-37	1 - 15	$10^{-11} \text{ Mpc}^{-3} \text{ yr}^{-1}$	~50
Tidal Disruption Flares	-15...-19	30 - 350	$10^{-6} \text{ Mpc}^{-3} \text{ yr}^{-1}$	6000
Luminous Red Novae	-9...-13	20 - 60	$10^{-13} \text{ yr}^{-1} \text{ Lsun}^{-1}$	80 - 3400
Fallback SNe	-4...-21	0.5 - 2	$< 5 \times 10^{-6} \text{ Mpc}^{-3} \text{ yr}^{-1}$	< 800
SNe Ia	-17...-19.5	30 - 70	$3 \times 10^{-5} \text{ Mpc}^{-3} \text{ yr}^{-1}$	200000
SNe II	-15...-20	20 - 300	$(3..8) \times 10^{-5} \text{ Mpc}^{-3} \text{ yr}^{-1}$	100000

Table adapted from Rau et al. 2009



LSST field-of-view well-matched to localize
LIGO events

See also poster 252.12, Becker et al.

★ Why provide Target of Opportunity Triggering and Cadencing?

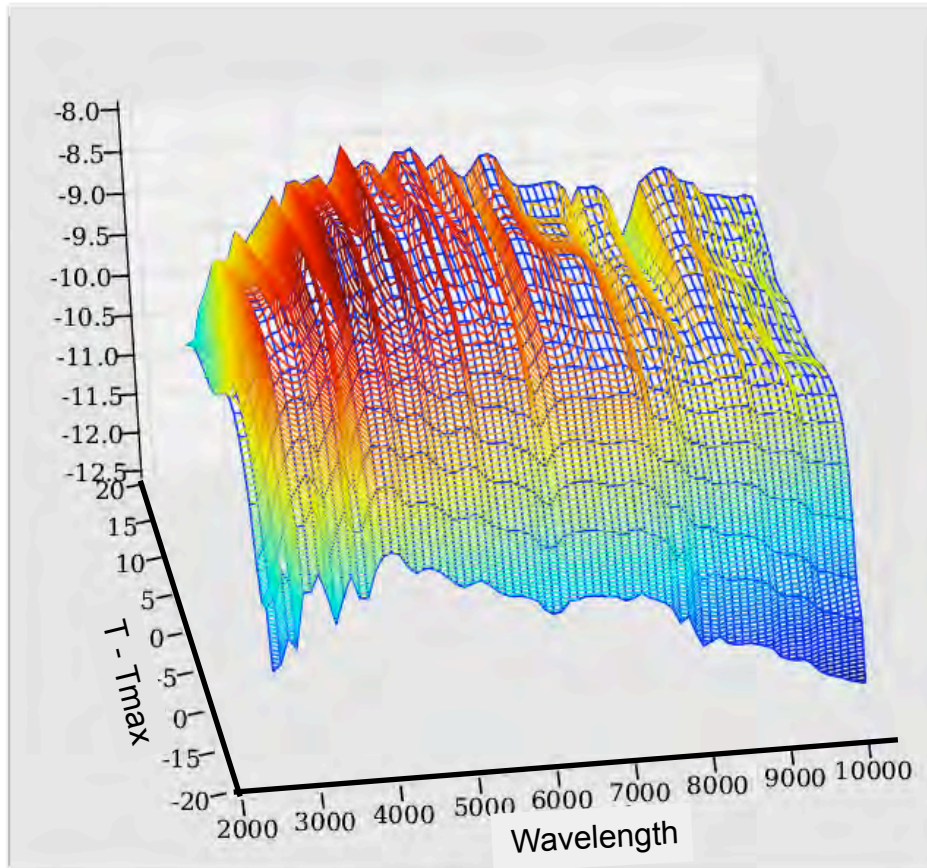
- LSST is uniquely suited to finding EM counterparts to GW events
- Supports NSF-funded a-LIGO and responds directly to DOE science

How would such a capability translate into operation requirements?

White paper in development on scientifically-motivated performance desires (Bloom, Becker, Cook, Walkowicz)

Current Work and Upcoming Challenges

Simulating LSST data stream



Hsiao supernova template

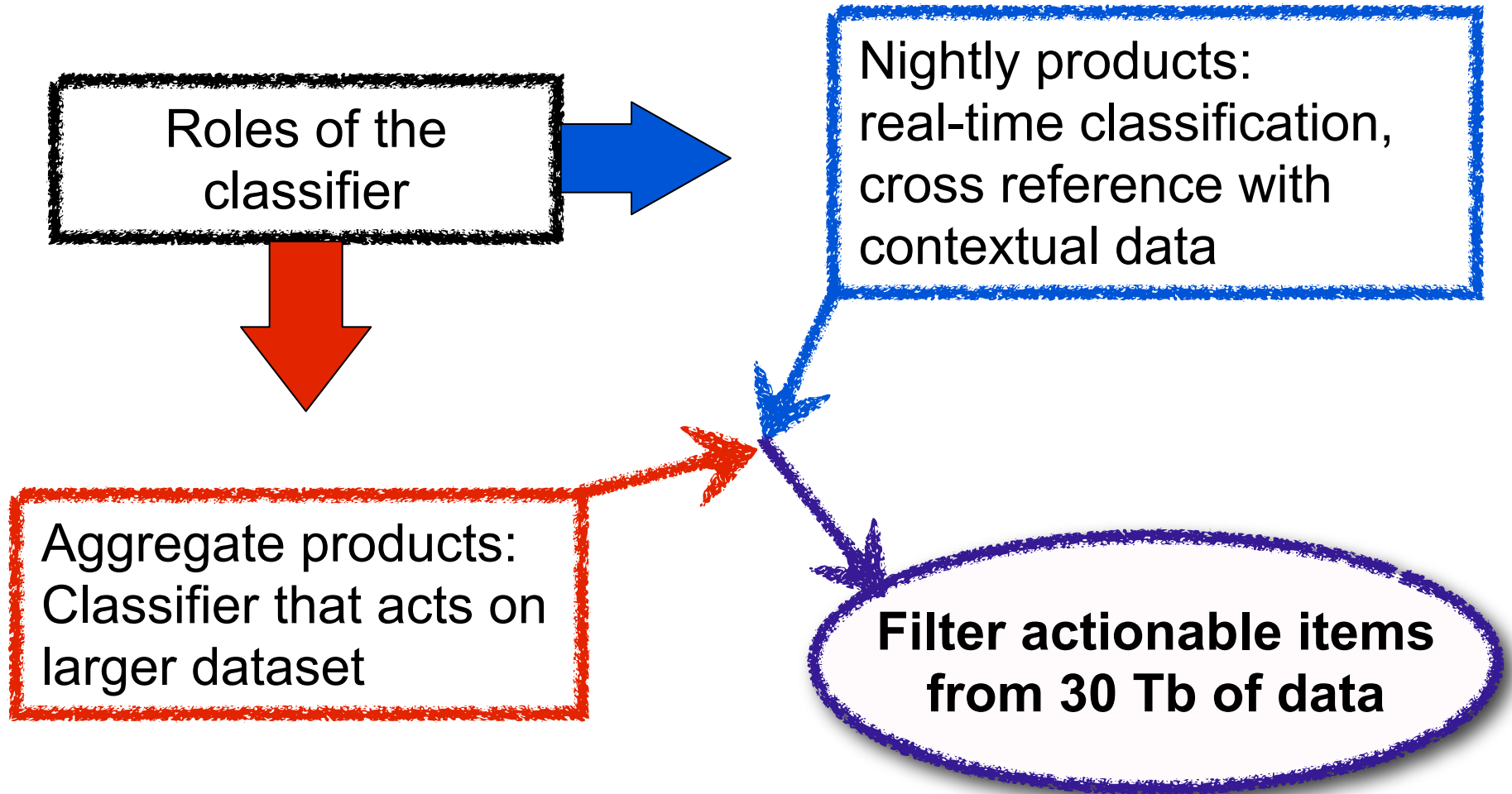
Include variables and transients in sims to evaluate requirements

Currently collecting spectrotemporal surfaces to provide to sim team

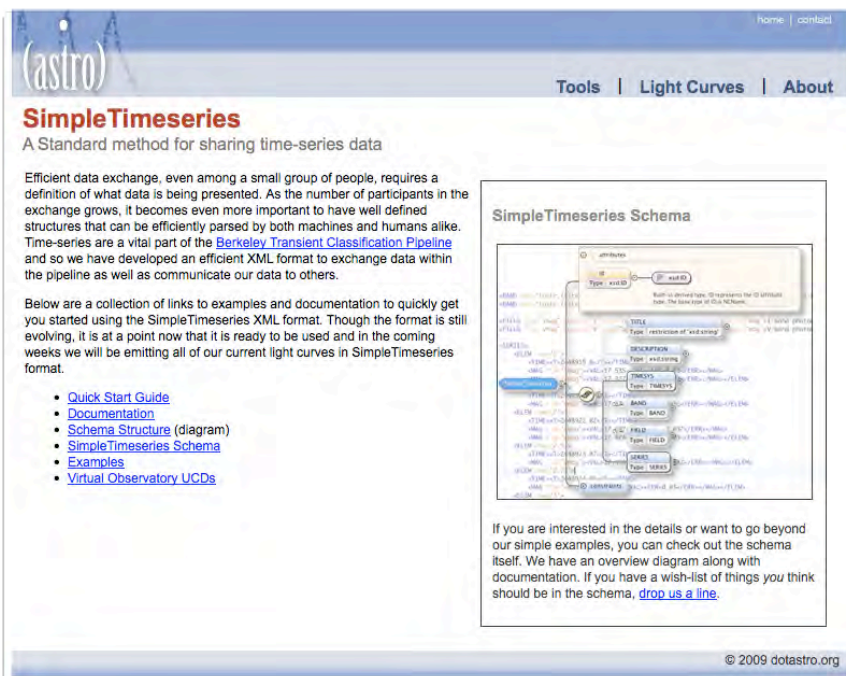
Example simulation: 1.7ppm of the survey



Classification



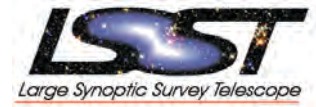
- <http://dotastro.org/simpletimeseries>
- <http://en.wikipedia.org/wiki/VOEvent>



The screenshot shows the SimpleTimeseries website. At the top is a navigation bar with links for 'Tools', 'Light Curves', and 'About'. Below this is the title 'SimpleTimeseries' and a subtitle 'A Standard method for sharing time-series data'. The main text explains the purpose of the format and provides a list of links: 'Quick Start Guide', 'Documentation', 'Schema Structure (diagram)', 'SimpleTimeseries Schema', 'Examples', and 'Virtual Observatory UCDs'. A 'SimpleTimeseries Schema' diagram is displayed, showing a hierarchical structure of XML elements. At the bottom, there is a copyright notice for 2009 dotastro.org.

VOEvent: Information Infrastructure
for Real-Time Astronomy
Roy Williams & Rob Seaman
ASP Conference Series, 2006,
Vol. 351, p.637

Early Science Verification



- About 10–15% of LSST point sources will be variable (at the few tenths of a mag level or above)
- Of these, only 10–15% will be periodic

Most things that vary do not vary periodically

Light curve library would
enhance LSST science and
provide an opportunity for
Science Verification



Thank you!