



Sarah Antier, IJCLAB, OCA, France



Skyporta

A data-science platform to enable time-domain astronomy







BNS and NS-BH GW events for O4 a and b



Distance (Mpc)



How to manage observations in time domain ?







Follow-Up Decision Making

Multi-band Follow-up

Discovery



Online Characterization





Decision Making and Follow-up When an alert comes As an astronomer...



Wake up

FocuS

Filter

GO / NO GO / ?



Do you have shifters / a rota ? Do you have automatic processing ?

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Is it Important ?
Is it Urgent ?
Can I solve it myself? Do I need a
team ?
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Pass or reject based on automated criteria Read manual to understand the Process Similar situation as before, can solve Don't know !

Is it worth it for the experts !!! Argg

Finding Counterparts of MM events: Where ? and When ? to Observe

Tools / Services

TOM : BH TOM, Skyportal, LCOGT GCN Brokers: AMPEL, Fink, ALICE, Boom



S240621dy Tiling strategy with TAROT/TCA GWEMOPT Package Coughlin

Windows on the Universe: Establishing the Infrastructure for a Collaborative Multi-messenger Ecosystem, Ahumada, 2024

Most telescopes are not AUTOMATIC It can be cloudy sometimes PI Telescopes \Rightarrow

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How to solve it?

Lots of data to look at, lots of people doing it at the same time

- Many surveys, with too much data to look through manually
- Lots of data for each seen by many people at simulatenous time
- Many instruments to coordinate

More in the race over time ...

- But not everyone sees the same data, complex data access rules
- Combine ToO with "regular" observations
- Report results quickely



We need

Automatization

Adequate tools for time domain

Alert Brokers

Astrophysics > Instrumentation and Methods for Astrophysics

[Submitted on 28 Apr 2023 (v1), last revised 14 Jun 2023 (this version, v2)]

A data science platform to enable time-domain astronomy

Michael W. Coughlin, Joshua S. Bloom, Guy Nir, Sarah Antier, Theophile Jegou du Laz, Stéfan van der Walt, Arien Crellin-Quick, Thomas Culino, Dmitry A. Duev, Daniel A. Goldstein, Brian F. Healy, Viraj Karambelkar, Jada Lilleboe, Kyung Min Shin, Leo P. Singer, Tomas Ahumada, Shreya Anand, Eric C. Bellm, Richard Dekany, Matthew J. Graham, Mansi M. Kasliwal, Ivona Kostadinova, R. Weizmann Kiendrebeogo, Shrinivas R. Kulkarni, Sydney Jenkins, Natalie LeBaron, Ashish A. Mahabal, James D. Neill, B. Parazin, Julien Peloton, Daniel A. Perley, Reed Riddle, Ben Rusholme, Jakob van Santen, Jesper Sollerman, Robert Stein, Damien Turpin, Avery Wold, Carla Amat, Adrien Bonnefon, Adrien Bonnefoy, Manon Flament, Frank Kerkow, Sulekha Kishore, Shloke Jani, Stephen K. Mahanty, Céline Liu, Laura Llinares, Jolyane Makarison, Alix Olliéric, Inès Perez, Lydie Pont, Vyom Sharma

SkyPortal is an open-source software package designed to efficiently discover interesting transients, manage follow-up, perform characterization, and visualize the results. By enabling fast access to archival and catalog data, cross-matching heterogeneous data streams, and the triggering and monitoring of on-demand observations for further characterization a SkyPortal-hased nlatform has been onerating at scale for 2 vr for the Zwicky Transient Facility Phase II community with hundreds of users containing tens of



Science portals

С g R

A solution: SkyPortal An all-in-one astronomical tool

- Receive large amounts of data concurrently -> API-based system + Web client
- Scan through incoming data streams -> Candidates page & API
- Visualize transients and trigger follow-up -> Source(s) pages & API Skyportal ICARE for ACME
- Visualize multi-messenger events and plan observations -> GCN(s) pages & API
- Classify and report to the community -> Integration with TNS
- Work as a team, collaborate -> Comment on important data products
- Stay up to date -> Real time & customizable notification system

Skyportal ICARE for ACME (open source project)

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Who?





J. Bloom (founder, Berkeley)



M. Coughlin (manager, UMN)



T. Du Laz (Dvp, Caltech)



A. Le Calloch (Dvp)





Laboratoire de Physique des 2 Infinis









S. Antier (ICARE scientist lead)



P. Hello (Host manager)



J. Peloton (Devp and security manager)



C. Douzet (ACME, dvp)

Joint supervision of students 2022 - 2023 : 10x2 ESILV students 2022/2024: T. Cullino, S. Clenet, T. Du Laz (6 months) 2024: A. Le Calloch, T. Bonzi, J. Di Basso (6 months) 9







Let's take a quick look : Overview





Scientific results with the use of Skyportal Gravitational waves with NSBH DECAM, ZTF, GRANDMA

Limits on the Ejecta Mass and Binary Properties During the Search for Kilonovae Associated with Neutron Star-Black Hole Mergers: A case study of S230518h, GW230529, S230627c and the Low-Significance Candidate S240422ed

M. PILLAS,^{1,2} S. ANTIER,^{1,3} K. ACKLEY,⁴ T. AHUMADA,⁵ D. AKL,⁶ L. DE ALMEIDA,⁷ S. ANAND,⁵ C. ANDRADE,⁸ I. ANDREONI,⁹ K. A. BOSTROEM,¹⁰ M. BULLA,^{11,12,13} E. BURNS,¹⁴ T. CABRERA,¹⁵ S. CHANG,¹⁶ H. CHOI,¹⁶ B. O'CONNOR,¹⁵ M. W. COUGHLIN,⁸ W. CORRADI,⁷ A. R. GIBBS,¹⁷ T. DIETRICH,^{18,19} D. DORNIC,²⁰ J.-G. DUCOIN,²⁰ P.-A. DUVERNE,²¹ M. DYER,²² M. FAUSNAUGH,²³ WEN-FAI FONG,²⁴ F. FOUCART,²⁵ D. FROSTIG,²⁶ N. GUESSOUM,⁶ VAIDEHI GUPTA,⁸ P. HELLO,³ G. HOSSEINZADEH,^{10,27} L. HU,¹⁵ T. HUSSENOT-DESENONGES,³ M. IM,¹⁶ R. JAYARAMAN,²³ M. JEONG,¹⁶ V. KARAMBELKAR,²⁸ M. KASLIWAL,²⁸ S. KIM,¹⁶ C. D. KILPATRICK,²⁹ N. KOCHIASHVILI,³⁰ S. KARPOV,³ K. KUNNUMKAI,¹⁵ M. LAMOUREUX,³² C. U. LEE,³³ N. LOURIE,²³ J. LYMAN,⁴ M. MAŠEK,³¹ F. MAGNANI,²⁰ G. MO,^{23,34} M. MOLHAM,³⁵ M. NICHOLL,³⁶ A. H. NITZ,³⁷ F. NAVARETE,³⁸ K. NOYSENA,³⁹ D. O'NEILL,⁴ G. S.H. PAEK,^{16,40} A. PALMESE,¹⁵ R. POGGIANI,⁴¹ T. PRADIER,⁴² O. PYSHNA,⁴³ Y. RAJABOV,⁴⁴ J. C. RASTINEJAD,²⁴ D. J. SAND,¹⁰ P. SHAWHAN,⁴⁵ M. SHRESTHA,¹⁰ R. SIMCOE,²³ S. J. SMARTT,^{46,36} D. STEEGHS,⁴ R. STEIN,^{47,48,49} H. F. STEVANCE,⁴⁶ M. SUN.³⁹ A. TAKEY.³⁵ A. TOIVONEN.⁸ D. TURPIN.⁵⁰ K. ULACZYK.⁴ A. WOLD.⁵¹ AND T. WOUTERS^{52,53}

Summary of the coverage from 0 to 6 days post T0

S230518h 81% cr. coverage

S230627c **96% cr.** coverage

> 21^h 18^h 30

Π	Filter	0 - 1	dav	1 - 2	2 day	2 - 6	dav	Instruments
	1 11001	% cr	upper	% cr	upper	% cr	upper	instruments
		70 0.1	upper	70 0.1	S23051	8h	upper	
Т	600 - 1000 nm	25%	16	25%	16	25%	16	TESS
	<i>R</i>	21%	21.6	18%	21.6		-	GECKO
	o-band	44%	17.9	-	-	25%	18.8	ATLAS
	c-band	-	-	25%	19.5	47%	19.5	ATLAS
	c-band			2070	W230	529	10.0	111 LAD
GW230529							COTO	
	a band	167	20.6	270	15.4	270	15.2	TTF COLOR
	g-band	1070	20.0	-	-	-	-	
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		1704	10.1	0.407	523062	7C	10.1	0.070
	L-band	45%	19.1	84%	19.0	23%	19.1	GOTO
	g-band	88%	21	-	-	-	-	ZTF
	<i>R</i> -band	4%	18.5	2%	20.7	2%	20.7	GRANDMA - GECKO
	r-band	88%	21	-	-	-	-	ZTF
	o-band	-	-	18%	18.6	17%	18.0	ATLAS
					S240422	2ed		
	g-band	53%	19.5	83%	19.7	<1%	22.5	GRANDMA, ZTF
	<i>L</i> -band	$96\% \ \%$	19.1	96%	19.6	94%	20.1	GOTO
	G-band	$19\% \ \%$	19.5	-	-	-	-	CSS/SAGUARO
	$R ext{-band}$	69 %	16.7	67%	21.6	22%	21.3	GRANDMA - GECKO
	<i>r</i> -band	86 %	23.15	90%	22.9	71~%	23.3	DECam, GRANDMA, ZTF
	o-band	99%	18.9	7%	18.7	99~%	18.6	ATLAS
	z-band	75%	22.6	81%	22.4	71%	23.0	DECam
	J-band	16%	16.5	-	-	-	-	WINTER

Meerlich, BlackGEM, Magellan

from 14.5 to 23.3 mag upper limit



37% cr. coverage from 13.2 to 21.7 mag upper limit



from 16.3 to 21.3 mag upper limit





S240422ed > **99**% cr. coverage

from 14.1 to 23.5 mag upper limit







Scientific results with the use of Skyportal Gravitational waves with NSBH **ZTF, GROWTH, GRANDMA, DECAM**



Optical Follow-up of NSBH events : S240422ed : optimized Example

One mocked KN (ArnandBulla) projected at distance and T0 from S240422ed



Compare the magnitude of the LC with one optical obs

- <u>Compare the magnitude of the light curve (M_{KN}) with the one of optical observations (M_{obs})</u> 3)
- epoch of the field
- Compute a score representing the probability of the « presence » of a KN:





Optical Follow-up of NSBH events : S240422ed : optimized Example



Observations taken one day after S240422ed 180 deg2 from NS-BH mergers

Observations taken one day after S240422ed ruled out Totally Kne Signal in sky coverage of



GRB Optical Counterpart discovery









(jetted) TDE discovery



A couple of fun facts: *First* relativistic TDE identified in near real time by an optical survey

Furthest TDE ever found

Absolute magnitude



Andreoni & Coughlin et al. (2022), Nature, 612, 7940



Let's take a quick look





Skyportal for ACME

We will provide access to ICARE to all ACME proposants It will guarantee privacy and but also sharing among groups and individuals Part of the grant is devoted to profile and customization for ACME

Create New Group	
Group Name	
Nickname	
Description	
Group Admins	
CREATE GROUP	
Group Management	
All Groups	

Sign in with your IdP



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Today	Back Next		April 06 – 12		Month Week	Work Week	Day Agenda
	06 Sun	07 Mon	08 Tue	09 Wed	10 Thu	11 Fri	12 Sat
12:00 AM	– 3:59 AM kilonova 3/7	– 3:59 AM kilonova 4/7	– 3:59 AM kilonova 5/7	– 3:59 AM kilonova 6/7	– 3:59 AM kilonova 7/7	– 3:59 AM supernova	– 3:59 AM supernova
2:00 AM	GRANDMA	GRANDMA	GRANDMA	GRANDMA	GRANDMA		2/6 GRANDMA
4:00 AM	4:01 AM - 11:59 kilonova 3/7	4:01 AM – 11:59 kilonova 4/7	4:01 AM - 11:59 kilonova 5/7	4:01 AM - 11:59 kilonova 6/7	4:01 AM - 11:59 kilonova 7/7	4:01 AM – 11:59 . supernova	4:01 AM - 11:59 . supernova
6:00 AM	GRANDMA	GRANDMA	GRANDMA	GRANDMA	GRANDMA	1/7	2/7
8:00 AM						GRANDMA	GRANDMA
10:00 AM							
12:00 PM	12:01 PM – 7:59 kilonova 4/7	12:01 PM – 7:59 kilonova 5/7	12:01 PM – 7:59 kilonova 6/7	12:01 PM – 7:59 kilonova 7/7	12:01 PM – 7:59 supernova	12:01 PM – 7:59 supernova	12:01 PM – 7:59 supernova
2:00 PM	GRANDMA	GRANDMA	GRANDMA	GRANDMA		2/7	3/7 CRANDMA
4:00 PM					GRANDIVIA	GRANDIVIA	GRANDIVIA
6:00 PM							
8:00 PM	8:01 PM – kilonova 4/7	8:01 PM – kilonova 5/7	8:01 PM – kilonova 6/7	8:01 PM – kilonova 7/7	8:01 PM – supernova	8:01 PM – supernova	8:01 PM – supernova
10:00 PM	GRANDMA	GRANDMA	GRANDMA	GRANDMA	1/6	2/6	3/6
					CRANDMA	CDVNDWV	GRANDMA

Sources - Search

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Candidates scanning page

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GCN page: overview

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GCN page: Observation plan

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Auto-annotations

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	ZTF Science Validation:Public Transients	acai_n	0.0001	fritz	3 years	Î
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Manage the source(s) pages

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ADD LOG VIEW ! Possibility to share results outside with public pages !







Manage the source(s) pages

Follow-up

Allocation

TAROT/TRE / TAROT/TRE - GRANDMA (PI Alain Klotz, Sarah Antier) Share Data With GRANDMA \mathbf{T} Filters* NoFilter \Box Start Date (UT)* 2025-04-07 10:43:38 End Date (UT) * 2025-04-14 10:43:38 Observation Preference* Earliest possible Priority (-5 - 5) * 0 Exposure Time [s] (use -1 if want defaults)*

300



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Spectroscopy

SOURCE





HR Diagram



Source(s) pages Spectroscopy





Found 74 candidates.





Ξ



Candidates scanning page





Plug your personnal rapid analysis



C

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Figure 8. Analysis posterior for a fit to ZTF 22abykahf with the Type Ia supernova analysis service.

Source Analysis page

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Integration and preparation of LSST / KM3NET





A / I I





And other partners

Skyportal

Who would like to collaborate with us in this new Time domain Poésie ?