

eROSITA TDA Working group summary of Potsdam meeting

J. Wilms, A. Rau

Wiki pages: <https://wiki.mpe.mpg.de/eRosita/EroTda>

Membership list: https://wiki.mpe.mpg.de/eRosita/eroTDA_Organisation

TDA Science Projects Walkthrough

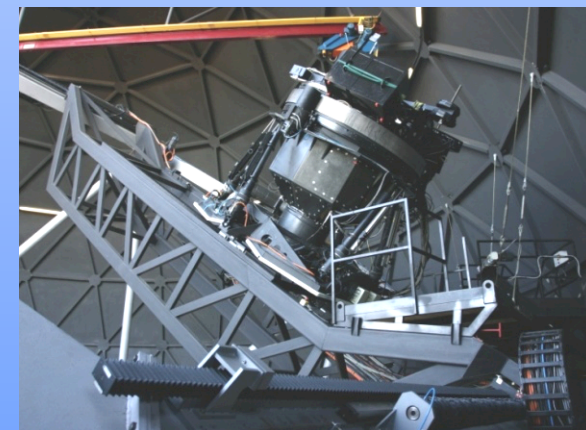
Submitted proposals (will be cleared w/other WGs if necessary, some mergers already happened):

Title	Contributors	Details	PhD Project	Other SWG
Infrastructure				
The pre-eROSITA all-sky survey catalogue of the variable X-ray sky	M. Freyberg, Th. Boller	Details	N	Cat
Machine Learning Classification of new events	J. Wilms, M. Krumpe	Details	Y	Cat
Classifying the Variable Sky of eROSITA	A. Malyali, A. Rau, K. Nandra, H. Brunner(?)	Details	Y	AGN, Cat
Very bright sources, X-ray Binaries, etc				
Outbursts of new and known X-ray binaries	J. Wilms, I. Kreykenbohm, the Remeis-gang	Details	Y	CO
The very brightest X-ray sources in the sky as seen with eROSITA	M. Freyberg, Th. Boller	Details	N	ISM,Cat,Cal,BKG
Tidal Disruption Events				
A first observed TDE from eROSITA	A. Malyali, A. Rau, K. Nandra, A. Merloni	Details	Y	AGN
Understanding the Differences between X-ray and Optical Tidal Disruption Events	A. Malyali, A. Rau, K. Nandra, A. Merloni	Details	Y	AGN
The Host Galaxy Properties of X-ray-selected Tidal Disruption Events	A.Rau, A. Malyali, M. Salvato	Details	N	AGN
New Transient Populations, Phase Space Exploration				
eROSITA non-detections of previously known (bright) X-ray sources	M. Freyberg, Th. Boller	Details	N	Cat,Cal
Following-up Fast eROSITA Transients	A. Rau, A. Malyali	Details	N	
Blazars, AGN				
Testing Blazar Jet models with X-ray Variability	J. Wilms	Details	Y	AGN
Magellanic Cloud Transients				
Transients in the Magellanic system	F. Haberl, C. Maitra	Details	N	Gal

see https://wiki.mpe.mpg.de/eRosita/eroTDA_ScienceProjects

The SALT Transient Programme

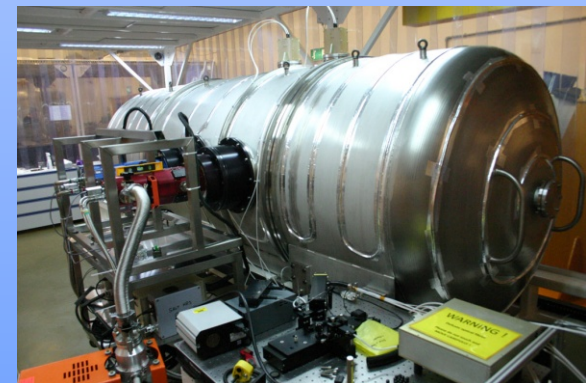
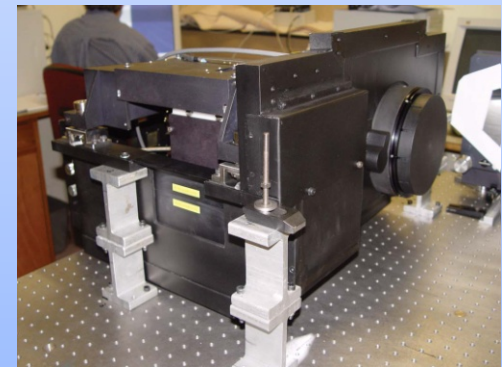
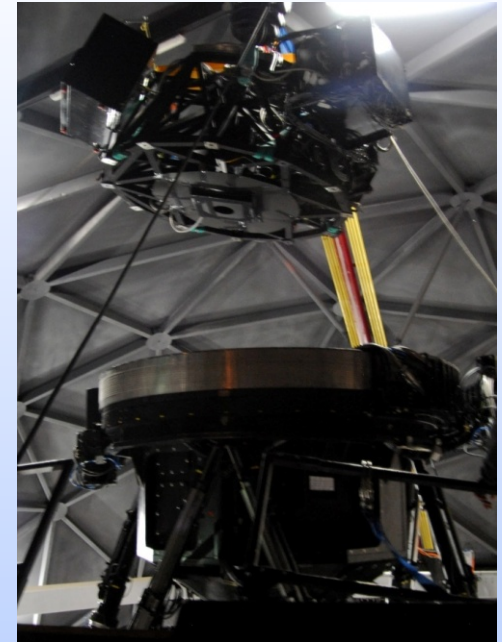
- **SALT Large Program on transients began in May 2016**
 - Large allocation in highest priority (e.g. ToO) class (P0)
 - allows for rapid response to alerts
 - Basic pipeline reduced data available in < 12 h (raw data immediately)
 - *Recently extended for 3 more years*
- **Multi-institutional/multi-partner program**
 - 5 South African institutions (SAAO, UCT, UFS, NWU, UJ)
 - 4 other SALT partners (Poland, IUCAA, UKSC, UW)
 - 32 investigators (incl. many graduate students)
 - Now being expanded to include other international participation (e.g. China)
 - Extended for another 3 years (to 30 April 2021)
 - Adding new followup and alert facilities
 - » MASTER, MeerLICHT, LCO, MONET, MeerKAT



Observing Transients With SALT

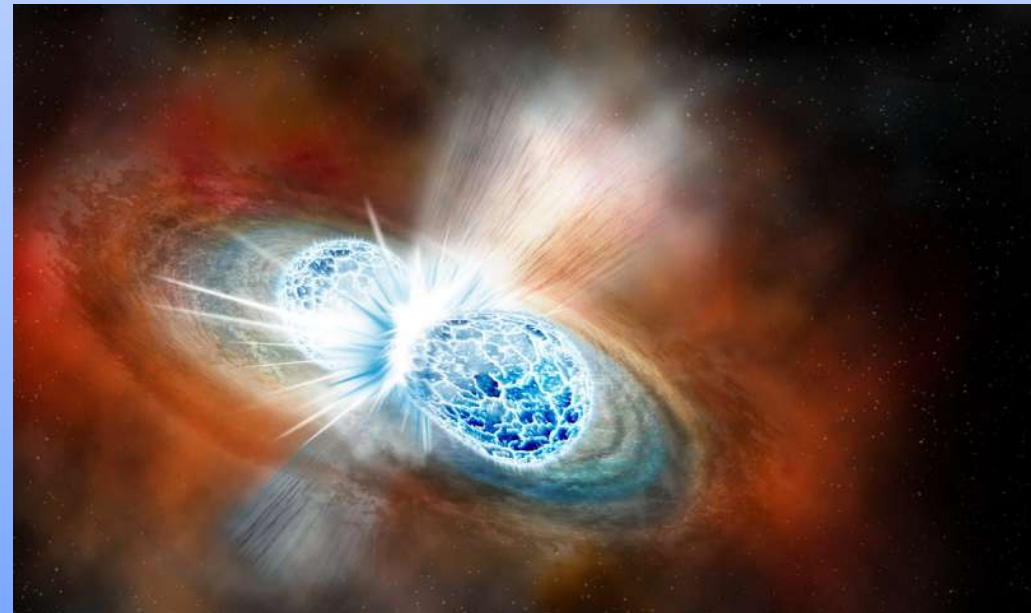
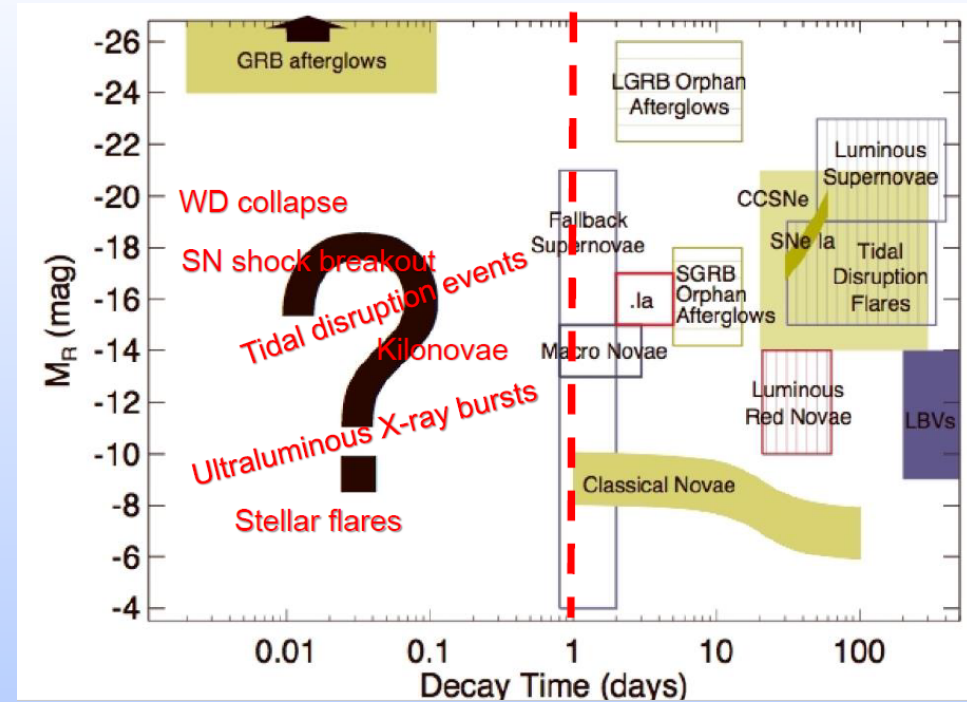
Available Instrumentation (< 1 min to change between them):

- **Robert Stobie Spectrograph (RSS)**
 - Low-medium resolution (300 – 6000)
 - 3200 – 9000Å
 - Fast spectroscopy (10 Hz)
 - Fast imaging (10 Hz)
 - Spectropolarimetry
 - Imaging polarimetry
 - Fabry-Perot imaging
 - Near IR arm to 1.7 μ m (sky limited) under construction (*delivery in 2021*)
- **SALTICAM**
 - Fast imaging (10Hz)
 - Deep multi-filter imaging (griz, UBVRI, H α)
- **SALTICAM High Resolution Spectrograph (HRS)**
 - High resolution (16,000, 34,000, 60,000)
 - 3800 – 8900Å
- **Berkeley Visible Image Tube (BVIT)**
 - Photon counting MCP
 - Time tagging photon events to 50 ns
 - Limited “campaign” availability



SALT Transient Program

- **Covering wide range in luminosity (& distance)**
- **Variability on wide range of timescales**
 - Sub-seconds domain a new frontier
- **Covering many object classes**
 - X-ray transients
 - Cataclysmic Variables
 - Novae
 - Intermediate luminosity transients
 - Tidal Disruption Events (TDEs)
 - » From Gaia, OGLE IV
 - Black Hole microlensing events
 - Flaring Blazars
 - Unusual supernovae (e.g. Super Luminous Supernovae)
 - Gamma-Ray Bursts (GRBs)
 - *Multi-messenger (Gravitational Wave & Neutrino) events*
 - *Radio transients with MeerKAT (ThunderKAT transient programme)*



NRTA update

I. Kreykenbohm: **demonstration of new capabilities in NRTA** since January

Bamberg meeting:

- **detection etc. in 4 standard eROSITA energy bands**
- **notifications via email, Telegram**
- **display spectra, light curves**
rebinning, display,...
- **better integration of Aladin**
same position, scale,...
- **improvement of housekeeping browser**
including demonstration of HK parameters transferred from Russia
- **various configuration options**
- **state/restore of whole system**
start working during breakfast → train → institute → beer garden

Trigger criteria

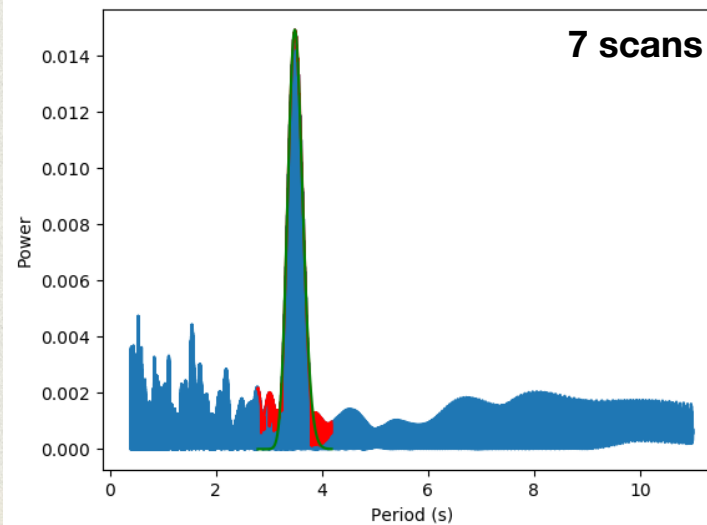
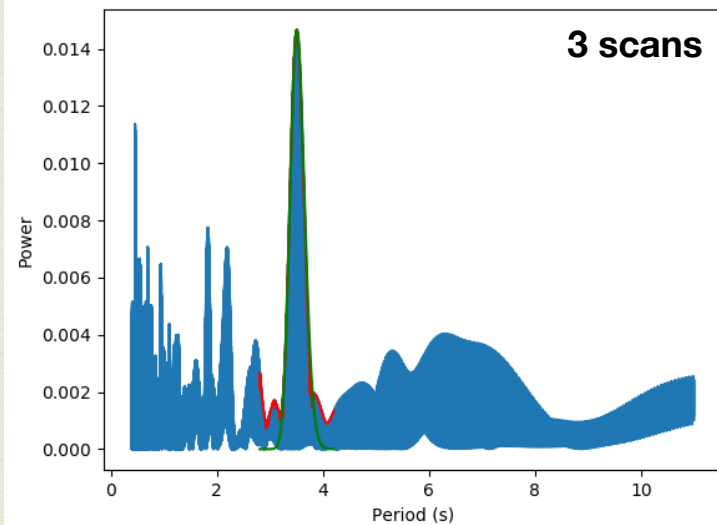
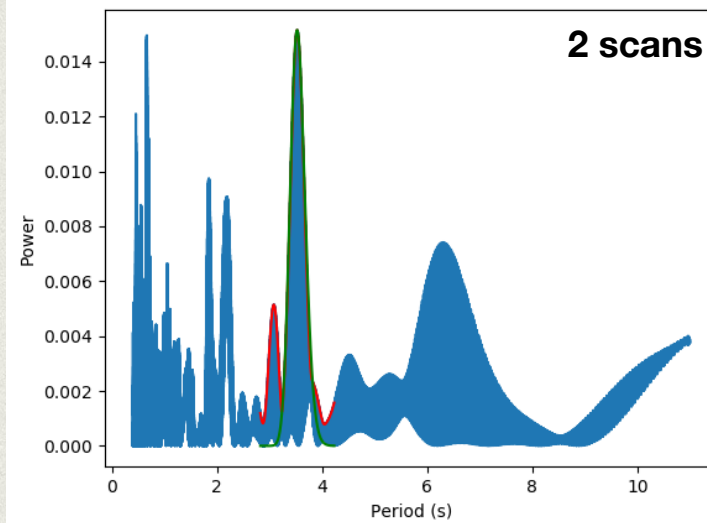
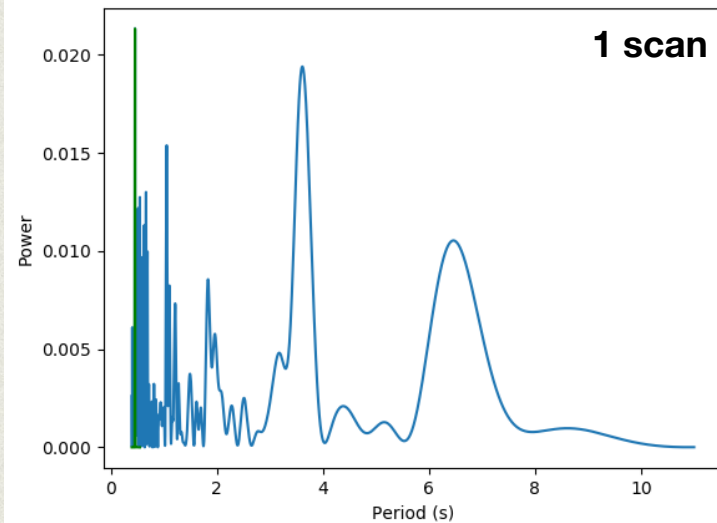
Criteria for “interesting sources”:

- *must* be quantitative
- trigger criteria can be matched against following:
 - source **is/is not in a well specified catalogue**
 - source is at a given **position**
i.e., always extract fields around list of sources
 - count rate range (“cps above”, “cps below”), in E-band or total eROSITA
 - bright sources: **Bayesian block trigger**
 - unknown sources: **type from machine learning**
 - hardness in a given **hardness band** (expect ~4 HR values)
 - **eSASS ML likelihood**
 - **relative change in count rate wrt previous eRO-Day (or later: eSASS)**
 - presence of QPO/periodicity/flare (TBD)

Are there other criteria we need to consider?

Please submit suggestions *ASAP* to
<mailto:ingo.kreykenbohm@fau.de> and
joern.wilms@sternwarte.uni-erlangen.de

Effect of multi scans on the periodogram (using Lomb-Scargle analysis)



Examples for Triggers

High Mass X-ray Binaries in the LMC and SMC:

Sources with ≥ 0.1 counts s^{-1} (\sum all 7 cameras) *and*

- LMC: circle with radius 4.5° centred on $\alpha_{J2000.0} = 05 : 22 : 15$, $\delta_{J2000.0} = -68 : 04 : 30$
- SMC: circle with radius 2.5° centred on $\alpha_{J2000.0} = 01 : 07 : 00$, $\delta_{J2000.0} = -73 : 18 : 00$
- Bridge: $01 : 30 : 00 \leq \alpha_{J2000.0} < 05 : 30 : 00$ and $-75^\circ < \delta_{J2000.0} < -72^\circ$

Examples for Triggers

Ultraluminous X-ray Sources

Known ULX:

- extract all sources with $EP8LMax > 10^{39} \text{ erg s}^{-1}$ in Earnshaw et al. (2019),
and
- Flag $F_{eROSITA} > 3 \times SF1uxEP9$ or
- Flag $F_{eROSITA} < SF1uxEP9/3$
SF1uxEP9: average 3XMM-Flux

Examples for Triggers

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SF1uxEP9: average 3XMM-Flux

New ULX:

- Source w/ $10^{39} \text{ erg s}^{-1}$ (equiv. eROSITA cps) within D_{25} ellipse of Galaxy in Catalog of Neighboring Galaxies (Karachentsev et al.) *or* HECATE catalogue (Zezas et al., to be submitted)

Next Steps

Next steps for the TDA working group:

- **finish implementation of initial triggering scheme**
until end of March
- **call for trigger suggestions from whole consortium**
email in week of 25 March, deadline: mid-April (Easter); request approval from WG chairs or StC
~mid-May
- **add additional features to NRTA**
bot-interface for further triggers, simple spectral fits
- **simulate PV phase**
- **NRTA duty shift planning**
- **collaboration Russia: draft MoU written, but have to clean up and then talk in StC first**
next weeks
- **TDA meeting in Bamberg: 7/8 May (noon–noon)**

We also need people to volunteer as “scientist on duty”; requires some training, but doable (and perhaps interesting!) even for MSc or PhD students (~1 week long shifts starting in fall 2019)