

ToO and RRM observations at ESO

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Transient events at ESO

- Highly rewarding multi-messenger science cases are transient phenomena that require a fast response (compact binaries, SNe, GRBs, AGNs)
- Target of Opportunity (ToO)
 - Follow-up observations of transients within a few days
- Rapid Response Mode (RRM)
 - Automatic trigger of observations of transients within a few minutes
 - Service/visitor mode override

Multi-messenger astronomy

■ Electromagnetic radiation

- **Optical (near-UV to near-IR)**
- **Mid-IR**
- **Radio, sub-mm**
- High-energy (UV, X-ray, gamma-ray)

Paranal
La Silla
ALMA, APEX

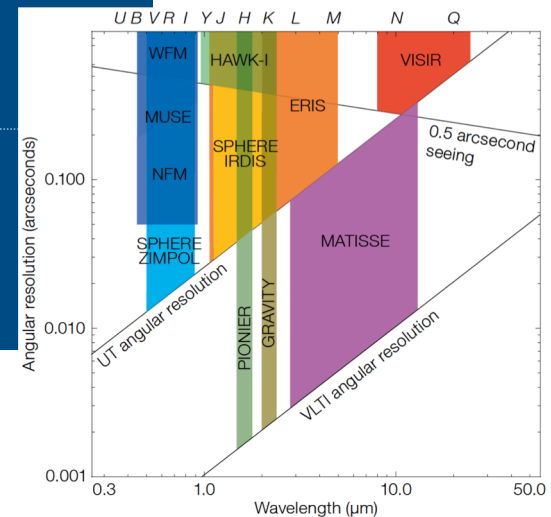
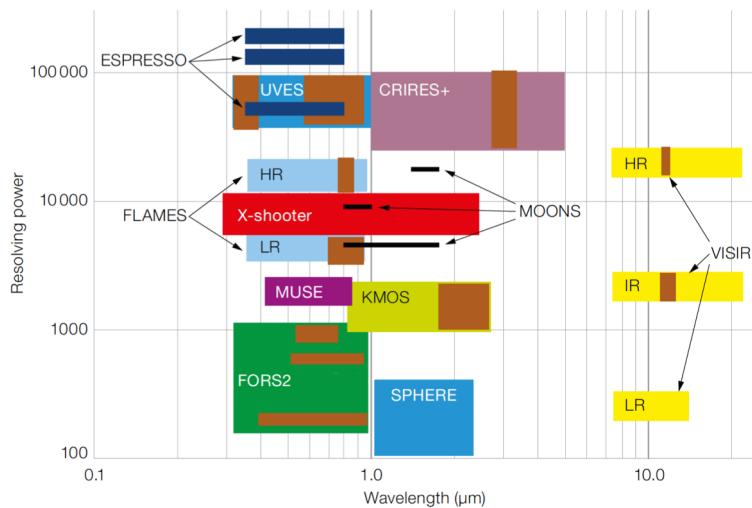
■ Neutrinos

■ Cosmic Rays

■ Gravitational waves

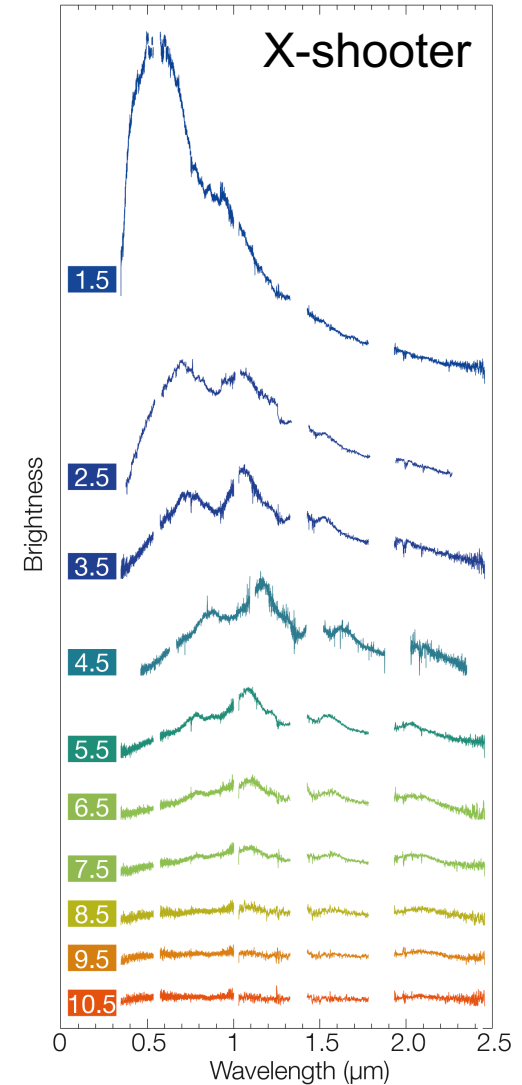
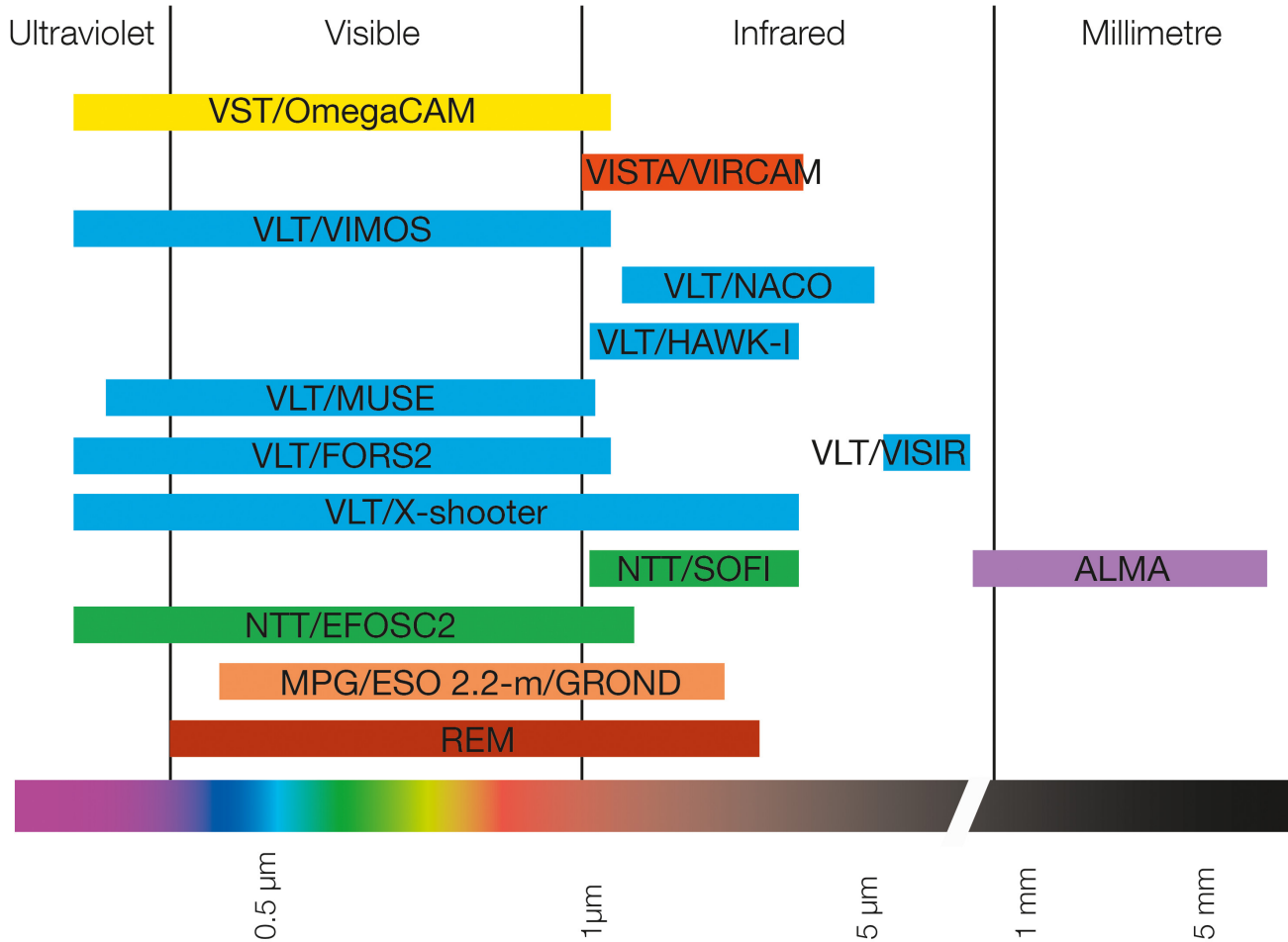


■ Spacecraft (geology, meteorology)



GW170817 at ESO

Spectral coverage of instruments used to observe NGC 4993



ToO science cases (P104 - Oct 2019)

- Electromagnetic counterparts and environments of gravitational wave sources
- Counterparts, distances, and host galaxies of SNe, GRBs, FRBs
- AGN activity
- Black hole accretion discs
- Near-Earth objects (e.g., Support to ESA's Space Situational Awareness Near-Earth Objects protection program)
- Microlensing events

Statistics of ToO/RMM programs

Period	Allocated time (hours)	Used time (hours)
P104 (Oct 2019)	415 for ToOs 18.5 for RRM	
P103 (Apr 2019)	481	176 (37%)
P102 (Oct 2018)	459	81 (18%)
P101 (Apr 2018)	292	74 (25%)
P100 (Oct 2017)	175	91 (52%)
P99 (Apr 2017)	230	111 (48%)
P98 (Oct 2016)	213	54 (26%)
P97 (Apr 2016)	187	32 (17%)

ToO and RRM observations

■ Target of Opportunity (ToO)

- Follow-up observations of transients within a few days

■ Rapid Response Mode (RRM)

- Automatic trigger of observations of transients within a few minutes

ToO and RRM observations

■ Proposals:

- Predictable: Generic proposal for known transient phenomena (GRBs, SNe, Novae)
- Unpredictable: Director's Discretionary Time (DDT)
- ToO-Hard (<48h), ToO-Soft (>48h)
- ToO-RRM (<4h)
- Follow-up with normal SM or ToO runs

■ Phase 2

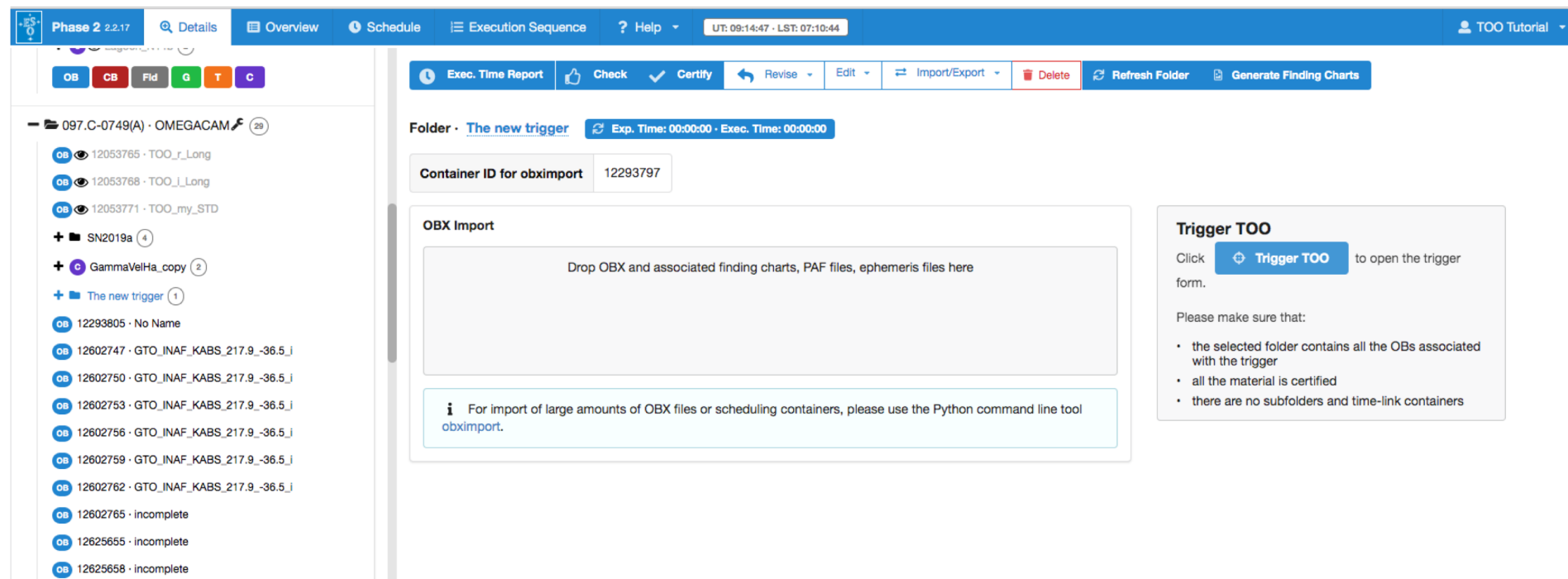
- Submission of generic Observation Blocks (OBs) describing the observations, to be used as templates for the actual trigger

Triggering of Soft/Hard ToOs

■ Preparation of OBs within a folder in p2

- Delegate phase 2 permissions to other users
- Copy template OBs into folder

■ Activation ("certify", "trigger")



The screenshot shows the Phase 2 interface with the following elements:

- Top Bar:** Phase 2 2.2.17, Details, Overview, Schedule, Execution Sequence, Help, UT: 09:14:47 - LST: 07:10:44, TOO Tutorial.
- Folder List:** 097.C-0749(A) · OMEGACAM (29)
 - OB 12053765 · TOO_r_Long
 - OB 12053768 · TOO_l_Long
 - OB 12053771 · TOO_my_STD
 - + SN2019a (4)
 - + GammaVelHa_copy (2)
 - + The new trigger (1)
 - OB 12293805 · No Name
 - OB 12602747 · GTO_INAF_KABS_217.9_-36.5_i
 - OB 12602750 · GTO_INAF_KABS_217.9_-36.5_i
 - OB 12602753 · GTO_INAF_KABS_217.9_-36.5_i
 - OB 12602756 · GTO_INAF_KABS_217.9_-36.5_i
 - OB 12602759 · GTO_INAF_KABS_217.9_-36.5_i
 - OB 12602762 · GTO_INAF_KABS_217.9_-36.5_i
 - OB 12602765 · incomplete
 - OB 12625655 · incomplete
 - OB 12625658 · incomplete
- Folder Details:** Folder · The new trigger, Exp. Time: 00:00:00 - Exec. Time: 00:00:00
- Container ID for obximport:** 12293797
- OBX Import:** Drop OBX and associated finding charts, PAF files, ephemeris files here
- Trigger TOO:** Click Trigger TOO to open the trigger form. Please make sure that:
 - the selected folder contains all the OBs associated with the trigger
 - all the material is certified
 - there are no subfolders and time-link containers
- Info:** For import of large amounts of OBX files or scheduling containers, please use the Python command line tool obximport.

Triggering of ToOs

Trigger TOO

[Run](#) | [Obs Blocks](#) | [Requester](#) | [Additional Requirements](#) | [Confirm](#)
 Review run info | Review OBs and identify calibrations | Fill-in contact info | Enter additional strategy requirements

- The Target of Opportunity you are about to trigger refers to the run below.
- The trigger will be identified by the corresponding folder name.

Run	097.C-0749(A)
Telescope	VST
Instrument	OMEGACAM
Principal Investigator	TOO Tutorial 53554@nodomain.net
Name of the Trigger	The new trigger

Trigger TOO

[Run](#) | [Obs Blocks](#) | [Requester](#) | [Additional Requirements](#) | [Confirm](#)
 Review run info | Review OBs and identify calibrations | Fill-in contact info | Enter additional strategy requirements

- This is a list of all the OBs contained in the folder you selected.
- They will be executed as part of this trigger.
- Please indicate if any of these are calibration OBs.

Container ID	Container Name	OB ID	OB Name	Target RA, Dec	Exec. Time [s]	Science or Calibration?
n/a	n/a	12293799	TOO_r_Long	NGC 104 00:24:05.350, -72:04:53.100	1609	<input type="checkbox"/> sci

Trigger TOO

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- Please fill-in the contact email address and phone number(s).
- You can enter up to 5 additional email addresses.
- These addresses will be used to provide email notifications on the progress of your trigger.

Requester	TOO Tutorial
Contact email	tootutorial@eso.org
Contact phone(s)	004912345678
Notify also	mycoi@eso.org
	Email 2
	Email 3
	Email 4
	Email 5

Trigger TOO

[Run](#) | [Obs Blocks](#) | [Requester](#) | [Additional Requirements](#) | [Confirm](#)
 Review run info | Review OBs and identify calibrations | Fill-in contact info | Enter additional strategy requirements

- Please select the time frame for the execution of these observations.
- Please enter additional observing strategy comments related to the trigger.

Execute observations within	Two Nights
Additional strategy comments	My comments

Improving the ToO process

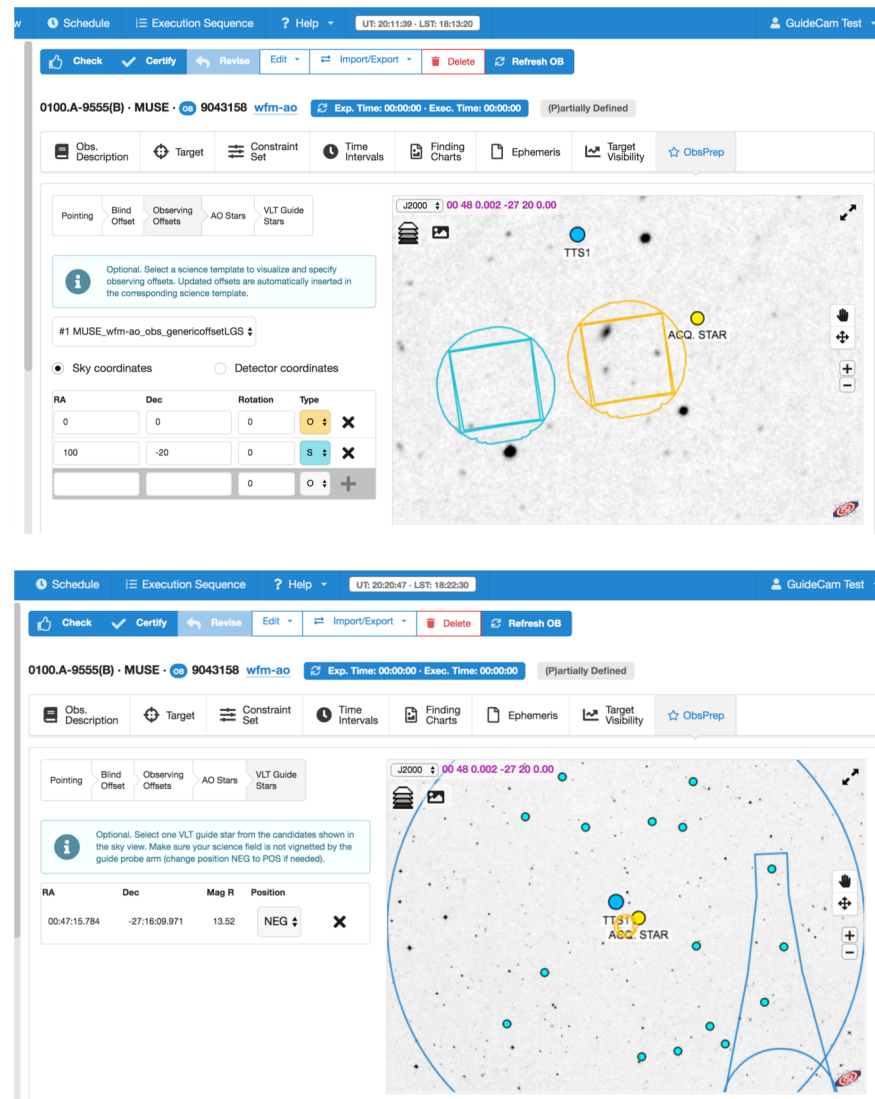
■ Observation Preparation

- One preparation tool, hide instrument specifics
- Visualization of pointing, offsets, windowing
- Selection of blind offset stars, AO stars, VLT guide stars

■ Time accounting

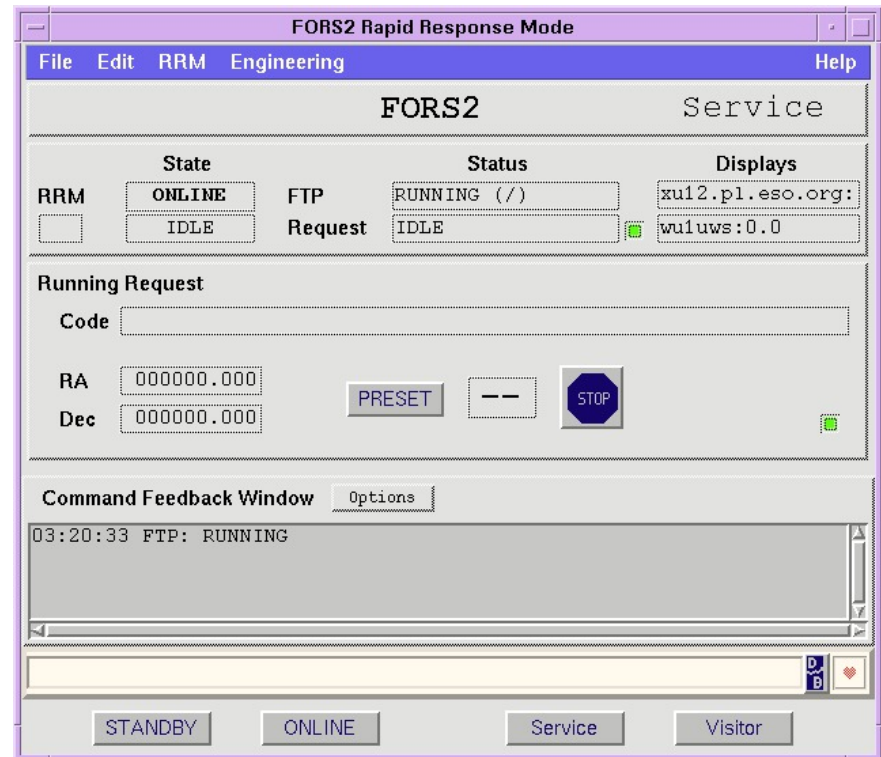
- Night log tool/User portal

■ Fast access to reduced data, quality information



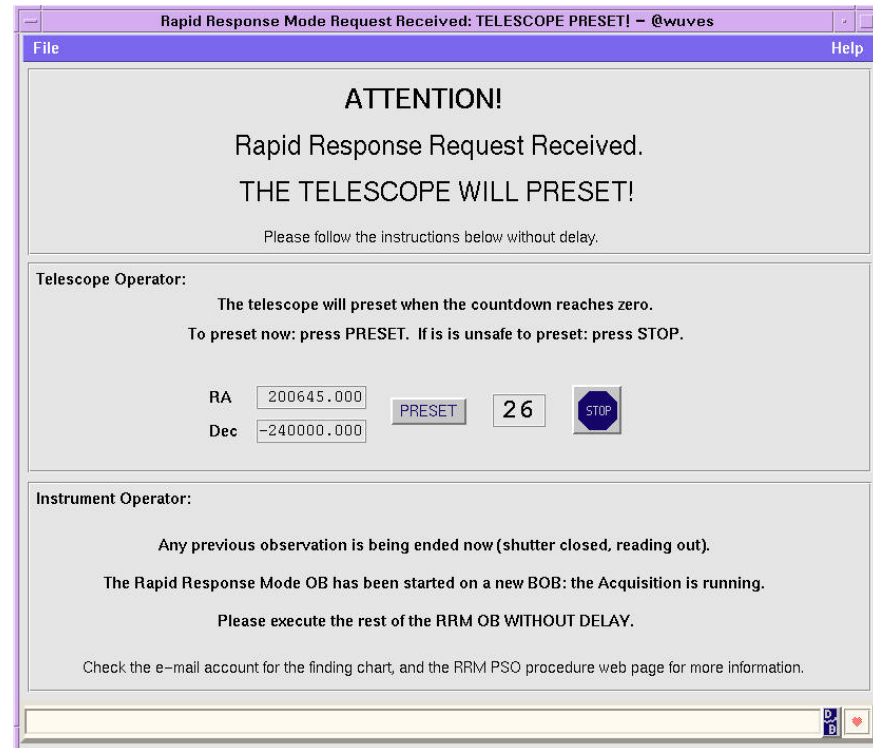
RRM specifics

- Offered for some instrument modes of FORS2, X-SHOOTER, UVES, SPHERE, HAWK-I, MUSE
- Trigger is send via ASCII file to ftp server
- When a trigger is found (cron job), the ongoing SM/VM observation is automatically ended



RRM specifics

- Telescope automatically presets to coordinates in the ftp file
- Instrument executes automatically the requested OB
- Manual acquisition by operator



Improving the RRM process

- Currently a necessary condition is that the requested instrument is in use, i.e. no instrument (focus) changes for RRM.

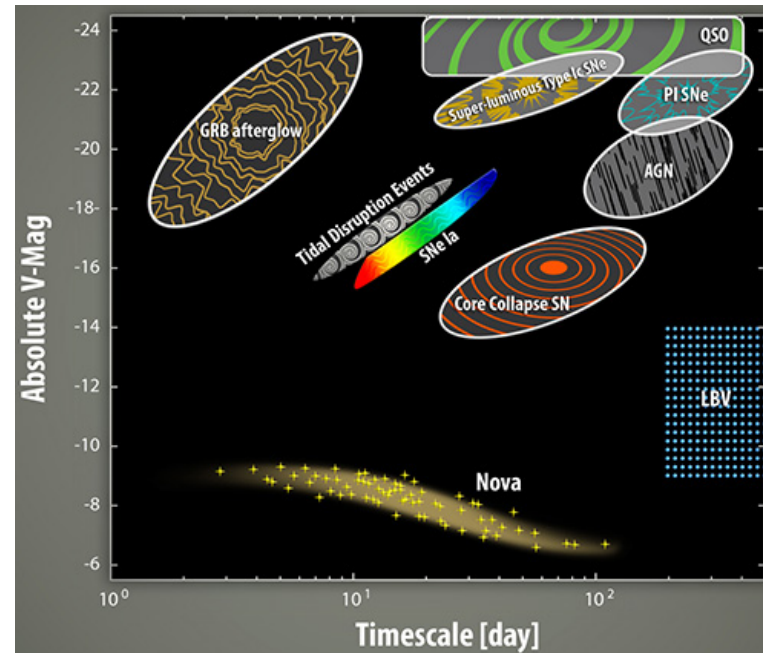
P105 at UT2 (UVES, X-SHOOTER)

- No on-focus restriction: automatic focus change
 - Users can specify if they accept the additional overhead
 - Max response time until start of observations is 10-15 min
- Automatic check whether the currently running observation is protected against RRM triggers

Summary

■ Increase of detection of transient events in the coming years

- Massive sky surveys (*GAIA*, *LSST*, *EUCLID*)
- Gravitational wave missions (*LIGO*, *LISA*)



■ Facilitate fast follow-up observations with ESO's instrumentation suit

- Optimization of tools and procedures

Feedback/suggestions: usd-help@eso.org, amehner@eso.org