Laboratoire d'Annecy-le-Vieux
de Physique des Particules

# CTA/LST Alert System

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cnrs

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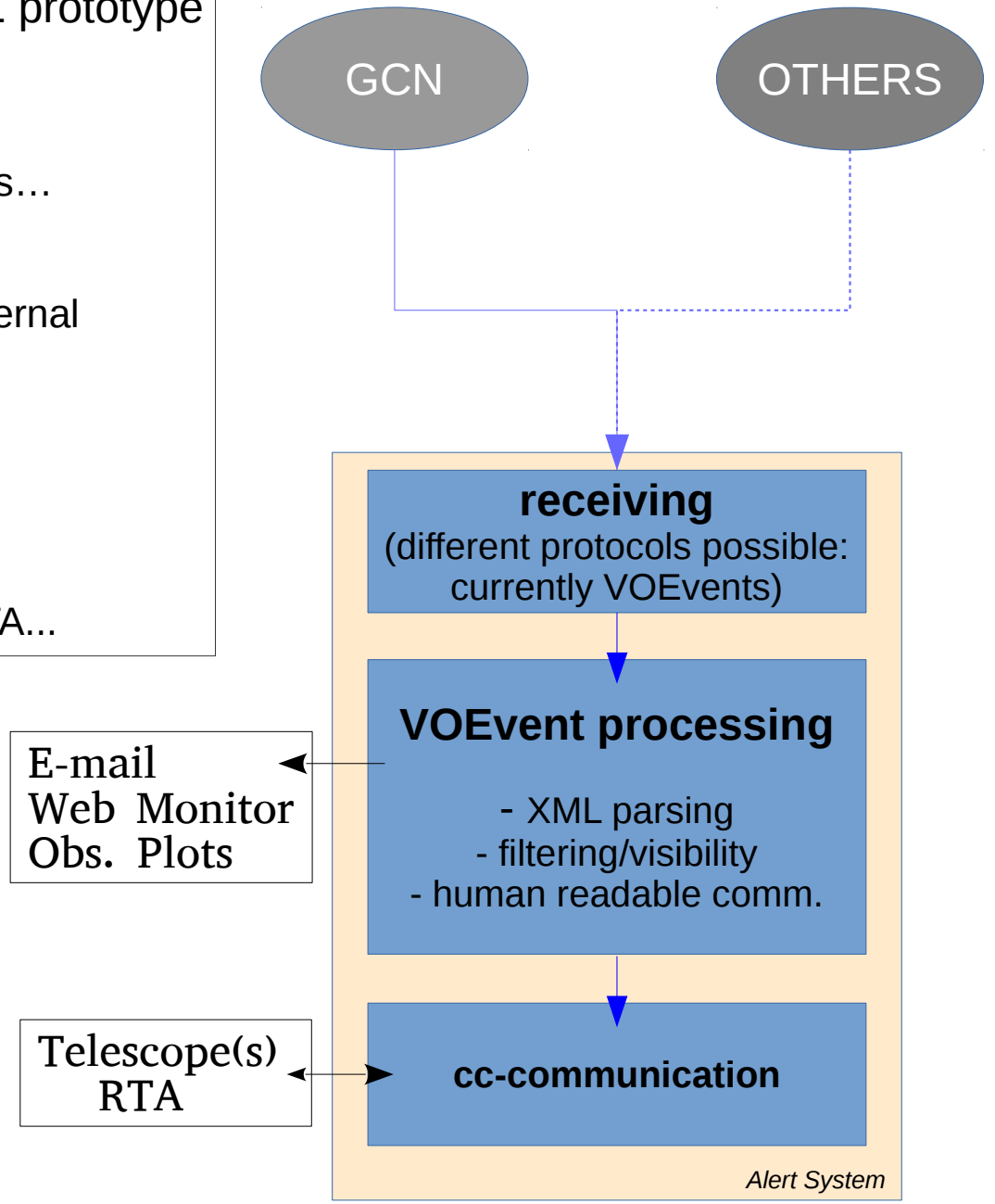
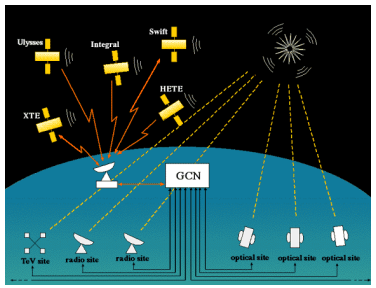
# CTA/LST – ALERT SYSTEM

- Developing of the Alert System for the LST-1 prototype for:
  - **External communication handling**
    → comm. protocols, connection(s) with brokers…
  - **Alerts handling**
    → receiving, parsing, archiving alerts from external facilities
  - **Visibility/filtering**
    → visibility evaluation, obs constrains…
  - **Internal communication handling**
    → communication with TCU/CC/scheduler, RTA...

→ Communication protocol:
VOEvent v2 (xml)
(only 1 broker until now: GCN)

→ Multi-thread modular design -
( C/C++(+libxml2) & Python )






LOFAR

AMON
Astrophysical Multimessenger Observatory Network

LAPP

GCN

OTHER BROKERS

thread1

TCP/IP

VOE

thread2, thread3....

CTA Science Use Cases (strategy)

*LST Alert System (baseline design)*

GET/SEND NOTICES

alerts

ALERT VALIDATION

not observable

EMAIL NOTIFICATION

imalive

is observable

EXT COMM STATUS

web_thread

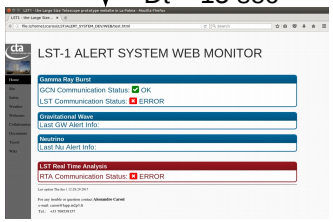
WEB MONITOR

ALERT BUFFER

ALERT STORAGE

INT COMM STATUS

Dt = 15 sec




report

GET/SEND NOTICES

SYSTEM CLIENT

VOE

GCN

*External world*

OTHERS

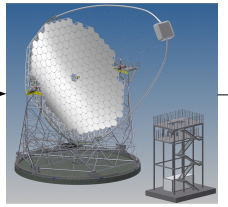
alerts

Observatory Use Cases

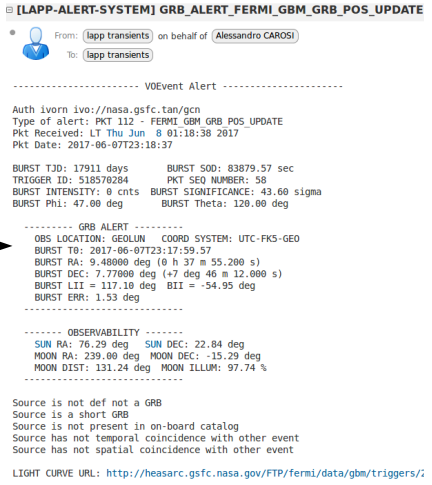
cc_thread

TCU

To Telescope(s)



RTA




cta cherenkov telescope array

A. Carosi

# CTA/LST – ALERT SYSTEM

{C} GET NOTICES
- init()
- establish_server_cnn()
- build_ima_response()
- build_voe_response()
- parsing_voevent()
- interpreters()
- .....

{C} EMAIL NOTIFICATION
- create_email_alert()
- send_email_alert()
- send_server_disconnected_email()
- send_daily_status()
- .....

{C} EXT COMM STATUS
- check_imalive()
- check_gcn_comm()
- set_comm_status()
- .....

{C} WEB MONITOR
- web_thread()
- make_web()
- make_status_web()
- .....

"Low-level" code (C/C++)

"High-level" code (Python)

{Python} ALERT VALIDATION
- check_multiple_alerts()
- check_visibility()
- obs_windows()
- Ranking() ?
- update_alert_coordinates()
- .....

{Python} GW MODULE
- .....


F. Schussler+2 students contribution

→ VOEvent protocol V2 (xml) – only 1 broker until now (GCN)

→ Multi-thread modular design ( C/C++(+libxml2) & Python )

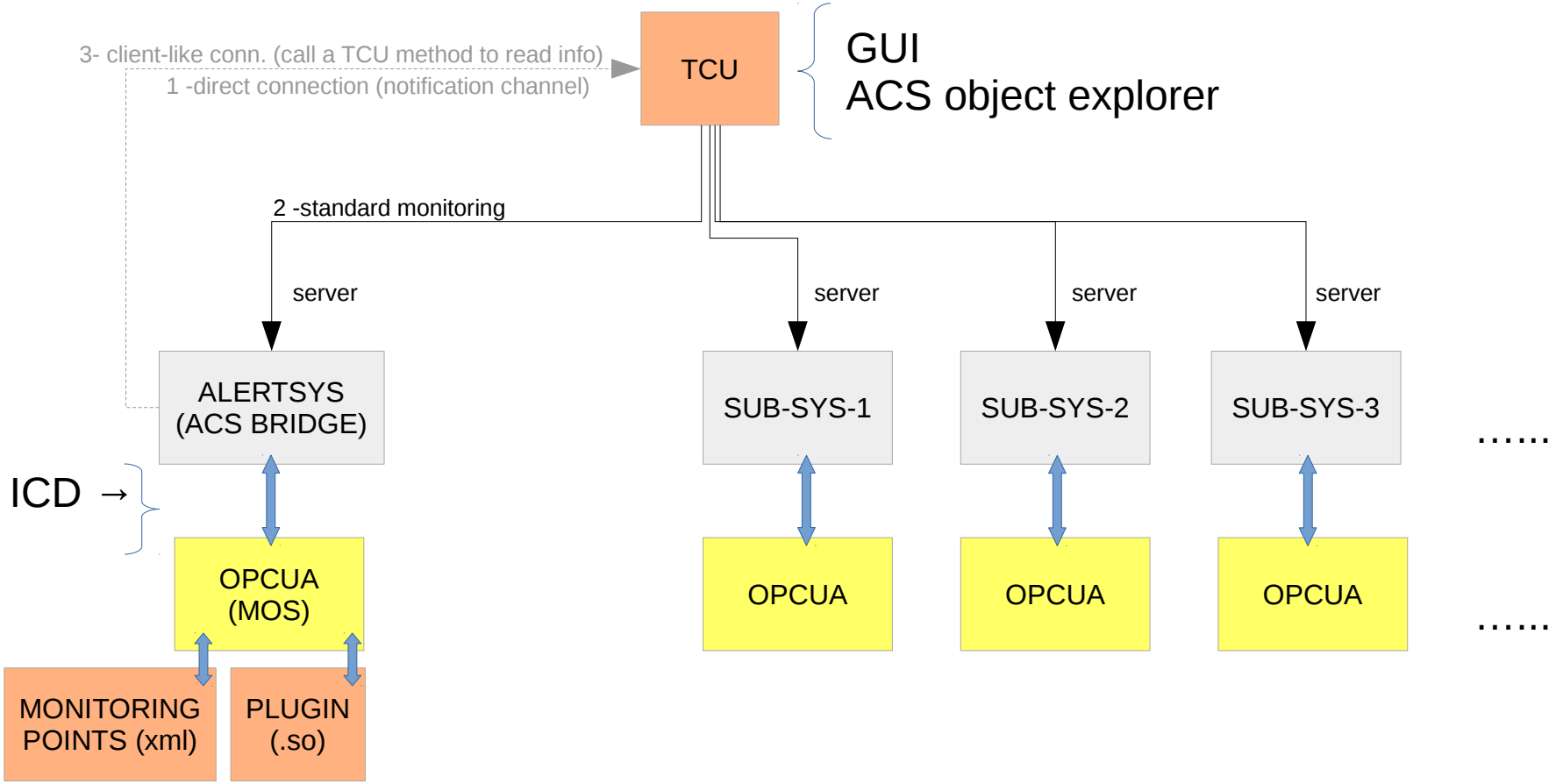
# CTA/LST – ALERT SYSTEM

we identified 3 possible solutions to spread these info to telescope:

--> using a notification channel from the ACS bridge component to TCU so that the occurrence of an alert is sent as soon as the alert system has validated it. Afterword, the TCU retrieves the full alert info by calling a method in the AS bridge. (AS Active)

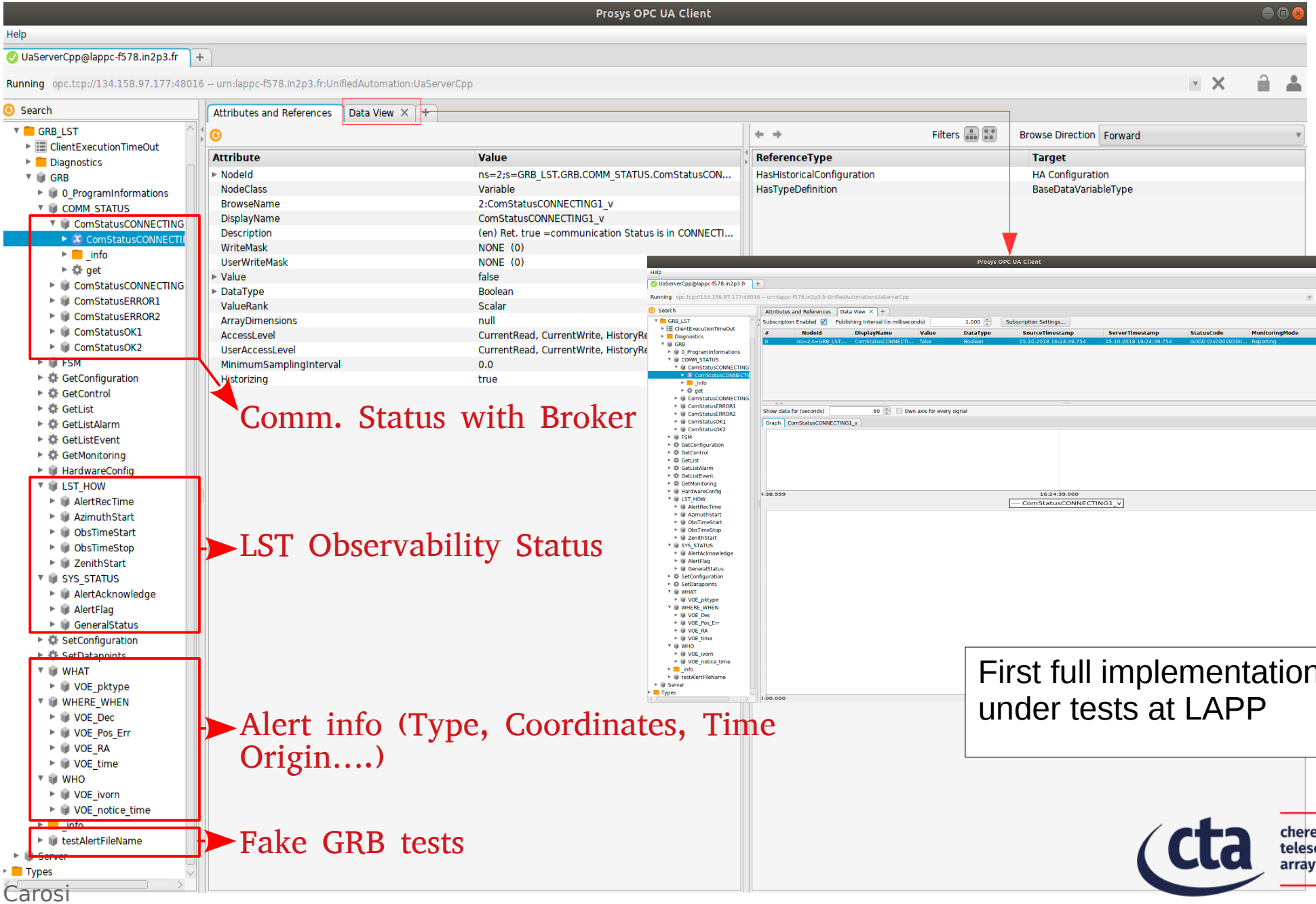
--> using 'standard' monitoring by TCU. The TCU makes a polling on 'alert flag' parameter retrieving the info when they are modified. (AS passive)

-->AS ACS bridge is a client for TCU. Thus TCU will be called from the AS and the TCU must has a method to handle these calls and retrieve all the info (AS active)



# CTA/LST – ALERT SYSTEM

– Internal interfaces defined and communication with OPCUA under test (work with J-L. Panazol and T. Le Flour)



# CTA/LST – ALERT SYSTEM

**GRB_ALERT_TYPE_SWIFT_BAT_GRB_POSITION**

From: Alessandro CAROSI
To: carosi@lapp.in2p3.fr

```
---------------------- VOEvent Alert ----------------------

Auth ivorn ivo://nasa.gsfc.tan/gcn
Type of alert: PKT 61 - TYPE_SWIFT_BAT_GRB_POSITION
Pkt Received: LT Wed Oct  3 18:27:25 2018
Pkt Date: 2017-05-31T22:09:32
```

ORIGIN

```
BURST TJD: 17904 days       BURST SOD: 79329.20 sec
TRIGGER ID: 755354       PKT SER NUMBER: 1
BURST INTENSITY: 48238 cnts  BURST PEAK COUNTS: 800.00 cnts
RATE SIGMA: 10.04 sigma  IMAGE SIGMA: 9.47 sigma
BURST Phi: -150.27 deg       BURST Theta: 20.42 deg

  --------- GRB ALERT ---------
    OBS LOCATION: GEOLUN   COORD SYSTEM: UTC-FK5-GEO
    BURST T0: 03 Oct 2018 15:50:09
    BURST RA: 286.89460 deg (19 h 7 m 34.704 s)
    BURST DEC: 16.42640 deg (+16 deg 25 m 35.040 s)
    BURST LII = 49.38 deg  BII = 3.95 deg
    BURST POS ERR: 0.05 deg
  -----------------------------
```

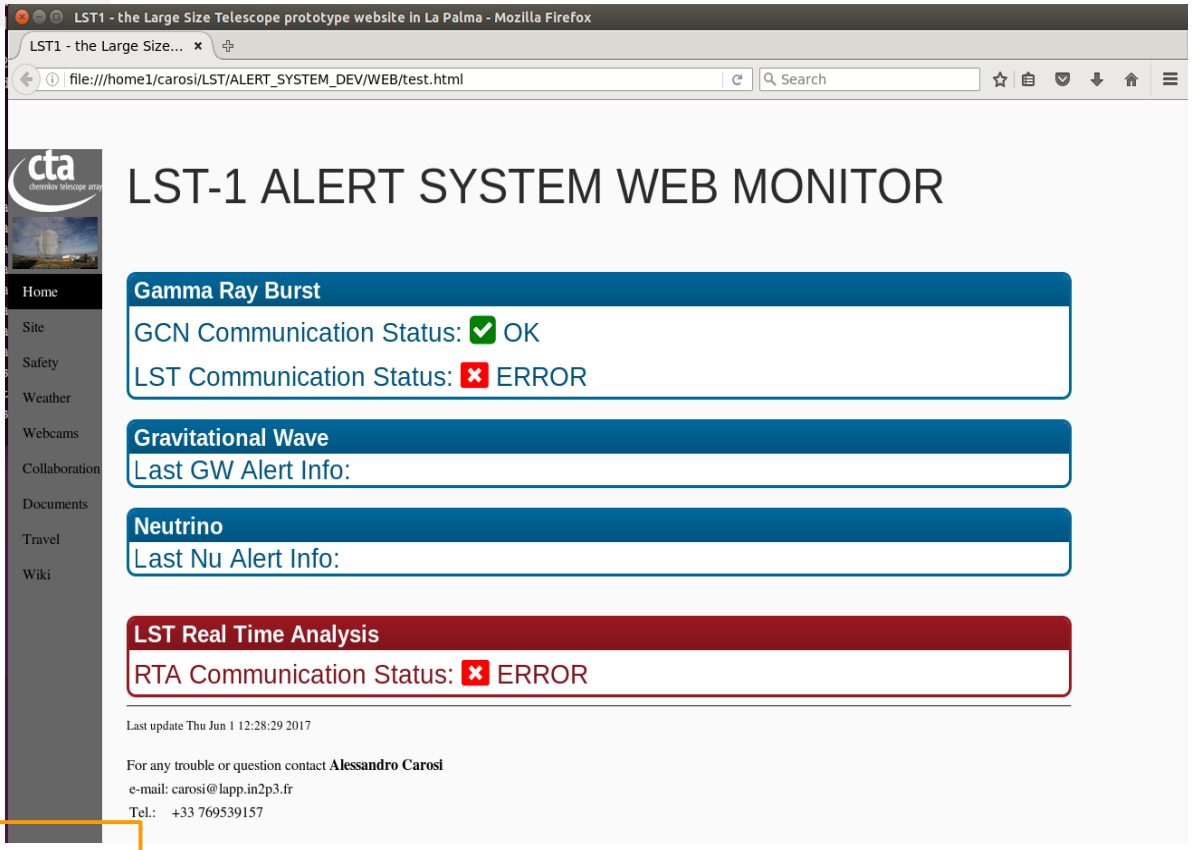
COORDINATES

```
  ------- OBSERVABILITY -------
    SUN RA: 69.04 deg   SUN DEC: 22.04 deg
    MOON RA: 155.45 deg  MOON DEC: 10.63 deg
    MOON DIST: 132.78 deg  MOON ILLUM: 43.76 %

    Source IS observable
    Obs. Time Start (UTC): 03 Oct 2018 15:50:09 (MJD 58394.659829)
    Obs. Time End (UTC)  : 03 Oct 2018 19:50:09 (MJD 58394.826495)
    In the zenith range 51.93 --> 13.14 deg
  -----------------------------
```

OBSERVABILITY

```
Source is a point source
Source is a GRB
Source is not def not a GRB
Source is not present in on-board catalog
Source has not temporal coincidence with other event
Source has not spatial coincidence with other event
```




Monitor Web Page (refresh rate: 15 sec)

# OTHER ACTIVITIES CTA

## Participation to the activities of the MWL working group:

– Author with S. Covino & A. Stamerra (INAF) of *"Critical assessments of optical support needs for CTA science"* for the GRB science case
Final version presented by S. Markoff at the CTA collaboration meeting in Berlin (2018/09)

**Critical assessment of optical support needs for CTA science: the GRB case**

GRBs are key project for CTA

- 5/yr/site (swift/SVOM) + 10/yr/site (GBM) → ~12 GRB/yr/site (overlap)
- 2 h/event → ~ 25 h/yr/site (prompt follow-up)

~ 50 h/yr/site

- Detection: ~1/yr/site → +10-15/h/site
- Late time follow-up on specific event: ~1/yr/site → 10/h/site

**Table 1:** Summary of GRB follow-up strategy and observing time for one array site. Numbers are equal for North and South sites.

| Strategy | Expected event rate ($yr^{-1}$) | Exposure per follow-up (hr) | Exposure per year (hr $yr^{-1}$) | Telescope type |
|---|---|---|---|---|
| Prompt follow-up of accessible alerts | ~12 | 2 | 25 | LST only |
| Extended follow-up for detections | 0.5-1.5 | 10-15 | 10-15 | LST+MST+SST |
| Late-time follow-up of LAT GRBs not accessible promptly | ~1 | 10 | 10 | LST+MST+SST |

* From *"transient key science project"*, Inoue+2014

## Transient Working Group: CTA consortium paper on GRB:

– Theoretical approach for GRB detection rate starting from a physically-modeled GRB population (work done together with Q. Piel & T. Gasparetto)

Inputs:
- Spectrum (theoretical model)
- Light curve (observations)
- IRF (CTA consortium)

ctools cherenkov telescope array
Version 1.3.0

- Impact of physical parameters on GRB detectability
- Estimate the number of GRB detections each year for the two CTA array
- Compare Fermi-LAT and CTA detections

## Transient Working Group: CTA consortium paper on Gravitational Waves:

– Responsible of one of the task (T3 – CTA simulation) for the GW consortium paper (with T. Gasparetto)

**GW consortium paper: team and timeline**

| | Task | Deliverables | Status | Timeline | Group/reference person |
|---|---|---|---|---|---|
| T1 | Simulation of GW events from BNS mergers | Database of BNS mergers and GW signals with LIGO-Virgo in Adv-phase | DB of BNS ready for release | September 2018 | INAF-SNS: **B. Patricelli**, Stamerra (CTA-external: M. Razzano, G. Cella) |
| | | Add KAGRA | massive simulation | end 2018? | |
| T2 | simulation-estimation of VHE emission | • phenomenological model **on-axis** sGRB<br>• templates on light-curves and spectra | Add EBL | September 2018 | Columbia group with **T. Di Girolamo**<br>Trieste group: **F. Longo** |
| | | • Rescaling for off-axis emission<br>• afterglow/delayed emission (literature) | literature dig | October 2018 | INAF-SNS group: **B. Patricelli**, Stamerra<br>**S. Inoue** |
| T3 | CTA simulation | Simulated CTA events from:<br>• LC and spectra from T1 and T2; EBL<br>• IRF (threshold, full, divergent) | code partially develop. need EBL; diverg. IRF | December 2018:<br>EBL implementat<br>Divergent IRF: ~1y | Saclay group: Schüssler, Lefaucheur<br>Columbia, Trieste, INAF-SNS, groups<br>Annecy group: **A. Carosi** |
| T4 | Optimisation of observing strategies | • set of observational constraints<br>• optimised tiling sequence<br>• Joint GW-CTA detection rates, coverages | code developed needs input T2-T3 | mass simulations: beginn2019 | Saclay (**F. Schüssler**) group<br>INAF-SNS group<br>Bologna group: **G. Stratta** |