Real-time simulation of SVOM Core Program alert sequences for the training of the Burst Advocates

Damien Turpin (CNES/CEA) & Henri Louvin (CEA)

with the collaboration of
Kamshat Tazhenova (CEA), Nicolas Dagoneau (CEA), Stéphane Schanne (CEA), Tatyana Sadibekova (CEA), Chrystel Moreau (LAM), Arnaud Claret (CEA), Bertrand Cordier (CEA), Li-Ping Xin (NAOC), Mo Zhang (NAOC)

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SVOM workshop @OHP
Nov, 9th 2021

Motivations and Goals

Our motivation for this training (Core Program only)

SVOM launch will be in 2023, we have one year to train the future Burst Advocates in **real conditions**.
"Real conditions" means

- **At the system level**
  1. Simulate (ECLAIRs) alert sequences generated onboard in real-time
  2. Transmit the alert informations in all the SVOM sub-systems (FSC & CSC DB, SDB, follow-up system) in real-time
  3. generate simulated voevent alerts to be followed-up by our SVOM follow-system (SVOM facilities, external partners, MoU partners, etc.)
  4. Build the first pieces of the future SVOM BA working environment

- **At the scientific level**
  1. interpret the data displayed on the iFSC and CSC-BA tools : validation of the optical GRB afterglow candidates
  2. take appropriate decision to perform further follow-up observations
  3. Post our first GRB follow-up GCN Circular as the SVOM Collaboration !

Outlines

1. **The SVOM alert simulator**
2. **How to follow-up the SVOM alerts ?**
3. **How to make my Burst Advocate job during this period ?**

1.
The SVOM alert simulator

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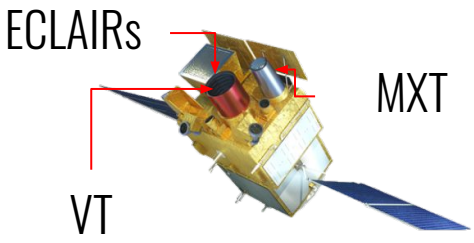
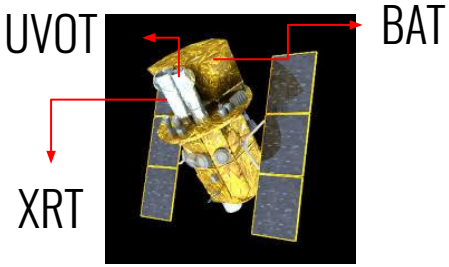
From real Swift GRB to SVOM simulated GRBs

SVOM (2023 -)



Swift (2004 - Now)



SVOM / Swift similarities

1. *Similar instruments onboard*, i.e. a soft gamma-ray trigger instrument associated with a 0.2-10 keV x-ray and an optical follow-up instruments

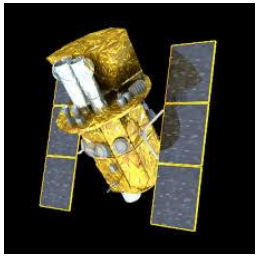
2. *Similar way to proceed onboard once a GRB is detected, i.e. intialization of an automatic alert/follow-up sequence*

3. *Similar GRB detection rate, alert notices sent in real-time*

Swift alert sequence (notices) sent for GRB 210818A

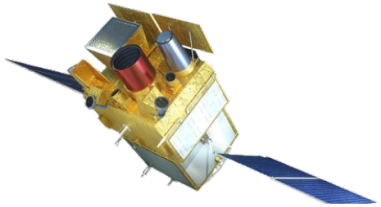
GCN Date	Notice Type	parts
2021-08-18 01:02:22	Swift-BAT GRB Position	[body.txt]
2021-08-18 01:02:40	Swift-FOM Will_Observe	[body.txt]
2021-08-18 01:02:47	Swift-S/C Will_Slew	[body.txt]
2021-08-18 01:03:32	Swift-XRT Position	[body.txt]
2021-08-18 01:03:41	Swift-XRT Image	[body.txt][xrt_raw_image.fits.gz] [xrt_raw_image.ps][png]
2021-08-18 01:03:43	Swift-XRT Processed Image	[body.txt][xrt_proc_image.fits.gz] [xrt_proc_image.ps][png]
2021-08-18 01:03:47	Swift-XRT Thresholded-Pixels	[body.txt][xrt_raw_threshpix1.fits.gz]
2021-08-18 01:03:54	Swift-XRT Spectrum	[body.txt][xrt_raw_spec1.fits.gz]
2021-08-18 01:03:56	Swift-XRT Processed Spectrum	[body.txt][xrt_proc_spec1.fits.gz]
2021-08-18 01:03:56	Swift-XRT Processed Thresholded-Pixels	[body.txt][xrt_proc_threshpix1.fits.gz]
2021-08-18 01:06:39	Swift-XRT Spectrum	[body.txt][xrt_raw_spec2.fits.gz]
2021-08-18 01:06:40	Swift-XRT Processed Spectrum	[body.txt][xrt_proc_spec2.fits.gz]
2021-08-18 01:06:43	Swift-BAT GRB Lightcurve	[body.txt][bat_attitude.fits.gz] [bat_raw_lc.fits.gz]
2021-08-18 01:06:50	Swift-BAT GRB Lightcurve	[body.txt][bat_raw_lcx.fits.gz] [bat_attitudex.fits.gz]
2021-08-18 01:07:53	Swift-UVOT Source List	[body.txt][uvot_raw_srclist.fits.gz]

Which Swift Notices / Which SVOM Notices?



Swift
(real world)

notice
timeline



SVOM
(simu world)

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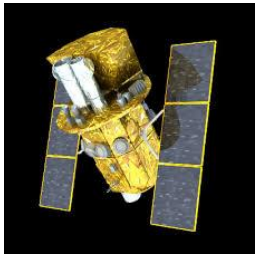
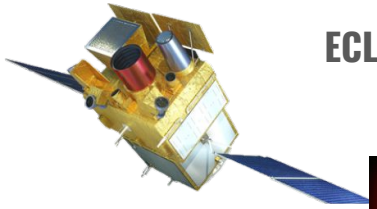


Swift
(real world)

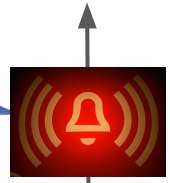
SWIFT_BAT_QL_POS

T0



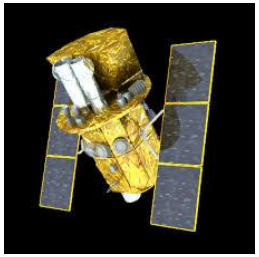
SVOM
(simu world)

ECLAIRs alert 1



T0

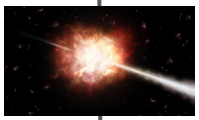
Which Swift Notices / Which SVOM Notices?



Swift
(real world)

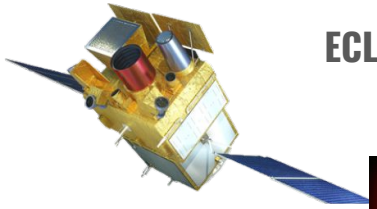
SWIFT_BAT_QL_POS

SWIFT_BAT_GRB_POS
_ACK



T0

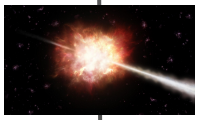
T0+1s



SVOM
(simu world)

ECLAIRs alert 1

ECLAIRs alert 2



T0

T0+1s

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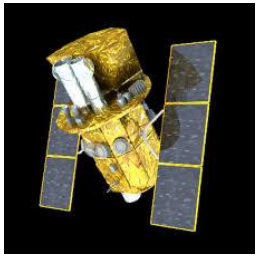
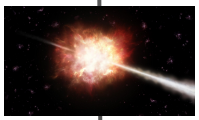


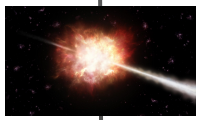
Swift
(real world)

SWIFT_BAT_QL_POS

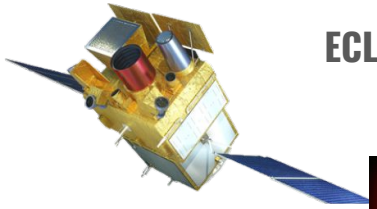
SWIFT_BAT_GRB_POS
_ACK

SWIFT_FOM_OBS



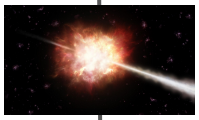


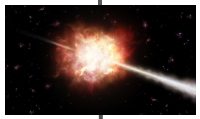
T0 T0+1s T0+10-40s



SVOM
(simu world)

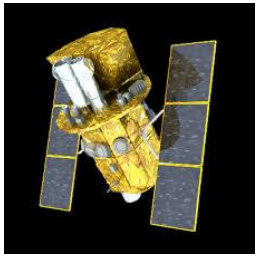
ECLAIRs alert 1 ECLAIRs alert 2 ECLAIRs alert 3





T0 T0+1s

Which Swift Notices / Which SVOM Notices?



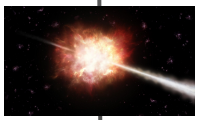
Swift
(real world)

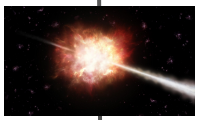
SWIFT_BAT_QL_POS

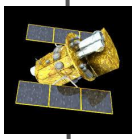
SWIFT_BAT_GRB_POS
_ACK

SWIFT_FOM_OBS

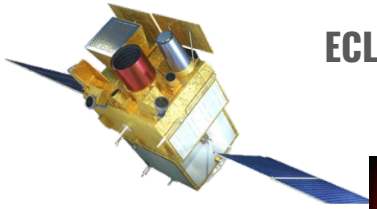
SWIFT_SC_SLEW







T0 T0+1s T0+10-40s T0+10-40s



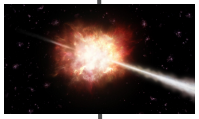
SVOM
(simu world)

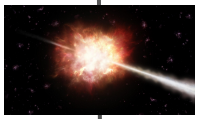
ECLAIRs alert 1

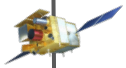
ECLAIRs alert 2

ECLAIRs alert 3

ECLAIRs alert 4

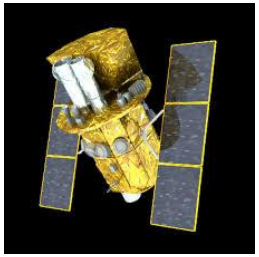






T0 T0+1s T0+10-40s T0+10-40s

Which Swift Notices / Which SVOM Notices?



Swift
(real world)

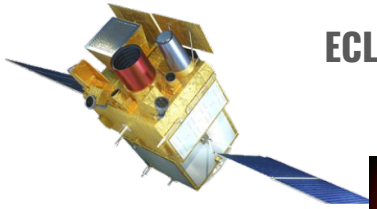
SWIFT_BAT_QL_POS — T0

SWIFT_BAT_GRB_POS_ACK — T0+1s

SWIFT_FOM_OBS — T0+10-40s

SWIFT_SC_SLEW — T0+10-40s

SWIFT_XRT_POS — T0+1-2 min



SVOM
(simu world)

ECLAIRs alert 1 — T0

ECLAIRs alert 2 — T0+1s

ECLAIRs alert 3 — T0+10-40s

ECLAIRs alert 4 — T0+10-40s

MXT_POS — T0+1-2 min

Which Swift informations ? / Which SVOM products?

Swift (alert notice sequence)

1. **SWIFT_BAT_QL_POS(T0=0s):** transient alert (Trigger time + sky position but no GRB confirmation yet)
2. **SWIFT_BAT_GRB_POS_ACK(T0=0s):** GRB alert (Trigger time + sky position + GRB classification + SNR) SWIFT_BAT_GRB_POS_NACK: GRB not localized
3. **SWIFT_FOM_OBS (ΔT=T0+14-41s):** figure-of-merit value for a Swift-BAT transient detection (Trigger time + sky position + GRB classification + ***FOM to trigger or not an automated follow-up sequence on-board***)
4. **SWIFT_SC_SLEW(ΔT=T0+14-41s):** response back from the Swift spacecraft to a Slew_request (Trigger time + sky position + GRB classification + ***confirmation that the slew has been performed or not***)

FSC VHF pipeline

(H. Louvin & C. Moreau talks)

SVOM (simulated sci. products)

1. **TT_ECL1, QPO_ECL1**
2. **TT_ECL2, QCL_ECL2, QPO_ECL2**
3. **TT_ECL3, QCL_ECL3, QPO_ECL3**
4. **TT_ECL4, QCL_ECL4, QPO_ECL4**

Practically speaking, how do we proceed ?

Swift GCN notices (pygcn service)

VOEvent (XML)
SWIFT_BAT_QPO, SWIFT_BAT_GRB_POS_ACK, SWIFT_FOM_OBS & SWIFT_SC_SLEW

SVOM decoder & ECLAIRs packet simulator
(gcn-interceptor)

ECLAIRs Alert packet (JSON)

JSON packet

FSC encoder code
(packets-decoder)

Encoded packet

FSC VHF upload in SDB

FSC alert broker

voevent-notices service

NATS com

SVOM / iFSC-tools
(C. Moreau talk)

French Science Center

Astro Colibri App

SVOM / CSC

External partners

Practically speaking, how do we proceed ?

Swift GCN notices (pygcn service)

VOEvent (XML)
SWIFT_BAT_QPO, SWIFT_BAT_GRB_POS_ACK, SWIFT_FOM_OBS & SWIFT_SC_SLEW

SVOM decoder & ECLAIRs packet simulator
(gcn-interceptor)

ECLAIRs Alert pac

Running 24h/7d

JSON packet

FSC encoder code
(packets-decoder)

voevent-notices service

FSC VHF upload in SDB

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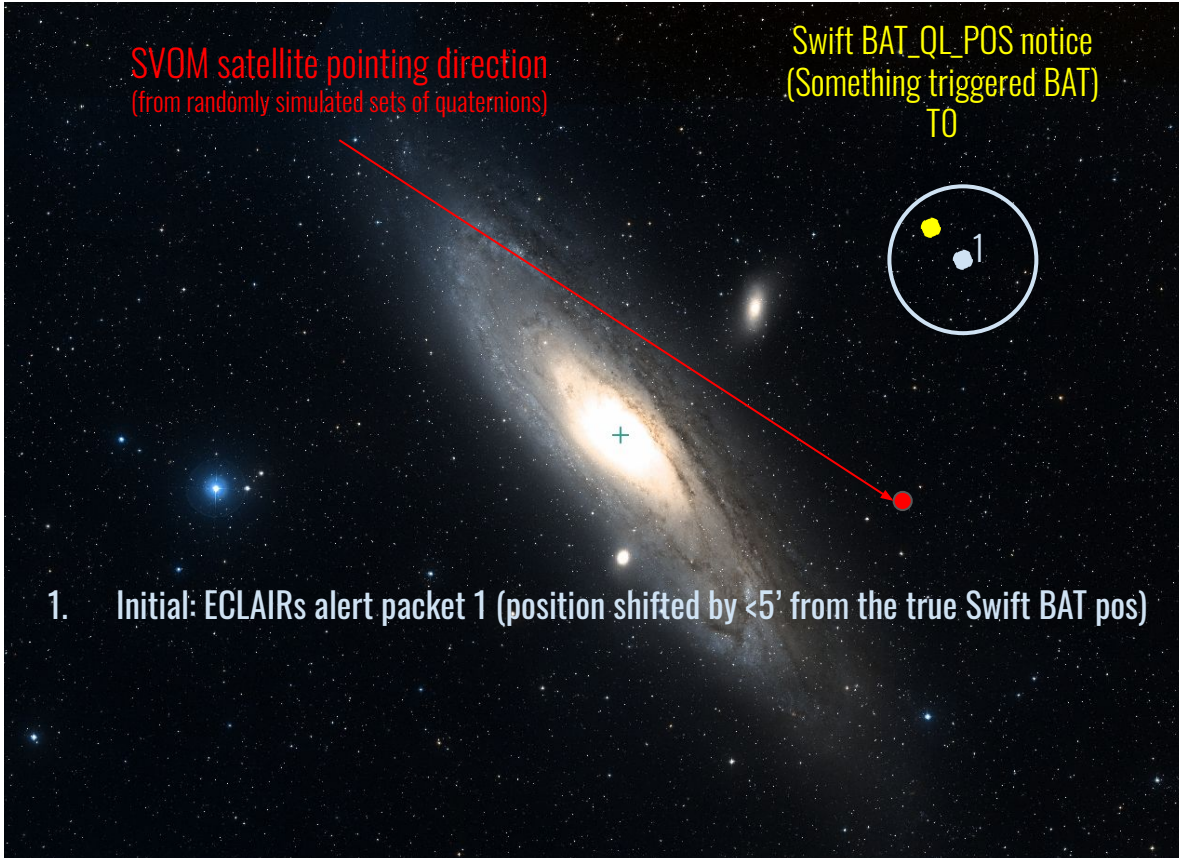
alert broker

External partners

The typical scenario for the follow-up facilities



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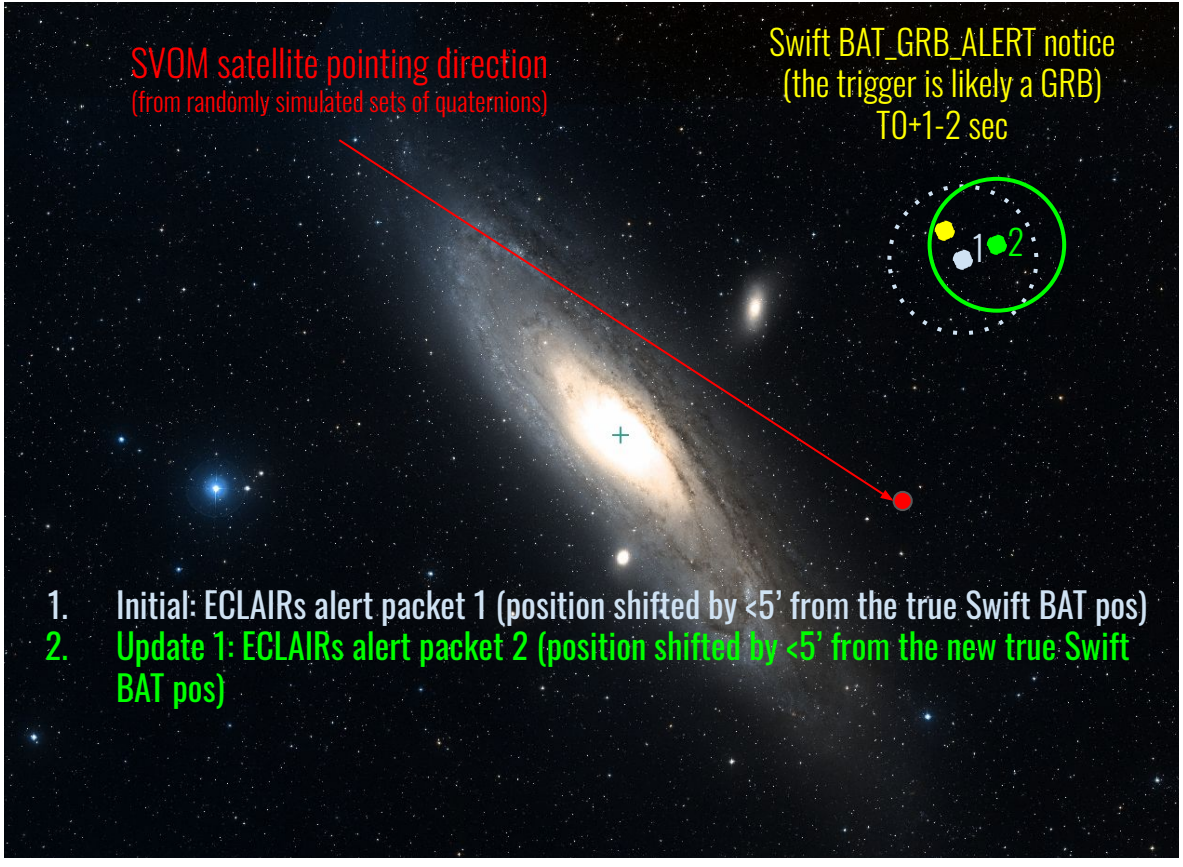

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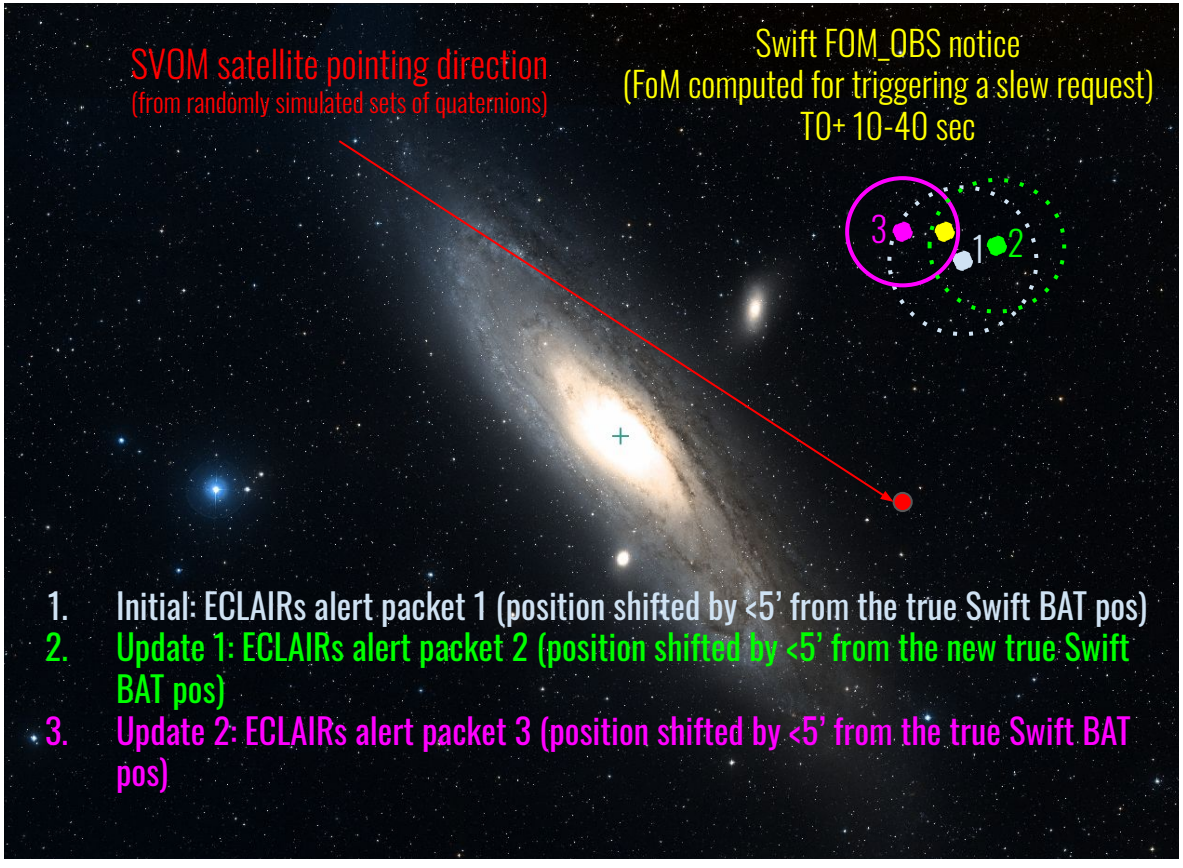

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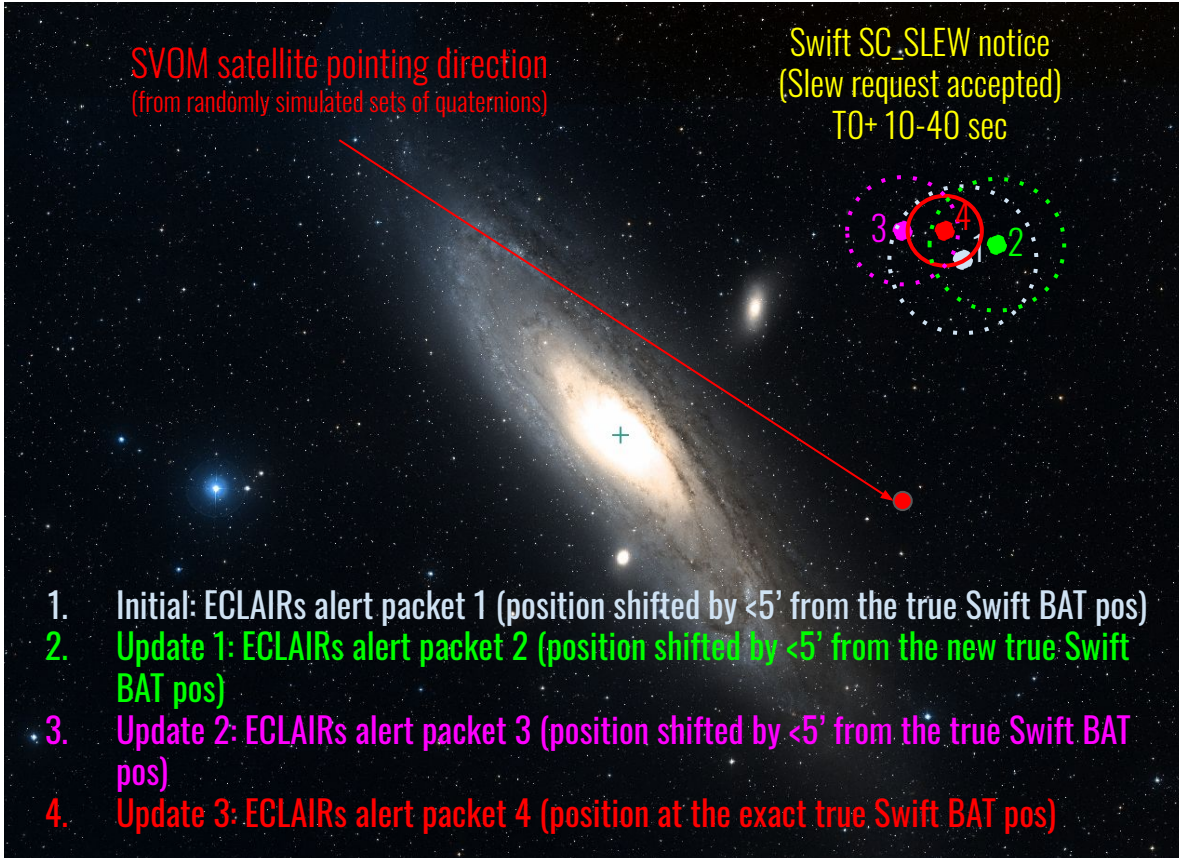

Conclusions about the alert simulator

- The gcn-interceptor service is running 24h/7d at FSC to convert Swift GRB alerts into ECLAIRs alert packets in real-time
- The simulated VHF alerts are well encoded and processed at FSC
- The subsequent VHF products are produced in real-time and populate the SVOM/SDB
- An FSC alert broker is running 24h/7d to broadcast the SVOM alerts to the external world

2.
How to follow-up the SVOM alerts ?

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SVOM workshop @OHP
Nov, 8th 2021

Step 1 : Contact us to get the SVOM / FSC broker info.

Swift GCN notices (pygcn service)

VOEvent (XML)
SWIFT_BAT_QPO, SWIFT_BAT_GRB_POS_ACK, SWIFT_FOM_OBS & SWIFT_SC_SLEW

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NATS com

SVOM / iFSC-tools
(C. Moreau talk)

French Science Center
H. Louvin talk

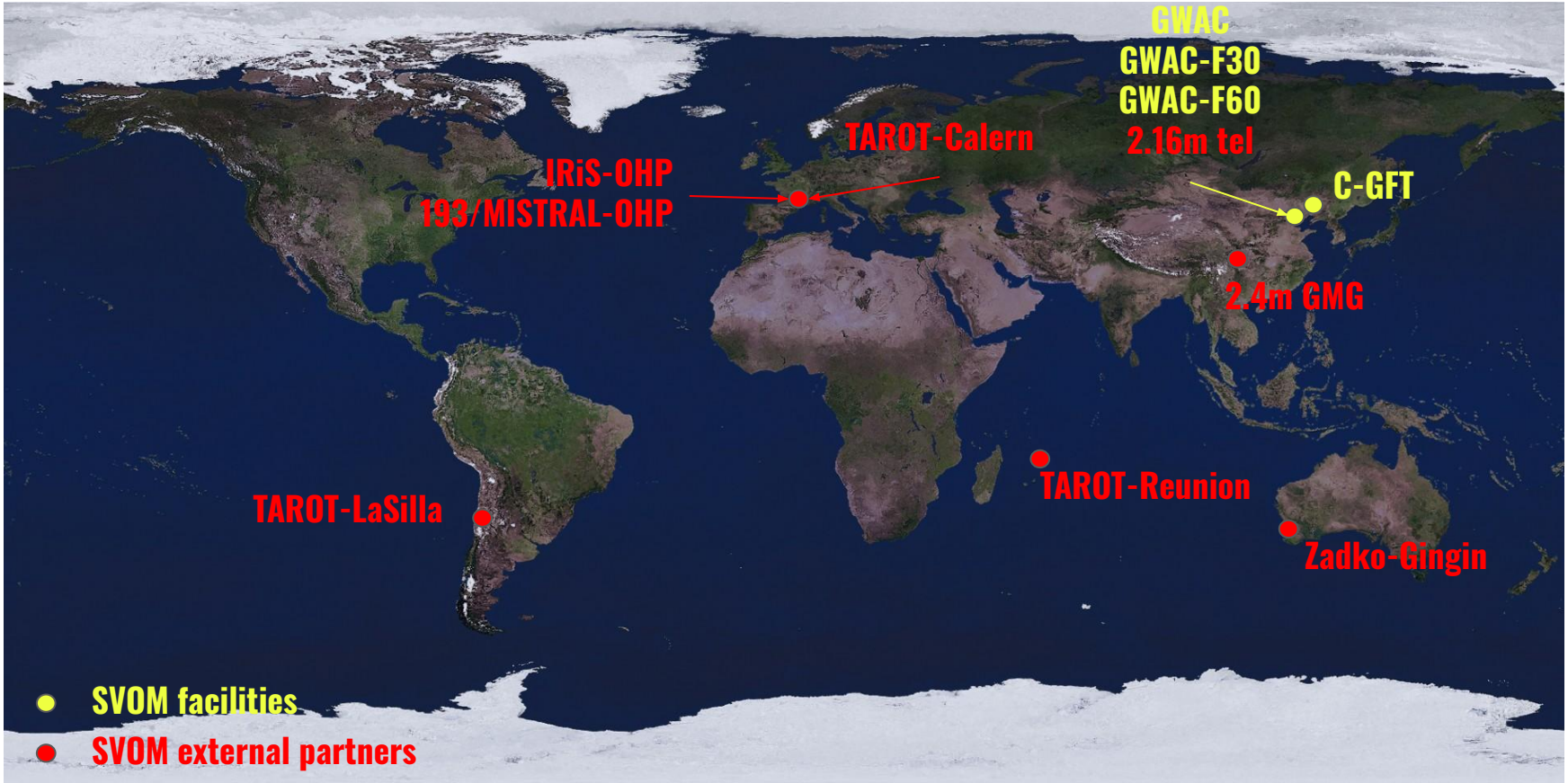
VOEvent (XML)

External partners

Subscribe to the FSC alert broker

contacts :
damien.turpin@cea.fr
&
henri.louvin@cea.fr

The potential follow-up partners for the training



Step 2 : Decode the SVOM VOEvents

ECLAIRs alert notice (N1a) generated by the FSC broker

```
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      <Param name="quality" value="100" ucd="meta.code"/>
      <Param name="attitude_q0" value="0.61494005" ucd="instr.param"/>
      <Param name="attitude_q1" value="-0.25127882" ucd="instr.param"/>
      <Param name="attitude_q2" value="0.21593325" ucd="instr.param"/>
      <Param name="attitude_q3" value="0.71559805" ucd="instr.param"/>
    </Group>
    <Group name="Satellite_data">
      <Param name="x" value="0.0" unit="m" ucd="pos.cartesian.x"/>
      <Param name="y" value="0.0" unit="m" ucd="pos.cartesian.y"/>
      <Param name="z" value="0.0" unit="m" ucd="pos.cartesian.z"/>
    </Group>
  </What>
  <WhereWhen>
    <ObsDataLocation>
      <ObservatoryLocation id="GEOLUN"/>
      <ObservationLocation>
        <AstroCoordSystem id="UTC-FK5-GEO"/>
        <AstroCoords coord_system_id="UTC-FK5-GEO">
          <Time unit="s">
            <TimeInstant>
              <ISOTime>2021-07-12T09:43:11.900000</ISOTime>
            </TimeInstant>
          </Time>
          <Position2D unit="deg">
            <Name1>RA</Name1>
            <Name2>Dec</Name2>
            <Value2>
              <C1>97.37495931560235</C1>
              <C2>-35.372674070812764</C2>
            </Value2>
            <Error2Radius>7.663831409109449</Error2Radius>
          </Position2D>
        </AstroCoords>
      </ObservationLocation>
    </ObsDataLocation>
  </WhereWhen>
```

some key IDs

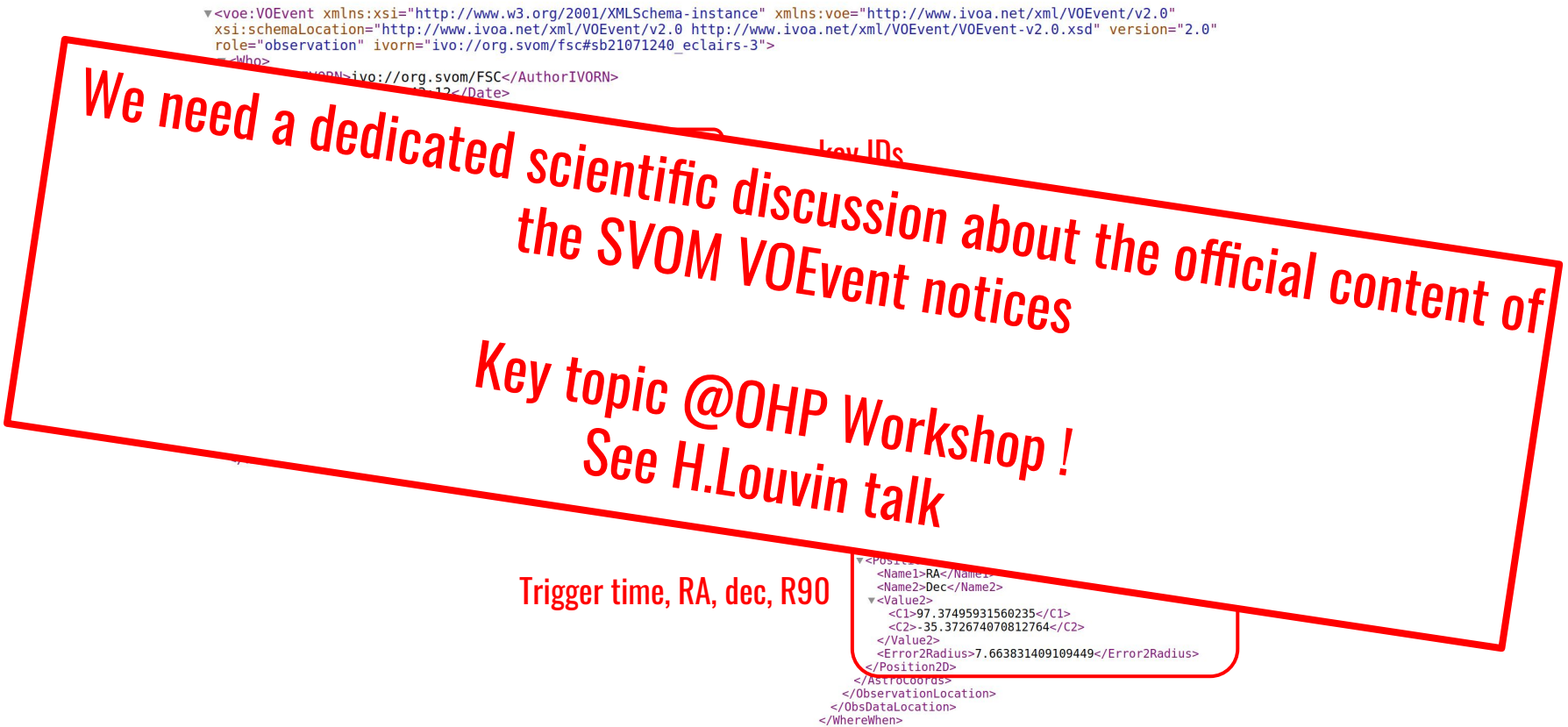
useful info about the SNR + slew decision

satellite quaternions (probably useless for the users)

Trigger time, RA, dec, R90

Step 2 : Decode the SVOM VOEvents

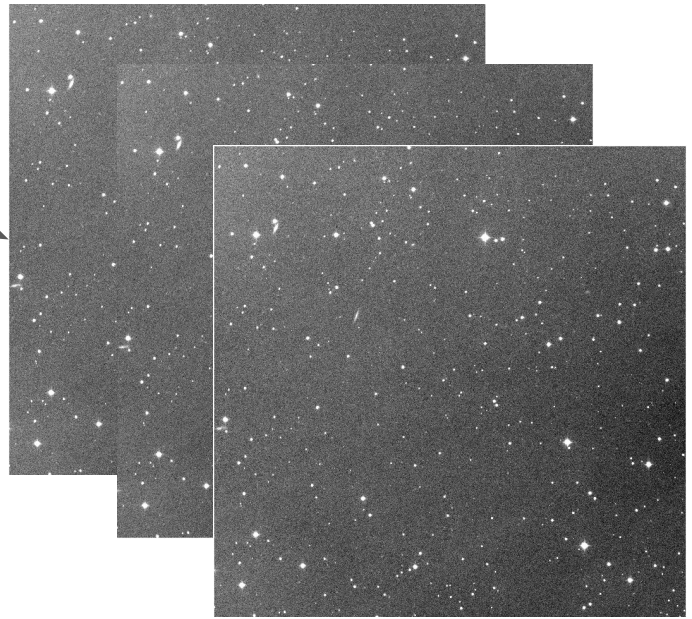
ECLAIRs alert notice (N1a) generated by the FSC broker



Step 3 : Perform follow-up observations

The IRiS robotic telescope @OHP

Follow-up images put in a repo accessible by SVOM for performing the transient detection analysis



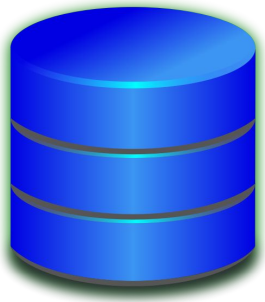
Step 4 : Create SVOM scientific products from the image analysis

Transient detection pipeline

produces sci. products

Which interface ?

Who develop that ?



FSC/CSC
SDB

iFSC-tools ?
CSC BA tools ?

other ?

BRAINSTORMING
in progress

Step 4 : Create SVOM scientific products from the image analysis

Transie

pro

There is no way for now to efficiently display the obs. results of the external follow-up telescopes

Opened question : Should we develop it to populate the SVOM SDB or is it too complicated ?

3.

How to make my Burst Advocate job during that period?

SVOM

cea

cnes
CENTRE NATIONAL D'ÉTUDES SPATIALES

SVOM workshop @OHP
Nov, 8th 2021

The current BA environment in SVOM

The BA training WIKI (redmine) D. Turpin

- Store the main documentations and presentations
- **BA working procedure**
- Template for BA report in the Wiki
- Template for GCN Circulars (TBD)
- General statistics about the follow-up campaign

The iFSC-tools (FSC) C. Moreau

- **Display VHF data products (alert & follow-up)**
- **Manage the French shifts**
- Display the FR/CN BA shift calendar
- Display the COLIBRI data and provide tools to identify the GRB afterglow
- **Display follow-up data from external partners?**

The CSC BA-tools (CSC) L. Xin

- Display X-band data products (alert & follow-up)
- **Manage the Chinese shifts**
- **Display the SVOM/CN follow-up data**
- **Provide tools to identify the GRB afterglows**

zoom slack

- Regular BA meetings
- Live discussions for any kind of concern related to the BA activities

Keep in mind the key opened questions

To be clarified during the first half of the BA training period

1. What should be the official content of the different SVOM VOEvents notices extracted from the VHF packet analysis?

2. Should we develop a dedicated pipeline to analyze the opt. images from external partners and produce sci. products to be stored in the SVOM SDBs ?

3. Where do we display the external partners sci. products ?