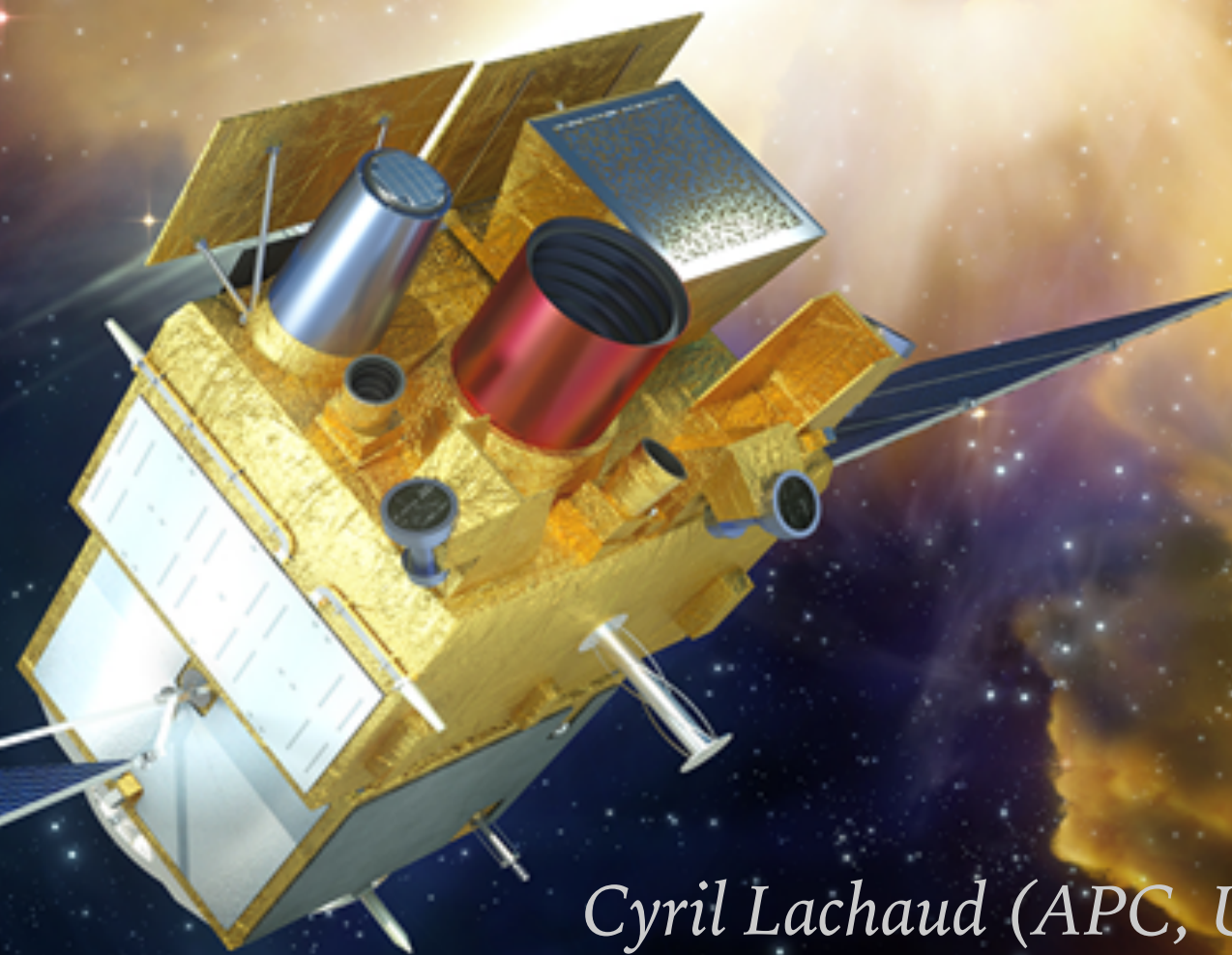


# SVOM

LOW-LATENCY ALERTS & DATA ANALYSIS  
FOR MULTI-MESSENGER ASTROPHYSICS



*Cyril Lachaud (APC, Univ. Of Paris)  
on behalf of the SVOM collaboration*



# The SVOM mission

« Space-based multi-band astronomical Variable Objects Monitor »  
Launch mid-2023, for 3+2 years

**VT**

“The Visible Telescope”  
Narrow-field visible telescope

Ritchey Chretien  $\Phi=400\text{mm}$   
Localization accuracy  $< 1\text{arcsec}$



**GRM**

“The Gamma-Ray burst Monitor”  
X-rays and Gamma-rays detectors

15 keV – 5 MeV  
Localization accuracy  $< 5^\circ$



**ECLAIRs**

« The trigger camera »  
Wide-field X and Gamma rays telescope  
Spectral range : 4 keV – 150 keV  
Localization accuracy  $< 12\text{arcmin}$



# SVOM OBSERVATION PROGRAMS

**The Core Program (GRB).** The first objective of the SVOM mission.

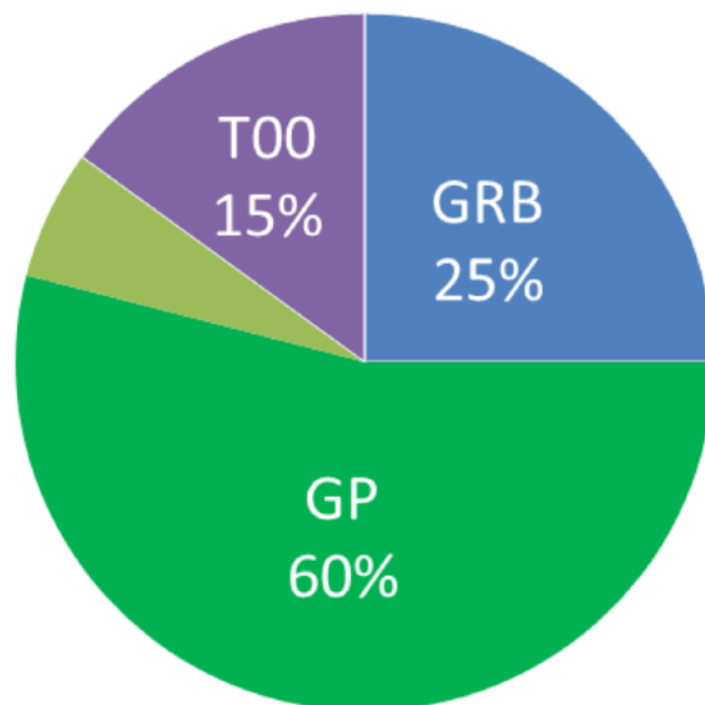
~50-60 ECLAIRs alerts/yr (loc. < 13 arcmin). ~90 GRM only alerts (loc. < 5-10 deg).

~30-40 GRBs/yr with **prompt emission over 3 decades + X-ray and V/NIR afterglow + redshift.**

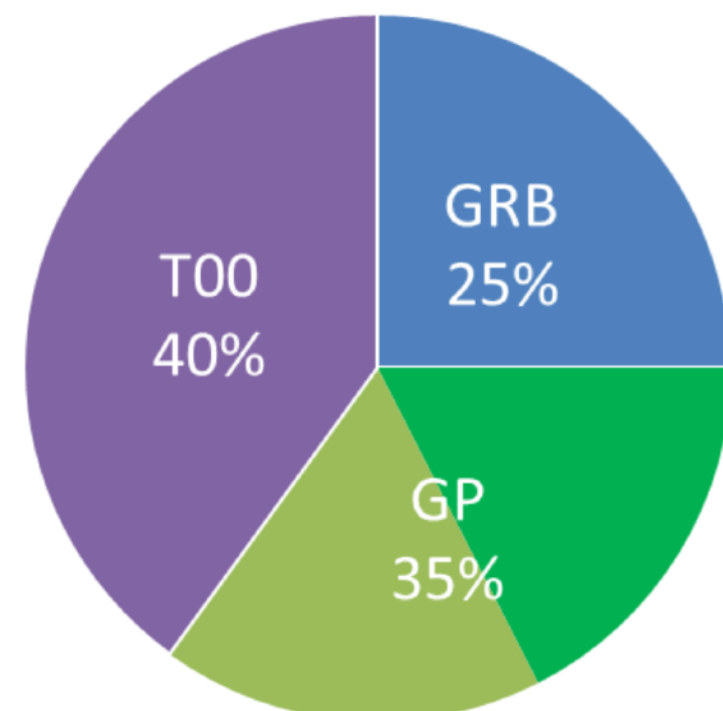
**General Program (GP).** SVOM will be an open observatory : observations will be awarded by a TAC (a **SVOM co-I needs to be part of your proposal**). 10% of the time can be spent on low Galactic latitude sources during the nominal mission (up to 50% during the extended mission).

**Target of Opportunity (ToO)** program : **alerts sent from the ground to the satellite.** Initially 1 ToO per day focussed on time domain astrophysics including multi-messengers. ToO program devoted time increases during extended mission.

*~3 first years*  
1 ToO per day, 10% of GP outside B1 law



*After...*  
5 ToOs per day, 50% of GP outside B1 law



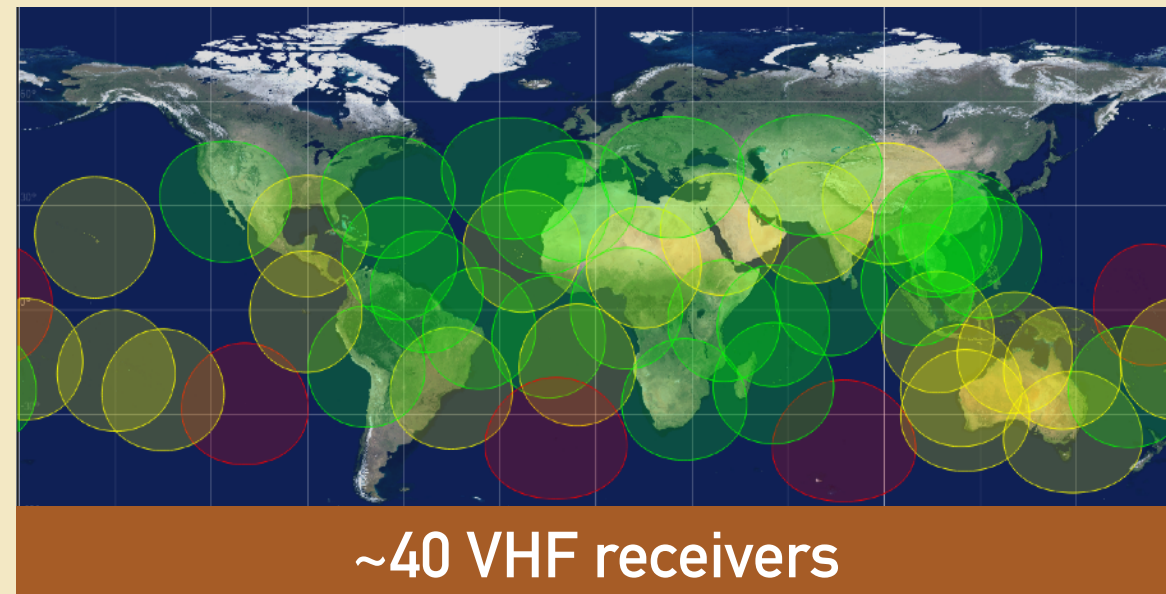
# CORE PROGRAM (GRB) DOWNGOING TELEMETRY LINKS



*VHF*

Alert products (ECLAIRs, GRM then MXT, VT).

65% of the alerts received within 30s at the French Science Center.



*Beidou*

Beidou Navigation Satellite System (BDS).

For **VHF redundancy** and only for **high priority alert products**.

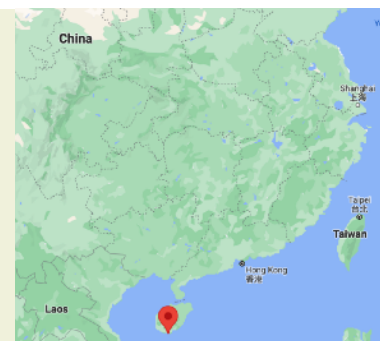
Fast but still under review (recent addition to the SVOM satellite).

First alert notices will be sent automatically within minutes after on-board GRB detection

*X-band  
stations*

All data are downloaded thanks to **X-band stations located in Sanya** (Hainan - China).

Time between 2 passages strongly depends on the orbit (max=12h).



Circulars with updated analysis will follow the data reception

GP & ToO-NOM	
<i>S-band stations</i>	<p>Standard S-band stations are located in Sanya, Kashi, Qingdao (China).</p> <p><b>GP</b> Work Plan is <b>uploaded one week in advance</b>.</p> <p><b>ToO-NOM</b> are uploaded with a typical <b>48h delay</b> after decision.</p>
ToO-EX & ToO-MM	
<i>S-band stations</i>	<p>To reduce the latency for fast <b>ToO</b> (<b>ToO-EX</b> and <b>ToO-MM</b> for exceptional and multi-messenger alerts), Kourou (French Guyana) and Hartebeeshoek (South Africa) can be used as well.</p> <p><b>We have a delay &lt; 12h between alert and start of observations.</b></p>
<i>Beidou</i>	<p><b>Beidou system will be used to reduce the latency</b> with respect to S-band stations for <b>ToO-EX</b> and <b>ToO-MM</b>.</p> <p>Delays still under review. The typical delay between alerts and observations will be <b>~5 hours at start but will be drastically reduced later.</b></p>

# GP & ToO DOWNGOING LINKS



## GP &ToO-NOM

*X-band  
stations*

Data downloaded through standard **X-band stations in China.**

## ToO-EX

*X-band  
stations*

ToO-EX will use **KUX** and **HBX** in addition to the **Chinese X-band stations.**

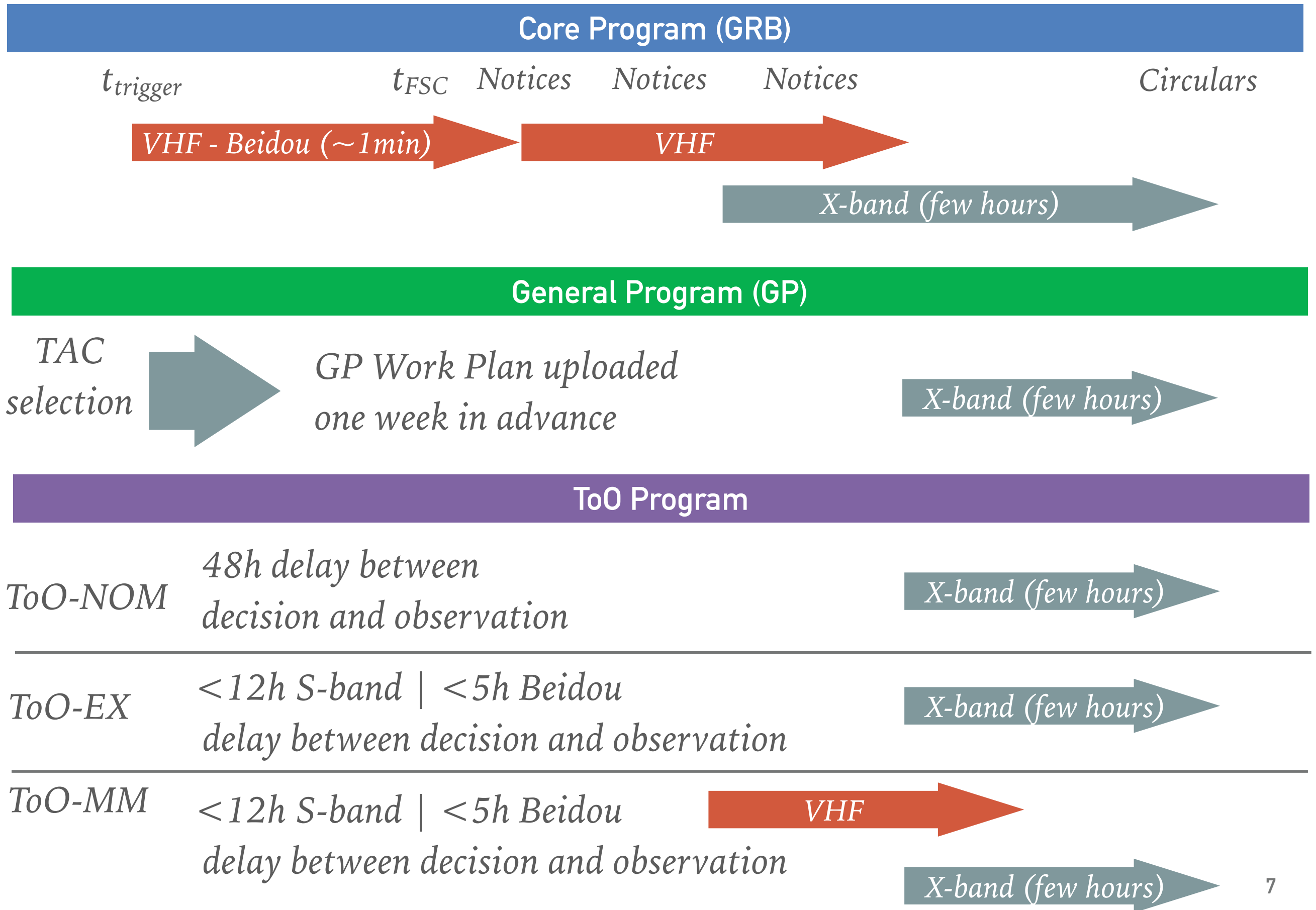
## ToO-MM

*VHF  
(Beidou)*

**MXT Position packet and photon packets** will be sent to the ground through **VHF for immediate analysis.**

Beidou could be used for MXT position packet but it is not confirmed yet...

# LATENCY SUMMARY



## Core Program (GRB)

**Real-time VHF scientific products** (under the supervision of the Burst Advocates) will be **public as soon as they are available** => similar to Swift or Fermi-GBM.

All the **scientific products are public six months** after the data production.

## General Program (GP)

**Semester Call for proposal** (in association with a **SVOM Co-I**), it can include ToO.

All the SVOM data will be distributed to the Responsible Co-I.

**One year of proprietary period** before all the scientific products become public.

## ToO Program (still under discussion)

**ToOs triggered by the SVOM CO-Is** => we will make **publicly available as soon as possible** any scientific product that is relevant to perform follow-up observations. The number of products to be publicly released will be addressed case by case.

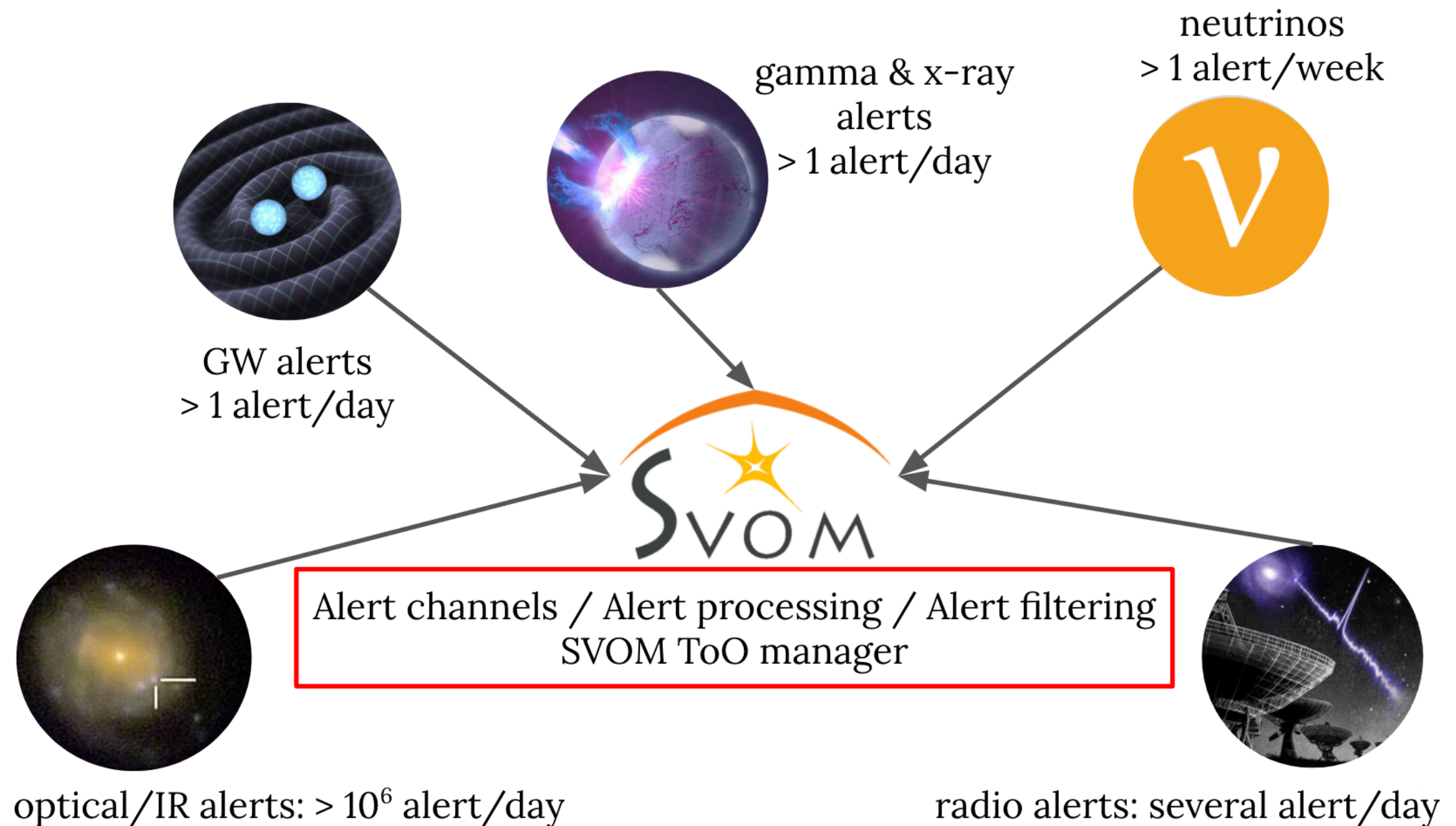
**ToOs triggered by non SVOM CO-Is** => **all the scientific products will be public** as soon as they are available.



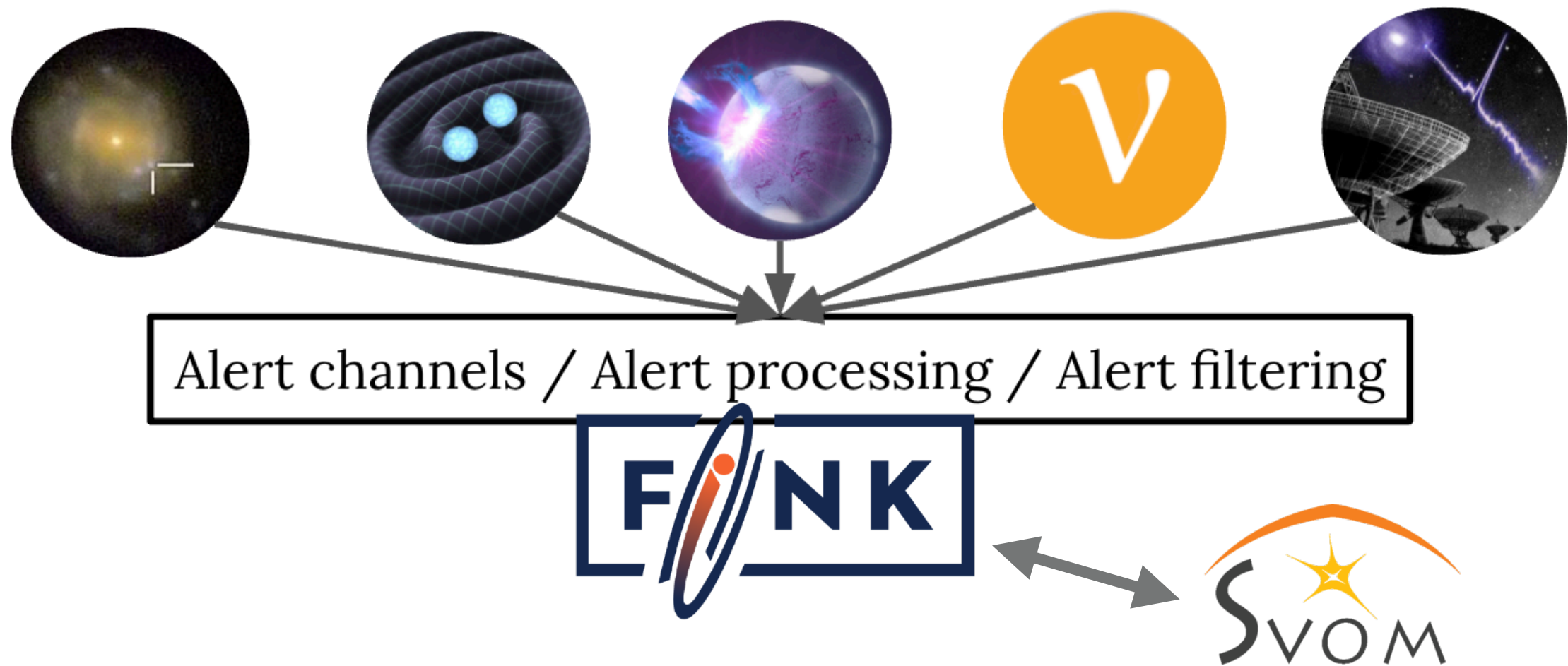
# SVOM ToO INFRASTRUCTURE

*The future = a large increase of the alert flow asking for transient candidate follow-up observations*

*Our first thought was to deal with the alert flow this way :*



# SVOM ToO INFRASTRUCTURE AND FINK



*We plan to use the FINK broker developed for the Vera Rubin Observatory / LSST which has the capacity to deal with a large volume of alerts to perform the filtering.*

*Thanks to FINK we will trigger our own ground telescopes to enrich promising candidates with data and decide to eventually trigger a ToO for the satellite.*

*SVOM will have also its own channel in FINK so that subscribers can receive our alerts this way (allowing the usage of the FINK filtering mechanisms).*



# CONCLUSION

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*SVOM will be launched mid-2023 and will be an important actor both for alerts and follow-up in space and ground.*

*The recent addition of the Beidou System to the satellite will shorten delays up and down. Still under evaluation by the System team.*

