The Virgo Detector Characterization Group (detchar)

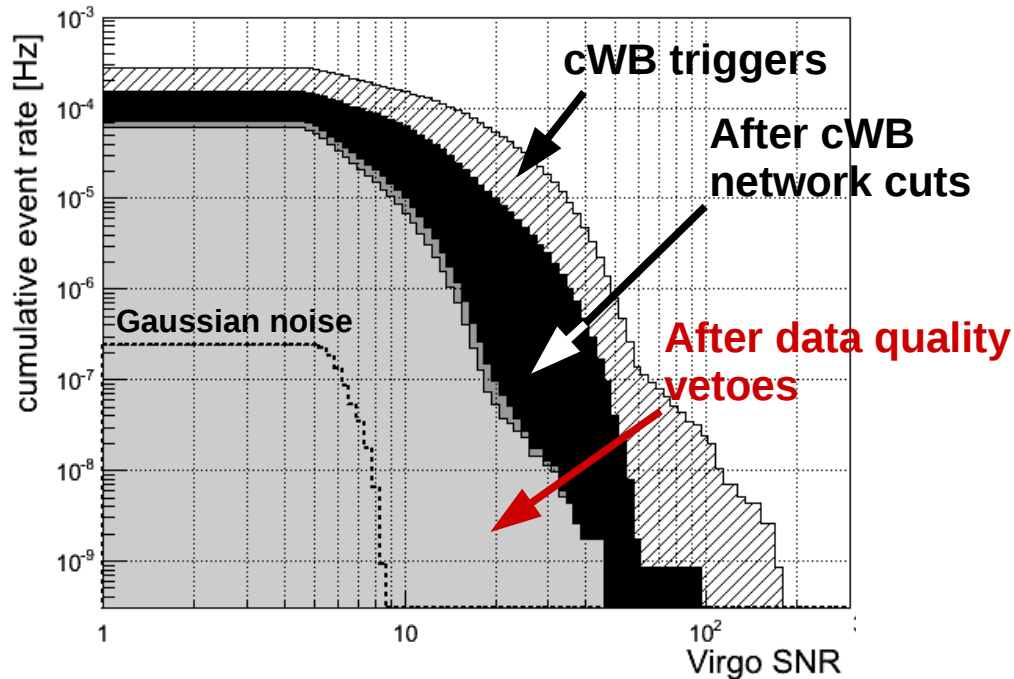*– Formerly VDQ+Noise groups –*

Florent Robinet

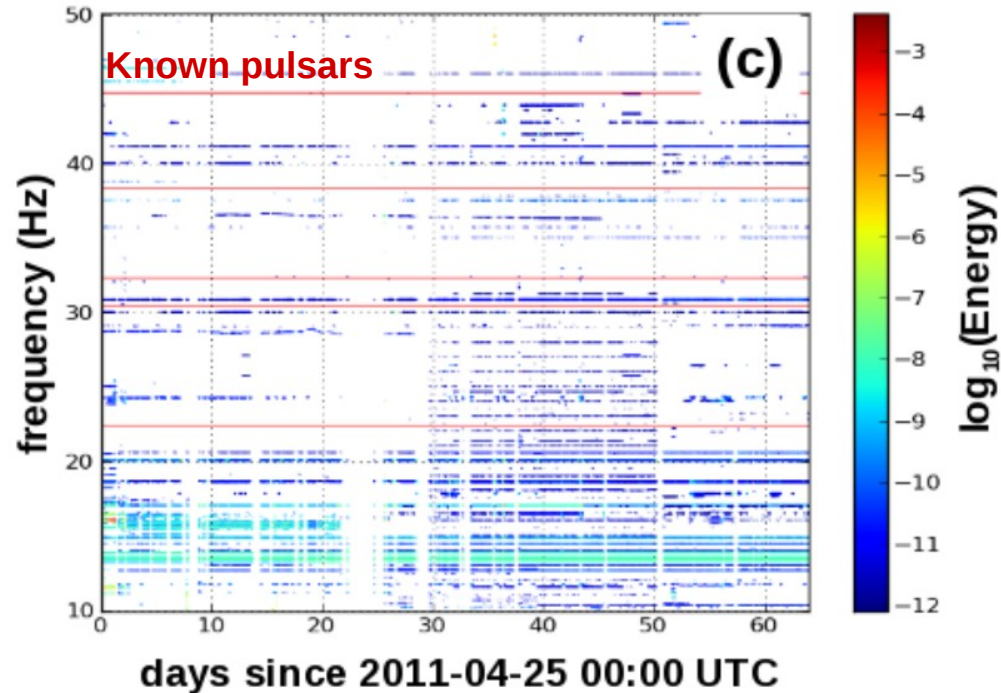https://wwwcascina.virgo.infn.it/DataAnalysis/Detchar/

Burst all-sky: background event distribution

Detector spectral lines over time (NoEMi)

cWB triggers

After cWB network cuts

Gaussian noise

After data quality vetoes
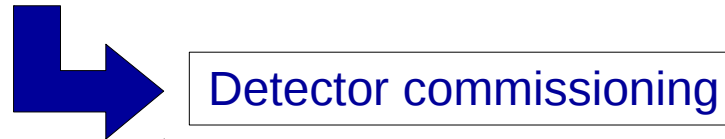
Known pulsars

The detchar group mission: <u>Enhance the sensitivity to GW signals:</u>
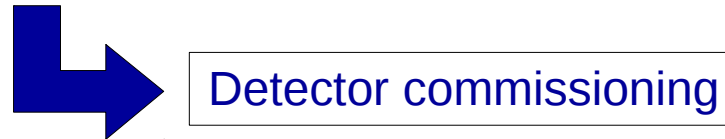
→ **Identify noise sources/coupling to remove noise glitches/lines from the data**
→ **Veto glitches, track spectral lines**

→   **Noise investigations**

→   **Detector monitoring**

→   **Data quality input for search groups**

→ **Noise investigations**

Detector commissioning

Adv Virgo sub-systems

→ **Detector monitoring**

Detector commissioning

Adv Virgo sub-systems

→ **Data quality input for search groups**

Improve the sensitivity to GW signals
Improve the significance of a detection

→ **Noise investigations**

- Develop analysis tools to detect noise events in the detector and its environment

- Develop analysis tools to isolate and characterize noise coupling in the detector

- Provide input to the commissioning

- Develop new investigation methods (noise classification, MVA, non-linear coupling)
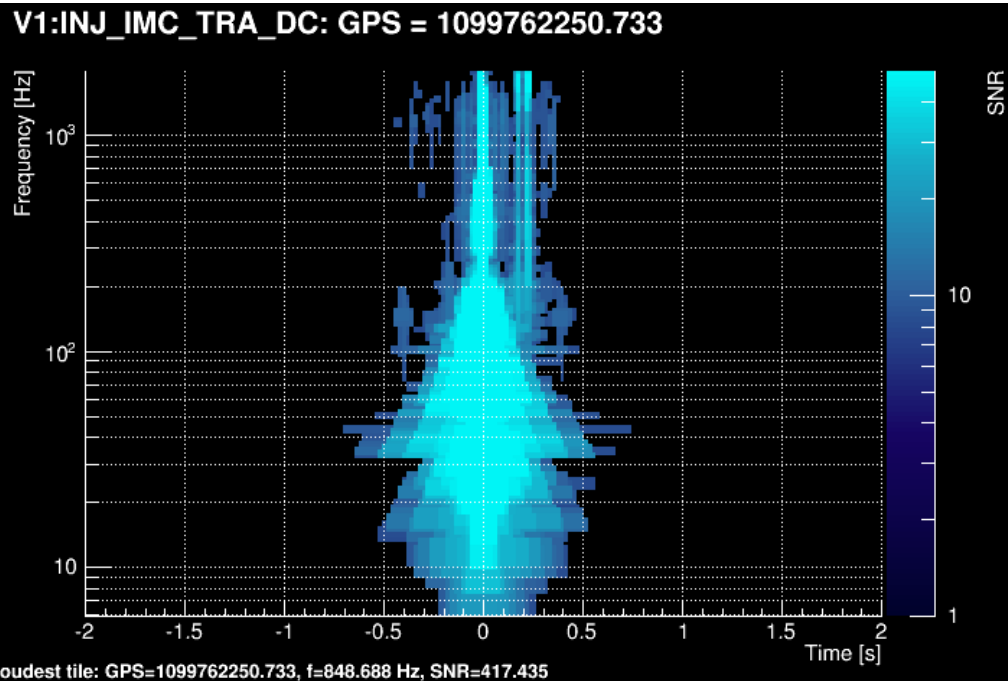
→ **Detector monitoring**

- Define sensor/channel monitoring/status

- Generate flags to track the general status of the detector/processes

- Run online analyses to monitor the noise in the detector

- Generate periodic web monitoring reports

- Develop/maintain the interactive data visualization tool (DataDisplay)

- Define scientific runs data quality requisites (shifts...)

→ **Data quality input for search groups**

- Define/produce/store/access data quality vetoes for transient GW searches

- Track/identify noise spectral lines for CW/Stochastic GW searches

- Provide data quality input before sending GW alerts to EM partners

- Provide data quality input to assess a GW detection

→ Omicron is an algorithm designed to detect and characterize **transient noises.**
→ Omicron is optimized to process **hundreds of channels with a low latency.**

→ Omicron is currently used at Cascina to monitor the laser, the injection and the environment (latency<20s)

→ Omicron triggers are used for many purposes: – noise investigations
 – detector monitoring
 – veto production

→ Omicron is also widely used in LIGO detchar

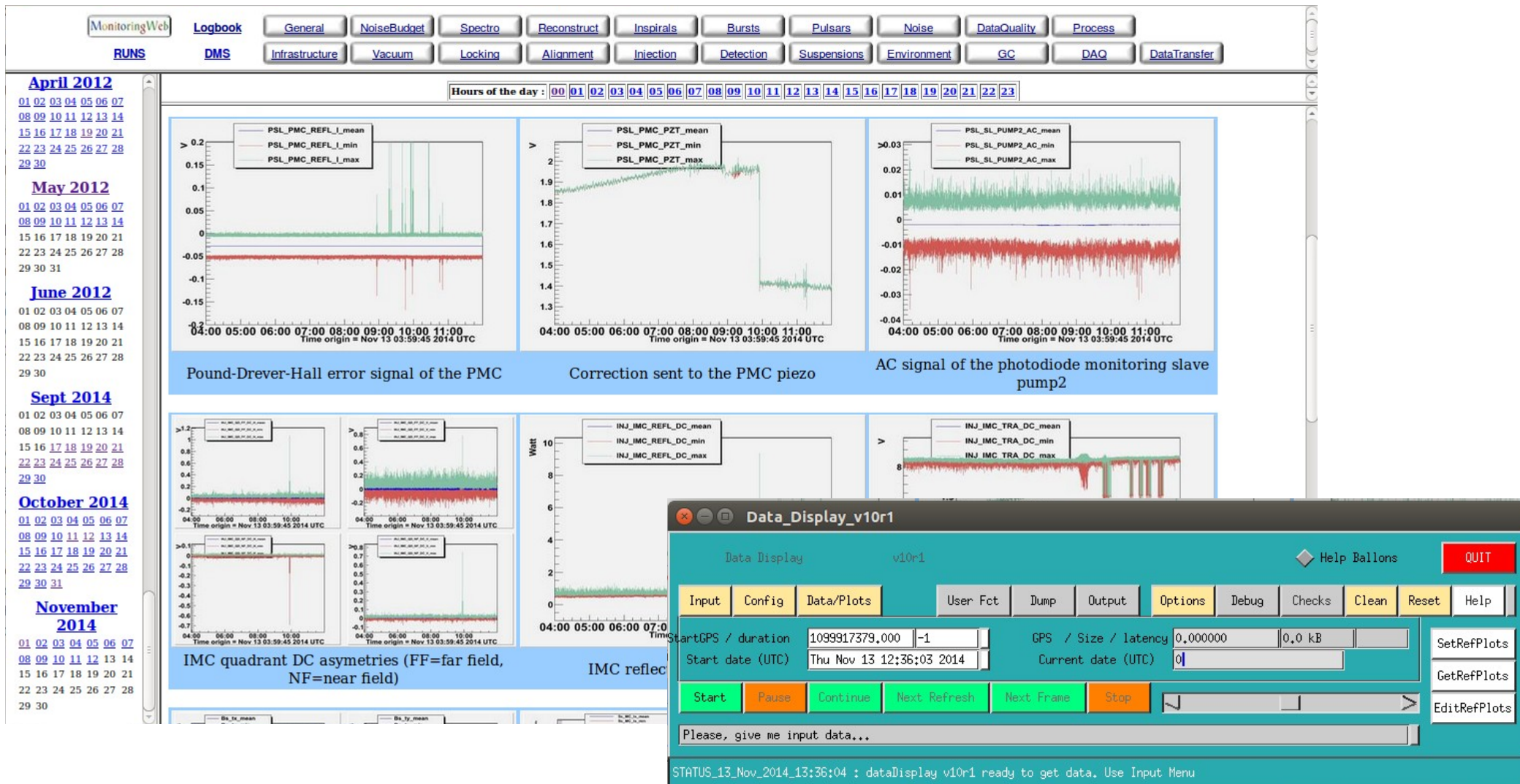**Omicron glitch in the IMC transmitted power**   **Seismic glitch time-frequency distribution**
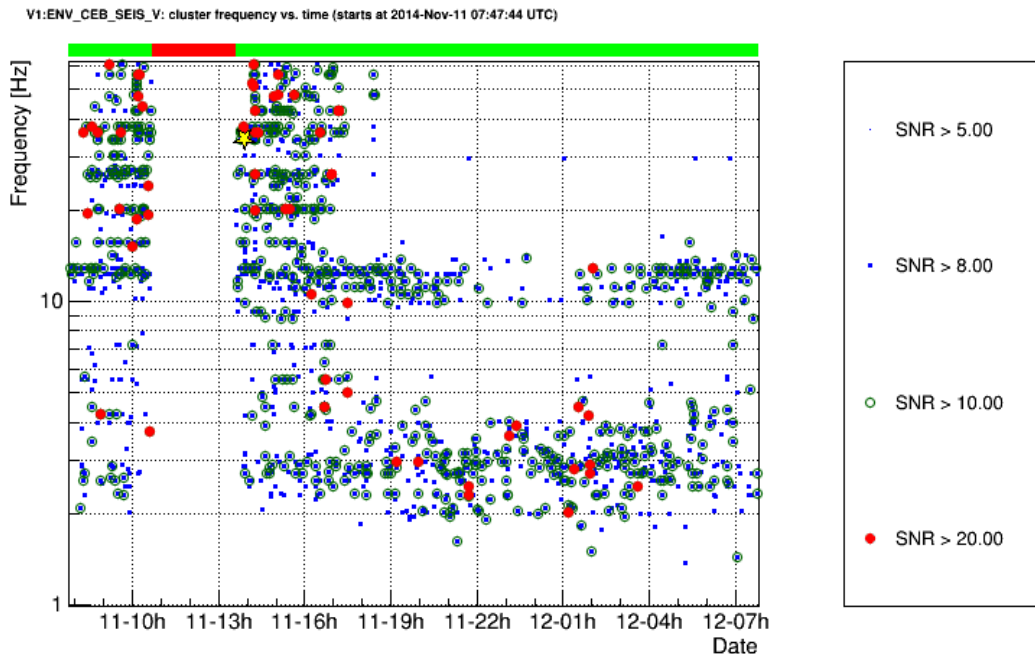
→ NoEMi is an analysis pipeline designed to **detect spectral lines**, to follow them over time, to perform coincidences between channels and to save the information in a user database.

→ NoEMi is used to identify noise coupling.

→ NoEMi database is used to discard fake GW candidates (i.g. CW).

→ NoEMi is also used in LIGO
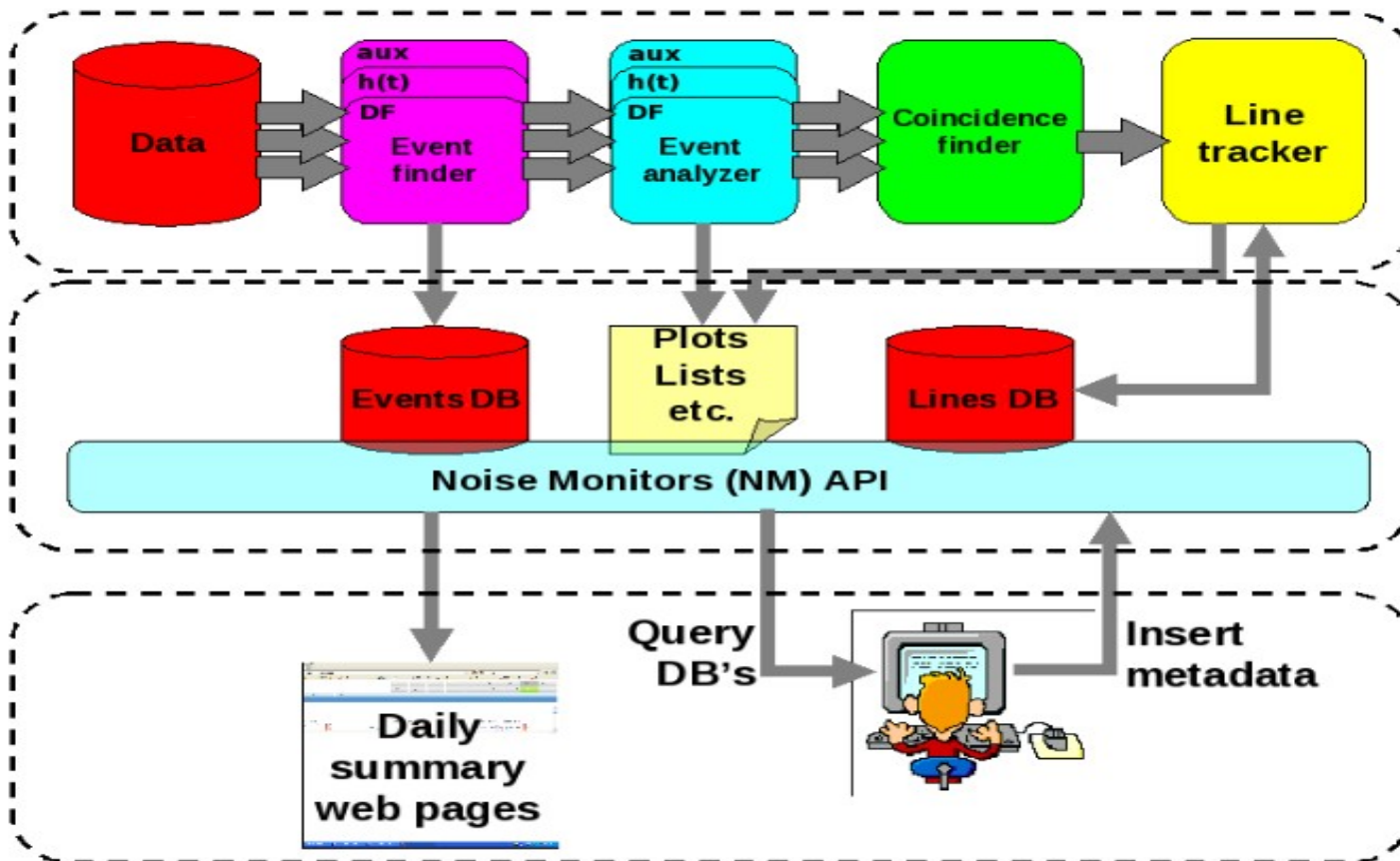
NoEMi pipeline
T Accadia et al. 2012 J. Phys.: Conf. Ser. 363 012037

→ MonitoringWeb was designed to monitor different aspects of the detector data quality
→ MonitoringWeb plots are displayed with a low-latency **and** archived
→ DataDisplay is an interactive tool to process and display the data "on demand"

→ Both tools are being improved to meet the commissioning/detchar needs

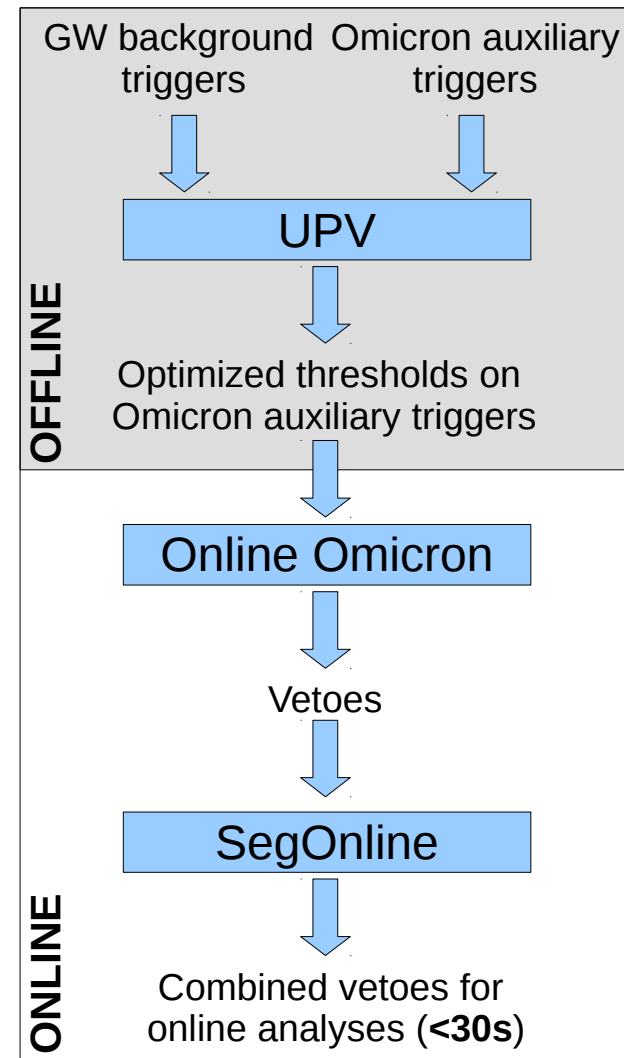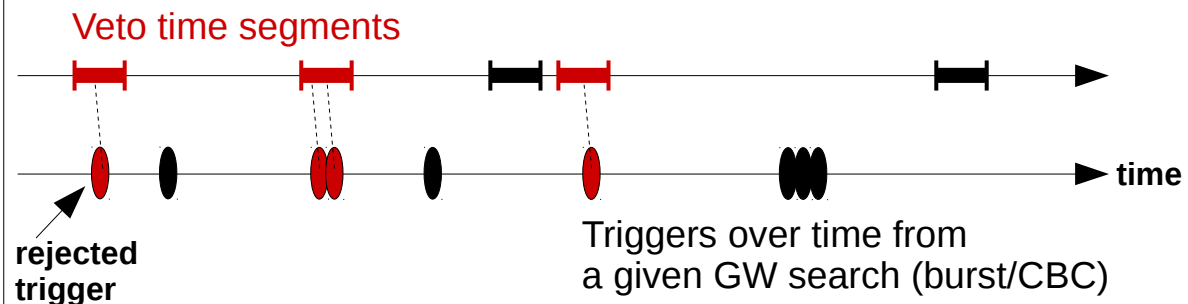**Seismic effect on the IMC transmitted power**   **Scattered light glitches as seen by Omicron**
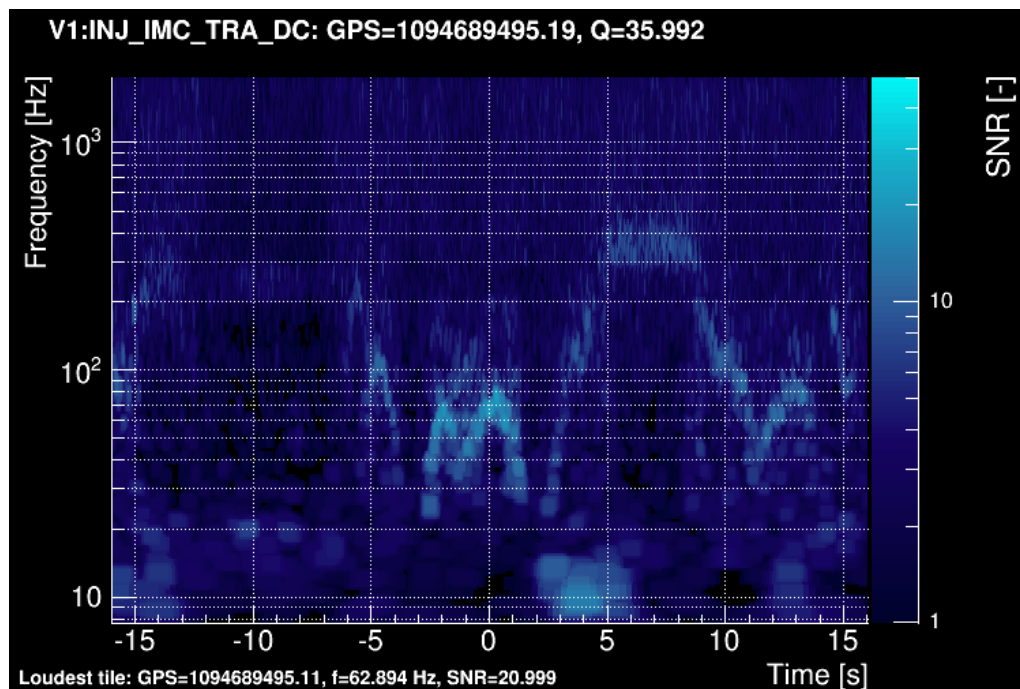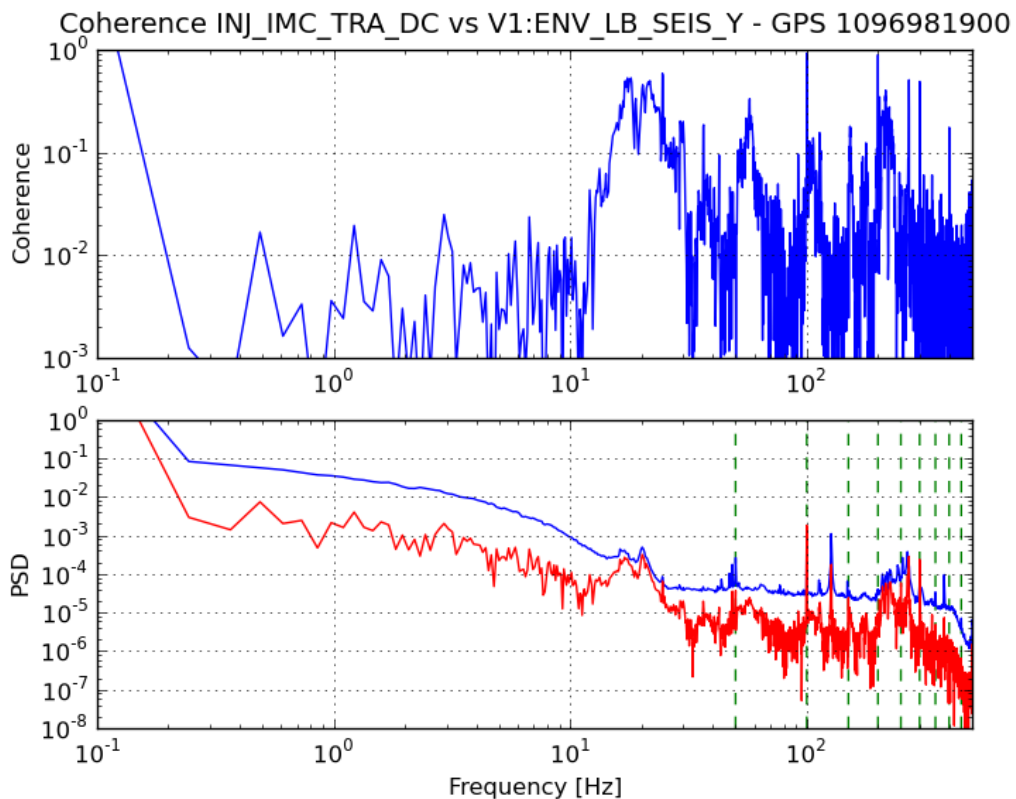
→ Improved veto producer: **UPV** is based on coincidences between Omicron triggers

→ New veto producer: **Excavator** is based on coincidences between Omicron triggers and the values of auxiliary data.

→ Implementation of an online architecture for UPV-based vetoes

What's a veto?
– list of time segments in which a noise glitch is suspected to occur

What's a good veto?
– must be highly effective and often "on target"

Veto time segments

time

rejected trigger

Triggers over time from a given GW search (burst/CBC)

GW background triggers   Omicron auxiliary triggers

OFFLINE

UPV

Optimized thresholds on Omicron auxiliary triggers

ONLINE

Online Omicron

Vetoes

SegOnline

Combined vetoes for online analyses (**<30s**)

→ LIGO and Virgo vetoes are stored in a database: DQSEGDB
→ DQSEGB is a new and joint project developed by/for LIGO and Virgo
→ DQSEGB has been implemented and the user-testing phase has started

→ **The Virgo detchar group today = 5.30 FTE**

– EGO	= 2.00 FTE	– INFN-Roma	= 0.40 FTE
– LAL	= 1.10 FTE	– Urbino	= 0.20 FTE
– LAPP	= 0.85 FTE	– Polgraw	= 0.05 FTE
– ARTEMIS	= 0.65 FTE	– APC	= 0.05 FTE

→ The goals of the detchar group are two-sided but closely coupled:

   1/ contribute to the commissioning of Adv. Virgo **to get the best detector as possible**
   2/ contribute to the data analyses **to get the most sensitive GW searches as possible**
   → The current activities of the group are focused on both aspects

→ In the near future we expect to spend more time in the commissioning of Adv.Virgo subsystems.

→ Virgo plans to broadcast "real" data for the next LIGO-Virgo Engineering Runs. This represents a good opportunity for the Virgo detchar group to deliver associated data quality products