Transients – GRB & FRB
ICRC Discussion Session

Andrew Taylor & Francesco Longo

Summary of “FRB” topics

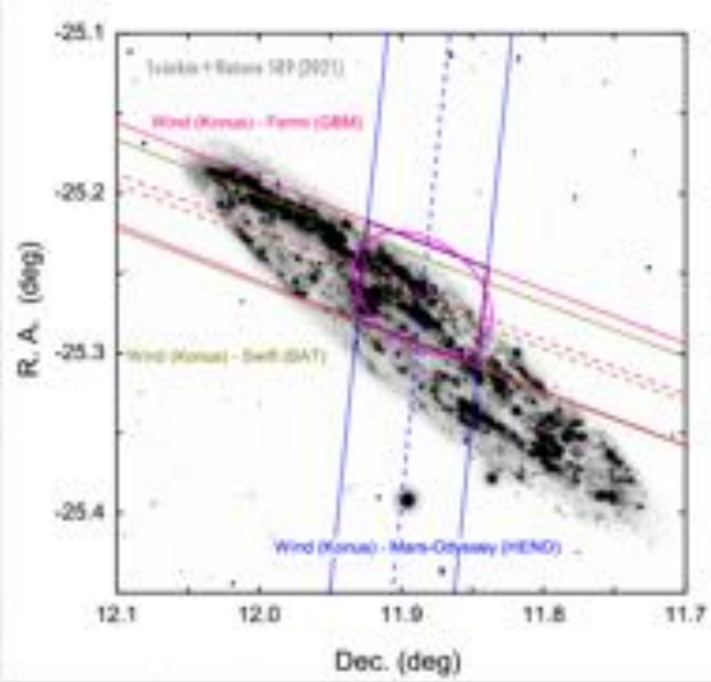
- GRBs and Magnetar flares
  - Magnetar giant flare in NGC 253 seen by Fermi-GBM (E.Bissaldi)
  - Detection of the third class of gamma-ray bursts: magnetar giant flares (M.Negro)
- Magnetars at VHE
  - High-energy and very high-energy gamma-ray emission from the magnetar SGR 1900+14 outskirts (V.Voitsekhovskyi)
  - Observation of burst activity from SGR1935+2154 associated to first galactic FRB with H.E.S.S. (D. Kostunin)
  - Monitoring the magnetar SGR 1935+2154 with the MAGIC telescopes (A. López-Oramas)
  - Prospects for Galactic transient sources detection with the Cherenkov Telescope Array (A.López-Oramas)
- FRB at HE/VHE
  - Hunting the gamma-ray emission from Fast Radio Burst with Fermi-LAT (G.Principe)
  - Gamma-ray and Optical Observations of Repeating Fast Radio Bursts with VERITAS (M.Lundy)

GRB and Magnetar Flares

ICRC 2021

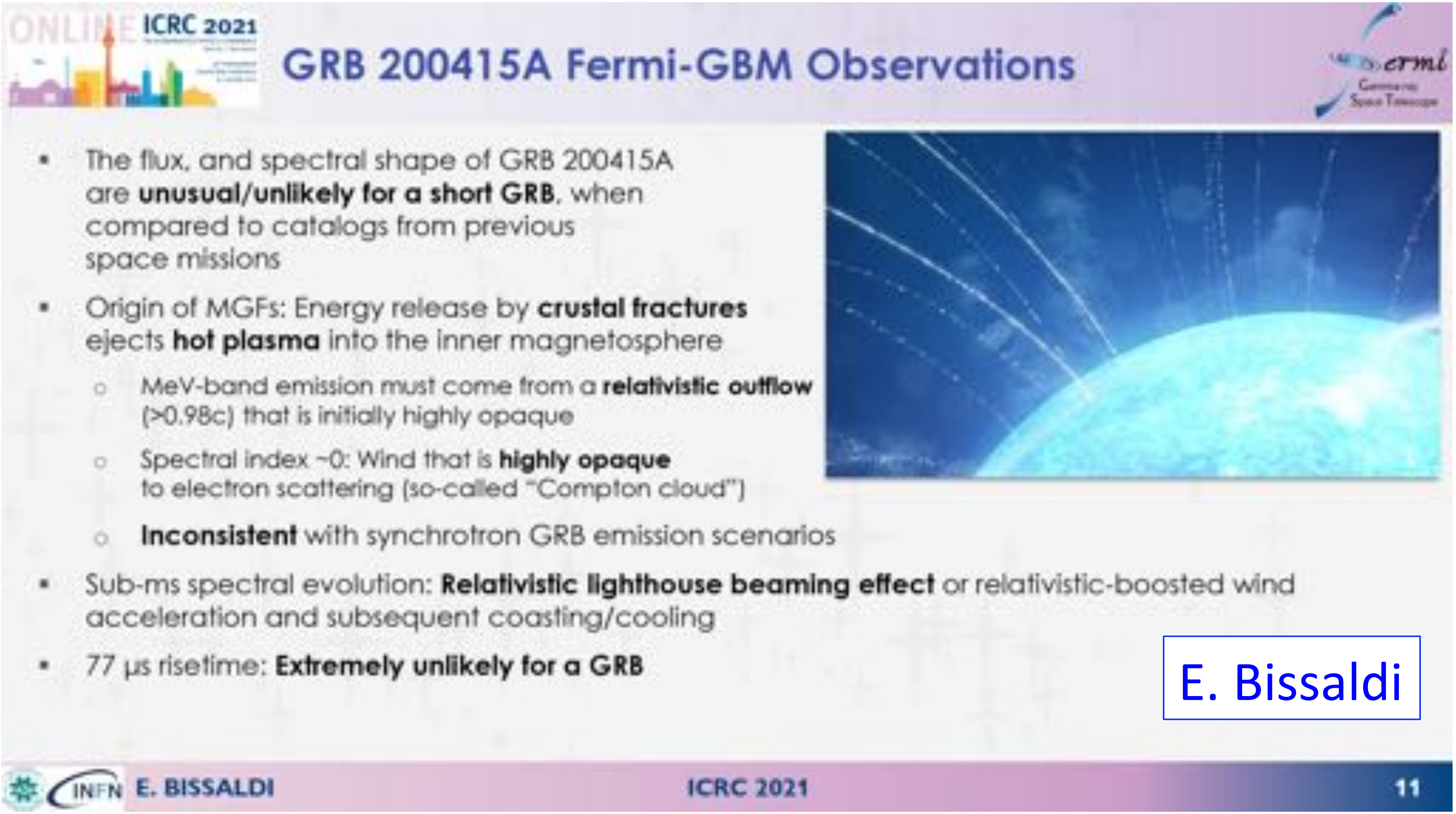
GRB 200415A

- **Bright transient** triggered the Inter-Planetary Network (**IPN**) and ASIM on **April 15th, 2020**
  - **Fermi Gamma-ray Burst Monitor (GBM) Trigger** at 08:48:05.56 UTC
    The Fermi GBM team, GCN 27579 (2020)
    E. Bissaldi, et al., GCN 27587 (2020)
    O. Roberts et al., Nature Vol.589, 207 (2021)
  - Triangulated by IPN to a 17 sq. arcmin region centered at RA. 11.88°, Dec. -25.26° (J2000), overlapping with **NGC 253 (Sculptor Galaxy)**, active star-burst spiral galaxy at a distance of 3.5 Mpc (11.4 Mly)
    D. Svinkin, et al., GCN 27585 (2021)
    D. Svinkin, et al., Nature Vol.589, 211 (2021)
- Chance coincidence with NGC 253: **1 in 230,000**
  E. Burns et al., ApJL 907 L28 (2021)
- **High Energy (GeV)** emission
  - **Fermi Large Area Telescope (LAT) detection**
    N. Omodei, et al. GCN 27586, GCN 27597 (2020)
    M. Ajello, et al., Nature Astronomy, Vol.5, 385 (2021)



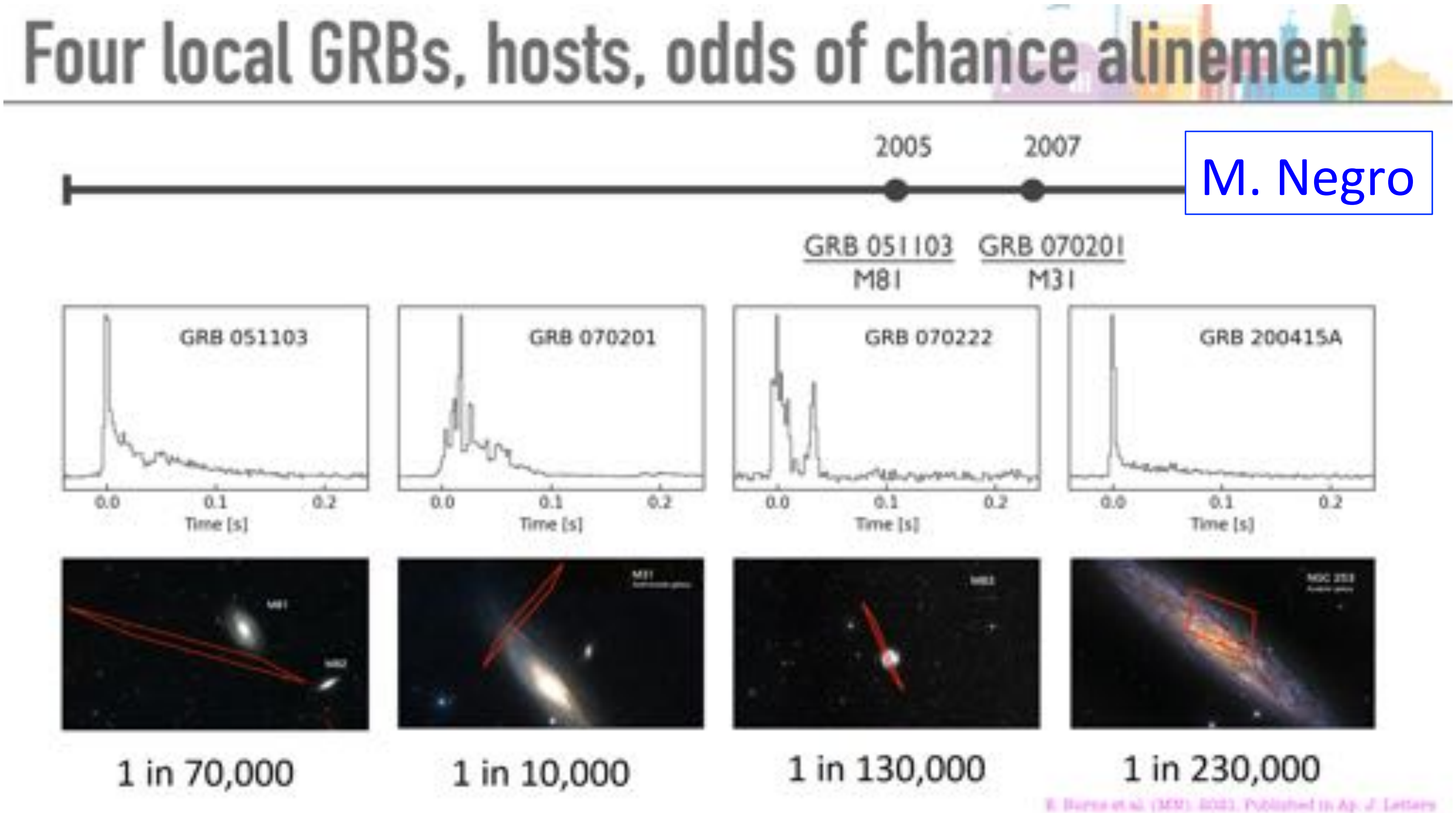
E. Bissaldi

GRB and Magnetar Flares

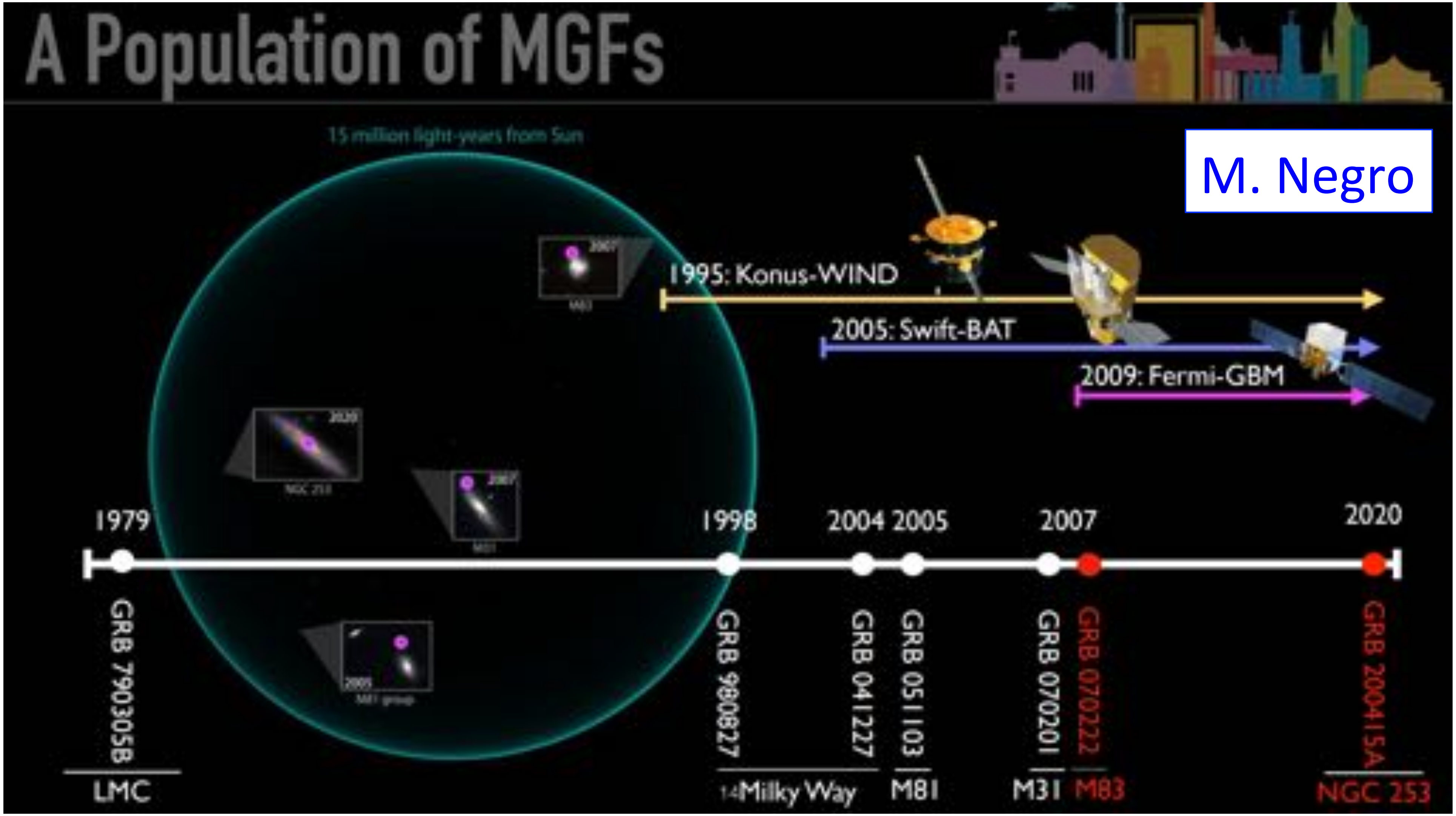


E. Bissaldi

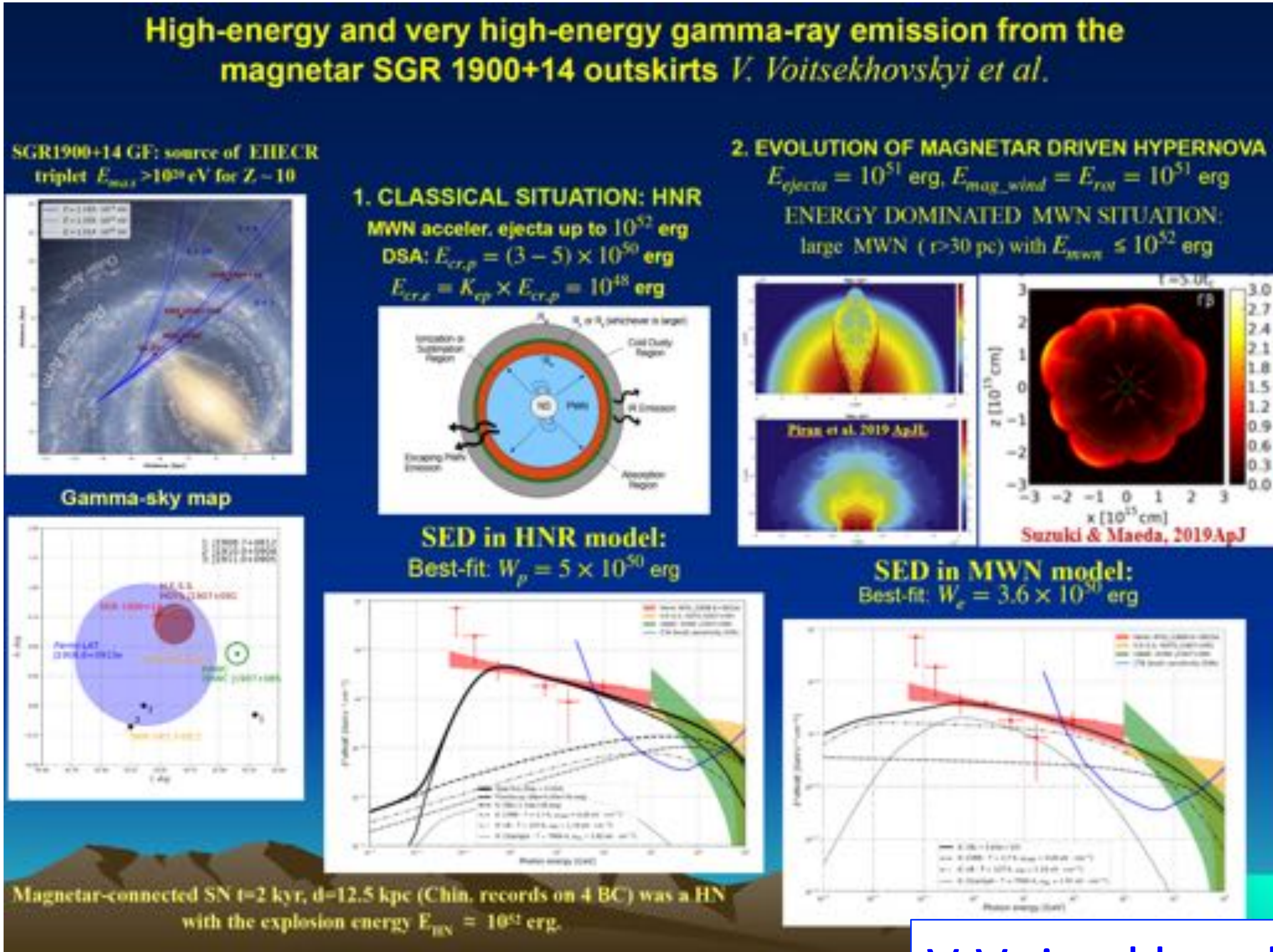
GRB and Magnetar Flares



GRB and Magnetar Flares



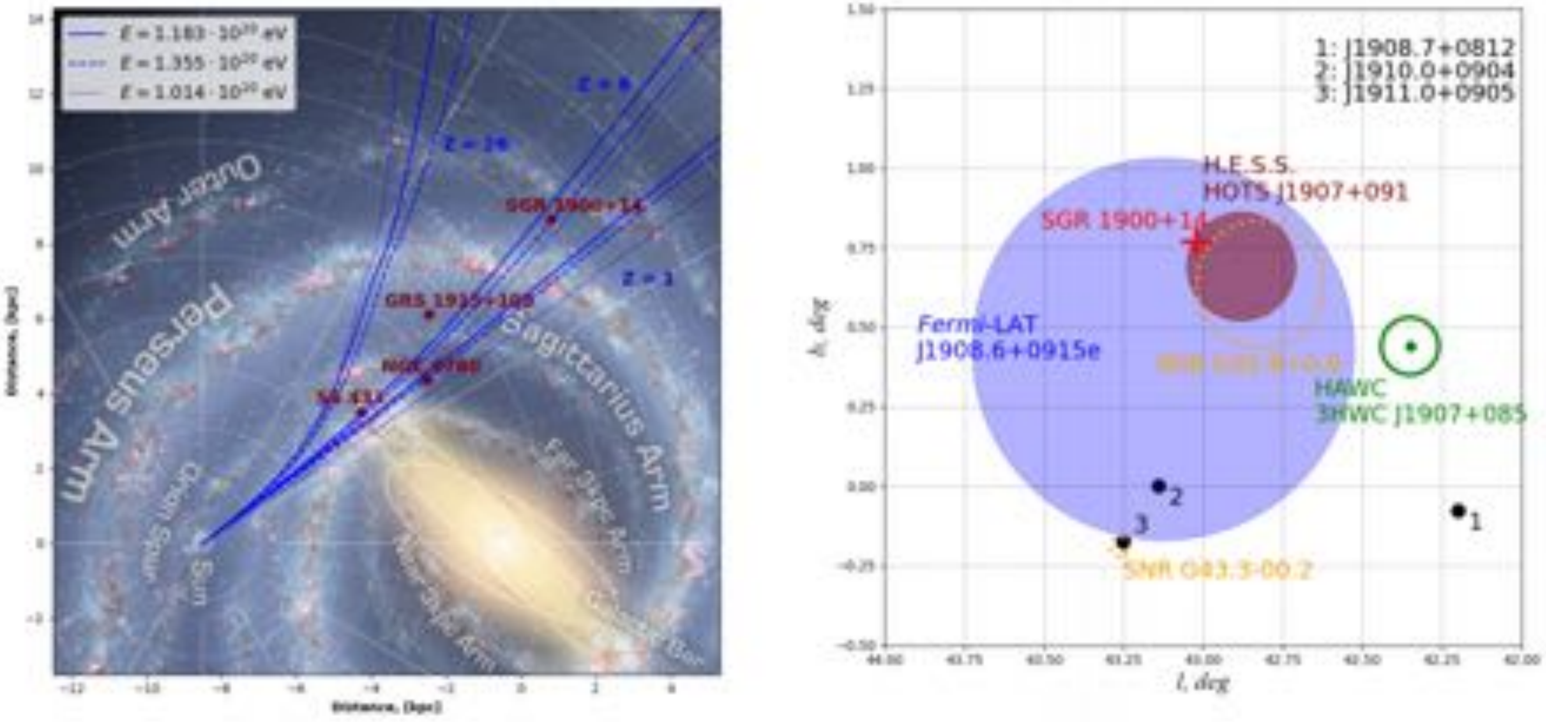
Magnetars at VHE



V.Voitsekhovskyi

Magnetars at VHE

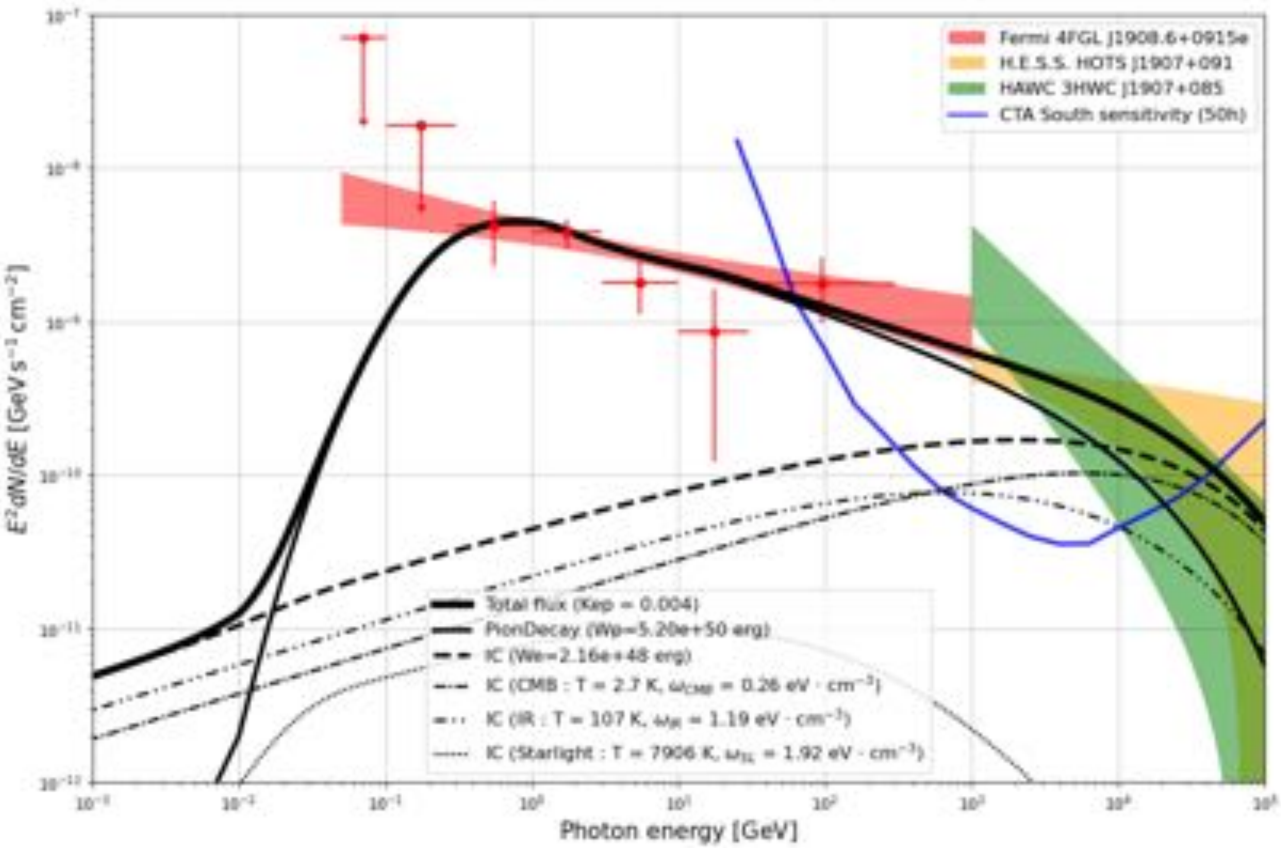
V.Voitsekhovskyi



(a) (b)

Magnetars at VHE

V.Voitsekhovskyi



FRB at HE/VHE

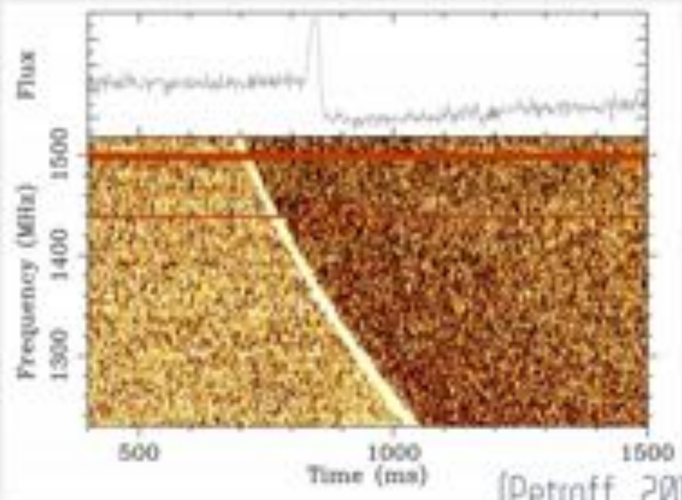
Fast Radio Bursts

-Fast Radio Bursts (FRBs) are energetic, extragalactic, ms radio bursts of unknown origin.

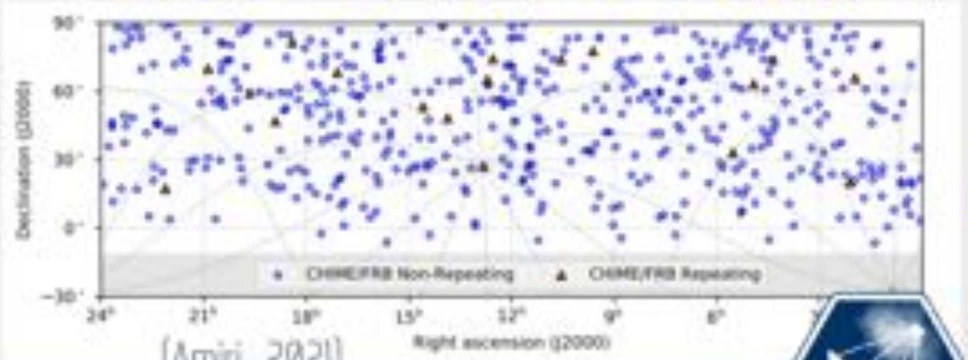
-Over 600 FRBs have been measured with most of the detections coming in the last 2 years from the CHIME radio telescope

-FRBs demonstrate a variety of phenomena including repetition, and periodicity.

-A handful of repeaters have been localized (~13) but there remains many FRBs with large error regions (~0.5 degrees).



[Petroff, 2019]



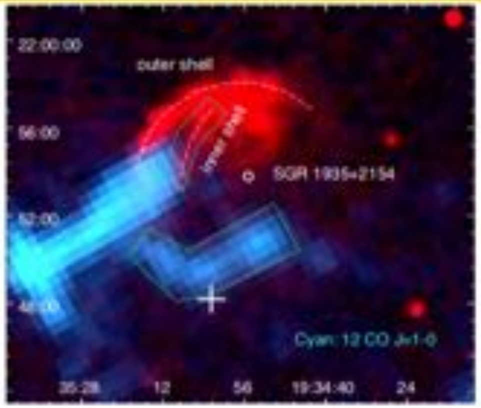
[Amiri, 2021]

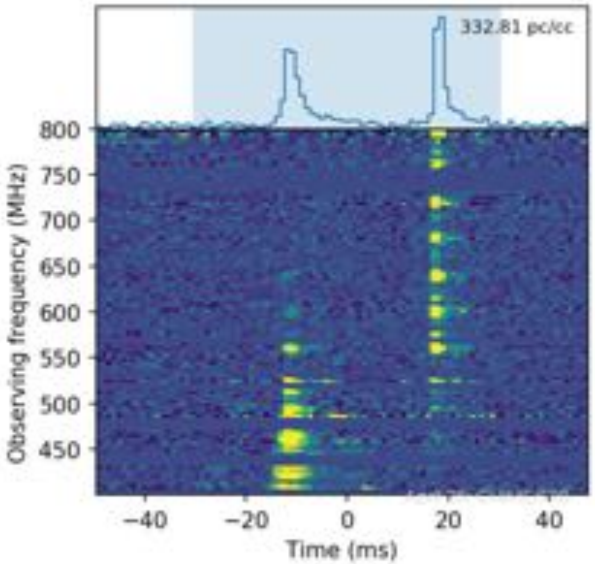
M.Lundy

Magnetars at VHE

SGR 1935+2154

A. López-Oramas





- Galactic magnetar located at 6.6 kpc (Zhou et al. 2020)
- **Hosted in an evolved SNR** (G57.2+0.8) and (likely) interacting with a **surrounding molecular cloud**

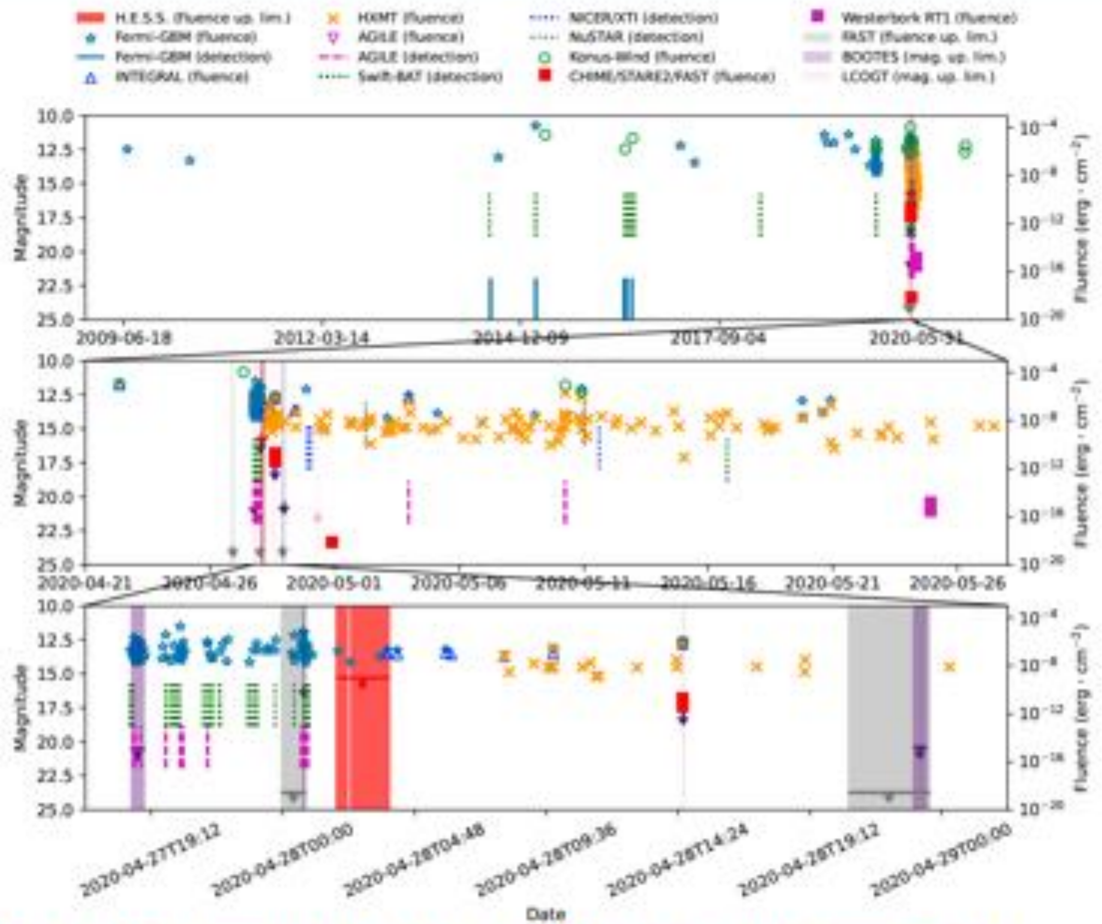
- April 2020: **a fast radio burst (FRB) is detected by CHIME/FRB** in coincidence with this magnetar (Andersen et al. 2020)
  - The burst had a **double-peak** structure with two components ~5 ms wide separated by ~30 ms
- Confirmation by STARE2 (Bochenek et al. 2020) and European dishes: Westerbork, Onsala, Toruń (Kirsten et al. 2020)
- **X-ray bursts** by Swift (Barthelmy et al. 2020), INTREGRAL (Mereghetti et al. 2020), AGILE (Tavani et al. 2021), Konus-Wind (Ridnaia et al. 2021),NICER (Younes et al. 2021), Insight HXMT (Li et al. 2021)
- MAGIC could not observe due to pandemic lockdown

SGR 1935 +2154 is the first FRB in the Galaxy and the first identified FRB source

3

Magnetars at VHE

MWL observations of SGR1935+2154

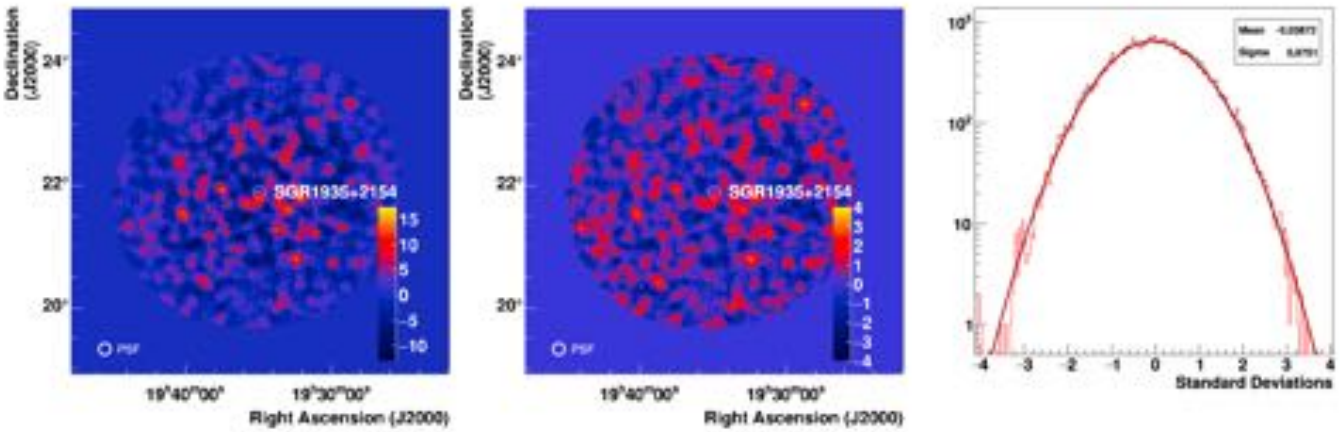


D. Kostunin, H. Ashkar, F. Schüssler, G. Rowell for the H.E.S.S. collaboration | ICRC2021 | Page 4

D. Kostunin

Magnetars at VHE

H.E.S.S. observations of SGR1935+2154

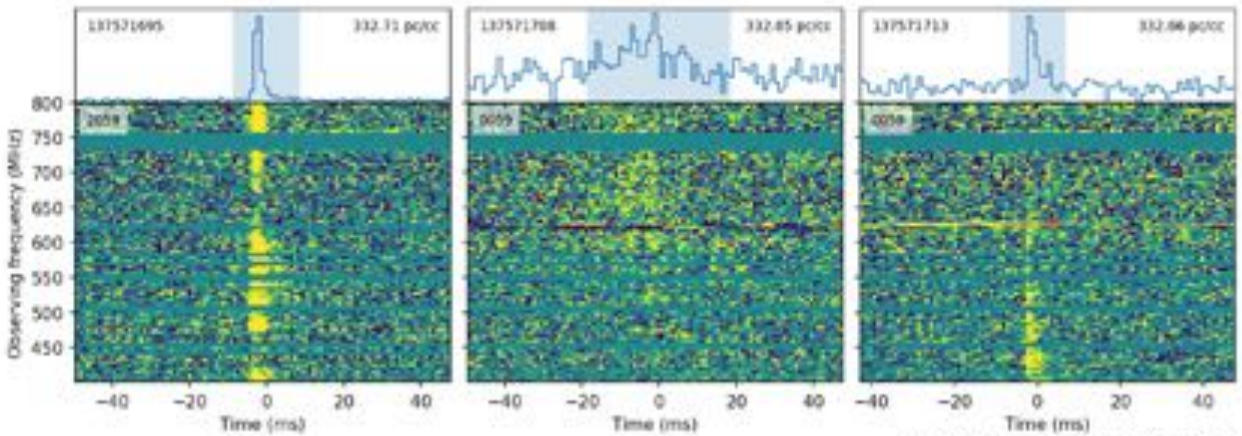


Excess (left) and significance (center) maps for SGR1935+2154 reconstructed by H.E.S.S. One-dimensional significance distribution (right) shows no detection

D. Kostunin

Magnetars at VHE

October 8, 2020: more **radio bursts**



CHIME/FRB (ATel #14074)

- **Three radio bursts** detected on October 8 by CHIME/FRB (ATel #14074)
  - Confirmed by FAST on October 9 (ATel #14084)
- **No X-ray counterpart**
  - No signal in Swift (ATel #14076)
  - No detection in INTEGRAL (ATel #14087)
- **Radio fluence lower than April 28 burst**

13

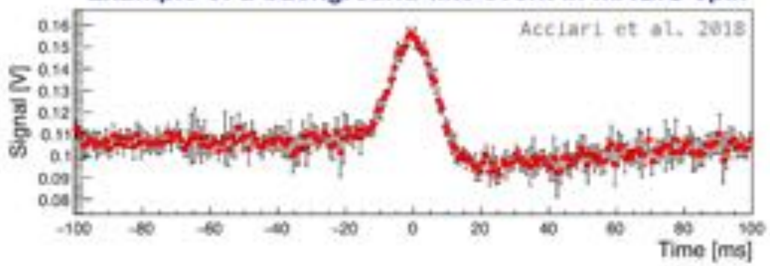
A. López-Oramas

Magnetars at VHE

October **radio bursts**

- MWL observations triggered on **October 9** (one day after CHIME/FRB detection)
  - **Swift** ToO approved:
    - Period of **bursting activity**: about **25 bursts detected** (Borghese et al. in prep)
  - **MAGIC** observed during the Swift burst window:
    - **Simultaneous gamma+optical observations**
    - **No VHE signal detected**
    - **Optical** data with cpix:
      - **ongoing analysis** for the identification of burst-like signals
      - cleaning of background events
  - **Radio** data:
    - No observations scheduled with Westerbork
    - **Onsala** observations did **not reported bursting activity**

Example of a background-like event in MAGIC cpix



- **FAST** performed 1-h observations on October 9 (ATel #14084): **pulsed emission and radio bursts**

A. López-Oramas

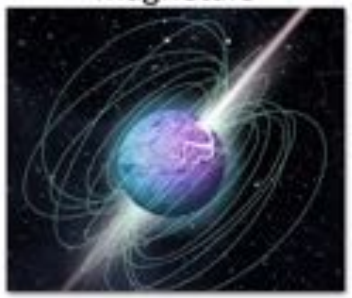
Magnetars at VHE

Galactic transients

- A wide range of sources in our Galaxy exhibit transient emission via **accretion/ejection processes** and interactions between e.g. jets, **outflows and/or strong winds**
- These events can accelerate particles up to relativistic energies, leading to the **production of high-energy (HE, E>100 MeV) radiation**
- **Some objects** such as microquasars, magnetars (giant flares), novae or flares from pulsar wind nebulae (PWNe) **have already been detected in the MeV- (few) GeV regime** (see e.g. Fermi collaboration 2010, Fermi collaboration 2012)

novae

magnetars



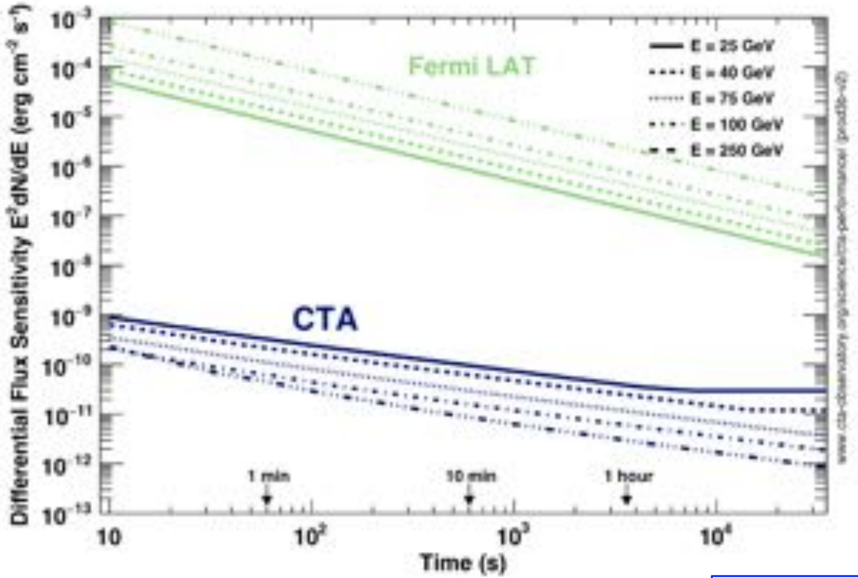
microquasars

A. López-Oramas

Magnetars at VHE

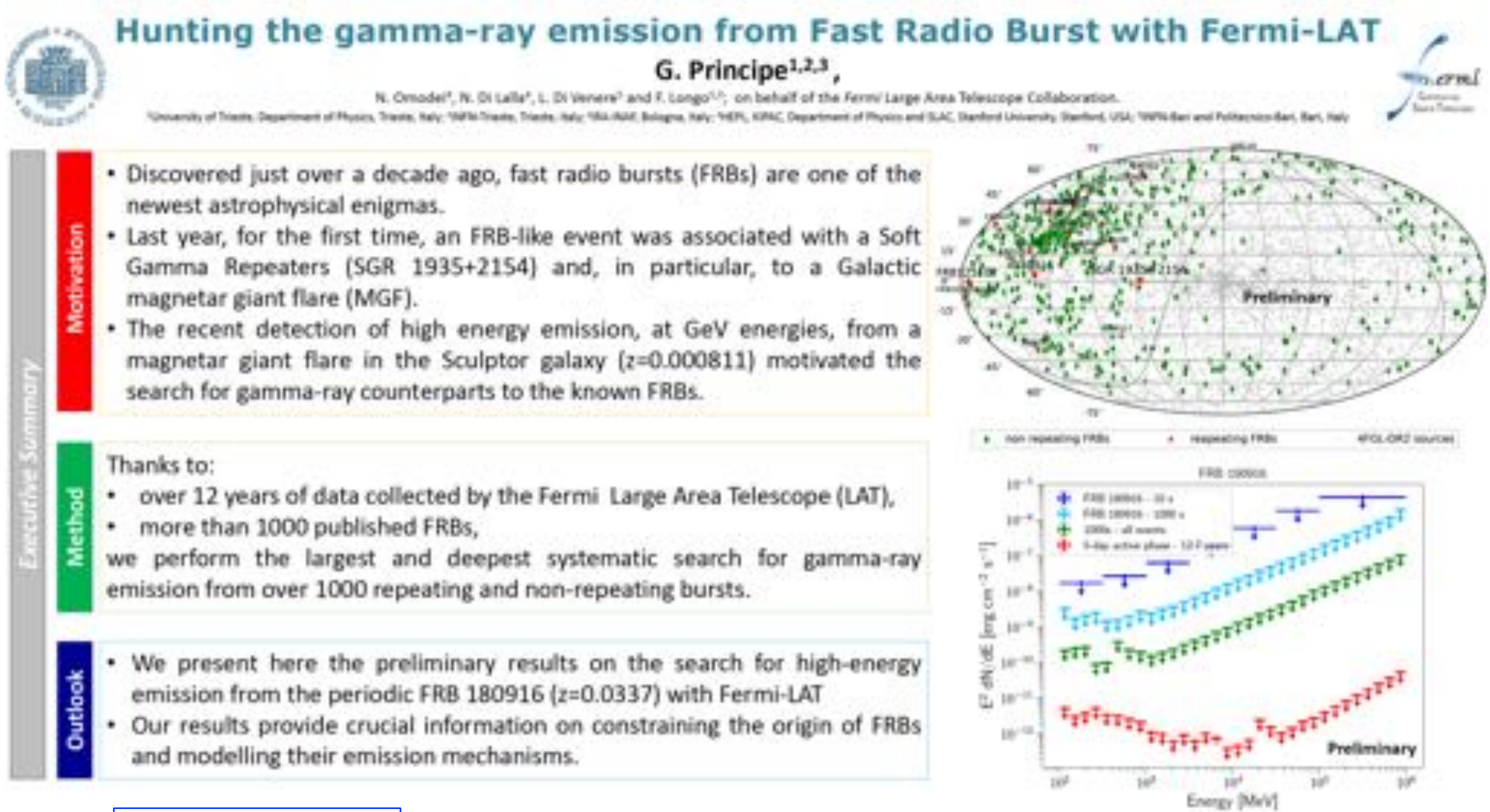
Galactic transients task force

- Sub-group inside the Transients/MWL working group of CTA consortium
- Study the **capabilities of CTA to detect Galactic transient events**
- Working on a CTA consortium publication "Galactic Transient Sources with the Cherenkov Telescope Array"
    - The results shown in this presentation are part of the **paper in preparation**
- **Short-time sensitivity of CTA will allow unprecedent transient detection**



A. López-Oramas

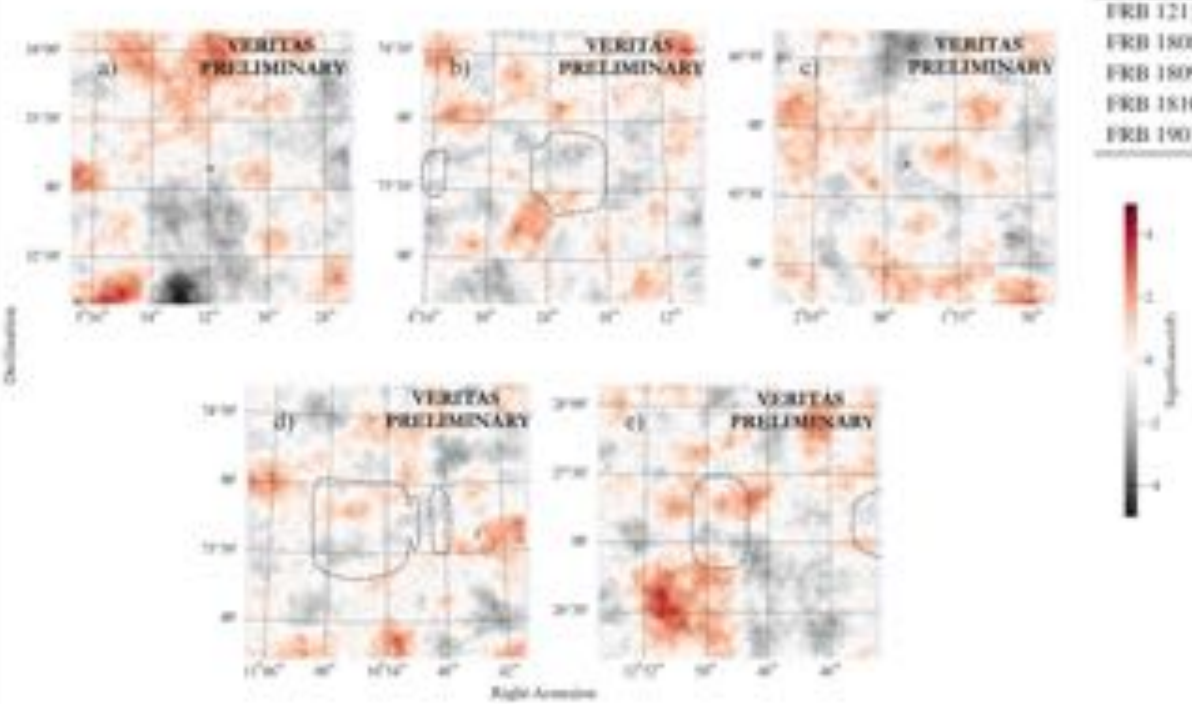
FRB at HE/VHE



G. Principe

FRB at HE/VHE

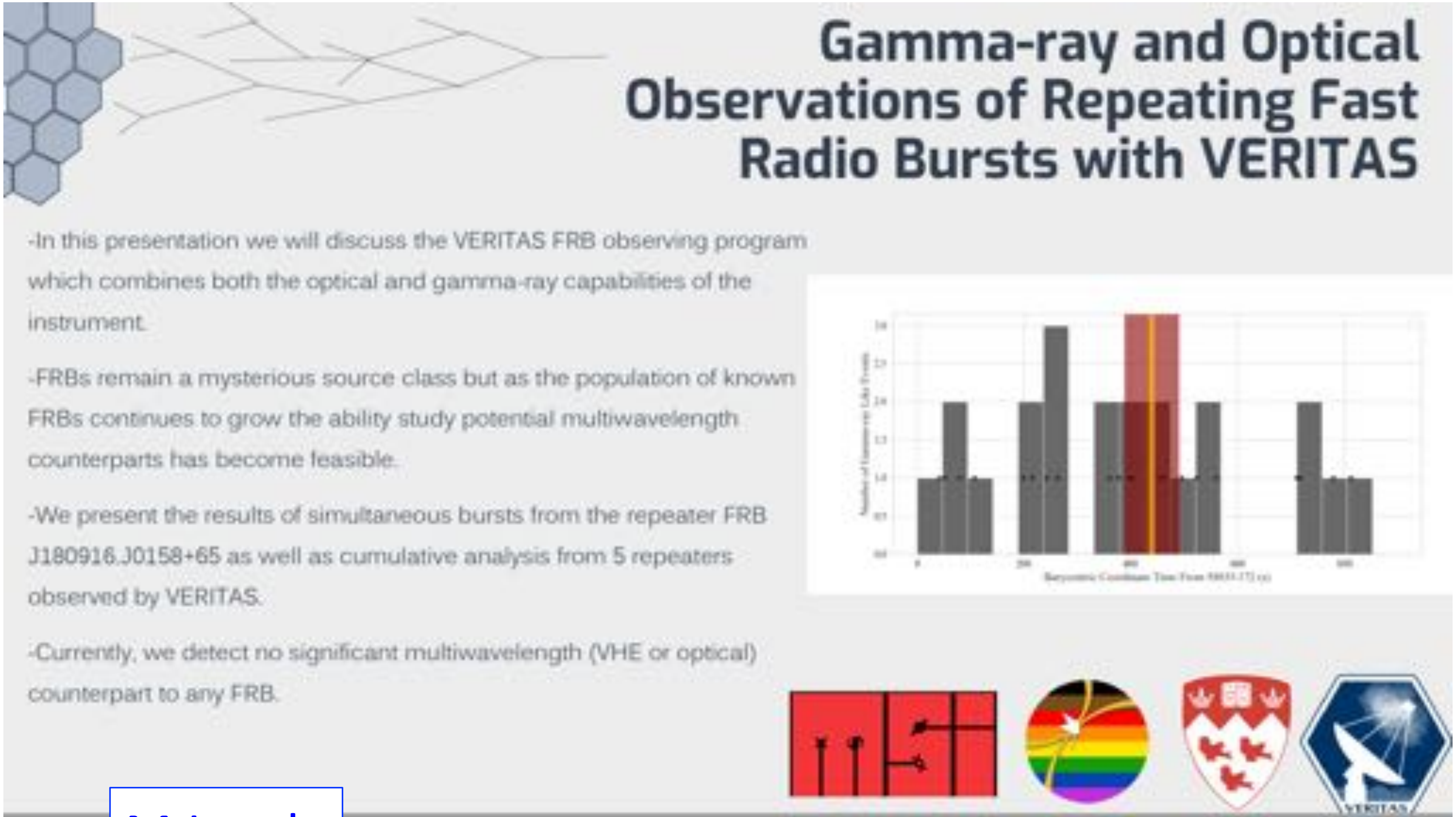
Cumulative Analysis



FRB Name	Exposure (min)	On Counts	Off Counts	Significance(σ)
FRB 121102	1216.64	1681	14134	-0.61
FRB 180814.J0422+73	1013.22	966	8955	-0.62
FRB 180916.J0158+65	397.45	522	4907	-0.06
FRB 181030.J1054+73	226.26	277	2650	-0.33
FRB 190116.J1249+27	45.00	111	768	0.83

M.Lundy

FRB at HE/VHE



M.Lundy

Question 1

- Where is the present observational frontier of FRB physics? What area of FRB physics is presently most contested?

Question 2

- Where are the observational bottlenecks limiting out ability to probe FRB physics? How have recent results affected these limitations?

Question 3

- What future observations are now needed to take the field beyond the current observational frontier?

Question 4

- Are the instruments planned for the coming decade sufficient in order to achieve the required next observations needed?

Question 5

- What observational strategies have we learnt to be most effective in ensuring that the most relevant FRB physics is probed? What mistakes have we made? (and what lessons have we learned?)