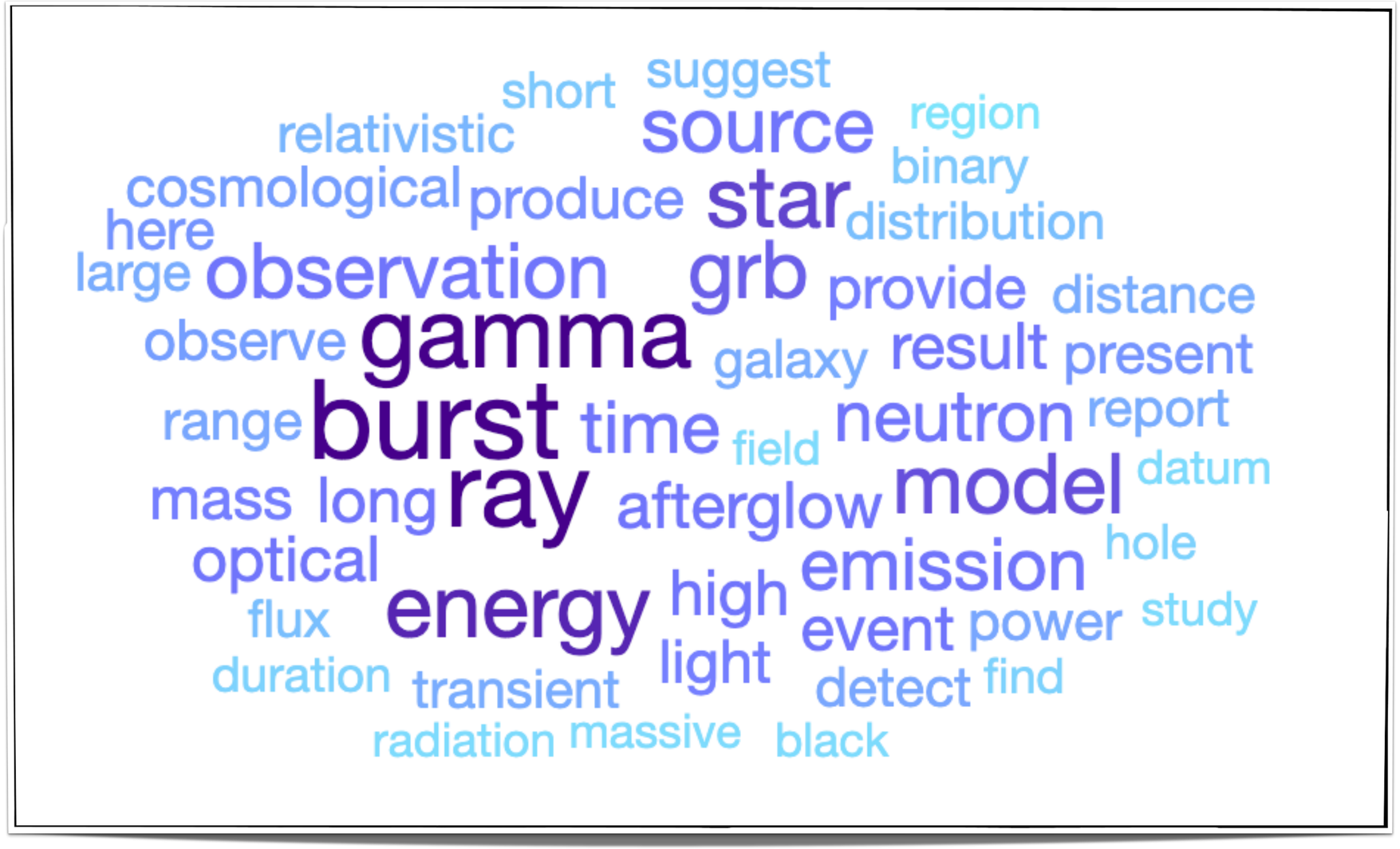


RSN4 - Napoli

Giancarlo Ghirlanda

22-24 / 11 / 2022

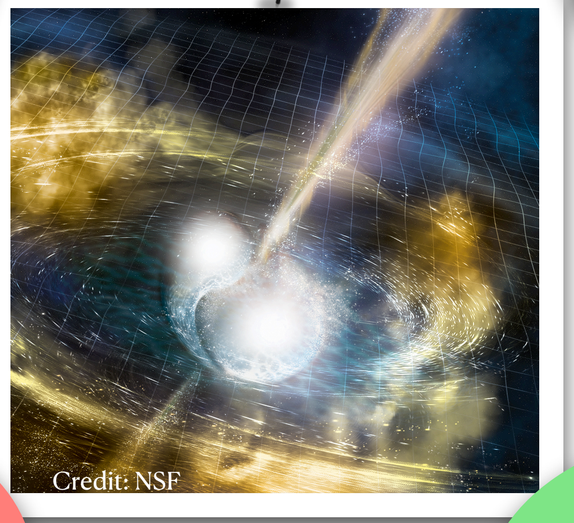
INAF
ISTITUTO NAZIONALE
DI ASTROFISICA

OSSERVATORIO ASTRONOMICO DI BRERA

The trans-disciplinary character of GRBs

Stellar & Galactic astronomy

Early Universe



Gravitational waves

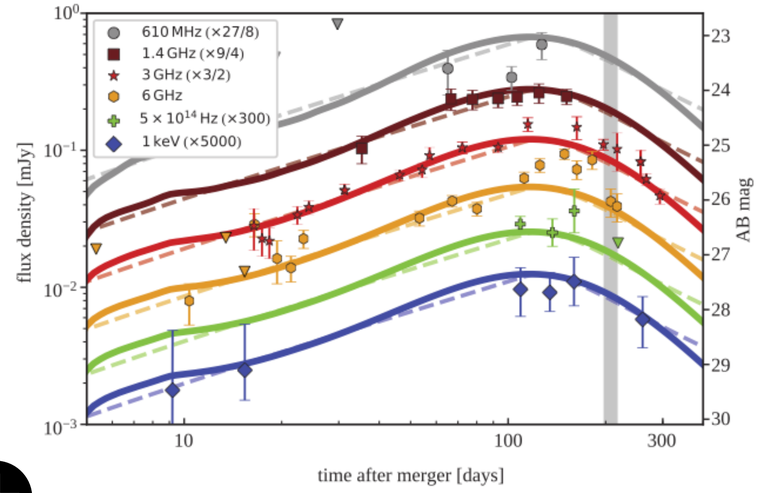
Relativistic Astrophysics

UHECR & ν

GRBs are bursts of knowledge. When nothing happens … a GRB pops up …

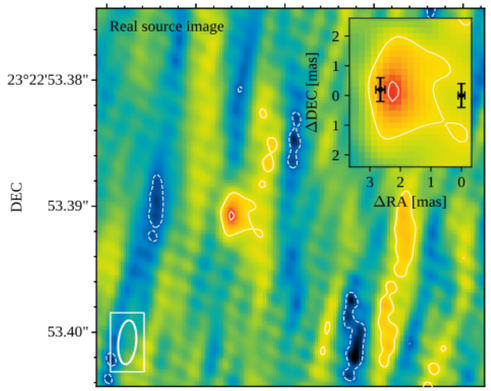
From GRB 170817 … to structured jets (for MM see Paolo's):

D'Avanzo, P.; Campana, S.; Salafia, O. S.; Ghirlanda, G. , et al. 2018, A&A



Structured jet in GRBs

Ghirlanda G., Salafia O. S., Paragi Z., Giroletti M., et al. 2019, Sci

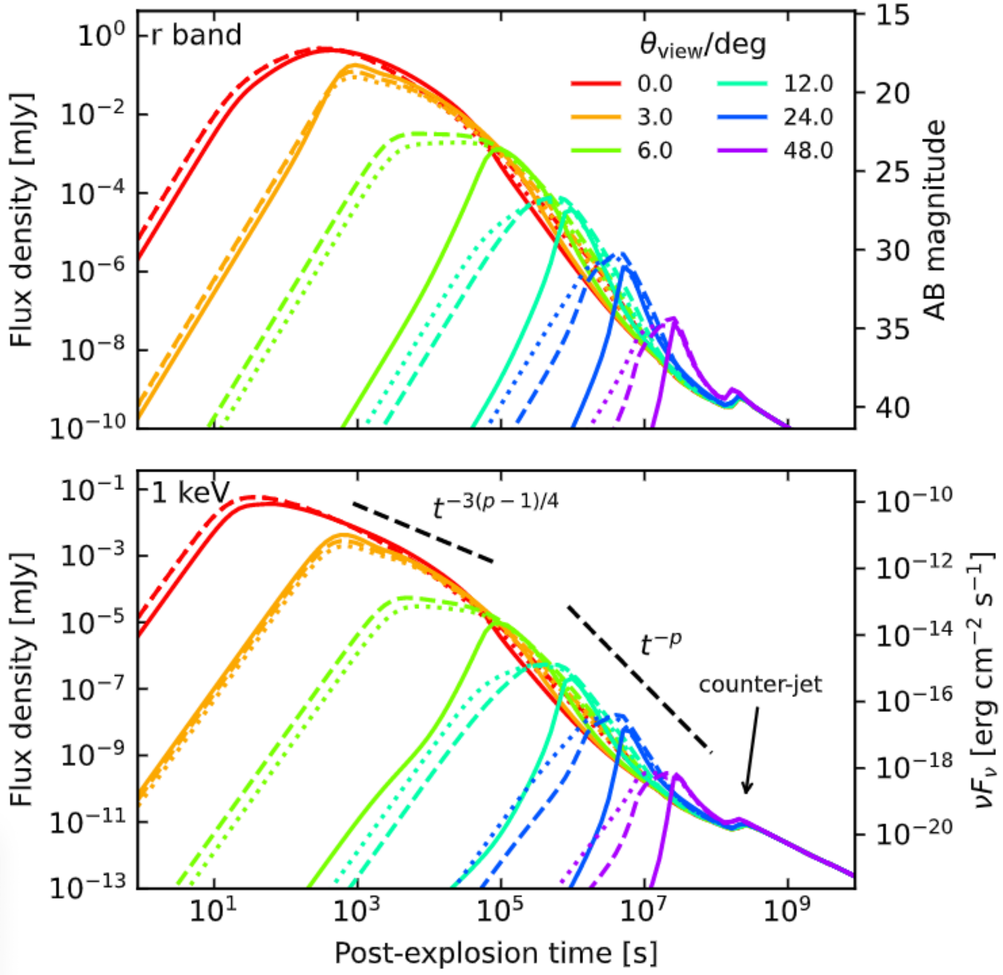


What is the structure origin?

Which observational features?

Successful vs failed jets

Jets, breakouts, cocoon ….

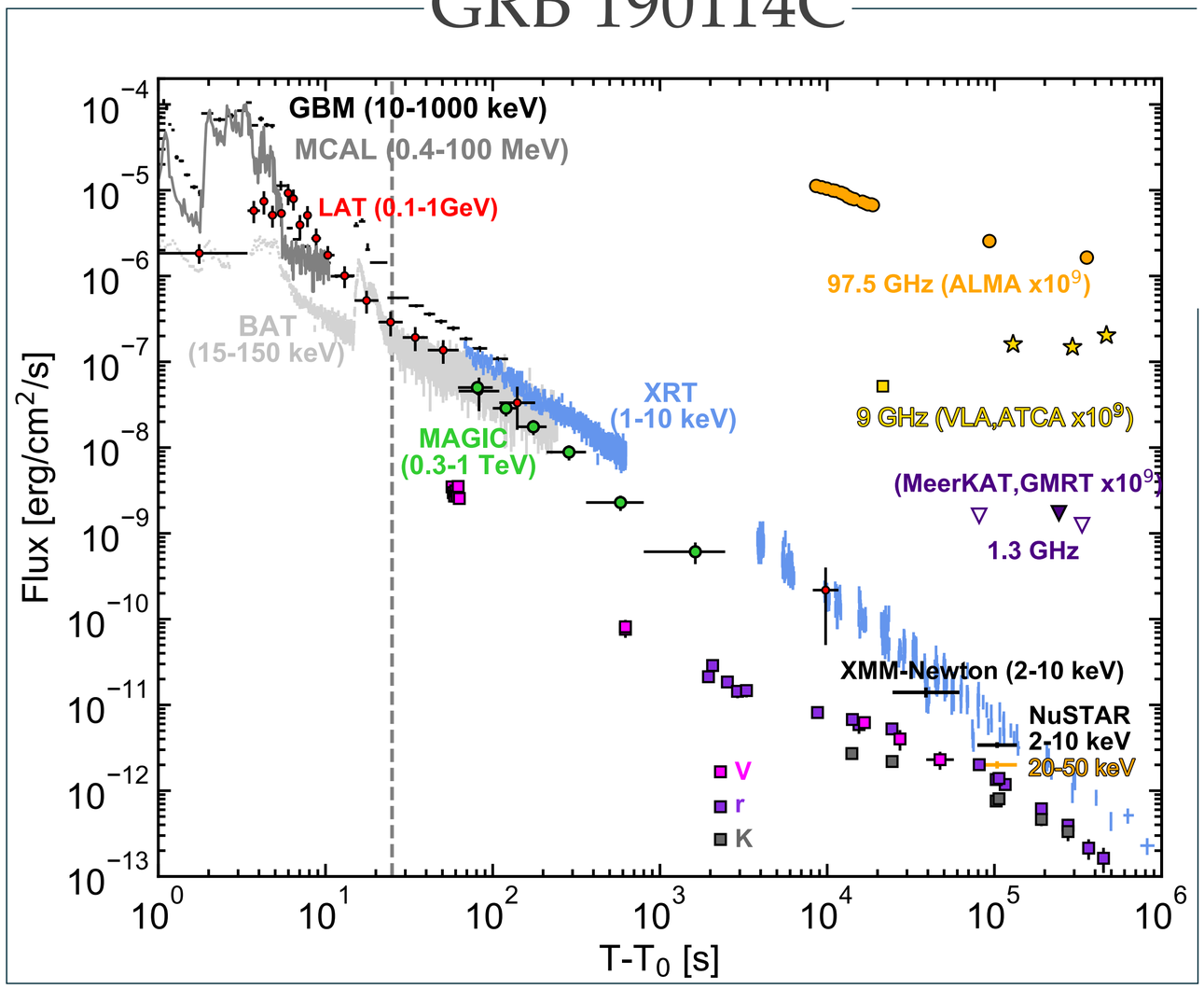


Review on structured jets in GRBs: *Salafia & Ghirlanda 2022*

TeV emission of GRBs

MAGIC collab., 2019, Nat.

GRB 190114C



Name	z	T_{90} s	$E_{\gamma,iso}$ erg	$L_{X,11h}$ erg s^{-1}	Energy TeV	Time s	IACT
180720B	0.653	49	[b] 6×10^{53}	3×10^{46}	0.1–0.44	$(3.6–4.3) \times 10^4$	H.E.S.S.
190114C	0.424	25	[c] 2.5×10^{53}	10^{46}	0.2–1	62–2454	MAGIC
190829A	0.078	[b] 63	[a] 2×10^{50}	4×10^{44}	0.18–3.3	$(1.5–20) \times 10^4$	H.E.S.S.
201216C	1.1	[b] 30	[a] 5×10^{53}	10^{46}	0.1	$56–8 \times 10^3$	MAGIC
201015A	0.42	10	10^{50}	2×10^{44}	0.14	$33–1.4 \times 10^4$	MAGIC

Reviews: *Nava L., 2021; Miceli & Nava 2022*

What is the nature of the TeV emission?

What the constraints on the GRB physics?

Constraints on the EBL

New physics?

Christmas gift: a long GRB with KN

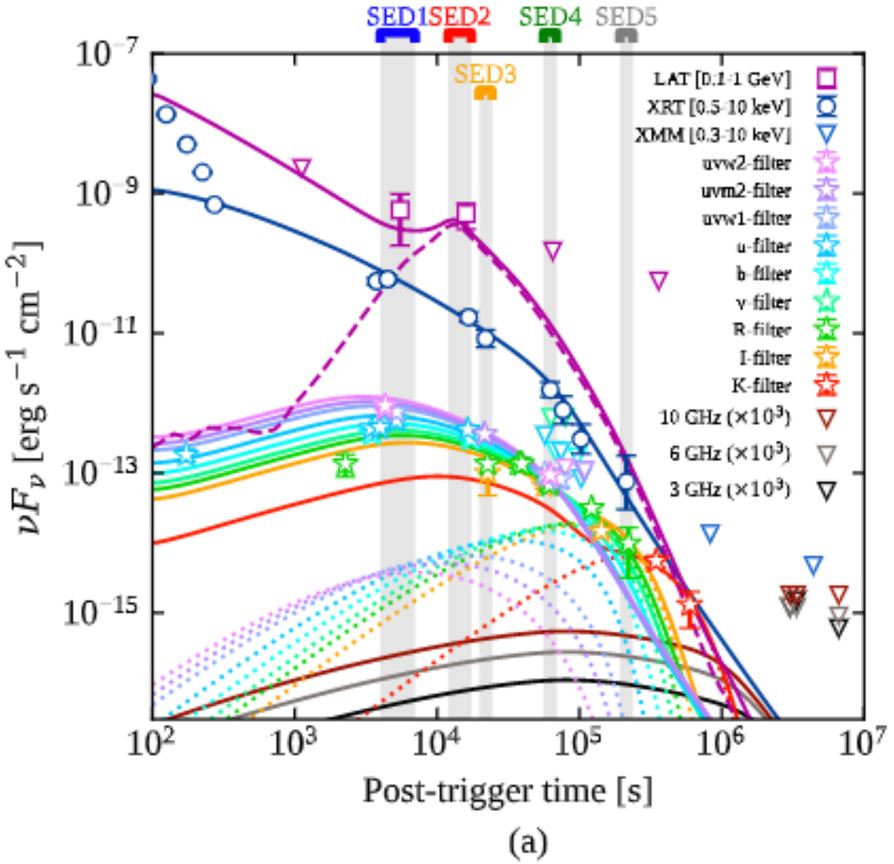
13 Papers + 30 GCN circulars

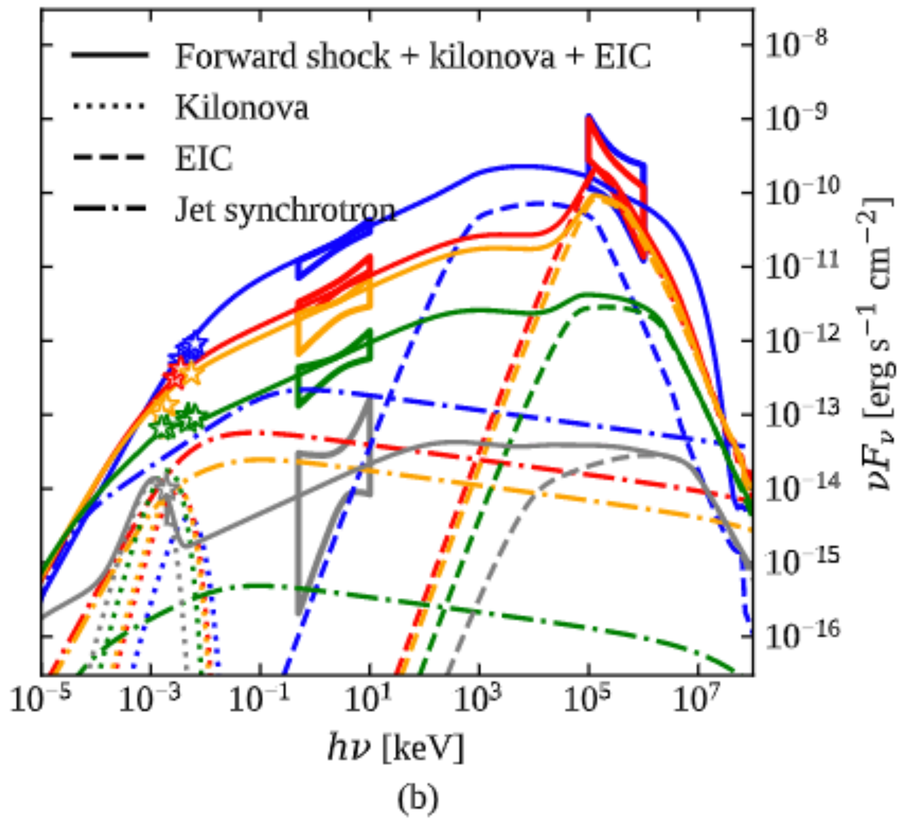
Nature submitted

1.Klonova signature (Rastinejad et al., 2022)
2.(another hint) for synchrotron prompt emission (Gompertz, Ravasio, et al. 2022)
3.Precursor periodicity (Xiao et al., 2022)
4.Late Fermi/LAT (GeV) detection (Mei et al., 2022)

GRB 211211A

A. Mei, B. Banerjee, G. Oganesyan, O. S. Salafia, S. Giarratana, M. Branchesi, P. D'Avanzo, S. Campana, G. Ghirlanda, S. Ronchini, A. Shukla, P. Tiwari, 2022, Nat. submitted





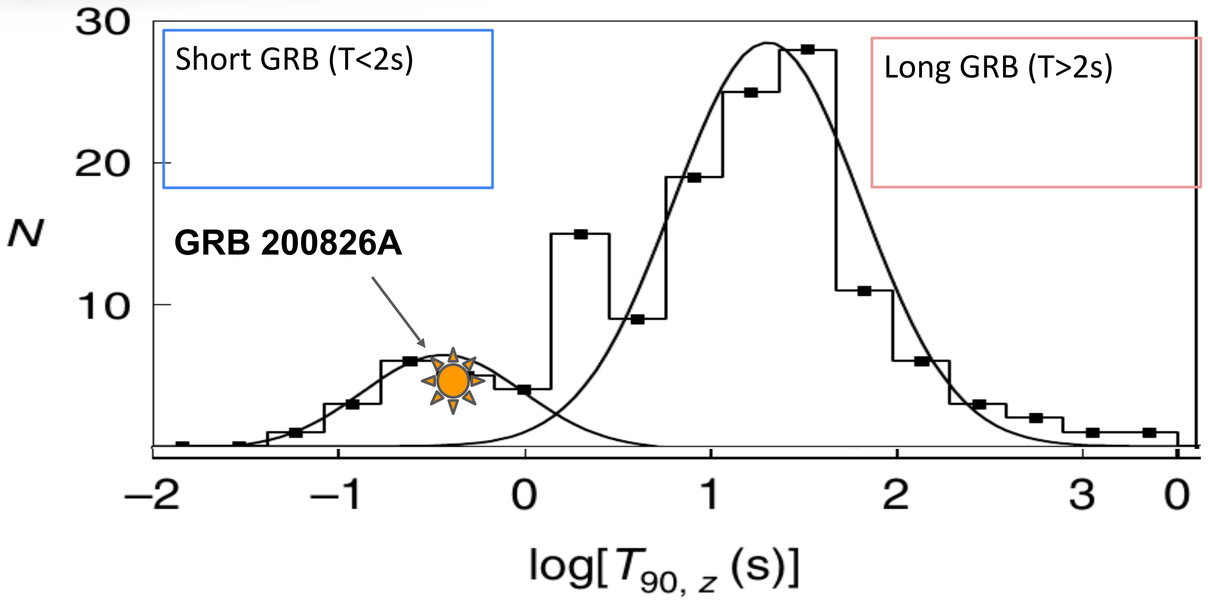
How the CE works?

Short and long

Extra components?

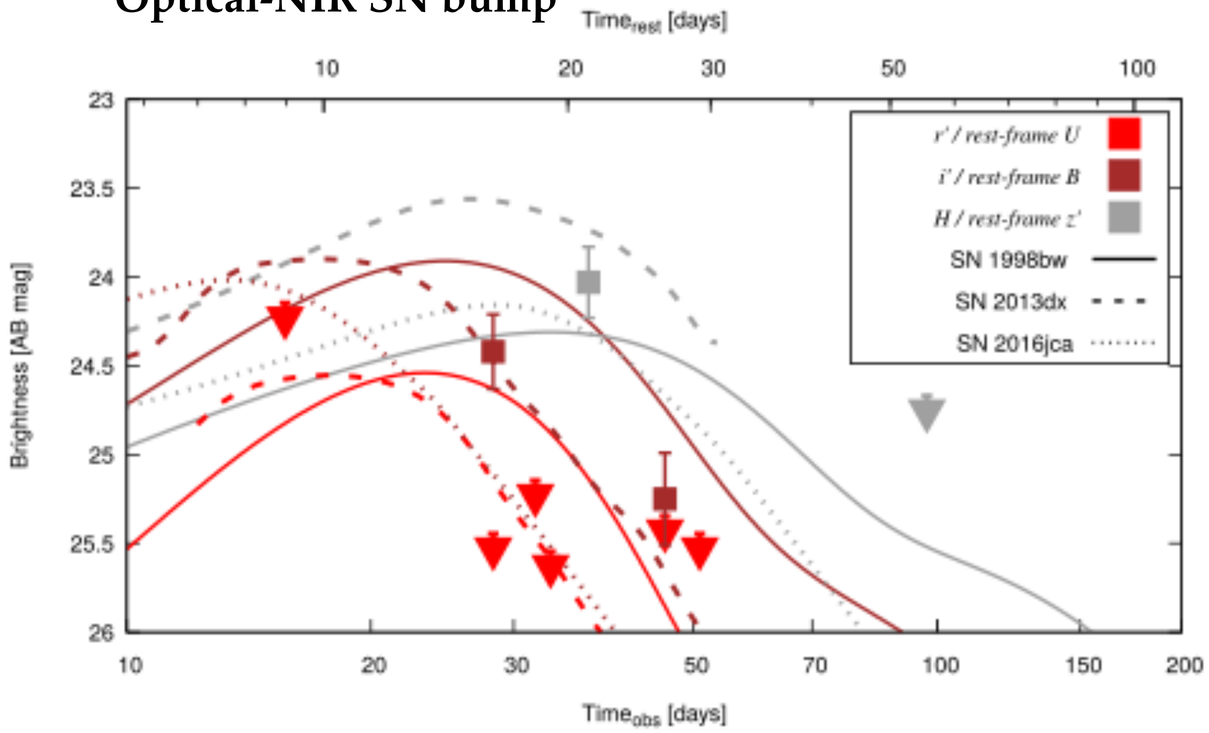
Summer gift: the shortest collapsar

Rossi, B. Rothberg, E. Palazzi, D. A. Kann, P. D'Avanzo, L. Amati, S. Klose, A. Perego, E. Pian, C. Guidorzi, A. S. Pozanenko, S. Savaglio, G. Stratta, G. Agapito, S. Covino, F. Cusano, V. D'Elia, M. De Pasquale, M. Della Valle, O. Kuhn, L. Izzo, E. Loffredo, N. Masetti, A. Melandri, P. Y. Minaev, A. Nicuesa Guelbenzu, D. Paris, S. Paiano, C. Plantet, F. Rossi, R. Salvaterra,
2022, ApJ, 932:1



GRB 200826A

Optical-NIR SN bump



Revisiting short/long divide

Progenitor nature

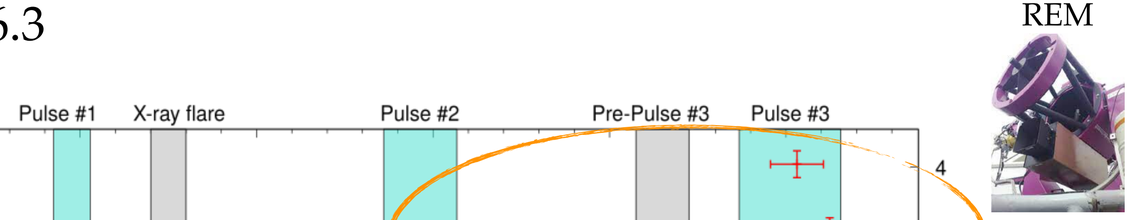
Monster blasts from the past

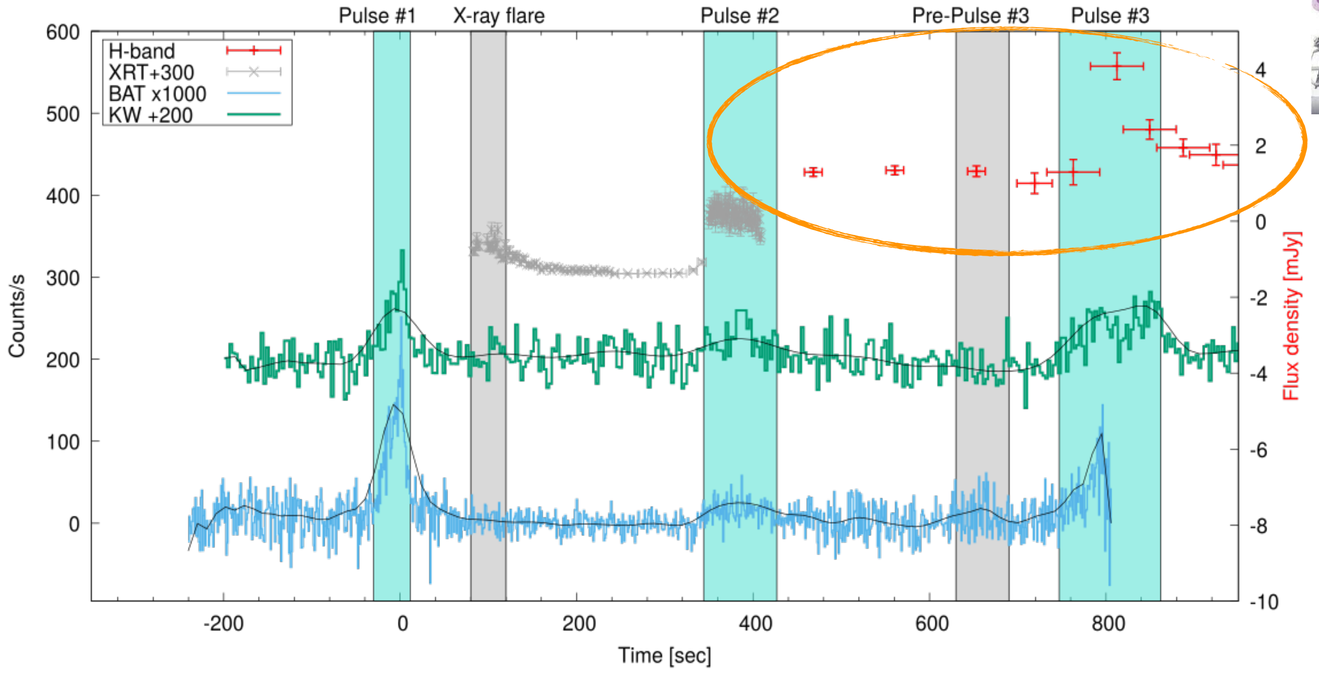
A. Rossi, D. D. Frederiks, D. A. Kann, M. De Pasquale, E. Pian, G. Lamb, P. D'Avanzo, L. Izzo, A. J. Levan, D. B. Malesani, A. Melandri6 , A. Nicuesa Guelbenzu, S. Schulze, R. Strausbaugh, N. R. Tanvir, L. Amati, S. Campana, A. Cucchiara, G. Ghirlanda, M. Della Valle, S. Klose, R. Salvaterra, R. L. C. Starling, G. Stratta, A. E. Tsvetkova, S. D. Vergani, A. D'Aì, D. Burgarella, S. Covino, V. D'Elia, A. de Ugarte Postigo, H. Fausey, J. P. U. Fynbo, F. Frontera, C. Guidorzi, K. E. Heintz, N. Masetti, E. Maiorano, C. G. Mundell, S. R. Oates, M. J. Pa… azzi, J. Palmerio , G. Pugliese34,35 , A. Rau36 , A. Saccardi19 et al.
2022, A&A, 665, 125

GRB 210905

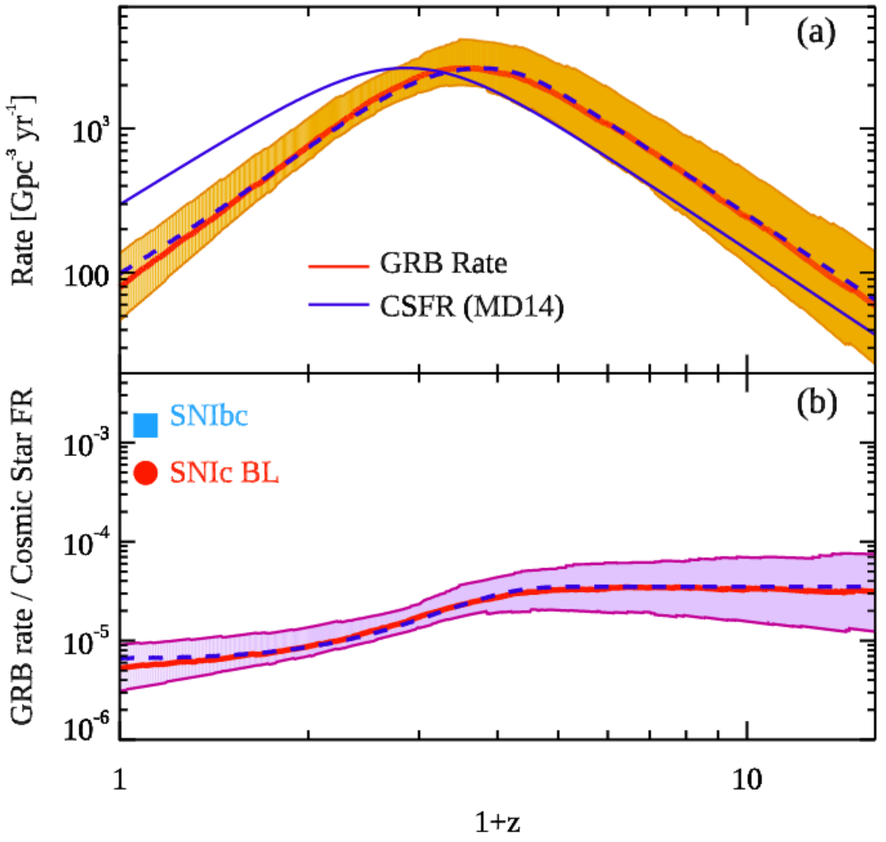
@ z=6.3

REM





Ghirlanda, G. & Salvaterra, R., 2022, ApJ, 932, 10

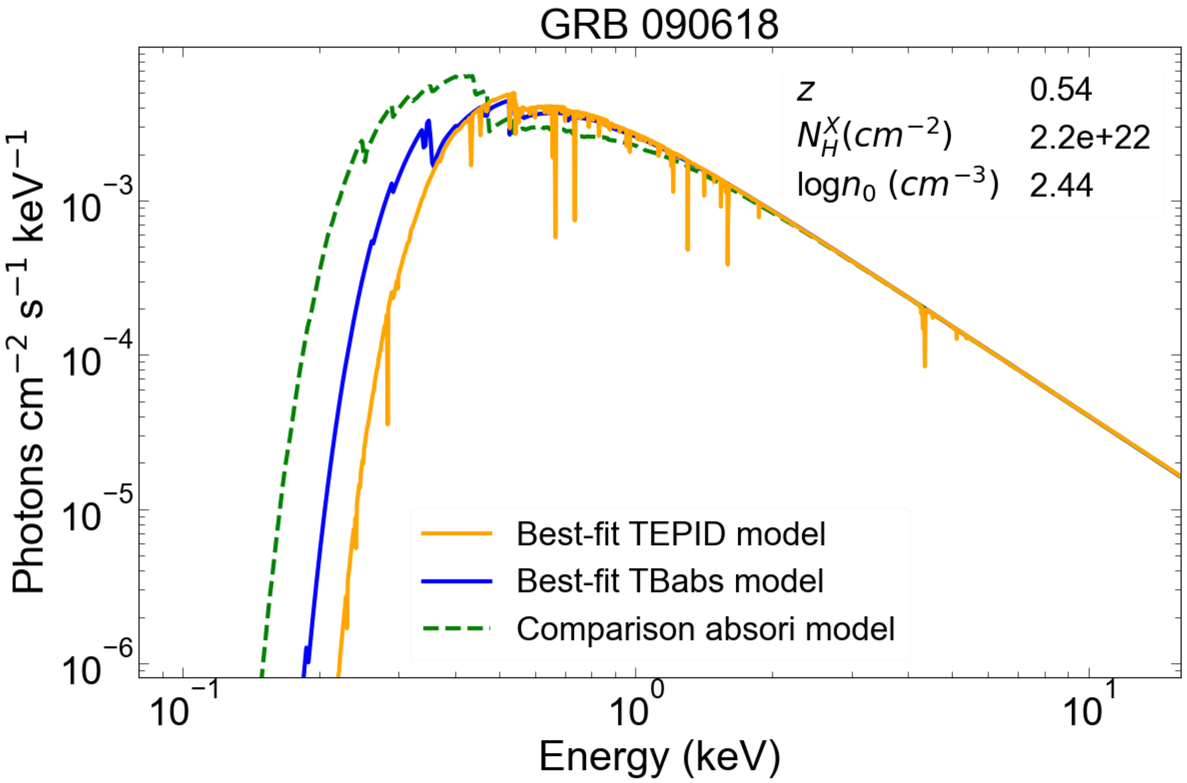


Population studies and simulations supporting mission concept design and science case studies [Theseus, HERMES, CTA …]

Environment matters

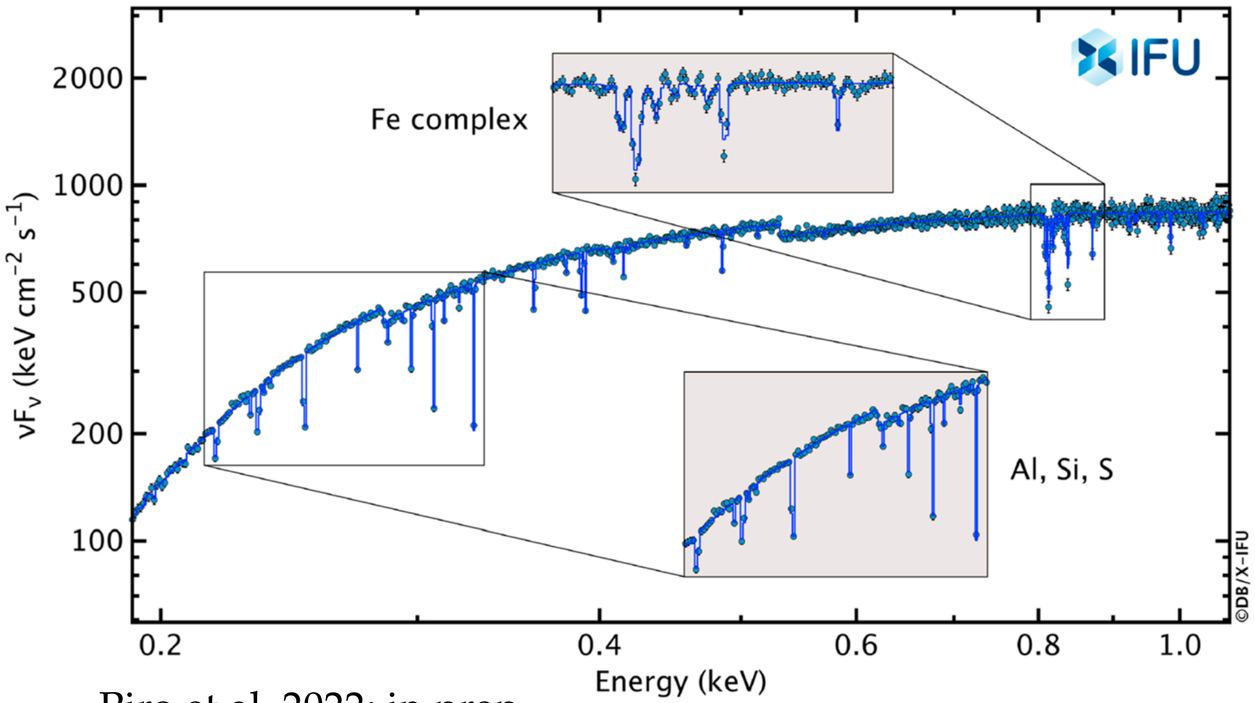
Highly variable and large GRB flux into the cricumbrust environs requires proper dependant modelling (TEPID: Luminari et al 2022)

Applied to a golden sample of XMM_Newton Obs (Thakur et al 2022, in prep.)



When did the first generation of stars explode to form the first seed black holes and disseminate the first metals in the Universe?

Gamma Ray Burst at z=7 with ATHENA

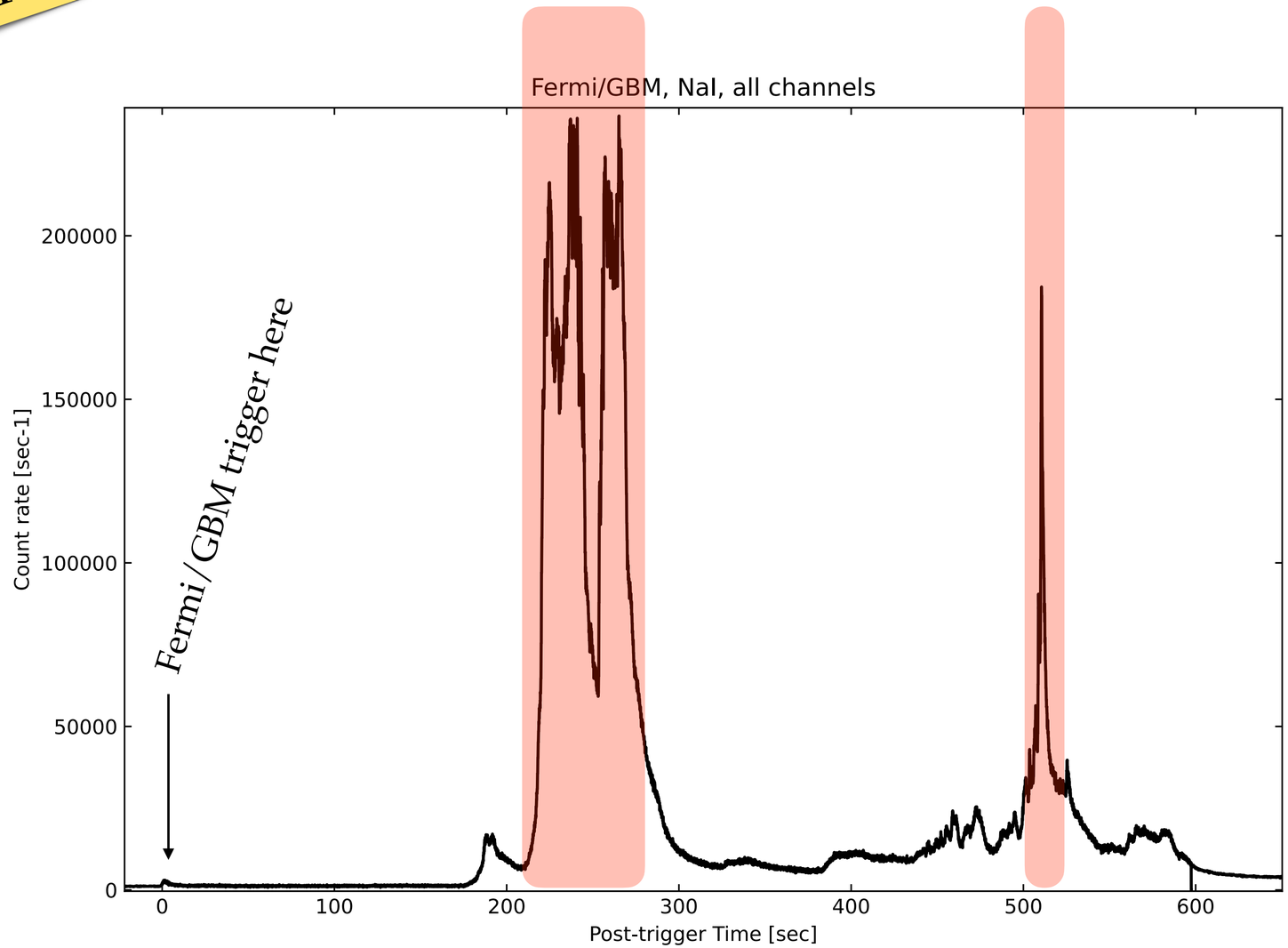


Piro et al. 2022; in prep.

A monster in the backyard

GRB 221009A

Data issues

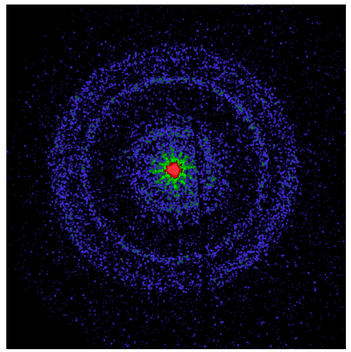


Long, energetic, luminous

$L > 6 \times 10^{52}$ erg s^{-1} $E \gtrsim 3 \times 10^{54}$ erg

VHE detection (up to 18 TeV …)

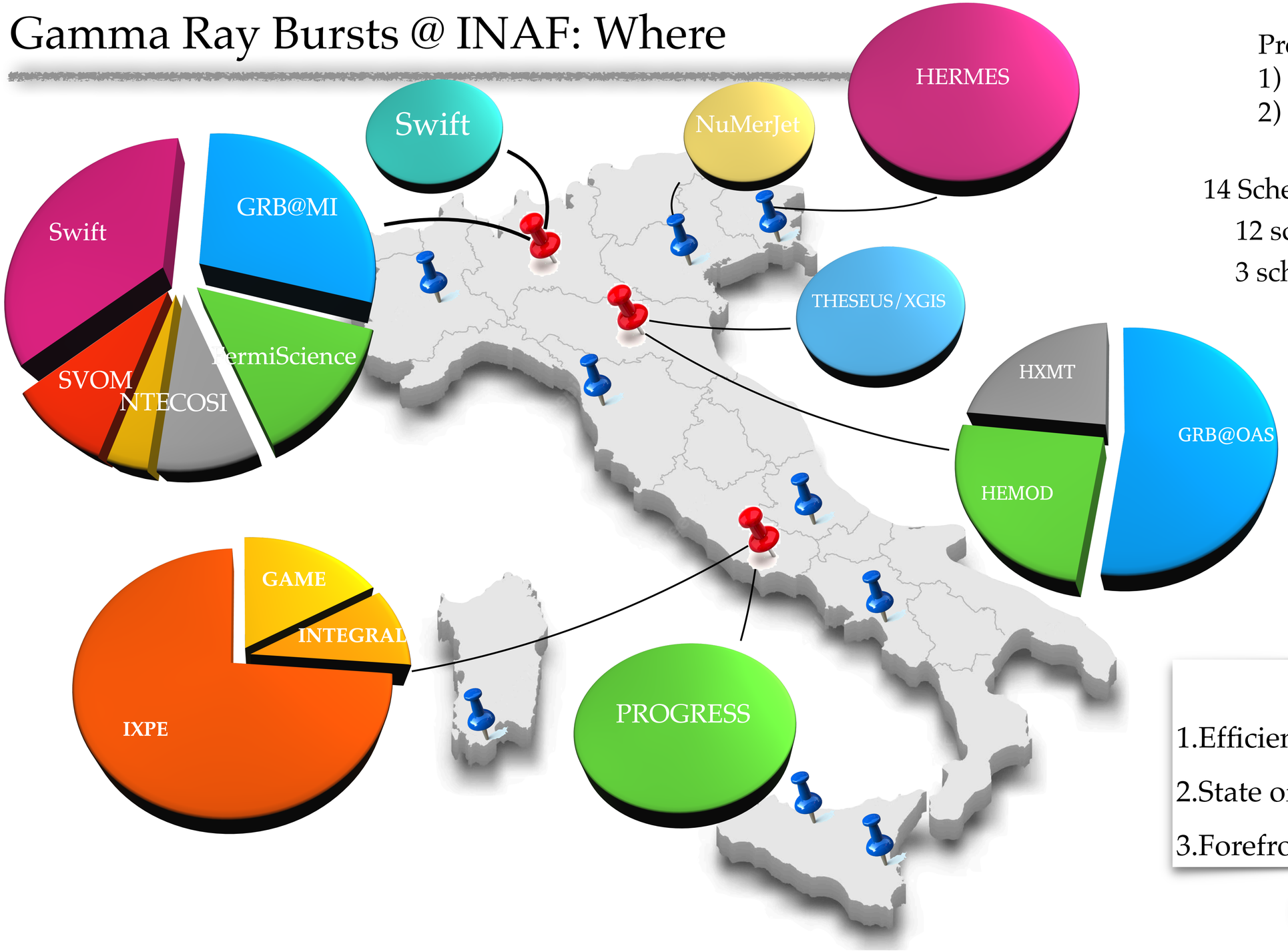
ALP interpretation (Galanti et al. 2022)



Dust rings
(Tiengo et al. 2022)

Much more to come

Gamma Ray Bursts @ INAF: Where



Preliminary remarks:

1) GRB only (MM —> Paolo)
2) Schede RSN4 primaria

14 Schede in RSN4 primaria + 1 in RNS5

12 schede legate a satelliti/strumenti

3 schede su GRB (>50% non GW):

1. GRB@MI
2. GRB@OAS
3. GAME

GRBs @ INAF

1. Efficient top level Observations
2. State of the art modelling and theory
3. Forefront in tecno devel.

Gamma Ray Bursts @ INAF: What

Preliminary remarks:
1) GRB only (MM —> Paolo)
2) Schede RSN4 primaria

14 Schede in RSN4 primaria + 1 in RNS5
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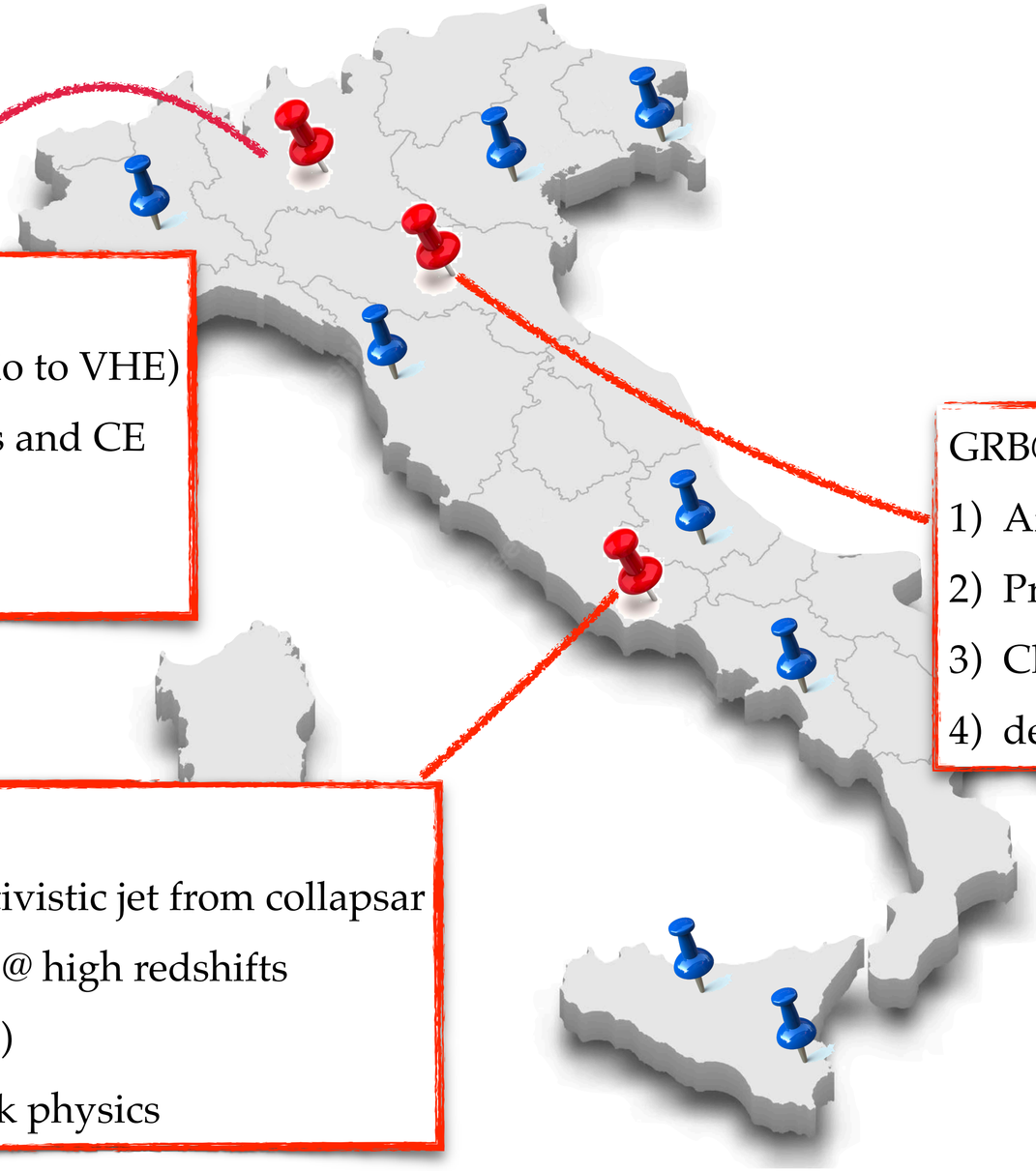
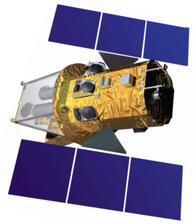


GRB@MI
1) Physics of GRBs (radio to VHE)
2) Nature of progenitors and CE
3) (MM)
4) Cosmic evolution

GRB@OAS
1) Afterglow observ/interpret.
2) Progenitor nature
3) Close/large environ.
4) detection/new instrument.

GAME
1) Relativistic jet from collapsar
2) GRB @ high redshifts
3) (MM)
4) Shock physics

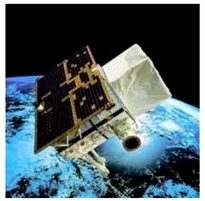
National and international collaboration



Italian *Swift* team
~ 20 people (INAF: OAB, IASF-Mi, OAR, IASF-Pa; ASI: SSDC)
PI: Gianpiero Tagliaferri (OAB)

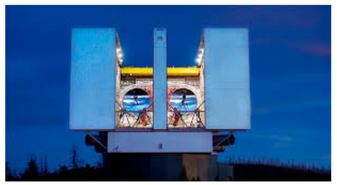
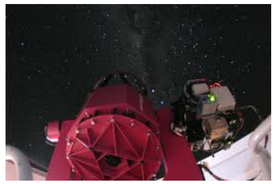
18 YEARS:
~1600 GRBs (90/yr)
80% XRT detection
30% UVOT detection
50% optical/NIR detection
7% radio detection
26% with redshift

Integral



AGILE

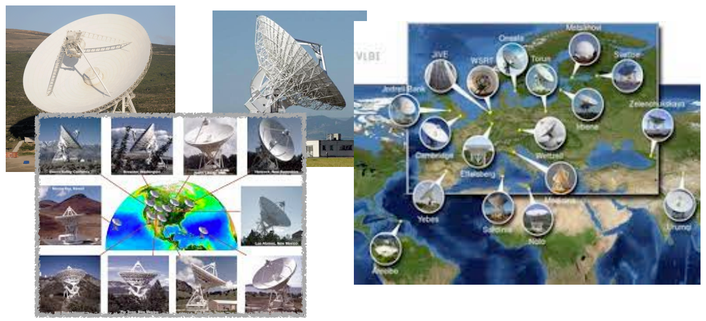
Fermi


Optical/NIR ground-based GRB follow-up

Coordinamento Italiano Burst Ottici: REM-TNG-LBT
~ 30 people, Italian collaboration INAF-led

STARGATE: ESO-VLT
~ 100 people, European collaboration
significant participation of INAF researchers



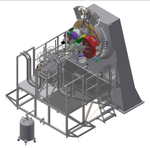
Radio follow up (SRT, Medicina, EVN, EAVN, VLBA, e-Merlin, VLA
~10-15 participants, international team - INAF led collaboration

Instruments & Facilities

Future

SKA

ELT



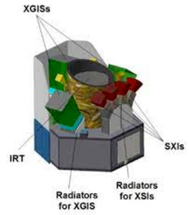
SoXS

JWST

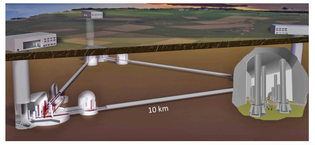
V. Rubin

Athena

THESEUS



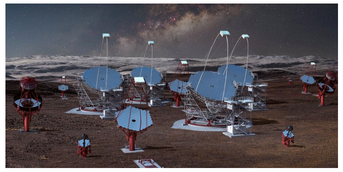
Einstein Telescope



Hermes

SVOM

CTA



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Medicina & Noto

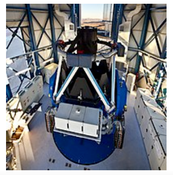
SRT

LBT

TNG

REM

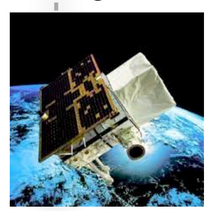
VST



Niel Gehrels Swift Obs.

ASTRI

Agile

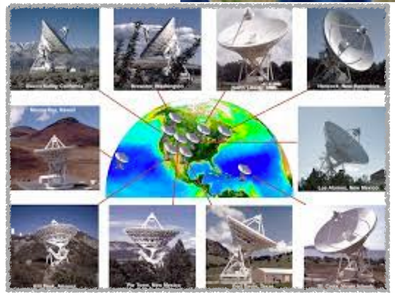


MAGIC

ν

EVN, g-VLBI, eMerlin

VLBA



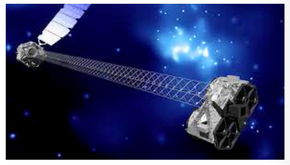
VLT

NTT

HST

Chandra

Nustar



XMM-Newton

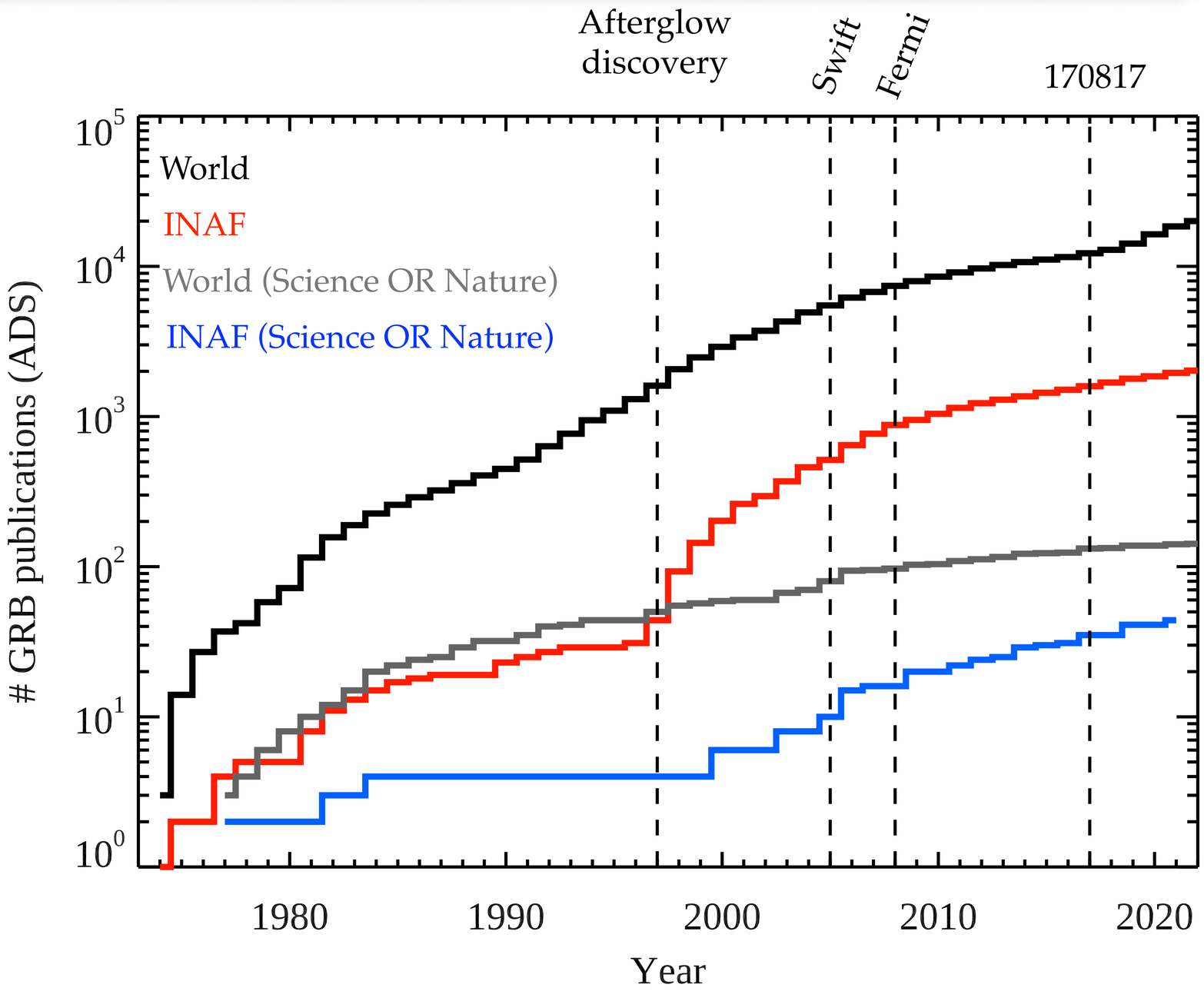
Integral

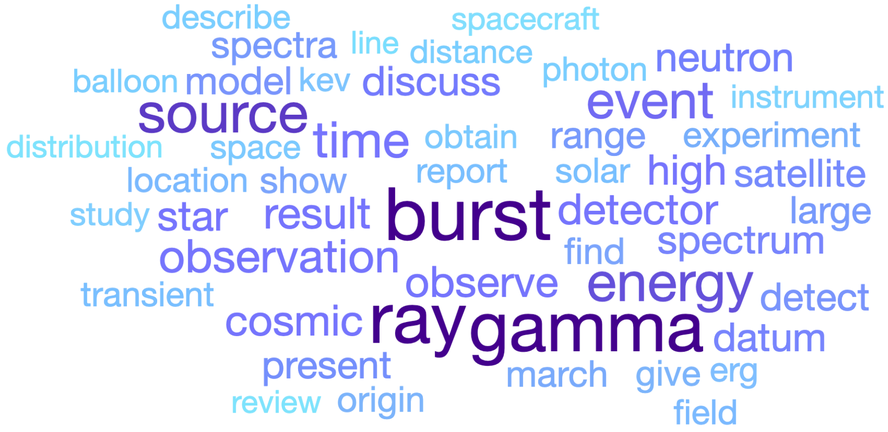
Fermi

LIGO & Virgo

Ice-Cube

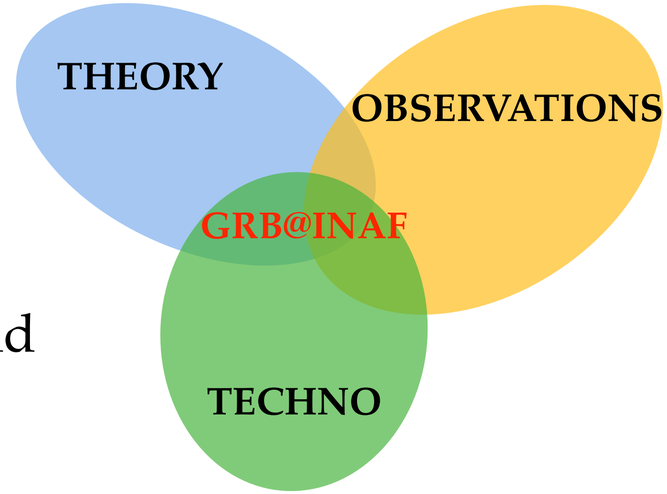
Scientific impact





Strengths, Weaknesses and Needs

- The success of GRB science in INAF



- As a community we have evolved into large (national and international) collaborations.
- INAF is at the forefront in this research field

- Perspectives? What will come after (and better than) Swift and Fermi? How INAF wrt ESA, NASA, etc.?

- Programmatic views (earlier career support) & Alta formazione
- INAF follow up facilities: present (REM, LBT, TNG, Magic, SRT …) and future (SOXS, CTA and new ideas - Hugo)
- Funding plans (ASI, INAF, MUR, EU)

Thank you