Short GRBs – DCO Mergers

Berger ARAA 2014

Fernandez & Metzger 2016 ARNPS
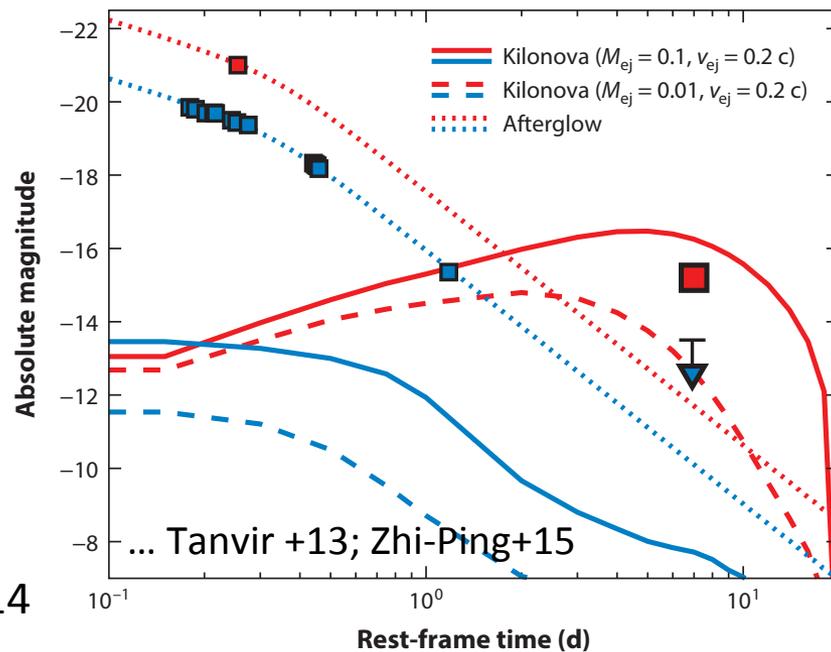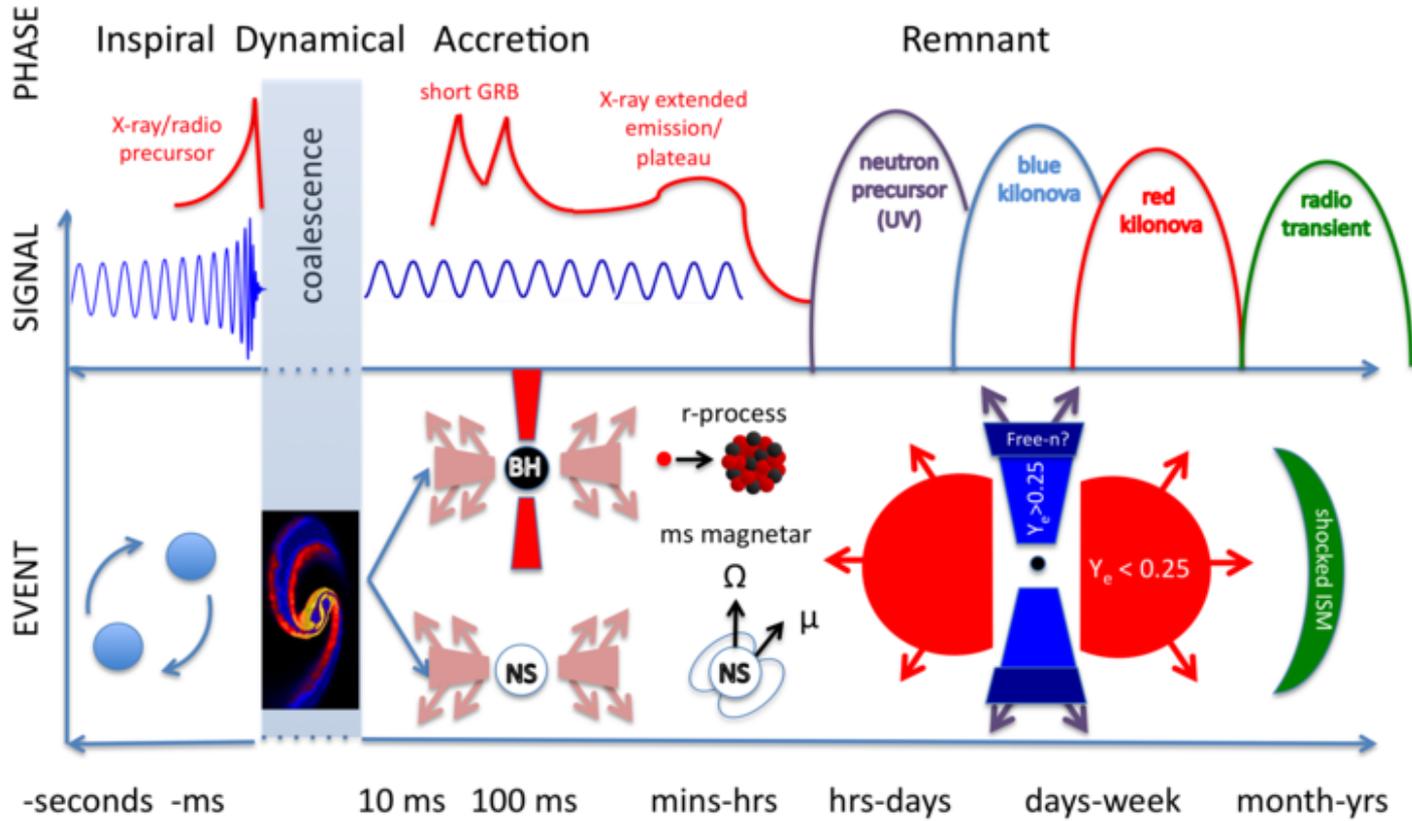
The seen and the unseen Gamma Ray Bursts

$\vartheta_{view} > \vartheta_{jet}$

GRB + Afterglow
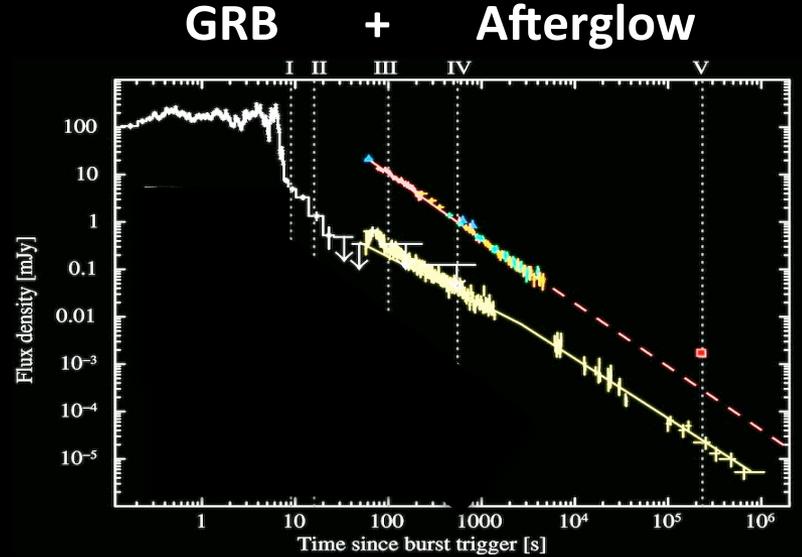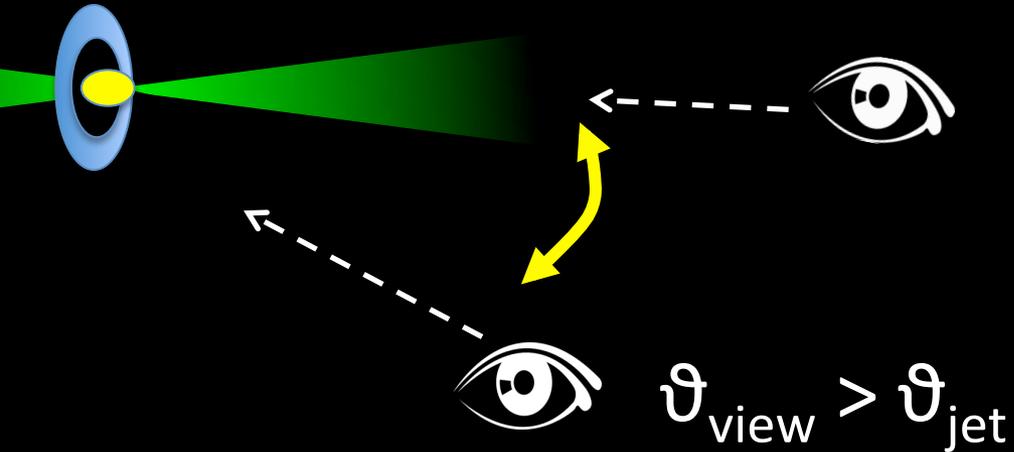
ORPHAN Afterglow

$\Gamma = 1/\vartheta_{view}$
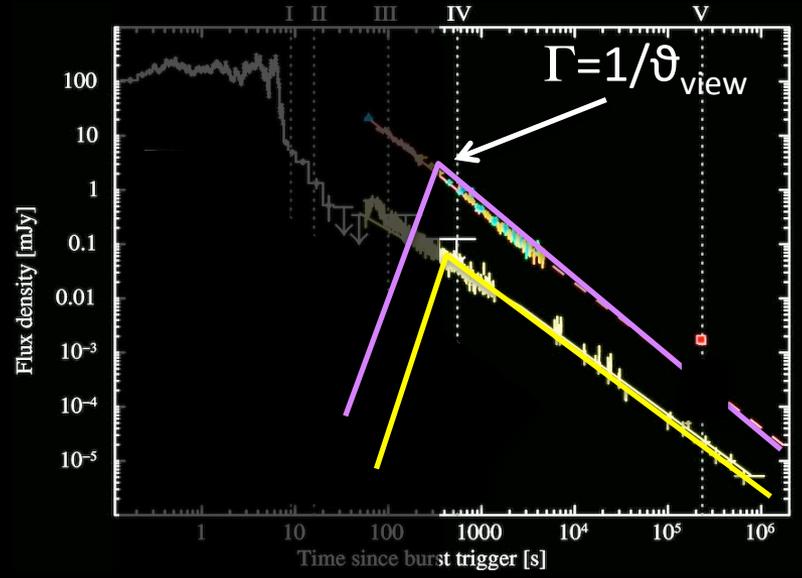
$R_{SGRB} \sim 53$ yr^{-1} (on-axis – γ-ray det)

Off-axis ~ On-axis * $1/(1-\cos\vartheta_{jet})$

$$\mathbf{f_b} = \frac{1}{1 - \cos\theta_{jet}}$$

700 ($\vartheta_{jet} \sim 3$ deg)

7 ($\vartheta_{jet} \sim 30$ deg)

Know a few (2-6) SGRBs ϑ_{jet}

For pointed rates:
1) $\Phi(L)$
2) $\Psi(z)$

$\dot{N}_{S\ GRB}(<200\ \mathrm{Mpc})\ [\mathrm{yr}^{-1}]$

$16\ \mathrm{yr}^{-1}$

$\vartheta_{jet}\sim3$ deg

$\vartheta_{jet}\sim30$ deg

$0.2\ \mathrm{yr}^{-1}$

$0.02\ \mathrm{yr}^{-1}$

Nakar

Ando

Guetta & Piran

Guetta & Stella

Diez

Coward

Stellez

Wanderman

Publication year

Number

Long
Short

Opening angle θ_j (degrees)

$\langle n \rangle \approx 0.15\ \mathrm{cm}^{-3}$
$(\epsilon_e = 0.1;\ \epsilon_B = 0.01)$

Circumburst density (cm^{-3})
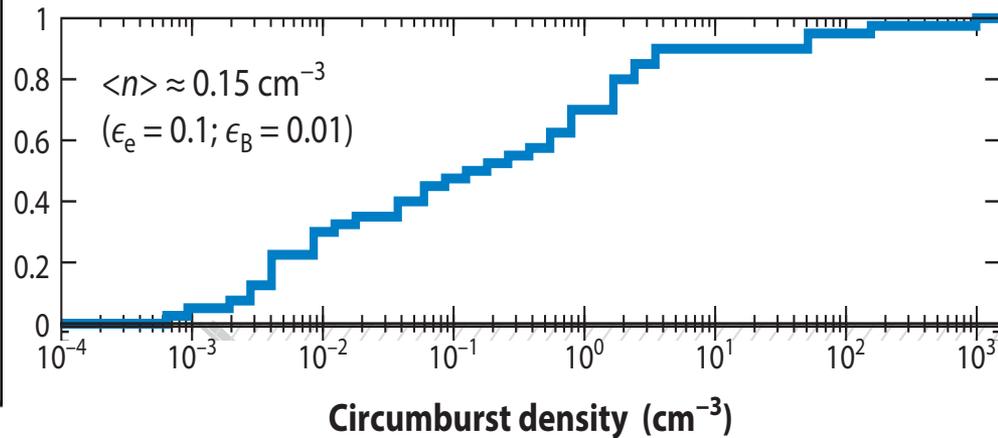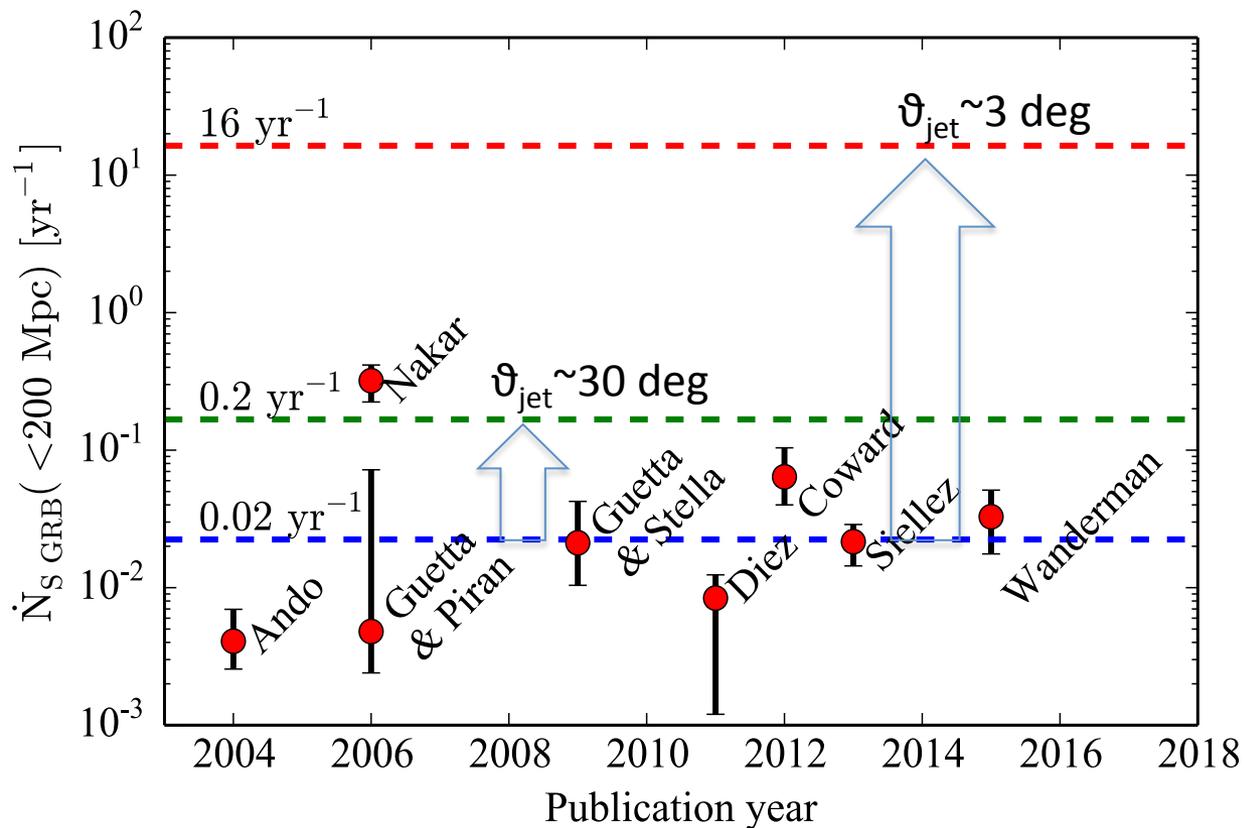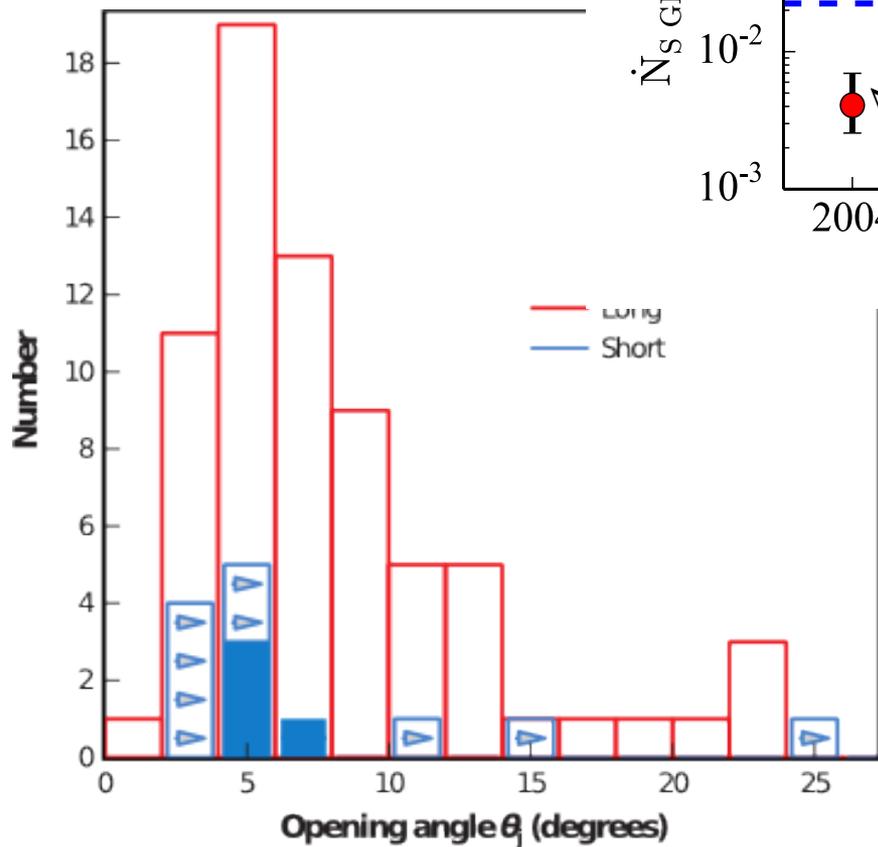
PSYCHE

Predict the emission of the ENTIRE GRB population (GRB+Orphans)

1. Luminosity Fct + formation rate(z)
2. Distrib (log-normal) Γ_0 and ϑ_{jet}
3. Randomly oriented in the sky

Population

SYnthesis

Code

and

Hydrodynamic

Emission model

1. Obs rate of GRBs (Swift, Fermi, Batse)
2. Fluence distributions
3. Ep-Eiso correlation (rest frame)
4. Ep,obs-fluence plane

5. Optical
6. X-ray
7. Radio

Macro-physical param

$$z, E_k, \Gamma_0, \theta_{jet}, \theta_{view}$$

Micro physical param

$$n, \epsilon_e, \epsilon_B, p, k$$

A. Canova (Louvre)

Ghirlanda+2012, MNRAS; Ghirlanda+2013, MNRAS; Ghirlanda+2014,PASA; Ghirlanda+2015, A&A
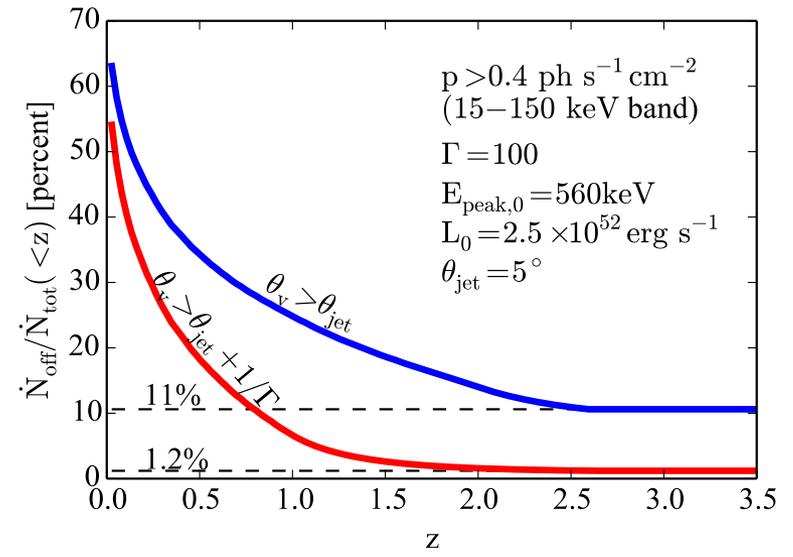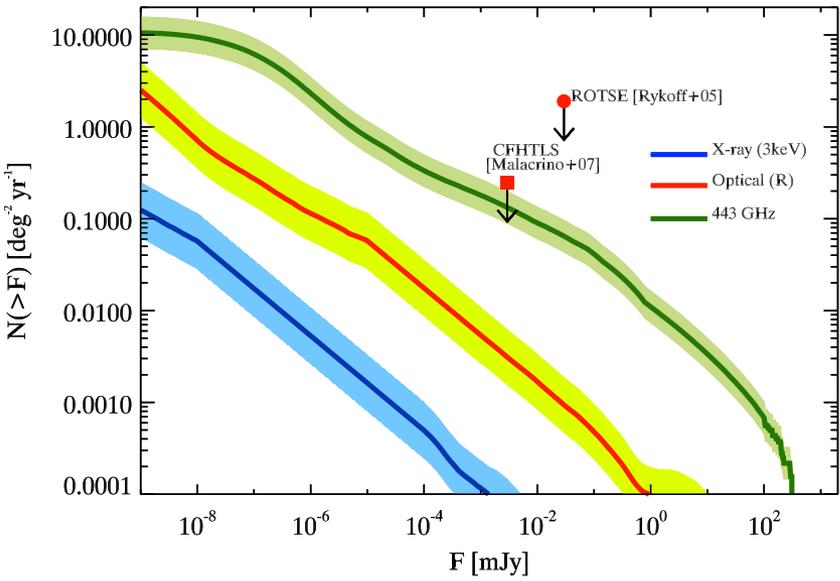
Salafia+2016
Salafia+2015 (structured jet)

Short PSYCHE … in progress
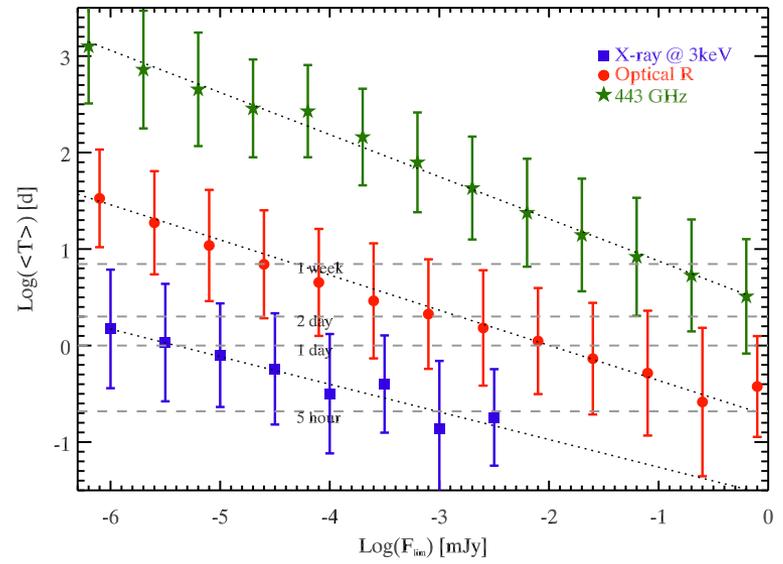
Ghirlanda+2014,2015

Current projects on SGRBs
[Milano group: Campana, Colpi, Covino, D'Avanzo, Ghirlanda, Ghisellini, Melandri, Nappo (PhD), Pescalli (PhD), Salafia (PhD), Salvaterra, Tagliaferri]

- Properties of the population of SGRBs (on-off/axis)
- Jet properties and structure
- Progenitor – SGRB connection (link bwt theory and obs)
- Parameter space (energetics, environment, jets, host galaxies)
- Increase the small sample (mainly need redshift and multi-λ follow up)

What GW can tell about GRB progenitors/central engine ?
1) Jet properties (structure and angle)
2) Masses of the progenitors (from GW power)
3) Orbit inclination
4) Spin
5) … several events … population properties
6) Evolution and formation of the progenitors (i.e. also disentangling different progenitors channels)
7) Standard sirens
8) Link between theory/observations and simulations