Gamma-Ray Burst Science with LOFT

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INTRODUCTION

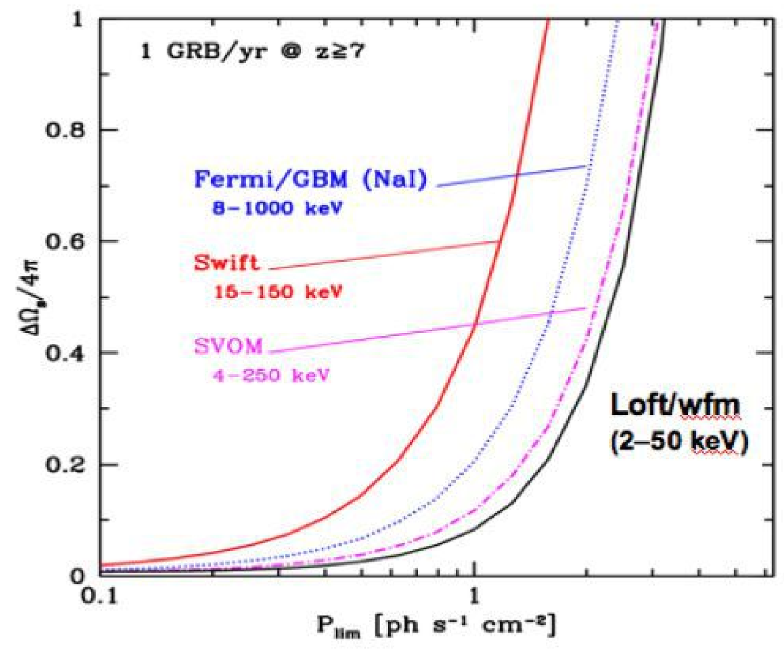
Despite of huge advances occurred in the last 15 years, the Gamma-ray Bursts (GRB) phenomenon is still far to be fully understood. Open issues include: physics and geometry of the prompt emission (burst), unexpected early afterglow phenomenology (e.g. plateau phase, flares), identification and understanding of sub-classes of GRBs (short/long, XRFs, sub-energetic GRBs), GRB/SN connection, VHE emission, nature of the inner engine, cosmological use of GRBs, and more.

LOFT will give us useful and unique clues to some of these still open issues, through two main achievements:

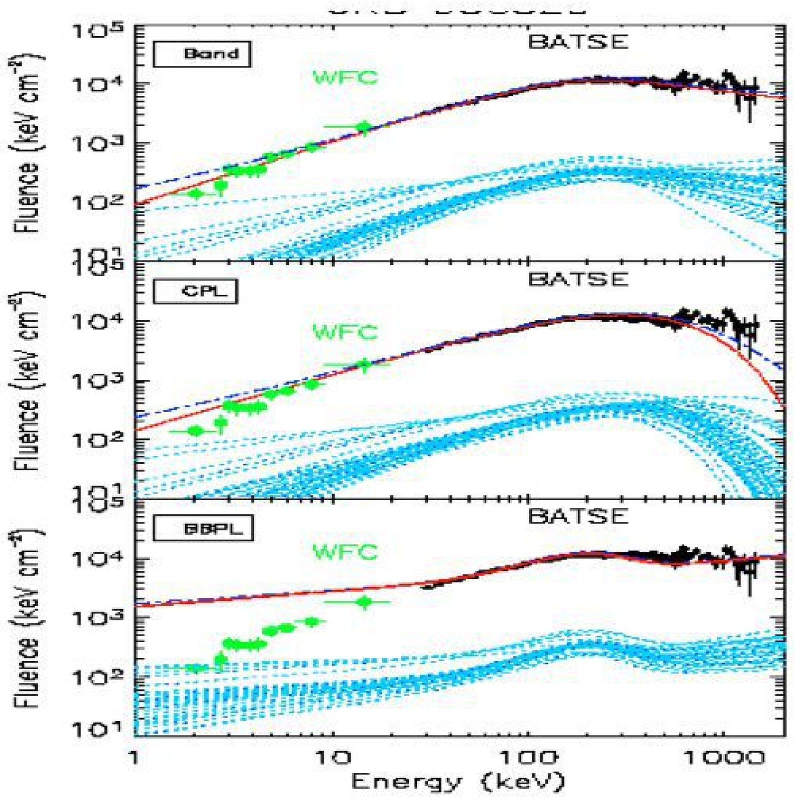
1. **Measures of the prompt emission down to 1-2 keV with 200-300 eV energy resolution and a few arcmin localization with the Wide Field Monitor (WFM) and arcmin localization with the Wide Field Monitor**
2. **Measures of the early afterglow emission with the Large Area Detector (LAD)**

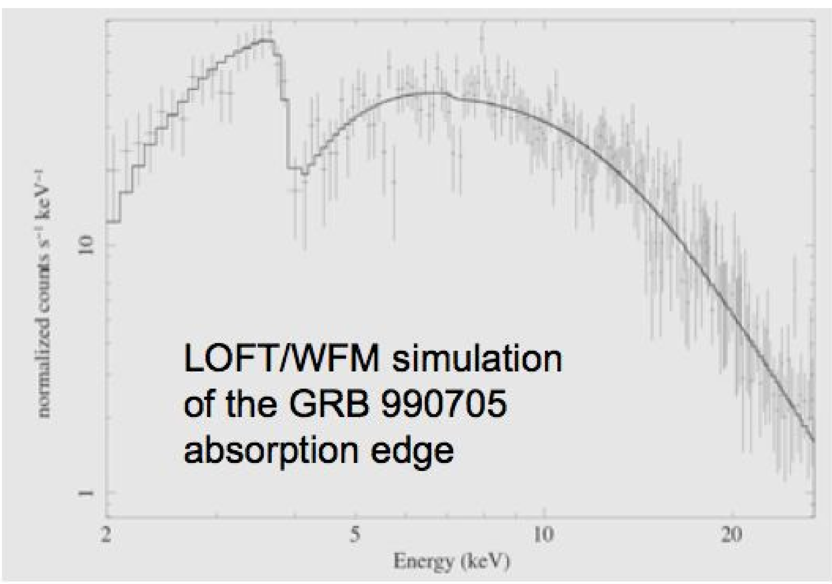
1.GRB Science with the WFM: measurements of the prompt emission down to few keV (with high sensitivity and large FOV)

i) Extend the GRB detection up to very high redshift (z>8): this will enable to study of the evolutionary effects, trace the star formation rate up to dark ages and possibly unveil population III stars (Figure adapted from Salvaterra et al. 2008)

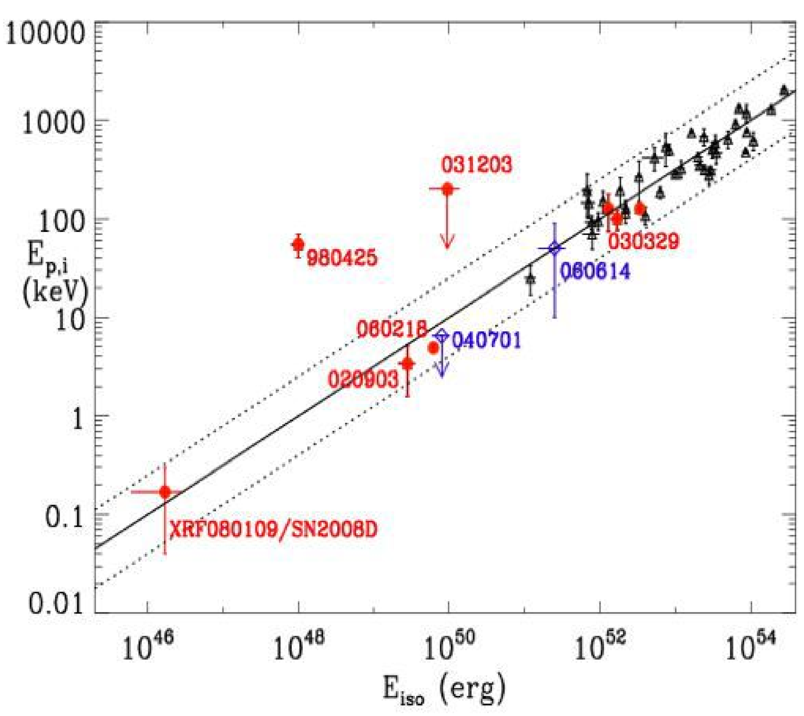


ii) Constrain the soft part of the GRB energy spectra down to 1 keV will enable to test different models proposed to explain the GRB prompt emission, today still unsettled, like the inconsistency at < 10 keV of a fraction of time resolved spectra with the predictions of the synchrotron shock model (e.g., Frontera et al. 2000) or with the simple BB + PL model (e.g., Ghirlanda et al. 2007; see figure).





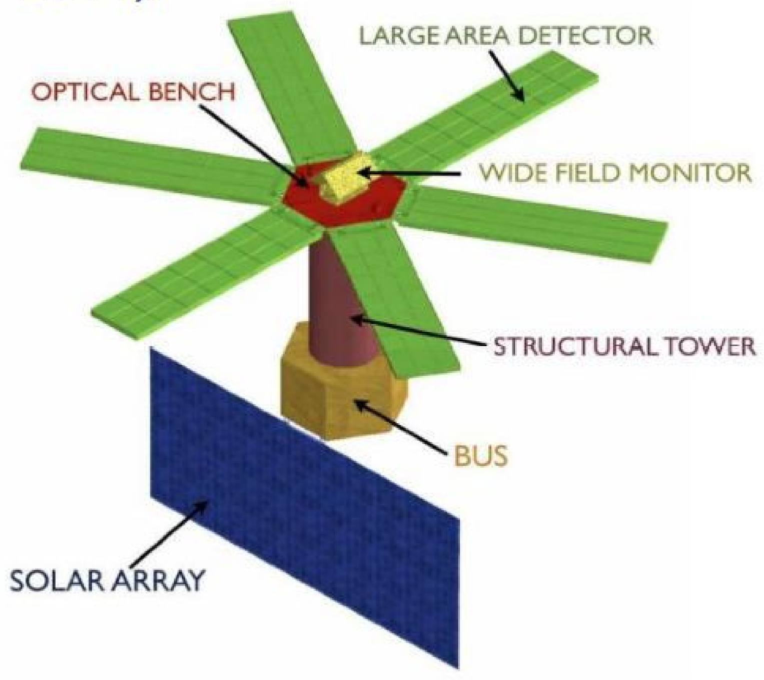
iii) Detect X-ray spectral features, probing the circumburst environment (density profile and chemical composition) and in turn the nature of the GRB progenitors, as well as providing optically independent redshift measures, as done with BeppoSAX/WFC with the transient absorption edge detected in the first 13s after trigger for GRB 990705 (Amati et al. 2000)

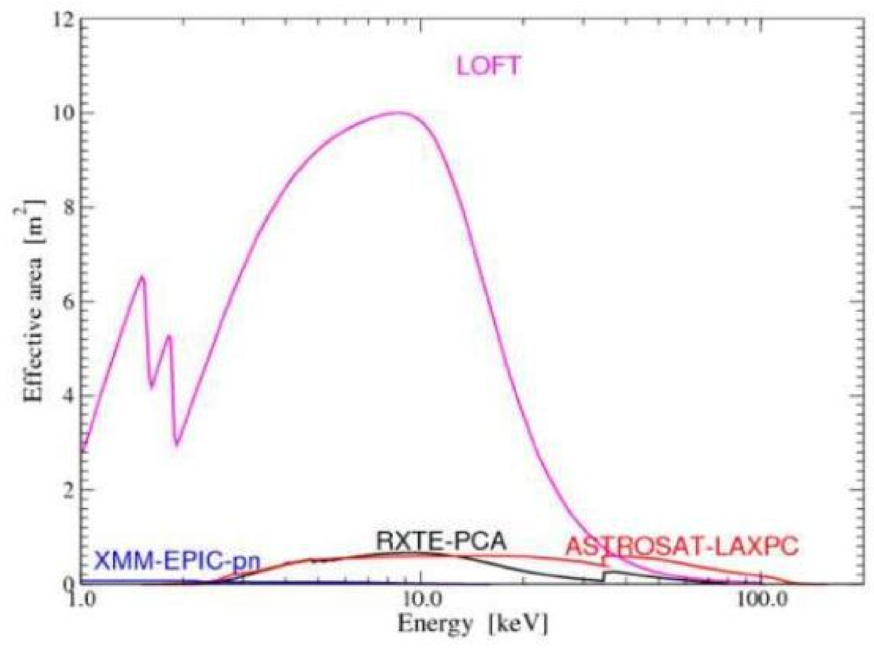


iv) Detect soft/long X-ray transients as GRB 060218 and XRF 080109), possibly solving the debate whether these are sub-energetic long GRB population or SN shock break out (Amati 2009)

Large Observatory For X-ray Timing (LOFT)

The Large Observatory For X-ray Timing, LOFT, was selected by the European Space Agency as one of the four Cosmic Vision M3 candidate missions to compete for a launch opportunity at the start of the 2020s. Thanks to an innovative design and the development of large-area monolithic silicon drift detectors, the Large Area Detector (LAD) on board LOFT will operate in the 2-30 keV range (up to 50 keV in expanded mode), and achieve an effective area of ~10 m2 at 8 keV, a time resolution of ~10 µs, and a spectral resolution of ~260 eV (FWHM at 6 keV) (Feroci et al. 2011).

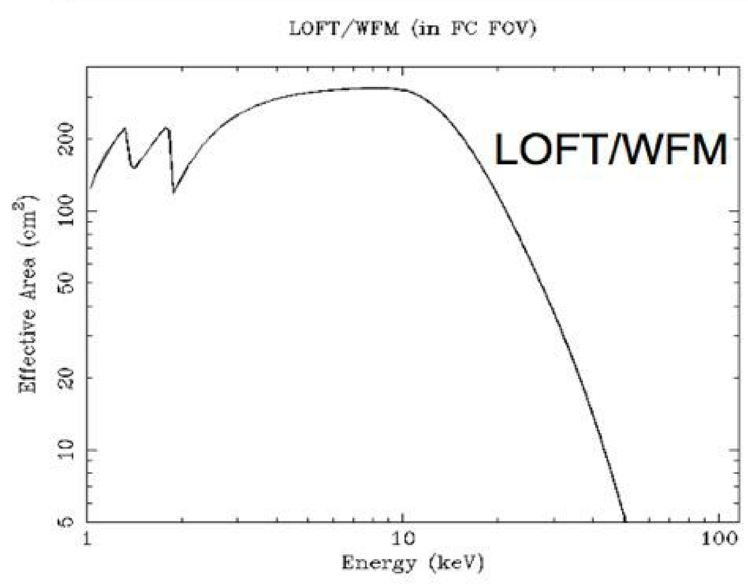


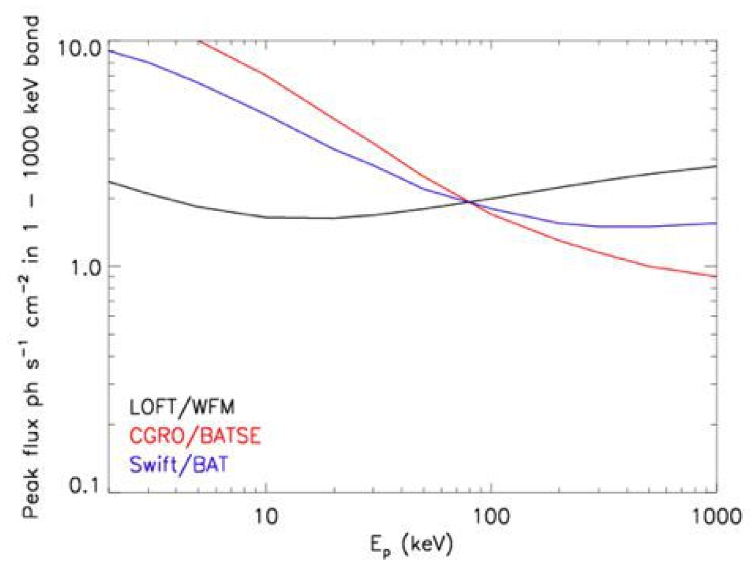


Left panel: Sketch of the LOFT satellite. The 6 deployable panels of the LAD, the WFM and the solar array are indicated. Right panel: effective area of the LOFT/LAD as a function of energy

The LOFT / Wide Field Monitor specifics (baseline configuration submitted to ESA)

Parameter	Single Unit	Overall WFM
Energy Range	2-50 keV	2-50 keV
Geometric Area	400 cm^2	1600 cm^2
Energy Resolution FWHM	< 350 eV	< 350 eV
Field of View Fully Coded	0.40 sr	0.80 sr
Partially Coded	2.90 sr	3.95 sr
Zero Response	118°	154°
Angular Resolution	5' x 2°	5' x 5'
Point Source Location Accuracy (10σ, 1D)	<1' x 20'	< 1'x1'
On-axis sensitivity at 5σ in 1 s	610 mCrab	430 mCrab
On-axis sensitivity at 5σ in 50 ks	2.7 mCrab	1.9 mCrab

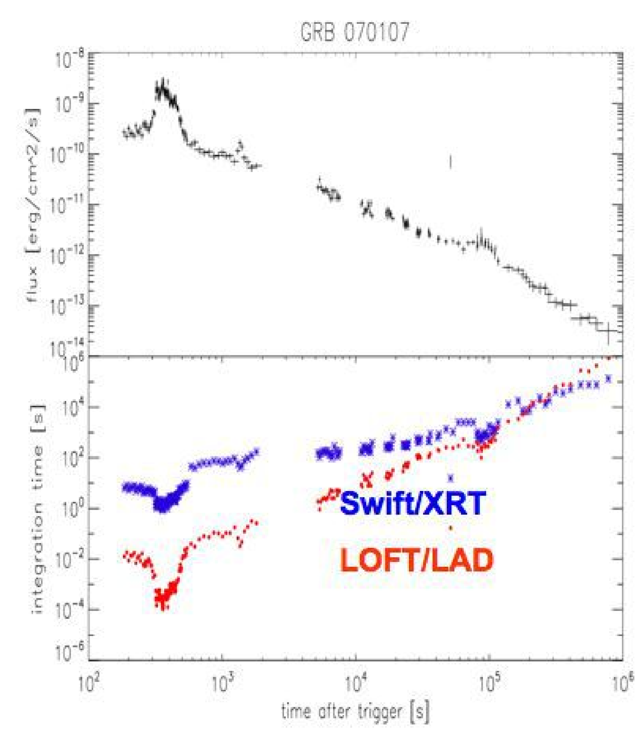




2. GRB Science with the LAD: measurements of the early afterglow emission

The Large Area Detector (LAD) observations of the X-ray afterglow will enable to investigate on the nature of the physical mechanism at the basis of the unexpected "plateau phase" still unexplained and possibly linked to prolongued activity of the central engine.

LAD will also complement the observations of the prompt emission by the WFM by exploiting the transparency of the collimator at energies > 30-40 keV



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CONCLUDING REMARKS

- LOFT will provide unique information for GRB science since no other present and/or future GRB mission (e.g. Swift, Konus/WIND, Fermi/GBM, MAXI) can observe GRB prompt emission down to few keV with high energy resolution and large FOV as WFM. Even in the past, BeppoSAX/WFC or HETE2/WXM had low energy threshold about 2 keV but with much worse energy resolution and smaller effective area and FOV. SVOM (2015->) will have low energy threshold of 4-5 keV but significantly worse energy resolution.
- LOFT will also provide arcmin localization of detected GRBs, allowing multi-band follow-up with ground and space based telescopes, the identification of the optical counterpart and/or the host galaxy and the redshift measure. Fast TDRSS-like link would be a fundamental service to the GRB community, given that neither Swift or SVOM are expected to be still operative in the > 2022 timeline. It would increase rate and reduce bias of redshift estimates, allow broad-band study of GRBs starting from prompt emission and provide trigger for GW detectors.