Update contributo ICRC GRB

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PROCEEDINGS OF SCIENCE

Prospects for Gamma-Ray Bursts detection by the Cherenkov Telescope Array

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Descrizione del progetto

The first Gamma-Ray Burst catalog presented by the Fermi-LAT collaboration includes 28 GRBs, detected above 100 MeV over the first three years since the launch of the Fermi mission. However, more than 100 GRBs are expected to be found over a period of six years of data collection thanks to a new detection algorithm and to the development of a new LAT event reconstruction, the so-called "Pass 8". Our aim is to provide revised prospects for GRB alerts in the CTA era in light of these new LAT discoveries.
We focus initially on the possibility of GRB detection with the Large Size Telescopes (LSTs). Moreover, we investigate the contribution of the Middle Size Telescopes (MSTs), which are crucial for the search of larger areas on short post trigger timescales. The study of different spectral components in the prompt and afterglow phase, and the limits on the Extragalactic background light are highlighted. Different strategies to repoint part of – or the entire array – are studied in detail.

- Update rispetto ai lavori presenti attualmente in letteratura (Inoue et al. e Gilmor et al.)
  1. Partire dai GRB rivelati da Fermi
     - Burst con redshift più brillanti di GBM
     - Burst con redshift più brillanti sopra i 10 MeV (GBM-LLE)
     - Burst con redshift più brillanti sopra i 100 MeV
     - Miglioramento grazie alla nuova ricostruzione degli eventi LAT (Pass 8)

Partire da un sample di GRB molto più promettente che in passato!

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- Update rispetto ai lavori presenti attualmente in letteratura (Inoue et al. e Gilmor et al.)
    2. Studiarne l'estrapolazione sia durante la fase iniziale (prompt) che durante la fase temporalmente estesa (afterglow).
        - Studio dettagliato dei vari parametri spettrali in ogni fase, in particolare dell'indice beta per la funzione Band nel prompt e dell'index alpha per le PL nell'afterglow [dN/dE ∞ $E^{-\alpha}$]
        - Per l'andamento temporale, si applica la relazione dN/dt ∞ $t^{-\gamma}$. Anche gamma si può ricavare dai dati LAT.

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3. Includiamo l'effetto di attenuazione dell'EBL

4. Studiamo diverse possibilità di osservazione da parte di CTA

Outline del proceeding

- Introduction
  - Sui GRB, molto generale
- CTA telescope configurations
  - Spiegazioni telescopi, molto generale
- High-energy GRB observations
  - Focalizzazione sui GRB visti da Fermi, ed in particolare sul GRB 130427A, che decidiamo di usare come "test case"
- Simulation of GRB observation with ctools
  - Spiegazione delle simulazioni
- Effect of the EBL
  - Spiegazione EBL, molto generale
- CTA operating modes
  - Dettagli dei vari modi di osservazione (parallel, convergent, divergent)

GRB 130427A: Si parte dal paper di VERITAS

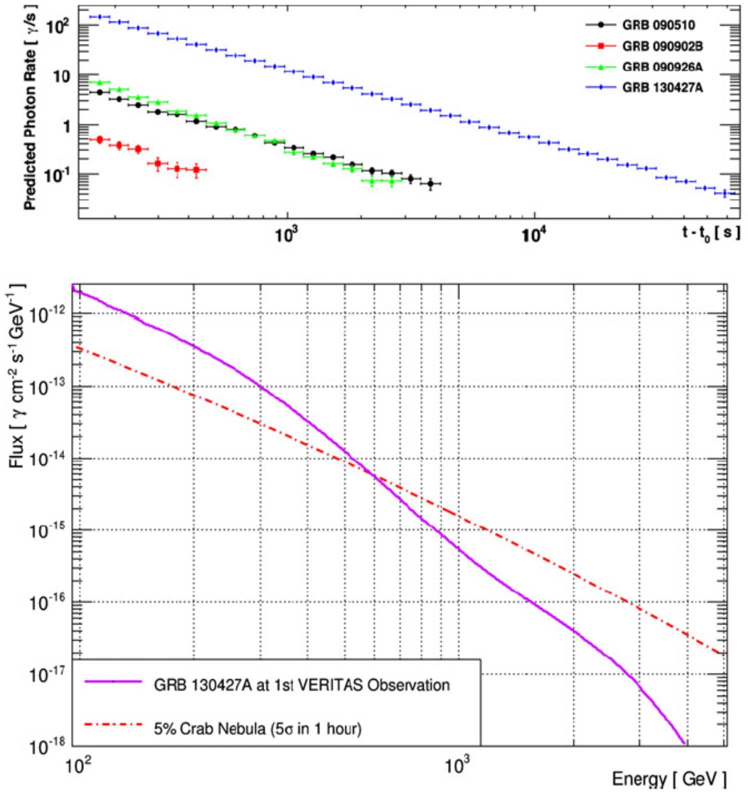

Figure 1. Upper panel shows predicted light curves for several fluent, LAT-detected GRBs: GRB 090510 (De Pasquale et al. 2010), GRB 090902B (Abdo et al. 2009), GRB 090926A (Ackermann et al. 2011), and GRB 130427A (Ackermann et al. 2014), as they would be seen by VERITAS at energies greater than 100 GeV assuming an elevation of 70 deg. Each bin in the upper panel is derived from a figure similar to that in the lower panel, which is a detail of the photon flux extrapolated from LAT data of GRB 130427A (including EBL absorption) over the period of the first VERITAS observation (see Table 1). The red dashed-dotted line is 5% of the average Crab Nebula spectrum for reference. VERITAS is capable of detecting a 5% Crab Nebula source over the duration of the first GRB 130427A observation (~1 hr). The lack of a detection by VERITAS suggests the presence of a spectral and/or temporal cutoff at high energies and late times, respectively.

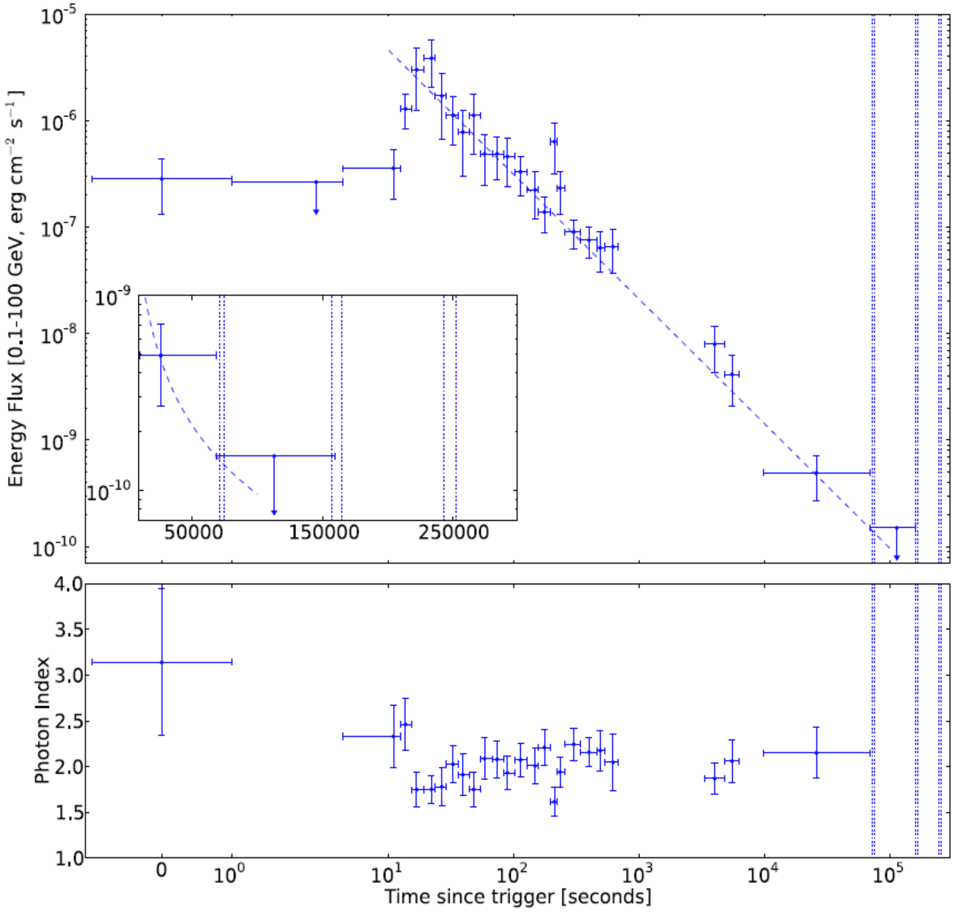

Figure 2. Upper panel shows the 0.1–100 GeV light curve for GRB 130427A as measured by the LAT. The dashed line is a power-law fit to the light curve. The lower panel shows the LAT-measured photon index. These data have been shown previously in Ackermann et al. (2014). The vertical dotted lines indicate the times of the three VERITAS observations given in Table 1. The inset details these observations.

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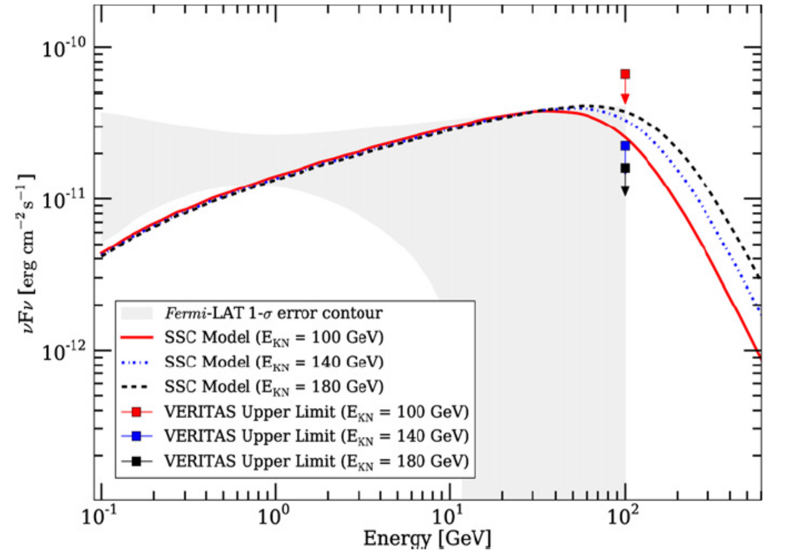
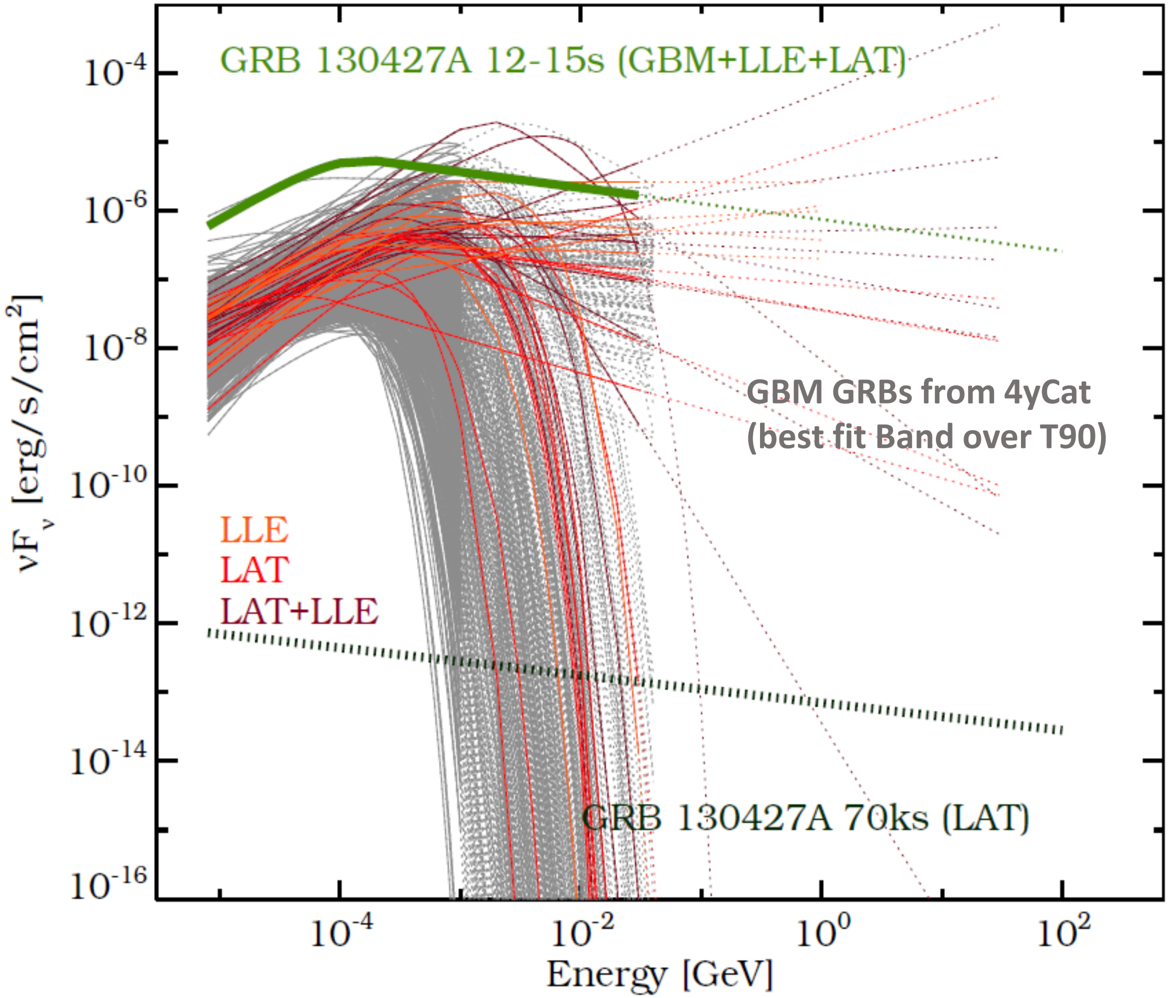


Figure 3. Joint VERITAS-LAT spectral energy distribution. The VERITAS upper limits are calculated assuming an SSC model (Sari & Esin 2001) with an electron spectrum $(dN/dE) \propto E^{-2.45}$ and breaks at 100, 140, and 180 GeV (solid, dot-dashed, and dashed lines). The electron energy distribution is determined from the LAT-measured spectrum, as described in the text. This SED is then absorbed using the EBL model of Gilmore et al. (2009). The LAT data are best fitted with a power law with an index of 2.2 ± 0.2. The gray shaded region (the "bowtie") shows the one-sigma range of power-law models compatible with the LAT data after extrapolating from the last LAT time bin (10 ks to 70 ks) into the VERITAS observing time (71 ks to 75 ks) using the photon flux relation $(dN/dt) \propto t^{-1.35\pm0.08}$, which was obtained from fitting the late-time LAT data (Ackermann et al. 2014). The electron spectral index of the SSC models is determined from the error-weighted mean of the late-time spectral and temporal indices measured by the LAT.

Extrapolation of the prompt emission's spectrum



Simulazioni con I ctools

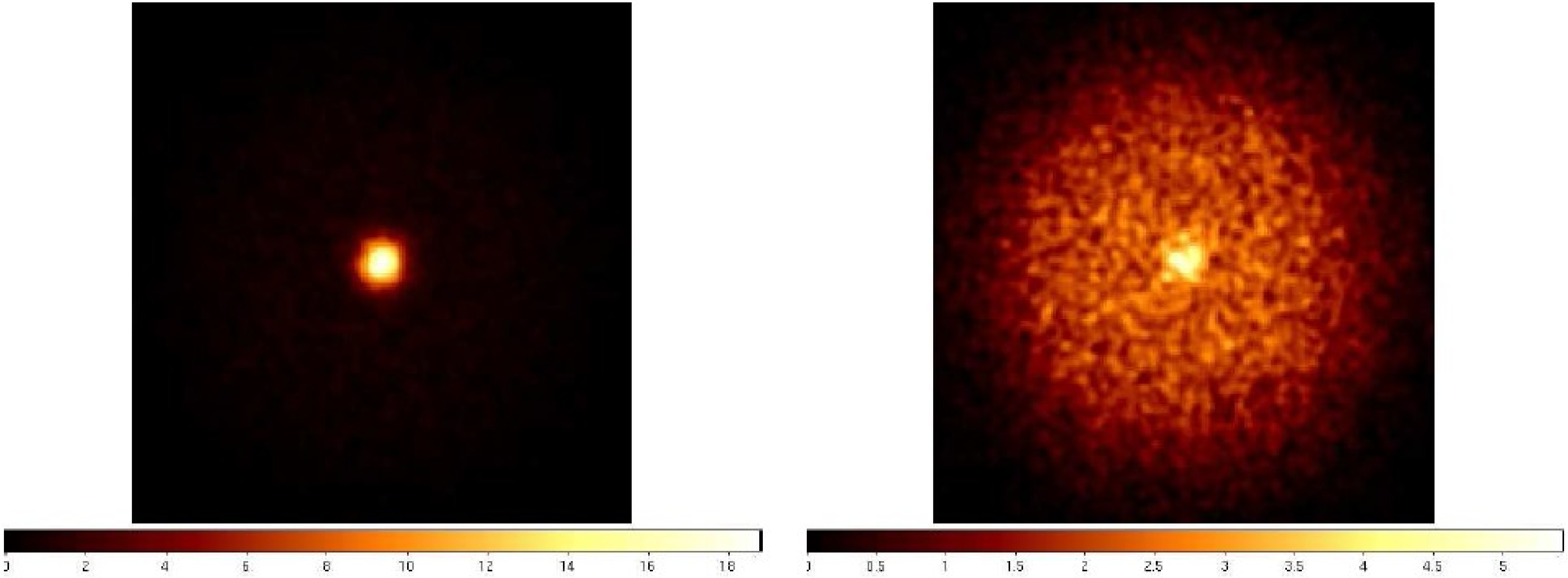


Figure 1: Simulation of GRB 130427A with ctools. *Left panel*: Counts map of GRB 130427A as seen by CTA North in 600 s, after 1000 s of the trigger in the energy range 20 GeV–100 GeV; *Right panel:* Counts map of GRB 130427A as seen by CTA North in 1800 s, after 10000 s of the trigger in the energy range 20 GeV–100 GeV

To di list

Entro ICRC

- Inserire l'EBL absorbtion nello spettro (e/o nelle Aeff)
- Vedere se ripetere lo studio per 130427A anche per altri GRB molto brillanti (magari evitando i più «famosi» giù utilizzati da altri

Progetto futuro:

- Analizzare un buon numero di eventi
- Cambiare i modi di osservazione
- Scrivere un paper in tempi “brevi”

Ctools

CTA people - INFN Bari

Leonardo di Venere, Francesco de Palma, Francesco Giordano

Ctools

- Ctools-00-08-01
- Irfs: cta-caldb-20150220
  - 3 calibration database: tenerife, aar, aar500
  - 3 instrument response functions: DESY20140105_50h, DESY20140105_50h_0deg, DESY20140105_50h_180deg

- Fermi tools-like
- Ctobssim for data simulation (spectrum and spatial model in a specific energy range and time)
- Ctselect and ctbin for data selection and binning
- Ctlike for likelihood analysis (spectral and spatial parameters)

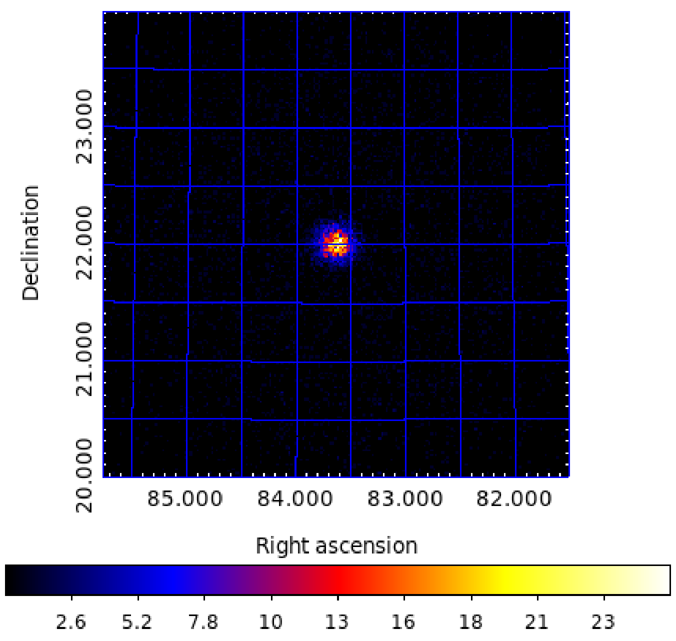
Crab simulation

- IRFs: tenerife – DESY20140105_50h (other IRFs to be tested)
- Spectrum: Power-law
- Spatial model: Point source and disk (radius 0.45°)
- Energy range: 100 GeV – 100 TeV
- Time of simulation: 3h

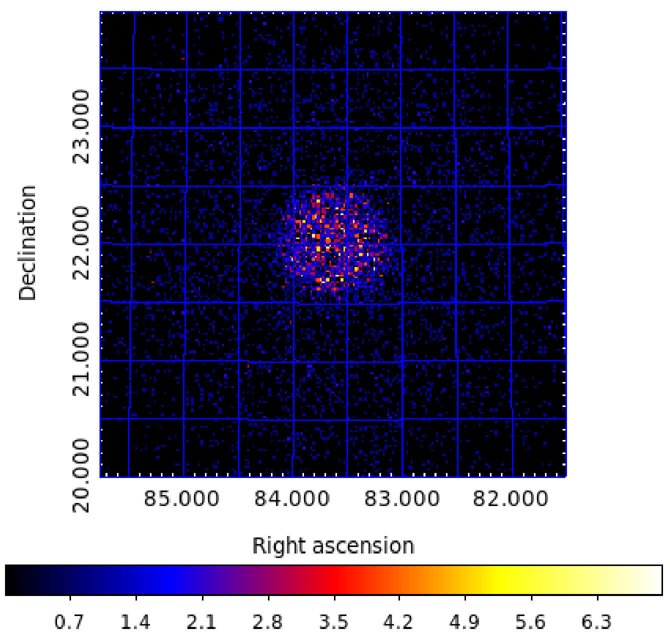
Crab simulation – counts map

Energy range: 100GeV- 140 GeV

Point source



Disk (radius=0.45°)



Next steps

- Simulation of middle-aged SNRs: W44, IC443, W51 – known proton accelerators from Fermi-LAT and AGILE observations (*pion bump*)

- Understand difference between IRFs (??) and simulate with different configurations (pointing, background)

- Evaluation of time needed for the observation and check if it is in line with KSP 50h requirement