

# Search for signature of the LIGO gravitational wave events in SPI-ACS and GBM/Fermi

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EWASS 2017

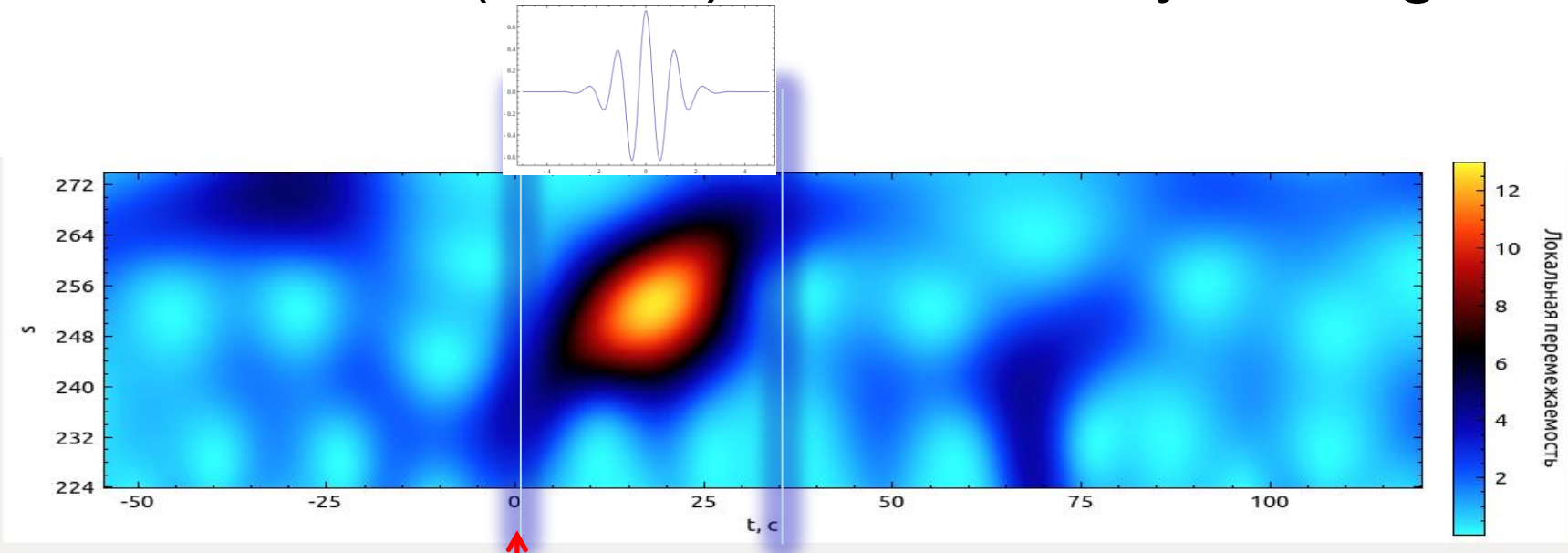
# Outline

- No evident GRB-like event is found for published LIGO GW150914, GW151226, LVT151012, GW170104
- Most sensitive omnidirectional GRB experiments = GBM/Fermi and SPI-ACS/INTEGRAL
- Searching for quasi-periodic transient events
- Special case of GW150914
  - comparison of sensitivity for short GRBs
- How to reconcile GBM/Fermi and SPI-ACS observations?
- ~~• BH-BH merging: what could be a model EM-emission?~~

# Searching for quasi-periodic transient events

- As a part of time series investigation we developed a code for continuous search QPO-like events localized in time.
- We apply the code to SPI-ACS ...

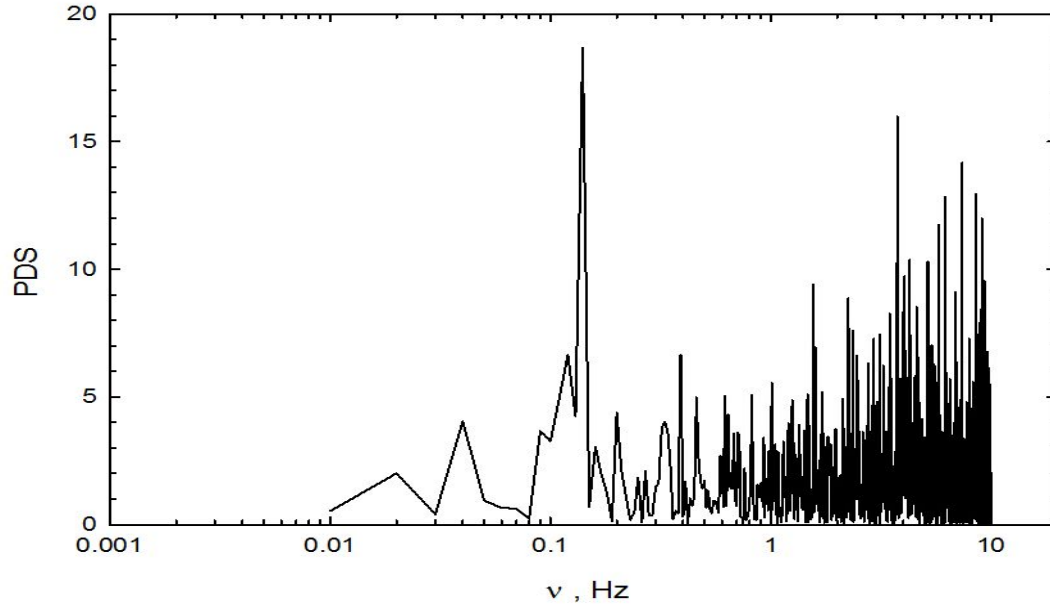
# SPI-ACS/INTEGRAL GW 150914 wavelet (Morlet) intermittency scalogram



GW150914

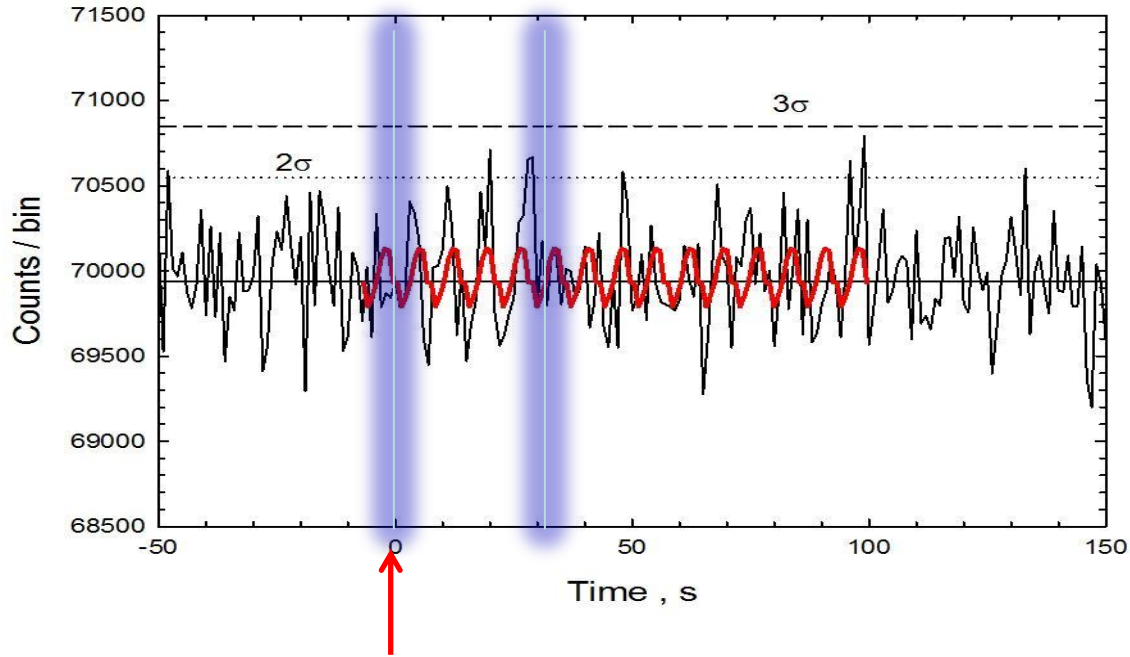
# Power Density Spectrum

$P = 7.1 \text{ s}$



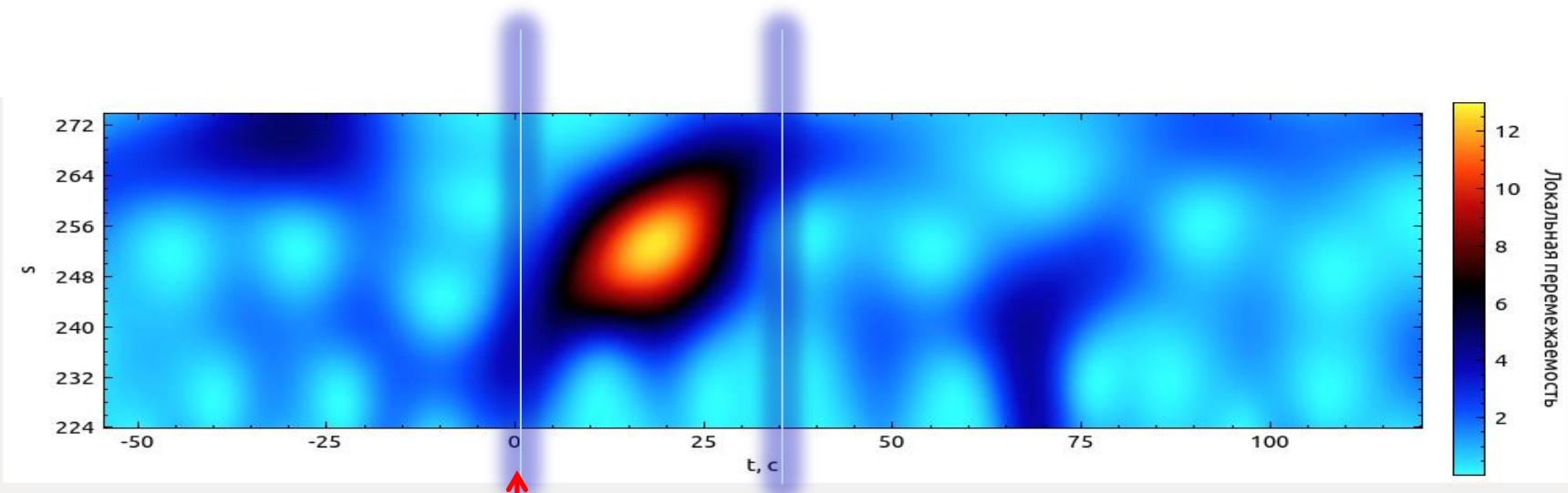
# SPI-ACS time profile

## $P=7.1$ s



GW150914

# SPI-ACS/INTEGRAL GW 150914-QPO wavelet (Morlet) intermittency scalogram



GW150914

# Chance probability?

$1 \times 10^{-5}$  –  $2 \times 10^{-4}$ , depending on the estimating procedure



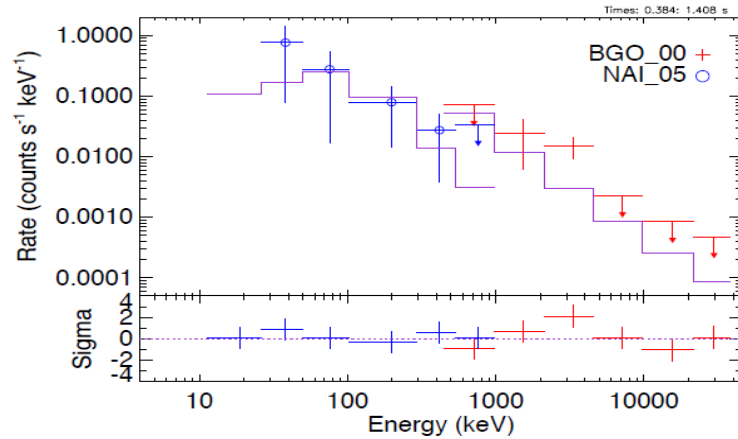
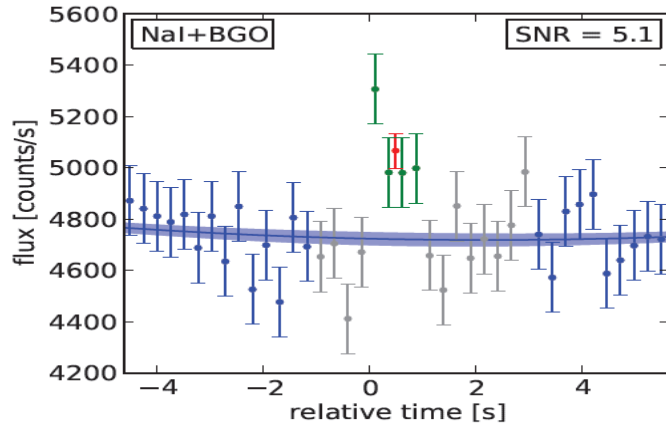
# GBM/Fermi scalogram?

- No significant feature analogous to GW 150914-QPO is detected in GRB/Fermi data at time of GW 150914-GBM

# GRB/Fermi GW 150914-GBM

(Connaughton+, 2016)

GBM detectors at 150914 09:50:45.797 +1.024s



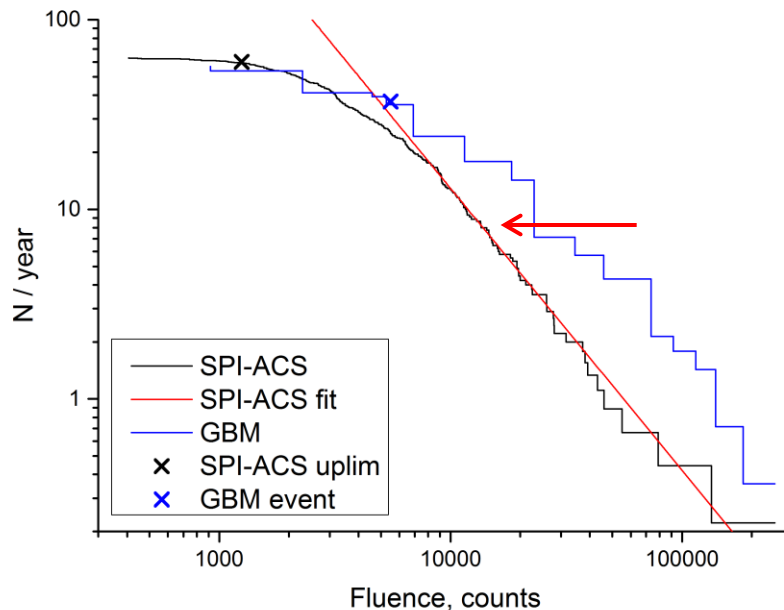
# GW 150914-GBM

- A typical short GRB?
- Should be detected by SPI-ACS?
- GW 150914-GBM may be detected by SPI-ACS at  $\sim 5\sigma$  based on our statistical comparison (cf.  $15\sigma$  deduced by Savchenko+, 2016)

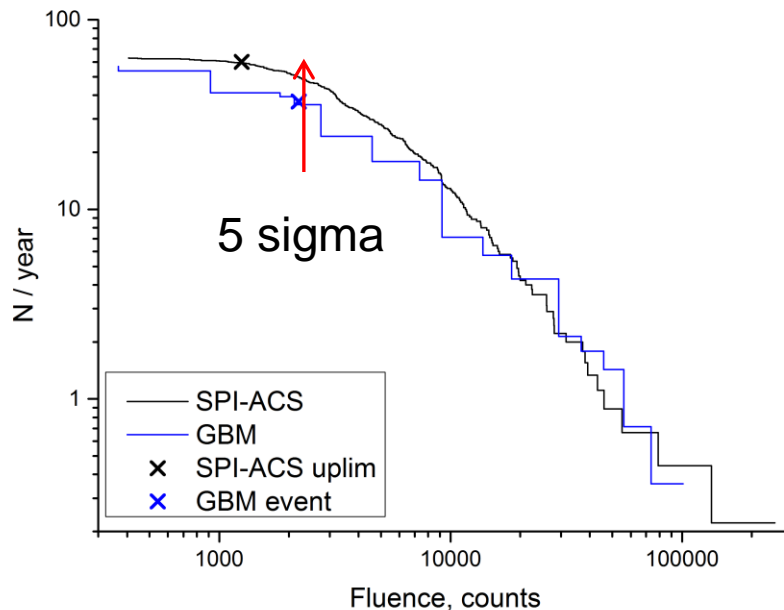
# Statistical SPI-ACS and GBM/Fermi sensitivity comparison

- SPI-ACS short GRBs sample
- Short GRBs of GBM catalog
- $\text{Log}N - \text{Log}S$  normalization assuming parent population is the same for both experiment

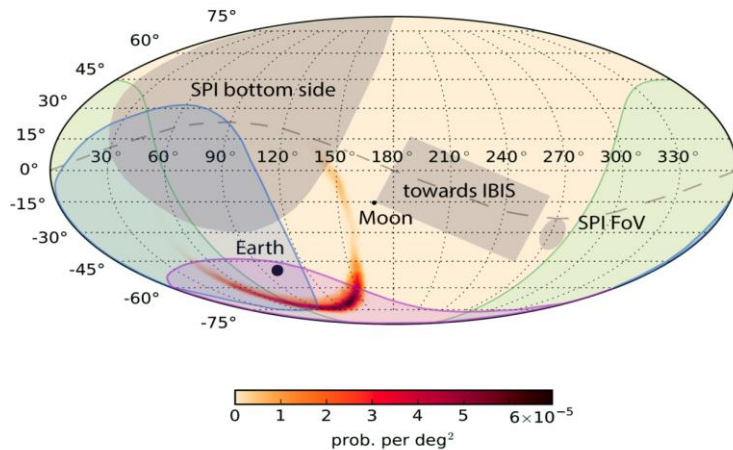
# Statistical SPI-ACS and GBM/Fermi sensitivity comparison



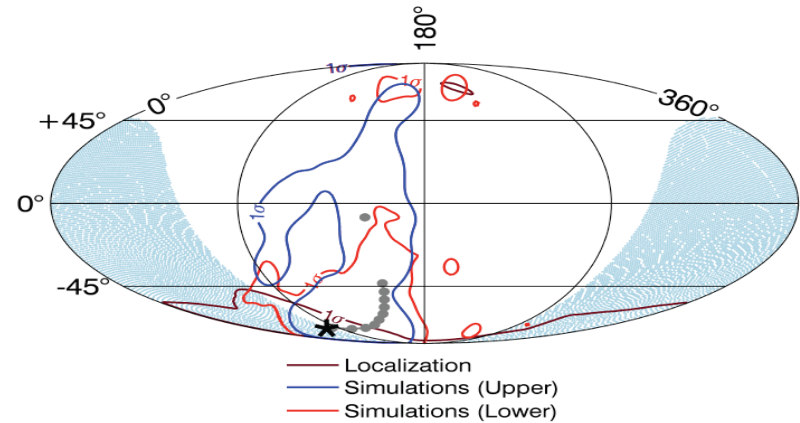
# Statistical SPI-ACS and GBM/Fermi sensitivity comparison



# SPI-ACS/INTEGRAL sky map



# Localization of GW 150914-GBM (Connaughton+, 2016)



# How to evenly reconcile GBM/Fermi and SPI-ACS observations? (0)

- Let suggest that GW 150914-GBM and GW 150914-ACS/QPO **are real astrophysical events**



# How to evenly reconcile GBM/Fermi and SPI-ACS observations? (I)

- GW 150914-GBM and GW 150914-ACS/QPO **have a different nature**
- **GW 150914-GBM** is a usual short GRB occulted by the Earth for SPI-ACS FOV and **not related to GW150914**
- **Actual position** of GW150914 EM counterpart (which registered as 150914-ACS/QPO) **is occulted by the Earth for GBM/Fermi**
- ***Complicated? But not impossible***

# How to evenly reconcile GBM/Fermi and SPI-ACS observations? (II)

- GW 150914-GBM and GW 150914-ACS/QPO **have the same nature**
- **GW 150914-GBM** is a short GRB related to **GW150914**
- GW 150914-ACS/QPO is **an extended emission** sometime observed after short GRBs
- For some reasons GBM/Fermi not detected GW150914-ACS/QPO and SPI-ACS not detected GW150914-GBM
- Actual position of GW150914 EM counterpart is significantly restricted by **small part of the LIGO localization error box**

# Thank you

