

Subtle Structure of Single Pulse and the Physics of Polar Gap

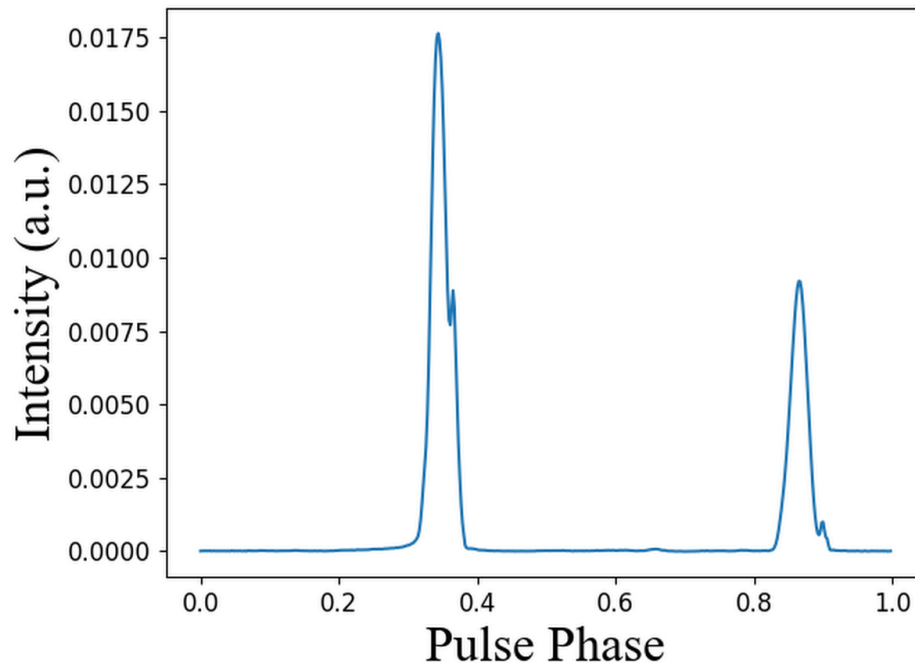
--Single Pulse of PSR B1937+21

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PSR B1937+21

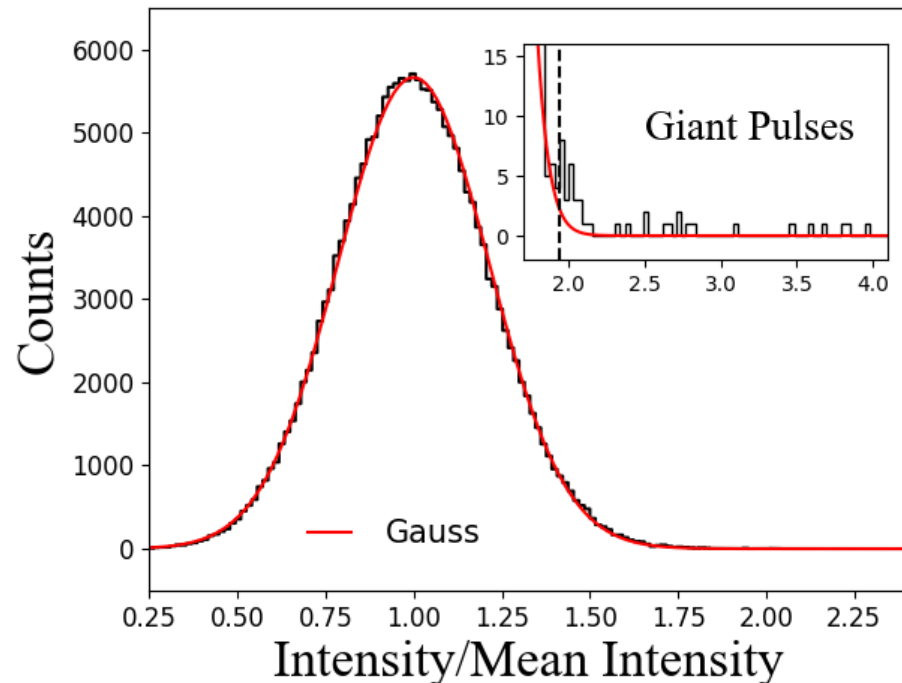
- FAST 19-beam
- 5 min observation
- Period=0.0015578 s
- DM=71.0237
- $n_{\text{period}} = 197119$
- $n_{\text{bin}} = 512$
- S/N=5760
- S/N of single pulse ~ 13



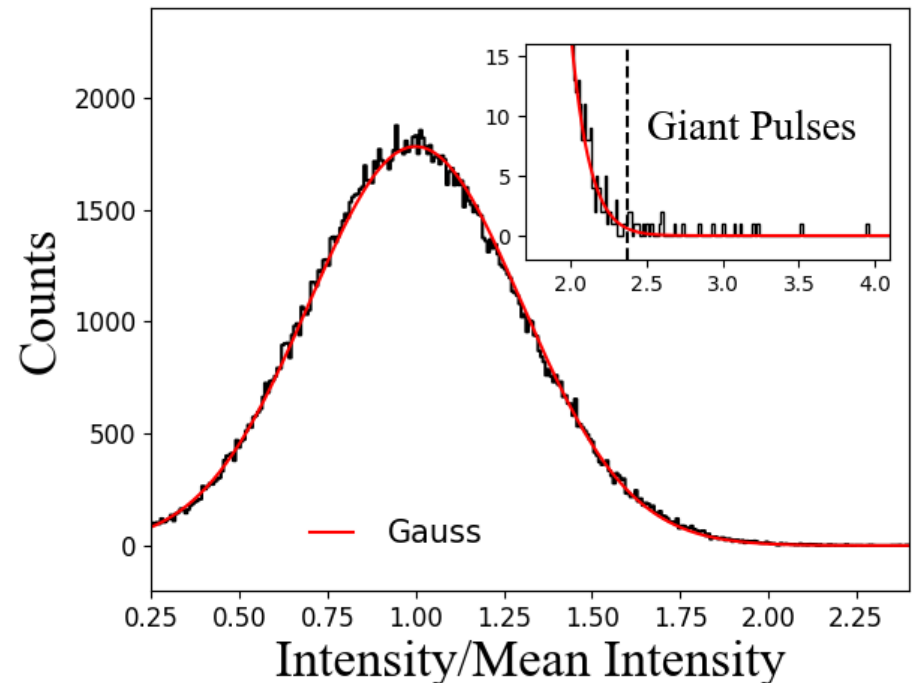
Statistics of Single Pulse Intensity

- The intensity of single pulse follows a Gaussian distribution.
- This may result from the law of large numbers.

Main Pulse



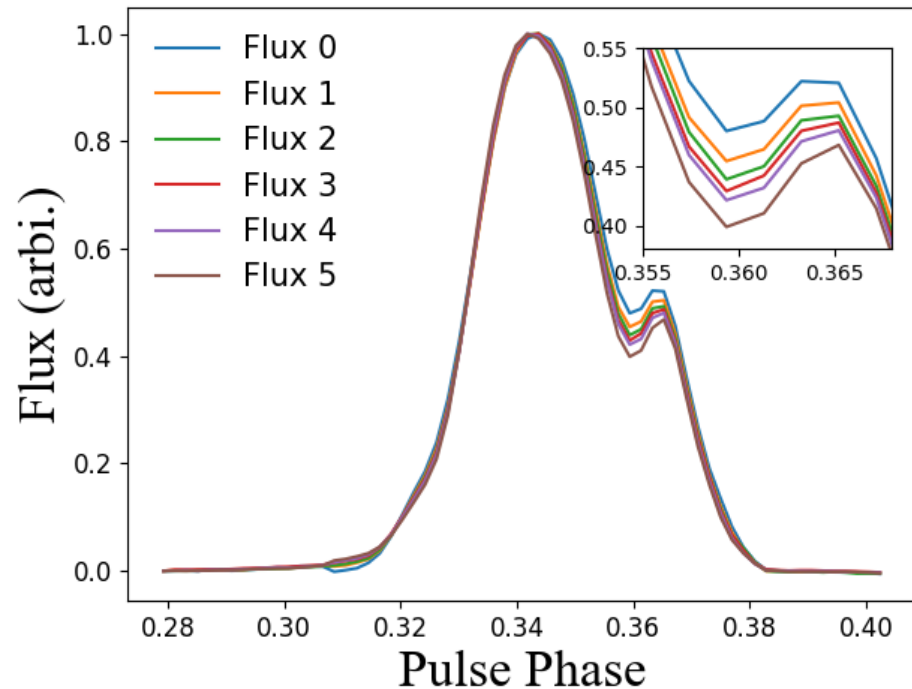
Inter Pulse



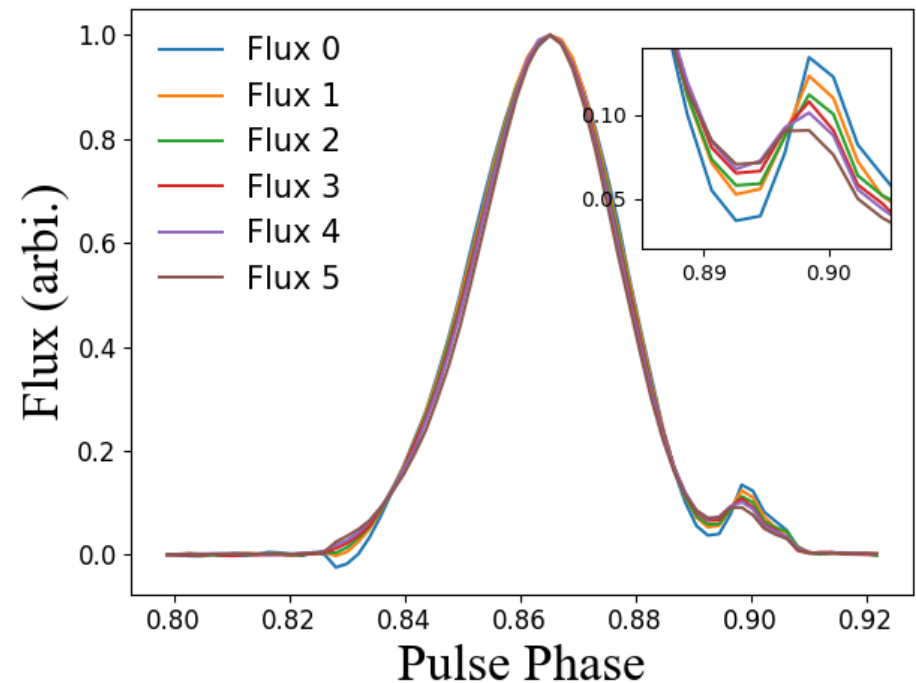
Intensity dependent Pulse Profiles

- The profile of lower intensity pulses is weaker in the bridge region between two peaks.

Main Pulse

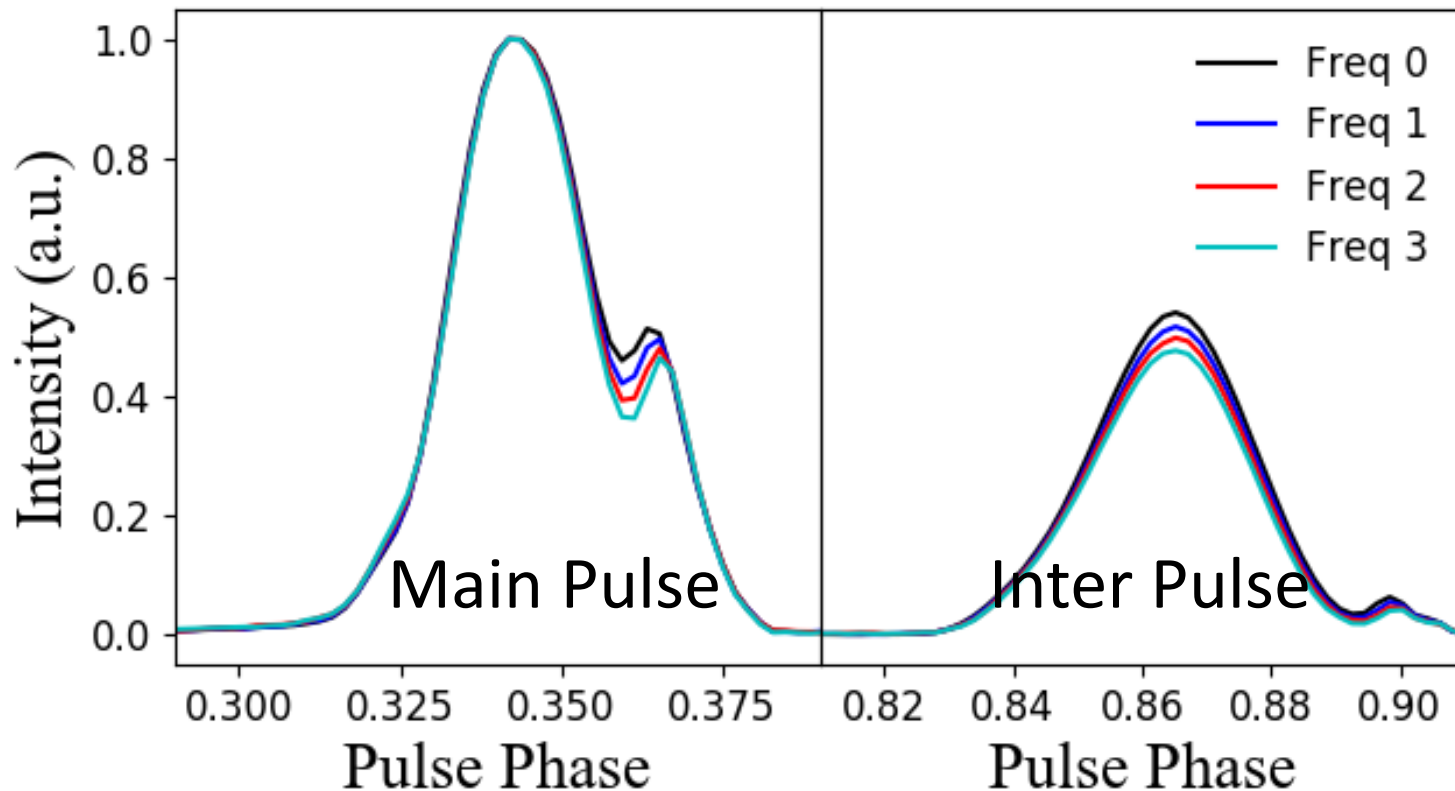


Inter Pulse



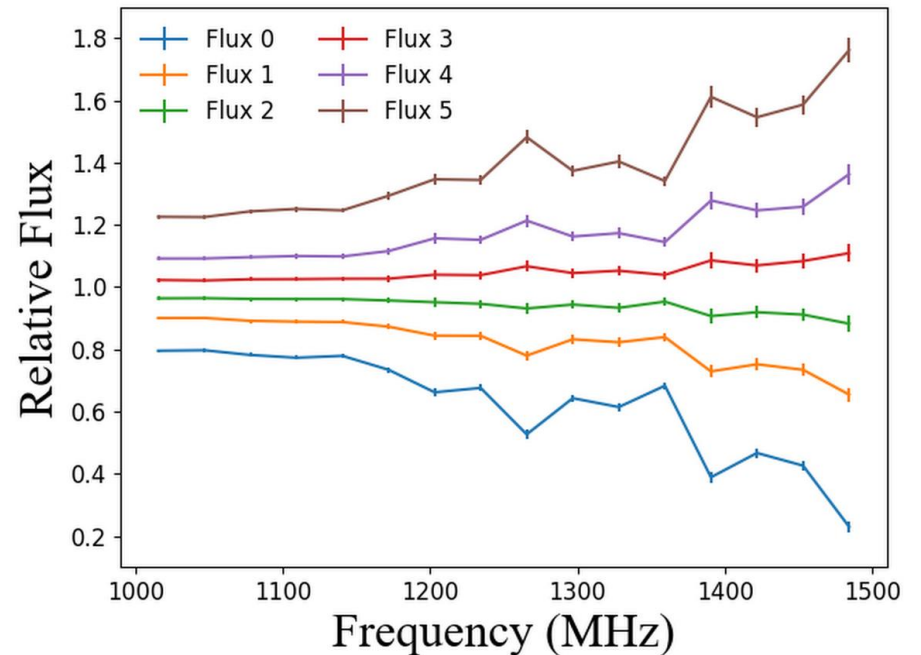
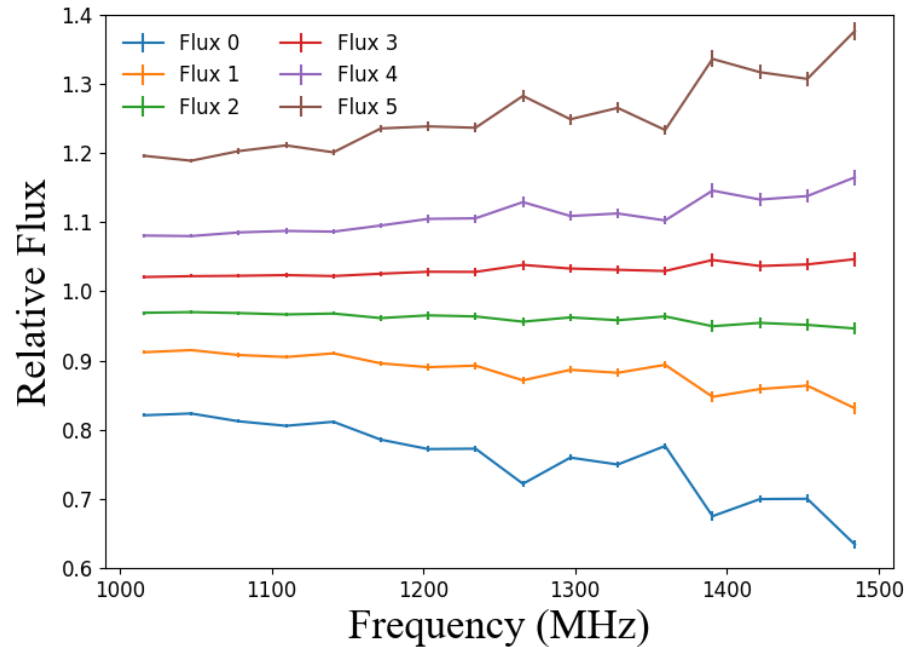
Multi-frequency Pulse Profiles

- Interestingly, profile evolves with frequencies show similar characteristics.
- It seems that weaker pulses have softer spectrum.



Relative spectrum of single pulses with different intensity

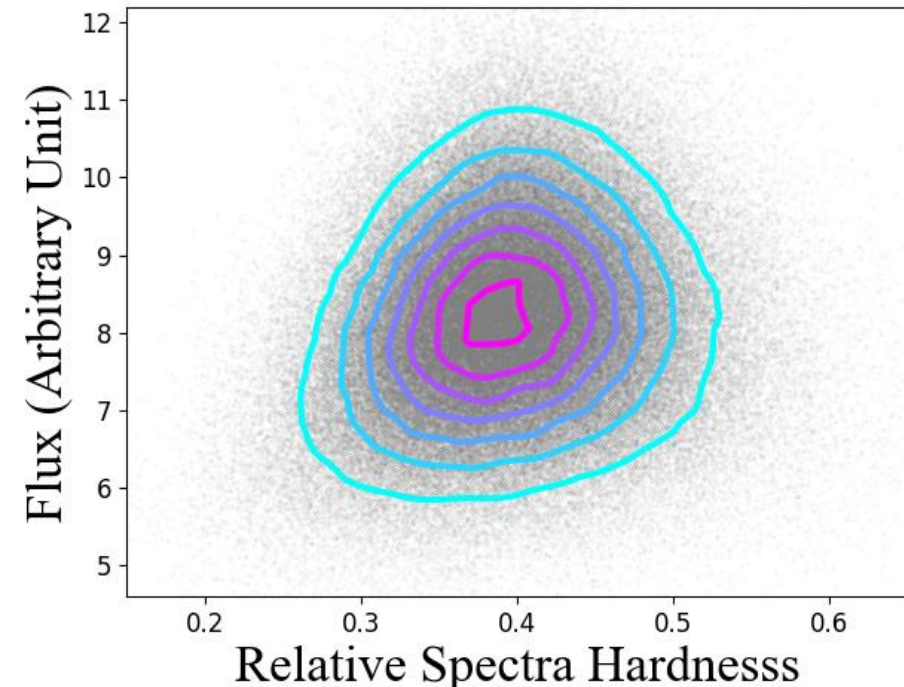
- Weaker pulses indeed have softer spectrum!



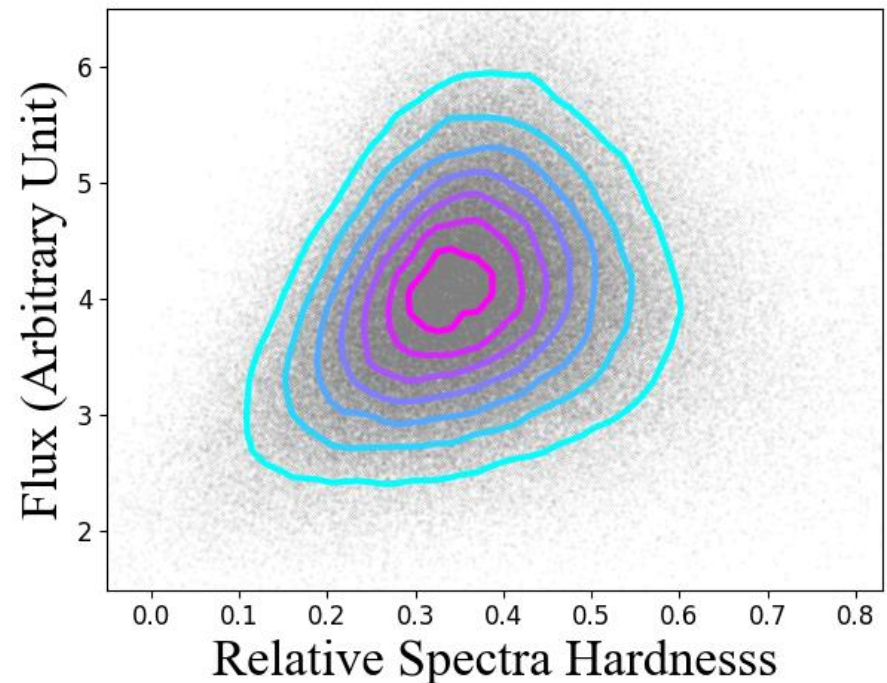
Single pulse intensity and spectrum hardness

- The triangle-shape distribution is confusing!

Main Pulse

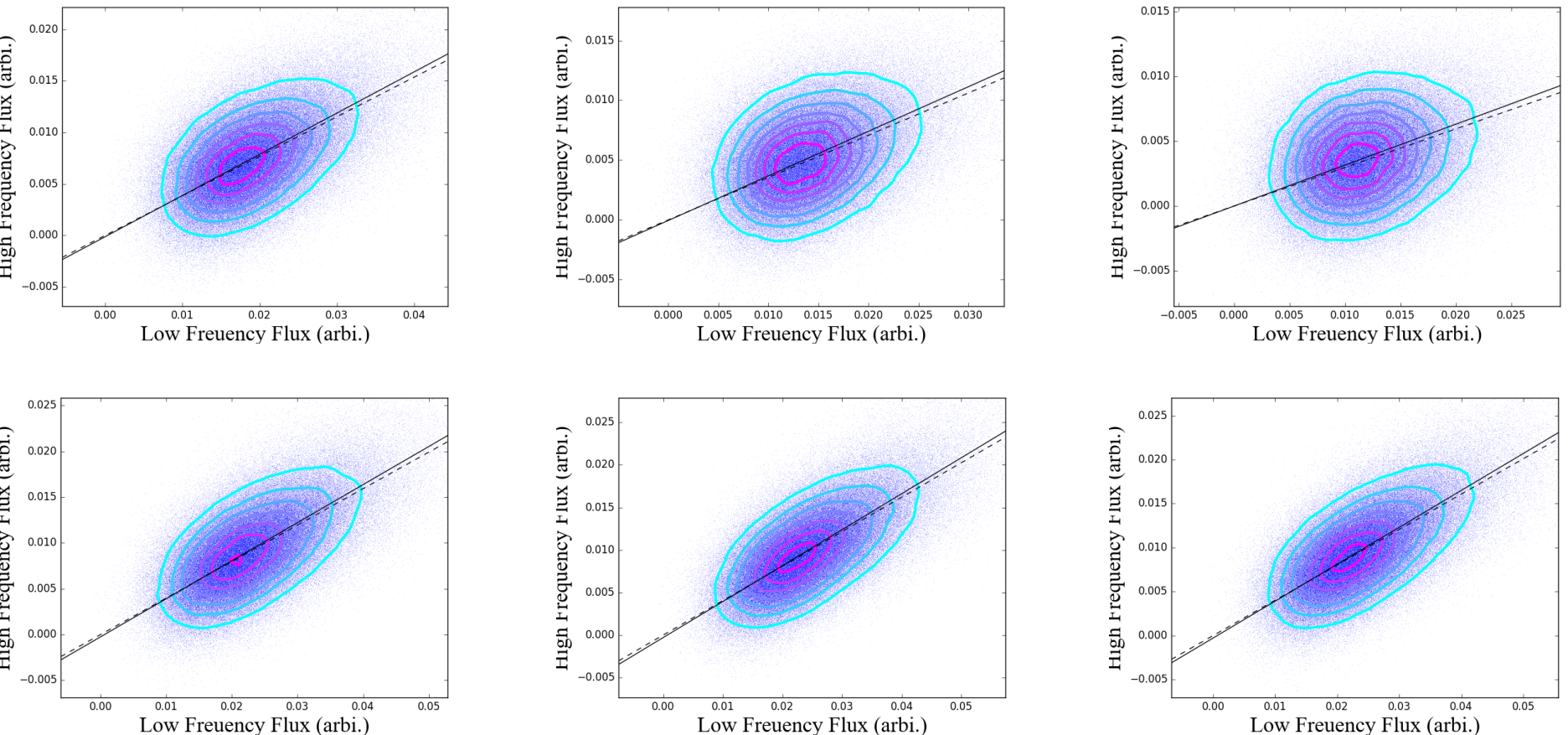


Inter Pulse



Single pulse intensity at different phase bin

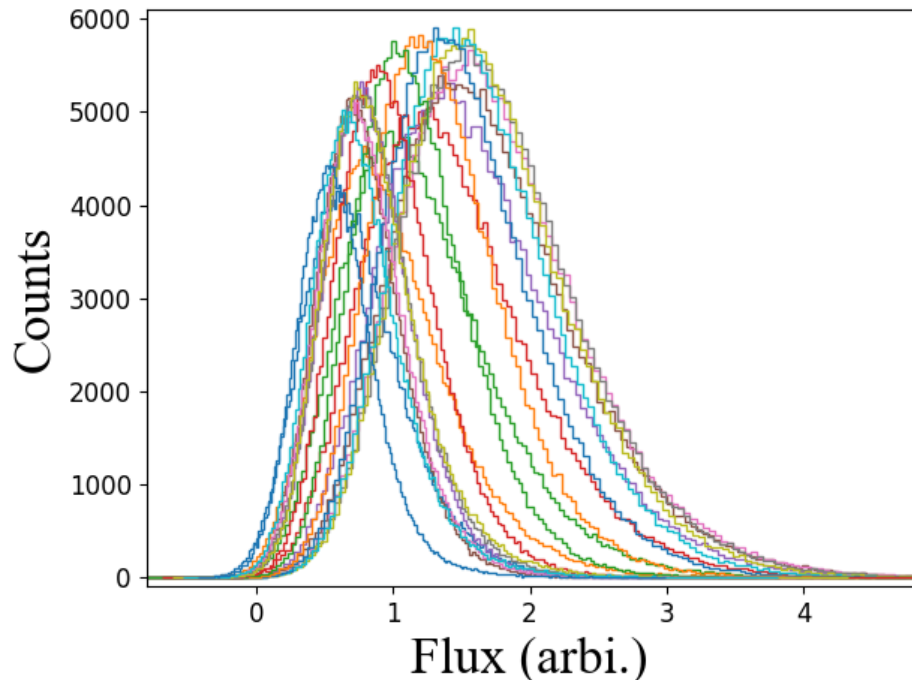
- The distributions of single pulse intensity



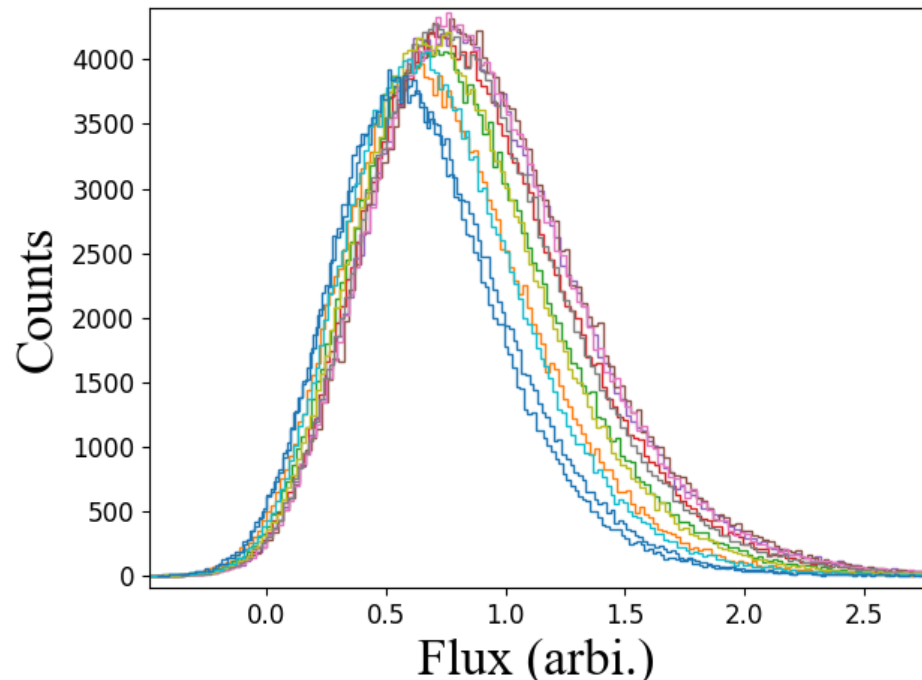
What is the distribution of the intensity within one phase bin?

- Low counts at 0-intensity implicate there may be multi-sparks-radiation recorded in one phase bin.
- The non-Gaussian distributions implicate intensity distribution of sparks.

Main Pulse

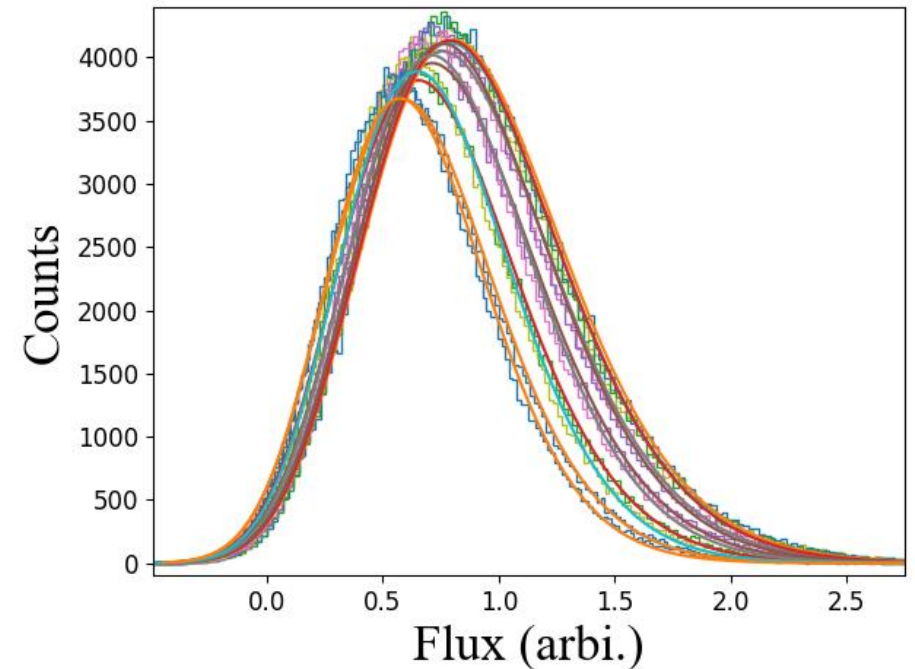
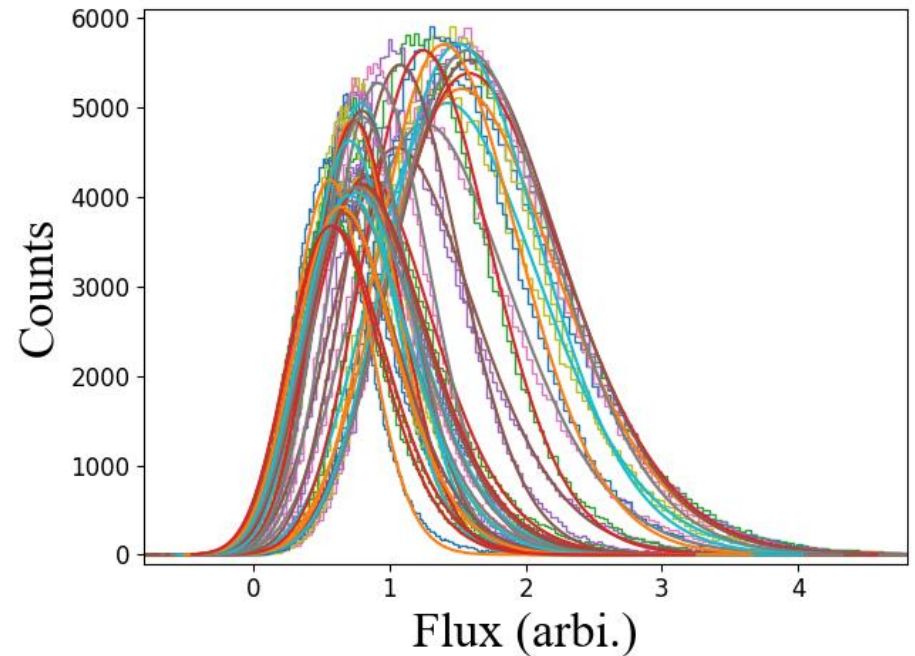


Inter Pulse

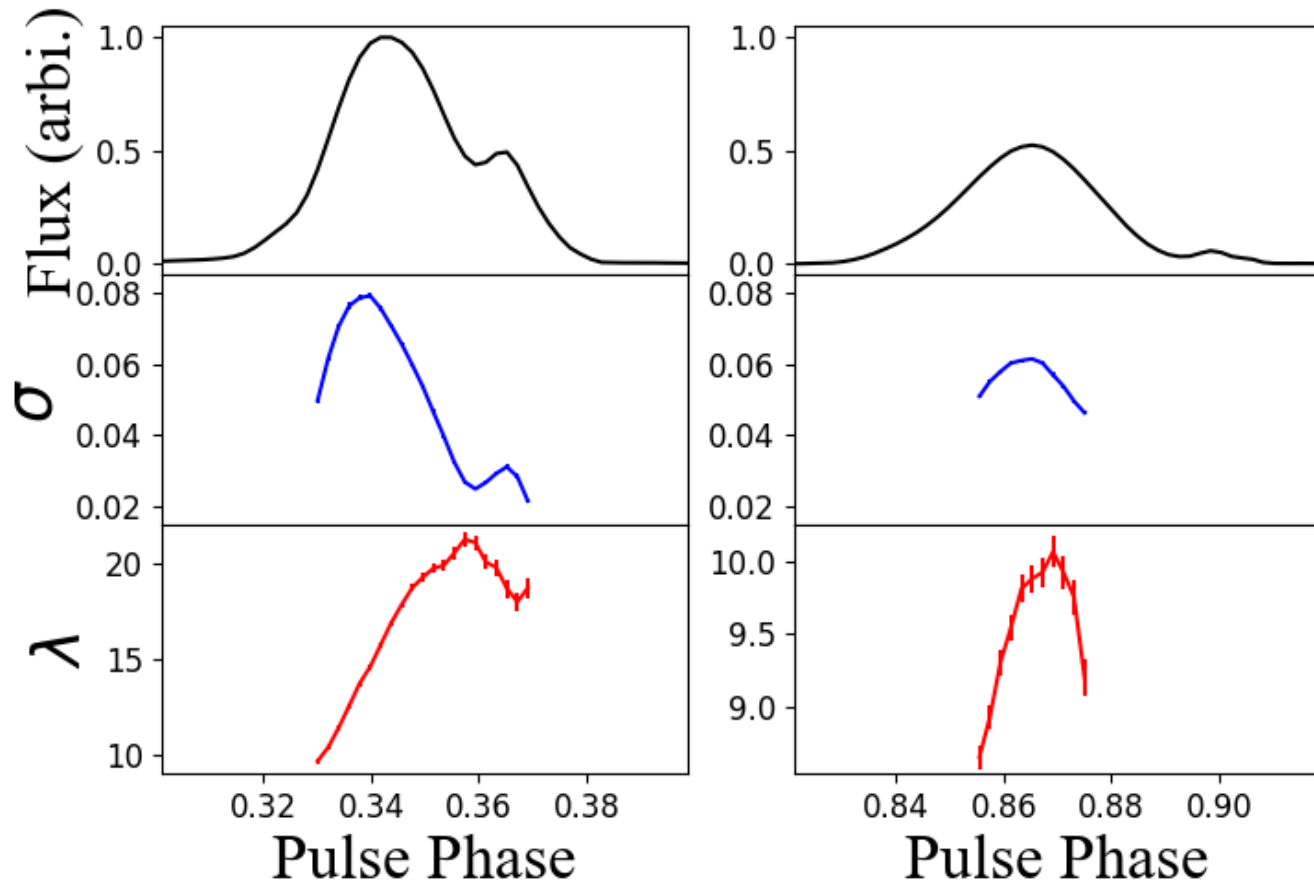


Intensity at
each phase
bin

$$f(x, A, \sigma, \lambda) = \frac{A}{x} \exp\left(-\frac{x}{2\sigma} - \lambda\right) \sum_{n=1}^{\infty} \frac{\left(\frac{\lambda^2 x}{2\sigma}\right)^{\frac{n}{2}}}{\Gamma\left(\frac{n}{2}\right) \Gamma(n+1)}$$



Intensity at each phase bin



$\lambda \Rightarrow$ “spark” density, $\sigma \Rightarrow$ “spark” intensity??

Summary

- Profile evolves with frequencies show similar characteristics as with intensity, and weaker pulses have softer spectrum.
- The time interval between sparks is ~ 100 ns or the space interval between adjacent sparks is ~ 5 m.

Thanks!