

Single pulse study of J1640+2224

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1. Single Pulse

- PSR J1640+2224 is a binary millisecond pulsar (BMSP) with a white dwarf (WD) companion.
- $P = 3.16 \text{ ms}$
- $DM = 18.4 \text{ pc/cm}^3$

- Distance = $1520_{-150}^{+170} \text{ pc}$ (Vigeland et al. 2018)
- Orb Period = 175 days
- $e = 7.9725 \times 10^{-4}$

The multivariate normal distribution

$$X = [x_1, x_2, x_3, \dots, x_n]^T$$

$$\mu = [\mu_1, \mu_2, \mu_3, \dots, \mu_n]^T$$

$$\sigma = [\sigma_1, \sigma_2, \sigma_3, \dots, \sigma_n]^T$$

$$f(x) = \frac{1}{2\pi^{n/2} |\Sigma|^{1/2}} e^{-\frac{1}{2}(X-\mu)^T \Sigma^{-1} (X-\mu)}$$



$$\sigma_{obs}^2 = \sigma_{rn}^2 + \sigma_j^2 + \dots$$

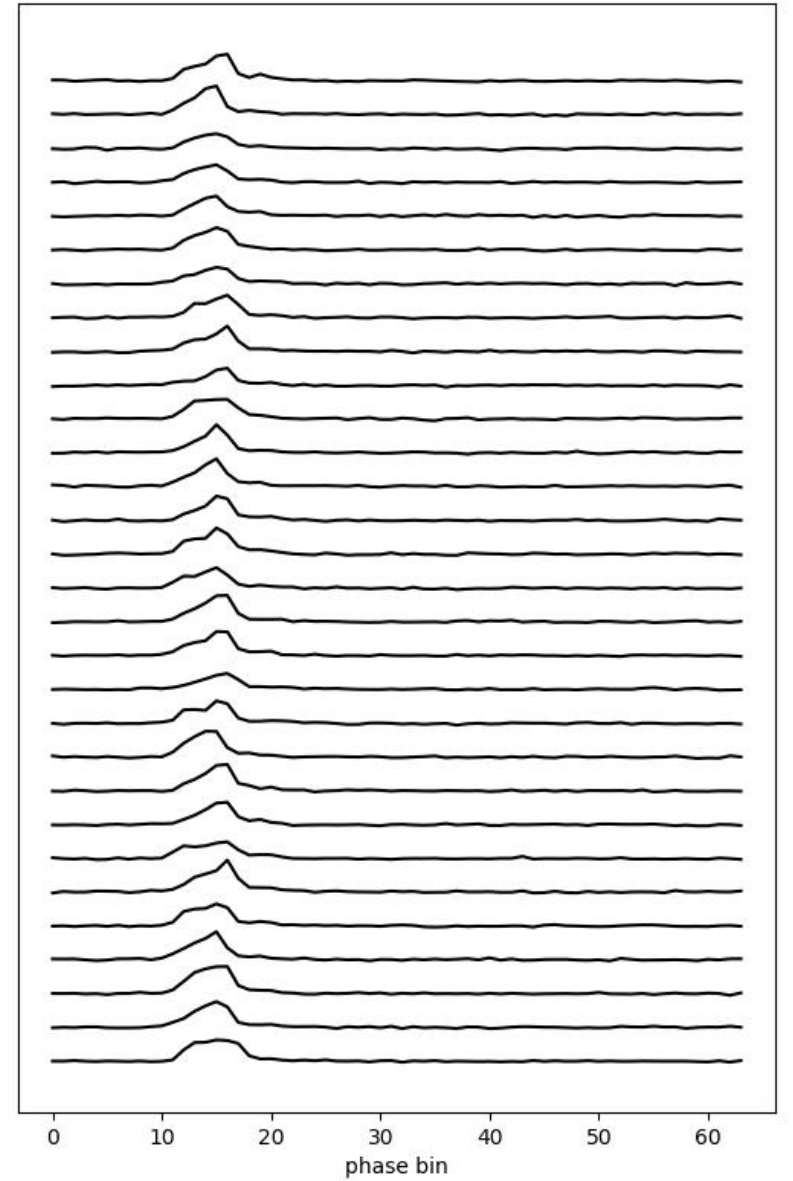
$$\Sigma = \begin{bmatrix} Cov(x_1, x_1) & \dots & Cov(x_1, x_n) \\ \vdots & \ddots & \vdots \\ Cov(x_n, x_1) & \dots & Cov(x_n, x_n) \end{bmatrix}$$

$$L(y) = \prod_{i=1}^n f(y_i; \mu, \Sigma)$$

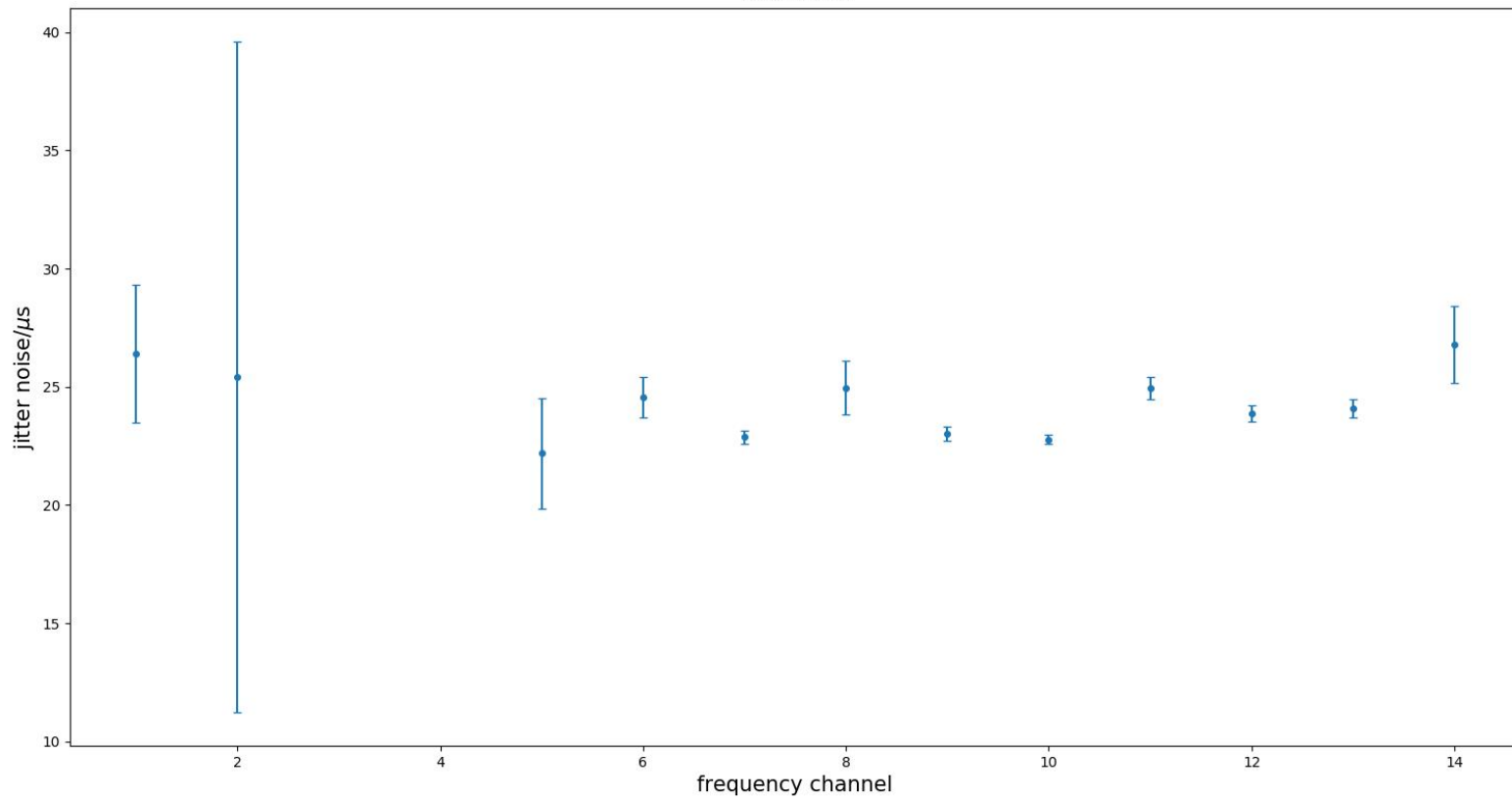
$$(\hat{\mu}, \hat{\Sigma}) = \operatorname{argmax}\{\ln L(y)\}$$

20200814
 $20.299 \pm 0.034 \mu\text{s}$

20210608
 $20.481 \pm 0.037 \mu\text{s}$

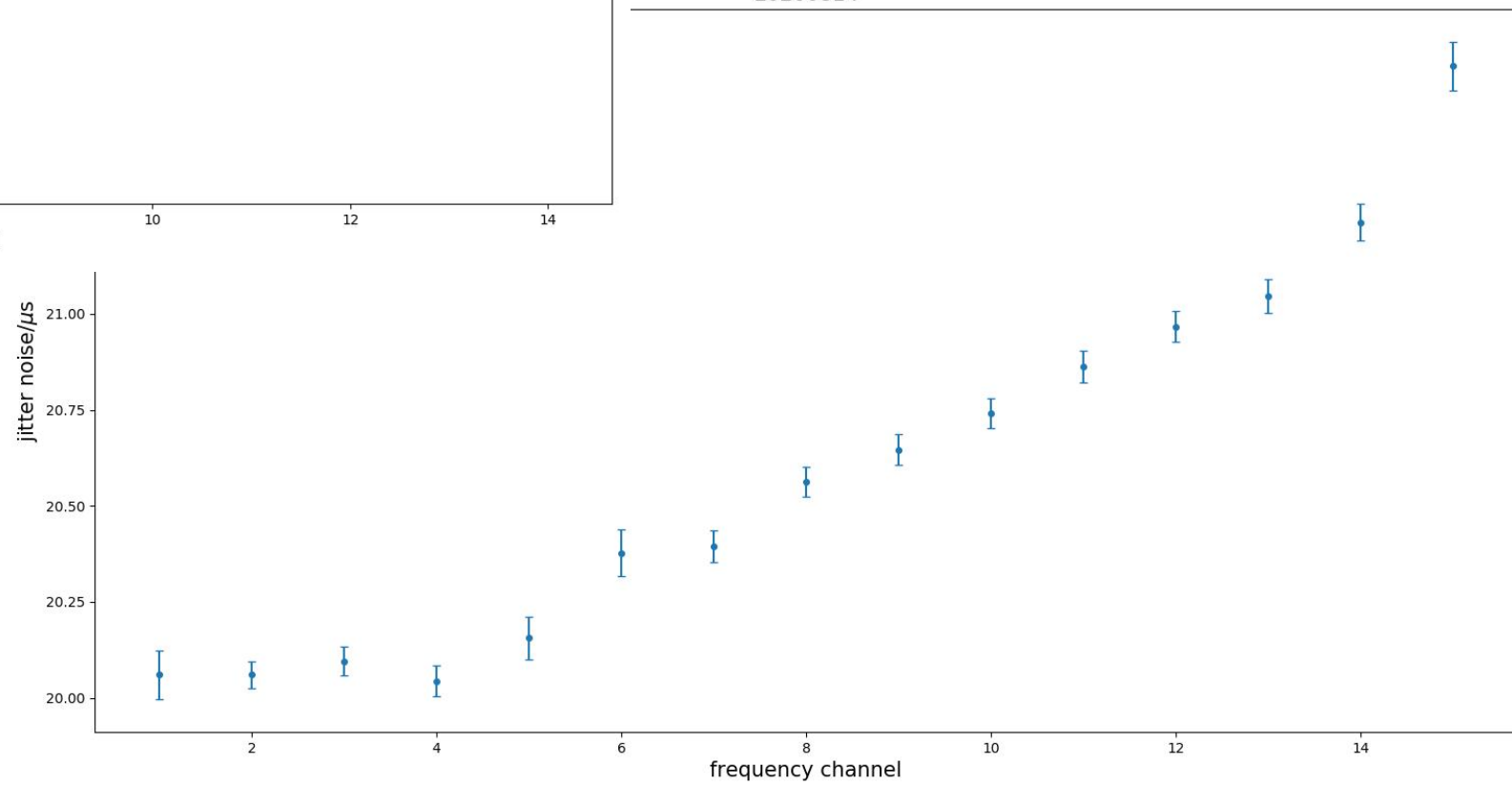


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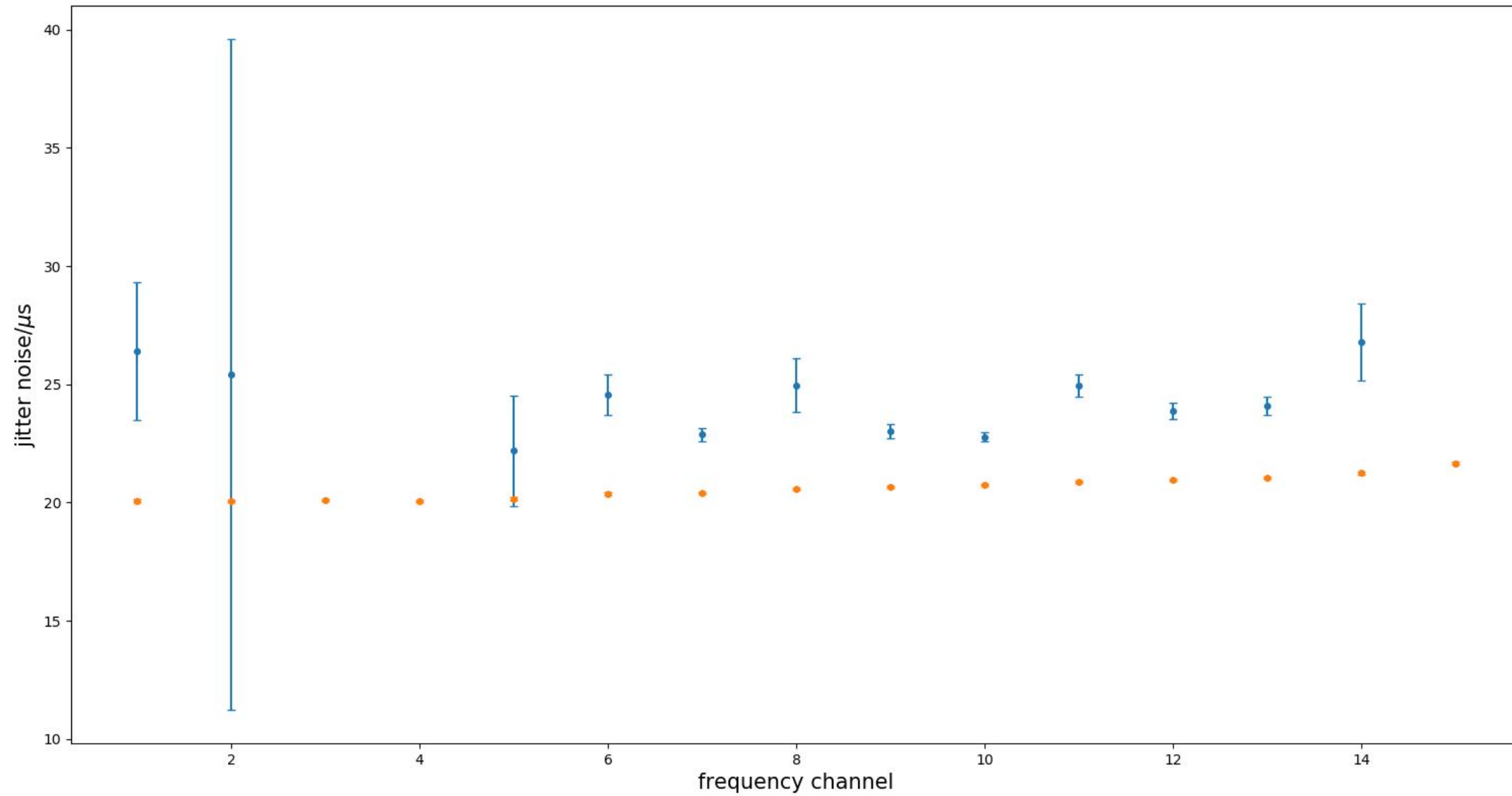
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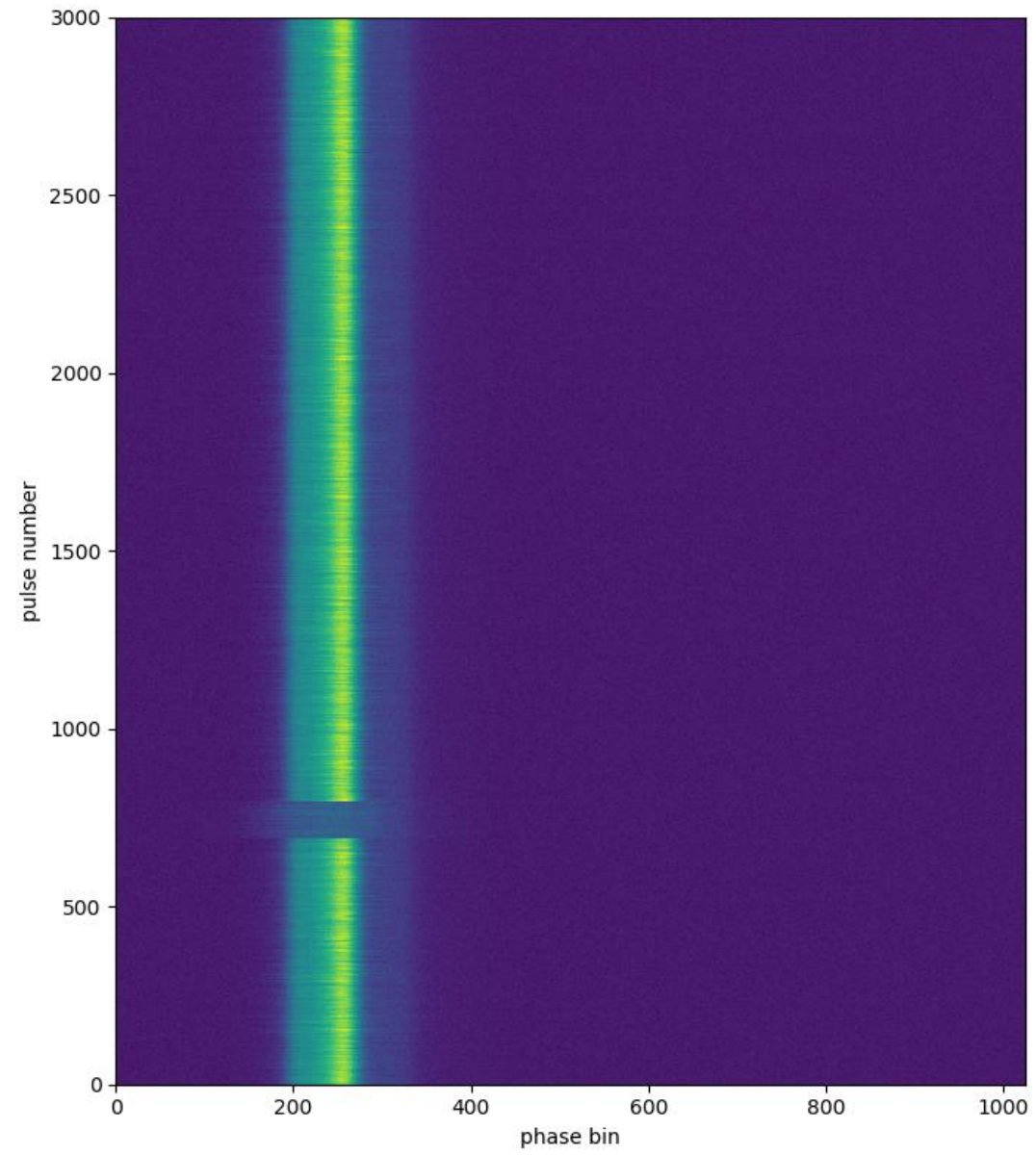
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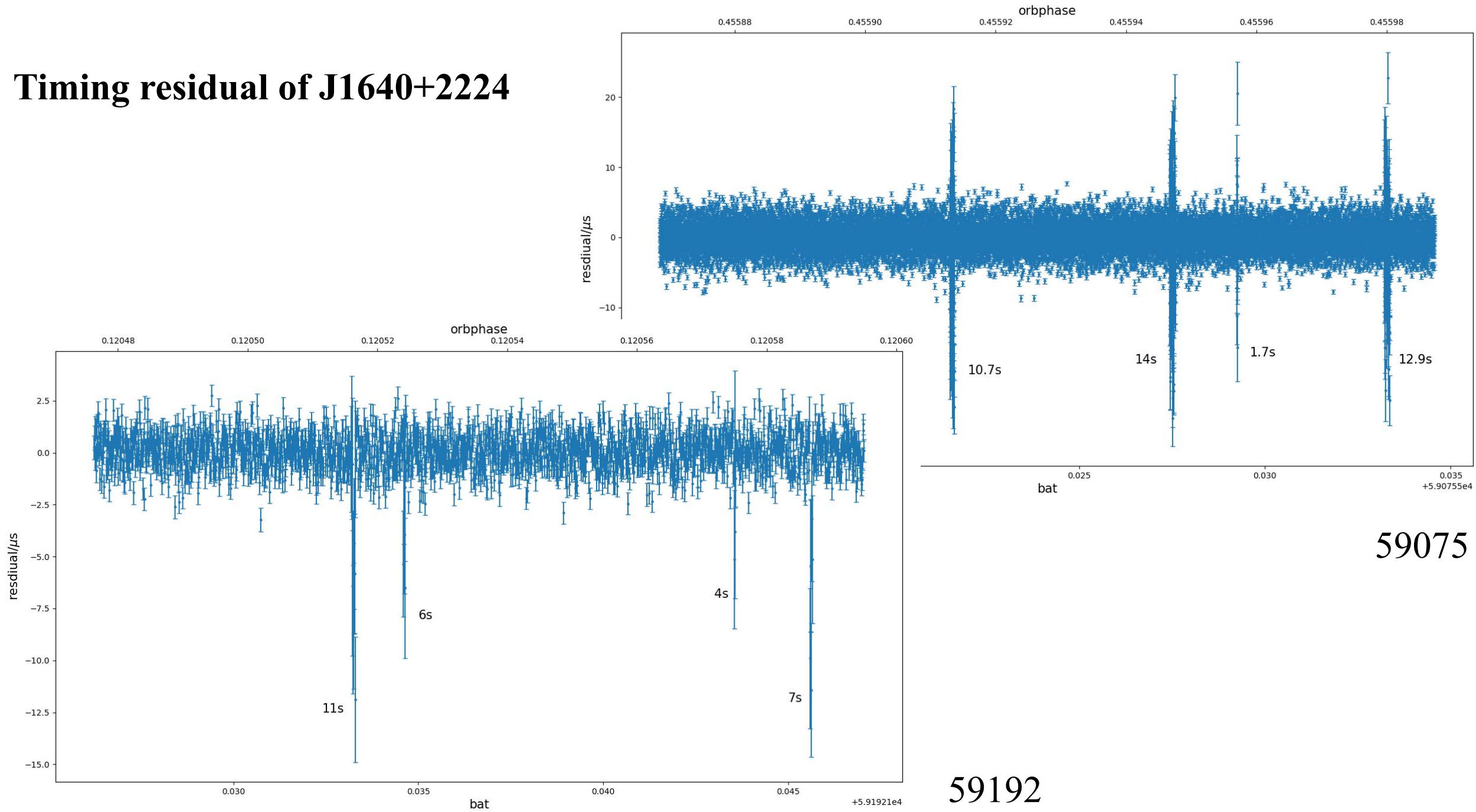
16chn jitter



2. Mode-change?

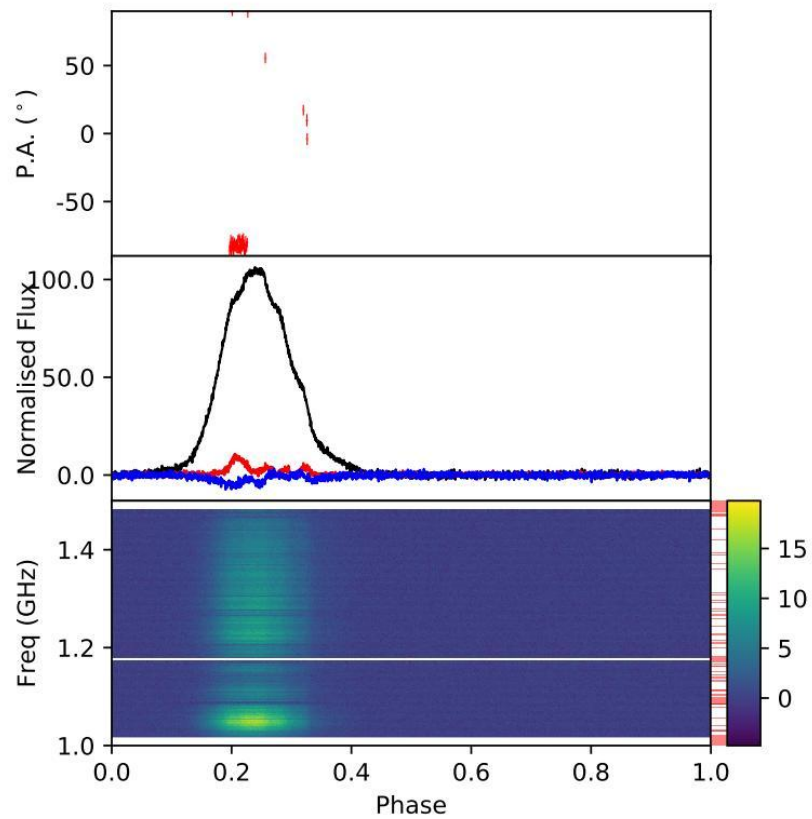


Timing residual of J1640+2224

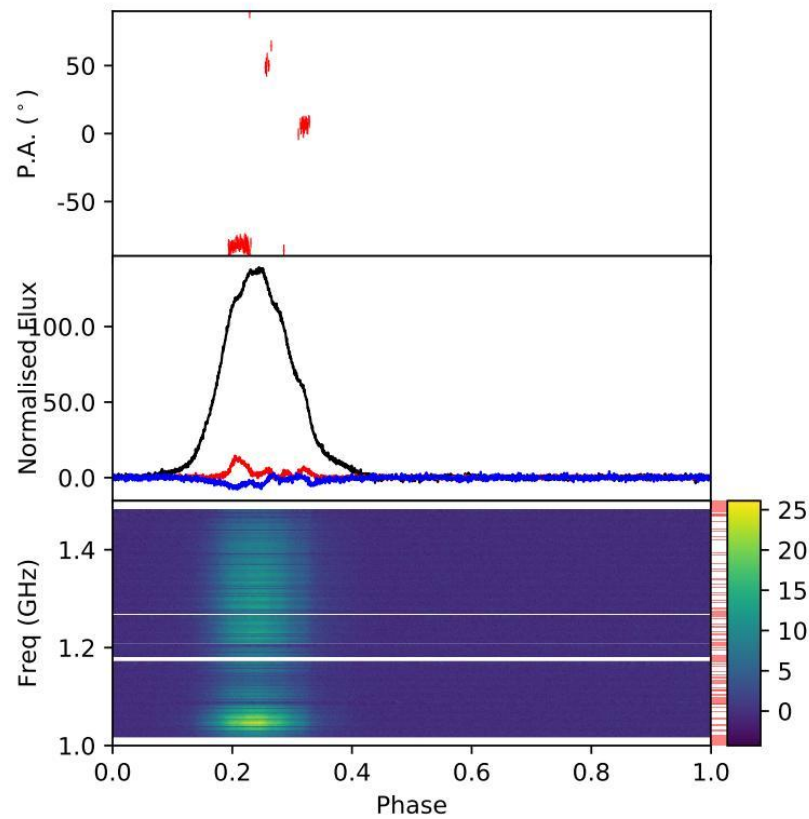


59075

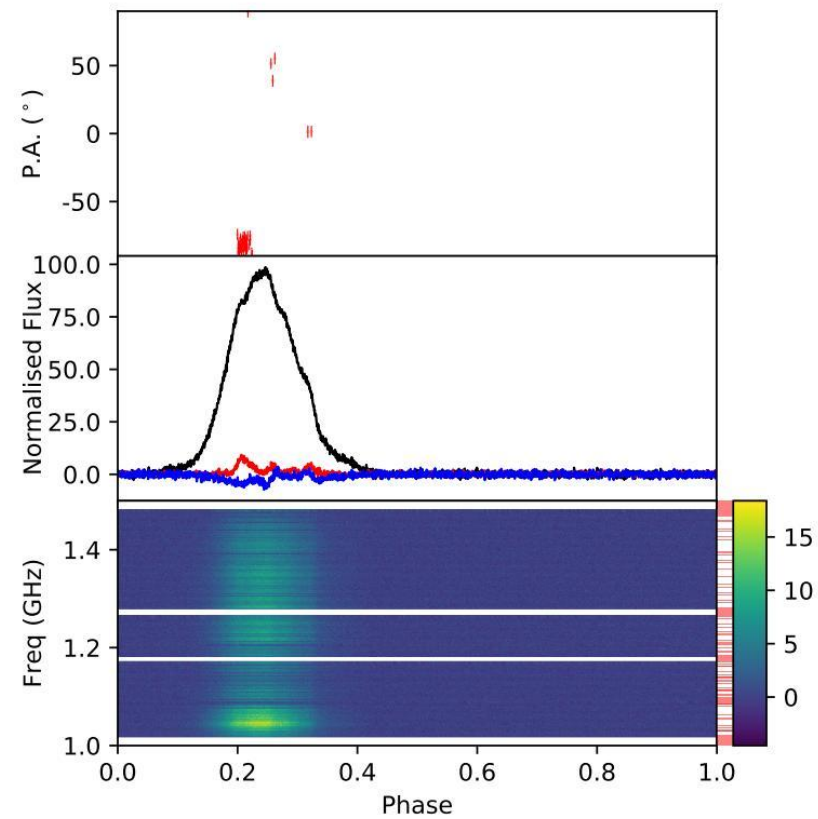
59192



59075.52162

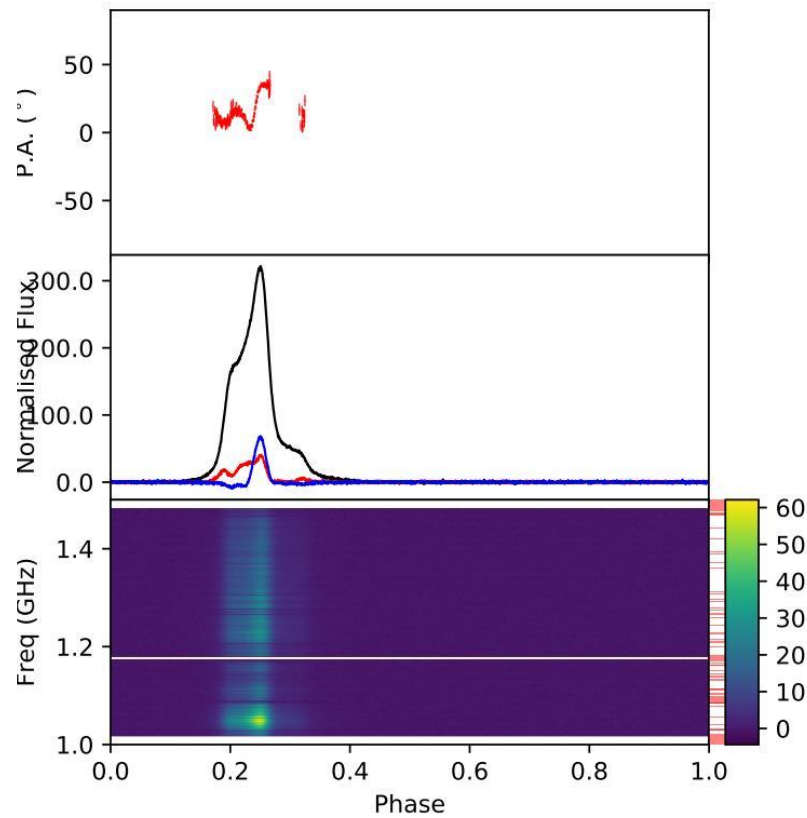
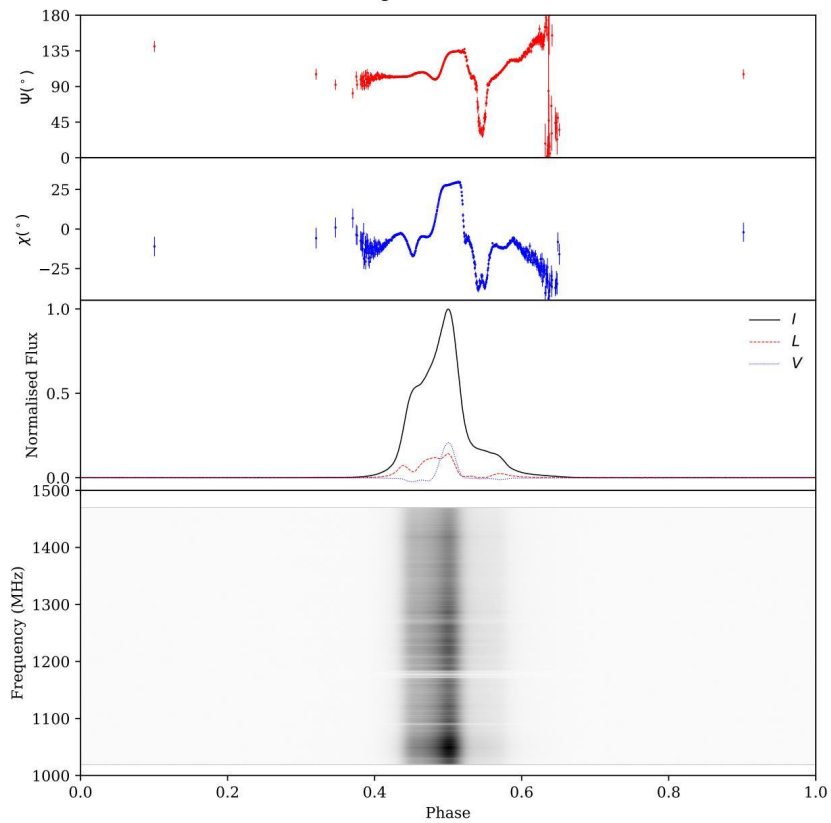


59075.52755

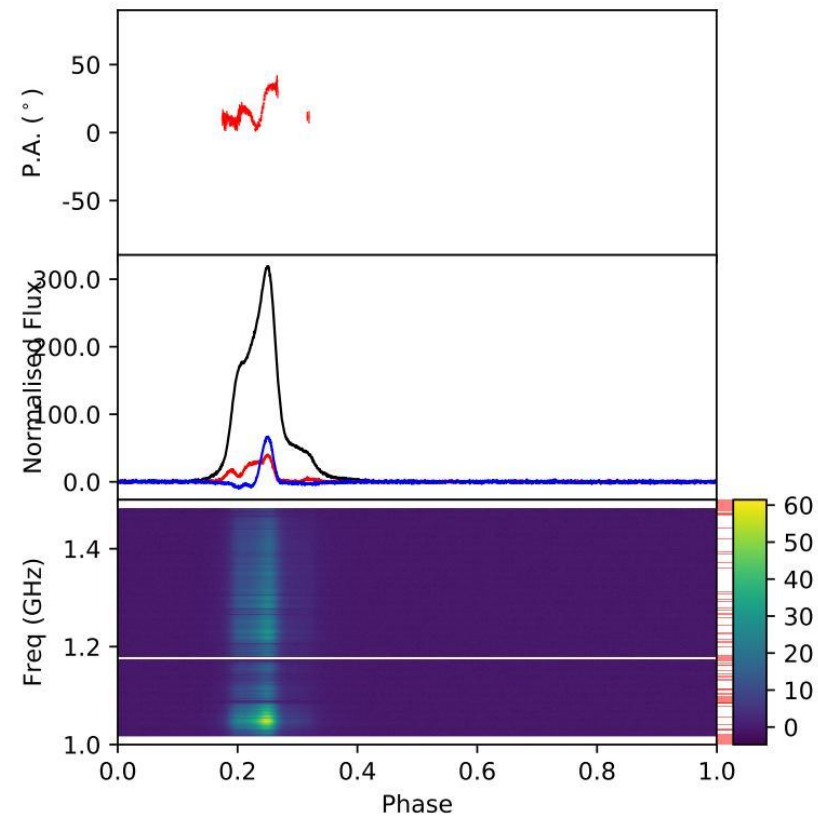


59075.53330

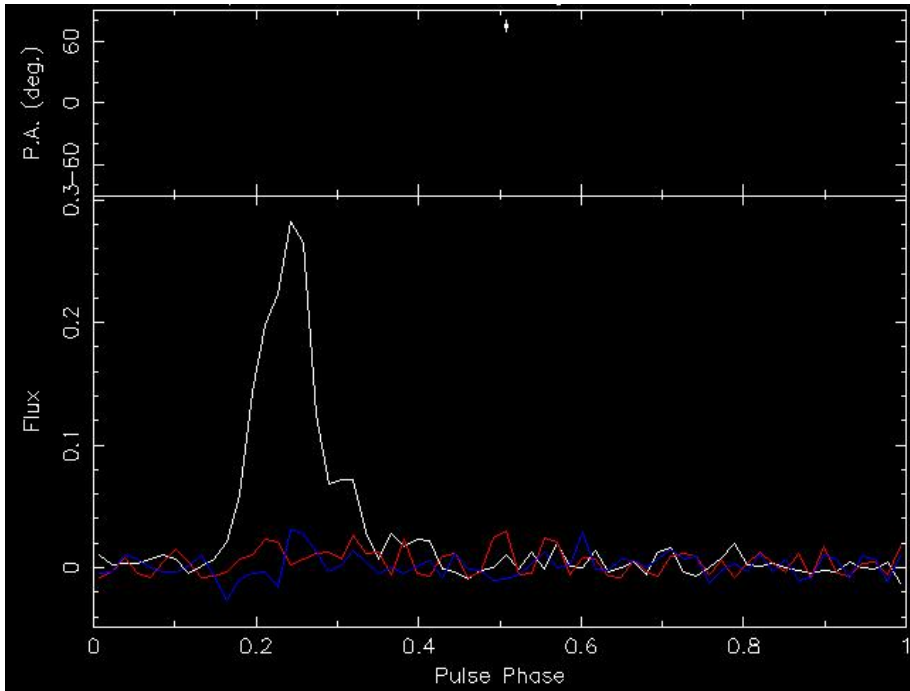
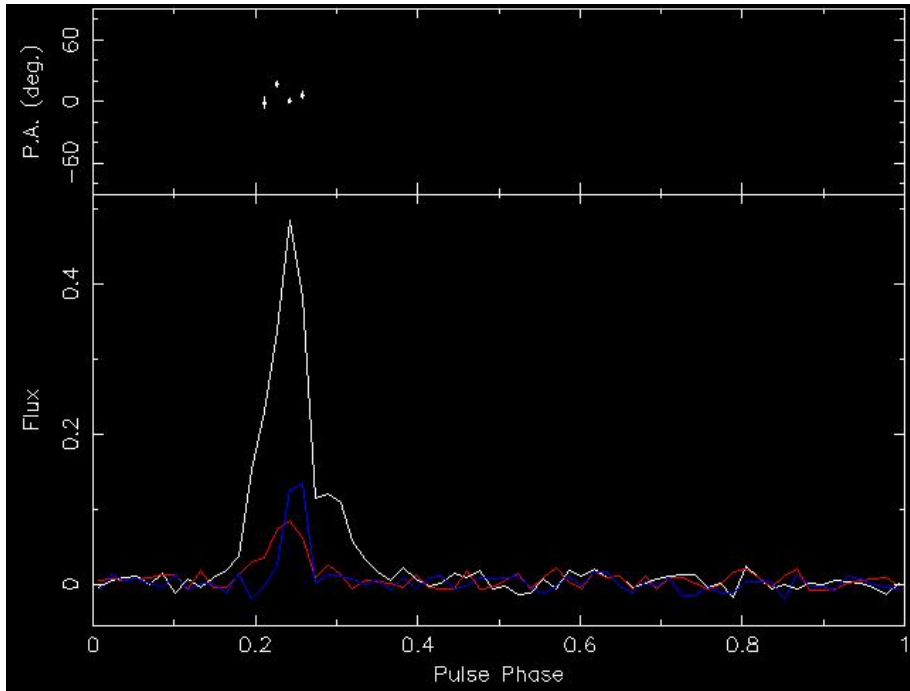
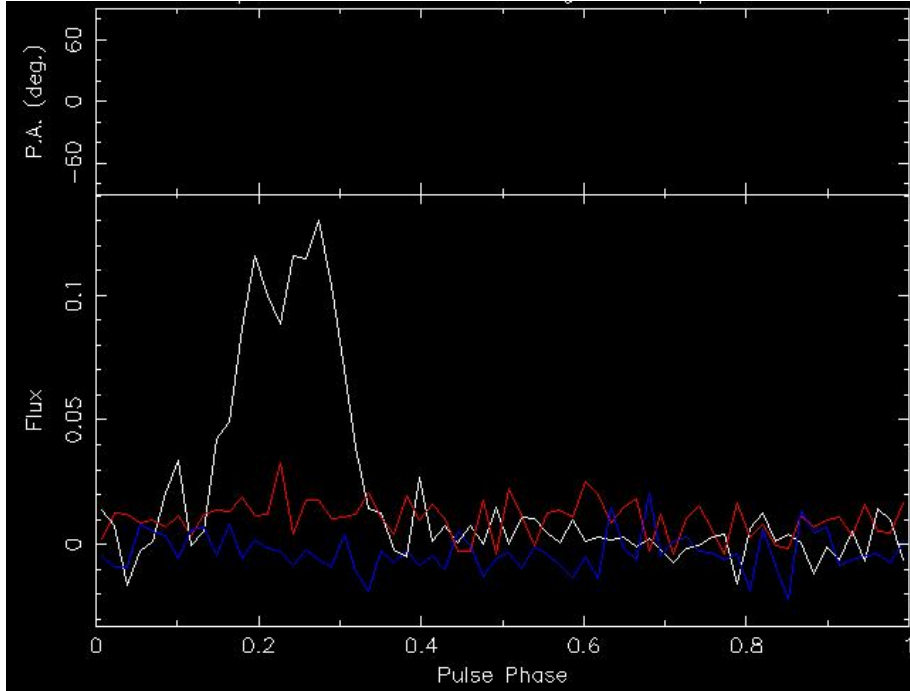
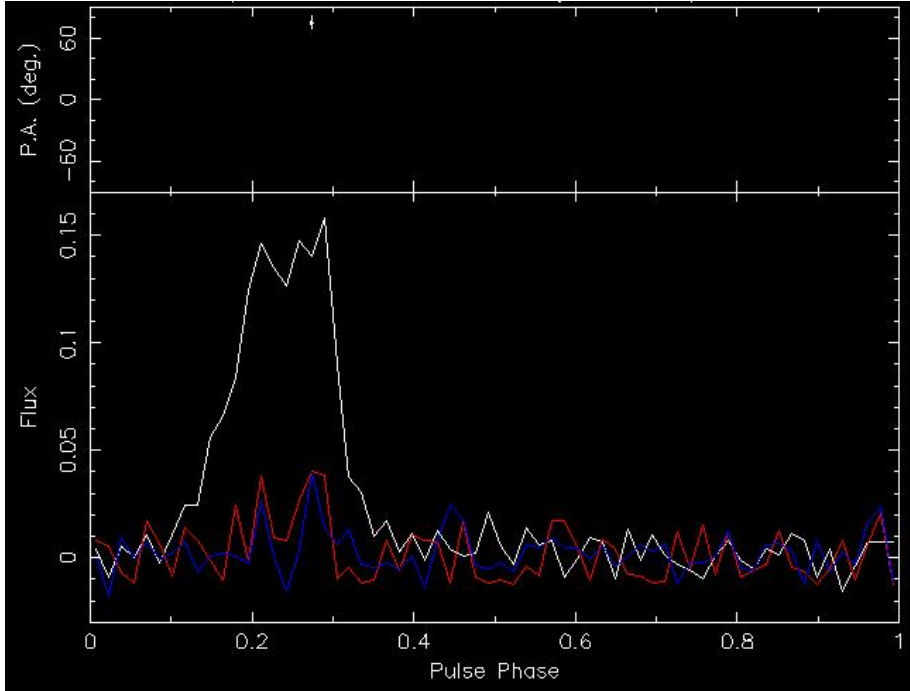
J1640+2224



before 59075.52162



after 59075.52162



Thanks