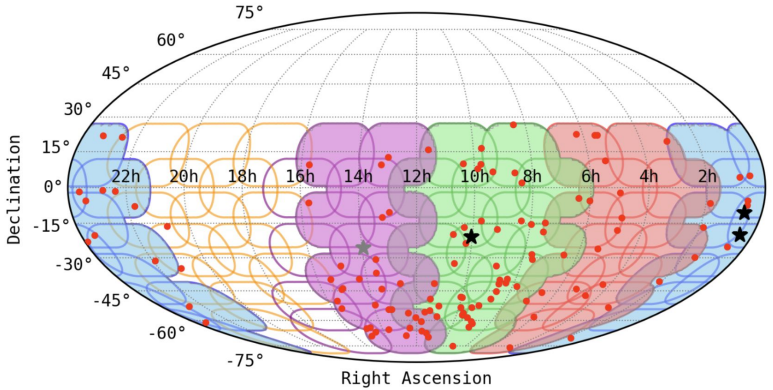
Speeding up the Pulsar Search Pipeline

Piyush Panchal (SCITAS, EPFL)

Introduction

- 4 PB data collected in SMART Pulsar survey (MWA)



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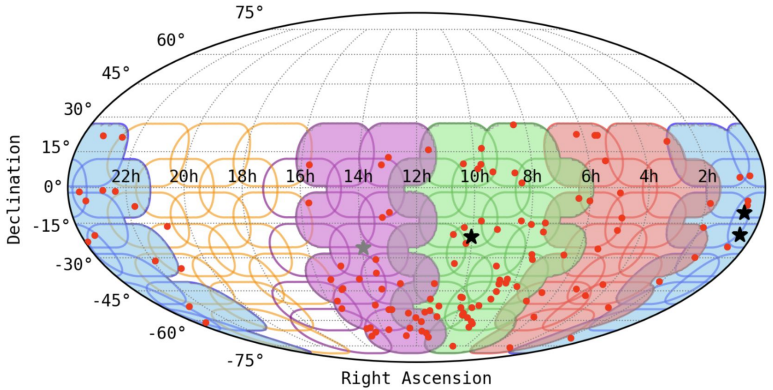

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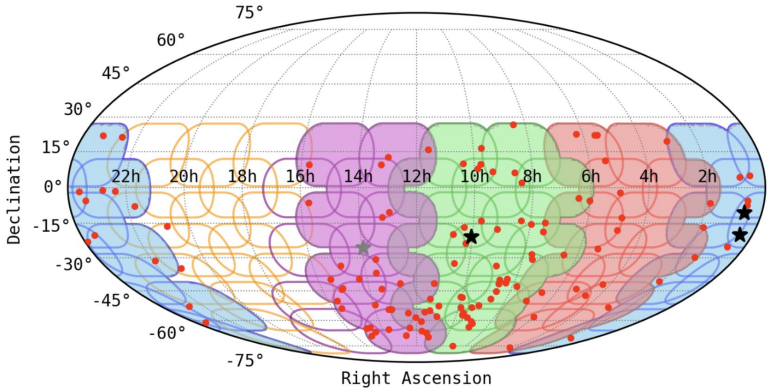

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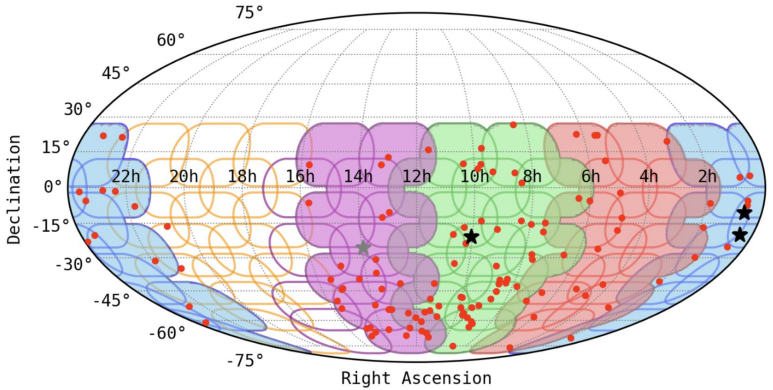

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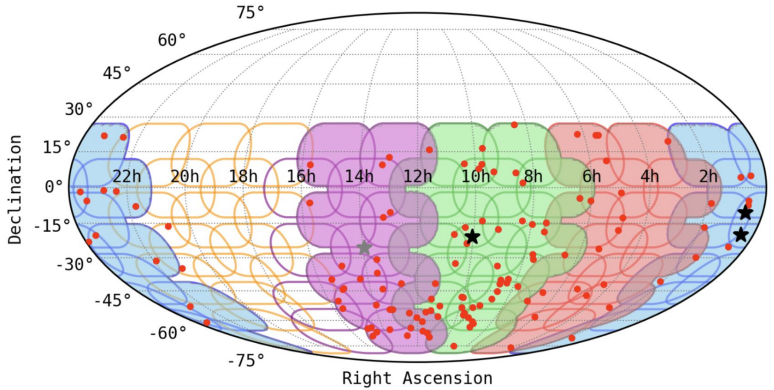
- Goal: GPU acceleration to enable full/faster processing



Pulsar Searching

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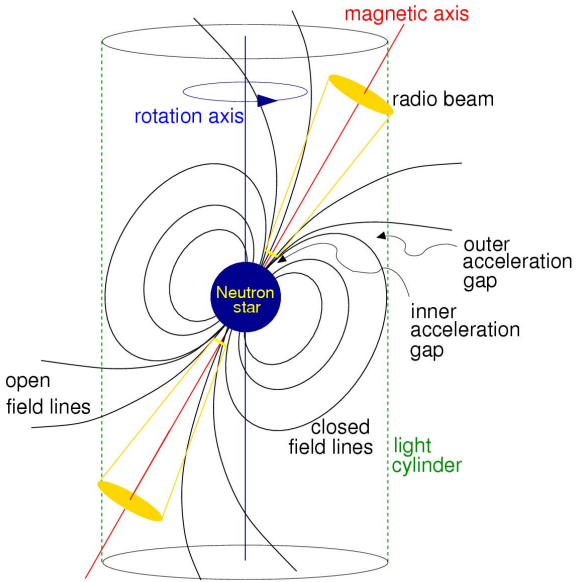

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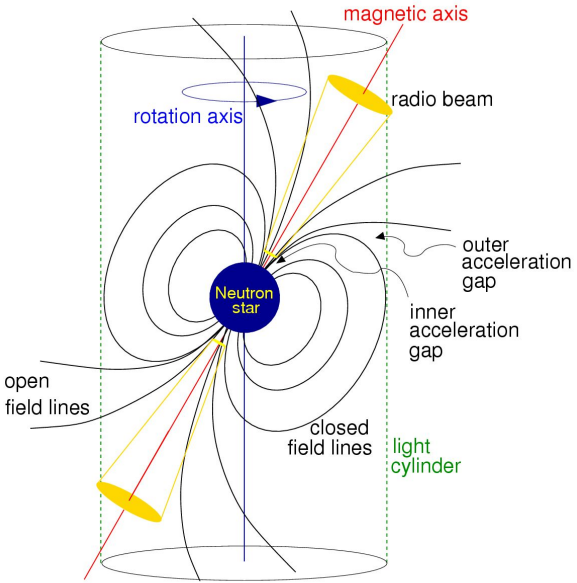

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- Pulsar: Rotating Neutron star, regular EM radiation from poles
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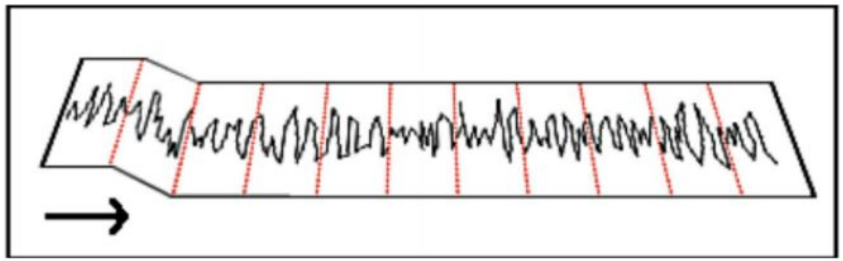
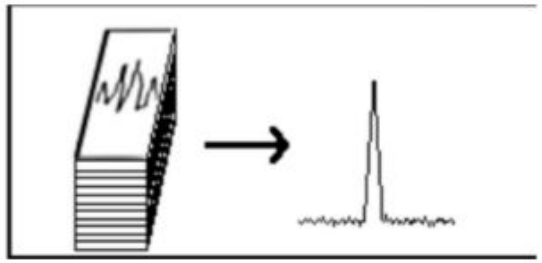
- Detection steps (post beamforming)
  - De-dispersion
  - Frequency domain search
  - Folding





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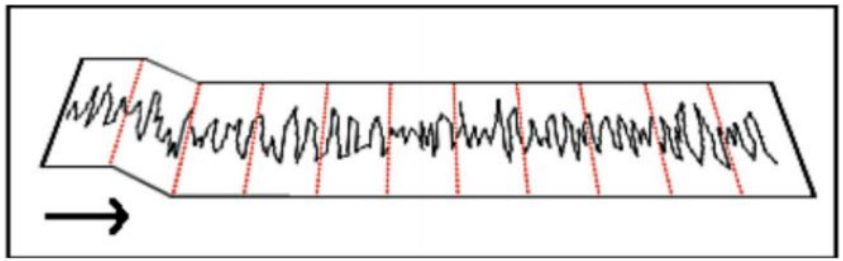

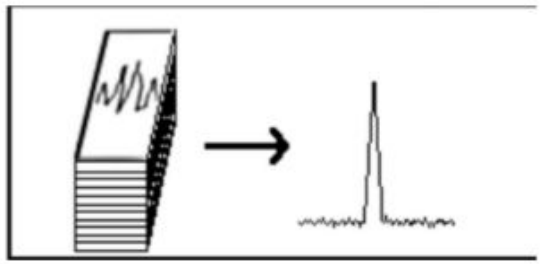

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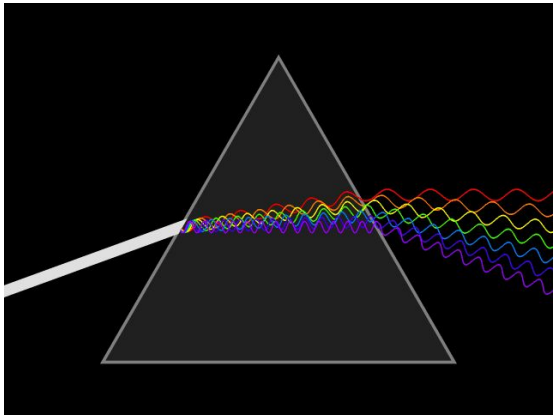

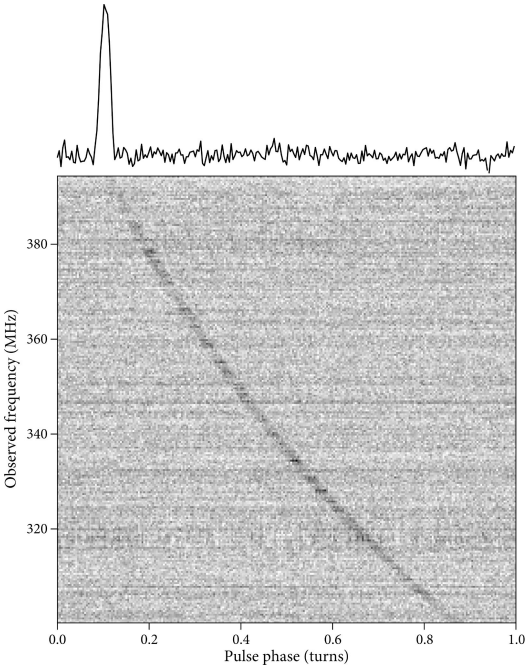

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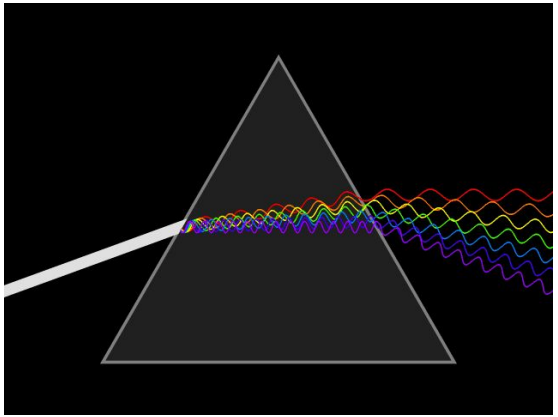

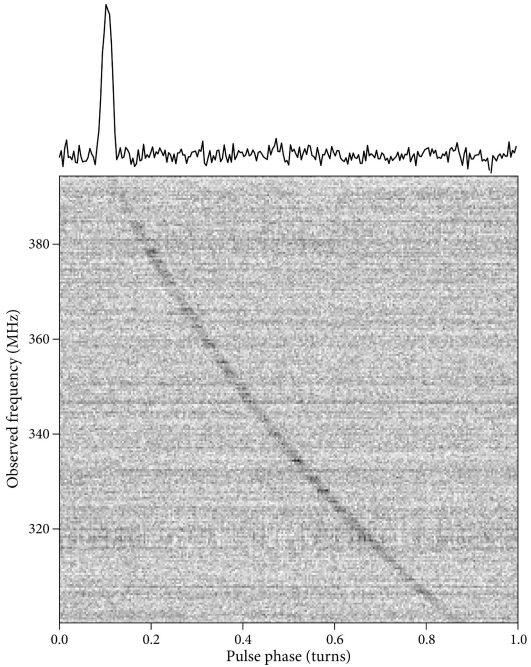

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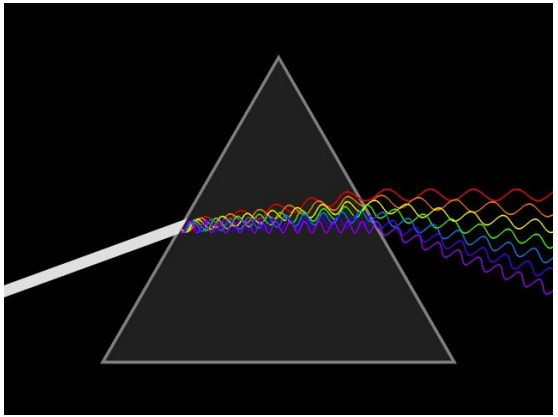

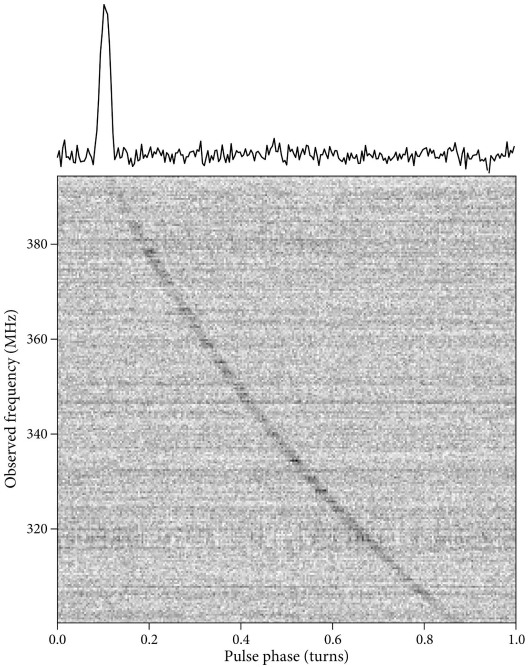

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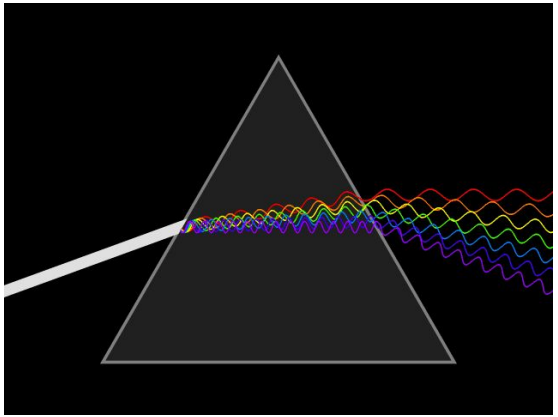
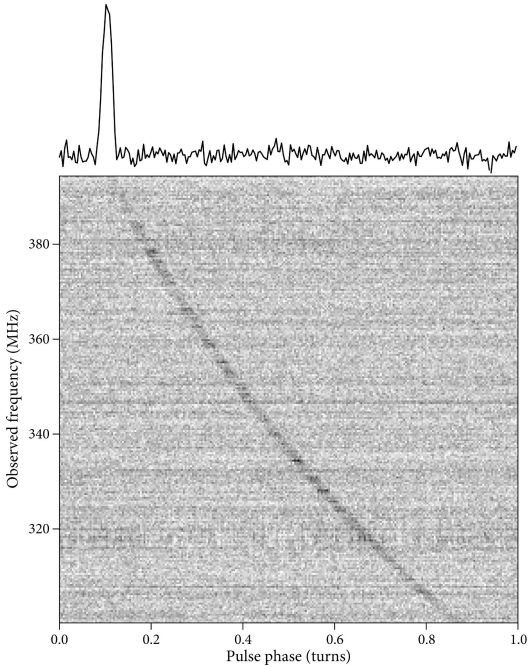
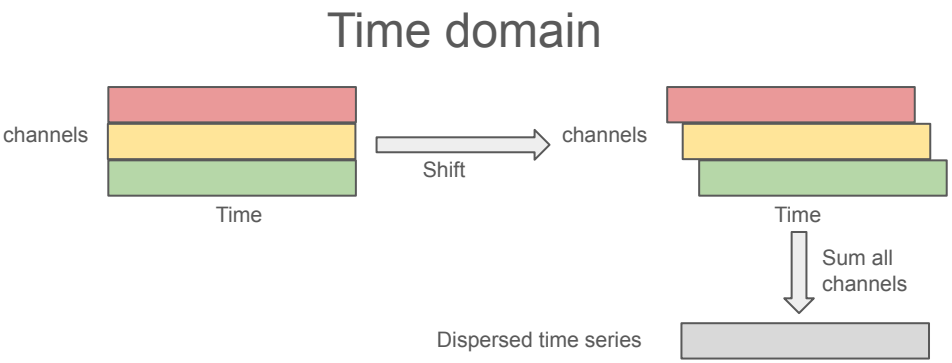
- Full search on SMART dataset: ~15000 DM values





Time vs Frequency Domain De-Dispersion



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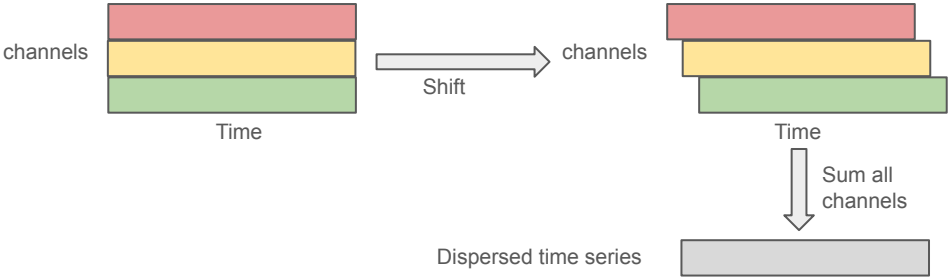

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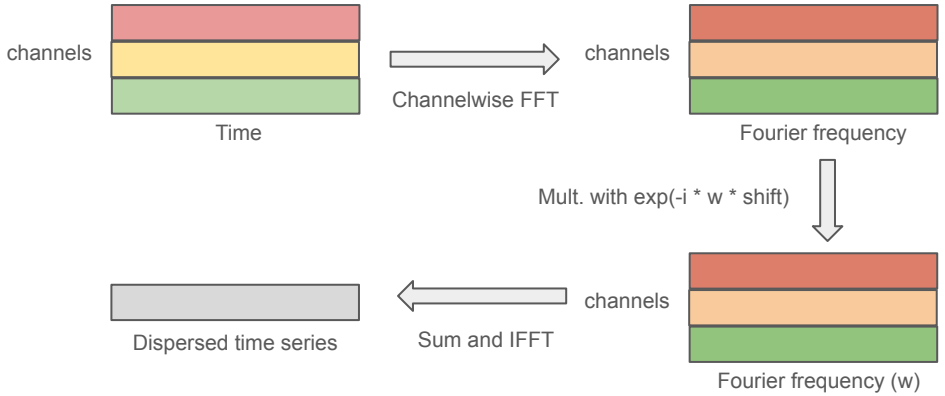

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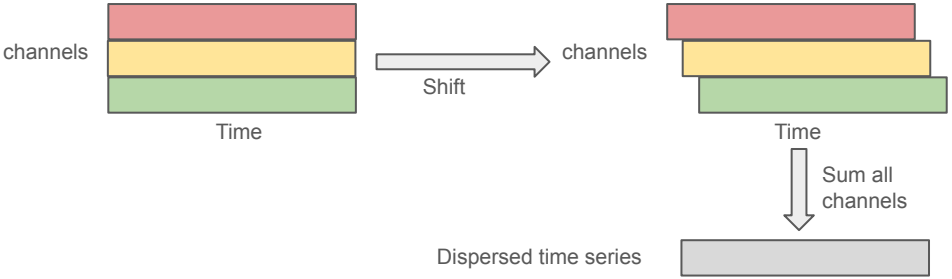

- Memory bound
- #DM FFTs

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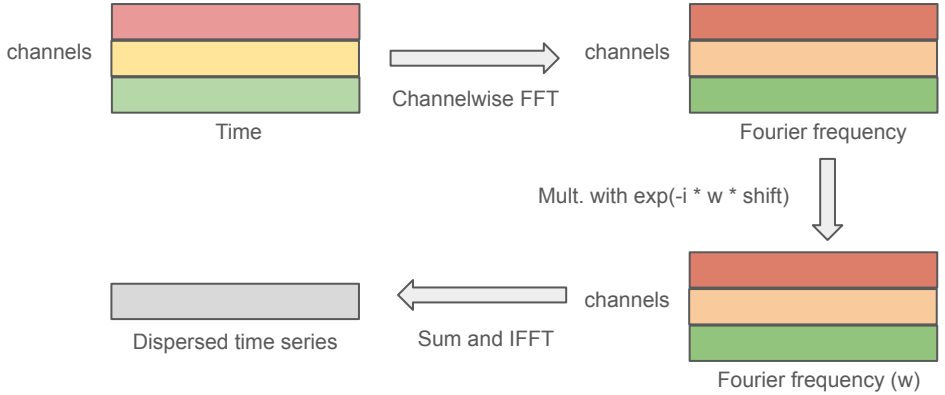

- Compute bound
- #channels FFTs
- Can skip IFFT

GPU Implementation

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- Compatibility with newer CUDA version
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Next steps:

- Porting to AMD GPUs
- MPI + GPU implementation for full input (~589 GB)
- Integration with the acceleration/jerk search, using FFT directly
- GPU specific optimizations

Preliminary Results

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	Dedisp (FDD, GPU)	PrestoZL (TDD, GPU)	Presto (TDD, CPU)
1000 DMs	28.95 s	> 139.77 s (800 DM)	8 hrs+
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- Kuma (H100): 15000 DMs, 116.223 s!

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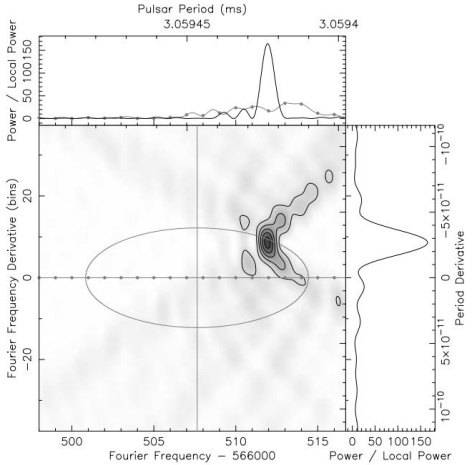

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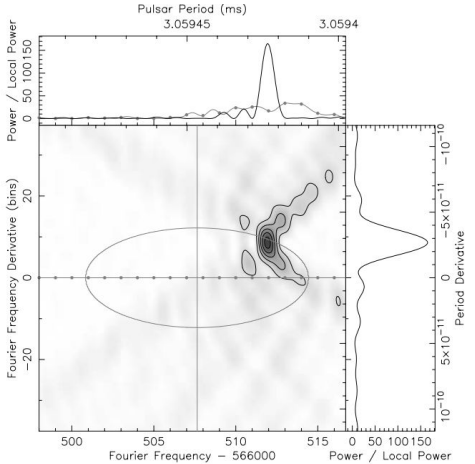

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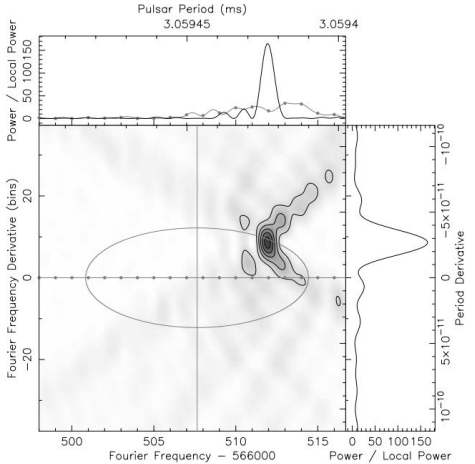
- Acceleration/jerk search capture effects from orbital motion of Pulsar
- Parallelizable algorithm, same filters for all de-dispersed time series
- Full search on SMART dataset: ~10000 filters



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Progress:

- Extracted Jerk search from Astro-accelerate into a standalone executable

Next steps:

- Further optimizations in Astro-accelerate (naive copy of Presto)
- Exploring PrestoZL
- Porting to AMD GPUs

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	Presto (CPU)				Astro accelerate
kernels	1	2	4	8	GPU
33	0.178	0.137	0.1	0.105	0.304
357	1.318	0.766	0.431	0.268	0.492
1111	4.014	2.272	1.192	0.859	1.233
4221	19.217	9.808	5.501	3.023	4.102
25551	205.56	112.495	68.914	47.432	18.04

Questions?