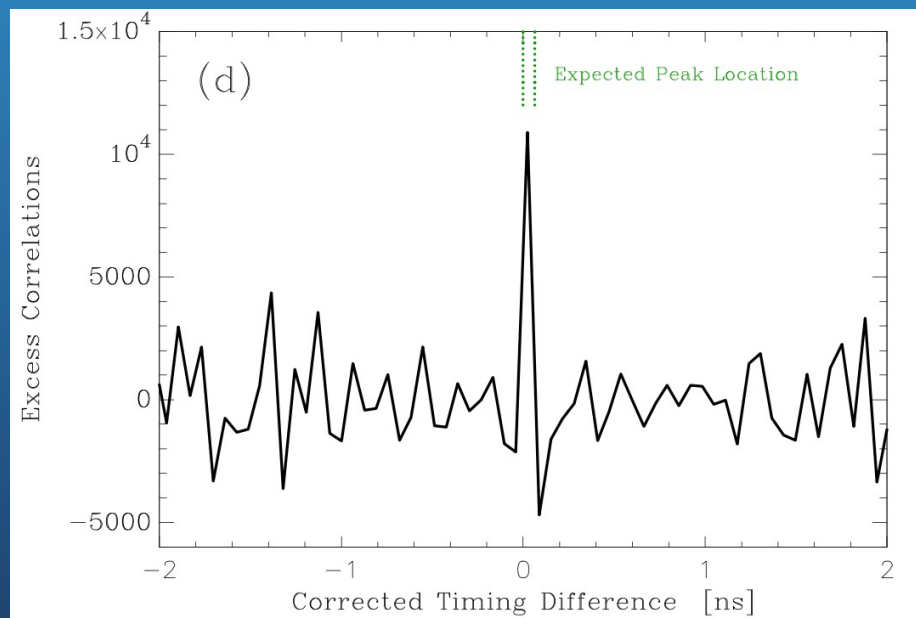


Progress Toward Multi-Channel Intensity Interferometry with the Southern Connecticut Stellar Interferometer

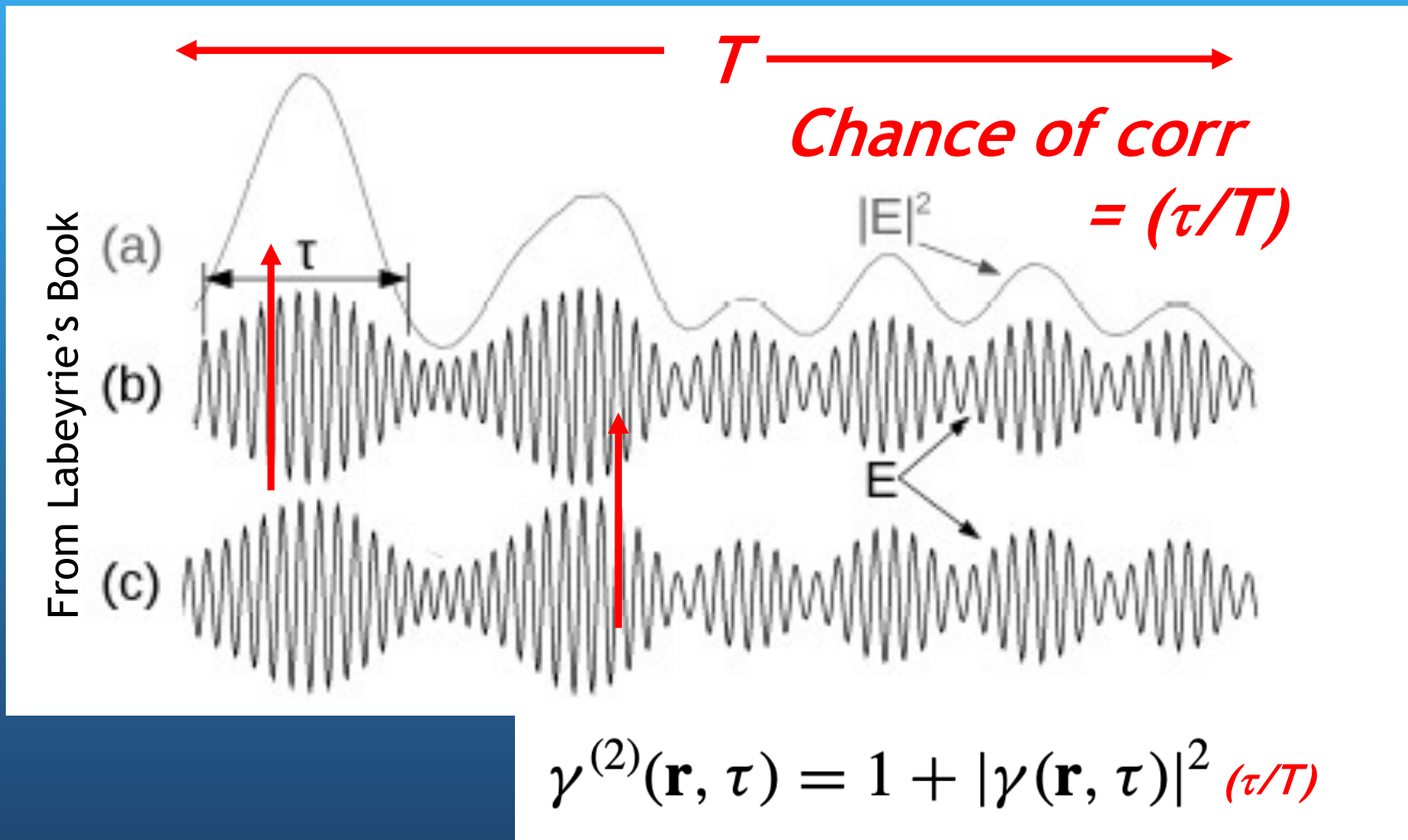
Elliott Horch,
Southern Connecticut State University

Astronomical Instrumentation Lab at SCSU.



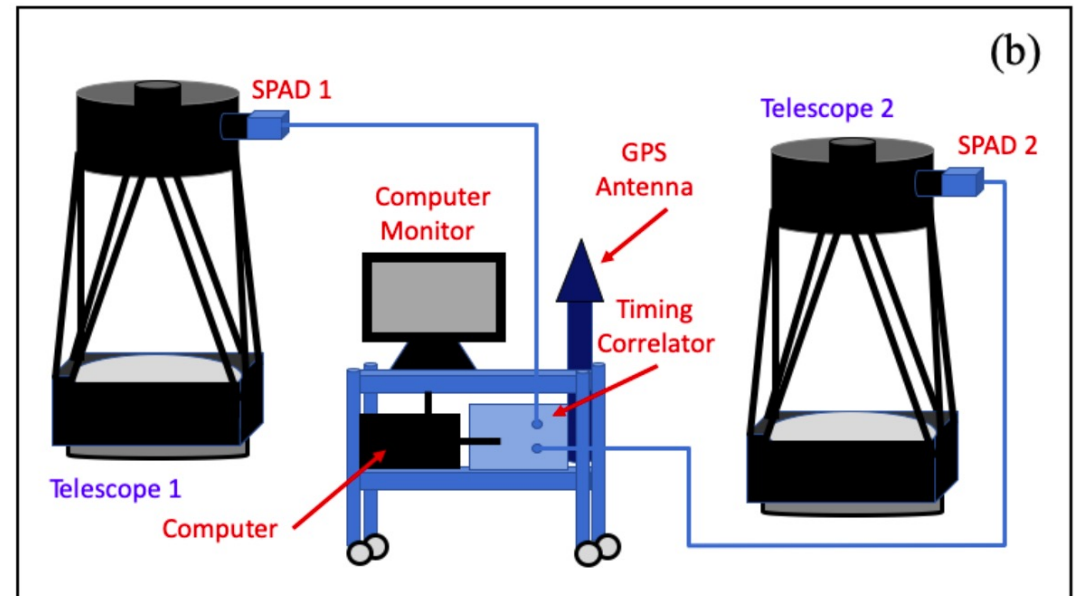
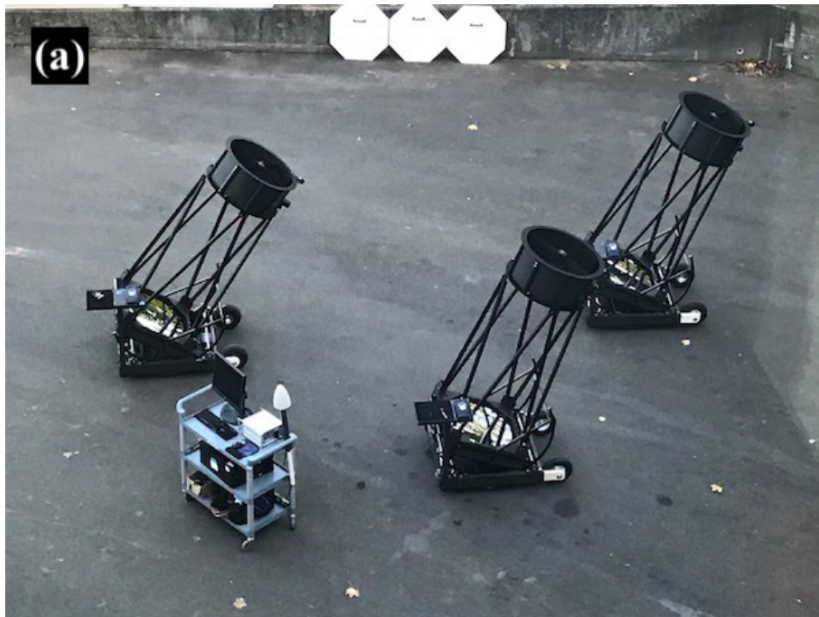
New Instrumentation and Software Development for High-resolution imaging.

What Makes Stellar Intensity Interferometry Hard?



SCSI: A three-station intensity interferometer

3



- *60-cm Dobsonian telescopes.*
- *Meinberg GPS modules*
- *MPD SPAD detectors*
- *Picoquant timing modules*

Group Members:

Justin Rupert, M.S. 2016

Olivia Weiss, M.S. 2018

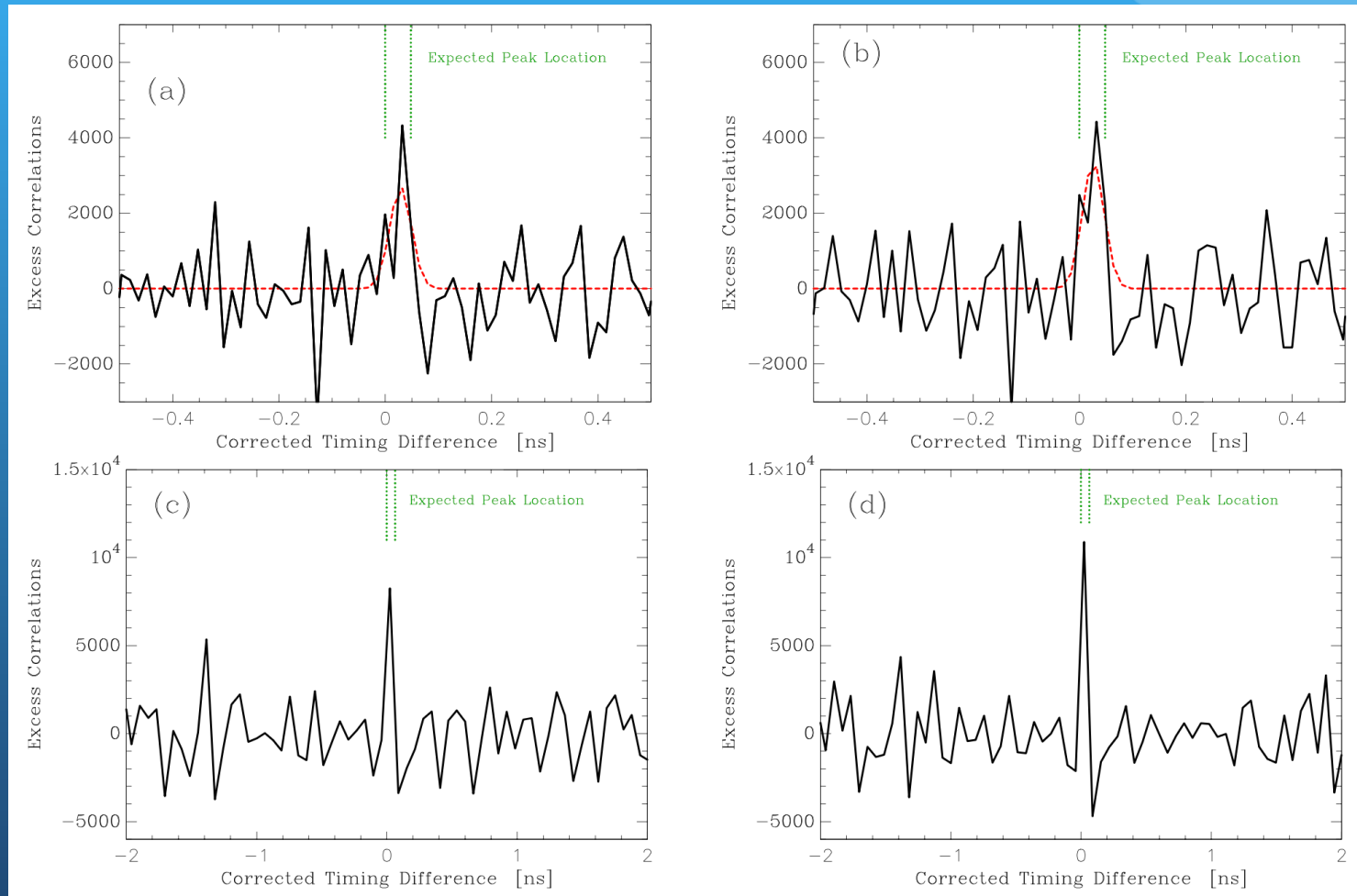
Paul Klauke, M.S. 2021

Rich Pellegrino, M.S. 2023

Torrie Sutherland, M.S. expected 2025

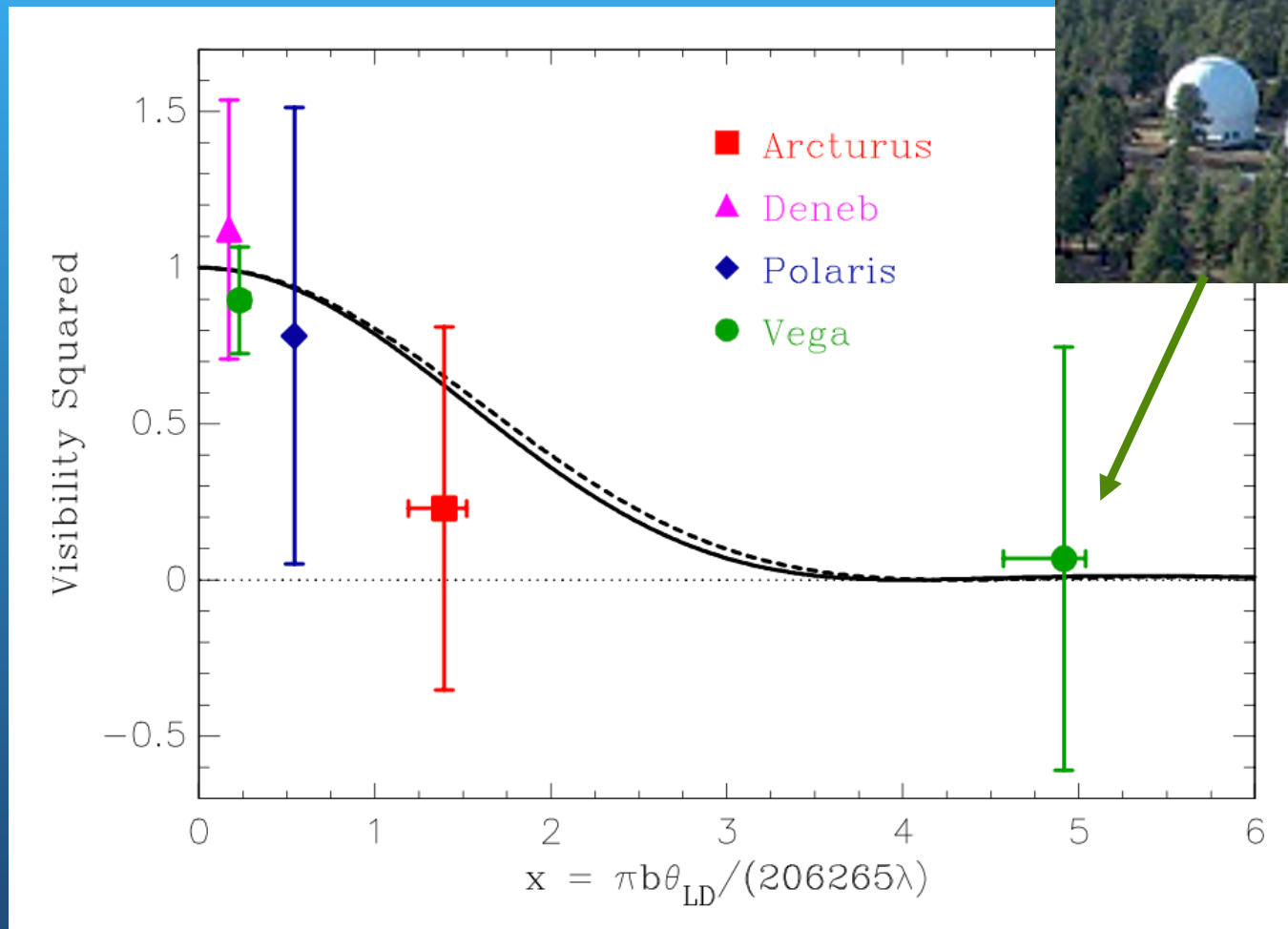
Sebastian Lucero, B.S. expected 2025

Photon Bunching Observed



A pedestal of $\sim 3 \times 10^6$ counts per 64 ps is subtracted!

Toward Stellar Diameters



Current Challenges

- Reliable Positioning of Telescopes
- Collimation and Focus of Telescopes
- Detector Active Area
- Telescope Tracking
- Operating 3 telescopes at the same time is hard!



Autoguiders for All!

Holy grail: Wireless operation - each telescope has its own clock and these are synchronized through GPS.

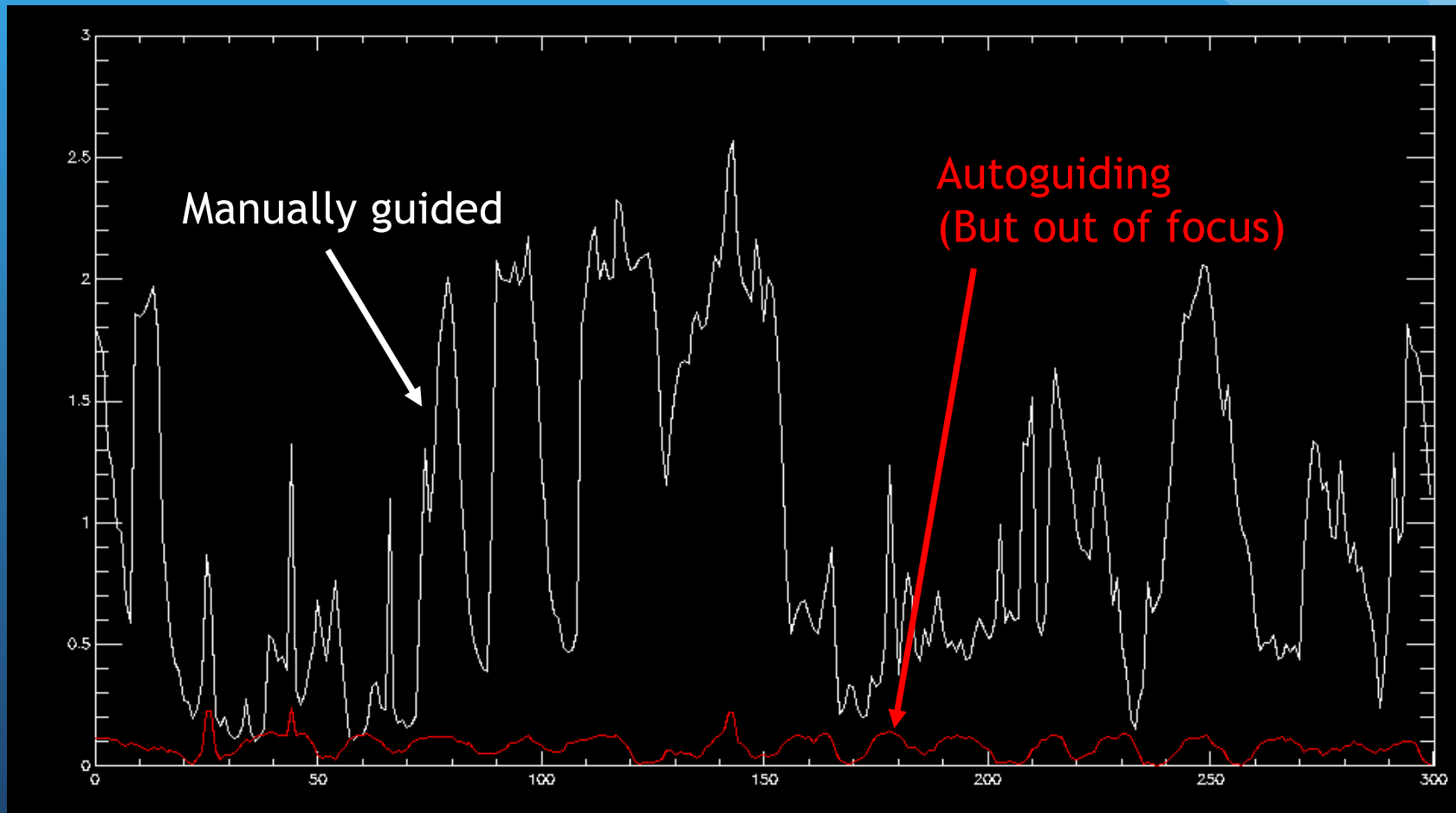
Two examples

Three-Telescope observations in Jun 2022.



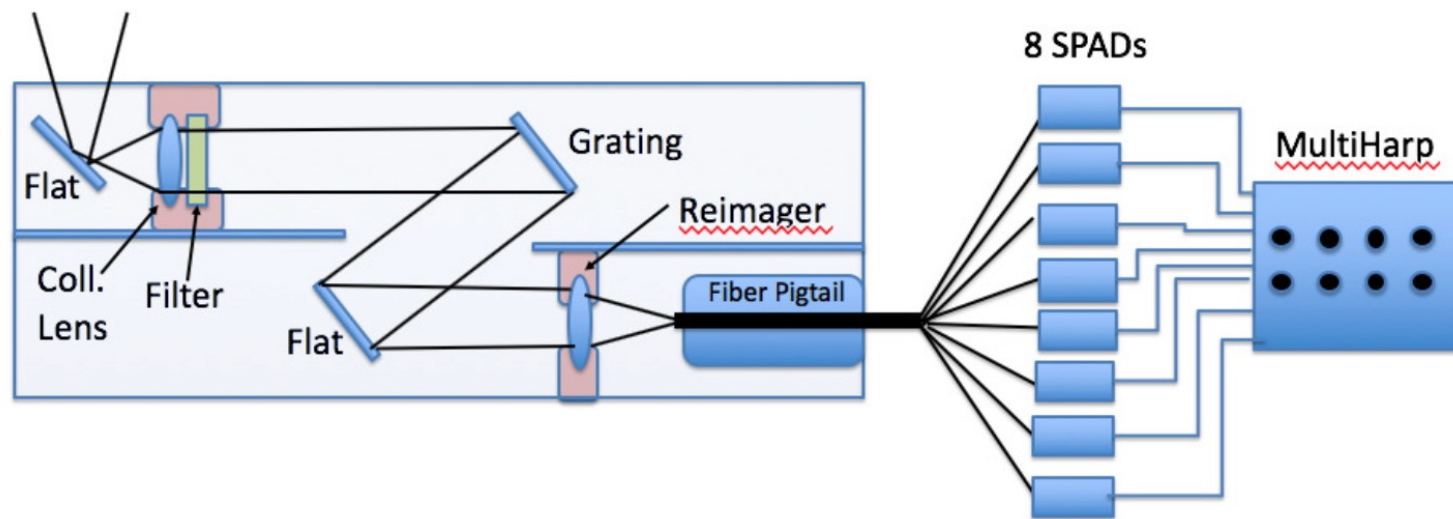
Two examples

Two Telescope operation (Aug 2024, Sebastian and me).



Increasing Efficiency

- Idea: Observe multiple wavelengths simultaneously. Originally, thought to fiber-feed with single-mode fiber.



SPAD Arrays

512-pixel Linear Array



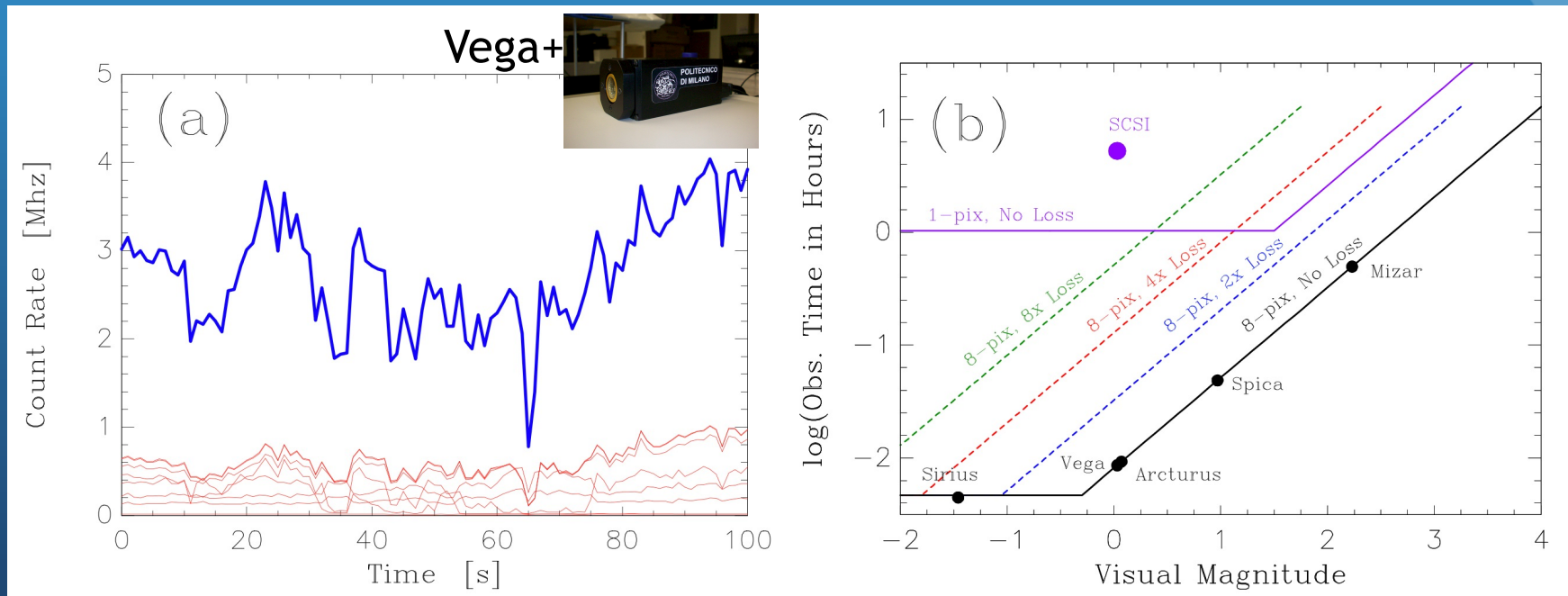
8-pixel linear array



- Deadtime and small size can be mitigated if you have many SPADs all looking at the same source.
- Can use more light.

Preliminary Multi-Channel Work

- Using our 8-pixel SPAD array, we have taken preliminary data reading out all 8 channels with a PicoQuant HydraHarp 8-channel timing correlator.



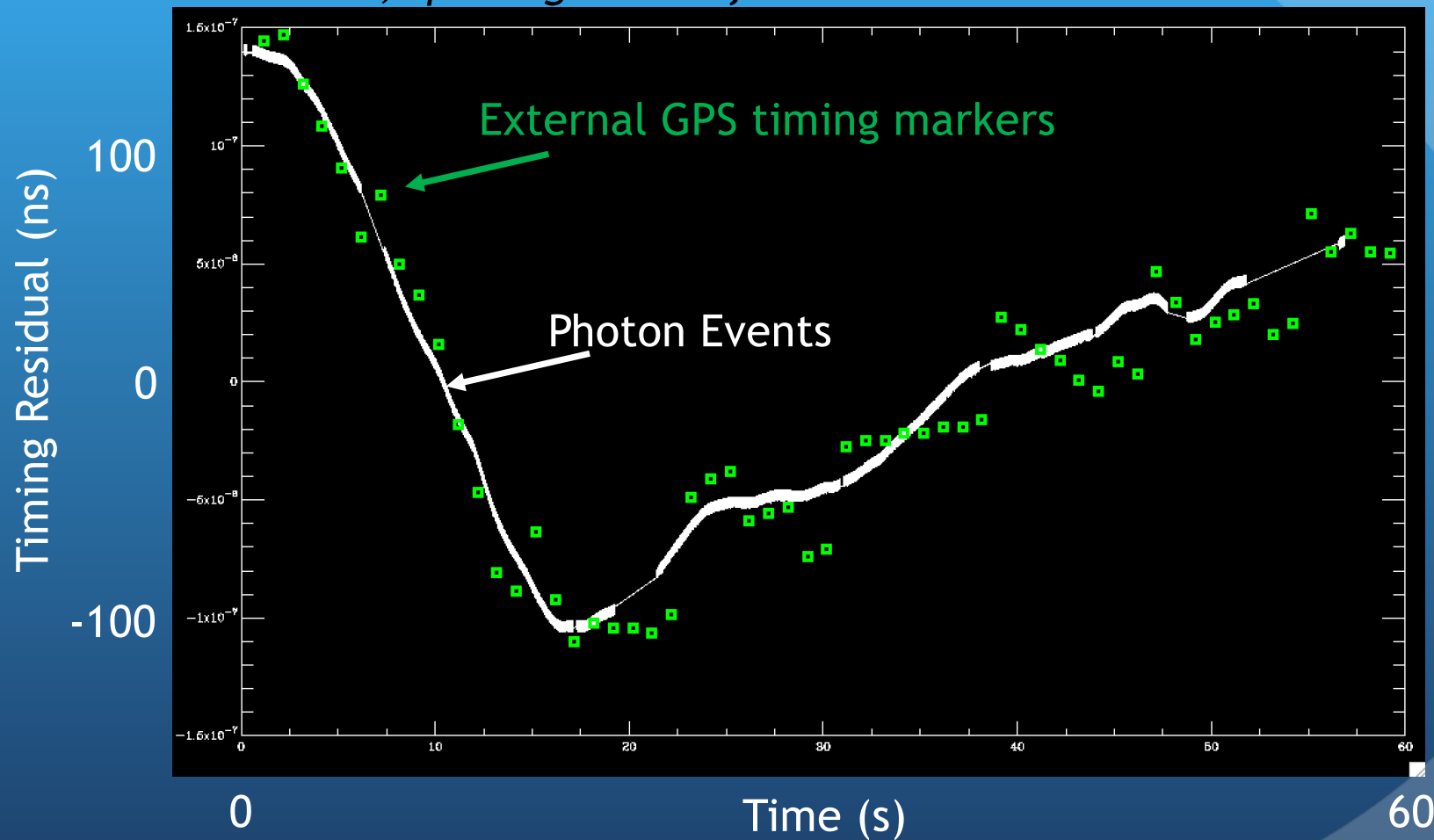
Optics Package for our 8-channel SPAD array



Matt Dever, B.S. 2020

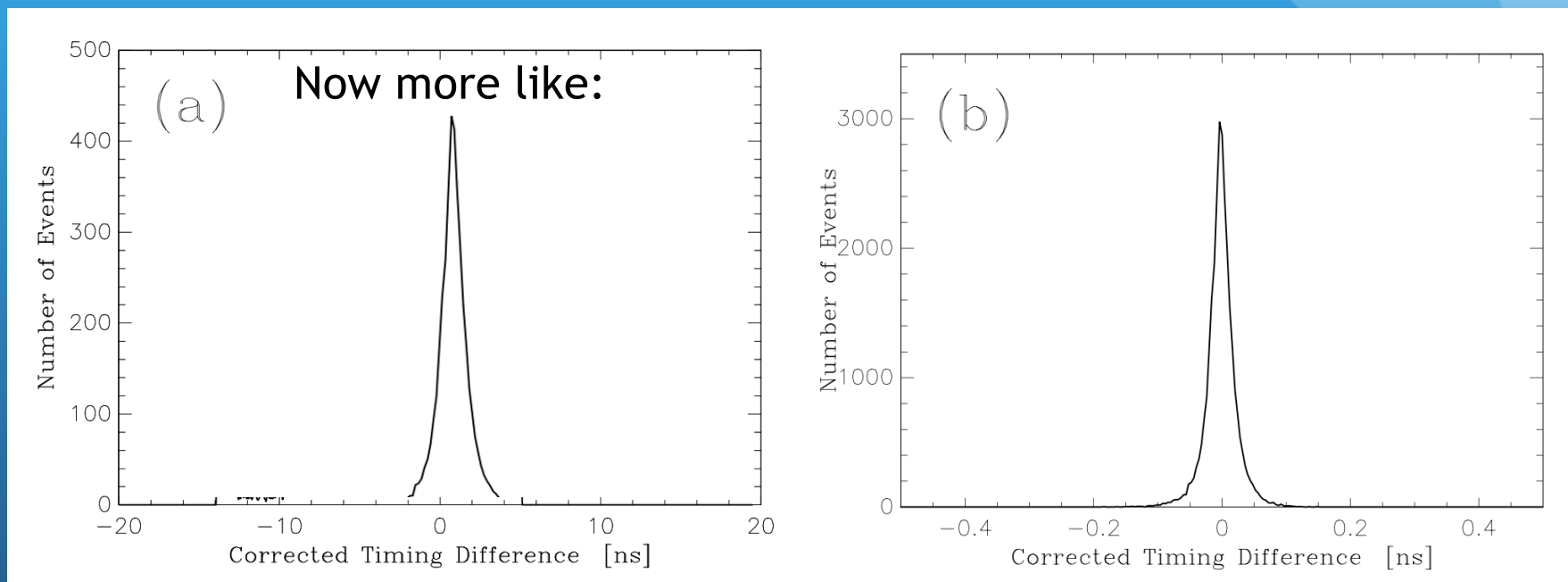
Multi-Channel SII may make wireless SII possible.

One SPAD; split signal and feed same events into two timers.



Better Efficiency Opens the Door to Wireless Interferometry

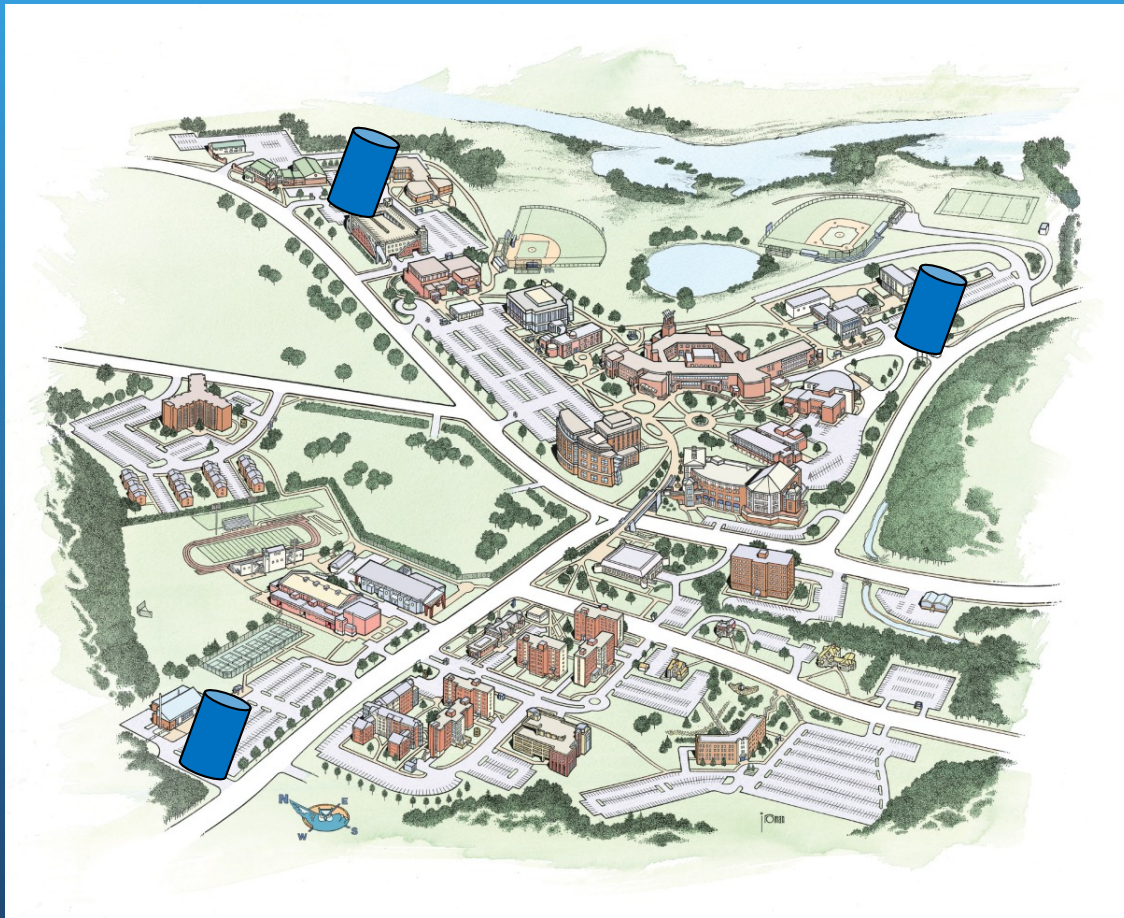
From: Horch et al 2018.



Histogram of timing differences for events read through two wireless stations.

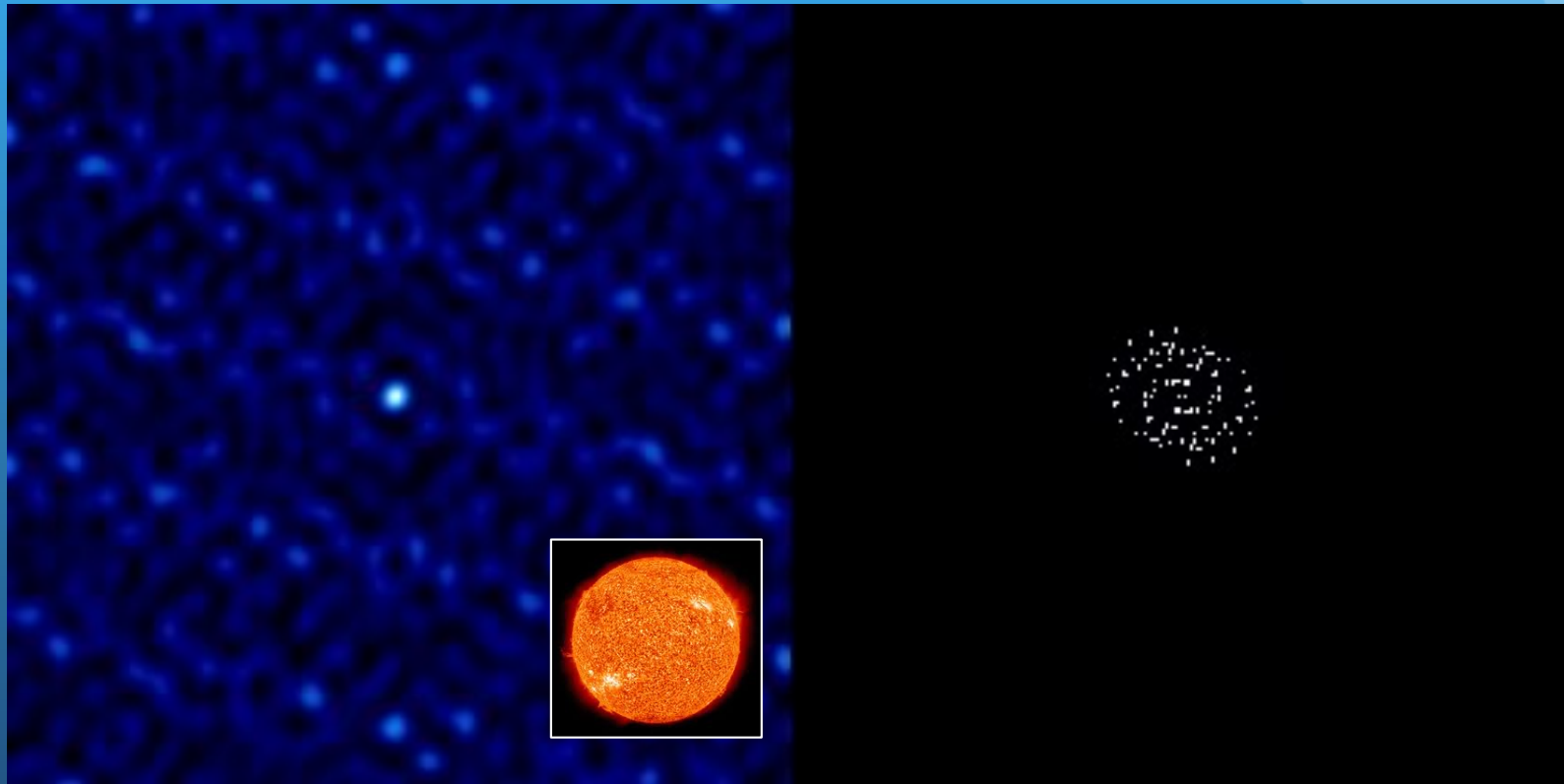
Histogram of timing differences for events read through a single wired set-up.

Three-Station Wireless Interferometer at SCSU



GPS
Computer
Cards:
~10ns
Synchronization
...
Or better! (~3ns in
Latest test)

“Dirty Beam” Simulation



FWHM \sim 0.1 mas

uv-plane coverage
6-hour observation

Summary

- SCSU has a working, highly re-configurable stellar intensity interferometer.
- *Possible Future Directions/Projects:*
 - *Work toward measurement of stellar diameters from our campus.*
 - *Take equipment to larger observatories.*
 - *Improving reliability and throughput (Autoguiders, 8 channels per station)*
 - *Wireless data on-sky.*
 - *We are interested in quantum-assisted ideas for stellar intensity interferometers.*

horche2@southernct.edu

[www/southernct.edu/astronomy](http://www.southernct.edu/astronomy)