Report from “Future Prospects of Intensity Interferometry” @ Perimeter Institute

Aaron Mueninghoff

11/5/24

Overview

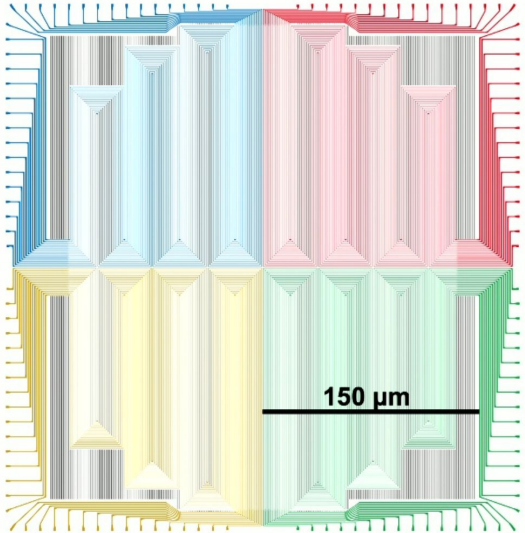
- Twenty 20+ minute talks over three days
  - Plus shorter talks and panel discussions
- 88 participants, most which were in person
  - People currently working on intensity Interferometry
  - Detector experts (SPAD & SNSPD)
  - Astrophysics theorists
  - Telescope array people (Cerenkov and spectroscopic) wondering if they could also do intensity interferometry
- All talks available at https://pirsa.org/24100100

Takeaways: Detectors

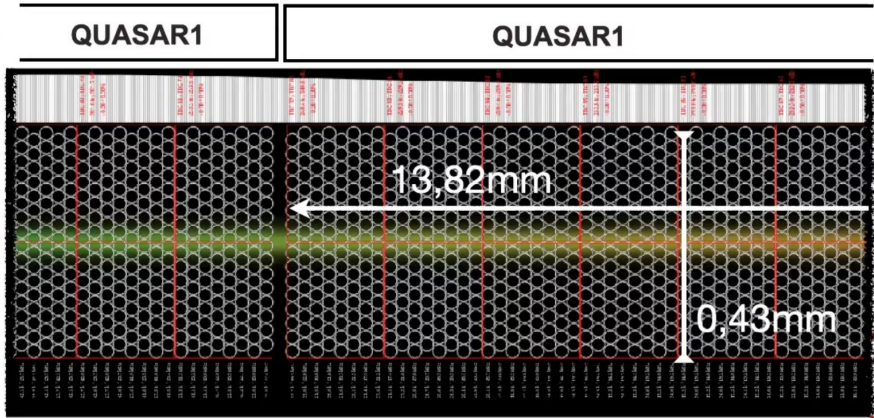
- SPADs are getting faster and arrays are getting bigger
- Example: QUASAR1 chip from EPFL
  - 16x512 SPADs, 60% fill factor, ~1 dark count/s at -30C
  - Also claimed EPFL SPADs with 5ps FWHM timing resolution and 50% PDE (unclear if the same device)
- SNSPD arrays are getting bigger
  - “Hero” devices exist with “ideal” quality in one area, but tradeoffs prevent detectors from being ideal in multiple areas
  - Cameras are also coming
  - SNSPD designs are actually easy to make, so designs specifically for intensity interferometry can be experimented with

Ioana Craiciu
https://pirsa.org/24100102

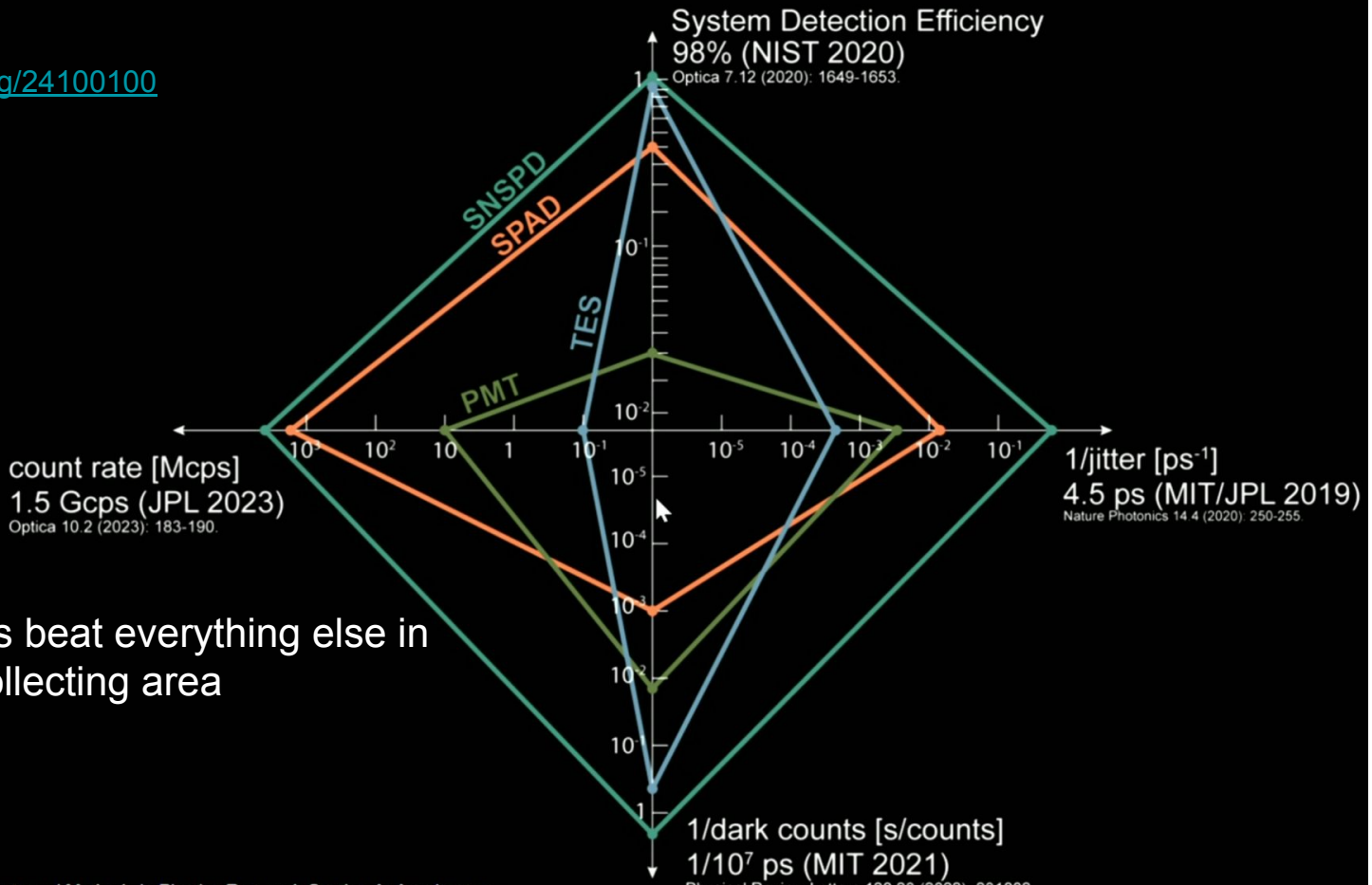
64 nanowire array in 4 quadrants



Roland Walter
https://pirsa.org/24100105



Karl Berggren
https://pirsa.org/24100100

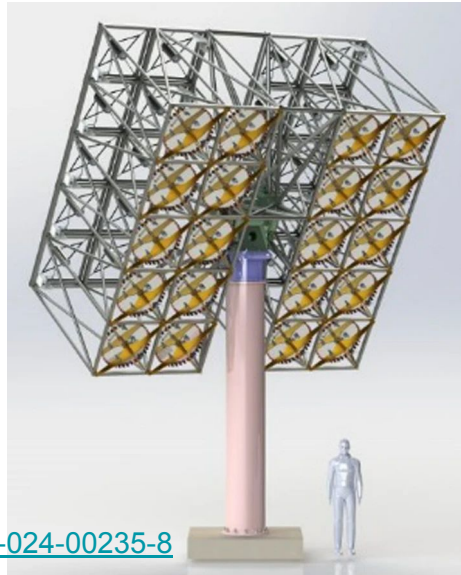


Note: PMTs beat everything else in terms of collecting area

PMT data: Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment, 926, 2-15.
SPAD data: Chip (2022): 100005.
TES data: [illegible]conducting devices in quantum optics (2016): 31-60.
Other missing data: Nature photonics 3.12 (2009): 696-705.

Takeaways: Telescopes

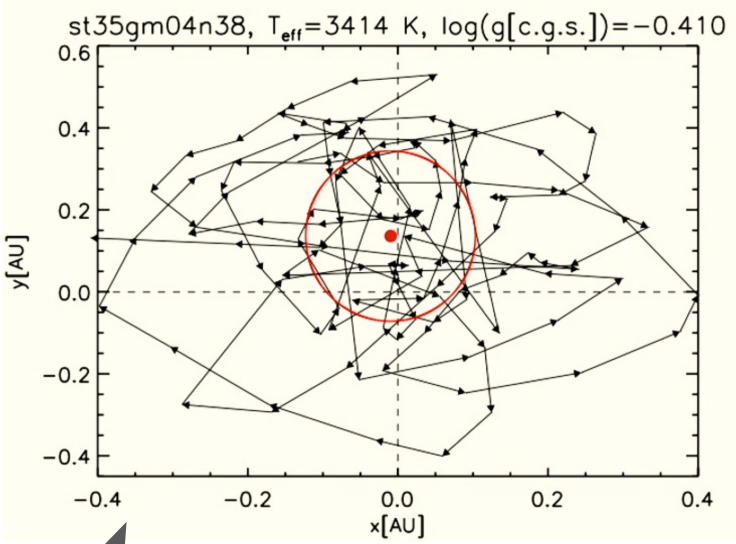
- Some large arrays are “up for grabs” soon
  - They are poor quality light buckets with ~5ns deviation across telescope and large spot size
  - But they have large collecting areas
- Small-aperture arrays for spectroscopy might be usable for intensity interferometry as well
  - MAST in Israel, LFAST in Arizona
  - Very cheap per collecting area compared to large telescopes
  - Modal dispersion in multimode fibers could be a problem
- Slowly coming to the agreement that we need to collect light into single mode fibers, even for standard HBT
  - Active work on first order adaptive optics in several groups
  - There may be off the shelf versions available for purchase soon
  - Box that takes in a MMF and spits out an SMF using AO



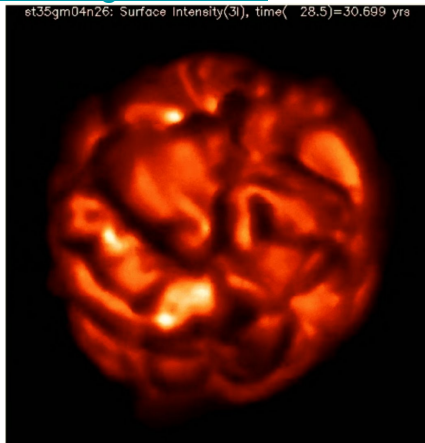
Joel Berkson, Chad Bender
https://doi.org/10.1007/s41871-024-00235-8

Takeaways: Science Cases

- Mostly far-future cases: 8-12mag, sub μarcsec precision, 10-1000km baselines
- Geometric distance measurements:
  - Type II-P supernovae expanding photosphere
  - AGN broad-line region
- Imaging:
  - Binary supermassive black holes
  - Supermassive black hole accretion discs (Milky Way and nearby)
  - Red supergiant star surfaces
- Convection of Betelgeuse
  - More feasible in the near future
  - Does Betelgeuse have a solar mass companion?
- Astrometric detection of exoplanets



Jared Goldberg
https://pirsa.org/24110038



Reception of SNSV

Ken Van Tilburg
https://pirsa.org/24110043

- Actually doing *amplitude* interferometry, not intensity
  - But we offer similar advantages and are struggling with similar problems
- Very similar to Extended-Path Intensity Correlation (EPIC)
  - Topologically equivalent in some regimes
- Some disagreement about whether looking through two different columns of atmosphere will result in problematic SNR falloff at wide angles
- Overall good reception
- Only report of multifrequency HBT in a spectrometer?