Title: High Throughput Single Photon Detection for effective SII

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Collection/Series: Future Prospects of Intensity Interferometry

Subject: Cosmology

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Abstract:

In this talk we want to promote a new kind of single photon detector able to record high count rates with the prospect of making stellar intensity interferometry (SII) measurements more effective. This micro-channel plate based photomultiplier tube from Photonscore (LINPix) is nearly dead time free and offers an active area of 8mm diameter. By choosing a matching photocathode, the quantum efficiency (QE) can take values greater than 30% at the desired wavelength. Using a Hi-QE Blue photocathode in a testbench featuring a fs-pulsed laser we were able to measure the timing resolution of the LINPix at different count rates from 190kHz up to 95 MHz. We find that the timing resolution of the detector only increases marginally when increasing the laser power and stays well below 100ps. Hence, we conclude that together with the LINTag, a suitable time to digital converter from Photonscore able to process the high throughput, this system can contribute significantly to the further development of SII.

High Throughput
single photon detection
for effective SII
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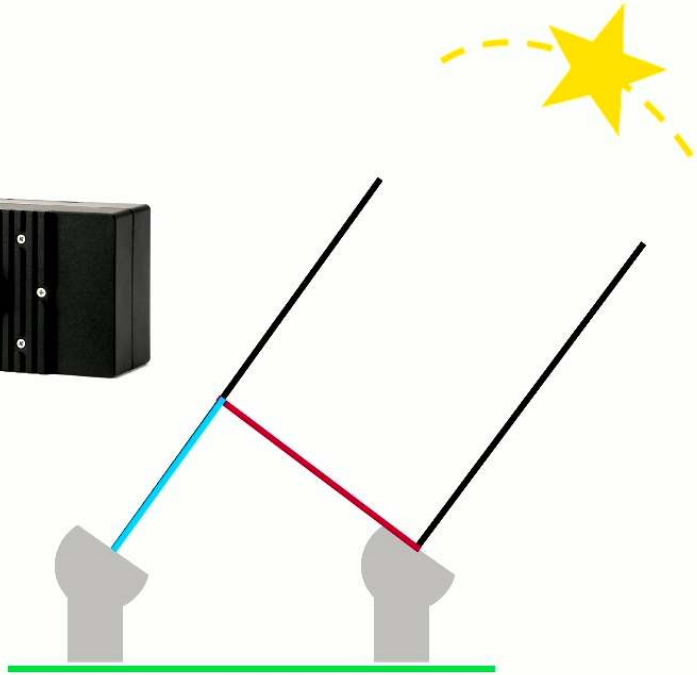
Future Prospects of Intensity Interferometry 2024

Agenda

1. Motivation
2. New kind of single photon detector: LINPix
3. Timing Resolution measurements
4. Synchronizing TDCs
5. Outlook



Motivation

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- Larger telescopes increase SNR in HBT measurements
- For bright stars: hybrid single photon detectors saturate for telescopes > 1m
- For spatial correlations ordered timestream is necessary
- Manageable data rate

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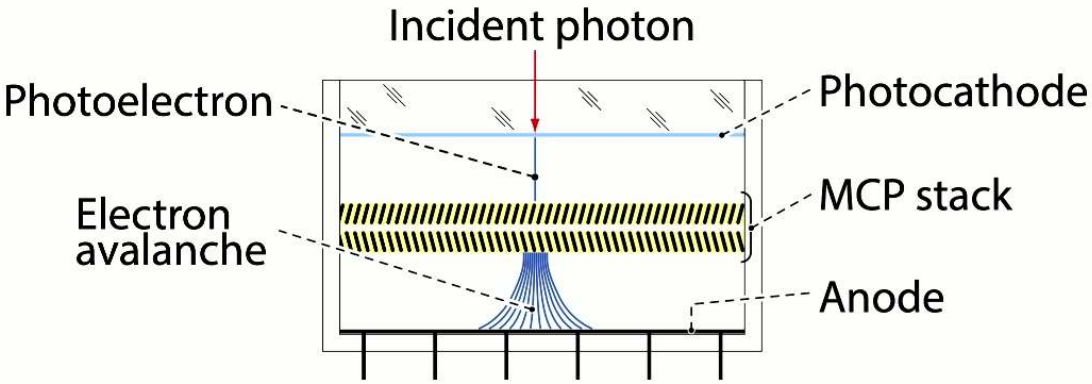
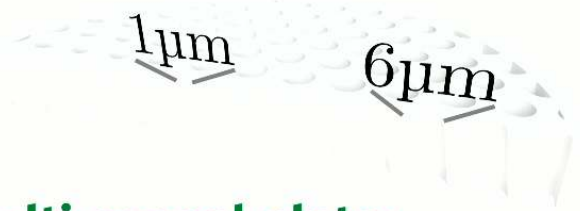
Solutions:

1) Use new kind of detector
2) Use White Rabbit
3) Use high throughput TDC

New kind of single photon detector: LINPix

LINPix from Photonscore



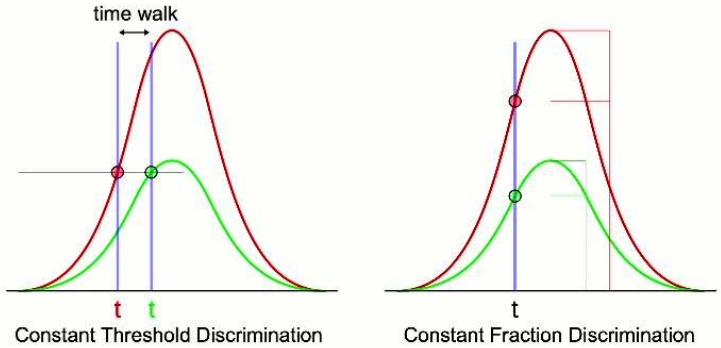


Multi cannel plate:

- Amplify signal
- Chevron stack → Gain > 10^6
- Channel tilt = 5° – 10°

Constant fraction discriminator (CFD):

- Reduce timing walk for varying pulse amplitude
- NIM out via SMA

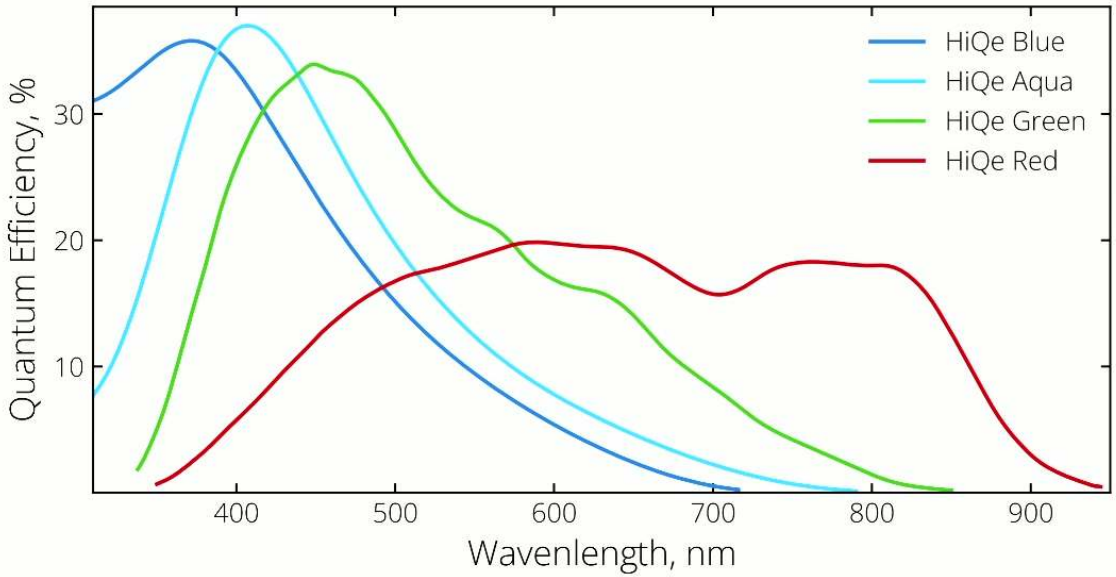


Possible Photocathodes for LINPix

FAU

Quantum efficiency

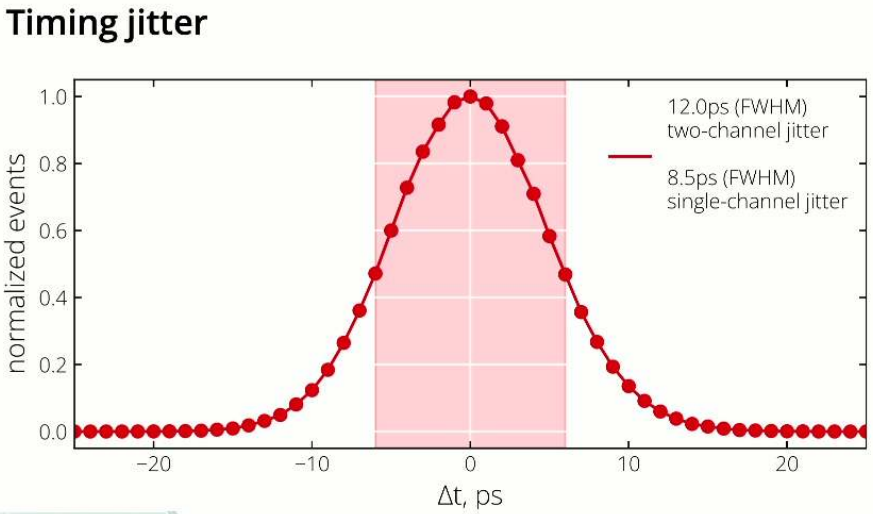
PHOTONIS
Reveal the invisible



Photonscore.
PHOTON COUNTING MADE EASY

LINTag from Photonscore

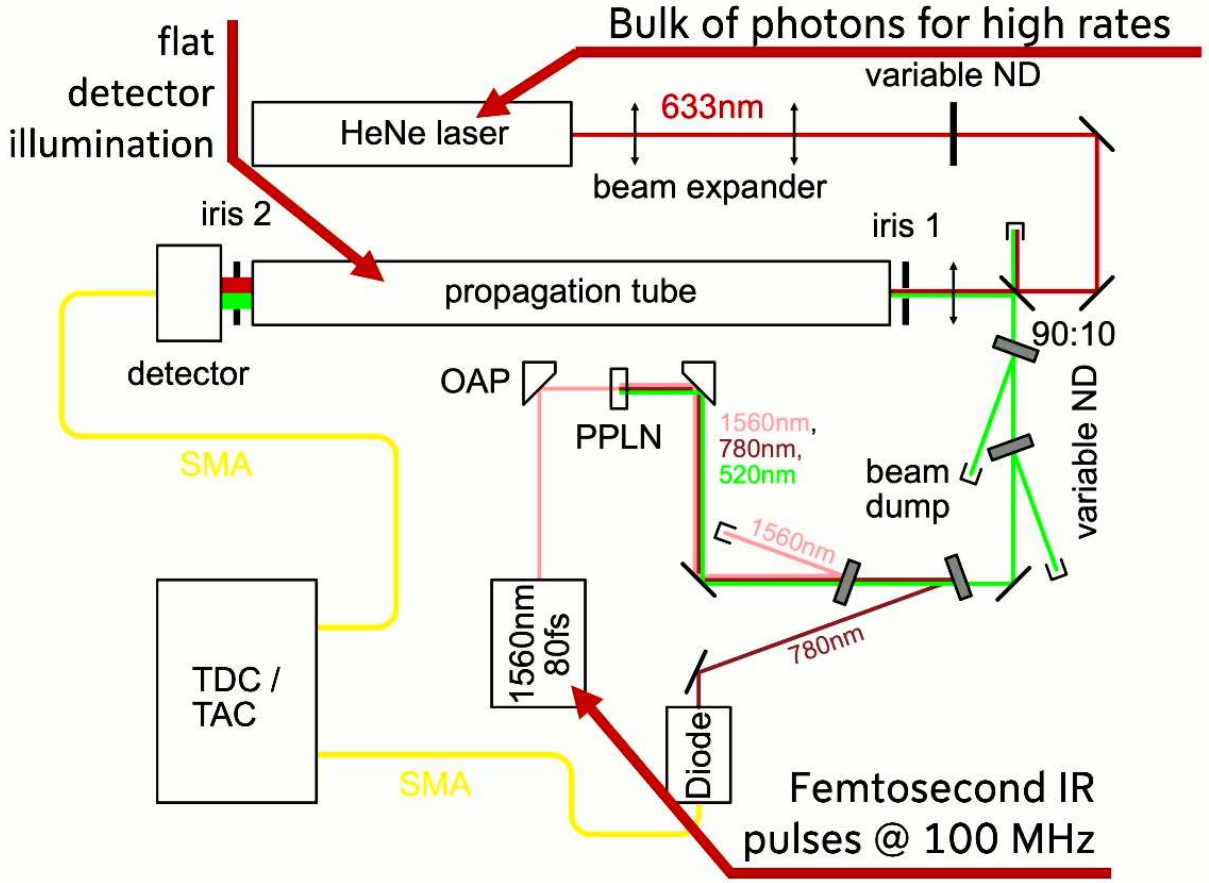
- time-tagger system developed for ultra-fast data acquisition
- Temporal accuracy of 8.5ps (FWHM) / 3.6ps (RMS)
- 8 high resolution channels
- 10G Ethernet SFB+ connection
- full-stack TCP/IP interface
- Transfer up to 400 MEvents/s in compressed hirarchical dataformat



Photonscore.
PHOTON COUNTING MADE EASY

Timing resolution measurements

Detector Testbench



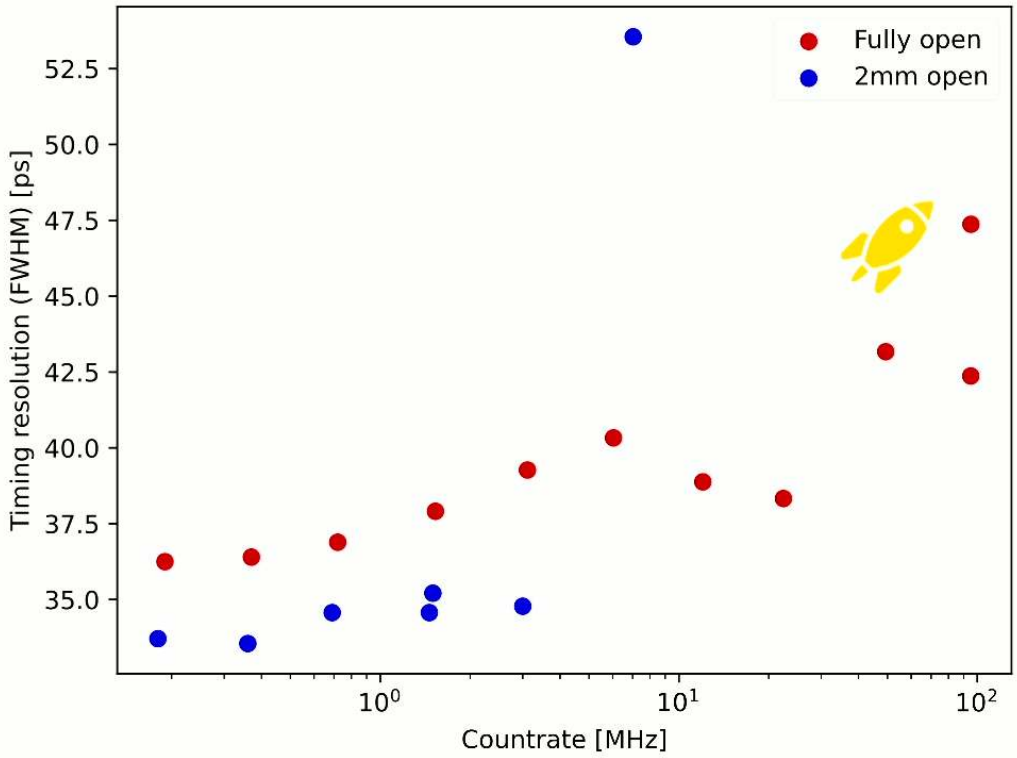
- Obtain timing resolution by correlating detector and diode signal
- Used Hi-QE Blue photocathode
- Tune count rate from 180kHz to 95MHz
- Vary opening diameter of iris 2

Timing resolution of the setup

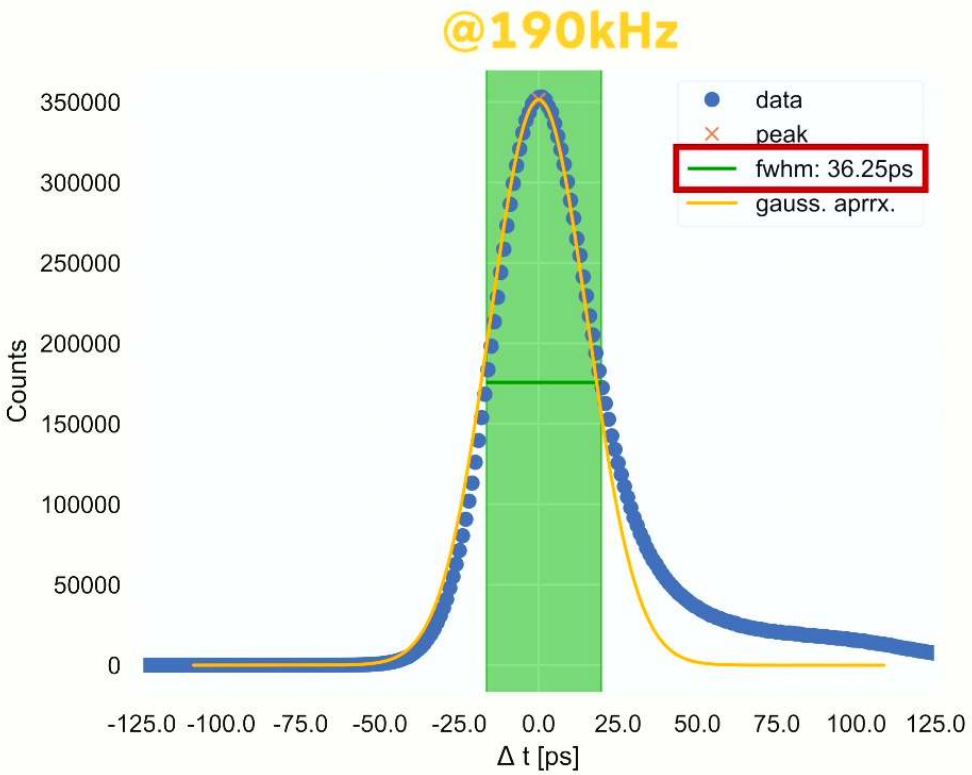
Varying the illuminated area:

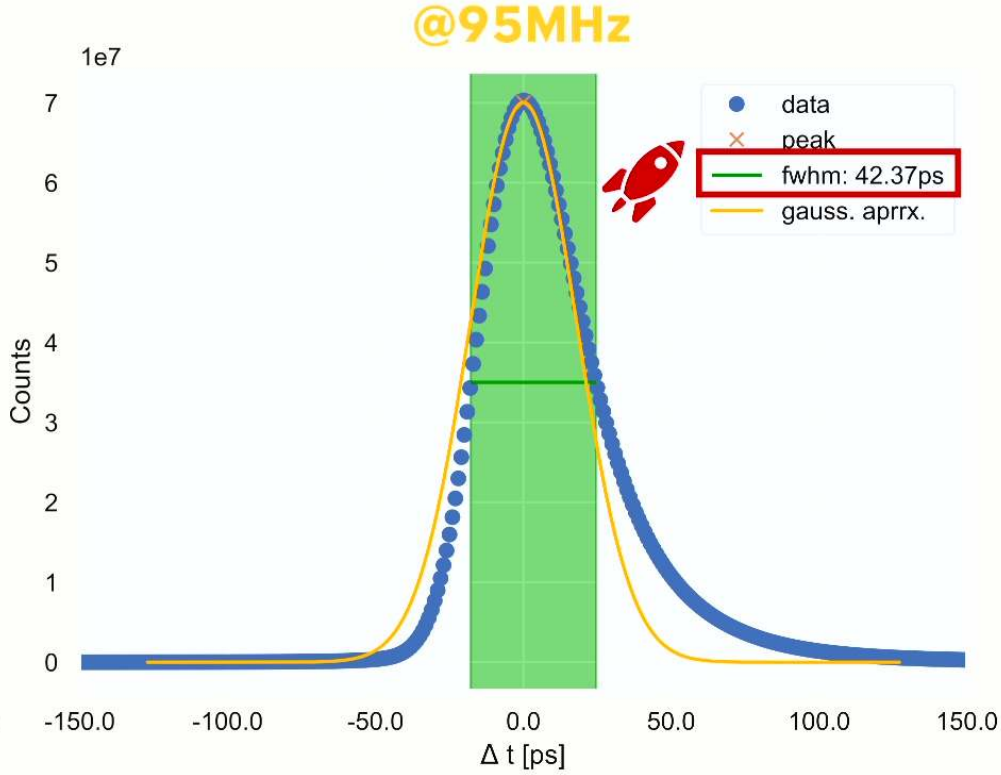
- Tune iris to 2mm opening diameter
- Smaller active area → similar timing resolution
- Full area increases jitter by < 5 ps

Iris closed and open

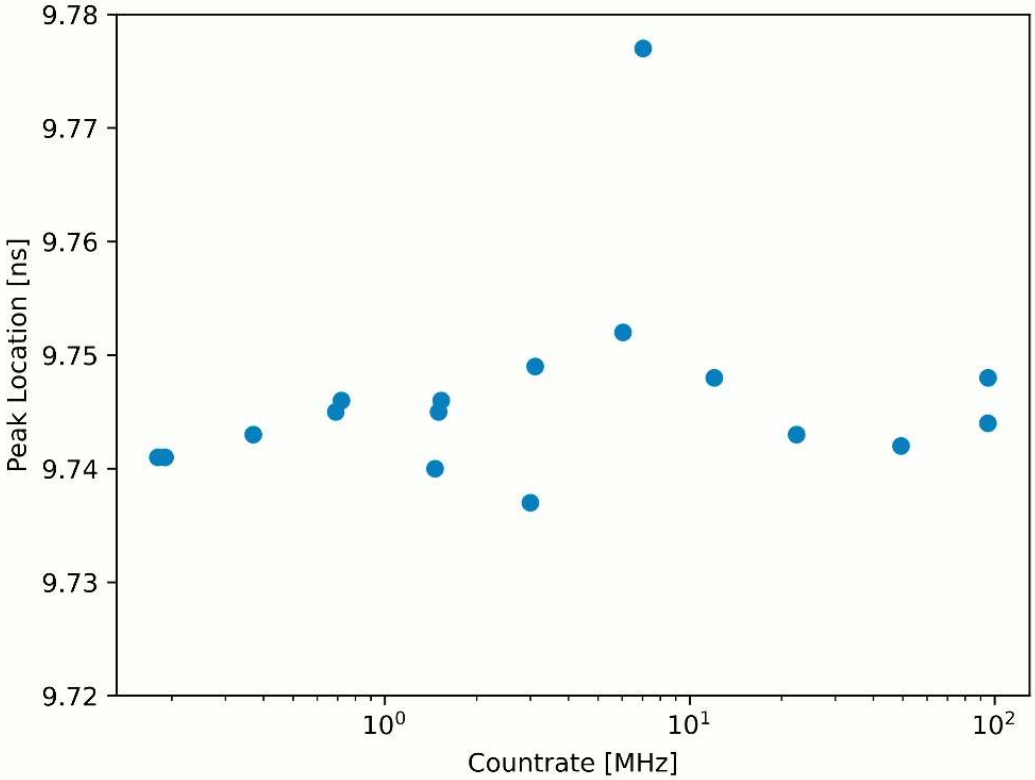


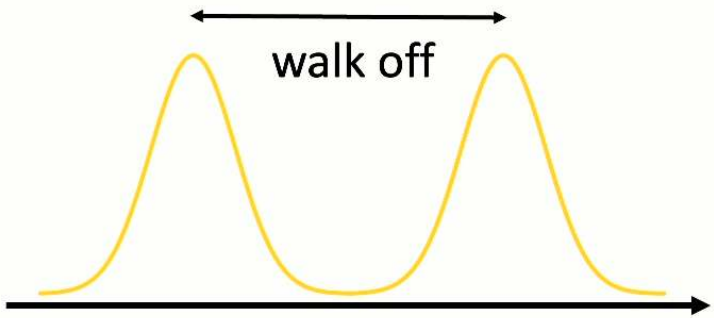
Timing resolution





Timing resolution of the setup



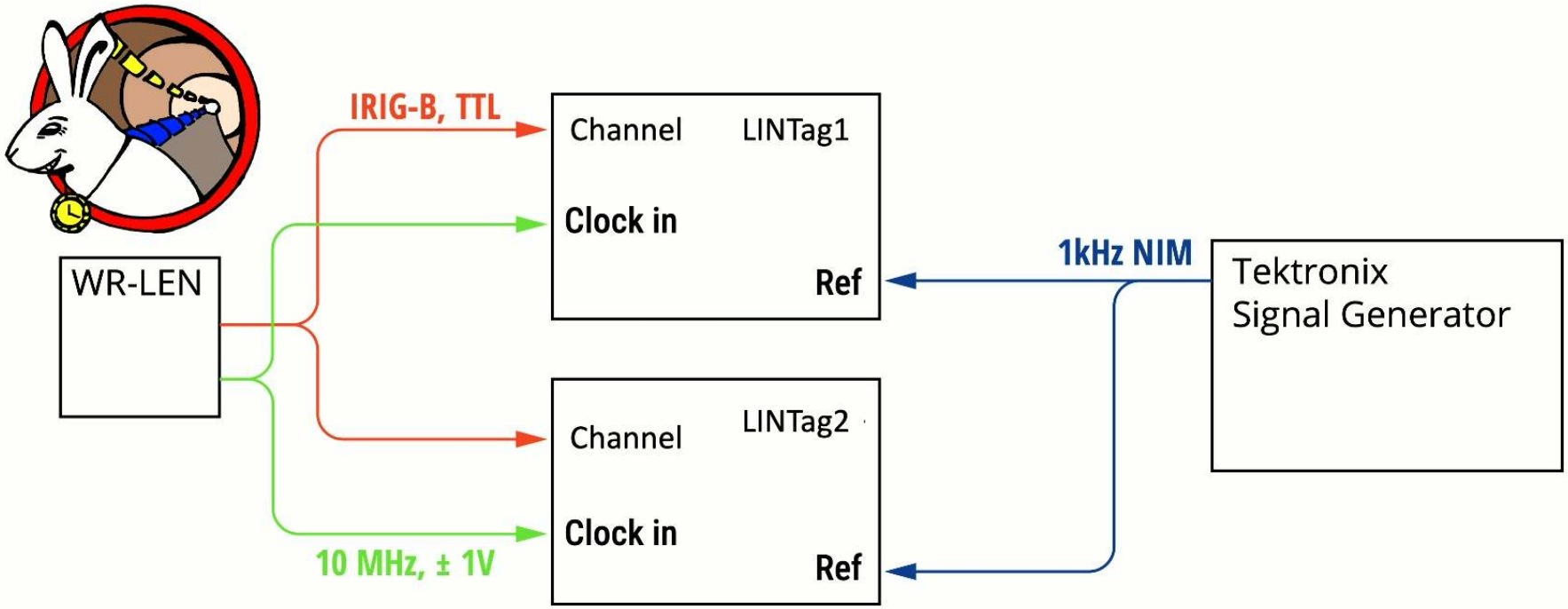


Peak position walk off:

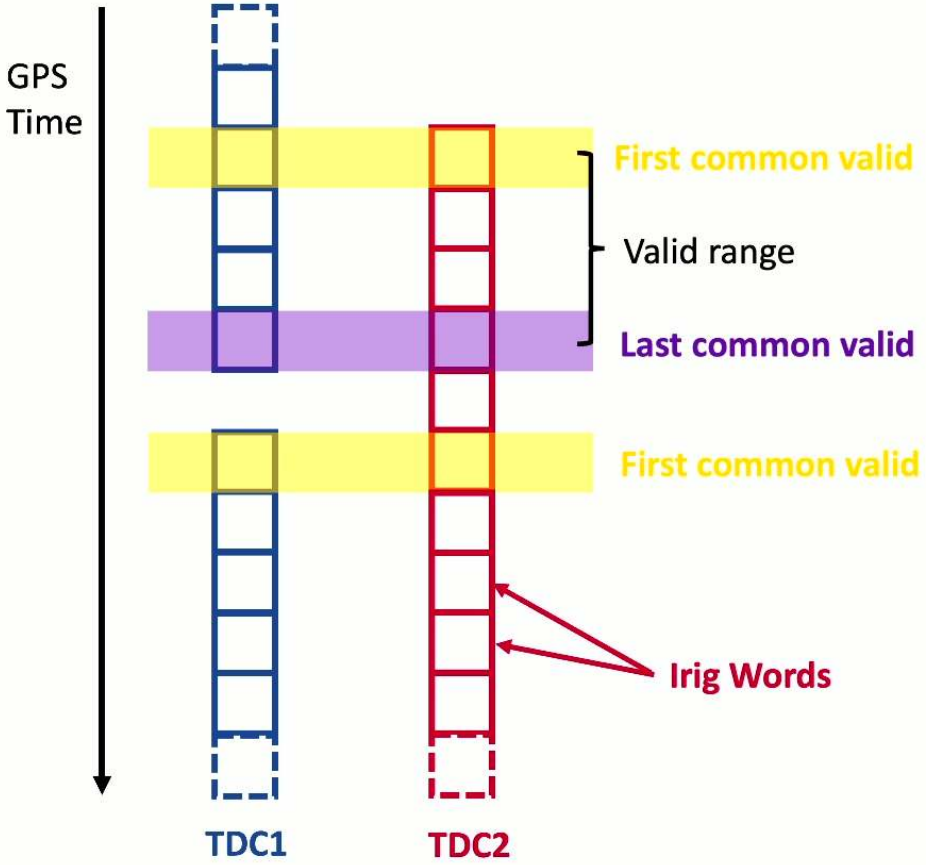
- Higher rates shifts peak to higher delay times
- Walk off < 20 ps

Synchronizing TDCs

Synchronizing TDCs Setup



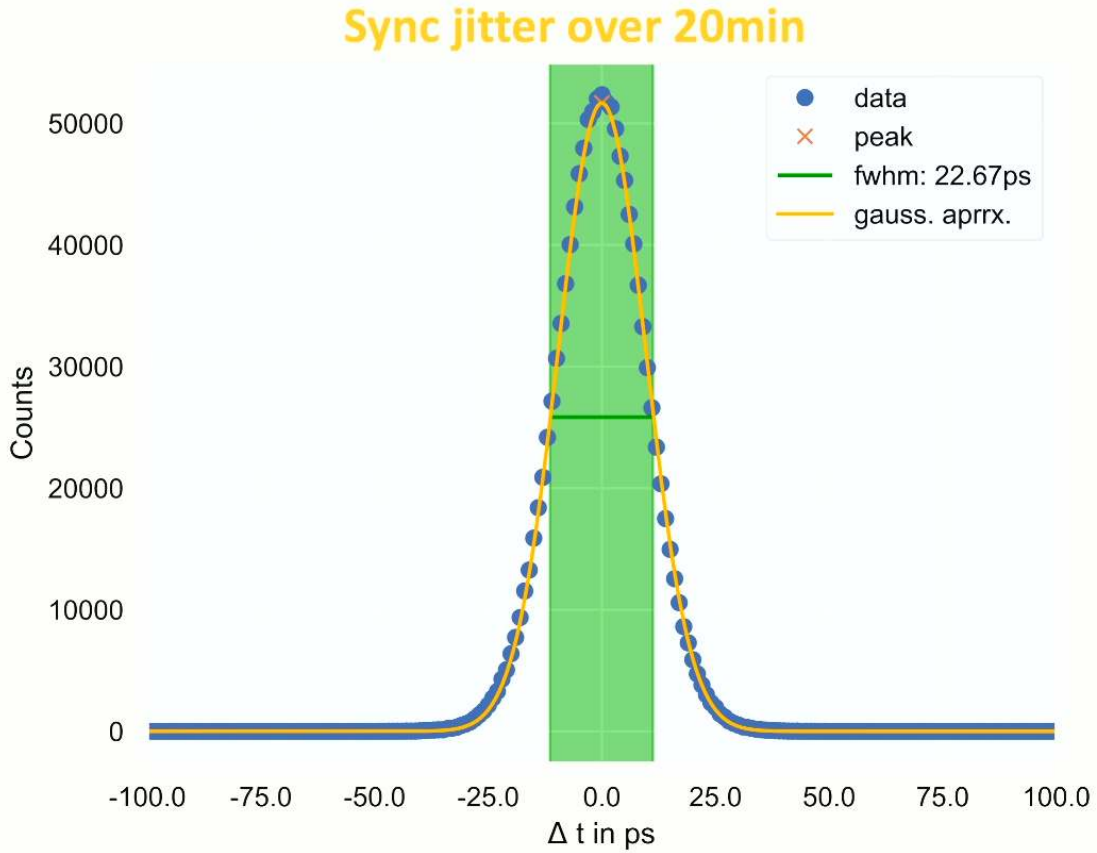
Synchronizing TDCs



Procedure:

- Build an IRIG-Word Stack to each provided file
- Finding the range when all overlap. If outliers exist they won't be processed
- Search for file with smallest TDC-Counter and use it as a time reference for all other files
- Check each second the offset between matching IRIGs and compensate using a smooth-function

Synchronizing TDCs



Outlook

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To Do:

1) Higher count rates?
2) Bursts?
3) Km baselines?

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To Do:

1) Higher count rates?
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1) Try 100MHz bunching
2) Check burst capability of LINPix

Outlook

To Do:

1) Higher count rates?
2) Bursts?
3) Km baselines?

1) Try 100MHz bunching
2) Check burst capability of LINPix
3) Try WR with long fibers and test synchroniz-ability of multiple TDCs in the field

Thank you
for your attention