Development & performances of 20 picosecond intensity interferometry setup

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2025, Oct 15

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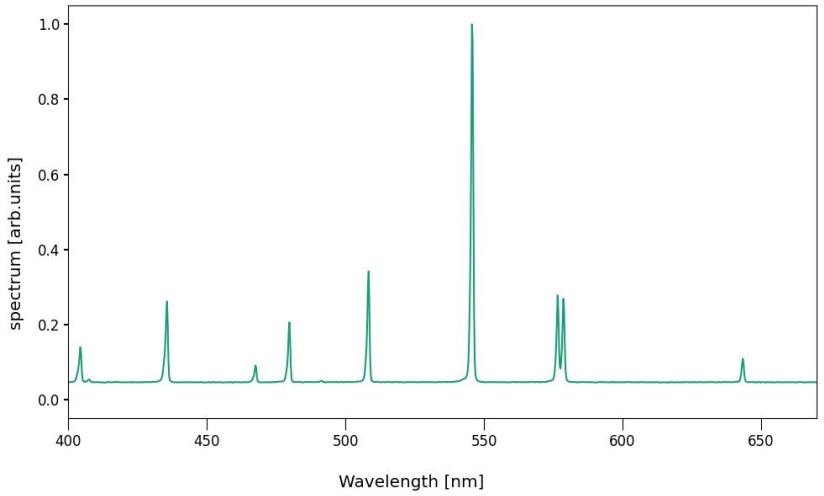
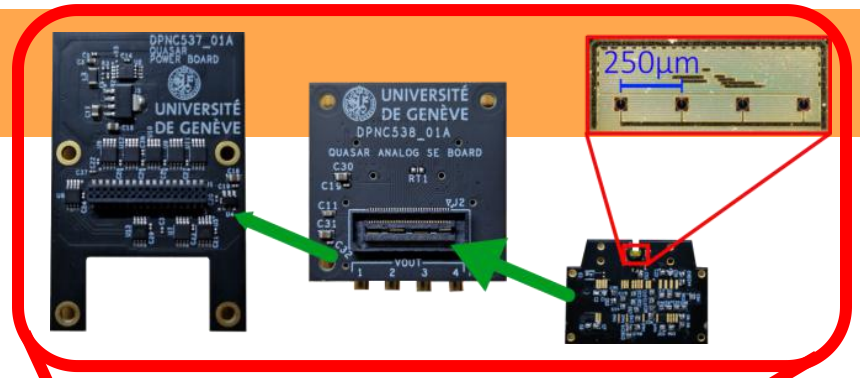
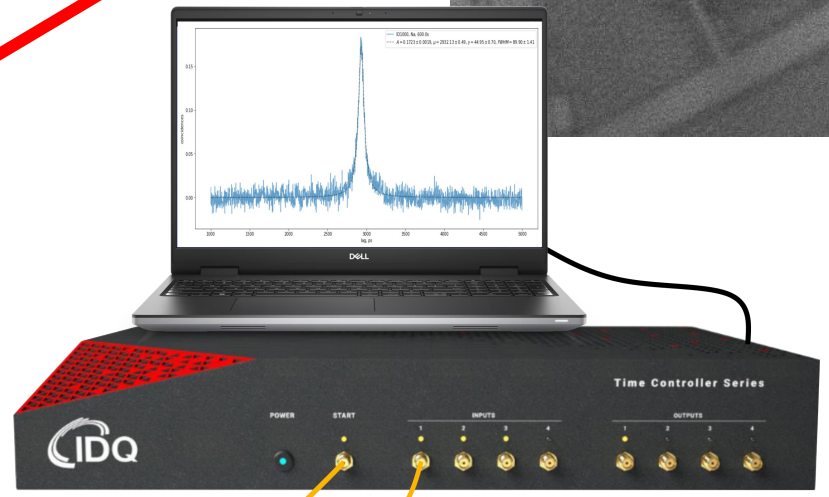
Experimental Setup

- SPADs (EPFL, CH)
  - 12.1ps FWHM
  - Analog readout (UNIGE boards)
- ID1000 TDC (IDQ)
  - 1ps dig. res
  - 3.6ps RMS measured
- Light sources (thermal)
  - LED / Hg-Cd lamps
  - Filters + tilting

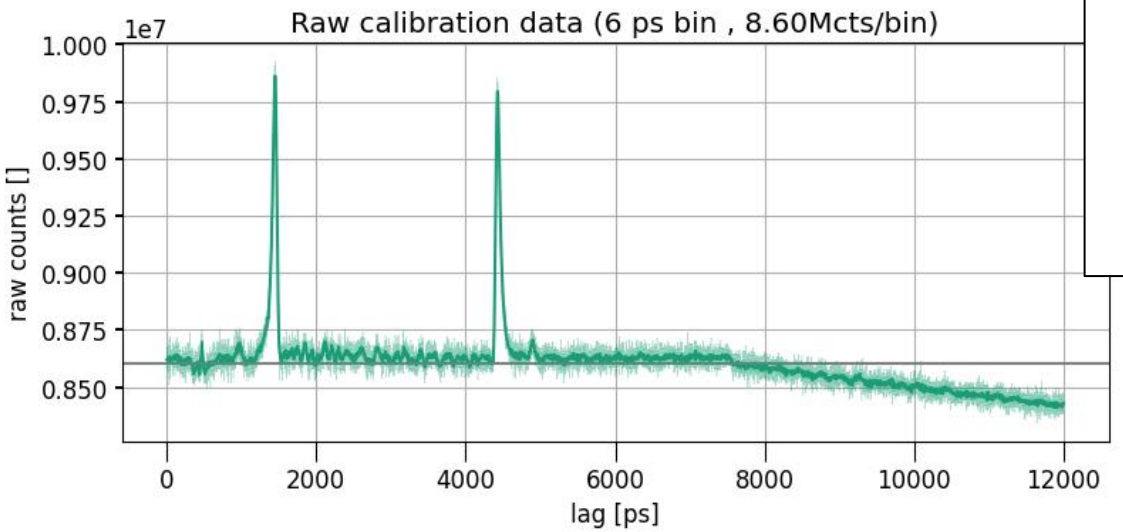


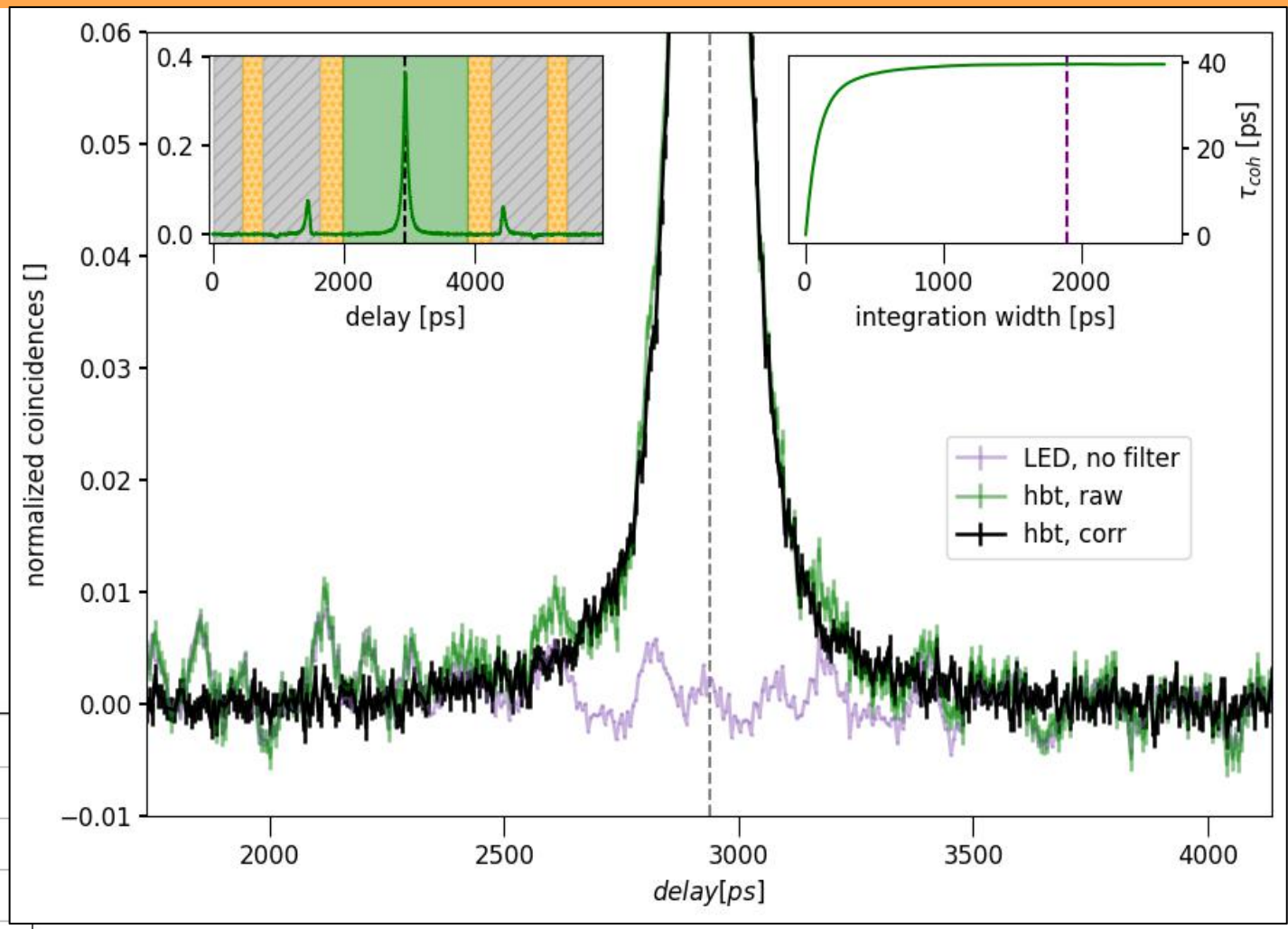




Features

- Correlated noise
  - SPADs + TDC
  - Stationary ⟶ removable (“calib”)
- Features
  - Reflections, dead-time
  - Systematically removed
- Signal
  - Electronic delay
  - Integration width



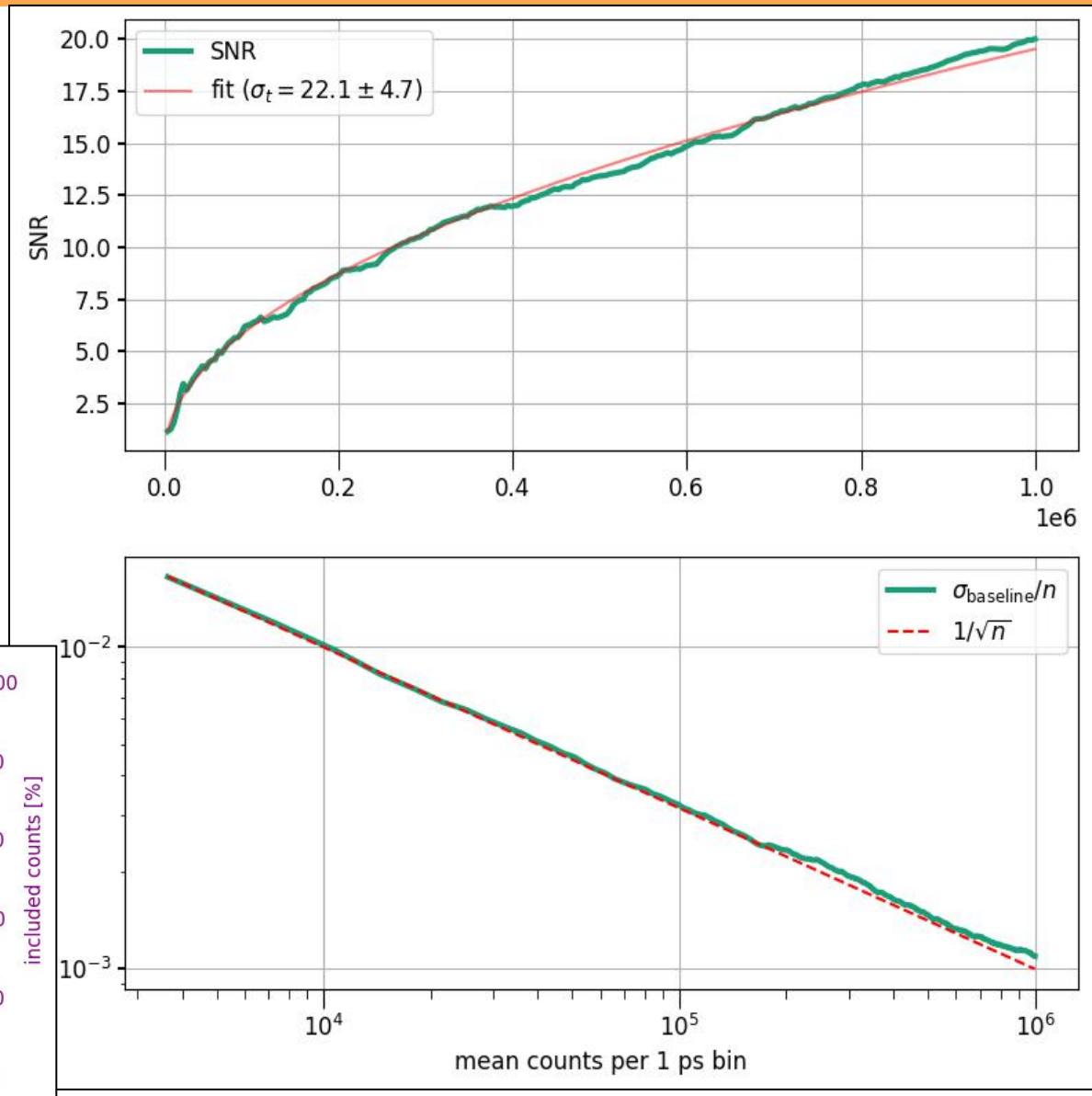


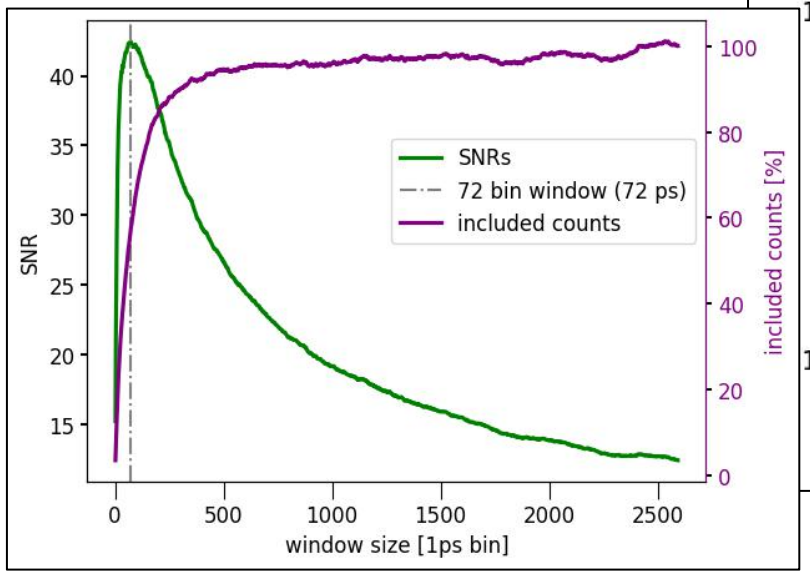
SNR

- LED light w/ 1nm filter
  - τ_{coh} 0.57ps
  - 160h data taking
  - Const 2.5MHz rate

- Noise subtraction accounted
  - Integration window: 72ps
  - Fit time resolution (assuming gaussian):
    $\longrightarrow 22.1 \pm 4.7$ps

- Low systematic
  - Line analysis

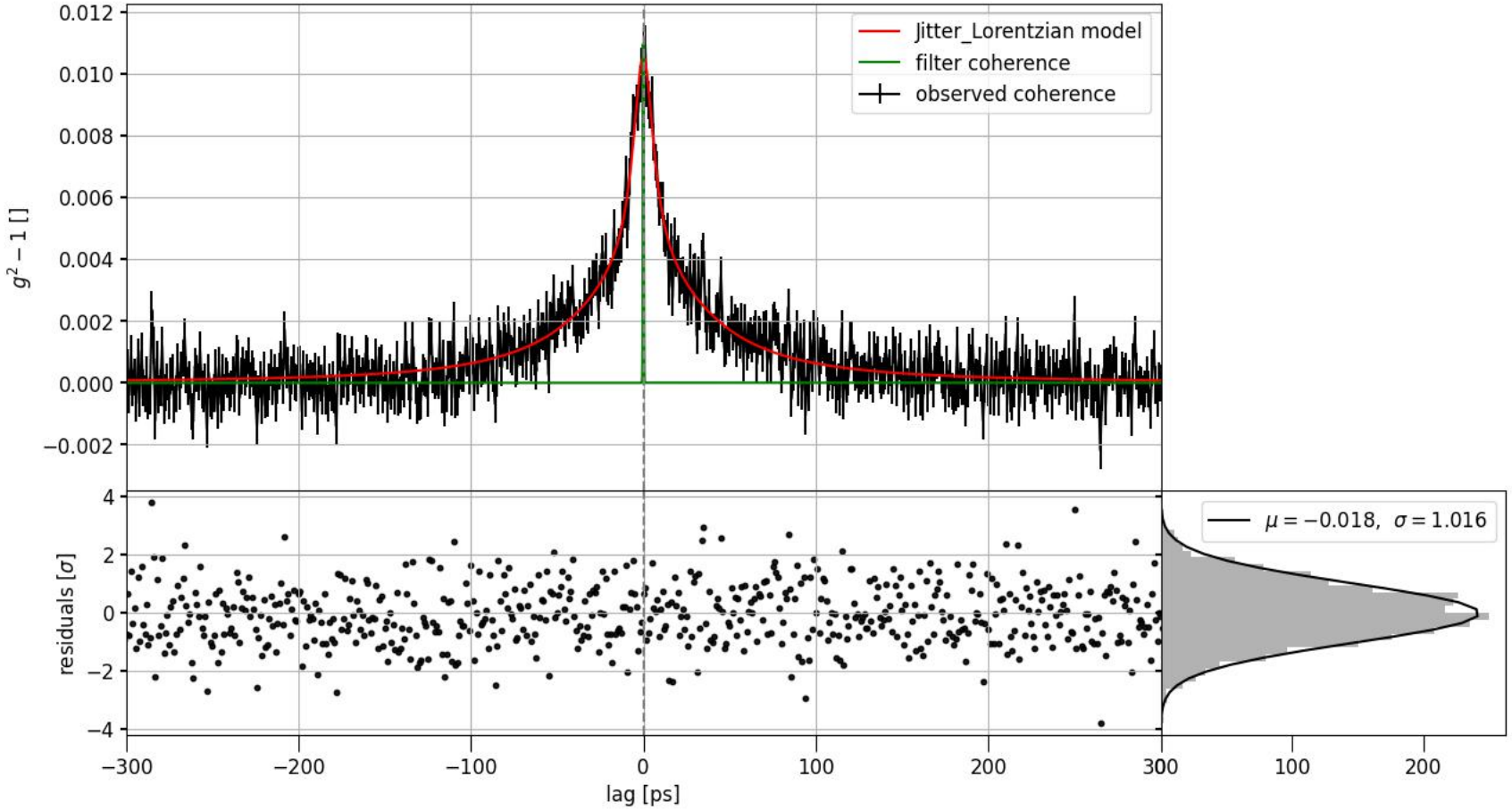




Time resolution

- LED light w/ 1nm filter
  - τ_{coh} = 0.57ps
  - measured : 0.59±0.02ps
  - gaussian with same integral : σ = 21.5ps

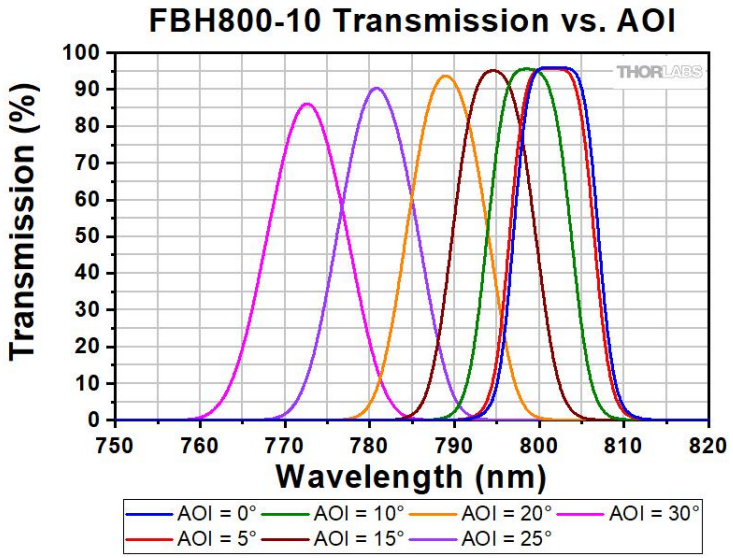
- Fit 2 lorentzian
  - Narrow core + tails
    - SPADs properties
  - ~23ps FWHM

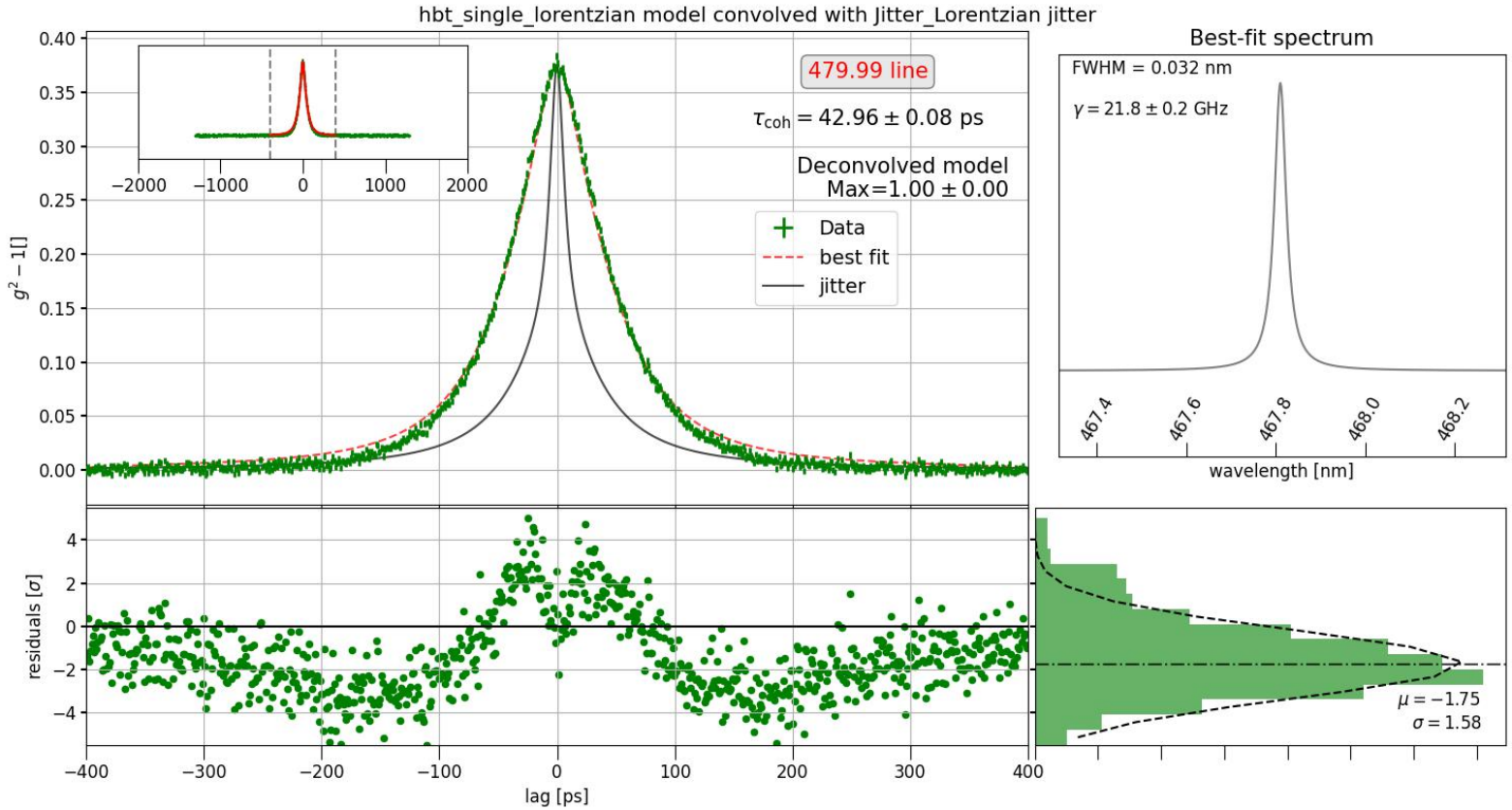


Line analysis

- Retrieve emission line width
  - Assume lorentzian/Voigt profile
  - Convolve with time res
  - Fit amp+linewidth
- Systematic W residuals
  - Time res ?
  - Filter ?
  - ⟶ Correct !

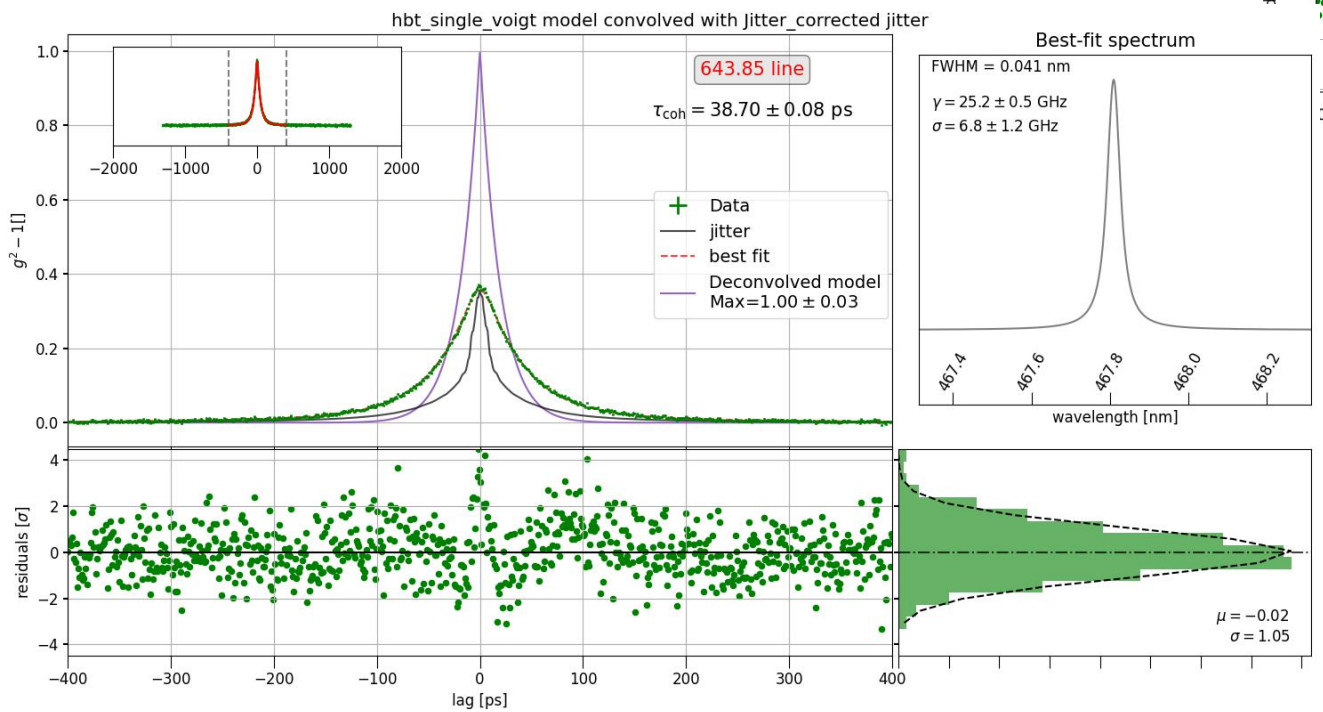
$$g^2(\tau) = 1 + \beta|g^1(\tau)|^2$$

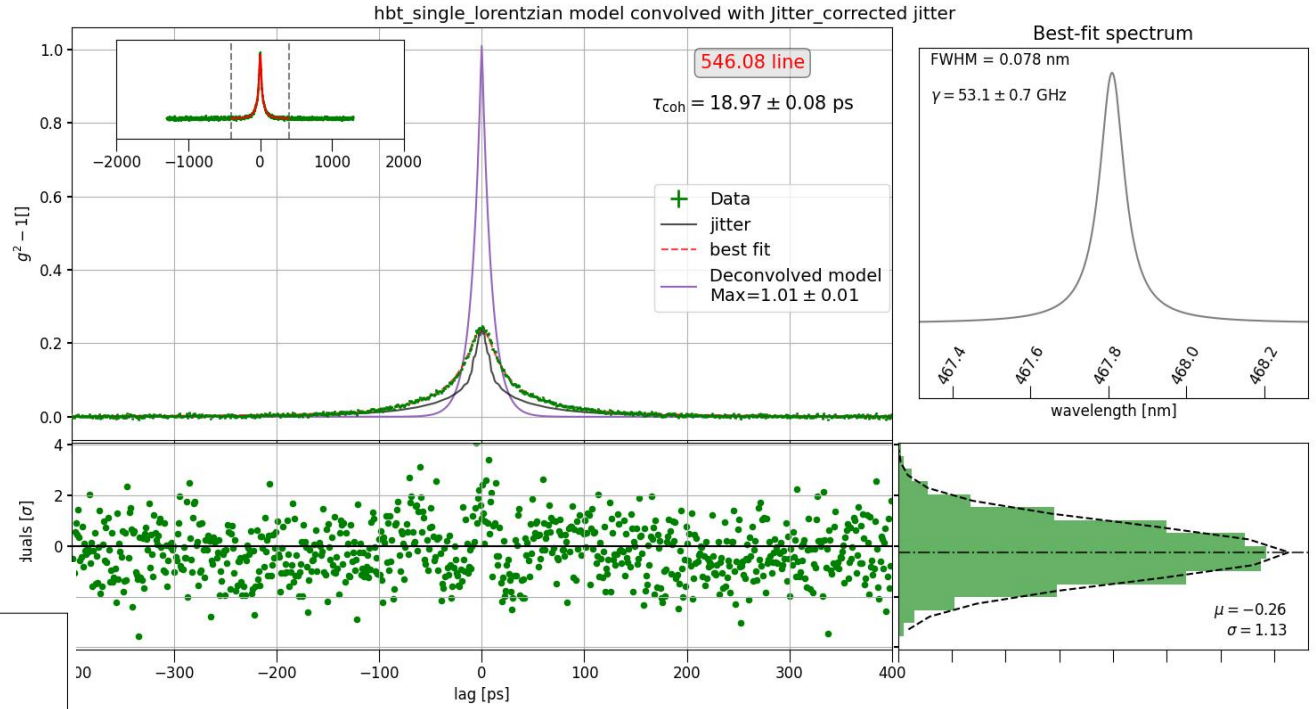




Line results

- Better residuals !
- Amplitude well estimated
- Lineshape dependant

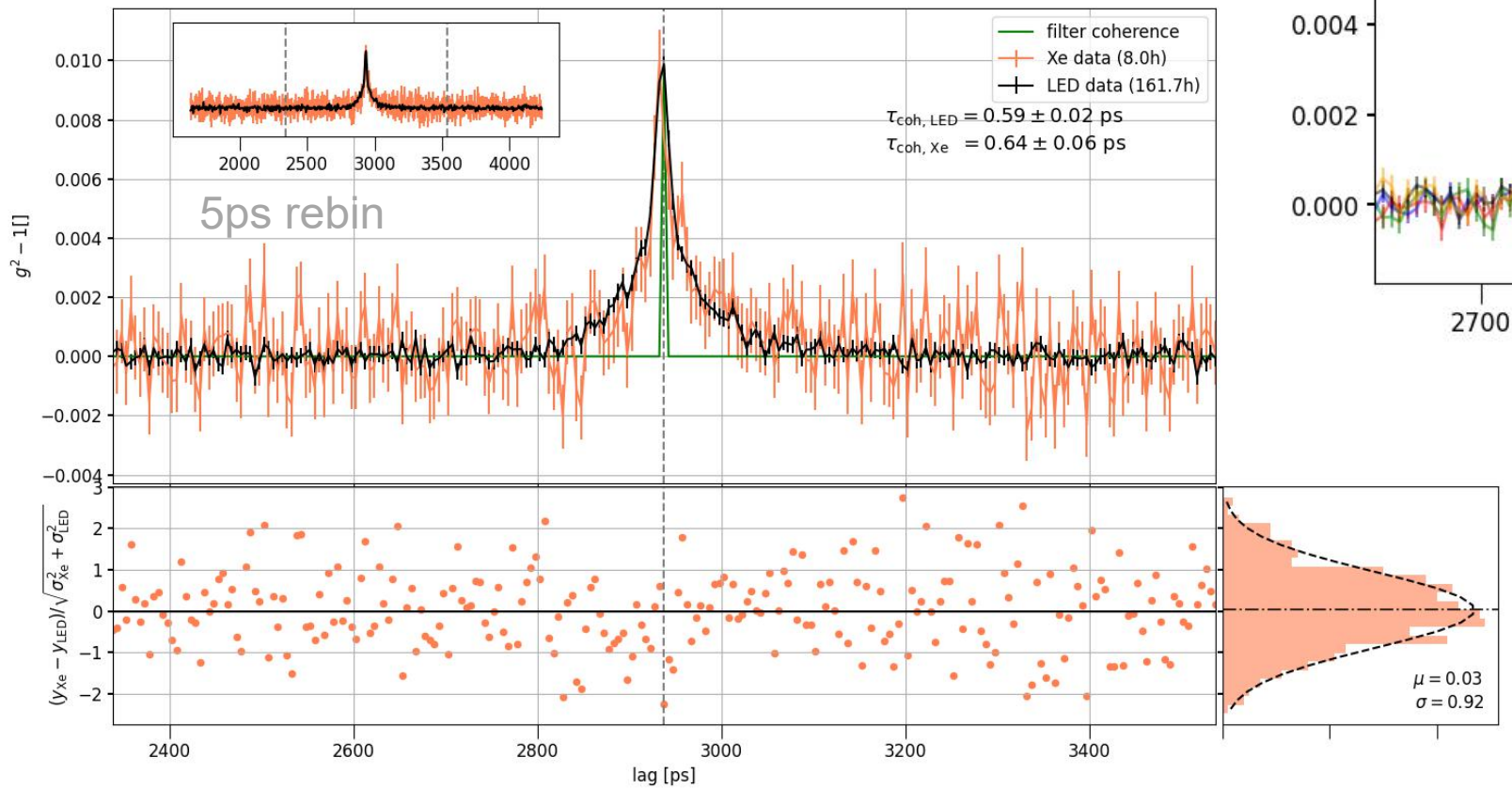


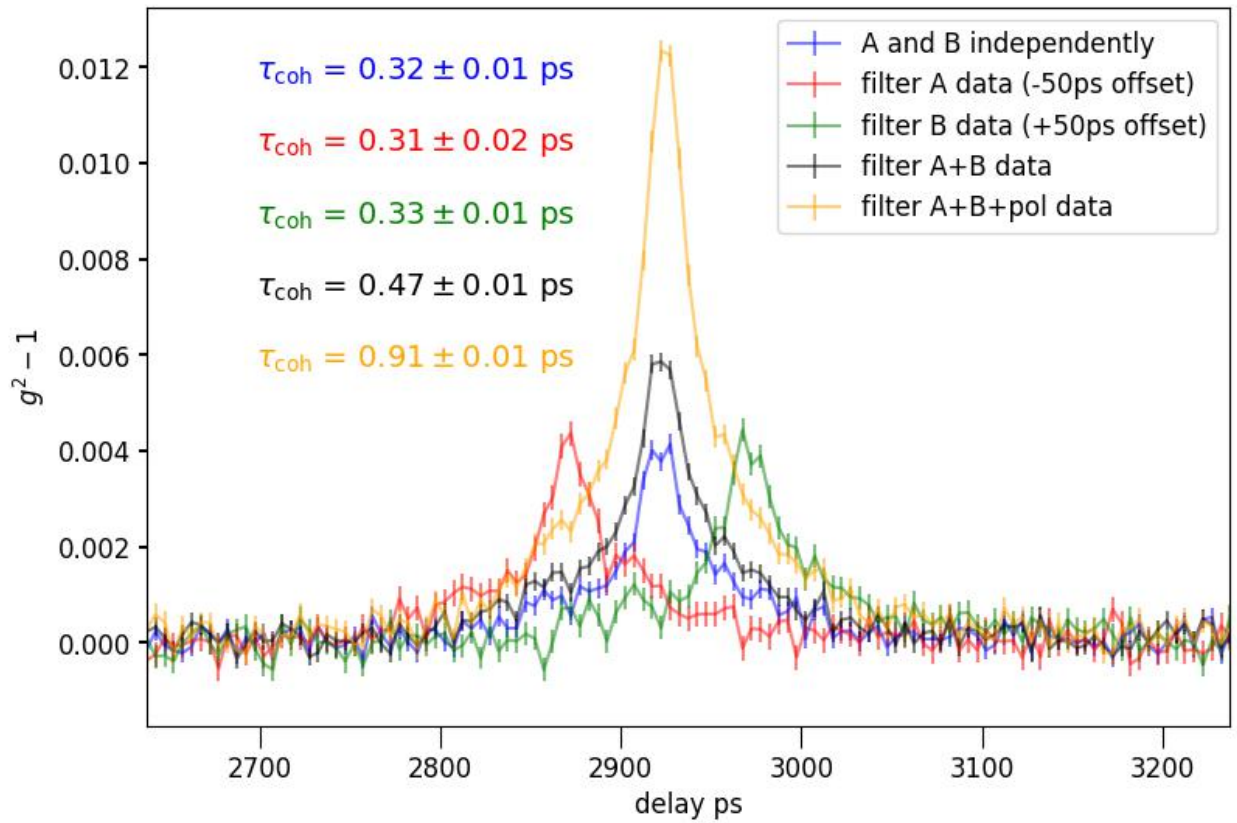


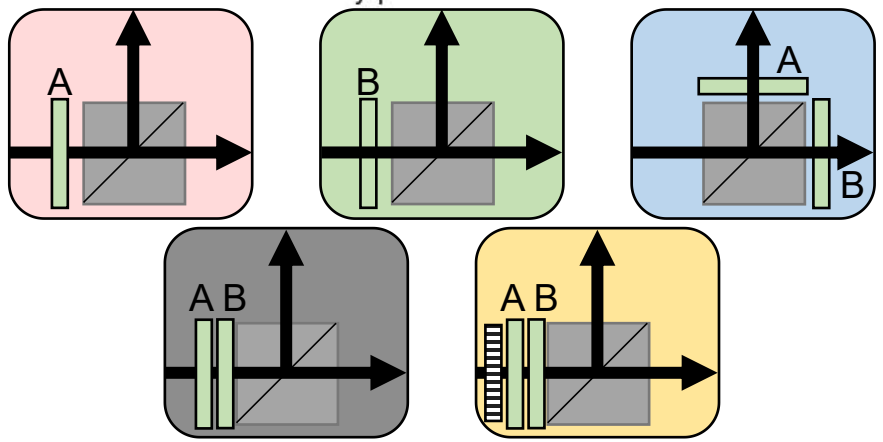
- Correction is τ_{coh} dependant ?
  - Could not apply to all lines !

Broad band analysis

- Similar to Telescope data
- Ensure concistency
- Xenon source & multiple filters/polarizers

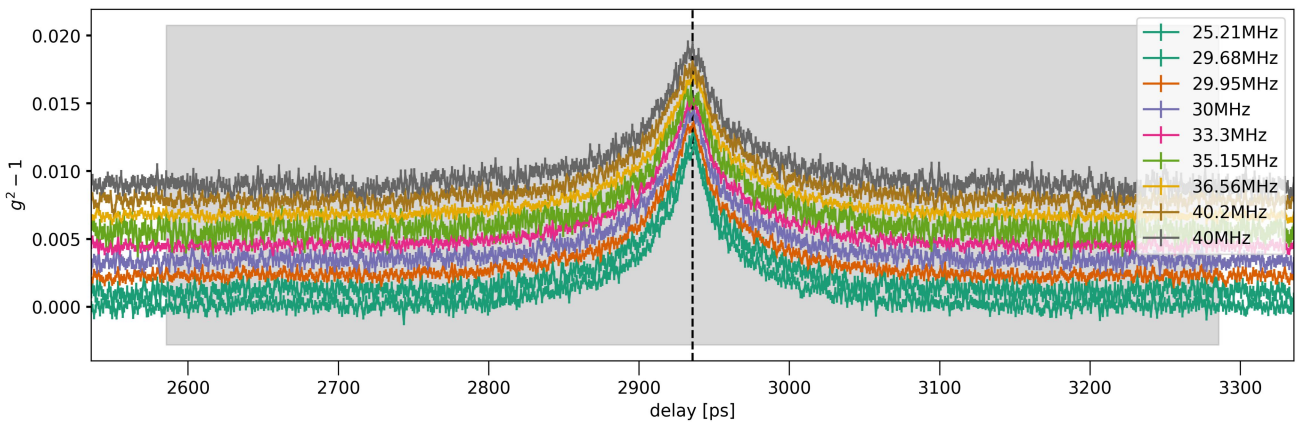


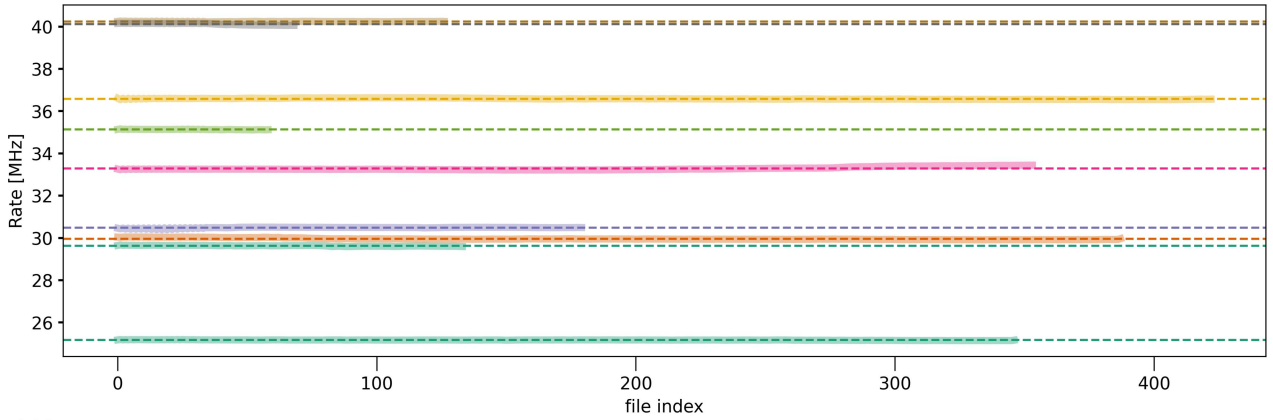


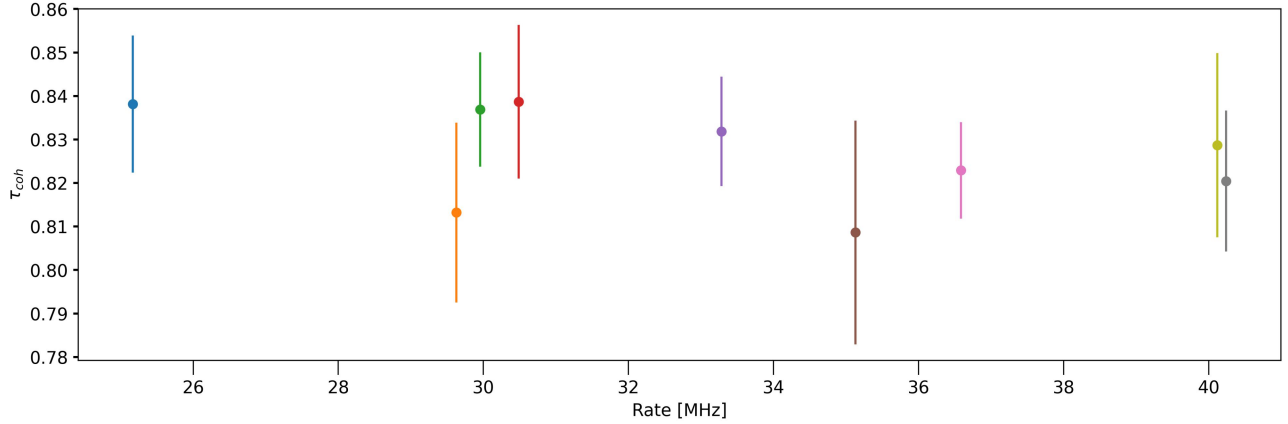


Rate analysis

- On telescope : variable rates
- Measure coincidences integral
  - Should only vary with baseline
  - NOT rate, calib, etc..
- Single calib @33MHz
  - Rates from 25 to 42MHz
  - Compute t_{coh} for each
  - No dependancy witout features



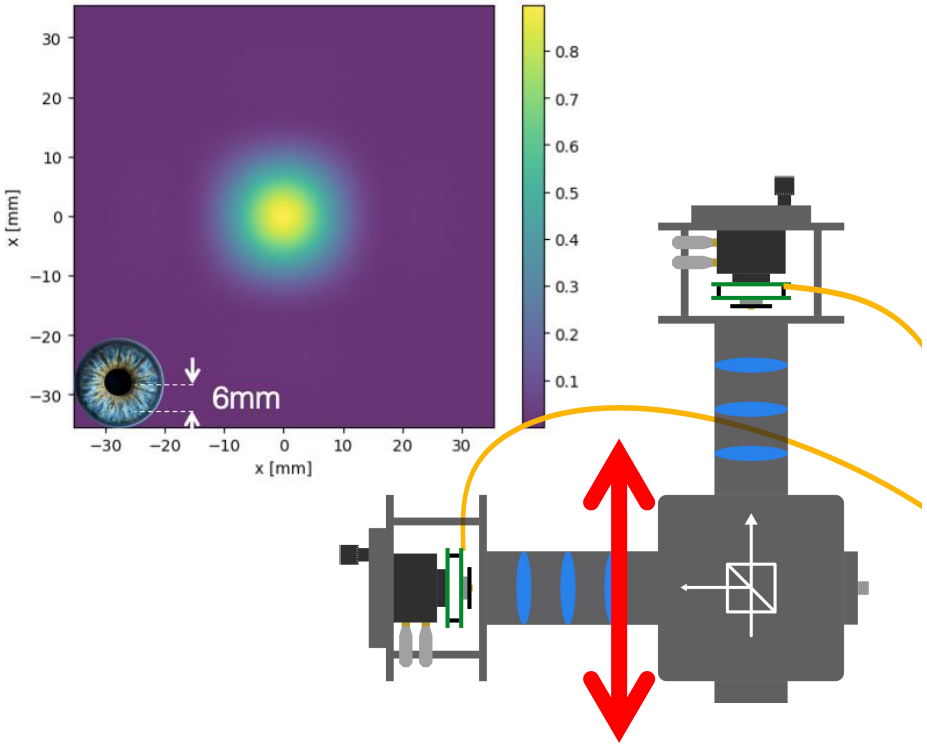


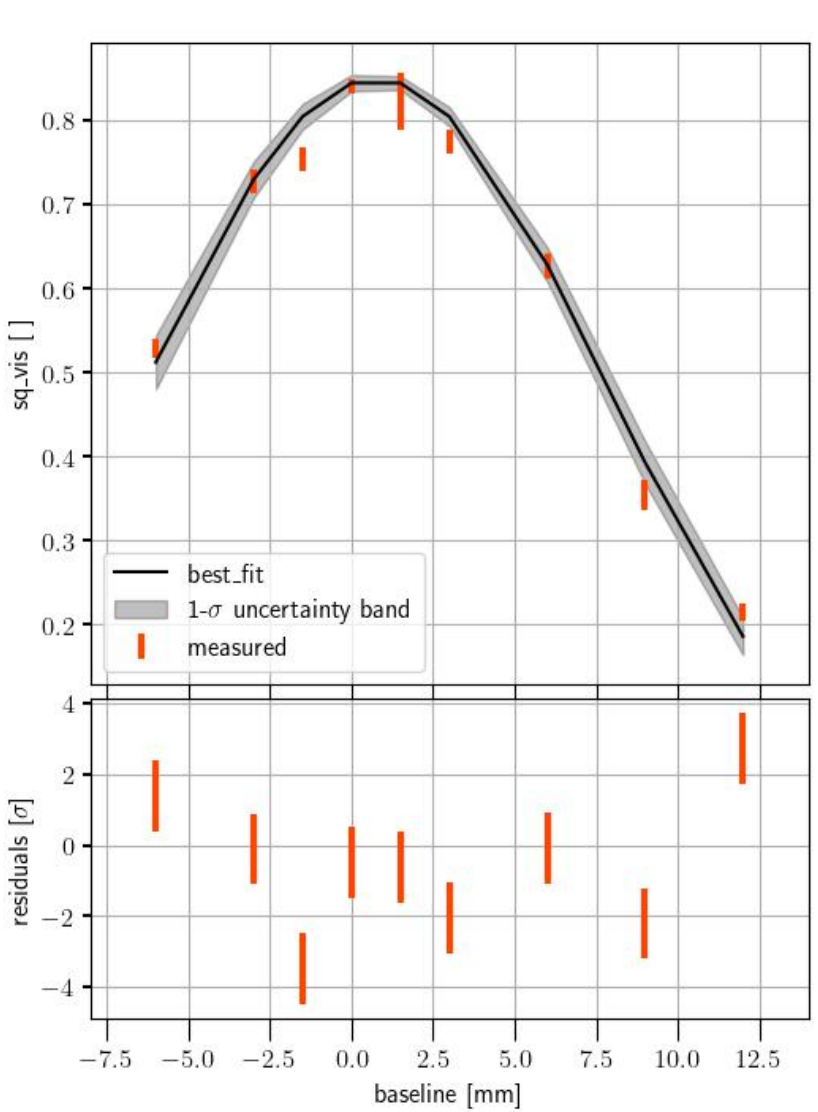


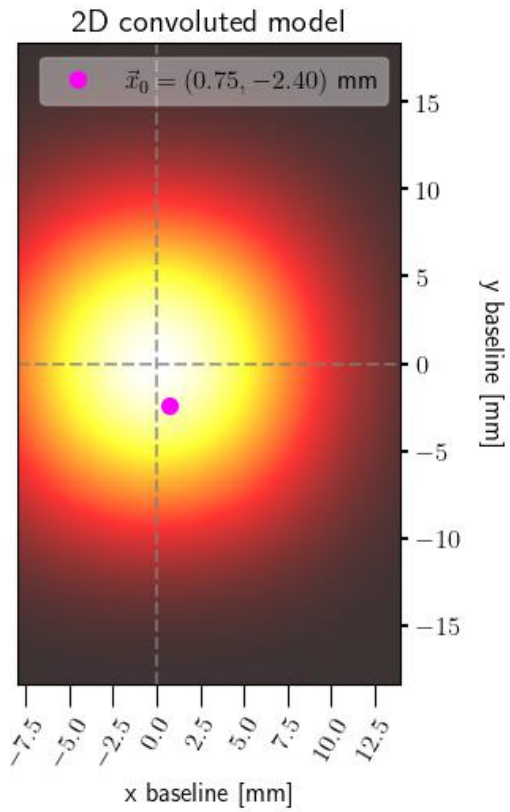
Non ZBC

- Resolving pinhole as “fake star”
  - Illuminated by Na lamp
  - 50um @1.2m
  - 6mm pupil size

D_{estim} = 48.4 ± 1.6 um



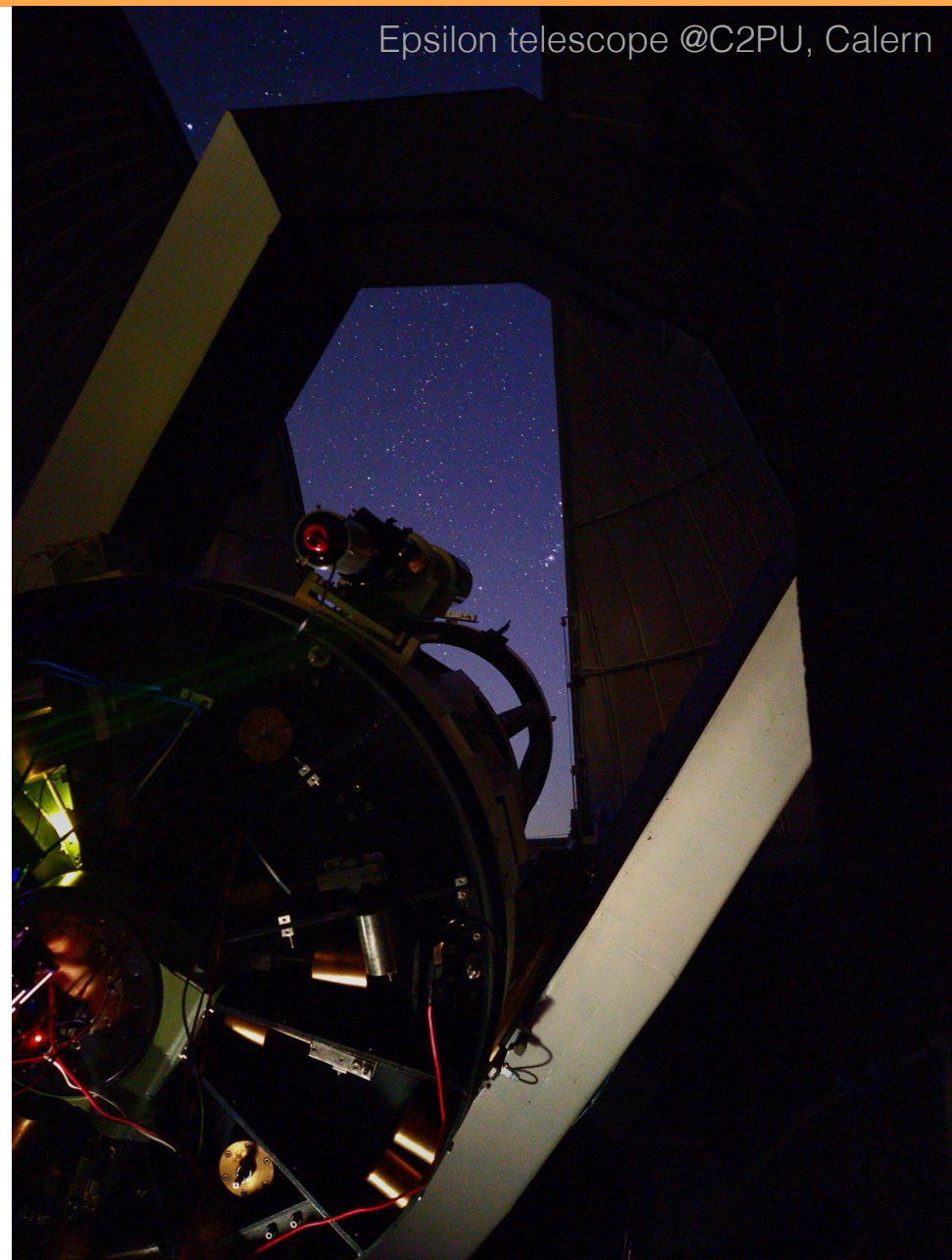




Green light to continue ☺

- Low systematics
  - Up to 10^6 coinc/ps
- Small time resolution
  - @~20ps : Same SNR as HBT in 3000 times less
- Narrow line analysis compatible with expectations
  - Very sensitive to time resolution & Lineshape
- Telescope data similar to the lab conditions
  - Compatible filters
  - Different rates

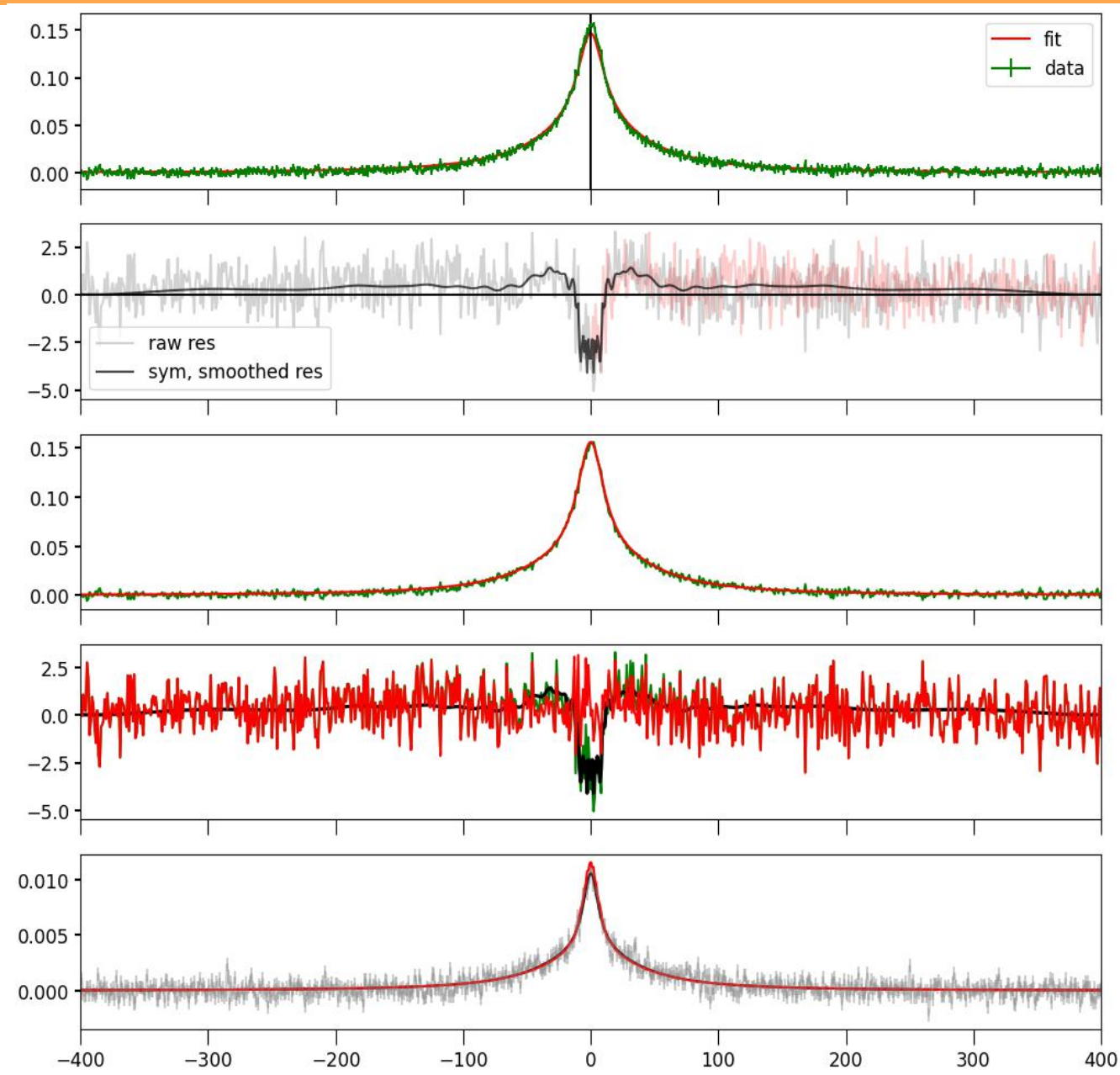
Questions ?


Epsilon telescope @C2PU, Calern

Backup

Line corrections

- Smooth W residuals
  - Symmetric correction
  - modify convolution kernel
  - Higher amp @ center
- Correction computed on 465nm line
- Use it as convolution kernel



Filter explanation

- Problem remains for some lines
  - Not only time resolution model
  - Filter ?