Long baseline interferometry in the visible:
first results of the FRIEND prototype

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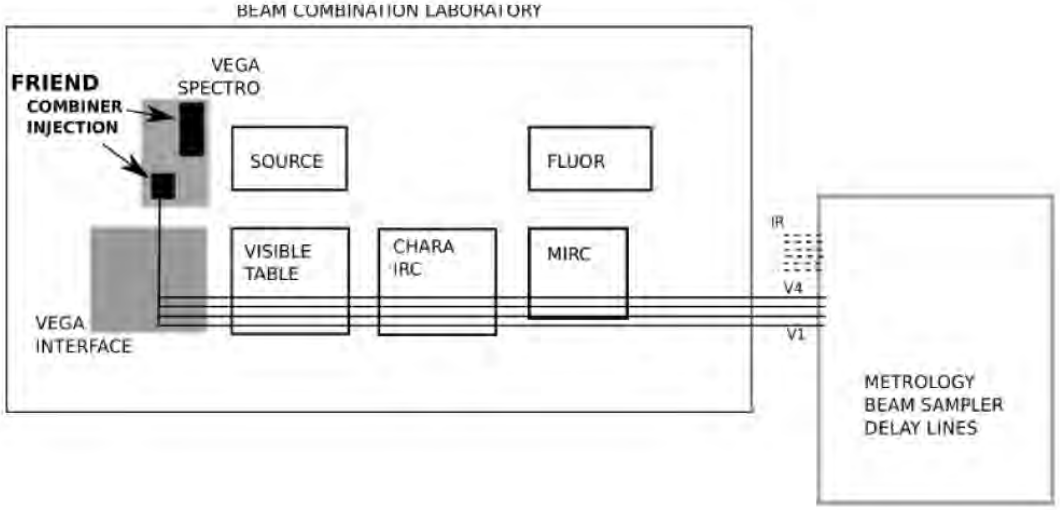
CHARA Meeting – March 2016

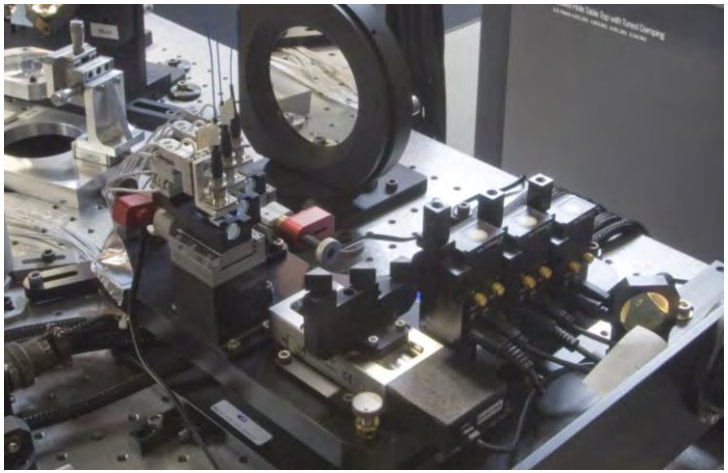
Outline

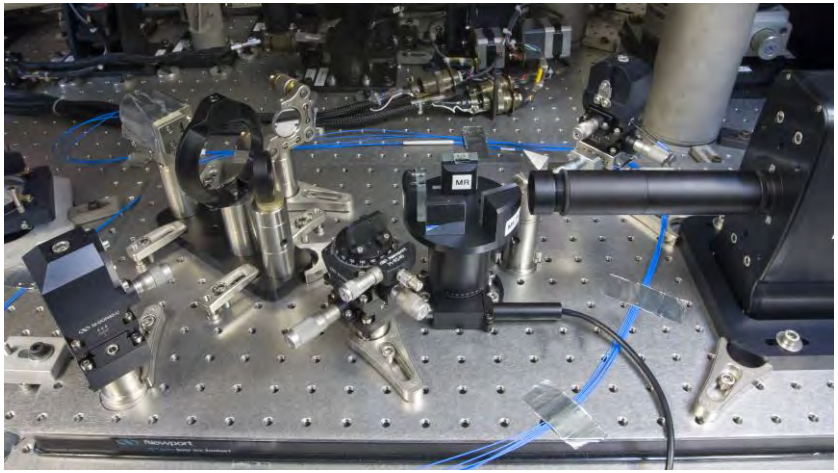
- Presentation of the FRIEND prototype
- Pipeline of FRIEND
- Polarization behaviour
- Optimal DIT
- First stellar diameter estimation
- Conclusion

PRESENTATION OF THE FRIEND PROTOTYPE

Presentation of the FRIEND prototype

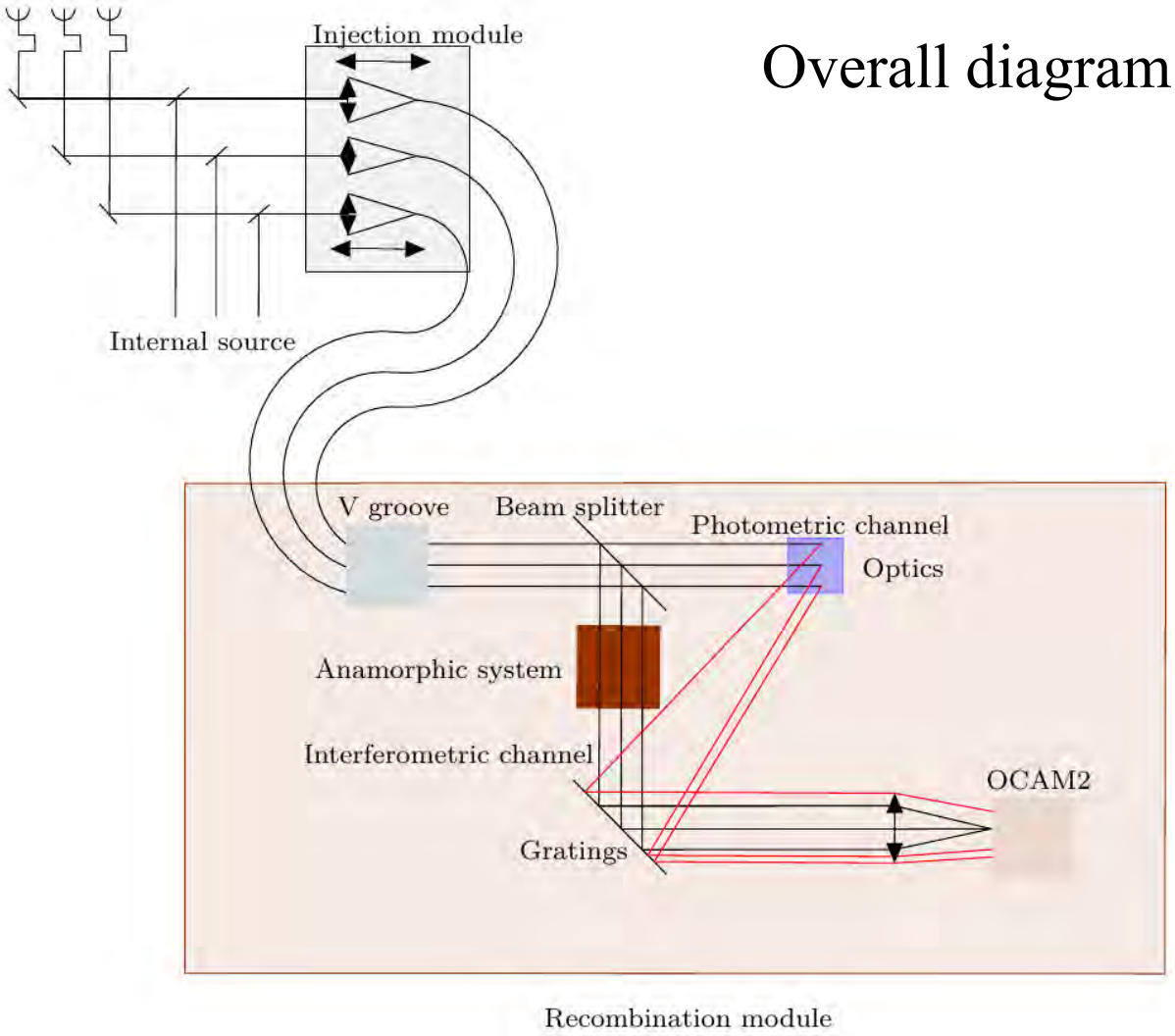




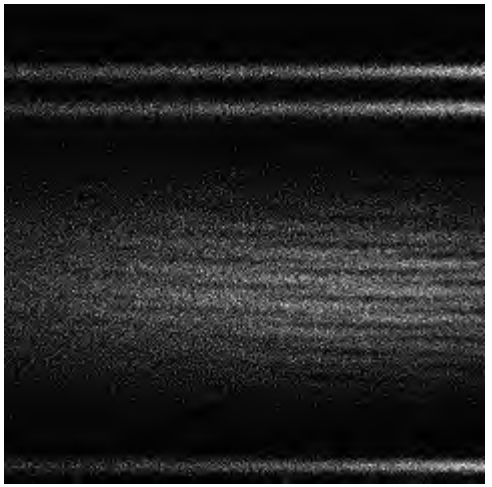


Presentation of the FRIEND prototype

Overall diagram



Fast and low noise EMCCD
Optical fibers
Limit magnitude ~ 4



Presentation of the FRIEND prototype

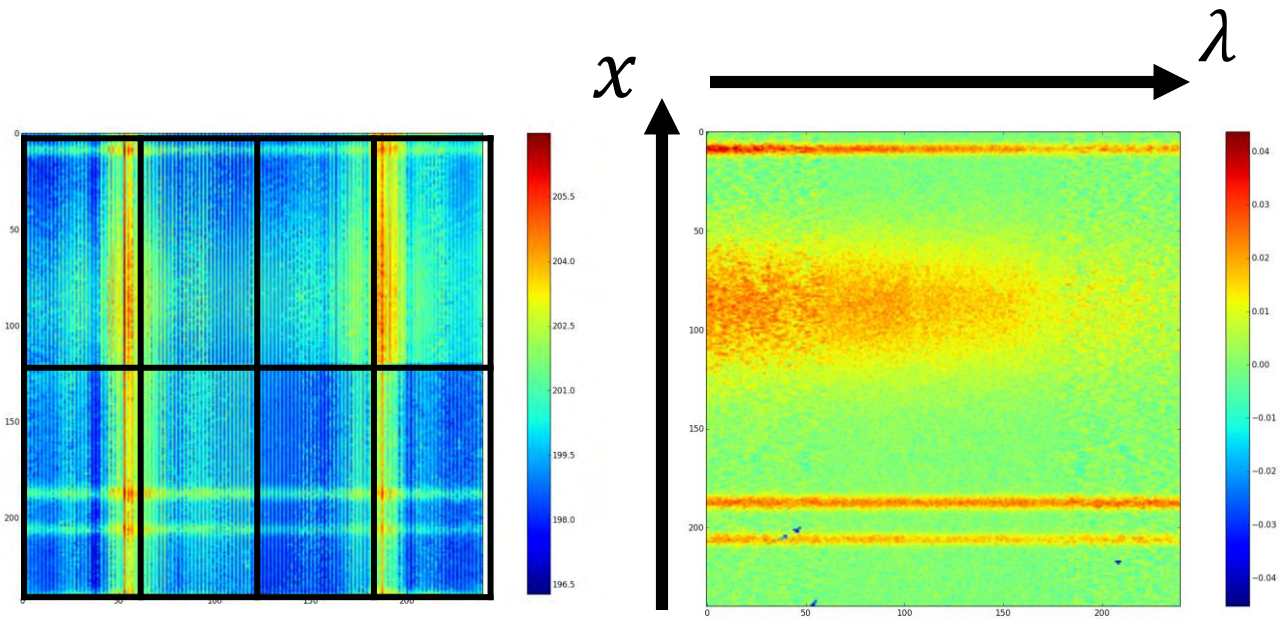
- Run :
  - Remote observations in December 2014 (2T fringes): 3 nights, r_0 ~2 cm
  - Remote observations in April/May 2015 (3T fringes): 1 night
  - July 2015: 2 nights
  - On site observations in September 2015 (lab test and sky observations): 3 nights, r_0 ~ 2 cm

PIPELINE OF FRIEND

Pipeline of FRIEND

- Input : FITS file with 6000 img
- $\frac{img - <dark>}{Gain\ map}$, Gain map (from dark histogram method)
- Sort images (hot pixel…)

Before

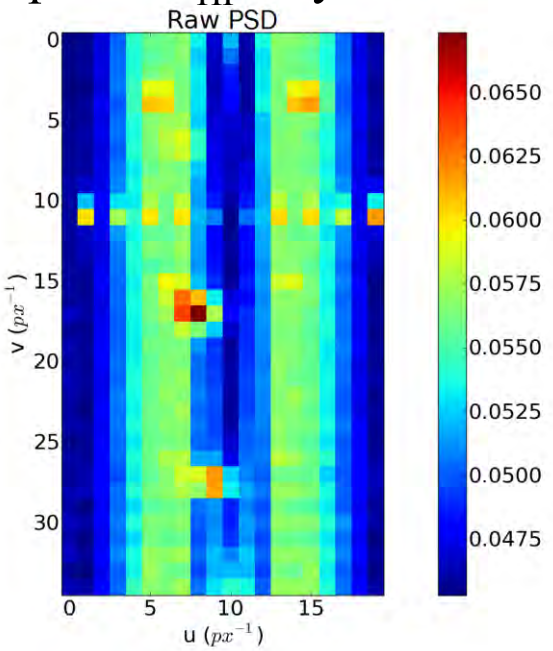


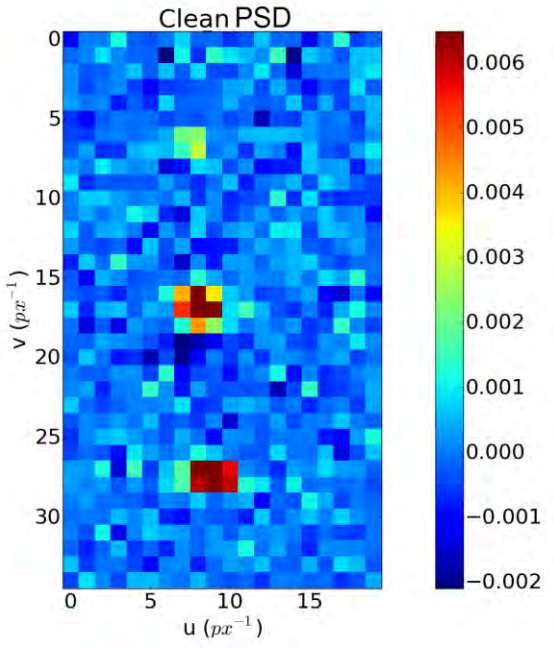
After

Pipeline of FRIEND

- On one side :
  i. Compute PSD (Power Spectral Distribution) for each frame
  ii. Mean them
  iii. Delete background noise (PSD of dark and PSD of no fringes data)
  iv. Compute $<E_{HF}>$ by fit with 2D-gaussian

Before





After
(ii and iii)

Pipeline of FRIEND

- On the other side :
  - κ : get contribution to each beam on interferogram thanks to the measurement on photometric channels.

$$\kappa(\lambda) = \frac{I_{interf}(\lambda)}{I_{photo}(\lambda)}$$

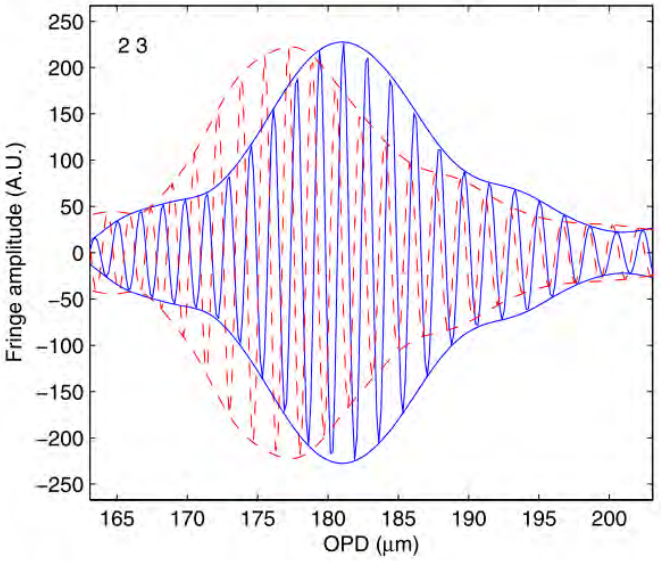
- Congratulations, you have a squared visibility.

$$< |V|^2 >= \frac{< E_{HF} >}{\int_{\Delta\lambda} \kappa(\lambda) \int_{\Delta x} < P_1(\lambda, x) P_2(\lambda, x) > dx d\lambda}$$

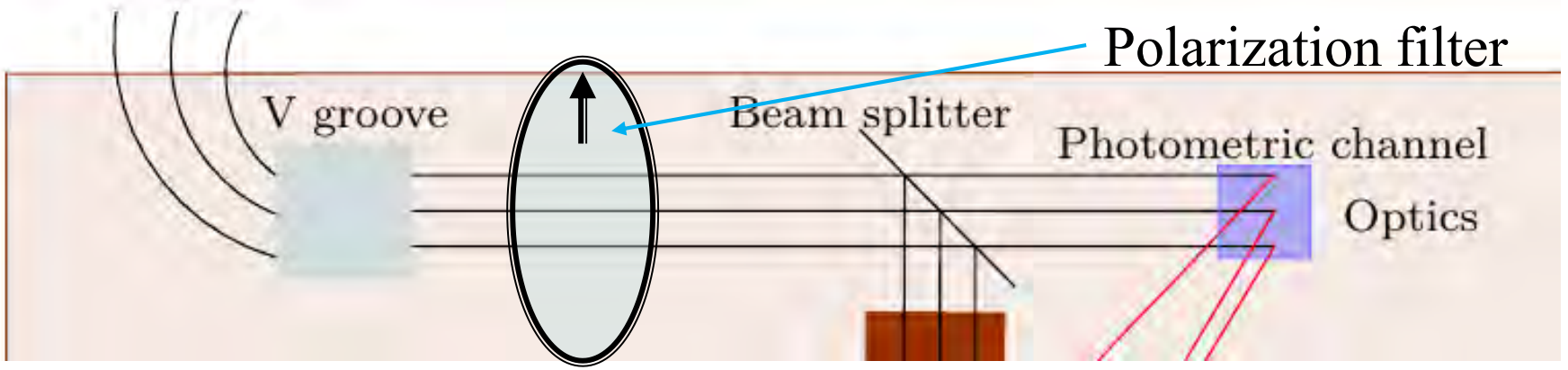
POLARIZATION BEHAVIOUR

Polarization behaviour

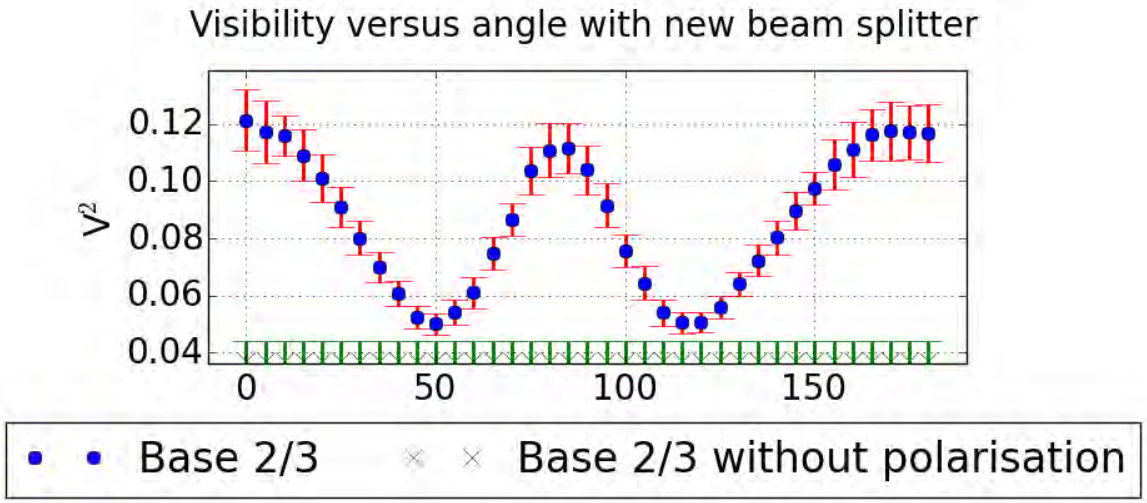
- Study of the birefringence of the optical fibers
- Purpose : improve instrumental visibility
- Lab test wih internal light source of VEGA
- Protocol :
  - polarisation filter between beam splitter and V-groove
  - Turn it every 10 degrees
  - Comparison without polarisation filter



Lazareff et al., A&A, *2012*

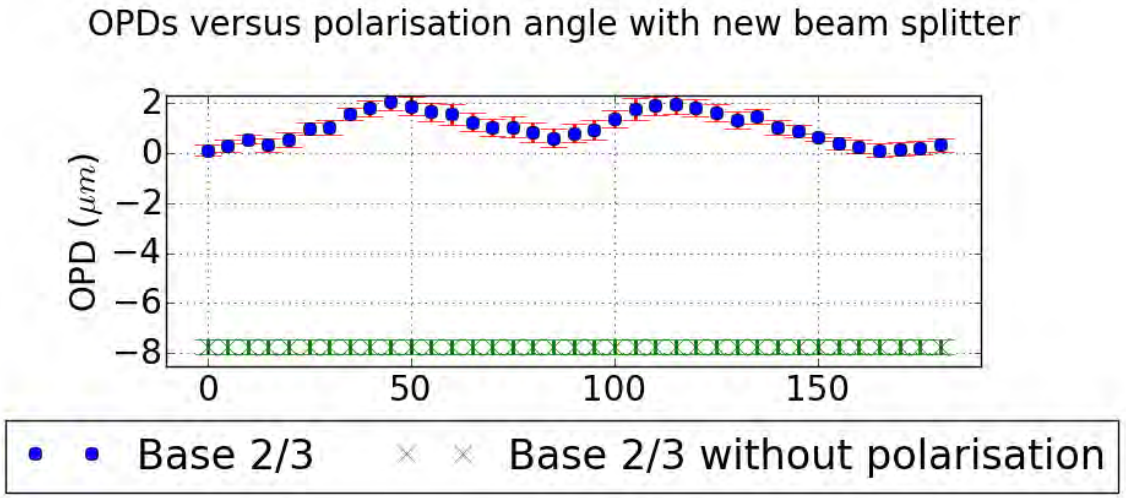


Polarization behaviour

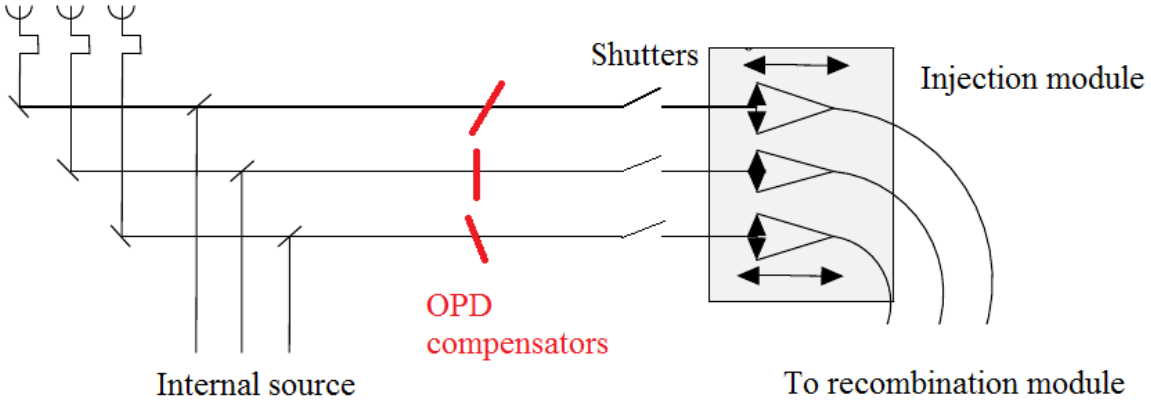


- Polarization effect from optical fibers

$$\Delta OPD \simeq 2\ \mu m$$



Polarization behaviour

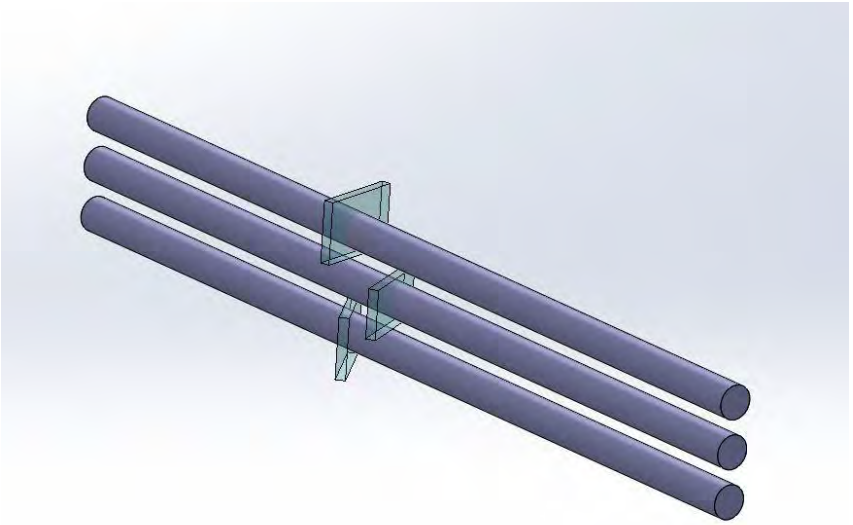


OPD optimization
(Setup in progress)

Inspired by PIONNIER
Lazareff et al., A&A, *2012*

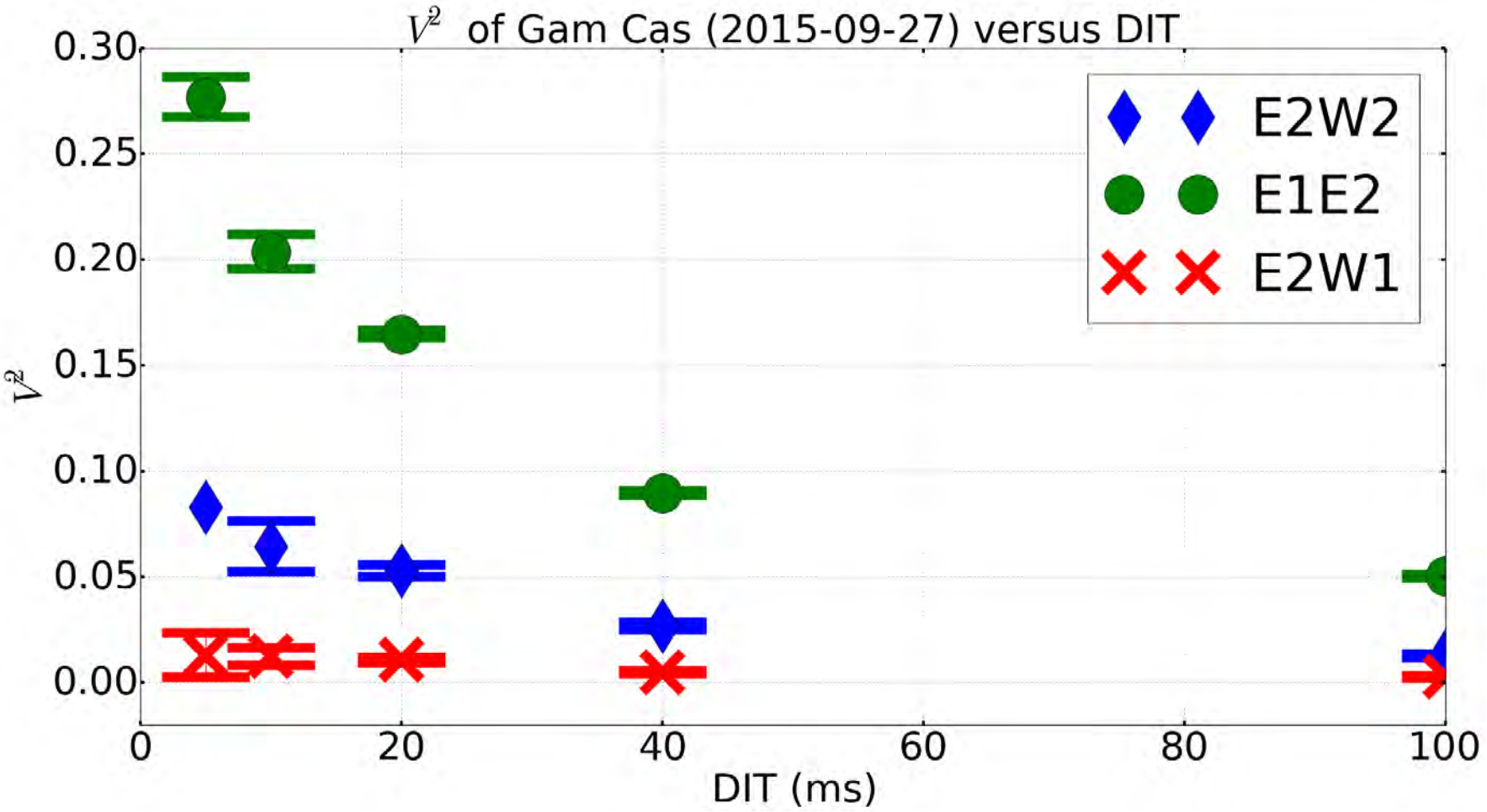
Plates : α BBO cristal

Optimisation before each night

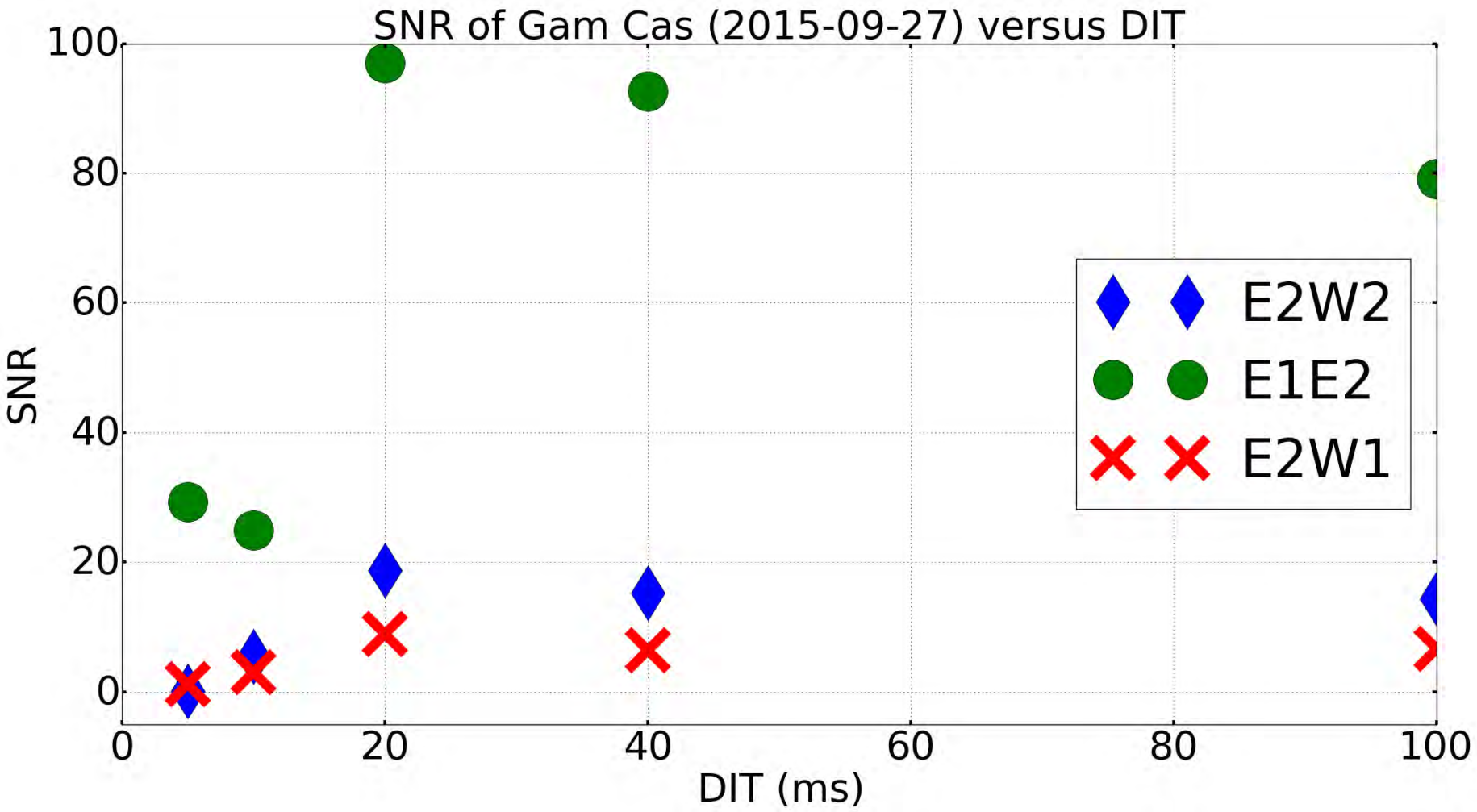


OPTIMAL DIT (DETECTOR INTEGRATION TIME)

Optimal DIT


V^2 of Gam Cas (2015-09-27) versus DIT
E2W2
E1E2
E2W1
V^2
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0
20
40
60
80
100
DIT (ms)

Optimal DIT

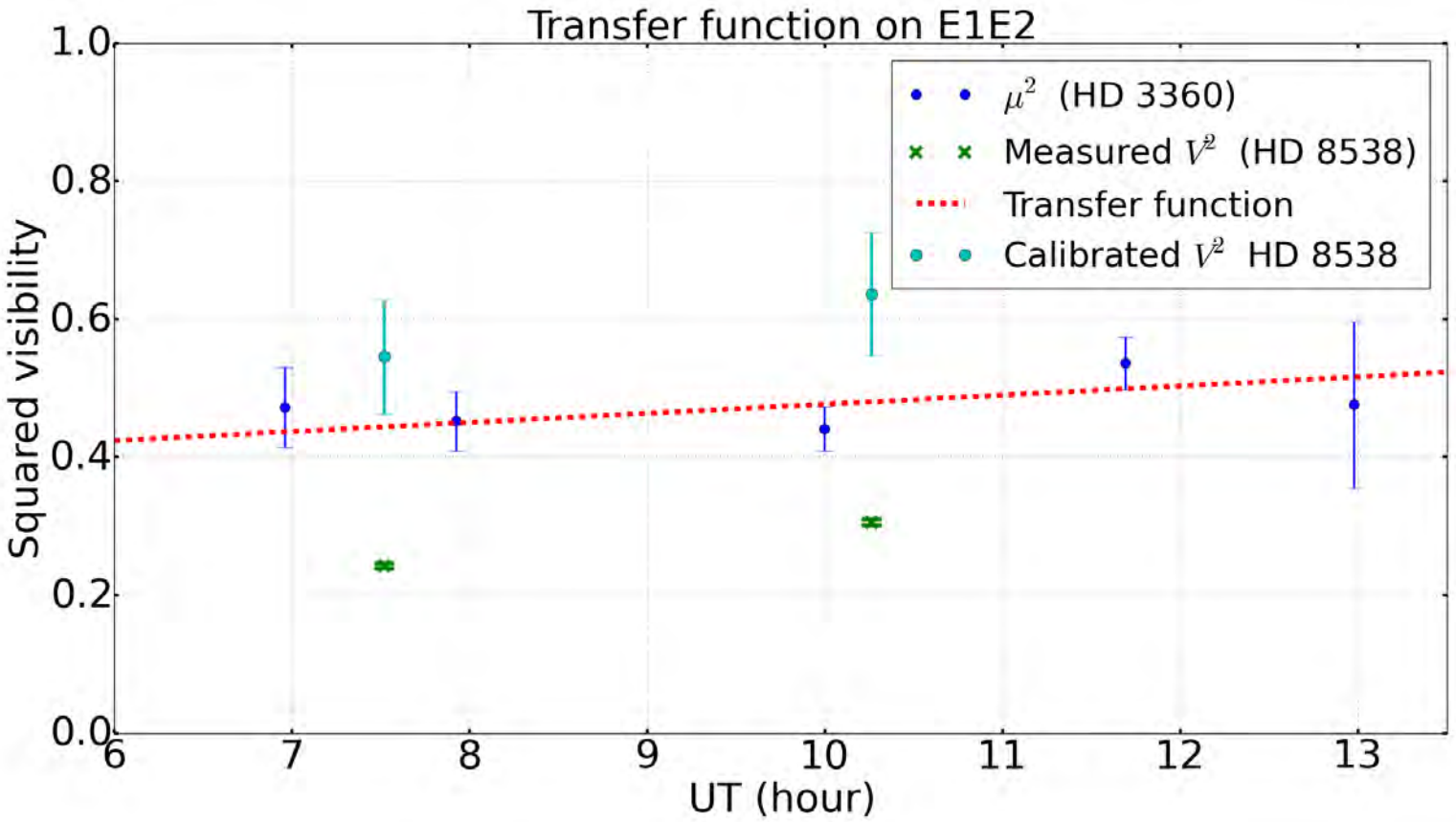


$\tau_0 \sim 5 - 10\ ms \quad DIT \sim 2 - 3 \times \tau_0$ *Buscher,* MNRAS, *1988*

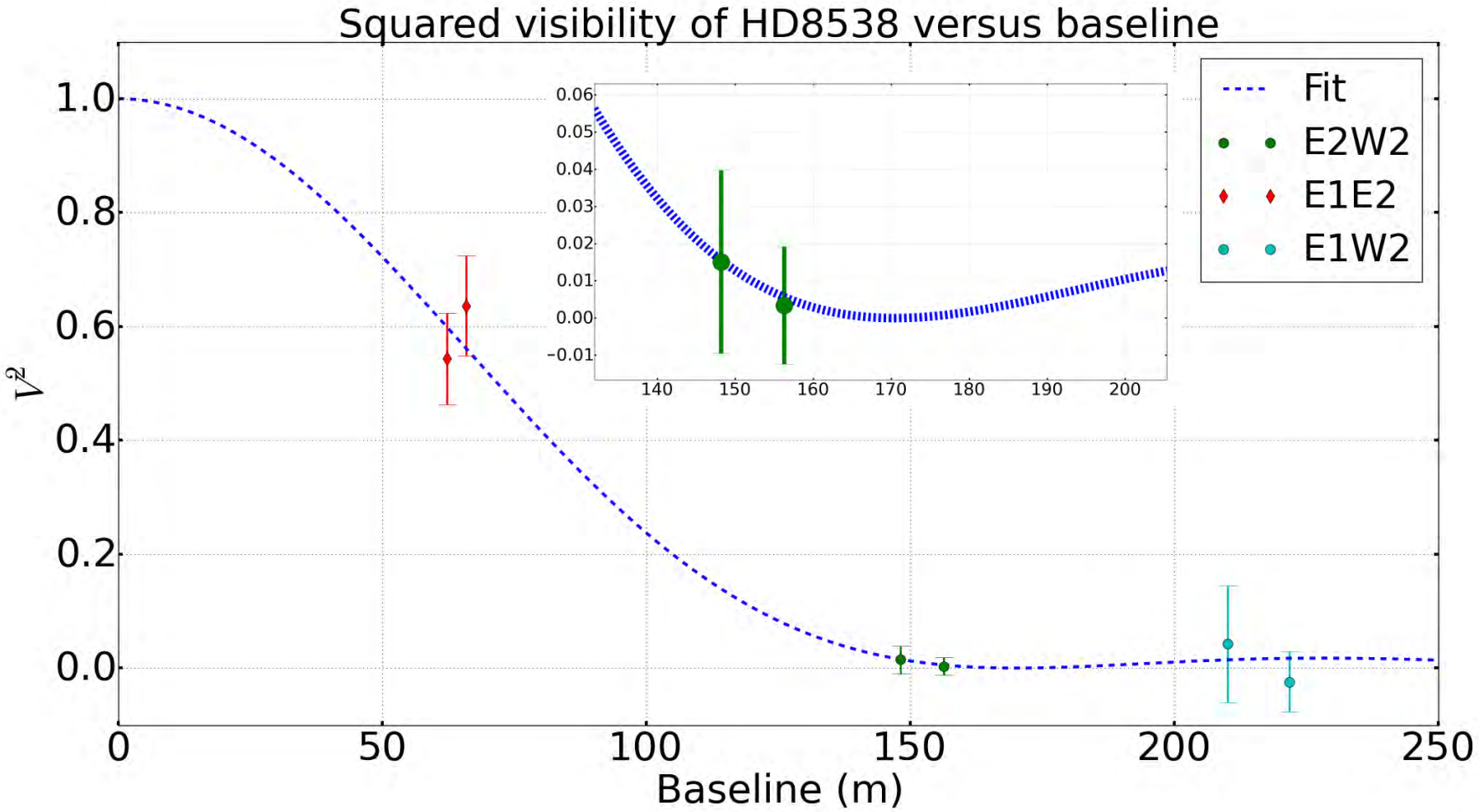
FIRST STELLAR DIAMETER ESTIMATION

First stellar diameter measurement

- Target : HD8538 (del Cas)
- Calibrator : HD3360 (zet Cas)



First stellar diameter estimation



- Diameter of HD8538 :1,02 ±0,04 mas

First stellar diameter estimation

- JSDC:
  - Surface brightness method
  - Diameter: 1.22 ± 0.09 mas
- Measured diameter :1,02 ±0,04 mas
- Difference of few sigmas: transfer function, # of points ?

Conclusion

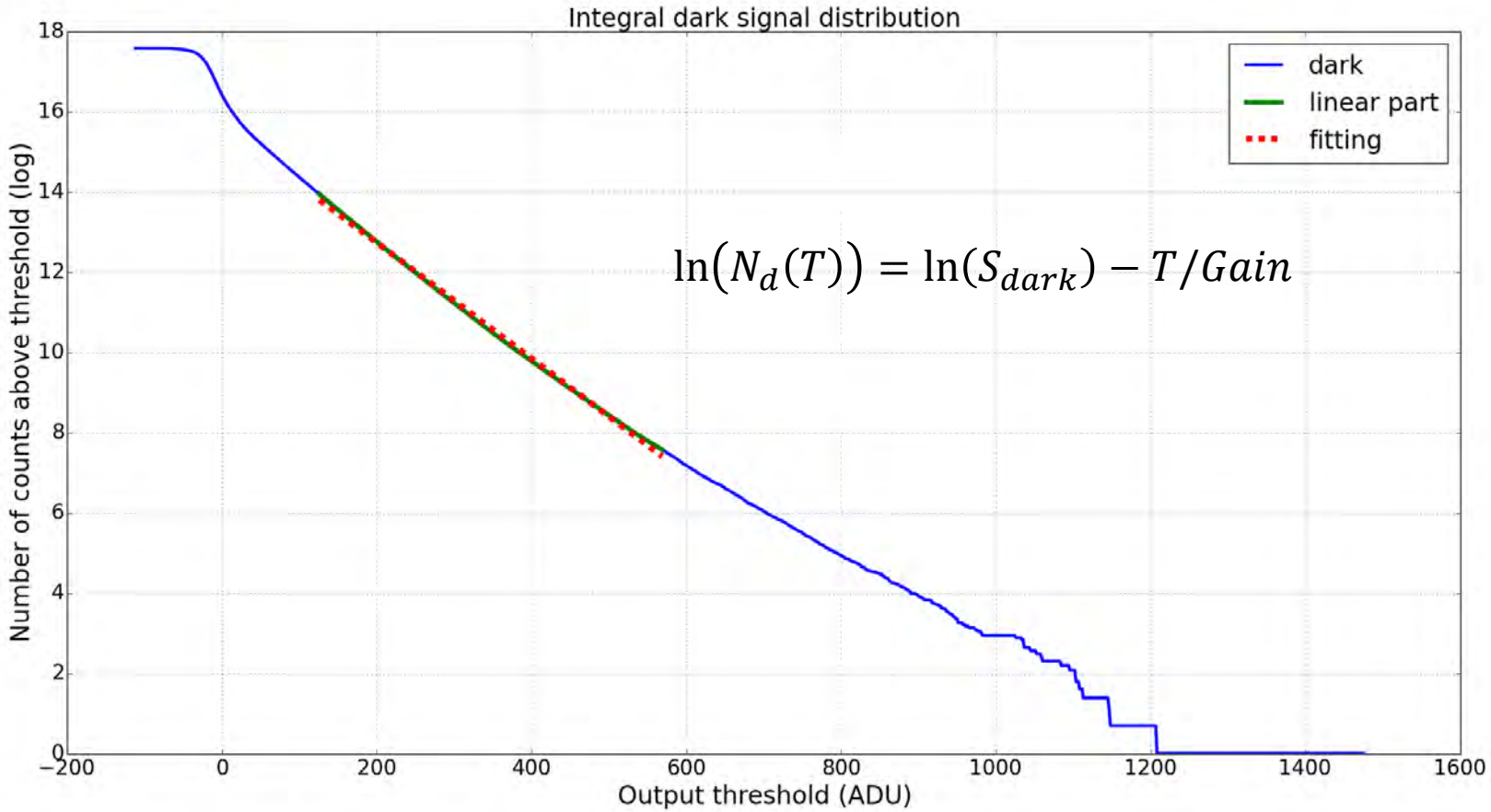
- Done:
  - Pipeline functional
  - Characterization of birefringence
  - Optimal DIT
  - First measurement of transfer function
  - Measure low visibilities
  - Better comprehension of the detector (temperature, dark current, matrix…)
    (More information the 3rd day)
- Next step:
  - OPD optimization (July 2016)
  - Monitoring τ_0 with AO
  - SPIE article (June 2016)
  - Transfer function stability (July 2016)
  - Acquisition sequence: dark-shut1,2,3-fringes-no fringes

Thank you for your attention

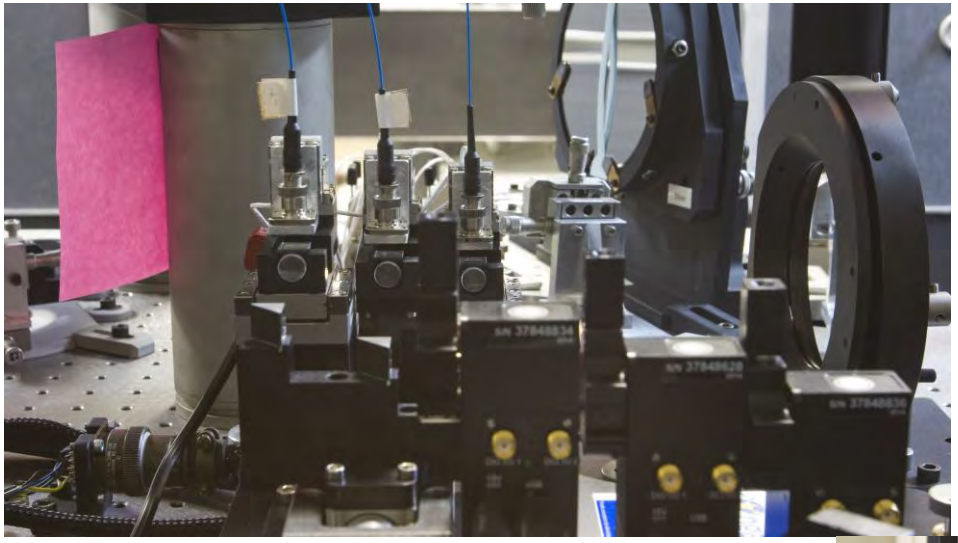
EXTRA DOCUMENTS

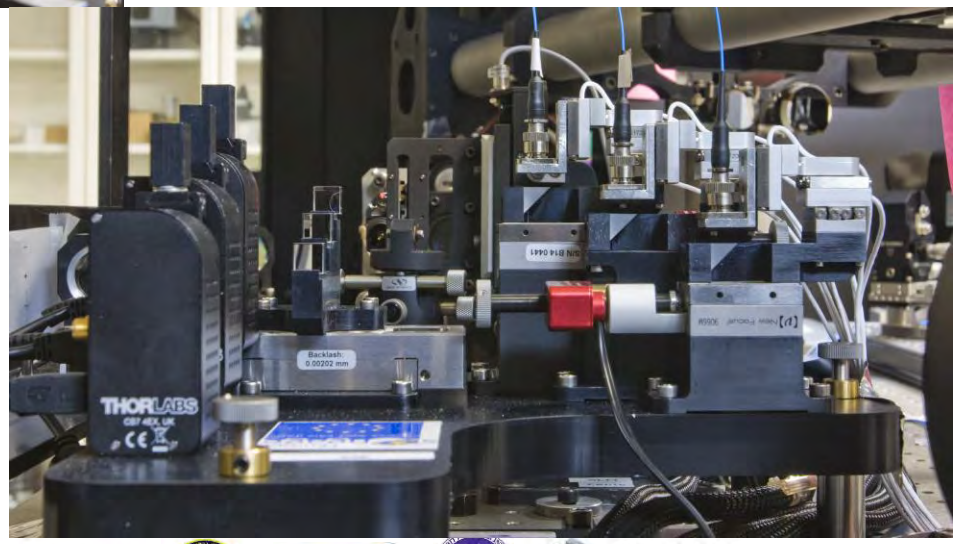
Gain map

- Histogram of dark for each part of matrix



FRIEND PHOTOS





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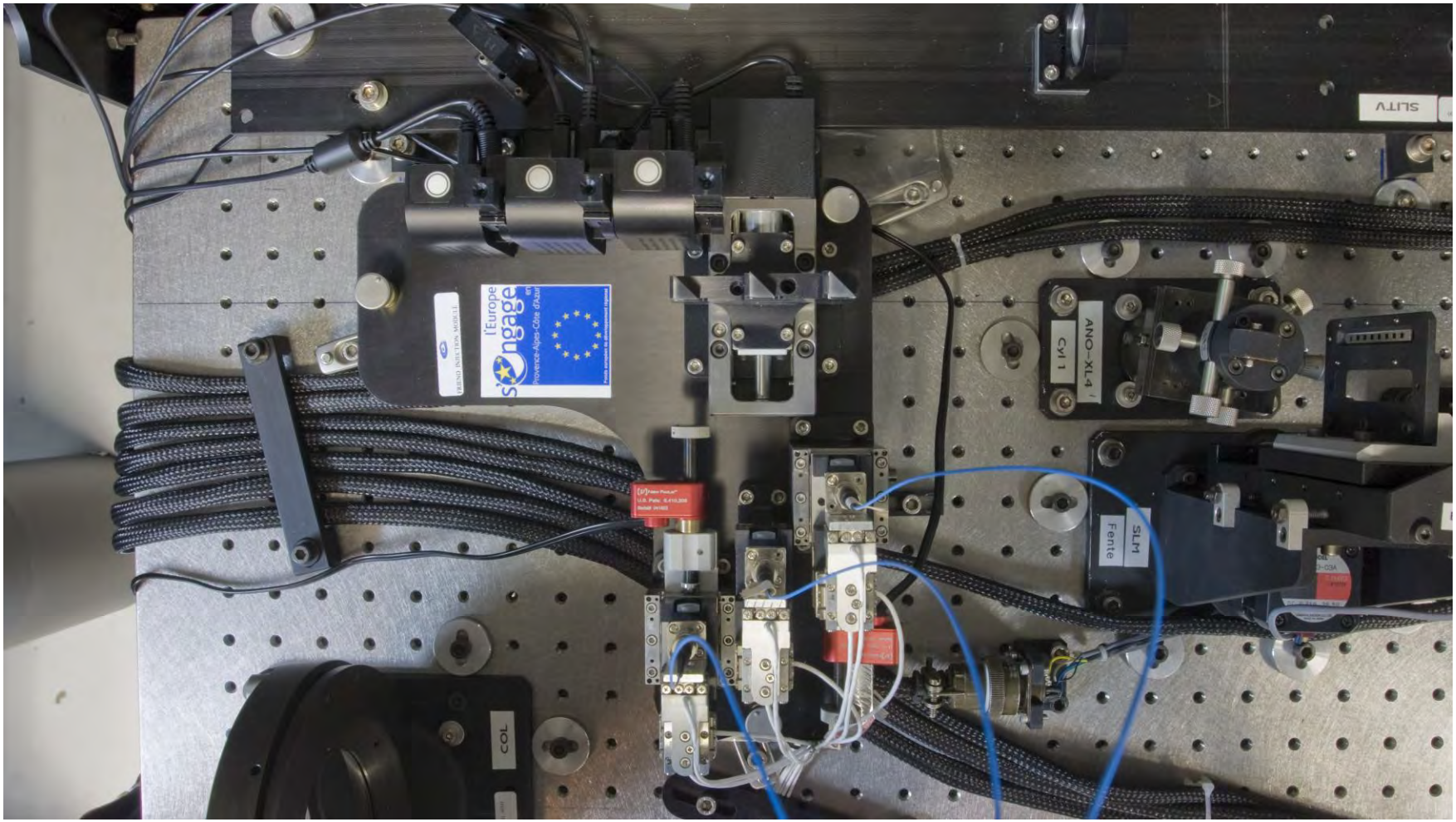
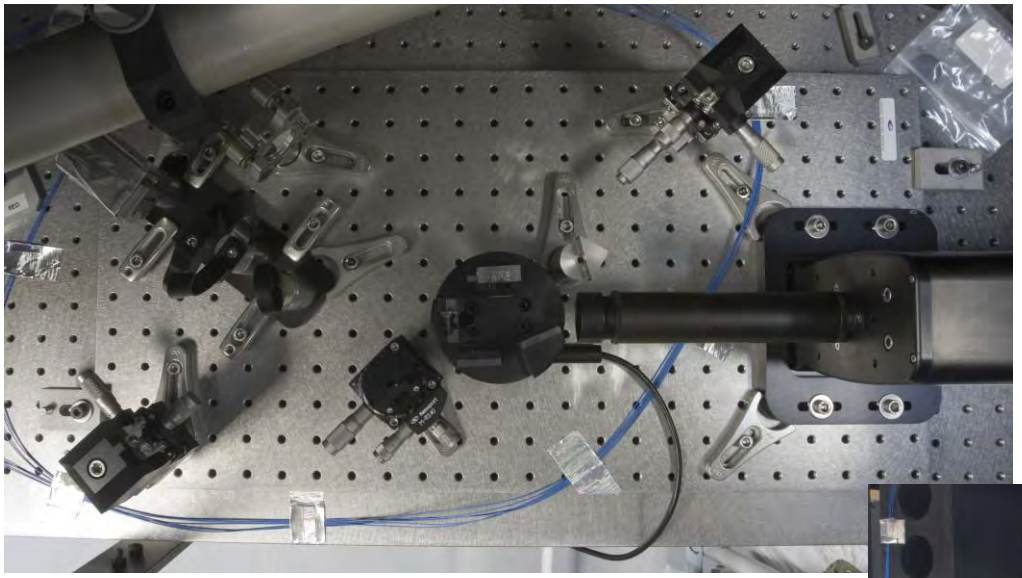
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