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

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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, $r_0 \sim 2$ 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, $r_0 \sim 2$ cm
PIPELINE OF FRIEND
Pipeline of FRIEND

- Input: FITS file with 6000 img
- \( \frac{\text{img} - \langle \text{dark} \rangle}{\text{Gain map}} \), Gain map (from dark histogram method)
- Sort images (hot pixel...)

![Pipeline Diagram](image)
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:
  – \( \kappa \): get contribution to each beam on interferogram thanks to the measurement on photometric channels.

\[
\kappa(\lambda) = \frac{I_{\text{interf}}(\lambda)}{I_{\text{photo}}(\lambda)}
\]

• Congratulations, you have a squared visibility.

\[
< |V|^2 > = \frac{< E_{HF} >}{\int_{\Delta \lambda} \int_{\Delta x} \kappa(\lambda) < P_1(\lambda, x) P_2(\lambda, x) > dx d\lambda}
\]
POLARIZATION BEHAVIOUR
Polarization behaviour

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

Polarization behaviour

- Polarization effect from optical fibers

\[ \Delta \text{OPD} \approx 2 \mu m \]
Polarization behaviour

Inspired by PIONNIER

Plates: $\alpha$ BBO crystal
Optimisation before each night
OPTIMAL DIT
(DETECTOR INTEGRATION TIME)
Optimal DIT

$V^2$ of Gam Cas (2015-09-27) versus DIT

- **E2W2**
- **E1E2**
- **E2W1**
Optimal DIT

SNR of Gam Cas (2015-09-27) versus DIT

$\tau_0 \sim 5 - 10 \text{ ms}$  $DIT \sim 2 - 3 \times \tau_0$

FIRST STELLAR DIAMETER ESTIMATION
First stellar diameter measurement

- Target: HD8538 (del Cas)
- Calibrator: HD3360 (zet Cas)
First stellar diameter estimation

Squared visibility of HD8538 versus baseline

- 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 3\textsuperscript{rd} day)

• Next step:
  – OPD optimization (July 2016)
  – Monitoring $\tau_0$ 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
Gain map

- Histogram of dark for each part of matrix

\[ \ln(N_d(T)) = \ln(S_{\text{dark}}) - \frac{T}{Gain} \]
FRIEND PHOTOS
FRIEND PHOTOS
FRIEND PHOTOS