Dark Hole Algorithms Working Group

6/30/2021: Baudoz/THD group

Link to presentation file:
DAWG_2021-06-30_Galicher_THD2.pdf

At the beginning of the meeting John Krist presented a brief update on the new release of the CGISim diffraction model, available at https://sourceforge.net/projects/cgisim/.

Raphaël Galicher presented an introduction to the THD2 bench and recent experiments.
- THD = Très Haute Dynamique, led by Pierre Baudoz (PI) and Raphaël Galicher (co-PI)
- In addition to research for space coronagraphy, THD speckle stabilization experiments have been applied to ground-based instruments at Palomar and SPHERE.
- Two testbeds. 2008: THD (1 DM); 2015: THD2 (2 DMs, 1 TT mirror, room for a third DM option); wavelength range is 450 - 950 nm.
- Control schematic comparison between ground-based and space coronagraph, different loops for speckle stabilization and speckle minimization.
- THD has hosted numerous experiments and international collaborations for coronagraph mask demonstrations. LESIA has led most WFS&C-specific experiments, also some with SRON and LAM.
- Recent result - 20% broadband half-plane dark hole with wrapped vortex - Galicher et al 2020
- After DMs were upgraded, implemented spatial modulation with self-coherent camera, contrast results below 1E-8. Comparisons of temporal modulation (pair-wise EFC) and spatial modulation (SCC) published by Axel Potier et al 2020a.

Pierre Baudoz discussed upgrades related to the Roman coronagraph experiments.

- French space agency CNES support still pending
- Algorithm comparison using THD2 bench
- Mainly LESIA and ONERA
- Numerical model development by PhD student
- Uses reflective LOWFS loop
- Upgraded Kilo-DM electronics: 14 bits to 16 bits; necessary to avoid departures from linearity at high contrasts
- Simulations completed with THD2+simplified HLC
- Andor sCMOS detector - some problems with non-linear behavior at low flux - Johan Mazoyer investigating.
- Need to improve low-order bench vibration stabilization. Goal is 2 kHz sampling, 300 Hz bandwidth with predictive control.
- New TT mirror received, being tested now.
- Fabricating transmissive SPC masks, for imaging and spectroscopy modes
- CGI vs THD2: Different DM locations; THD will operate at longer wavelength, 730-740 nm (DM protection plate had best AR coating at this wavelength); since SPC is transmissive, slightly different pattern, simulated to work ok; HLC is simplified to a Roddier coronagraph mask.
- Masks fabricated by GEPI lab at Obs. Paris
- Simulations indicate performance may be limited by number of DM actuators
- Johan is developing Asterix code (Python) to compare performance between control algorithms and different testbed configurations. Code is public on github.
- Plan to upgrade software control from Labview to C/Python
- Question from Eric Cady: Adding field stop? No, saturation not a problem
- SCC tests unlikely in CGI hardware configuration.

Related links
THD project website: https://thd-bench.lesia.obspm.fr
Baudoz et al 2018 SPIE paper on THD:
https://ui.adsabs.harvard.edu/abs/2018SPIE10706E..2OB/abstract
AO4ELT Conference Proceeding:
http://cdsads.u-strasbg.fr/abs/2018arXiv180106600B