

Update on the BIFROST beam combiner

- **Daniel (Dan) Mortimer**, S. Kraus, S. Chhabra, O. Snaith, T. Gardner, I. Codron, Y. Lu, A. Kitching, J. Simmons, S. Skellett, B. van Moppes (Exeter), N. Anugu (CHARA), J. Monnier (Michigan), Andrea Bianco, Michele Frangiamore (INAF), Philipp Huke (Emden), Francisco Garzón (IAC), Asgard partners, interest from some Paranal affiliates: Aaron Labdon, Abigail Frost



The BIFROST beam combiner

- VLT I 4T combiner
- Y+J and H band combiner ($\lambda = 1.0 - 1.65 \mu\text{m}$)
- $R = 50, 1,000, 5,000, 25,000$
- Off-axis mode



G.Hüdepohl/ESO, <https://creativecommons.org/licenses/by/4.0/deed.en>



ASGARD suite

- **HEIMDALLR**
 - High sensitivity fringe tracker, K band
 - PI: Mike Ireland, Frantz Martinache
- **Baldr**
 - Zernike wavefront sensor, fiber injection optimiser, H band
 - PI: Mike Ireland, Frantz Martinache
- **BIFROST**
 - 4T IO chip 'classic' combiner, YJ and H band
 - PI: Stefan Kraus
- **NOTT**
 - High contrast nuller L band
 - PI: Denis Defrère



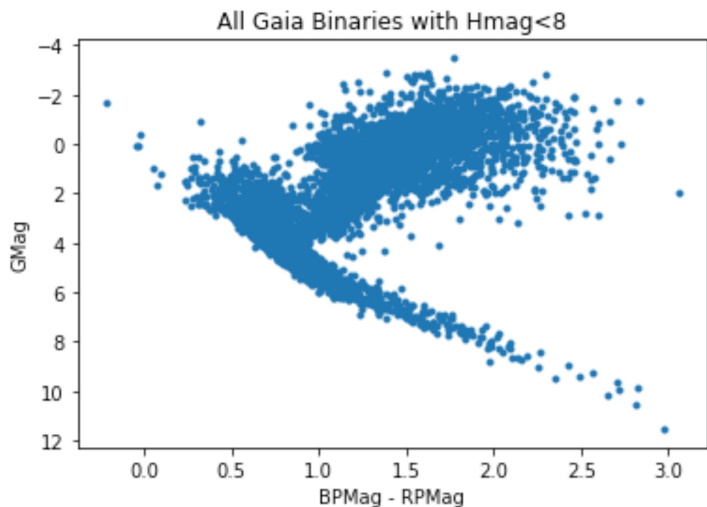
ASGARD

HEIMDALLR | Baldr | BIFROST | NOTT



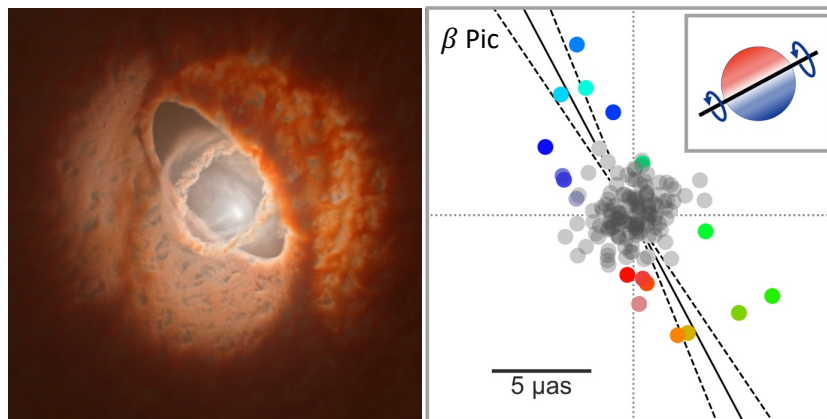
BIFROST combiner – Science

(1) GAIA binary survey



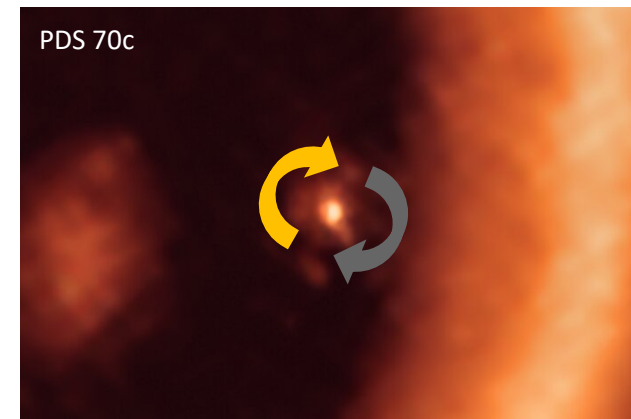
What are the fundamental properties of stars?

(2) Architecture of binary & planetary systems



What determines star & planetary system architectures?

(3) Exoplanet Spectroscopy & Circumplanetary Disk kinematics

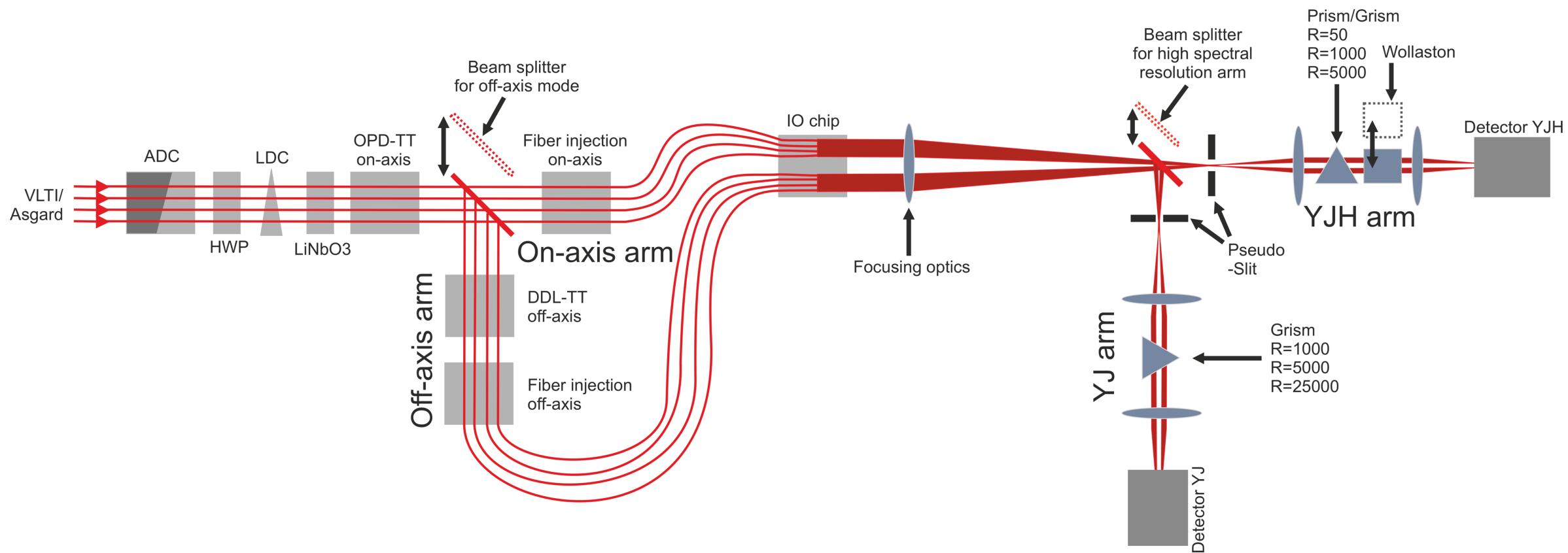


How are planets forming?

One survey (mainly ATs)

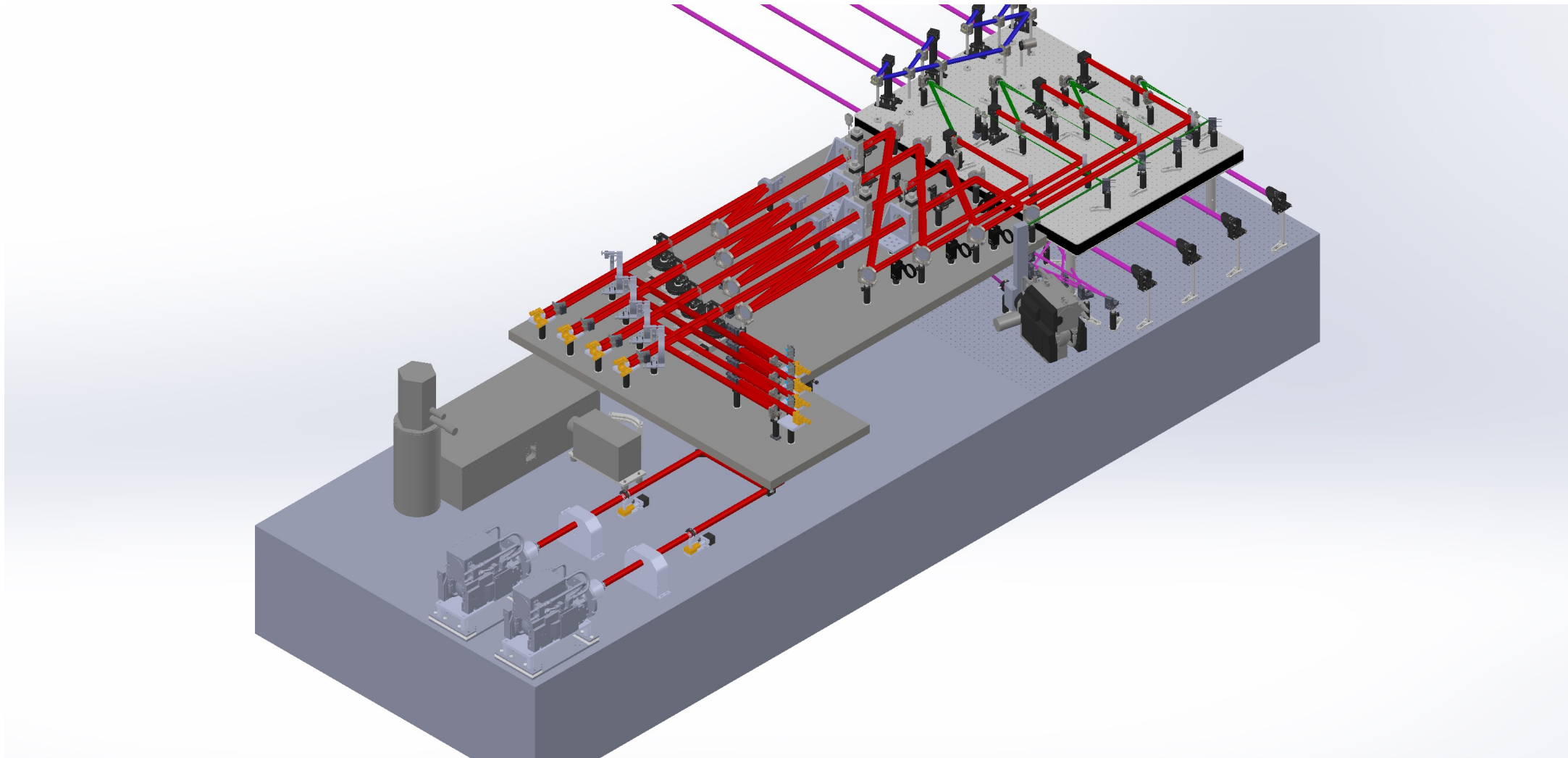


BIFROST layout



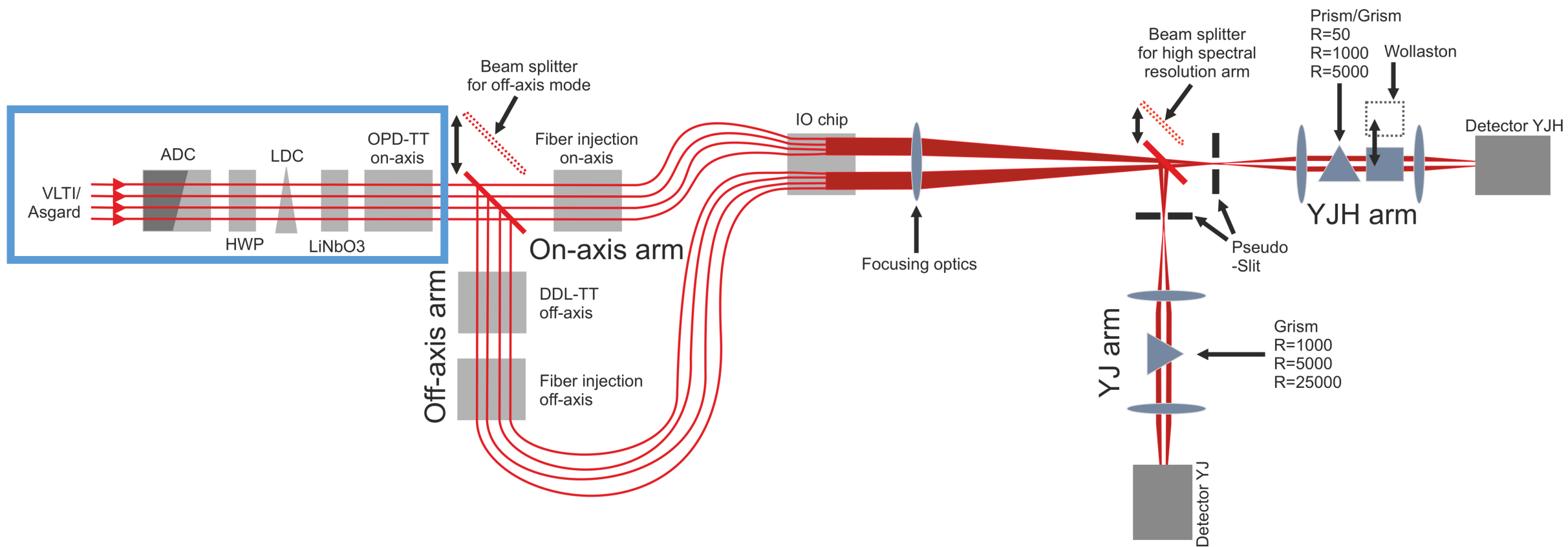


BIFROST preliminary optomechanics



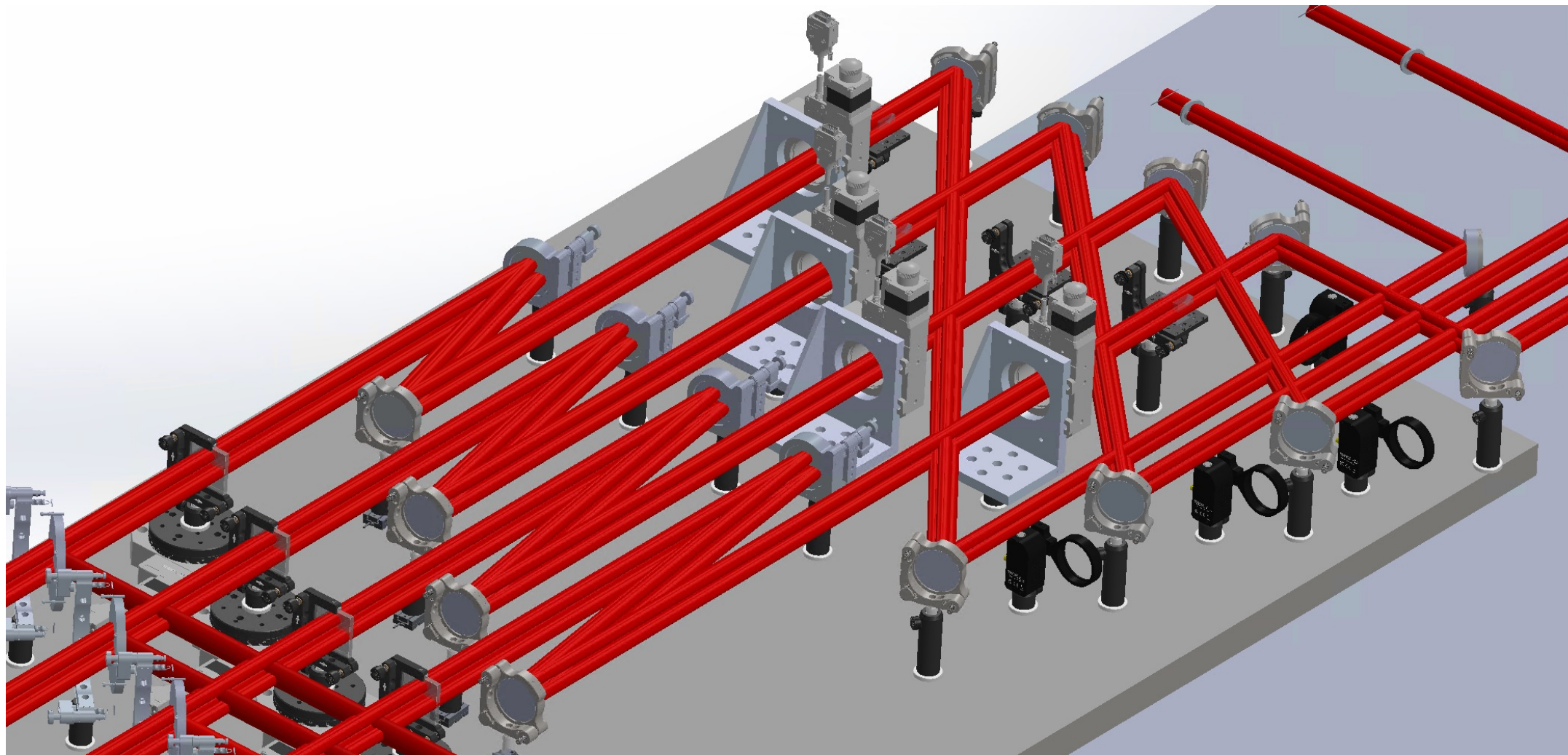


BIFROST layout – Pre-injection optics



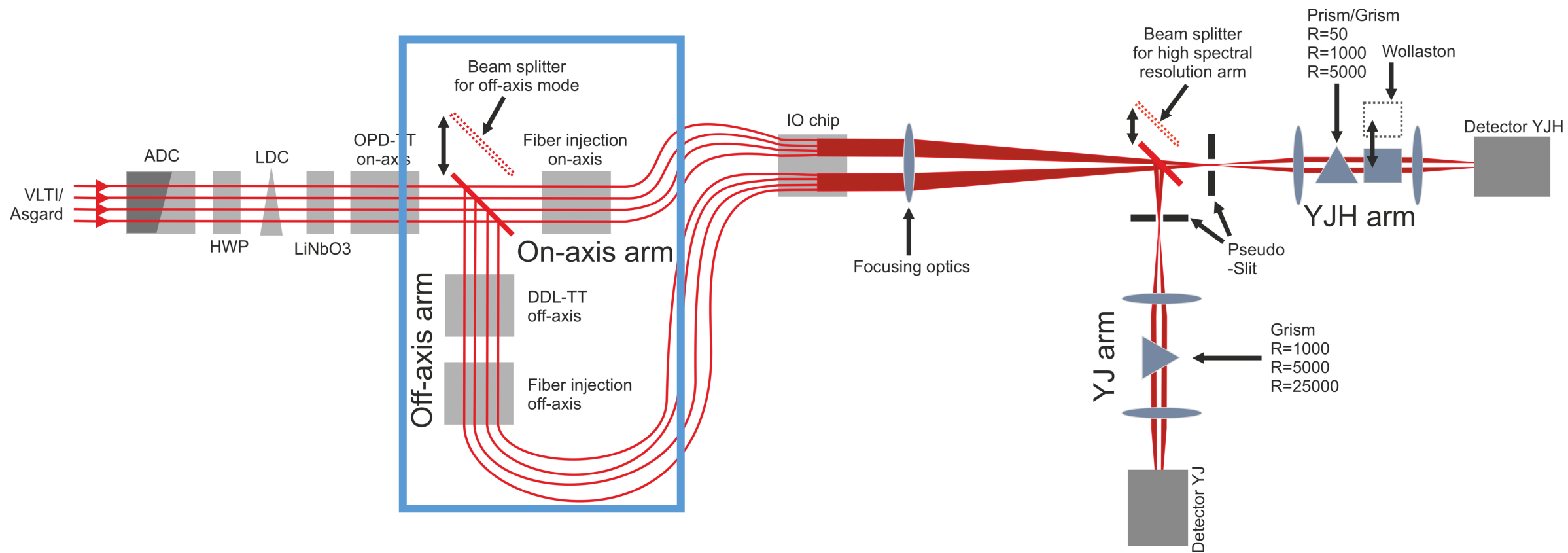


BIFROST layout – Pre-injection optics



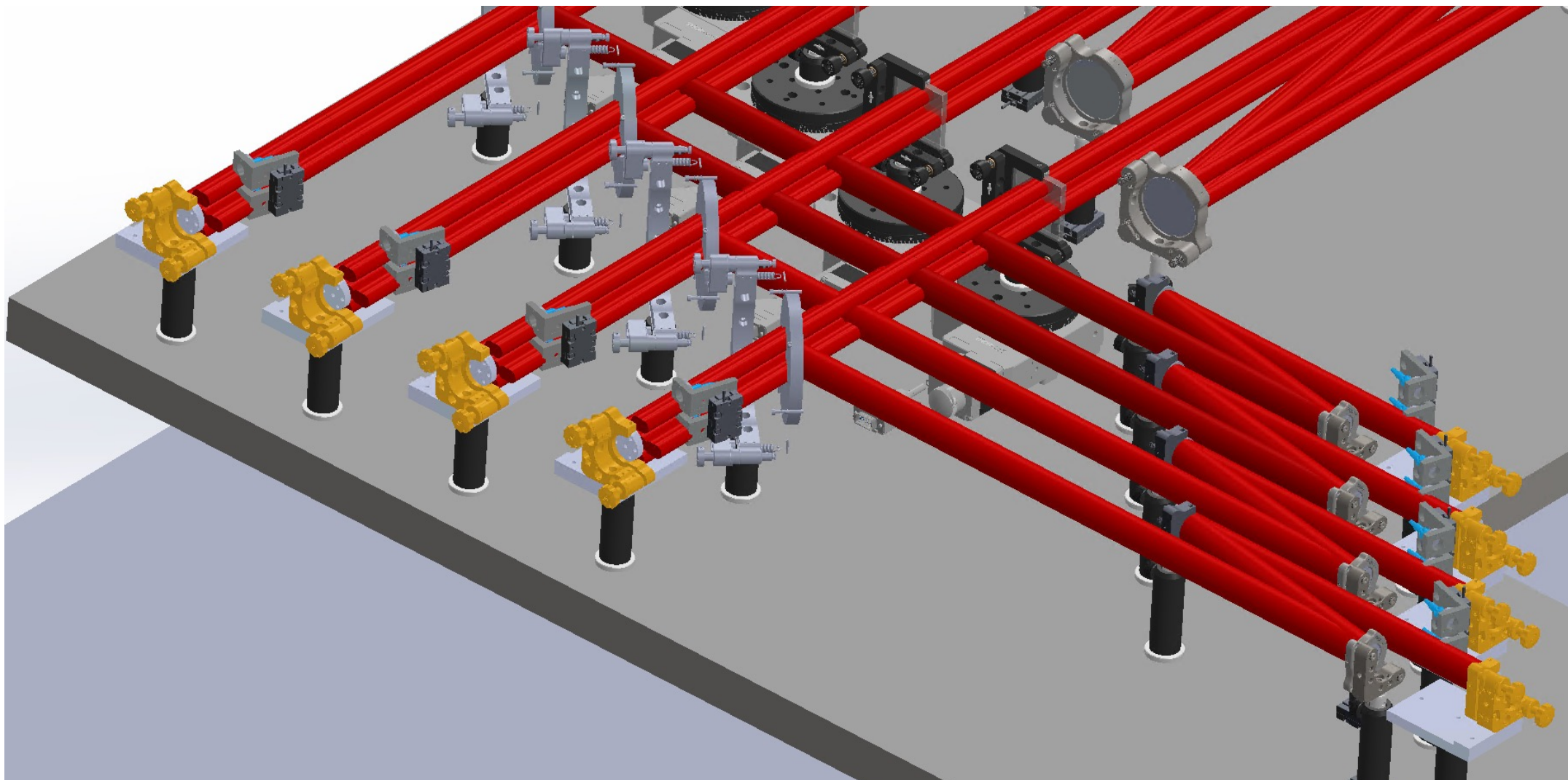


BIFROST layout – Fibre injection stage



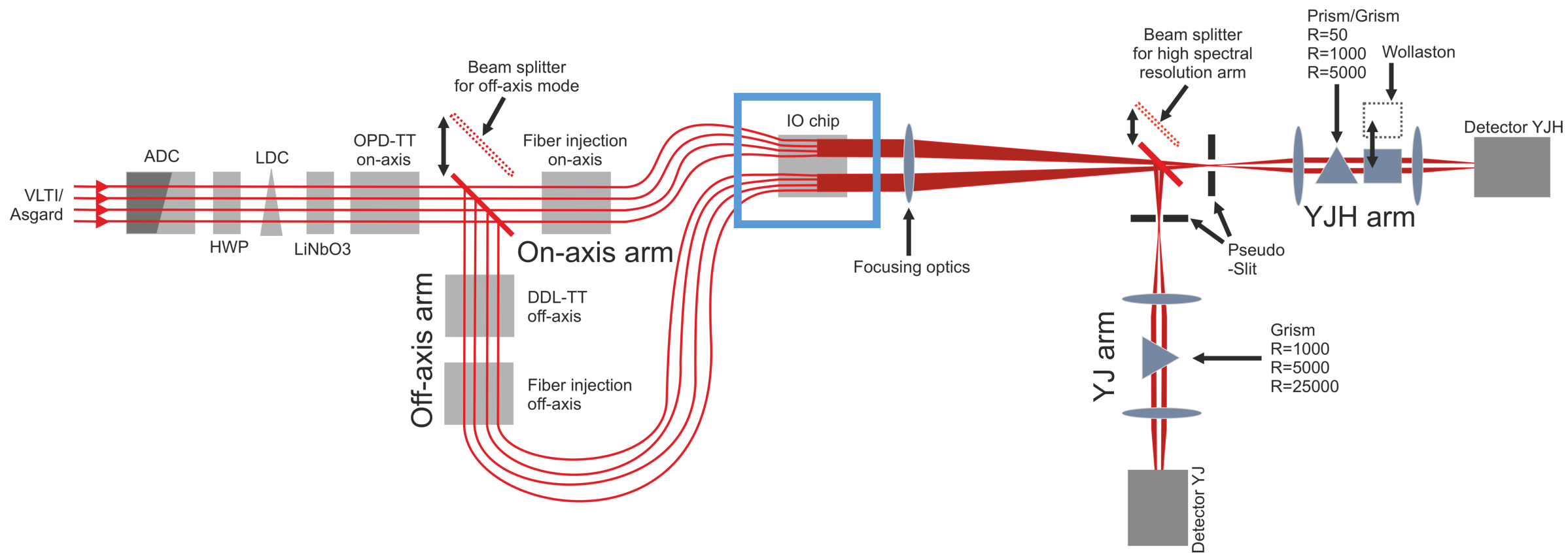


BIFROST layout – Fibre injection stage





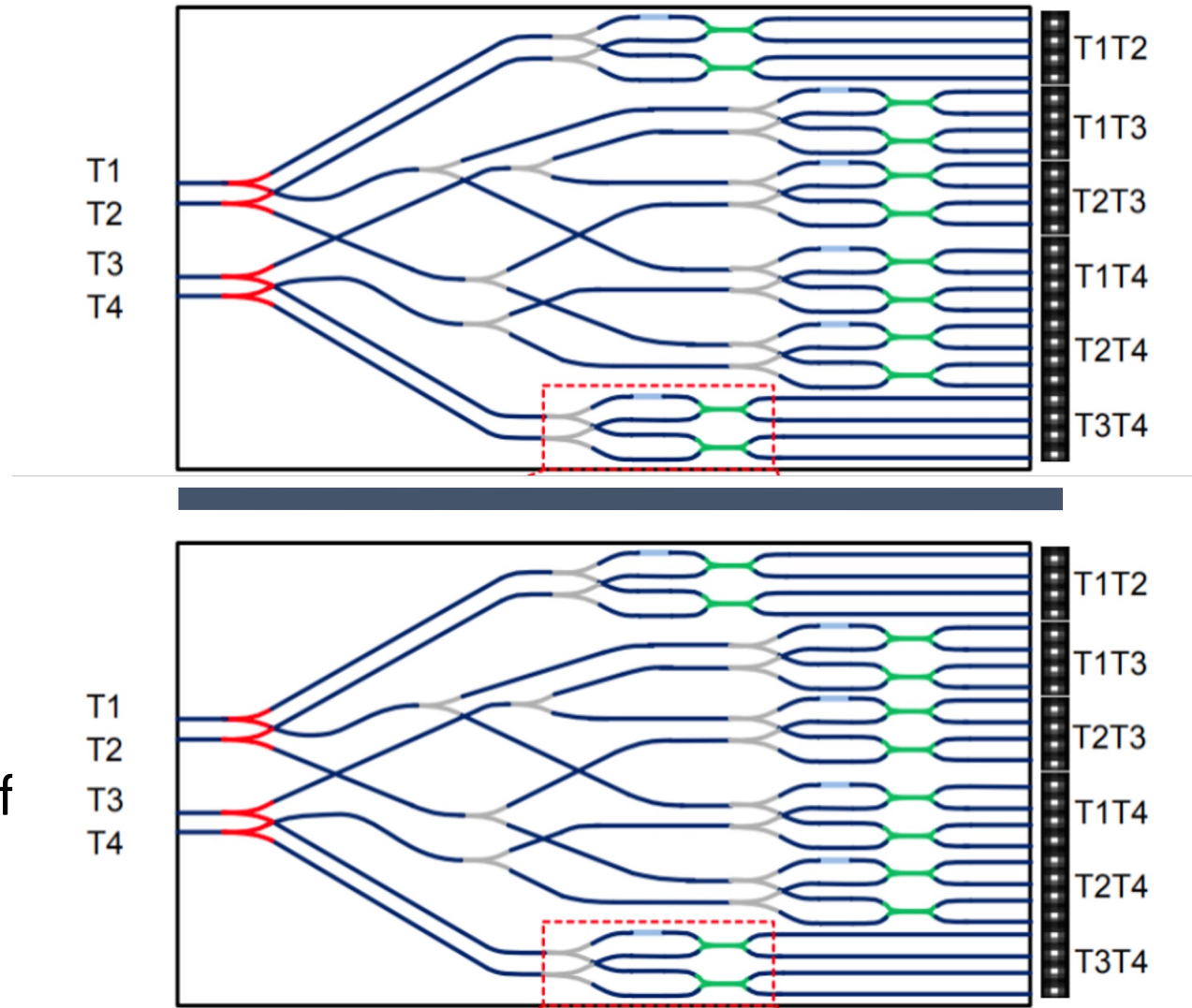
BIFROST layout





Integrated optics

- ABCD sampling
- Two devices, one Y+J, one H band
- Two circuits on same device
 - On-axis
 - Off-axis
- Sample outputs both circuits on detector at same time
- Tender published in next couple of weeks
- Discussions with Bright photonics, teem photonics, VLC

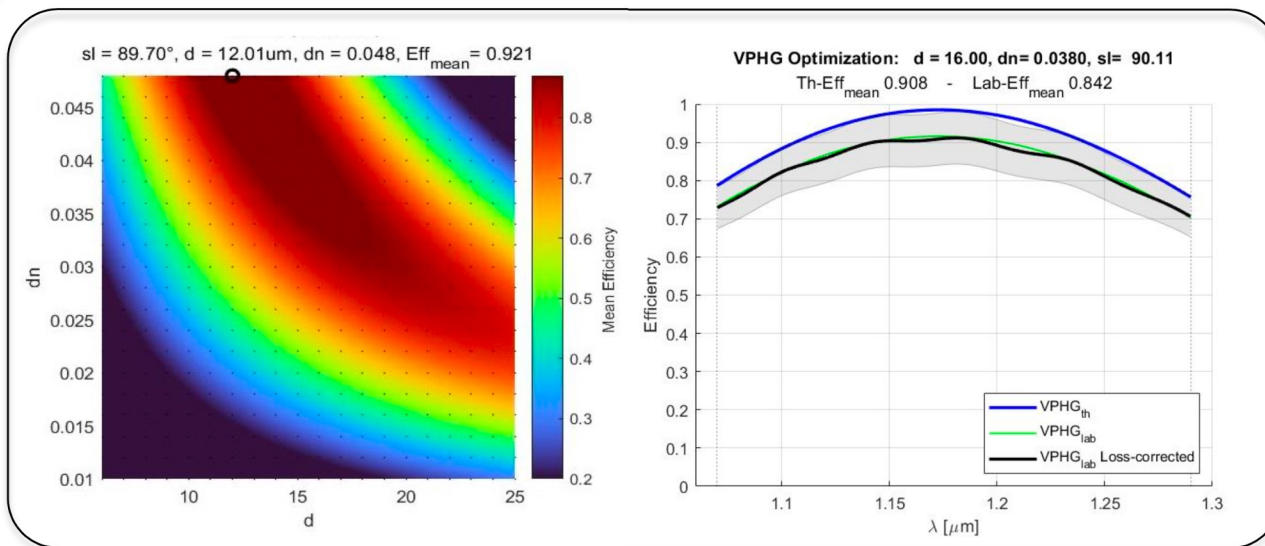




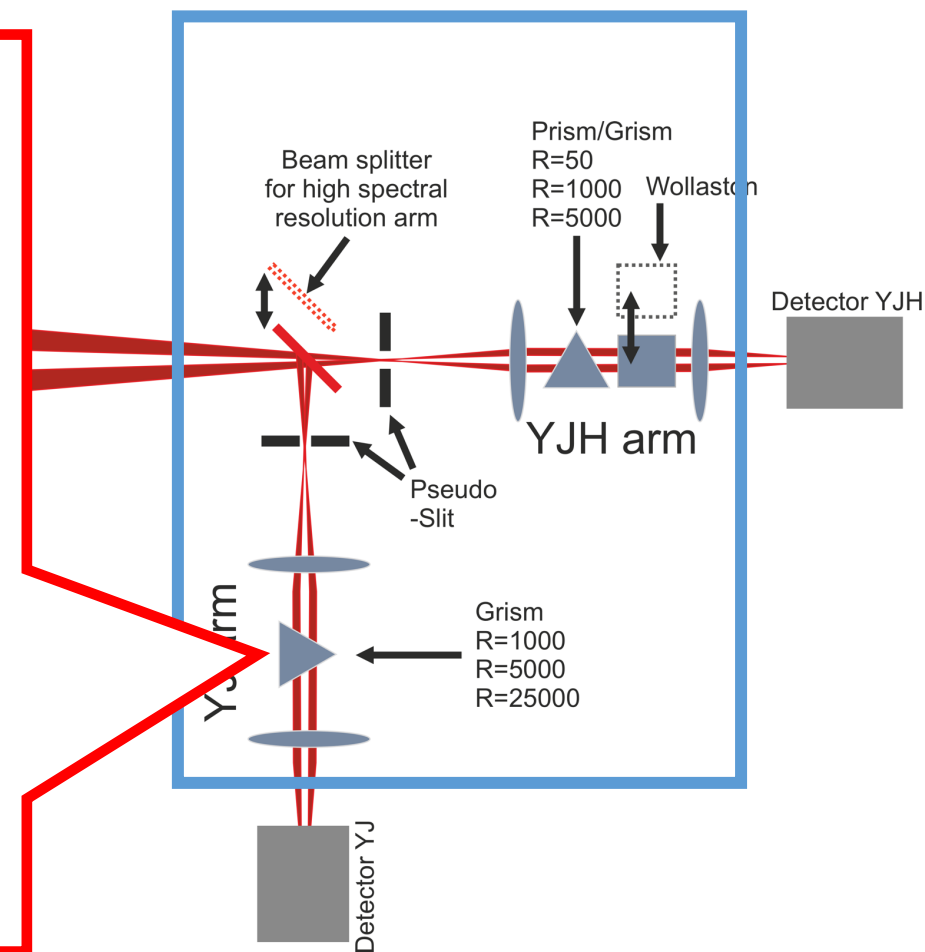
BIFROST layout – Spectrograph

Volume Phase Holographic Gratings

manufactured by Andrea Bianco's team, INAF Brera

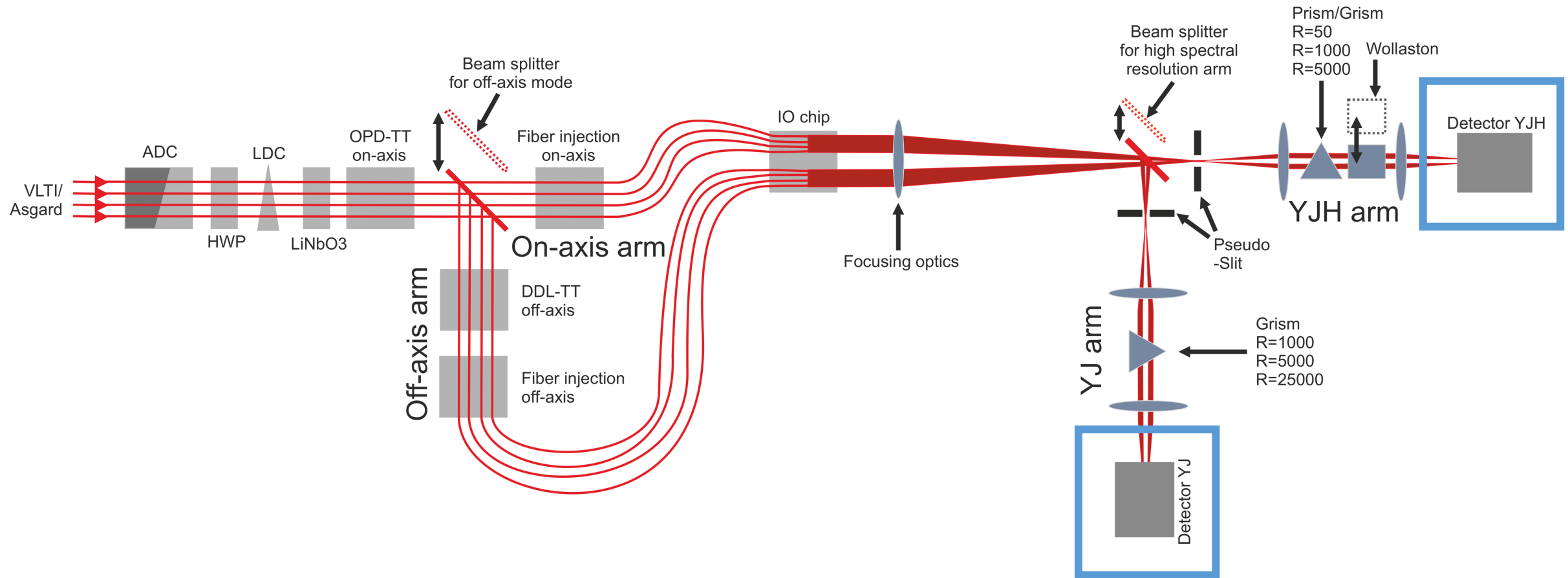


VLT
Asgard





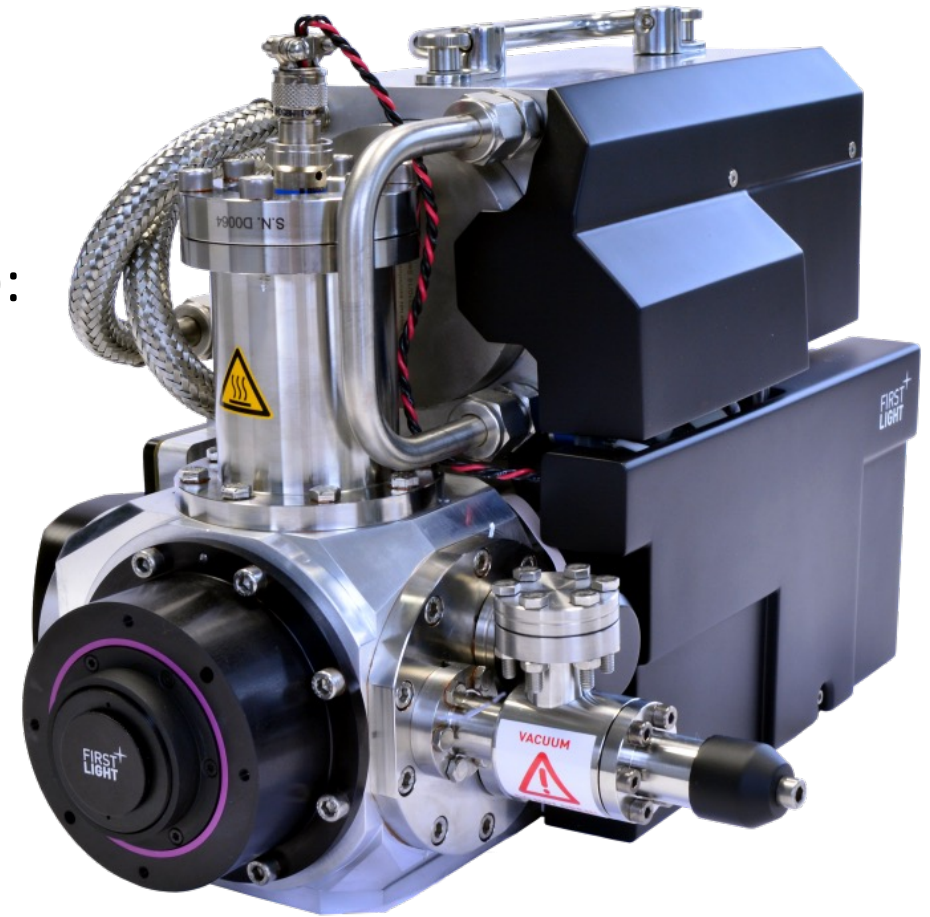
BIFROST layout – Detectors





BIFROST layout – Detectors

- Acceptance testing 2023 Oct/Dec
- Updated FLI SDK drivers for Ubuntu 20.04 LTS
- New custom baffles, higher f-number
- R&D to lower background (expected 30 e-/s/pix):
 - optimising read-out electronics for low frame rate
 - changing BIAS voltage
 - testing different operational temperatures
 - powering down amplifier for long integrations





Software

- Building on legacy of MIRC-X software
- First control server, Muninn in operation
- Full time postdoc dedicated to preparing BIFROST software

By Tyler Gardner





Phased commissioning

- Phase 1:
 - Single fiber injection unit on-sky with Baldr
 - Verify J band injection
 - May 2025
- Phase 2:
 - On-axis AT operation
 - GAIA binary survey, Spin-orbit alignment
 - October 2025
- Phase 3
 - Off-axis mode, UT operations
 - Exoplanet science, faint UT targets
 - April 2026

Next steps

- Design review June 2023
- Feb 2024: injection module integration w. ASGARD
- Dec 2024: final inspection in Exeter
- Jan 2025: Ship to paranal
- **Hiring for an optical engineer!**
 - Deadline 31st March
 - <https://jobregister.aas.org/ad/027c872a>

