Canada France Hawai'i Telescope (CFHT)

Subaru Users Meeting FY2022

02/01/2023

Jean-Gabriel Cuby
Executive Director

Agencies

National Research Council Canada | Conseil national de recherches Canada

cnrs

University of Hawai'i

Associate Partners

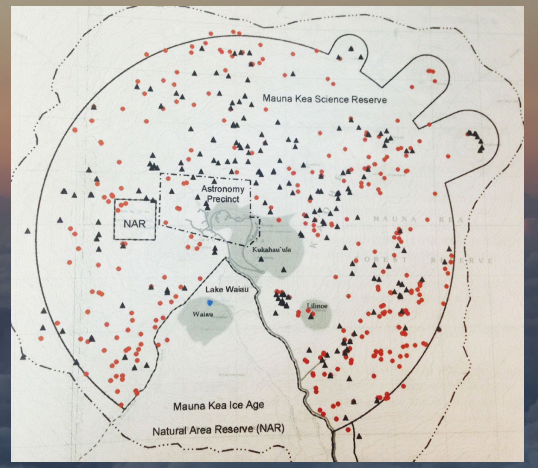
中央研究院 天文及天文物理研究所
ACADEMIA SINICA
Institute of Astronomy and Astrophysics

NAOC
National Astronomical Observatories
Chinese Academy of Sciences

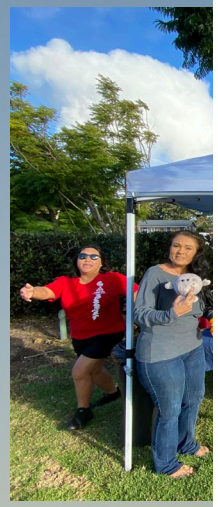
Acknowledgment

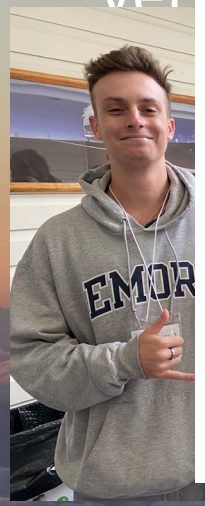
CFHT acknowledges the reverence and importance that the summit of Maunakea holds within the Hawaiian community. In Hawaiian tradition, Maunakea is a place of worship, the realm of deities, where earth and sky connect. There are hundreds of historic properties, archaeological remains, shrines, and burial sites on its slopes and summit.

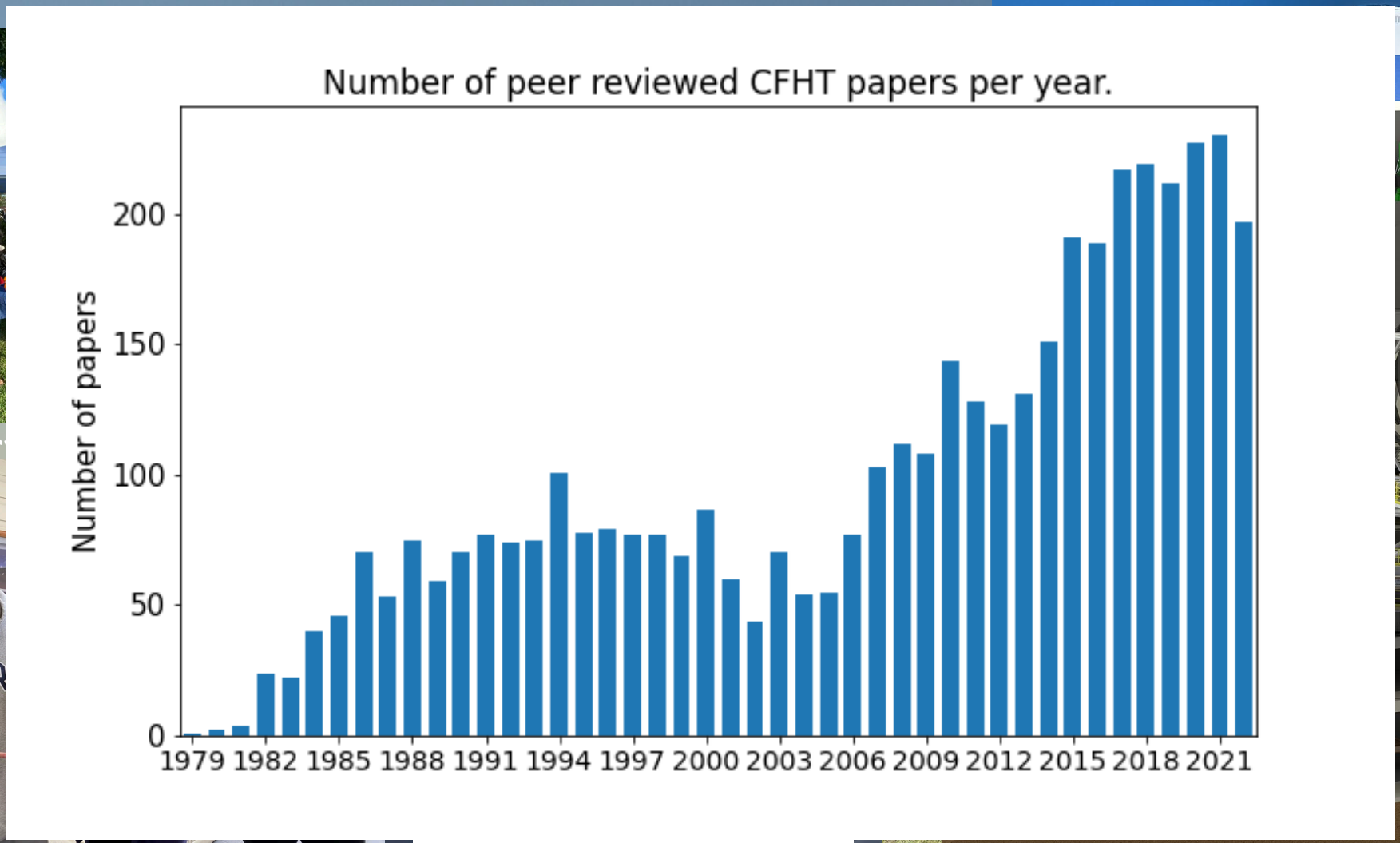
As astronomers, we are privileged and honored to have the opportunity to observe the sky and advance our knowledge of the universe through the facilities hosted there.

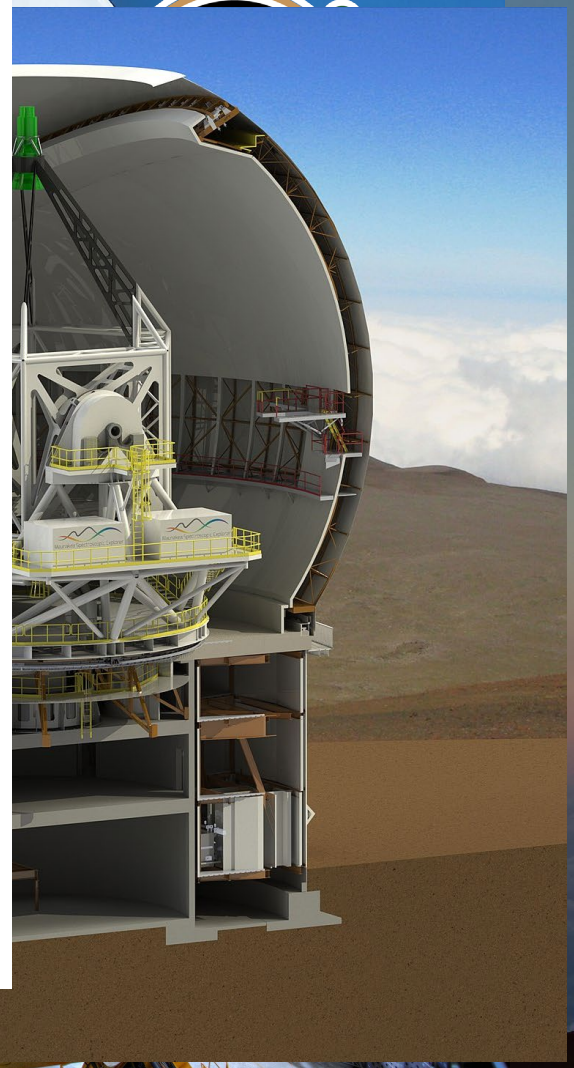


CFHT in a nutshell



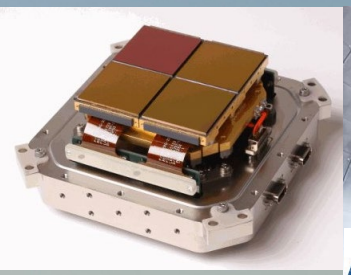






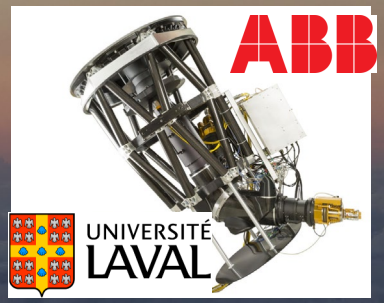
CFHT Instruments

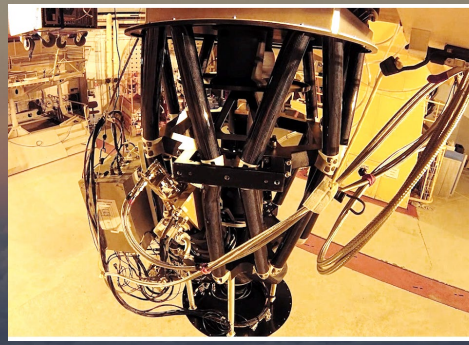
Prime Focus: WIRCam
- 20’ x 20’ NIR imager
- 128 Mpix @ 0.306 arcsec/pix
- Broad band and Narrow band filters

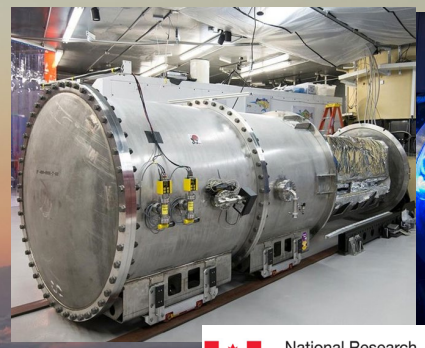


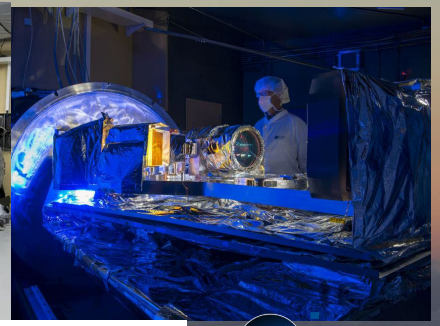
Prime Focus: MegaCam
- 1º x 1º optical imager
- 360 Mpix @ 0.189 arcsec/pix
- Broad band and NB filters

Cass: SITELLE
- 11’ x 11’ Fourier Transform Spectro-imager
- 350-900 nm
- 2k x 2k @ 0.32 arcsec/pix
- R = 6,000 – 10,000









SPIRou
- High Resolution NIR spectropolarimeter
- 970-2490 nm - R = 70,000
- 1.5 $m.s^{-1}$ radial velocity accuracy

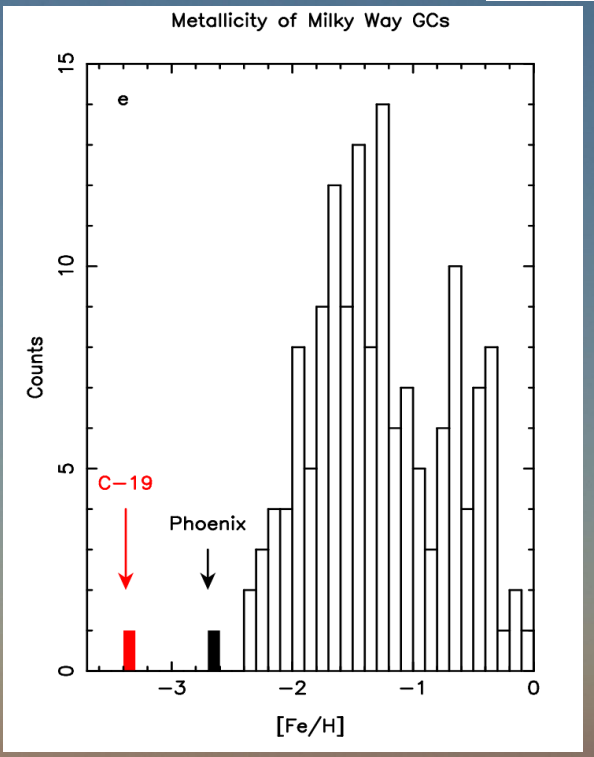
ESPaDOnS
- High Resolution optical spectropolarimeter
- 370-10,000 nm
- R = 70,000

Science highlights

The PRISTINE collaboration

Pristine is a PI program using MegaCam equipped with a custom made narrow band interference filter, the CAHK filter, that optimizes the photometric measurements of metals in stars. By combining Gaia DR3 data and Pristine data, C-19 was identified as a very low metallicity stellar stream.

Artist's rendering of C-19's place in the Milky Way, one of the structures discovered by PRISTINE. C-19 was a new candidate stellar stream that was identified as the tidal remnant of a globular cluster. The data on C-19 revealed stars with an extremely low photometric metallicity.



Metallicity distribution of all known globular clusters of the Milky Way. The metallicity of the C-19 progenitor is highlighted in red.

Credits: Martin, N.F. et al Nature, 601, 7891

Science highlights

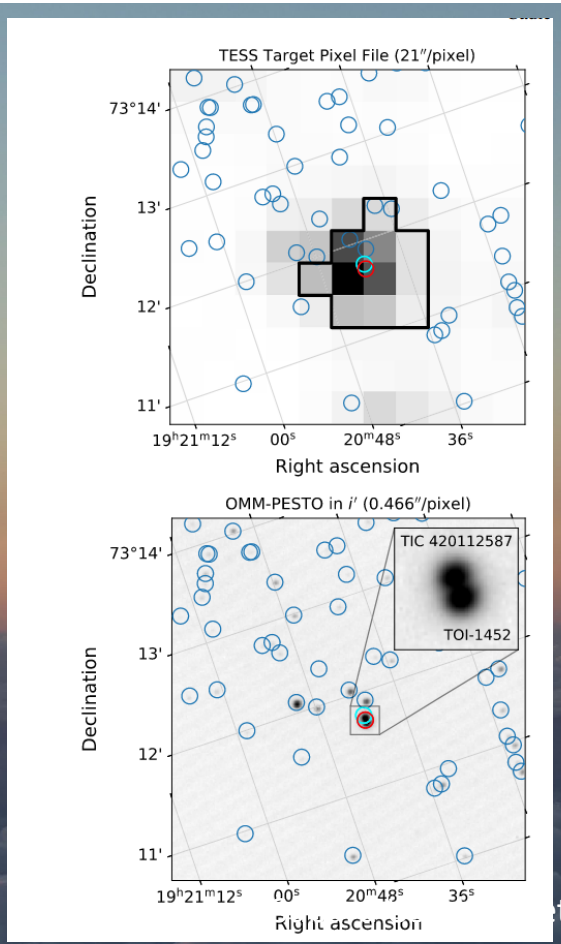
The Astronomical Journal, 164:96 (28pp), 2022 September
https://doi.org/10.3847/1538-3881/ac7cea

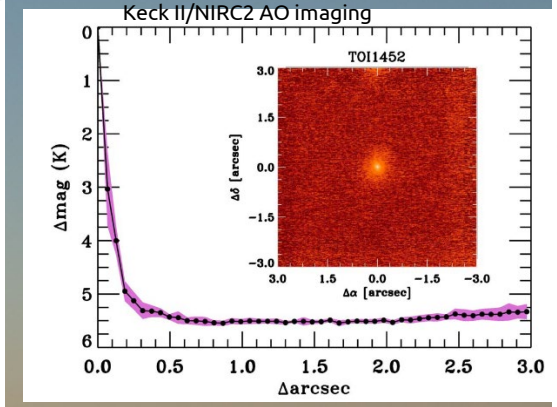
TOI-1452 b: SPIRou and TESS Reveal a Super-Earth in a Temperate Orbit Transiting an M4 Dwarf

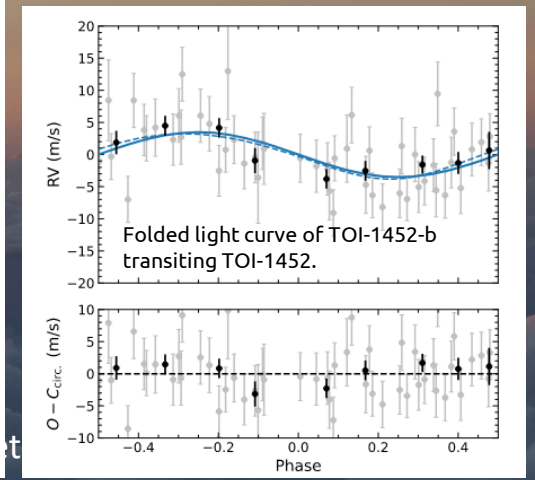
Credits: Cadieux et al AJ, 164:96

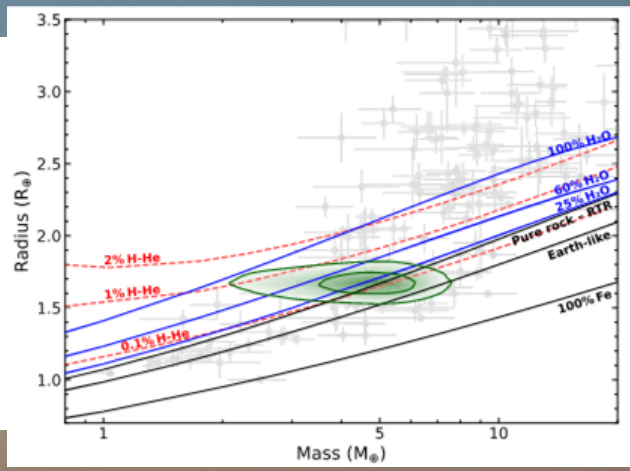
Discovery of TOI-1452b, a transiting super-Earth in a 11.1 day temperate orbit around an M dwarf star that could possibly be a water world.

Higher resolution observations using OMM PESTO, MuSCAT3 on the 2 m Faulkes Telescope North of Las Cumbres Observatory (LCO) at Haleakala observatory and Keck II/NIRC2 AO imaging confirmed that the transit light curve is associated with TOI-1452 (lower right).





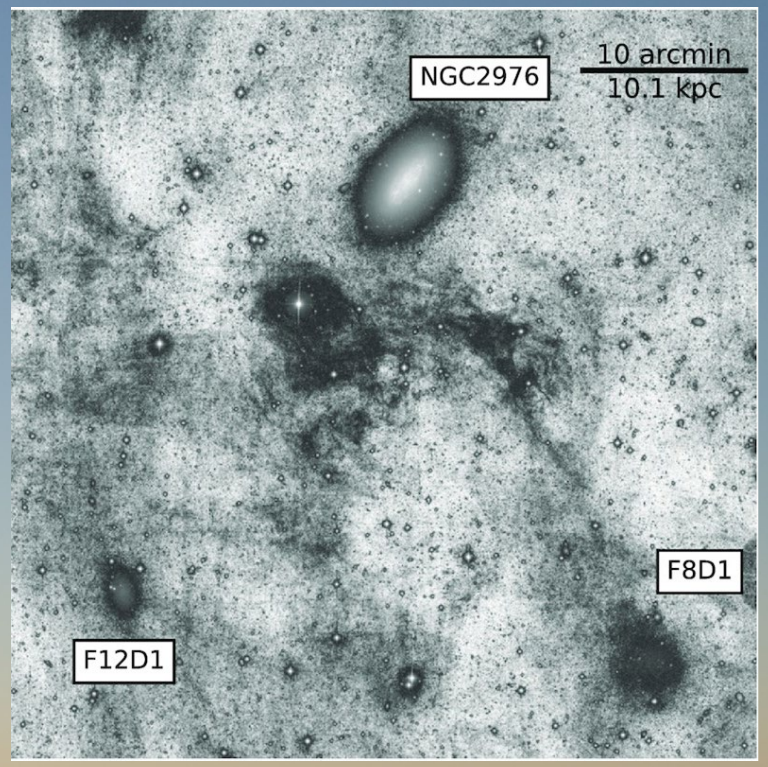


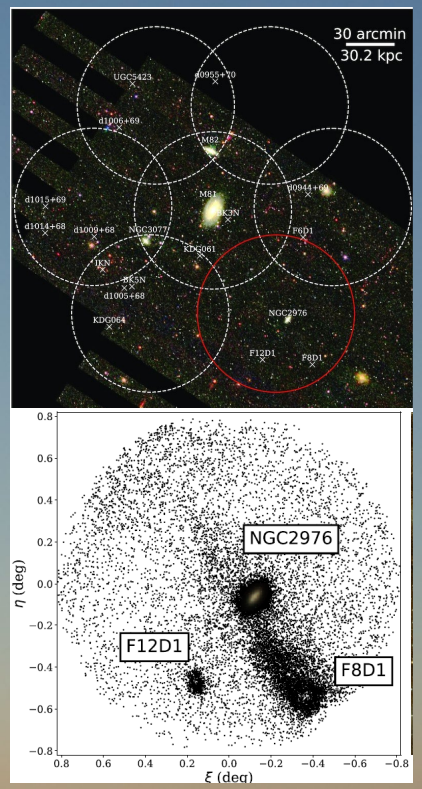


Mass and radius of TOI-1452-b overlaid on models. The planet's mass and radius constrains the planetary models to either a solid rock with a 25% water or a barren rock. Also, mini-Neptunes (0.1% H-He) could not be ruled out.

Science highlights

A Tale of A Tail
Collaborations with HSC at Subaru





Ultra-Diffuse Galaxy F8D1 in M81 Group.

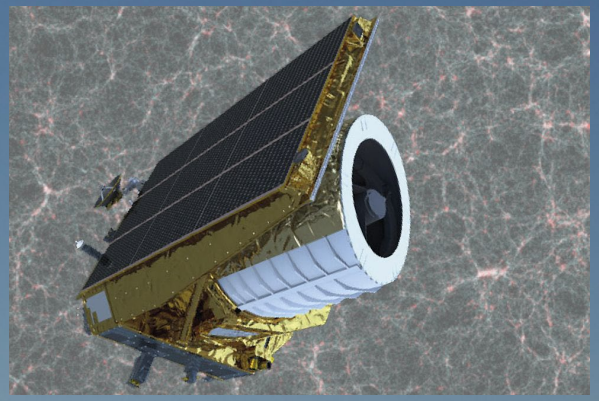
Zoom-in deep i-band image taken with CFHT/MegaCam. Highly structured cirrus is present throughout this region, complicating the integrated light studies of low surface brightness emission from F8D1 and neighbors. Right: footprint of Subaru/HSC M81 Group Survey.

Discovery of a giant tidal tail from an ultra-diffuse dwarf galaxy. F8D1 is is now recognised to be one of the closest examples of an “ultra-diffuse” galaxy. Using observations with Hyper Suprime-Cam (HSC) on the Subaru Telescope and the MegaCam imager on the Canada-France-Hawaii Telescope, a team of researchers has mapped the tidal stream of stars from F8D1 over 1 degree on the sky, corresponding to two hundred thousand light-years at the distance of the galaxy. Revealing **F8D1 to be a galaxy in an advanced state of tidal disruption** has implications for both the dynamical evolution of the M81 Group and for the origin of galaxies that exhibit UDG properties.

Žemaitis et al., 2022, MNRAS, 518,

https://www.cfht.hawaii.edu/en/news/M81TidalTails/

CFHT & Euclid



- CFH… 2016 in a ma… colla… ce, Cana… f Haw… nd base… uclid.
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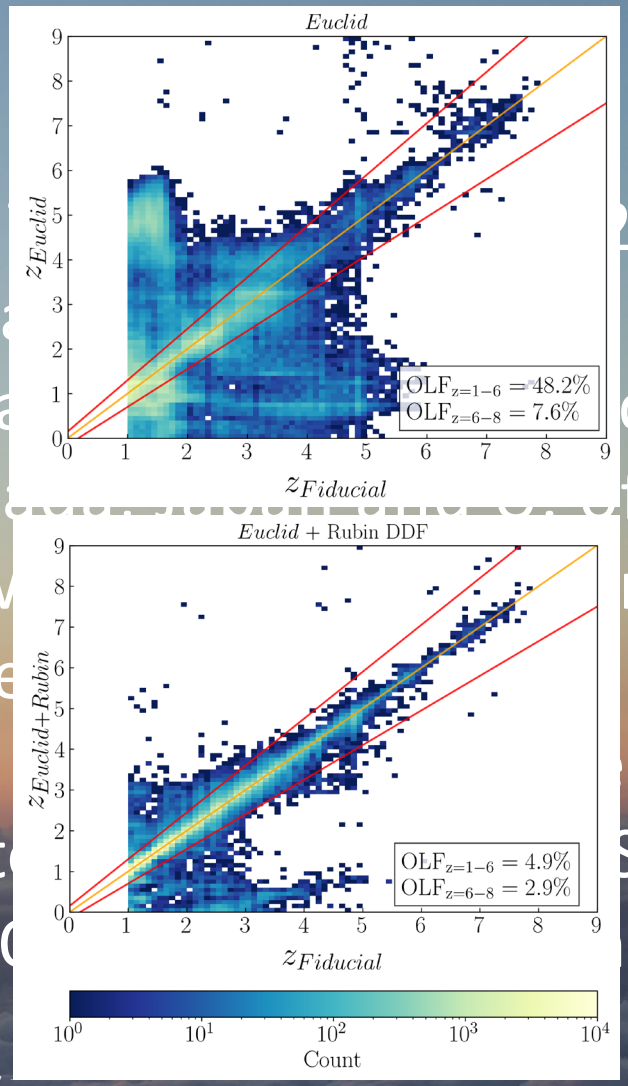
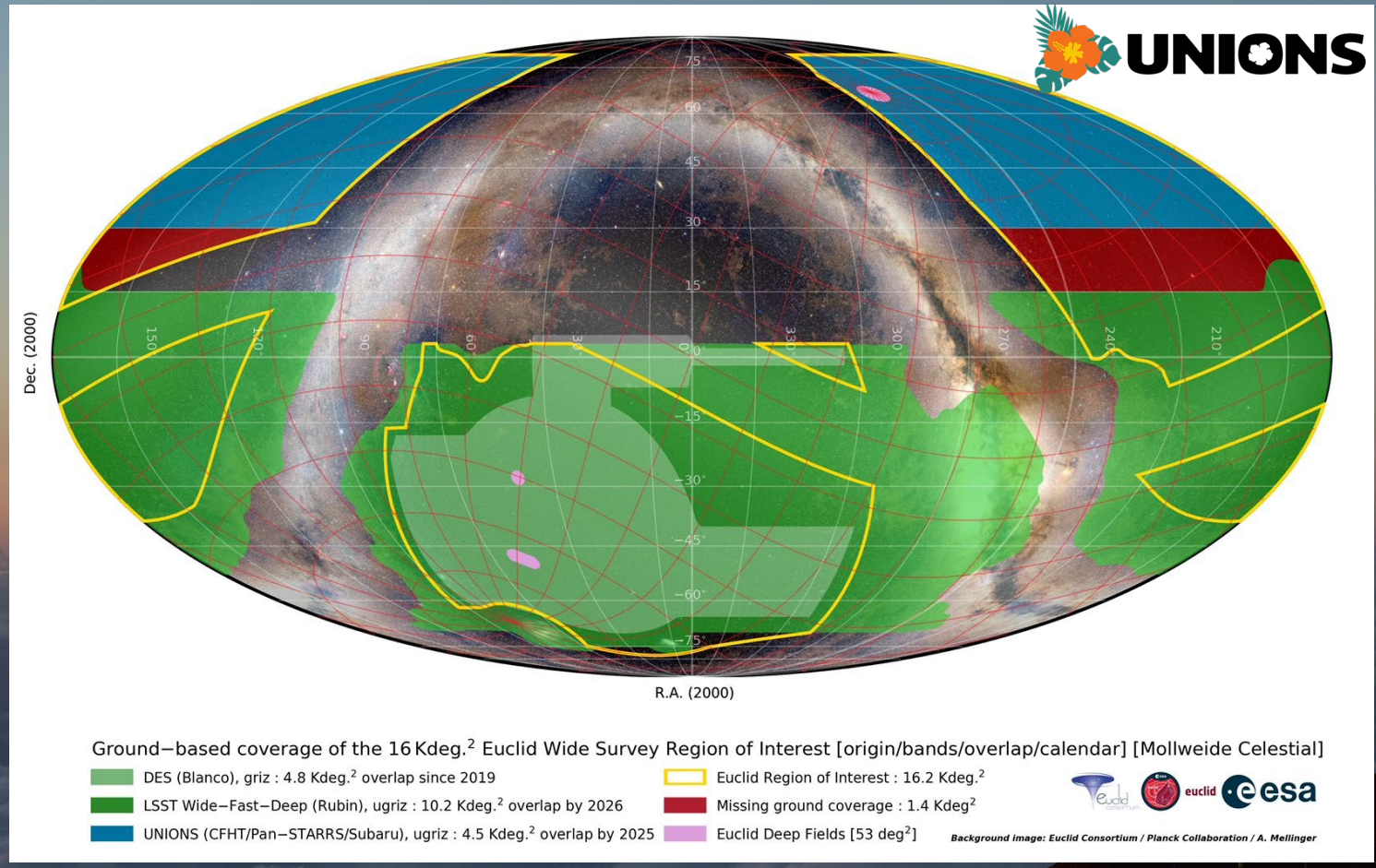
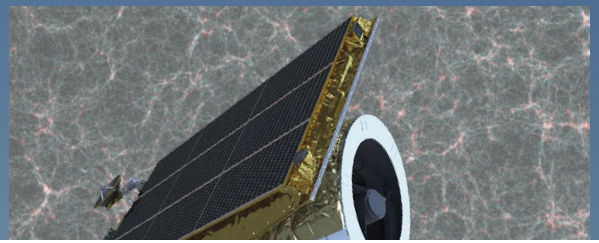
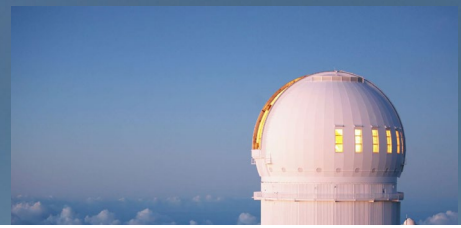




Slide Courtesy Jean-Charles Cuillandre

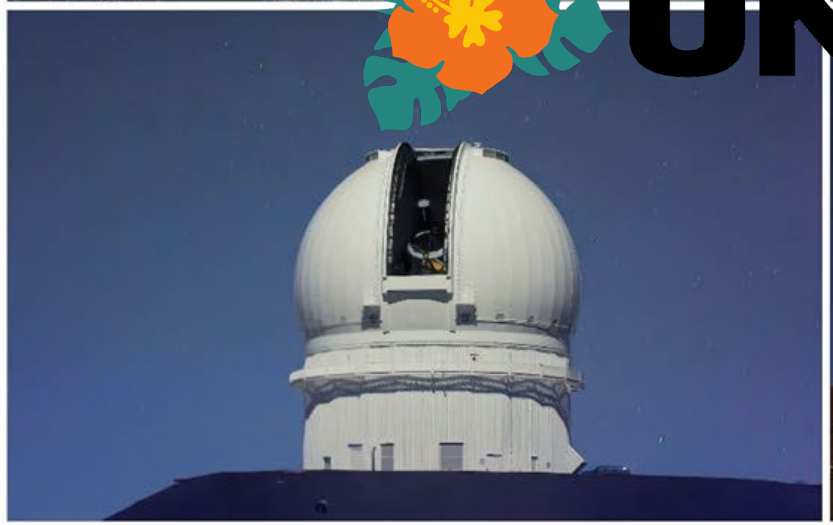
CFHT & Euclid

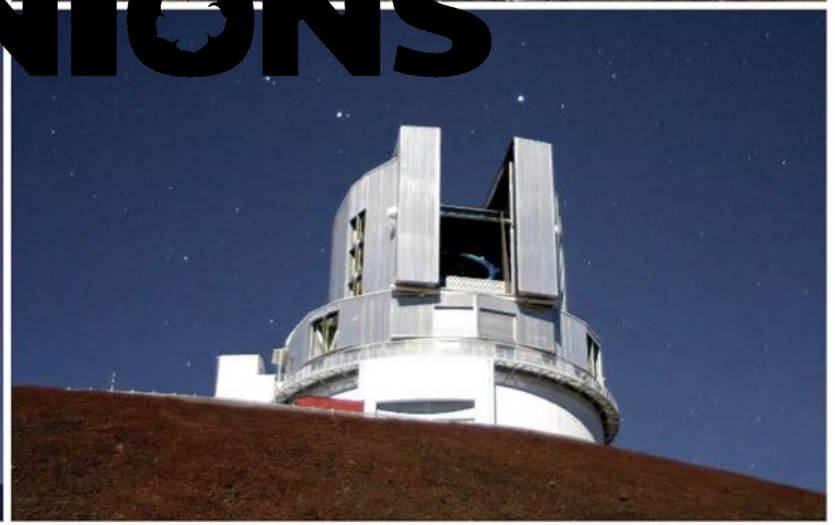




The Ultraviolet Near Infrared Optical Northern Survey

UNIONS

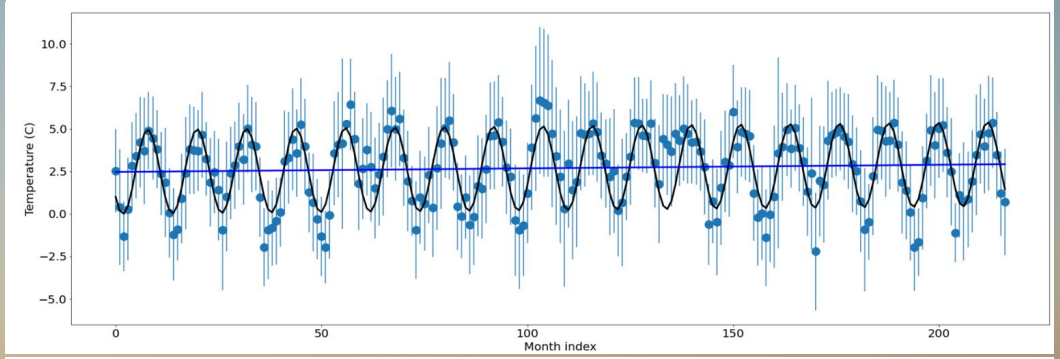




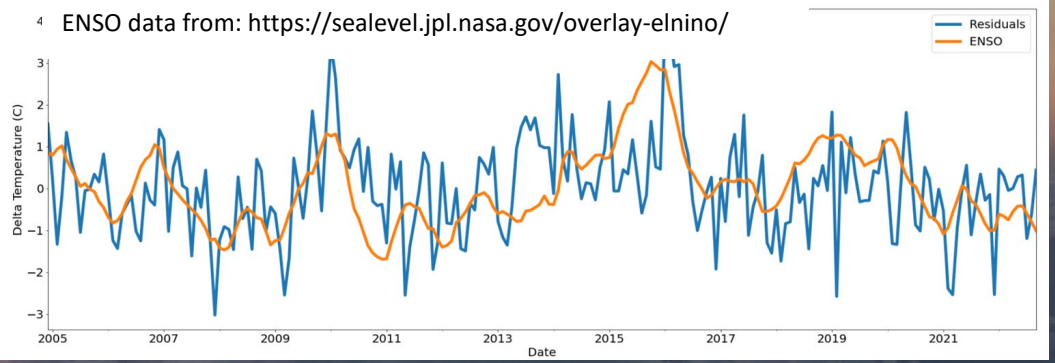
Slide Courtesy Jean-Charles Cuillandre

Decadal variations of seeing above Maunakea

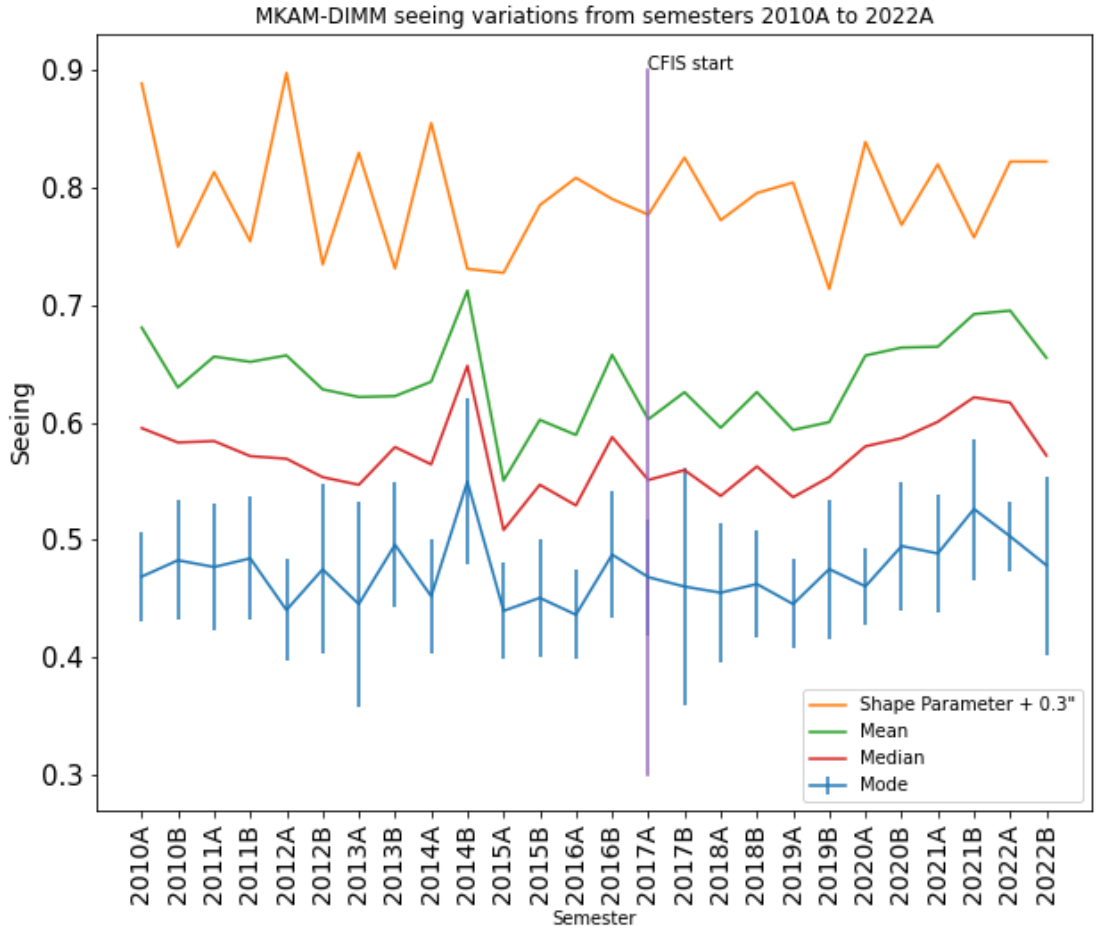
Temperature variations since 2005. The slope is 0.25 deg C per decade consistent with the findings of Haslebacher et al 2022. Residuals from the fit above compared to the variations of the El-Niño Southern Oscillation index.



ENSO data from: https://sealevel.jpl.nasa.gov/overlay-elnino/

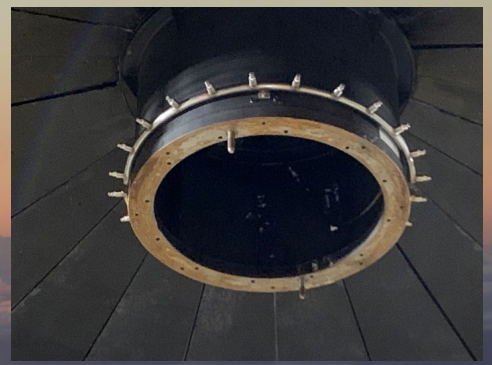


Seeing variations over 10+ yrs from MKAM-DIMM

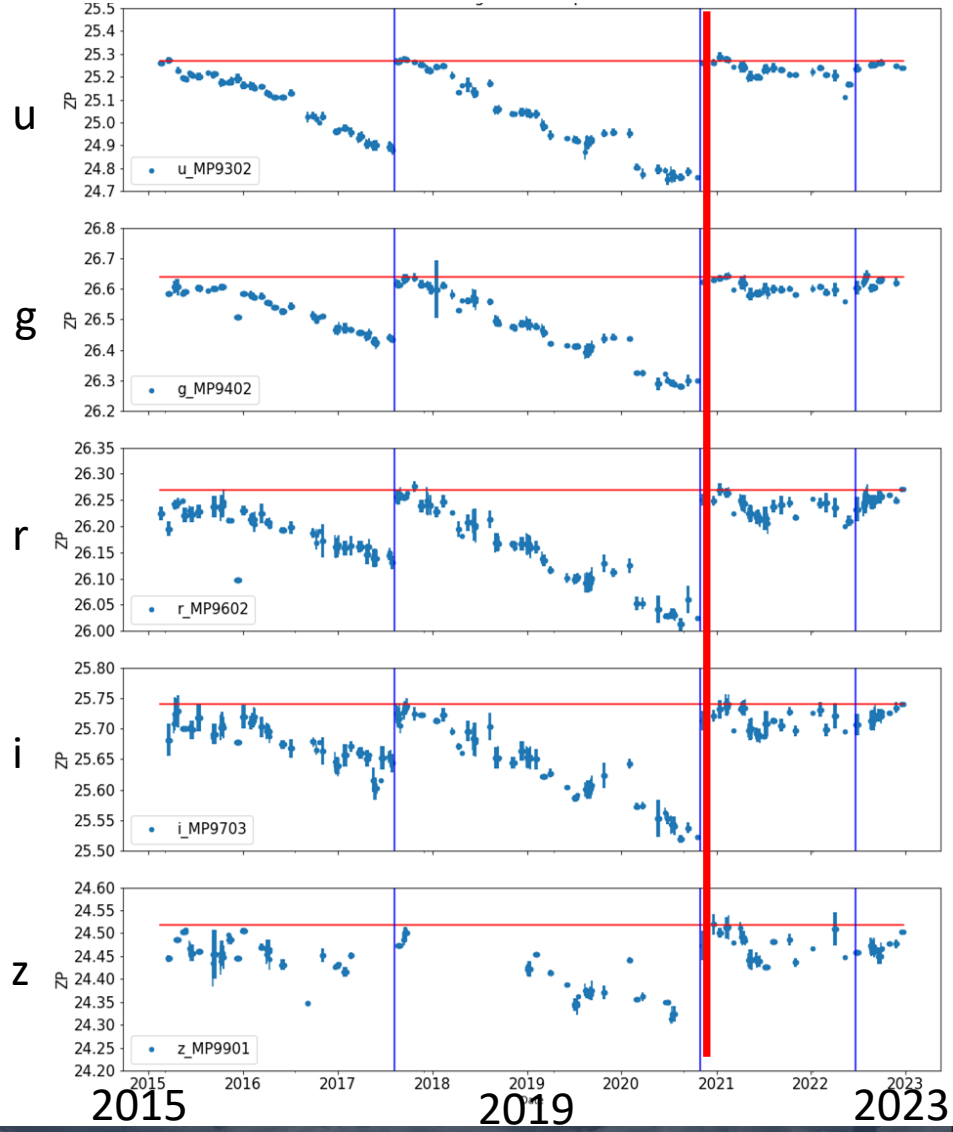


CFHT News – Engineering

- Dry Air System above primary mirror
- Zero Point much more stable!

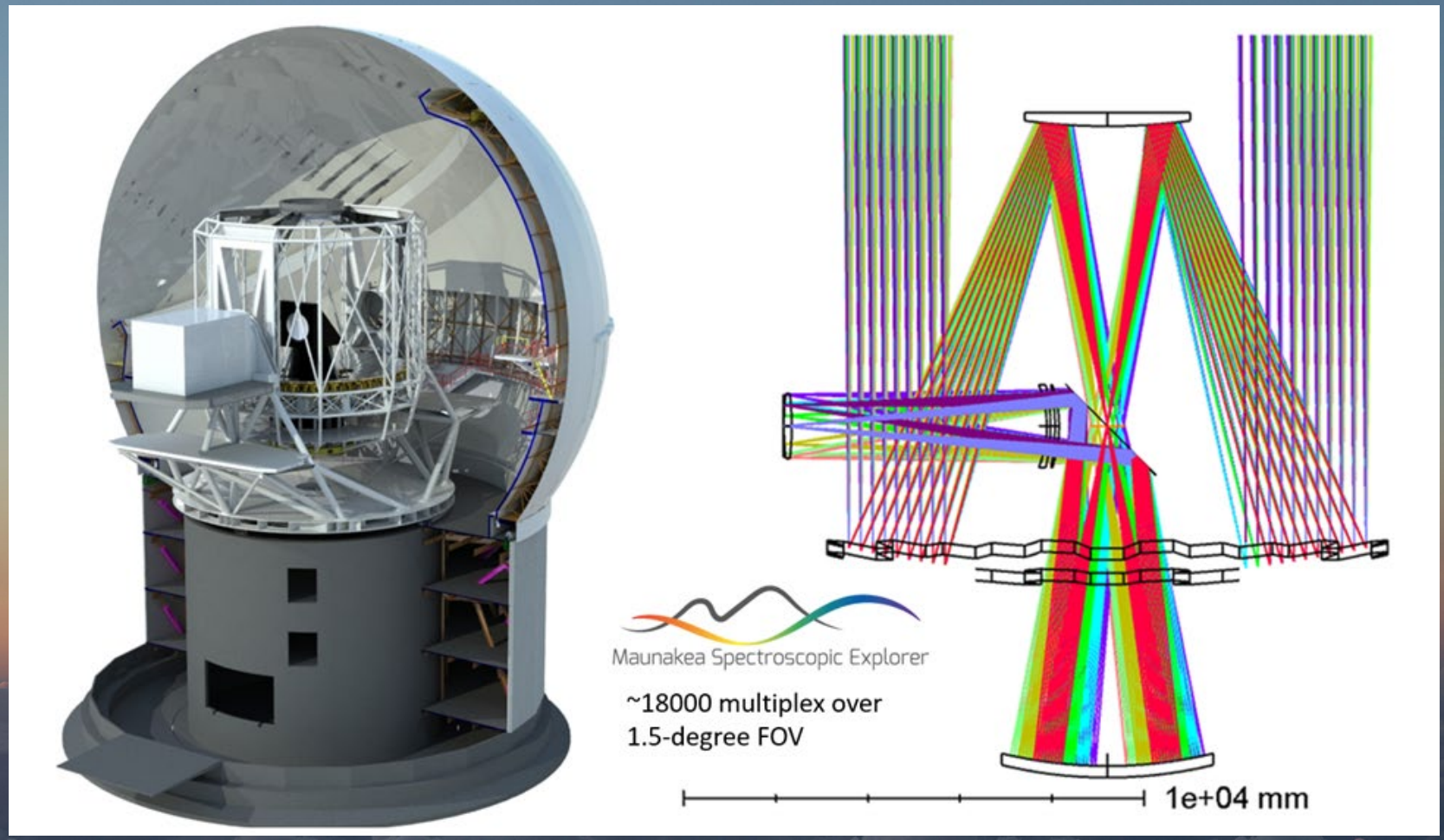


Variation of the MegaCam Zeropoints over time



Maunakea Spectroscopic Explorer (MSE)

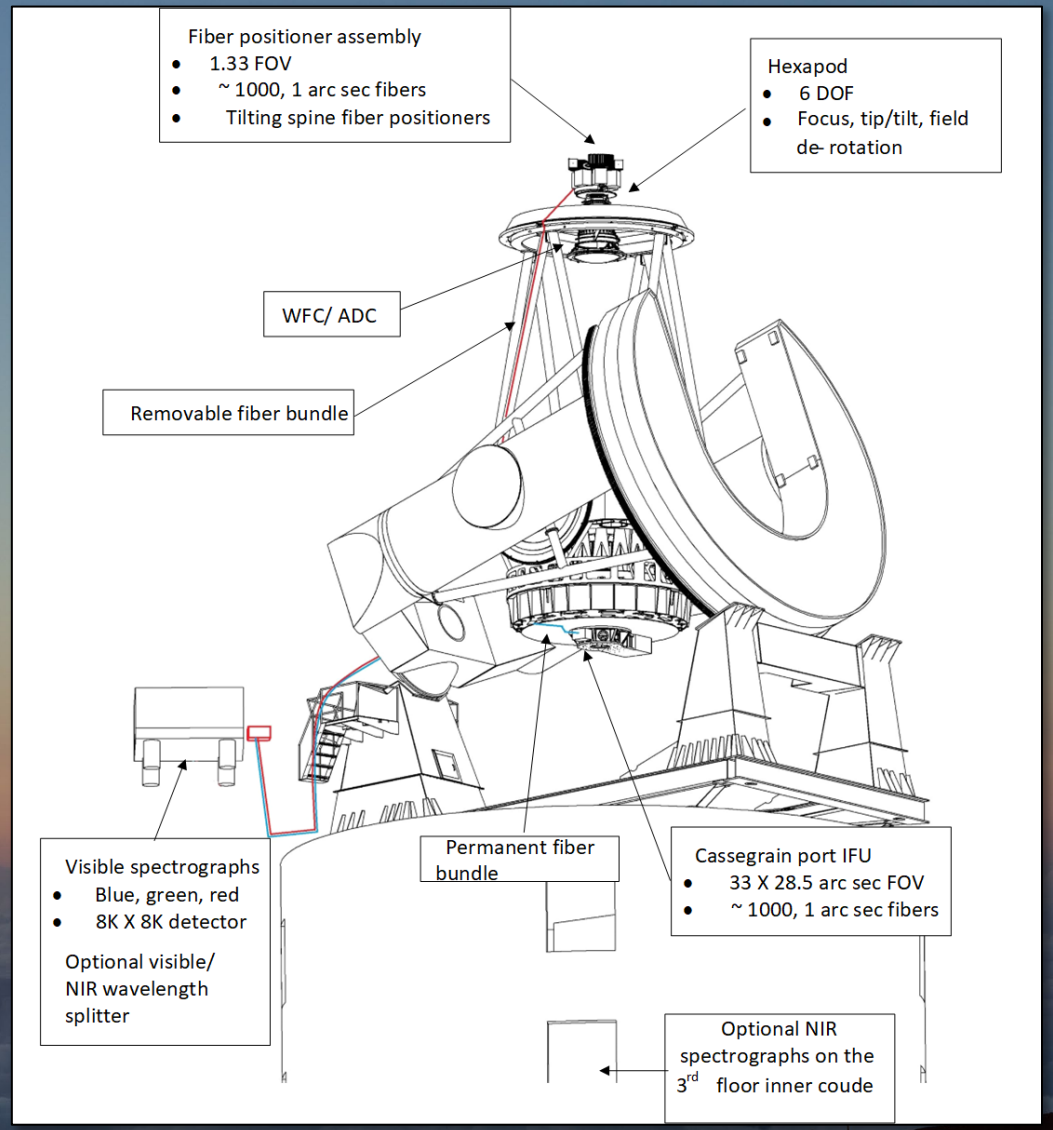
- Schedule has to follow the process with the new authority on Maunakea (MKSOA): start of construction no earlier than early 2030s
- Make MSE a model of an Indigenous & sustainable project to be developed on Maunakea
- New design under consideration:
  - 4-mirror design, Nasmyth foci
  - Can accommodate up to 20,000 fibers
  - R&D programme



MSE Pathfinder @ CFHT

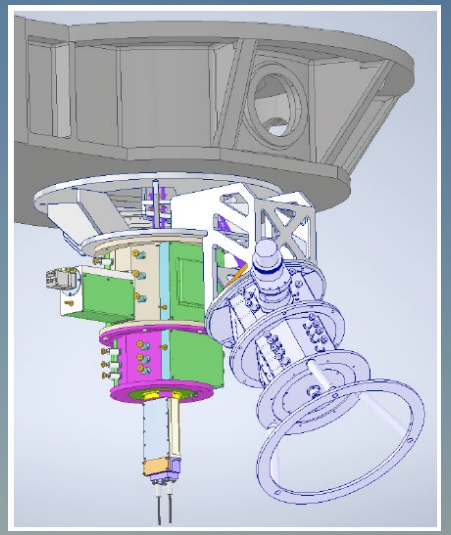
- Multi-Object Spectrograph (MOS) and Integral Field Unit (IFU) for CFHT, to carry out surveys before MSE construction starts
- Call for proposals to be issued shortly

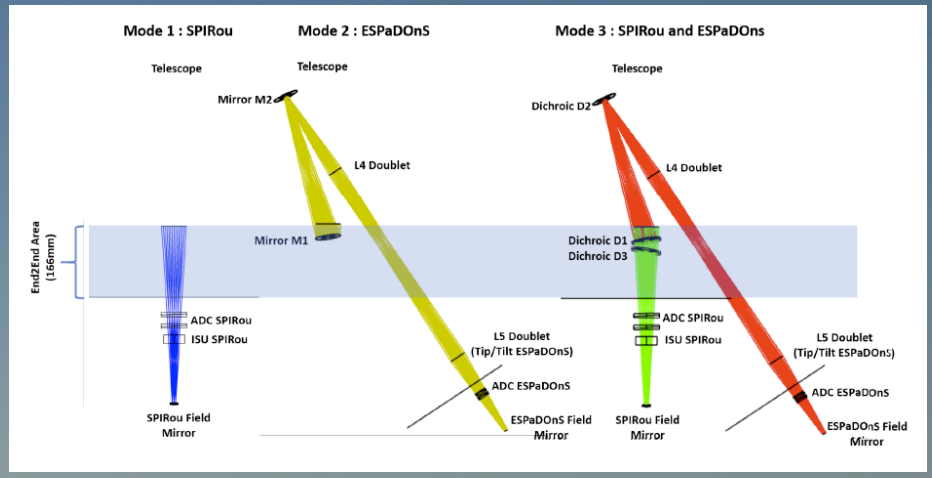
Fiber diameter	1 arcsec
Plate scale	65 um/ arcsec
FOV	1.084 deg^2
Fiber positioner pitch	119 arcsec
Number of positioners	1000 (2 spectrographs)
Spectral Coverage	350 – 980 nm
Spectral Resolution	2000-5100



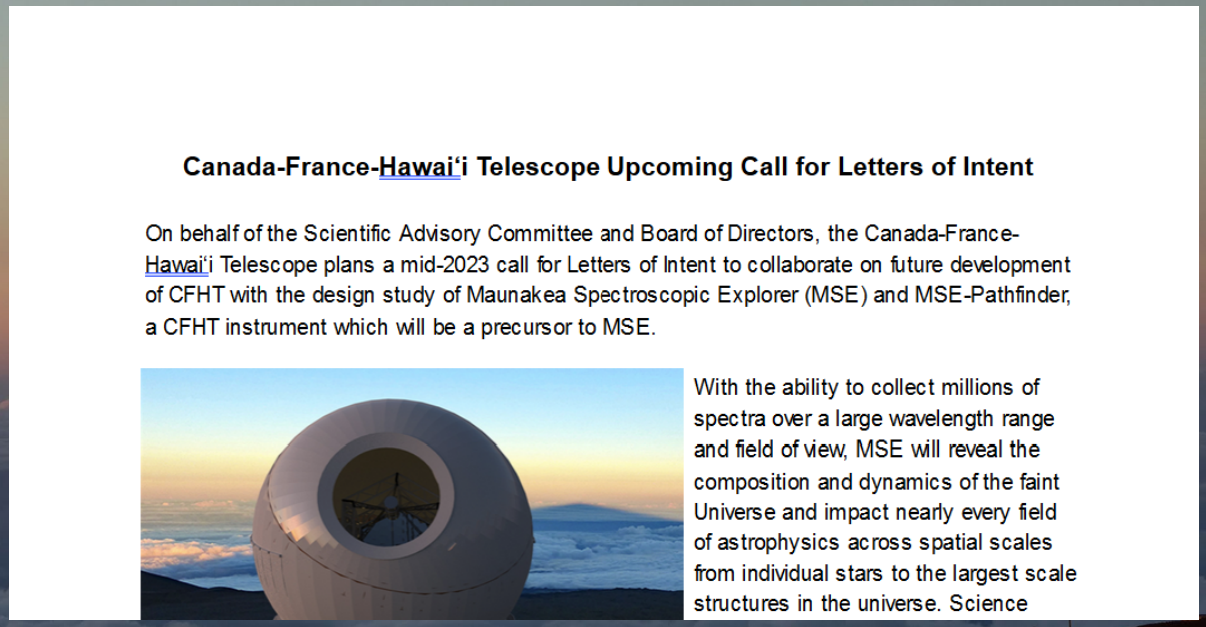
Last news

- Development of VISION: a new Cassegrain module feeding ESPaDOnS and SPIRou simultaneously (and MSE pathfinder)





- Announcing call for Letters of Intent to be issued within a few weeks on three possible partnerships:
  - CFHT Associate Partnership
  - MSE Pathfinder Partnership
  - MSE Design Study Partnership



Canada-France-Hawai'i Telescope Upcoming Call for Letters of Intent

On behalf of the Scientific Advisory Committee and Board of Directors, the Canada-France-Hawai'i Telescope plans a mid-2023 call for Letters of Intent to collaborate on future development of CFHT with the design study of Maunakea Spectroscopic Explorer (MSE) and MSE-Pathfinder, a CFHT instrument which will be a precursor to MSE.

With the ability to collect millions of spectra over a large wavelength range and field of view, MSE will reveal the composition and dynamics of the faint Universe and impact nearly every field of astrophysics across spatial scales from individual stars to the largest scale structures in the universe. Science

Mahalo

BACKUP SLIDES

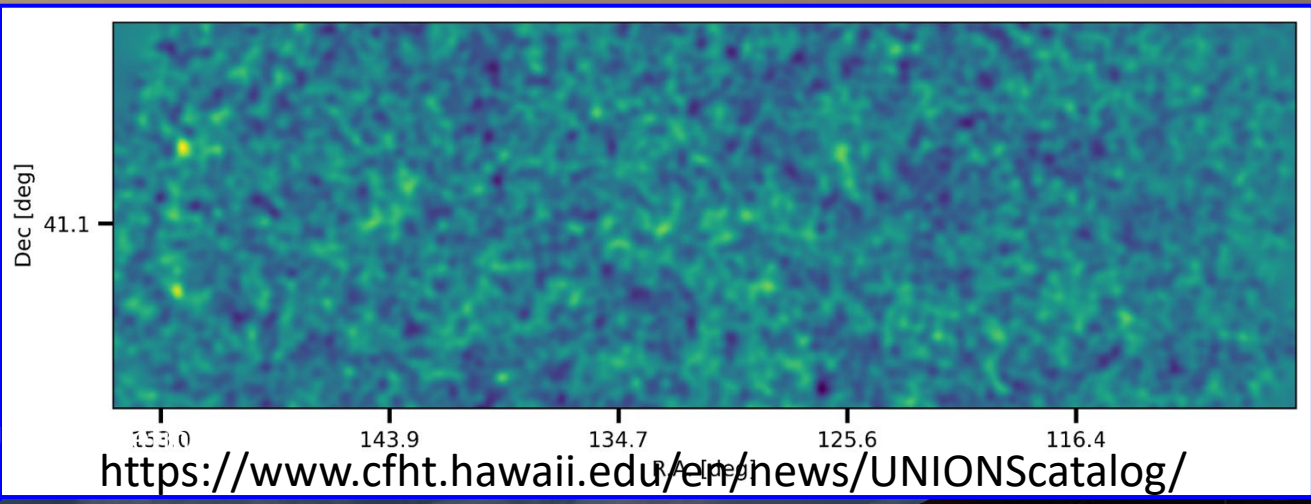
Science highlights

Weak Gravitational Lensing Reveals Dark Matter Maps of the Cosmic Web

Guinot et al., 2022, A&A 666, A162
Ayçoberry et al., 2022, arXiv:2204.06280

Release of a catalog of precisely measured shapes of 100 million galaxies observed with MegaCamTwo versions of the shape catalog, obtained with different, independent methods, have been released internally to the Ultraviolet Near Infrared Optical Northern Survey (UNIONS) science collaboration.

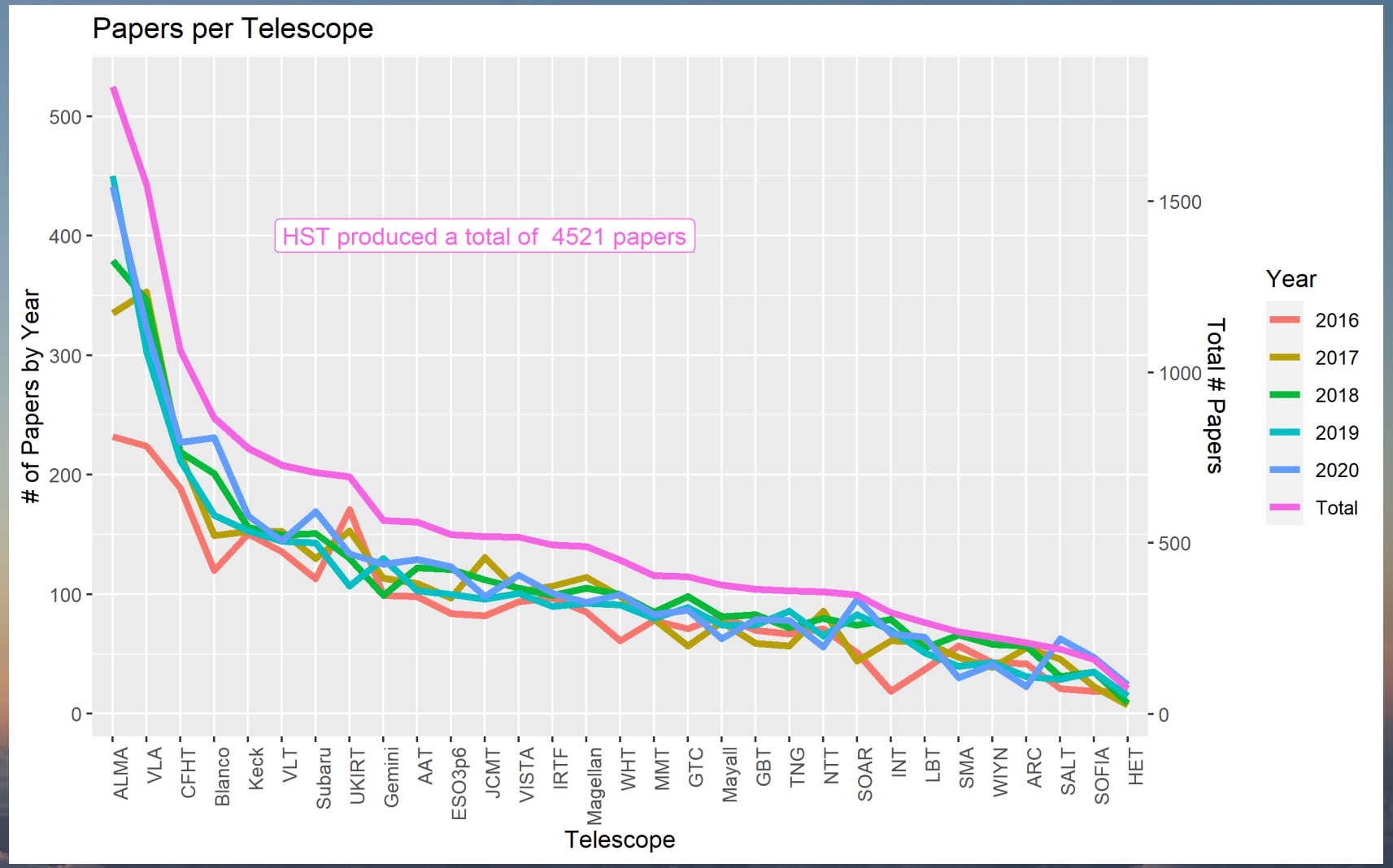
A dark-matter map of the projected cosmic web reconstructed from UNIONS weak-lensing data. This patch located in the Lynx constellation is 275 deg2. UNIONS will cover 5000 square degrees. Yellow peaks show locations of over-densities corresponding to galaxy clusters, while blue regions correspond to underdense areas, called voids.



https://www.cfht.hawaii.edu/en/news/UNIONScatalog/

CFHT Suite of Instrumentation

Instrument	Type	FOV/Spectral Resolution	Wavelength Regime	Pixel Scale	Magnitude Limitations/Performance
MegaCam	Imaging	57.6' x 56.4'	u, g, r, i, z, Halpha, Halpha off, OIII, OIII off, CaHK, gri	0.187 arcsec/pix	Zero points (e- / sec) at 1 airmass: 25.74, 27.00, 26.50, 26.38, 25.34, 25.78, 27.11, 26.74, 26.22, 25.02
WIRCam	Imaging	20' x 20'	YJHKs	0.307 arcsec/pix	Zero points (e- / sec) at 1 airmass (AB system): 25.06, 25.87, 26.37, 26.28
ESPaDONS	Stellar Spectropolarimeter	R= 68000; 81000	369-1048 nm	1.8 km/s	Limiting magnitude V ~ 15~17 (N. Manset presentation)
SITELLE	IFU/Imaging Fourier Transform Spectrometer (IFITS)	11' x 11' R= 1-1000	350-900 nm	0.32 arcsec/pix	
SPIRou	Spectropolarimeter	R= 70000	967-2493 nm	2.28 km/s	Limiting magnitude H ~14


Papers per Telescope
HST produced a total of 4521 papers
# of Papers by Year
Total # Papers
Telescope
Year
2016
2017
2018
2019
2020
Total
0
100
200
300
400
500
0
500
1000
1500
ALMA
VLA
CFHT
Blanco
Keck
VLT
Subaru
UKIRT
Gemini
AAT
ESO3p6
JCMT
VISTA
IRTF
Magellan
WHT
MMT
GTC
Mayall
GBT
TNG
NTT
SOAR
INT
LBT
SMA
WIYN
ARC
SALT
SOFIA
HET