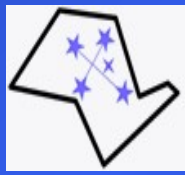


Unveiling the local and distant Universe with Subaru's Prime Focus Spectrograph (PFS)

Laerte Sodré Jr.
Departamento de Astronomia
Instituto de Astronomia, Geofísica e Ciências Atmosféricas
Universidade de São Paulo

SPAnet Instrumentation Meeting 2019
Universidade Presbiteriana Mackenzie
October 25, 2019

a bit of history

- 2001 – Gemini Science Committee recommends to launch discussions on new instruments
- 2003 – Gemini meeting @Aspen: concept of WFMOS (based on Sam Barden's KAOS)
- 2005 – Gemini commissions two competing conceptual designs for WFMOS
- 2008 – DeGaS concept (Dark Energy Galactic Archaeology Spectrograph) – PI: Richard Ellis
- 2009 – Gemini approves the DeGaS proposal
- 2009 – Gemini abandons the WFMOS proposal: $$!
- 2009 – Japan/Subaru assumes the project
- 2020/21: first light and beginning of the survey

PFS collaboration

Caltech

NASA Jet Propulsion Laboratory
California Institute of Technology

国立天文台 NAOJ

中央研究院 ACADEMIA SINICA

CPPC

PRINCETON UNIVERSITY

Max-Planck-Institut für Astrophysik

KAVLI IPMU INSTITUTE FOR THE PHYSICS AND MATHEMATICS OF THE UNIVERSE

MPE Max-Planck-Institut für extraterrestrische Physik

LNA LABORATÓRIO NACIONAL DE ASTROFÍSICA

LAM LABORATOIRE D'ASTROPHYSIQUE DE MARSEILLE

JOHNS HOPKINS UNIVERSITY

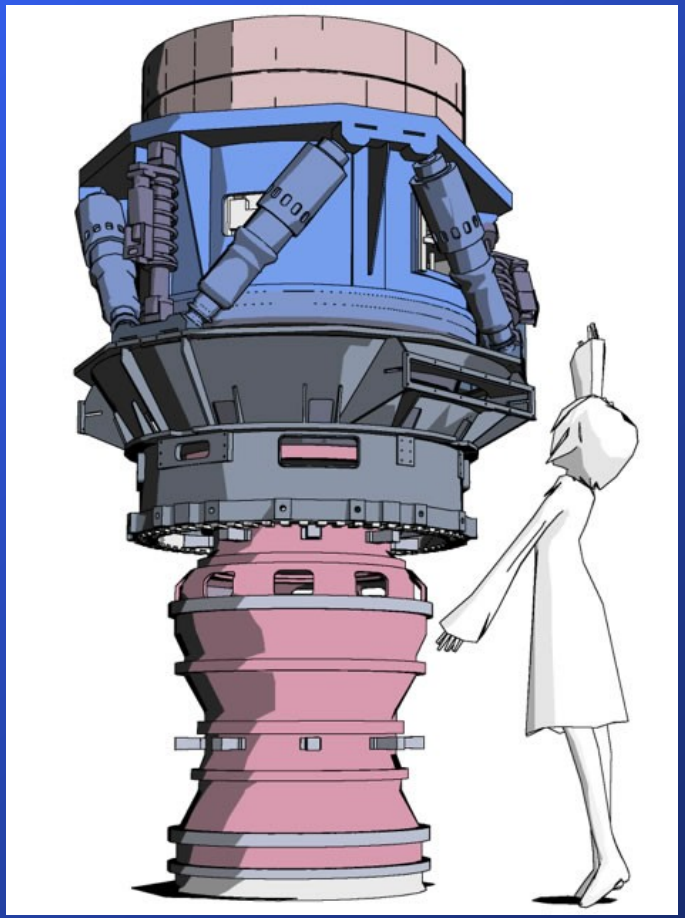
Subaru Prime Focus Spectrograph (PFS)

wide field (1.3 deg wide hexagonal FOV)
massively multiplexed: ~2400 optical fibers
4 spectrographs, each with 3 arms: blue, red, NIR

- **built by an international collaboration**
- **PI: Hitoshi Murayama (Kavli IPMU)**
- **start of the PFS survey: 2021**
  (~360 nights during ~5 years)
- **goal: address questions on cosmology, galaxy and AGN evolution, and Galaxy archaeology to understand the dark sector of the universe**

SuMIRe
Subaru Measurement of Images and Redshifts

- Imaging and spectroscopy on the Subaru telescope



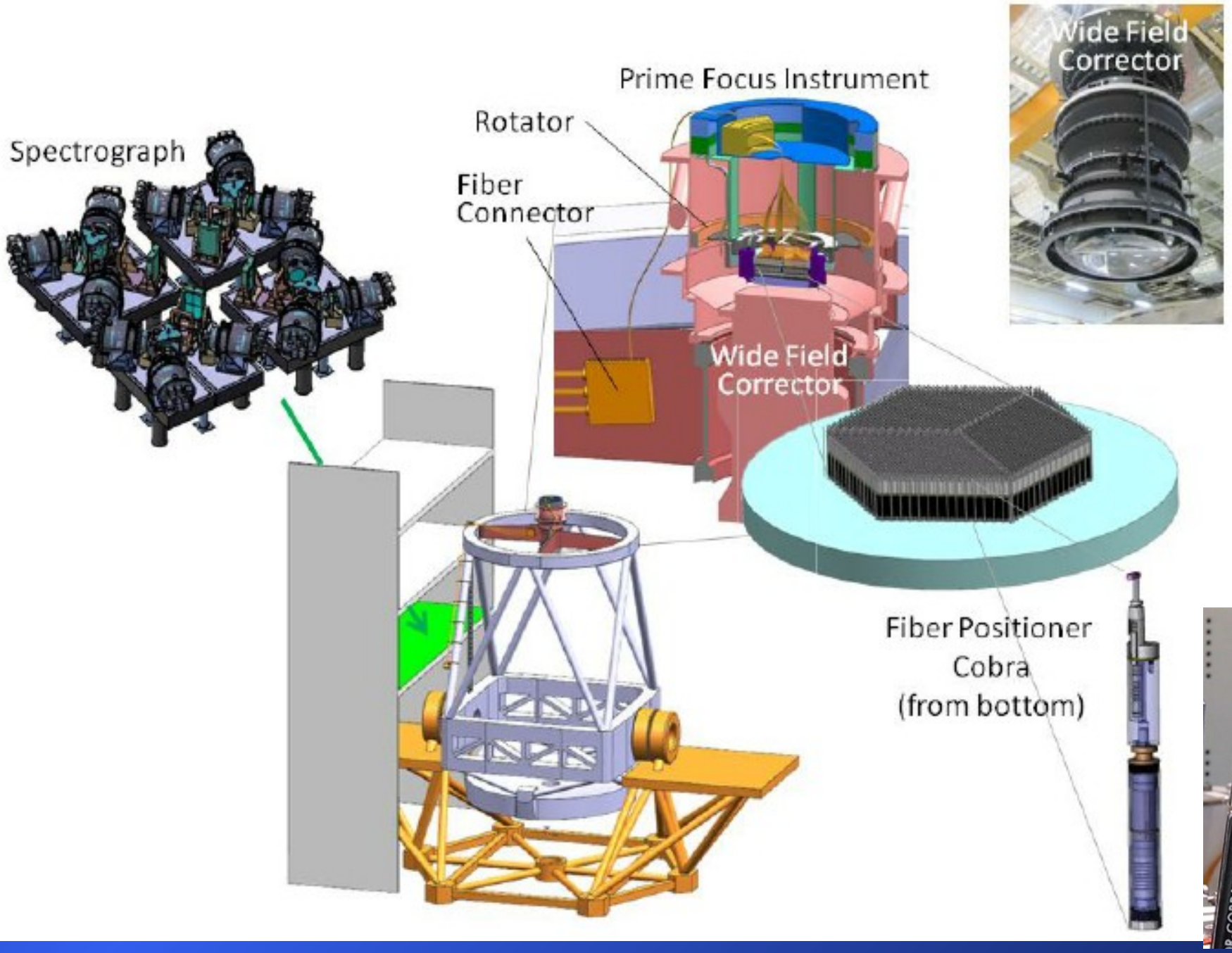
- imaging:
- HyperSuprimeCam (HSC)
- 0.9B pixels, 3 ton camera
- 1.5 degree diameter FOV
- HSC survey: 2014-2019
  Subaru Strategic Program (SSP)

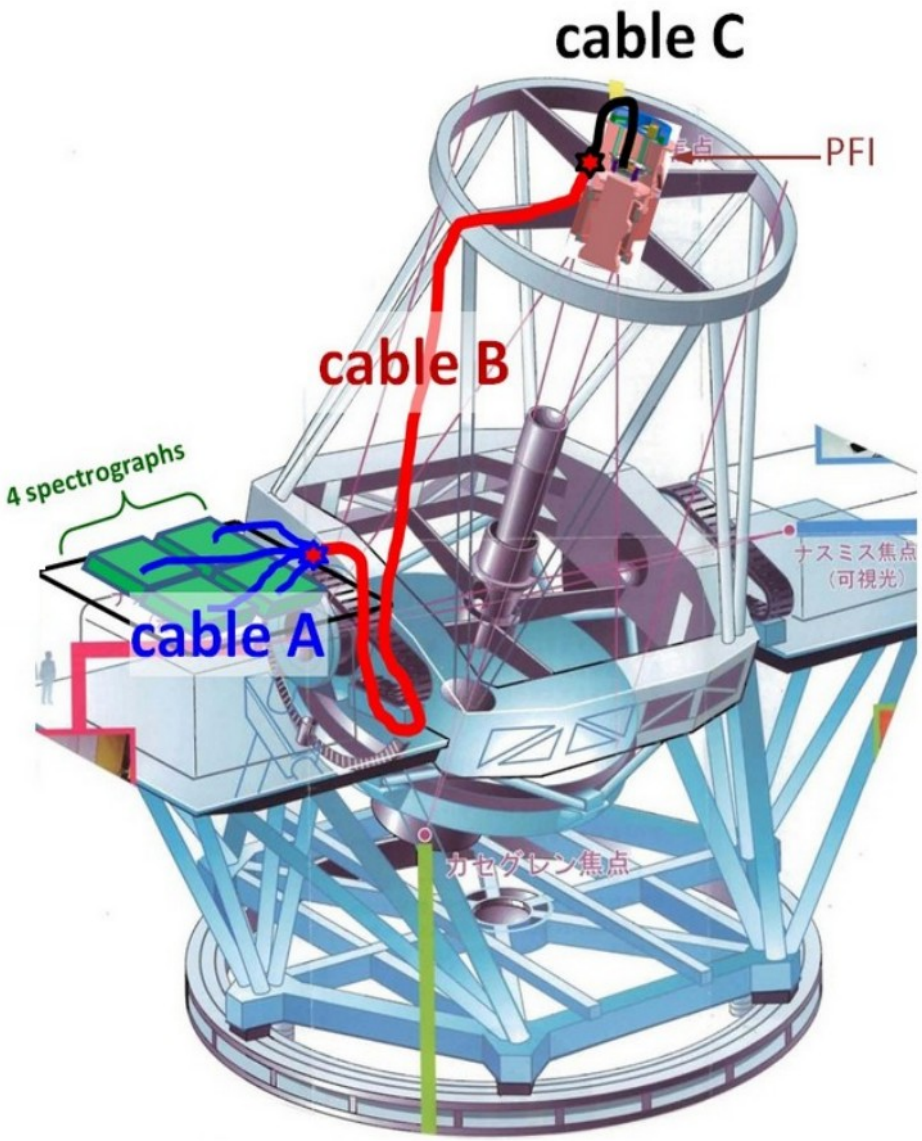
- spectroscopy: PFS

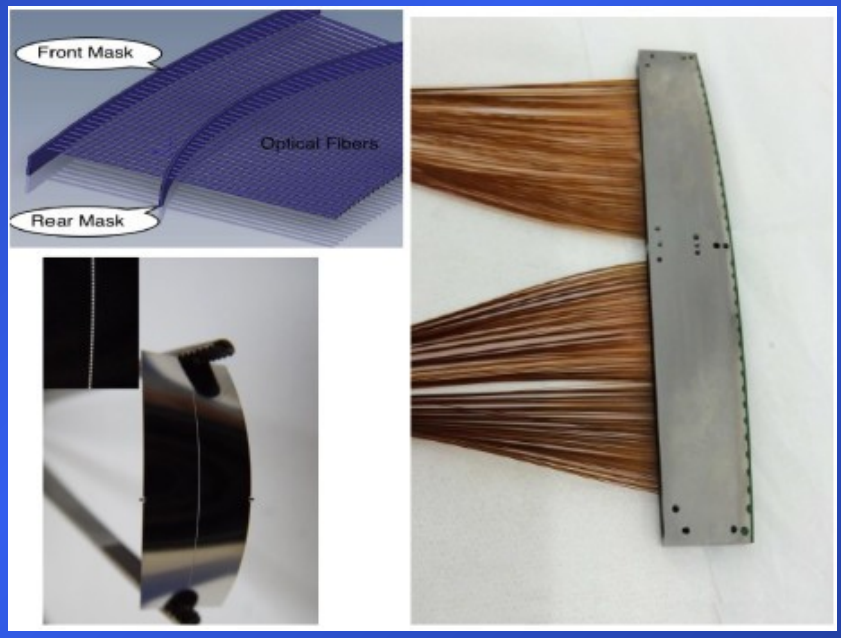
PFS Fast Facts

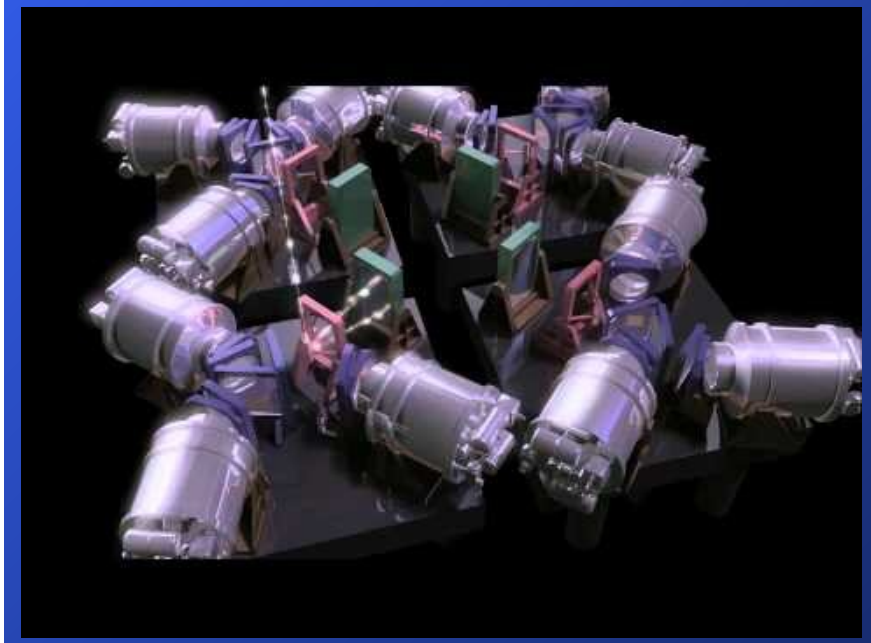
- Subaru Prime Focus Spectrograph: spectroscopic part of the SuMIRe project
- wide field: ~1.3 deg diameter
- high multiplicity: 2394 fibers
- fiber diameter: ~1.05 arcsec
- minimum fiber separation ~30 arcsec
- quick fiber reconfiguration: ~60 – 120 sec (TBC)
- VIS-NIR coverage: 380-1260nm simultaneously
- low resolution mode: ~2.5 A resolution
- medium resolution mode (around 800nm): ~1.6 A resolution
- science operations: from 2021

by Naoyuki Tamura


Prime Focus Instrument
Rotator
Fiber
Connector
Spectrograph
Wide Field
Corrector
Wide Field
Corrector
Fiber Positioner
Cobra
(from bottom)

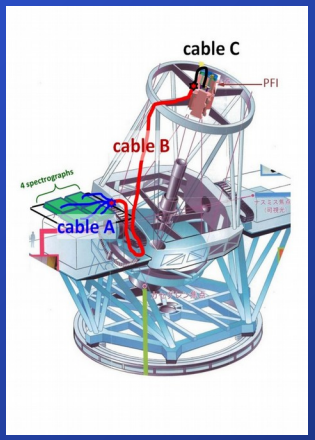

cable C
PFI
cable B
4 spectrographs
cable A
ナスミス焦点
（可視光）
カセグレン焦点


Front Mask
Optical Fibers
Rear Mask



summary

- PFS will be a major player in the study of the low and high-z universe during the next decade
- **wide field (1.3 deg wide hexagonal FOV)**
- **massively multiplexed: ~2400 optical fibers**
- **4 spectrographs, each with 3 arms: blue, red, NIR**
- **start of the PFS survey: 2021**
  (~360 nights during ~5 years)



M. Takada et al., 2014, PASJ, 66, 1 (arXiv:1206.0737)
N. Tamura et al., 2018, SPIE 10702E

http://sumire.ipmu.jp/en/2652
https://www.youtube.com/watch?v=5mW3v2k8Ofo

Prime Focus Instrument (PFI)				
Field of view (hexagonal)	Diameter of circumscribed circle: 1.38 deg Area: 1.25 deg^2			
Number of fibers	2394 science fibers and 96 fixed fiducial fibers.			
Fiber density	2000 deg^{-2} (0.6 arcmin^{-2})			
Fiber core diameter	127 μm (=1.12 (1.02) arcsec at the field center (edge), respectively)			
Positioner pitch	8mm (=90.4 (82.4) arcsec at the field center (edge), respectively)			
Positioner patrol field diameter	9.5mm (=107.4 (97.9) arcsec at the field center (edge), respectively)			
Fiber minimum separation	$\sim$30 arcsec			
Fiber configuration time	$\sim$60-120 sec (TBC)			
Number of AG cameras	6			
Field of view per AG camera	5.1 arcmin^2			
Sensitivity of AG camera	S/N =30(100) for $r = 20$ mag (AB), 1(10) sec exposure.			
Spectrograph System (SpS)				
Spectral arms	Blue	Red		NIR
		Low Res.	Mid. Res.	
Spectral coverage	380-650nm	630-970nm	710-885nm	940-1260nm
Dispersion	0.7 Å/pix	0.9 Å/pix	0.4 Å/pix	0.8 Å/pix
Spectral resolution	2.1 Å	2.7 Å	1.6 Å	2.4 Å
Resolving power	2300	3000	5000	4300
SpS throughput	53% (at 500nm)	57% (at 800nm)	54% (at 800nm)	33% (at 1100nm)

The competition

Facility	Telescope Diameter (m)	Surface Area (m^2)	Field of view (deg^2)	Multiplex Number
MAYALL DESI	3.8	9.6	8	5,000
SUBARU PFS	8.0	48.75	1.33	2,400
VLT MOONS	8.0	48.75	0.136	1,000
MSE	11.2	96.0	1.5	4,000
SpecTel	**11.4**	**87.89**	**4.91**	**15,000**

arXiv:1907.06795

landscape of fiber-fed spectrographs in large (D > 6m) telescopes

- **Gran Telescope de Canarias (10.4m) – MEGARA – IFU & MOS capabilities MOS with ~100 fibers in a 3.5 x 3.5 arcmin^2**

- **Hobby Eberly Telescope – VIRUS spectrograph 150 IFUs, each with 230 optical fibers**

- **VLT@ESO - FLAMES/GIRAFFE – 130 fibers, FOV = 25 arcmin diameter**

thanks to Alessandro Ederoclite