

CUBES


Cassegrain Ultraviolet Brazil-ESO Spectrograph



IAG - Universidade de São Paulo
Laboratório Nacional de Astrofísica – MCTI
European Southern Observatory



Outline:

- Consortium: IAG-USP, LNA/MCTI
 - Brief Description of CUBES = Cassegrain U-Band Brazilian-ESO Spectrograph
 - Brief Description of IAG, LNA capabilities
 - Science: brief description
 - Competition
 - Status of the project
- 

Brazil:

PI - Beatriz Barbuy - IAG

Co-PI - Bruno Castilho

Project Manager: Clemens Gneiding

Engineer: Vanessa Bawden

ESO:

PHASE A:

ESO Instrument Scientist – Harald Kuntschner

ESO Project Manager – Florian Kerber

General Managing: Gero Rupprecht

PHASE B:

ESO Instrument Scientist – Joel Vernet

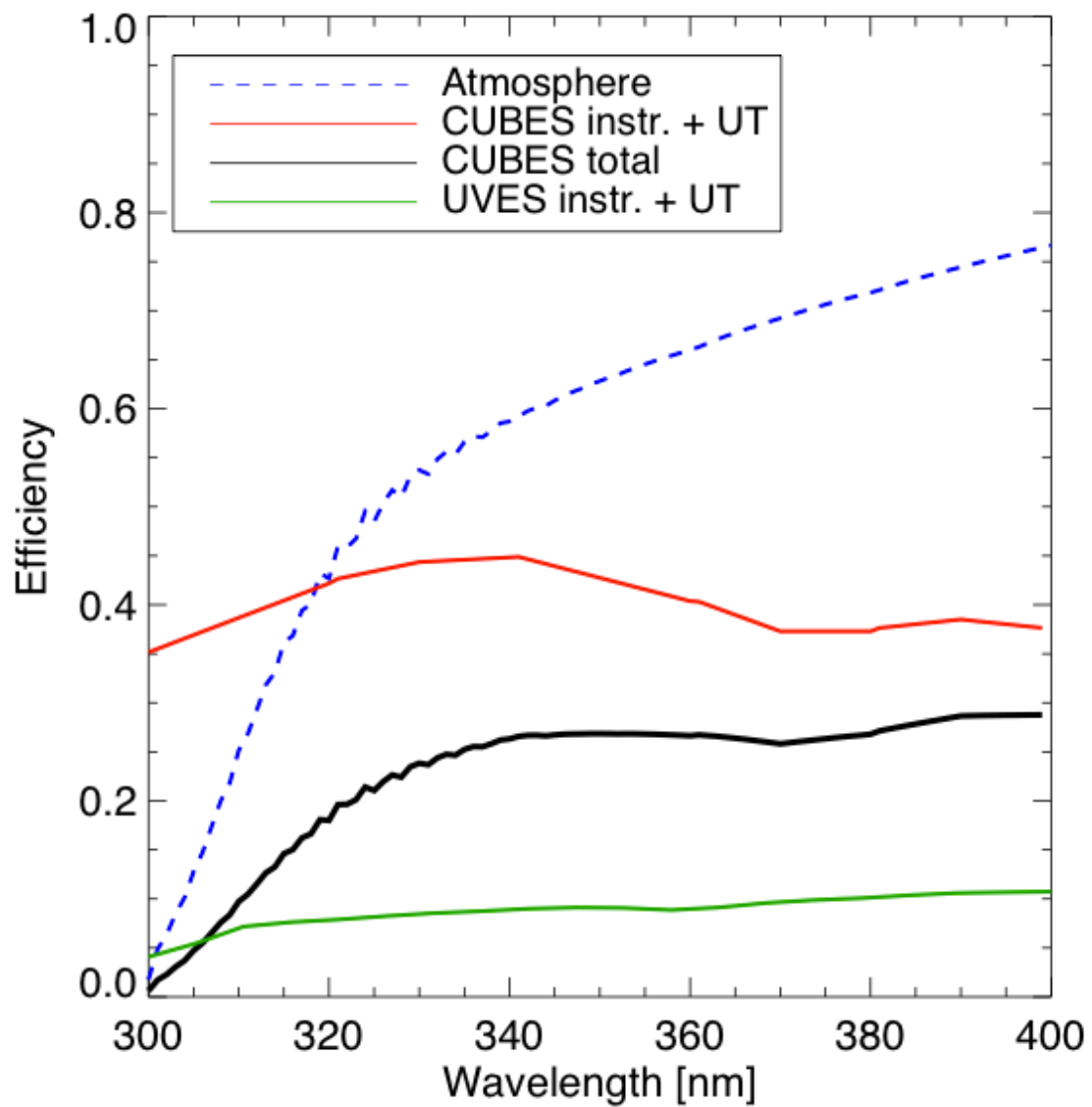
ESO Project Manager – Hans Dekker

ESO System Engineer – Paul Bristow

Optical Designer: Bernard Delabre

CUBES Spectrograph for VLT

- Cassegrain U-Band Brazil-ESO Spectrograph
- $R=20,000$ (13,000)
- 305 – 390 nm; (goal: 300 - 400 nm)
- Scientific niche with an optimised instrument
 - Limited wavelength coverage complementing ESPRESSO – optimised design and components
 - Resolution suitable for elemental abundance analysis (X-shooter too low in UV)
 - Throughput: 3 mags at 320nm, 2 mags at 350nm, relative to UVES



Astronomy in Brazil

Brazil: 61 institutions with $\sim > 1$ astronomer

Number of astronomers:

permanent staff: 320

graduate and post-doc: 350

IAG-USP:

Staff = 35

Graduate students = 60; posdocs: 25

Papers/year = 100

What is LNA?

It is a Research Institute of the Brazilian Ministry of Science, Technology and Innovation, created in 1985.

➤ **Mission** Plan, develop, provide, operate and coordinate the resources and infrastructure, to foster, in a cooperative way, the Brazilian observational astronomy.

➤ **What do we do at LNA?**

- Management and operation of Pico dos Dias Observatory;
- Management of the Brazilian participation in international Observatories;
- Development of astronomical instruments.

Infrastructure for instrumentation development

In 2006, a new building was inaugurated at LNA's Headquarters to house a complete set of laboratories and workshops for astronomical instrumentation:

- Mechanical design/fabrication;
- Mechanical Metrology;
- Optical Fibers;
- Optical Metrology;
- Integration.



Fully dedicated technical team:

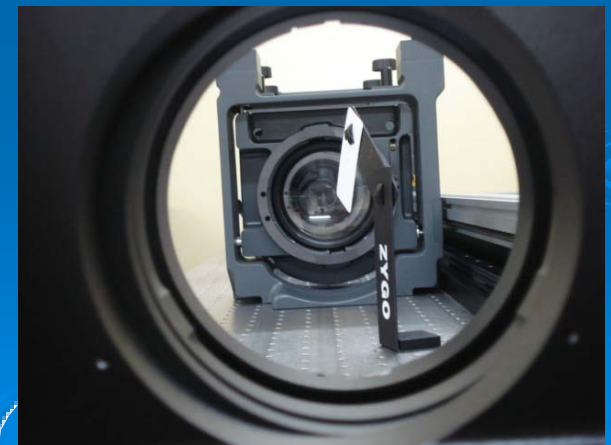
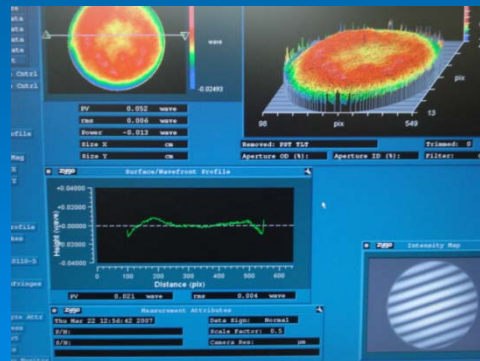
- 2 researchers; 4 engineers;
6 technicians; 8 researchers.

Laboratories and Workshops

Optical Metrology

Some equipments:

- Stabilized optical table;
- Zygo Interferometer;
- Fisba portable interferometer;
- Gratings/Filters characterizer;
- Monochromator;
- Clean cabin class 100;
- Autocollimator telescope;
- Shark-Hartman wave front sensor.

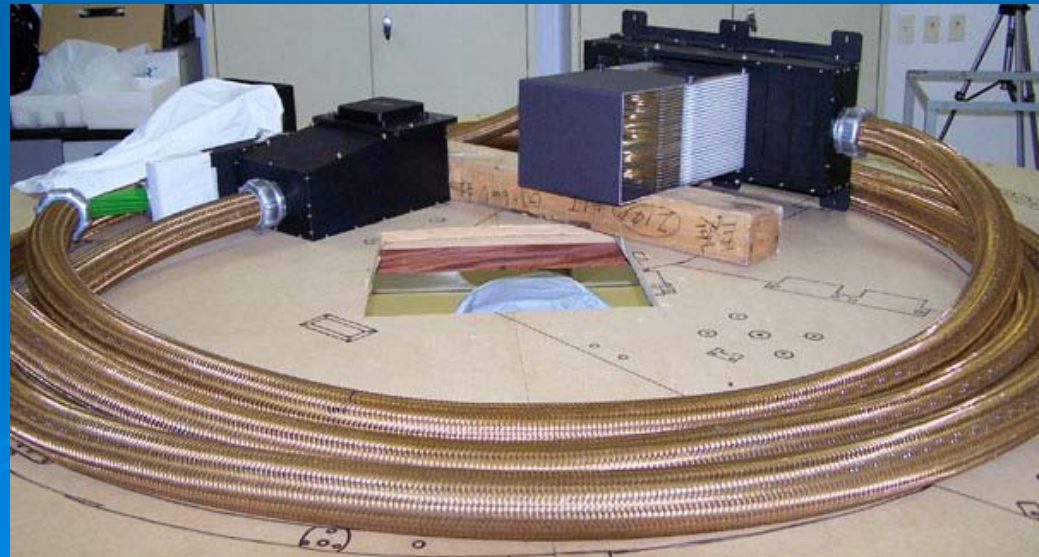


SIFS -SOAR Integral Field Spectrograph

- 1300 fibers;
- 400-1000 nm;
- 10 x 5" field;
- $R = 5 - 30k$;
- VPH gratings.



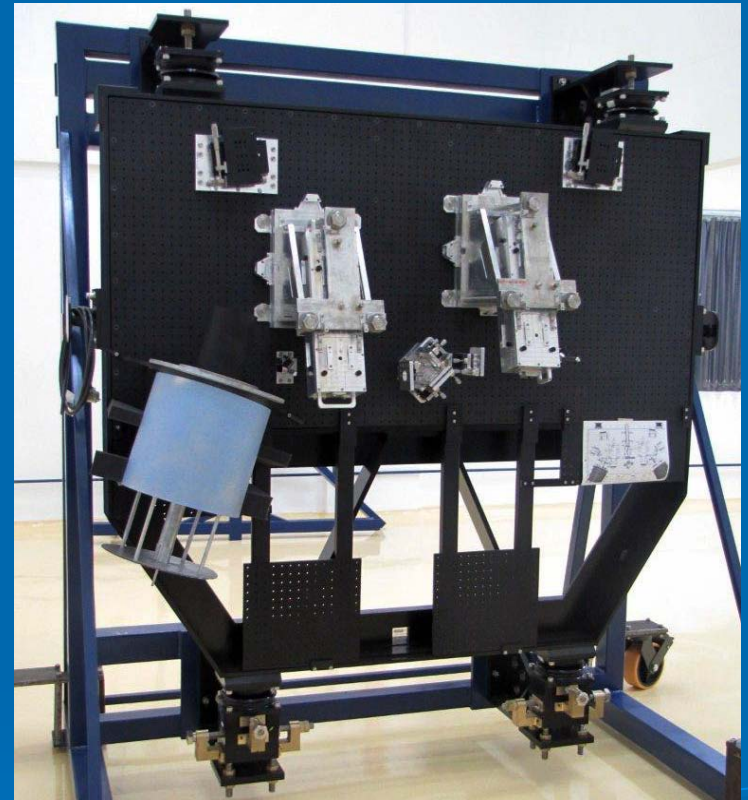
Visão da IFU



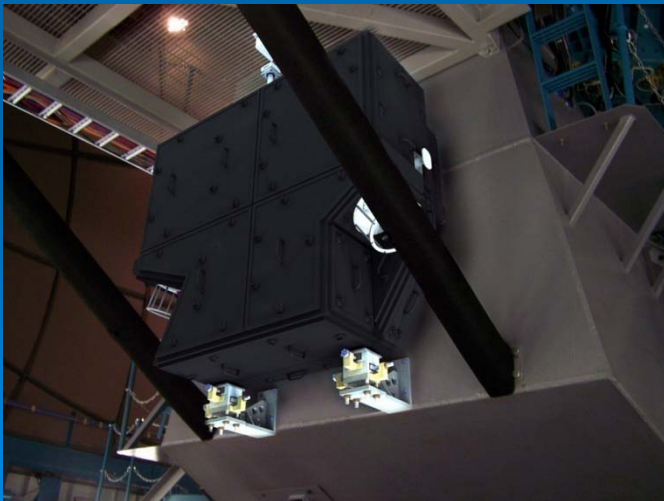
STELES - SOAR Telescope Echelle Spectrograph

- $R = 50k$ (80k max);
- 300 – 900nm in one shot – UV;
- Nasmyth fed – flux calibration;
- Fixed configuration – stability;
- No moving optical parts;
- 1.8 x 1.5m;
- 800kg.

It should be installed at SOAR in 2014.



STELES at integration Lab
now.

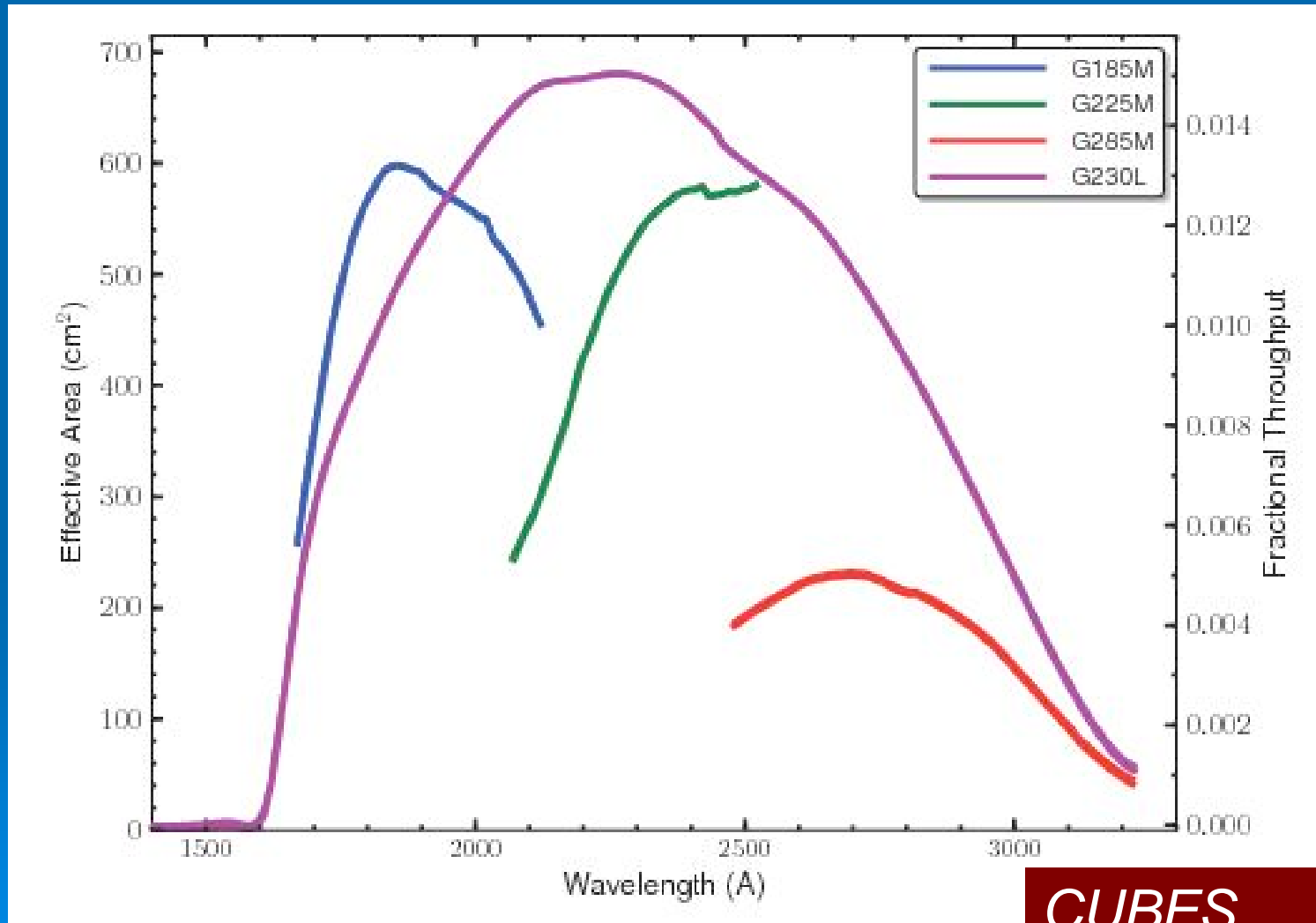


Artistic impression of STELES
installed at SOAR.

Space competition

- HST/STIS has high-res, close to near-UV:
 - Grating E230M $R=30,000$ λ 163.0-311.0nm
 - Grating E230H $R=114,000$ λ 162.0-315.0nm
 - <http://www.stsci.edu/hst/stis/design/gratings>
- HST/COS:
 - Grating G285M $R=20-24,000$ λ 250.0-320.0 nm
 - <http://www.stsci.edu/hst/cos/design/gratings>
- HST continuity is not guaranteed

HST/COS sensitivity



COS Handbook Chapter 5, Fig. 5.2

CUBES

Is HST competitive at 315nm?

- Example ETC calculations for Be II resonance lines at 313nm
- $R \sim 20,000$ in both cases

	HST/COS G285M	CUBES
Exp. Time	1800s	1800s
Template	K0V; V=15	K0V; V=15
Achieved S/N per res. element	~ 0.3	~ 25

Science with CUBES

- Science: metal-poor stars, dwarf galaxies
- (C,N,O, Be, heavy-elements)

- White dwarfs, PN, symbiotics, novae
- comets, ISM, AGN, QSO absorption lines

Be II 310nm

- COS/HST: several orbits
- ESO/UVES, Keck/HIRES: best options
- STELES/SOAR: 4m

- CUBES: a few thousand stars more relative to UVES

→ Talk by R. Smiljanic

Heavy Elements: $38 < Z < 92$

Cayrel+2001
Nature, 409,
691

CS31082-001
14 Gyr

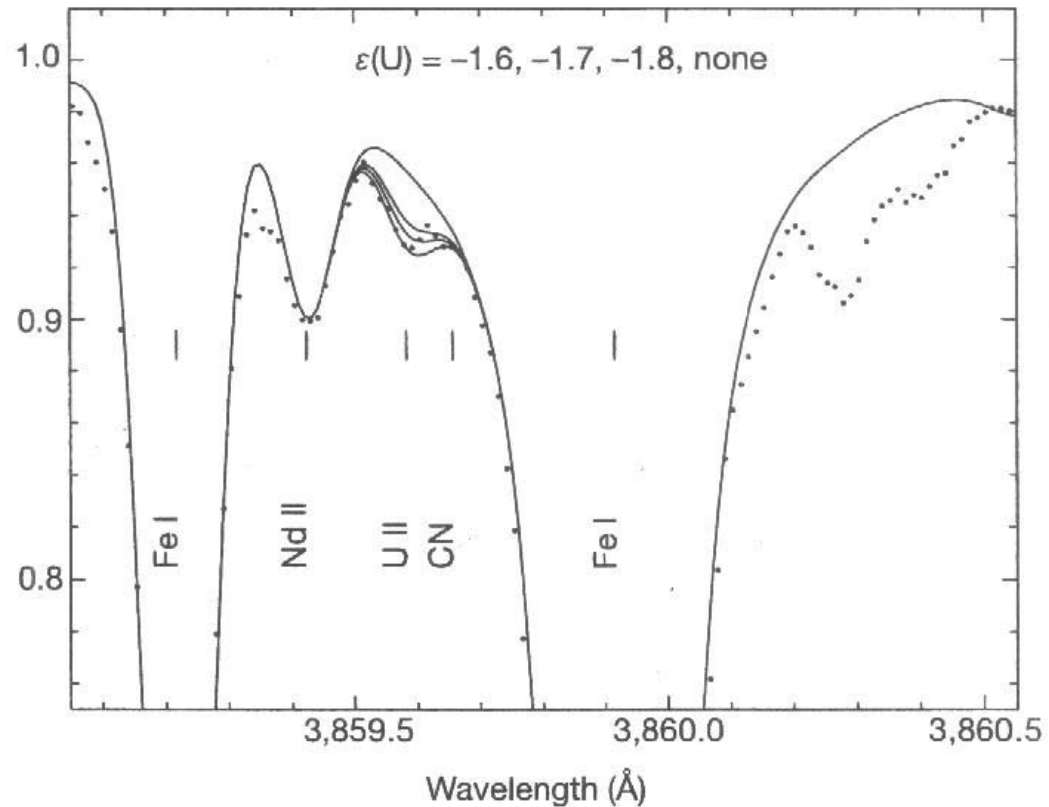
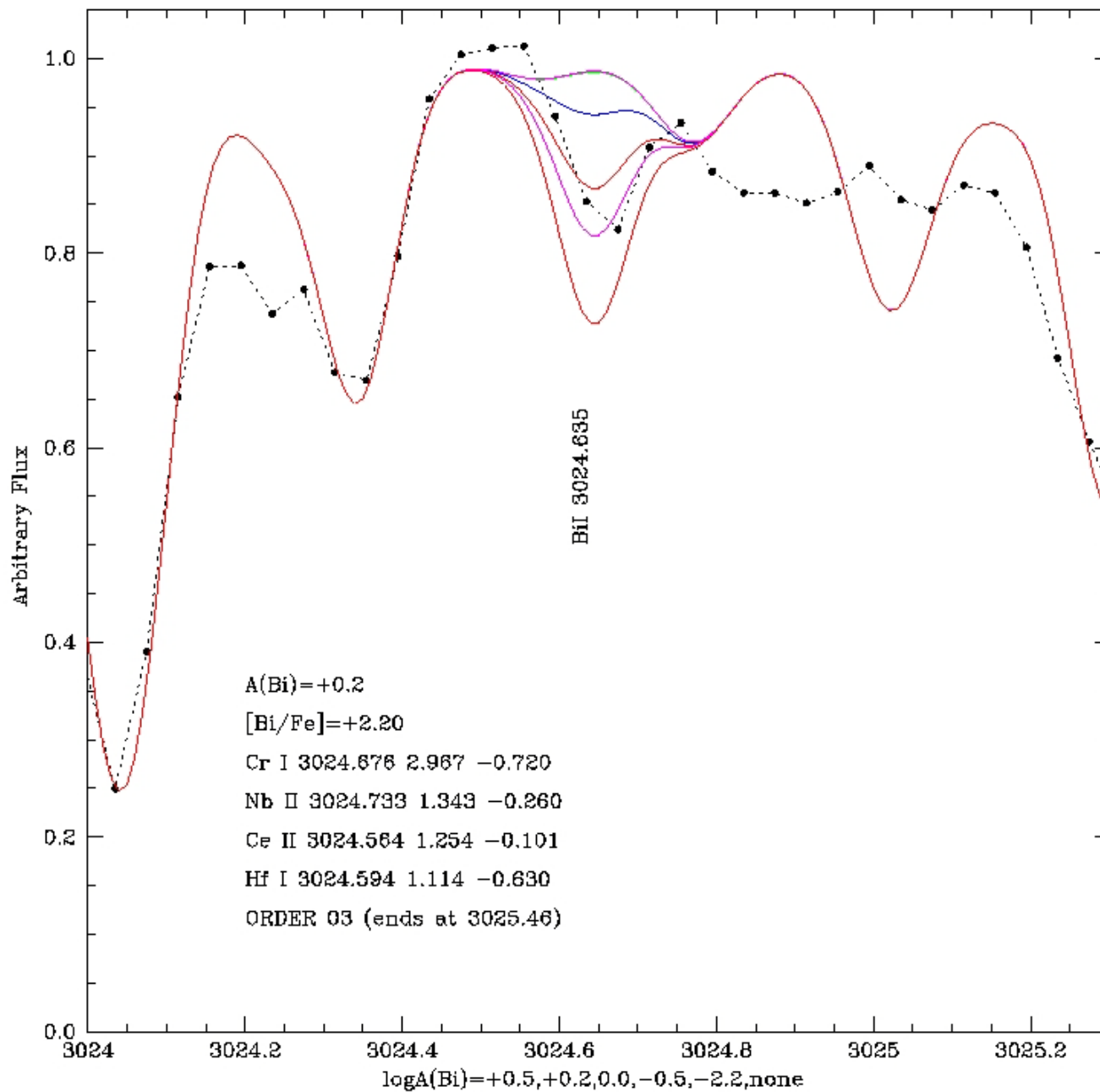


Figure 1 The spectrum of CS31082-001 around the U II line at 385.959 nm. The synthetic spectra (solid lines) were computed with the stellar atmospheric parameters given in the text, and for the three U abundances indicated, adopting an oscillator strength $f = 0.053$ for the line (ref. 13). The observed spectrum (data points) was obtained in four hours, for a total S/N ratio of 300.

→ Talk by C. Siqueira Mello

HST STIS



Molecular bands: CN, NH, OH

- NH 3360, OH 3000-3300 → unique
- NH is unique way to measure N directly
- UV OH are the only measurable lines in very metal-poor turn-off stars

→ Talk by P. Bonifacio

Status of project:

- CUBES = Cassegrain U-Band Brazilian-ESO Spectrograph
- Phase A study completed:
 - Kickoff July 2010
 - Review completed September 2012
 - Positive recommendation from STC
 - Phase B started at low level; awaiting ratification
- Instrument Consortium: IAG-USP, LNA/MCTI
- ESO to lead certain activities: Phase B project management, detector system
- System integration & test in Brazil

The End

