Introduction and History

Sandro D'Odorico, ESO

SUBTITLES

26 years of defining, managing and commissioning instruments +detectors at ESO

The best detector for your instrument is the one that you can get

A couple of thoughts from my first and my last ***instrument - digital detector(s) pairing*** *at the ESO telescopes*

CASPEC Echelle Spectrograph +RCA CCD at the ESO 3.6m
June 1983

X-shooter, 3 arm spectrograph+ (E2V&MIT LL CCDs and HAWAII 2RG array) at the VLT
March 2009

In the early 80's ESO was very much child of a lesser God with respect to other Observatories with 4-5 m telescopes

The 3.6m at la Silla had started operation in 1978. Main instrument was a B & C spectrograph with the 1D IDS.

Other detectors in use at La Silla:

- photographic plates,
- Mc Mullan Camera for imaging
- reticon 1D array,
- first ESO CCD camera for imaging at the Danish 1.5m,
- 1 pixel IR sensors
- as occasional visitor at the 3.6m, Boksenberg's IPCS

A turning point in ESO's history

Annual Report 1980

VLT and NTT

Some further studies of the Very Large Telescope were made. In the context of the membership of Italy and Switzerland, the possibility has arisen to construct a 3.5 m New Technology Telescope which would have two functions: to increase the amount of available observing time at La Silla and to serve as a test object for the newer technologies which will be required in the VLT.

CASPEC + CCD commissioning - 1983

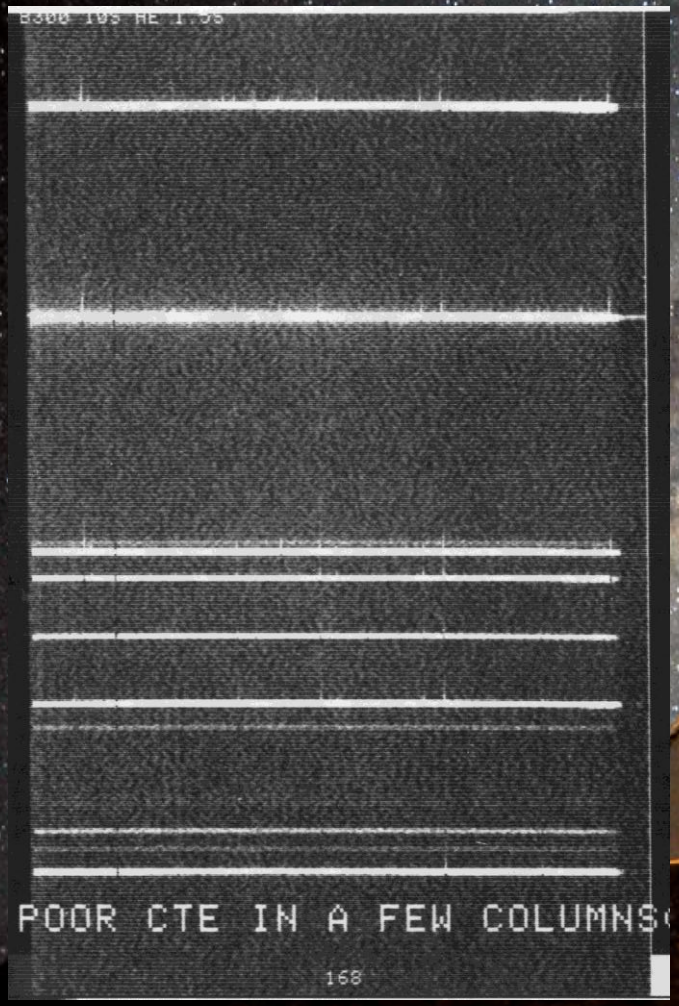
- CASPEC, first ESO-designed spectrograph for the 3.6m telescope. Echelle format, best suited for 2D detectors

- Instrument based on excellent French optical design . Essentially completed but stuck in Garching in 1982 due to problems with the SEC Vidicon detector

- Fateful (for me) proposal to use RCA 512x320 pixel CCD system with fast optical camera for first light at telescope.

- Configuration well matched to the relatively poor seeing of 3.6m. Competitive for faint work at 20000 resolution, with 90nm spectral coverage

CASPEC + CCD commissioning - 1983



ESO CCD #2
RCA SID 501 EX
thinned backside illuminated

512x320 , 30x30mμ pixels

r.o.n. 40 e^- rms

Saturation: 240000 e^-

Dark current: 15 e^- /hr

QE: **50% at 400nm**
70% at 550nm
50% at 700 nm

Defects: ***strong fringing in the red, poor charge transfer efficiency at low light levels***

CASPEC +CCD Commissioning Report 1983 style:
letter sent via DB

Snow storm during the 8 weeks of CASPEC Commissioning - July 1983

Picture shows 33% of the comm team on the mountain

EUROPEAN SOUTHERN OBSERVATORY

Organisation Européenne pour des Recherches Astronomiques dans l'Hémisphère Austral
Europäische Organisation für astronomische Forschung in der südlichen Hemisphäre

ESO-CHILE
S. D'Odorico

June 22, 1983

Dear Lo:

this is a quick report on the test of CASPEC to give you a feeling on how things are proceeding.

I had so far four clear nights out of seven. The instrument performs well. We had to deal with minor software and hardware bugs, but actually these occurred during day time only. I have lost not a single hour of observation because of technical problems. I think this is quite a performance for a new,complex instrument and it comes as a compliment to the work of the technical staff which has set it up.

Now on the astronomical side. Again all of the exposures obtained so far are of good quality. I have observed several stars in the magnitude range 9-13 and 6 Seyfert nuclei and QSO between 13 and 15.5. The speed appears close to my predictions, when operating in good seeing conditions (< 1.5 arcsec). We will be facing the known problems of CCD flat fielding and cosmetics. It will take months in Garching to test fully the data reduction procedure and to assess exactly the accuracy, but some

Data reduction software was the main concern, very much as it is with today instruments….

Results of the CASPEC + CCD commissioning in 1983

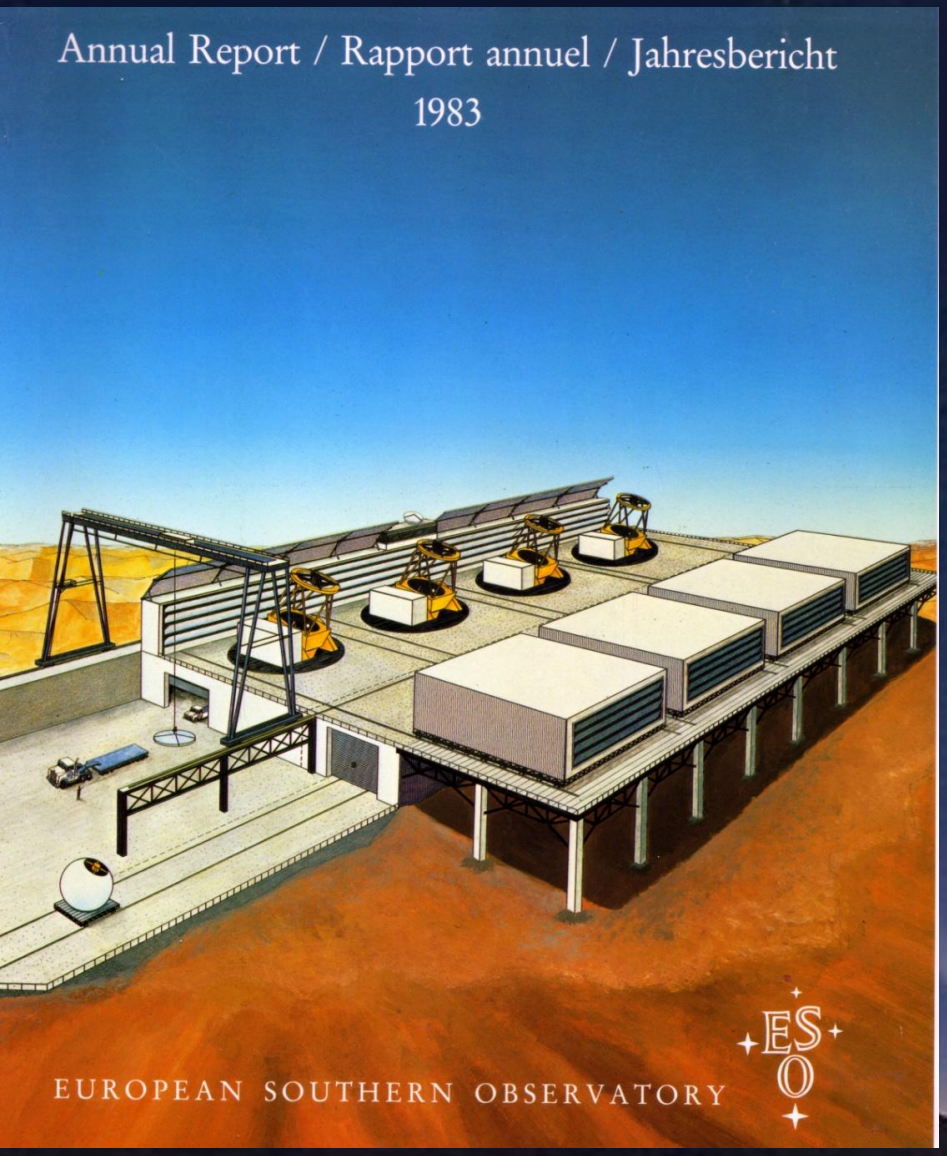
- very smooth and successful implementation of the first ESO-built instrument at the 3.6m
- limited on the faint limit by the CCD r.o.n.
- Providing an unique capability to European astronomers for stellar and extragalactic work

the MAMA device never made to regular operation on the instrument. CASPEC was operated with CCDs till its retirement more than 10 years later.

Instrumentation

ESO Annual Report 1983

The Cassegrain Echelle Spectrograph CASPEC was installed at the 3.6 m telescope with for the moment a CCD detector. A photon counting system with microchannel plate and multianode read-out has been ordered and should become available later in 1984. The first results show that the instrument fully lives up to expectations. Spectra have been obtained with a resolution of 20,000 and a signal-to-noise ratio of 50 of stars of V magnitude 13.5 in 1 hour.


Annual Report / Rapport annuel / Jahresbericht
1983
EUROPEAN SOUTHERN OBSERVATORY
ESO


ESO
La Silla
La Serena
Santiago
EL MENSAJERO
No. 34 – December 1983
The Very Large Telescope Project
D. Enard, Head of the VLT Project Group, and
J.-P. Swings, Chairman of the VLT Astronomy Advisory Committee
Artist's view of an early ESO VLT concept, representing a array of four 8 metre telescopes, of which two are shown to be linked for interferometric capabilities. It now seems preferable to do interferometry by adding to the large dishes a few smaller size (2–3 metre) telescopes that would be movable. (Drawing by J.-M. Leclercqz.)

25 years later……

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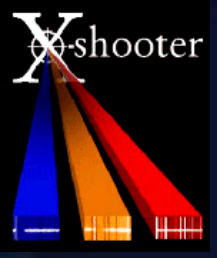
March 2009



- X-shooter is the first of the 2nd generation of VLT instruments

- It has been built by a Consortium led by ESO and including institutes from Denmark, France , Italy and the Netherlands

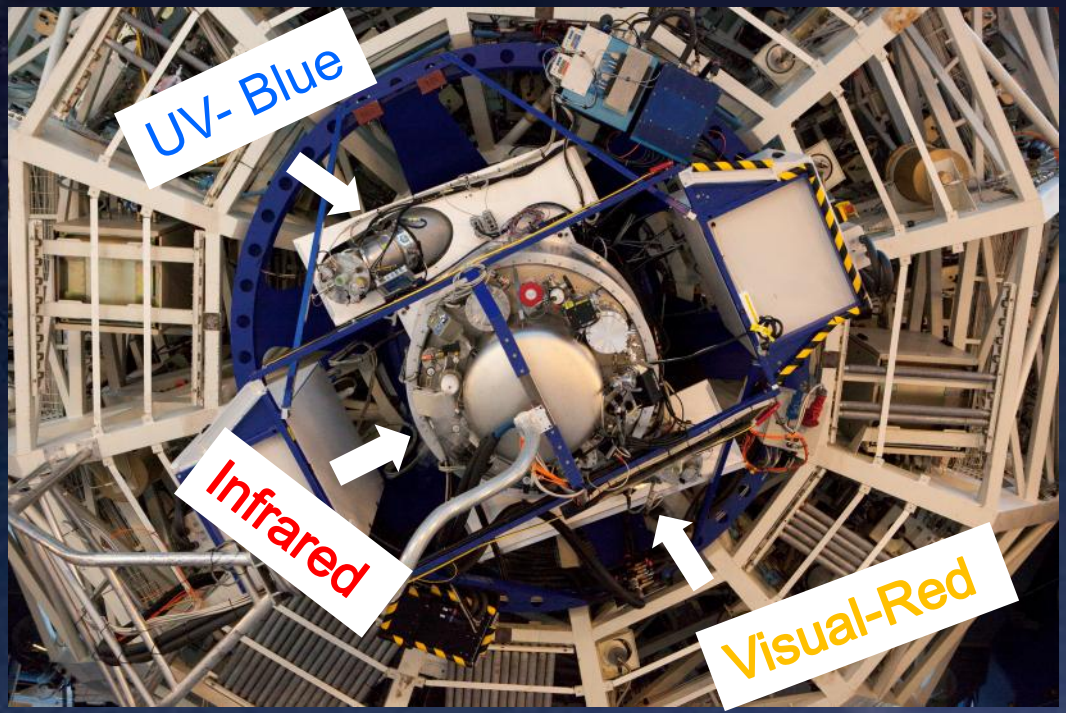
- It consists of three fixed format echelle spectrographs which operate in parallel and deliver an intermediate resolution spectrum of the target from 300 to 2400 nm

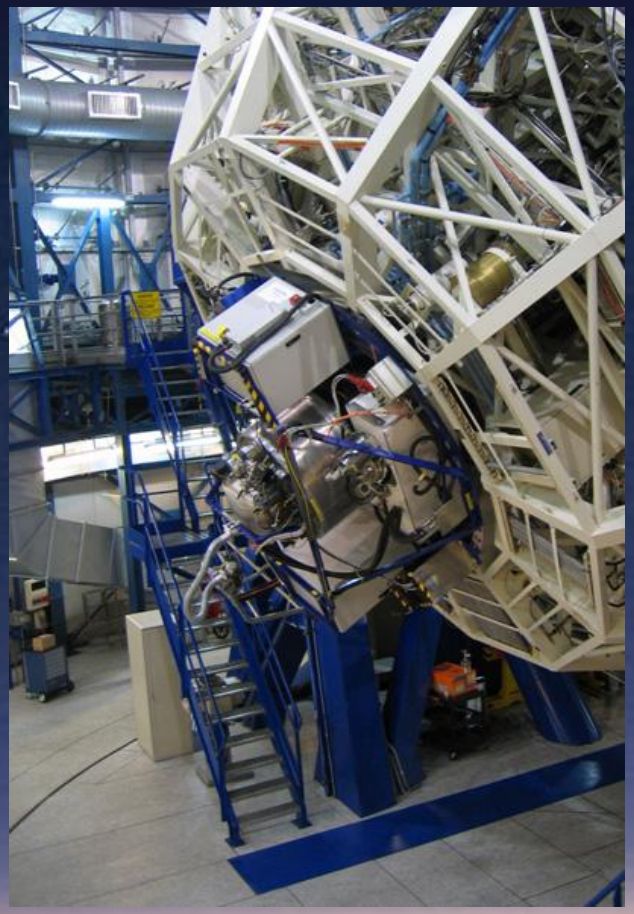
- Approval and Kick-off : November 2003; Commissioning of three arms: March 2009

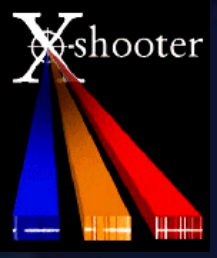
It fullfills a long standing dream to eliminate the artificial separation between optical and NIR instruments -alias astronomers

Made finally possible by availability of large NIR arrays with good cosmetics, reduced r.o.n and d.c.

X-shooter at the Cassegrain focus of the 8m UT2







X-shooter collects its data on superb detectors:

You can think of it as three detectors with some simple optics and mechanics in place to connect them to the 8m telescope and to format the spectra……

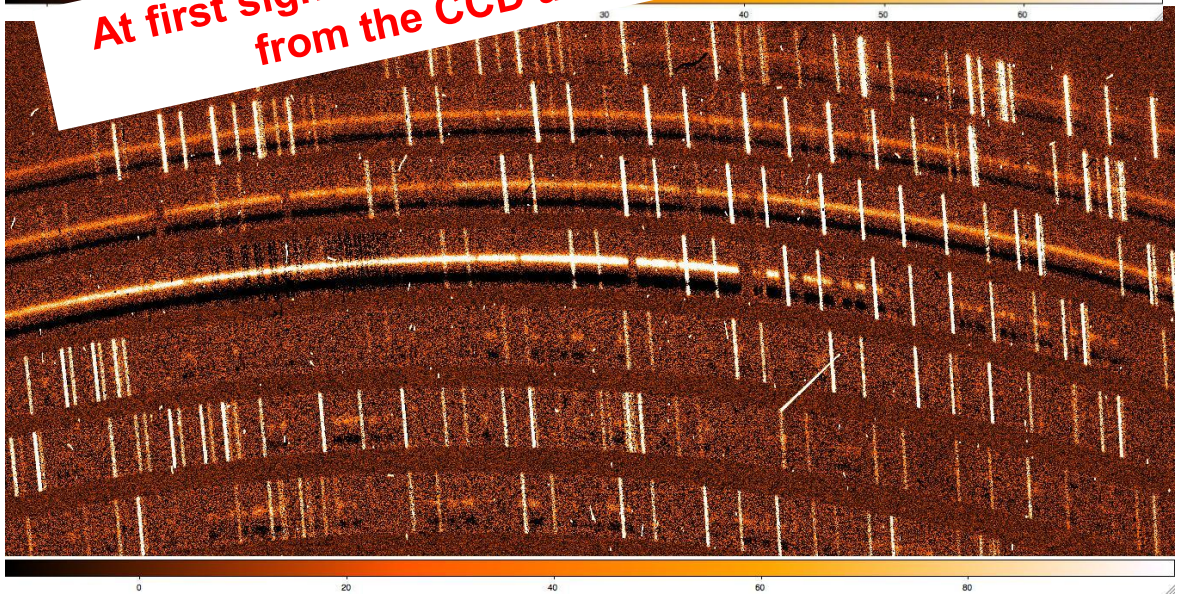
	UVB	**VIS**	**NIR**
Detector type	E2V CCD44-82	MIT/LL CCID 20	substrate removed Teledyne Hawaii 2RG
Operating temperature	153 K	135 K	81 K
QE	80% at 320 nm 88% at 400 nm 83% at 500 nm 81% at 540 nm	78% at 550 nm 91% at 700 nm 74% at 900 nm 23% at 1000 nm	85% over the J, H, K bands
Number of pixels	2048×4096 (2048x3000 used)	2048×4096	2048×2048 (1024×2048 used)
Pixel size	15 µm	15µm	18µm
Gain (e^-/ADU)	High: 0.62 Low: 1.75	High: 0.595 Low: 1.4	2.12
Readout **noise** (e^- rms)	Slow: 2.5 Fast: 4.5	Slow: 3.1 Fast: 5.2	Short DIT: ~25 DIT>300s: ~8.0
Saturation (ADU)	65000	65000	45000 (for a single readout). TLI used for long DITs
Full frame **read-out time** (s)	1x1, slow-fast: 70-19 1x2, slow-fast: 38-12	1x1, slow-fast: 92-24 1x2, slow-fast: 48-14	0.665 (for a single readout)
Dark current level	<0.2e-/pix/h (TBC)	<1.1e-/pix/h (TBC)	21 e-/pix/h
Fringing amplitude	-	~5% peak-to-valley	-
Non-linearity	Slow: 0.4% Fast: 1.0%	Slow:0.8% Fast: 0.8%	<1% up to 45000 ADUs

First 3 arm observation in March 2009

Size of commissioning teams have increased in 25 years more than the areas of the telescope

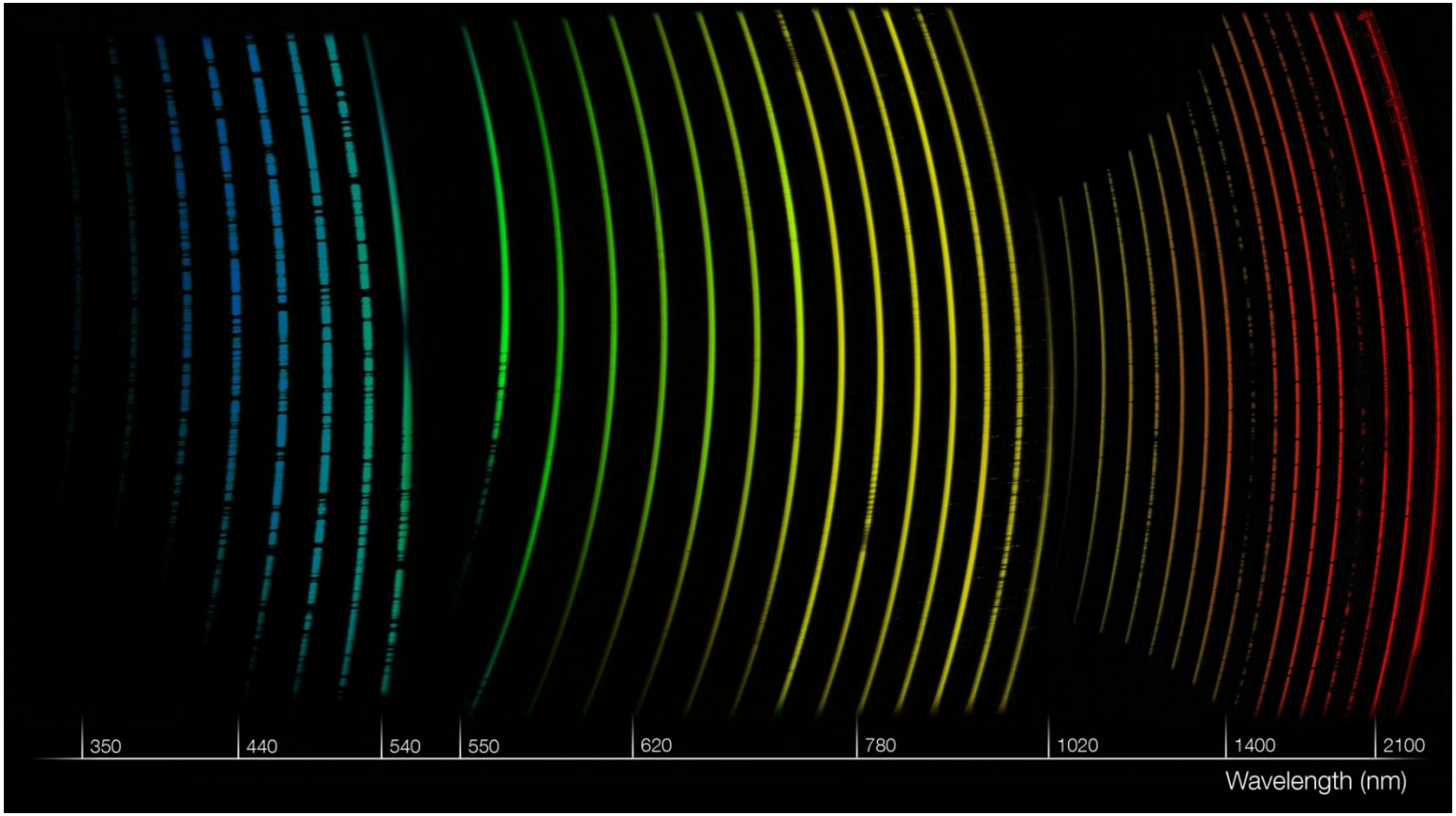
Examples of scientific performance: QSO at z=6.016 . J (Vega)=18.8 (2x30m, A-B)

H and J Bands,
R= 5900



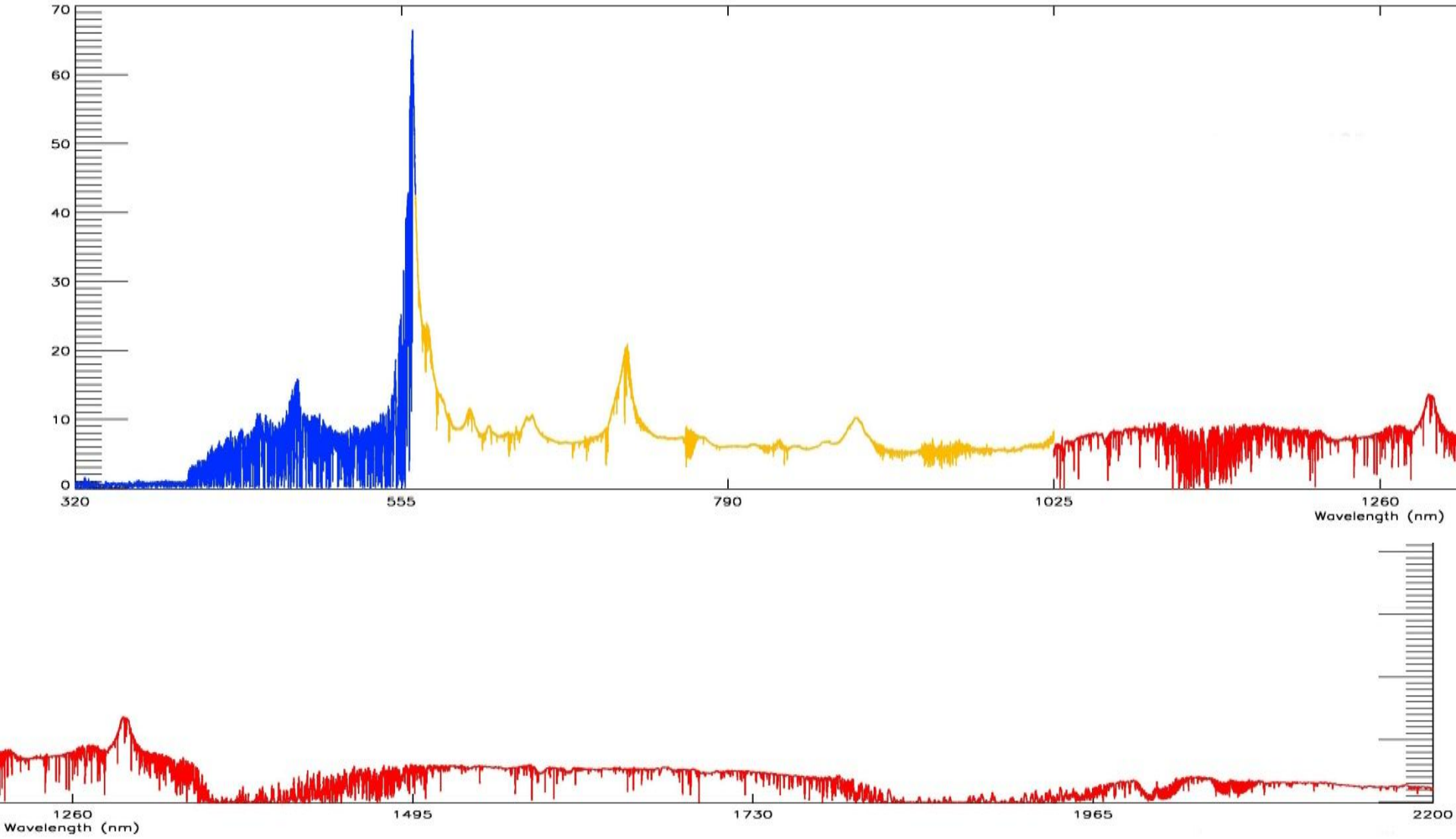
VIS-R above 700nm,
R= 8800

X-shooter spectra of a quasar at a distance of billions of light years



In one shot the instrument records on its 3 detectors the spectrum of the source from the ultraviolet to the infrared

X-shooter: the QSO extracted spectrum



Any new instrument+detector matching opens new opportunities in astrophysics, if you trust astronomer's judgement

Results of Survey on Possible New Instrument Start for Gemini

ALTAIR Access to Large Telescopes for Astronomical Instruction & Research

In the last issue of *Currents*, we described the possibility of a new instrument start for Gemini in 2010. This development is an outcome of the Access to Large Telescopes for Astronomical Instruction and Research (ALTAIR) study, which called for an improved Gemini instrumentation suit responsive to the needs of the US Con response, the US members of the Gem Committee (GSC) and the Gemini Bo working with NOAO to create a new i for Gemini on a short time scale.

To provide input to this process, we as respond to an online survey to help id instrument that has the highest priority start. The survey described three new instrument concepts currently being considered by the GSC: an optical echelle (R ~ 40,000), an IR echelle (R ~ 30,000; 1-5 microns), and an intermediate resolution O/IR spectrograph similar to the X-shooter at the VLT (single object; R=4,000-14,000; optical to K-band in one shot). Readers were asked to indicate their highest priority, either from among these capabilities or an instrument they could specify. We also gave readers the opportunity to provide further comments regarding their selection.

The fraction of respondents who favored a high resolution instrument (optical or IR echelle) was comparable to the fraction favoring the moderate resolution instrument. A similarly significant demand for high resolution spectroscopy was indicated in the ALTAIR survey. The IR echelle was the highest priority among the small number of grad student respondents, while the X-shooter was the most requested among the postdocs who responded. Both the X-shooter and the IR echelle had significant demand among the more senior respondents.

Table 1. Instrument Priorities

	All (246)	US-based (208)	Grad Students (14)	Postdocs (56)	More Senior (138)
Opt. Echelle	13%	14%	21%	11%	14%
IR Echelle	31%	34%	50%	27%	35%
X-shooter	45%	43%	21%	57%	40%
Other	10%	9%	0%	5%	11%
None	1%	0%	7%	0%	0%

The comments showed enthusiasm for a new instrument start. One respondent noted that, "It is imperative that Gemini get a quick start on new instrumentation. Whichever instrument is built, it should be a desirable resource that is tradeable for complementary capabilities on other platforms." Another respondent commented, "The focus on highly capable single-object spectrographs is a wise move, as these are sorely needed, relatively straightforward capabilities that take advantage of Gemini's aperture while not being hurt by Gemini's narrow field of view." Many respondents also took advantage of the comments section of the poll to

X-shooter is the second most requested instrument since it is offered in the ESO CfP (April 09)

A X-shooter-type instrument scored first in the wish list of the Gemini Community (Sept 09)

The advances in detector technology have been responsible for a large fraction of the progress in astronomy and astrophysics in the last 25 years.

The move from 4 to 8-10m telescopes, the space missions alone would not have had the same impact without the jump in detector performance

Thank you to you all for your work and your contribution to astronomy.
I wish you 25 years as exciting as the past ones