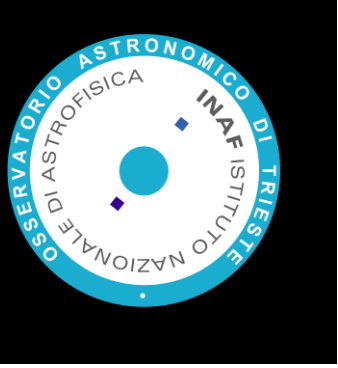




ANDES WG 3

Galaxy formation and evolution
and the intergalactic medium

Italian members of the int. science team

Valentina D'Odorico (INAF – Trieste) - Coordinator of the WG

Stefano Covino (INAF – Brera)

Giovanni Cresci (INAF – Arcetri)

Annalisa De Cia (ESO / Univ. of Geneva)

Chiara Feruglio (INAF – Trieste)

Michele Fumagalli (Univ. di Milano Bicocca)

From WG2

Donatella Romano (INAF – Bologna)

Stefania Salvadori (Univ. di Firenze)

WG 3 Science cases

- **Cosmic reionization** – studying the details of the reionization process using the absorption spectra of quasars at $z \geq 6$;
- **Near pristine gas at high-redshift** – detecting the elements synthesized by the first stars with very metal poor/high- z quasar absorption systems;
- **Extragalactic transients** – using high-luminosity supernovae and gamma-ray burst afterglows as alternative to quasars for probing the interstellar medium in high-redshift galaxies and the intergalactic medium along the line of sight.

WG 3 White paper – D'Odorico et al. 2024



Technical requirements



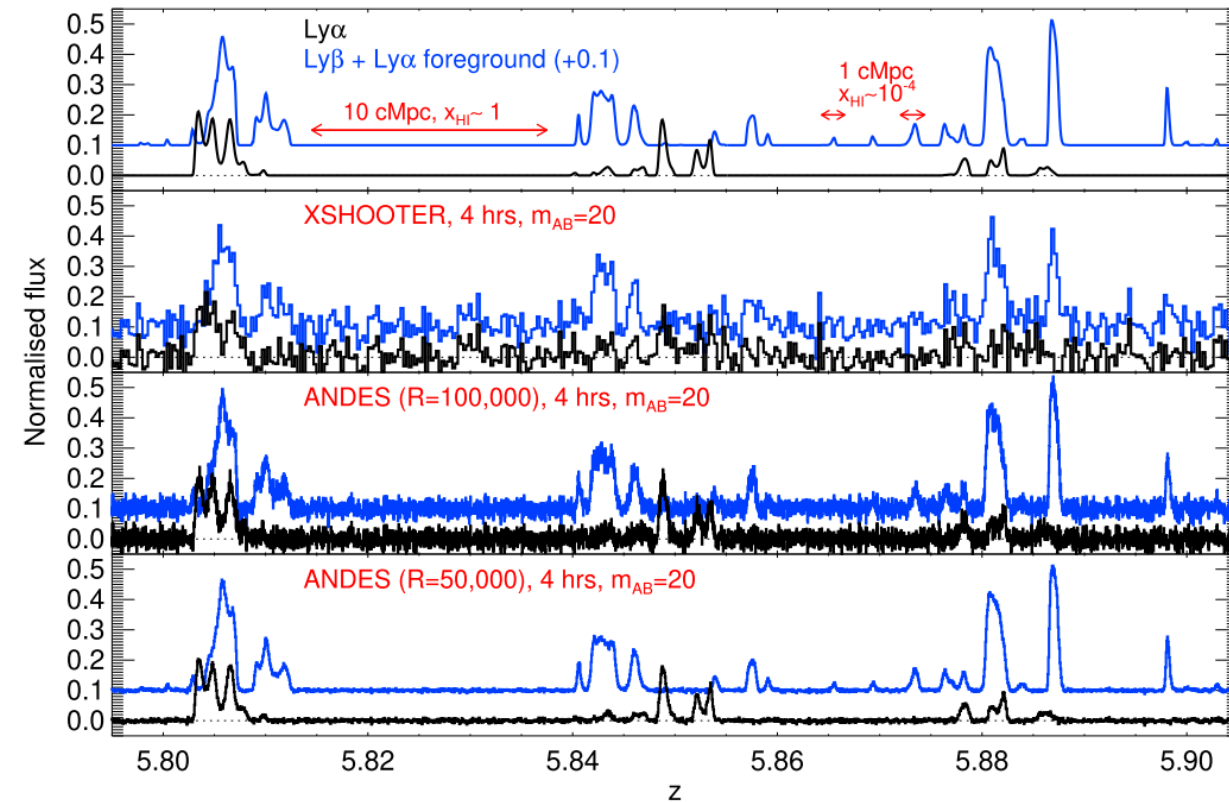
Faint objects, absorption spectroscopy

Science Case	Resolution	Wavelength coverage (μm)	Wavel. accuracy (km/s)	Simultaneous coverage
Reionization	50,000 (100,000)	0.8 – 1.8 (0.6 – 2.5)	0.6 (0.3)	desirable
PopIII signature	50,000 (100,000)	0.4 – 1.8 (0.37 – 1.8)	0.6 (0.3)	desirable
Transients	50,000 (100,000)	0.4 – 1.8 (0.4 – 2.5)	0.6 (0.3)	required

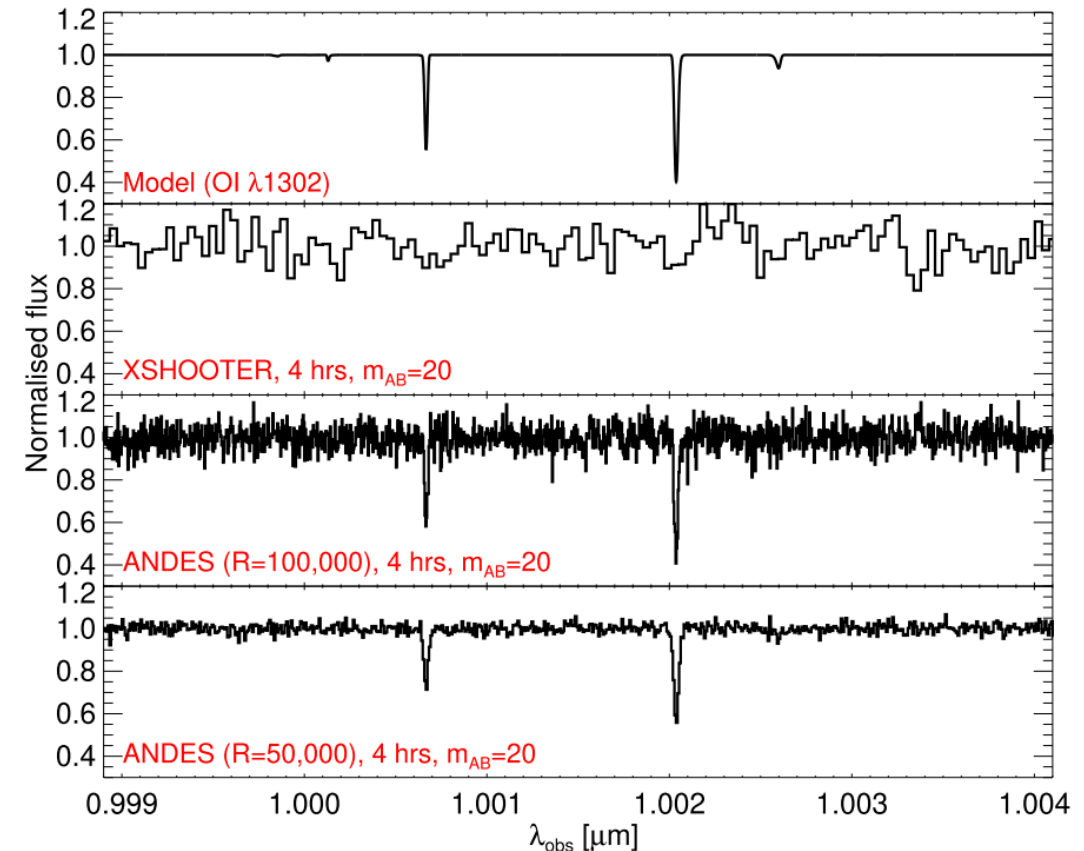
Cosmic Reionization

Simulated observations of a $z \gtrsim 6$ quasar with $m_{AB}=20$ observed for 4 hours with X-shooter and ANDES
 $R=100,000$ and $50,000$

HI transmission peaks,
structure on small scales
complementarity with 21 cm

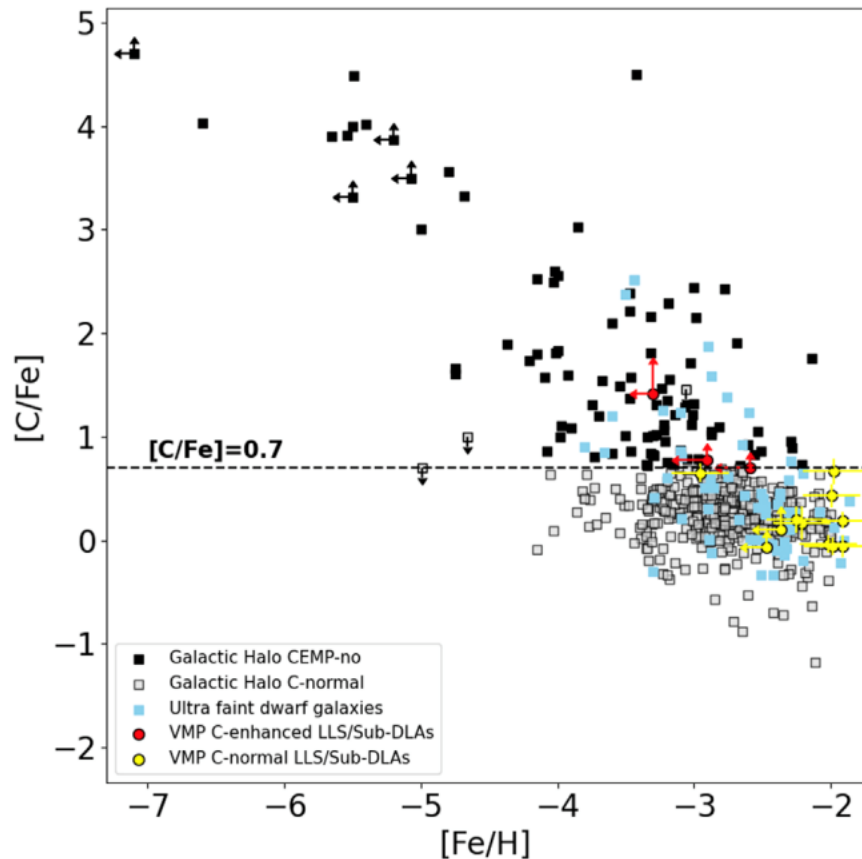


OI as a tracer of HI above $z \sim 6.0-6.5$

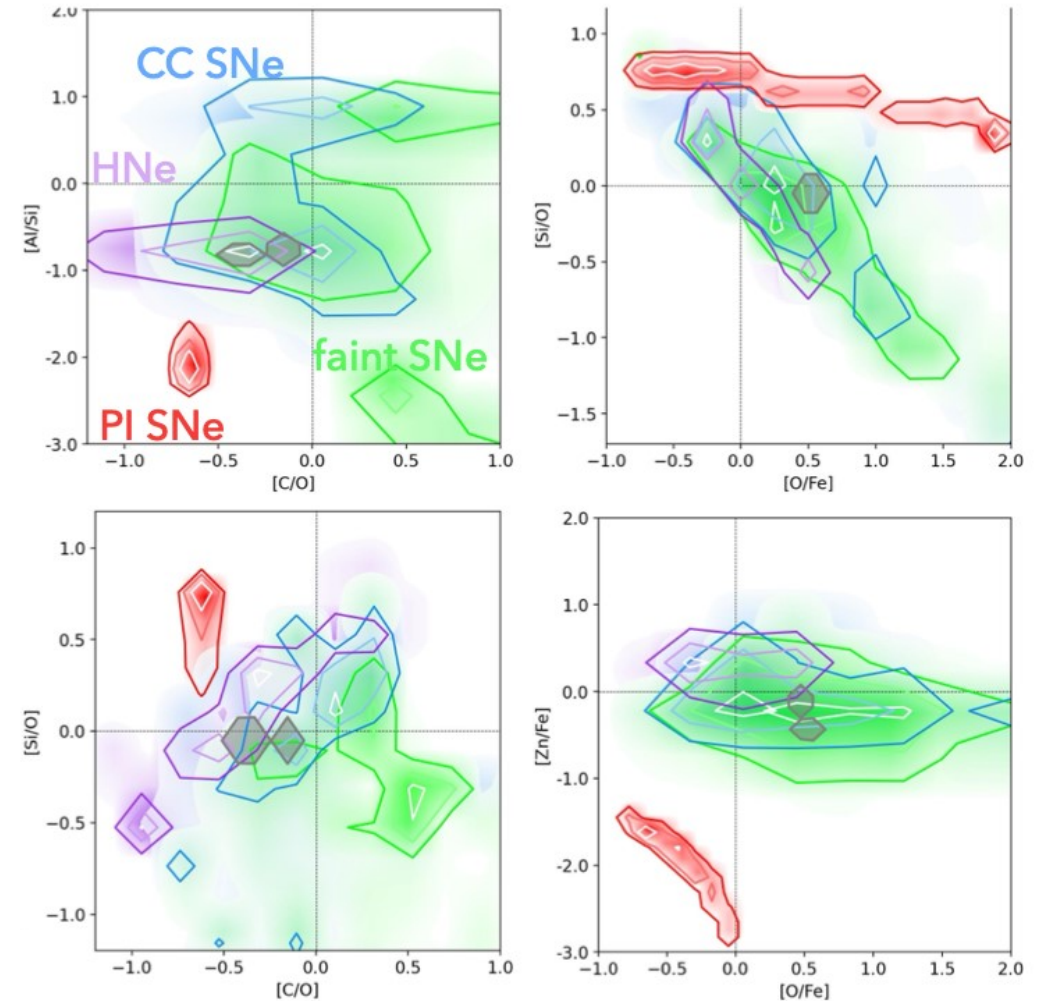


PopIII signatures at high redshift

Very metal poor, high HI column density absorption systems (Damped and Lyman limit systems) at $z \geq 2$ as tracers of PopIII enriched gas.

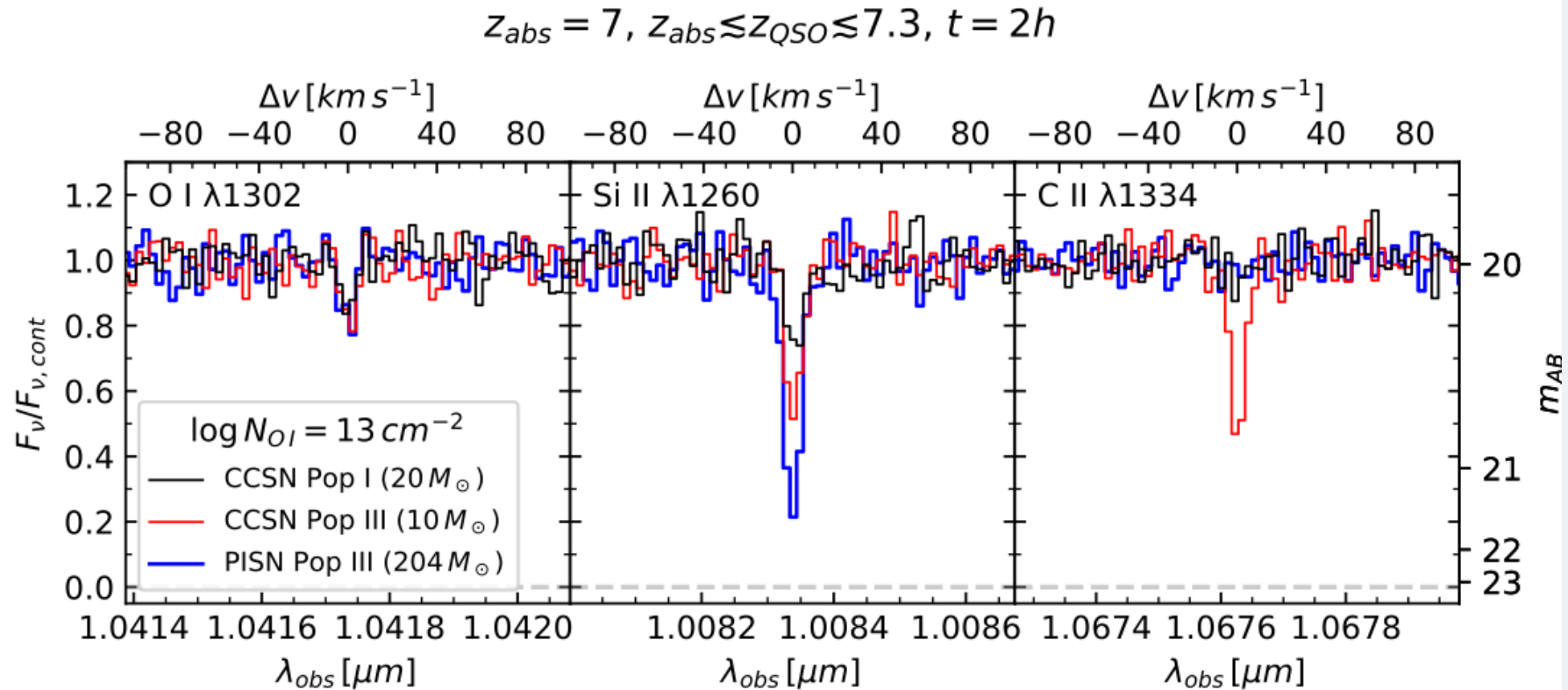


Evidence of first stars enrichment at $z \sim 3$ (Saccardi+2023)



Abundance ratios predicted for gaseous environment imprinted by a single zero metallicity Pop III SN

PopIII signatures at high redshift



Simulated ANDES spectrum of a metal absorption system at $z = 7.0$, with $N(O I) = 10^{13} cm^{-2}$ along the line of sight to a background $m_{AB} = 20$ quasar observed for 2 hours.

Transients

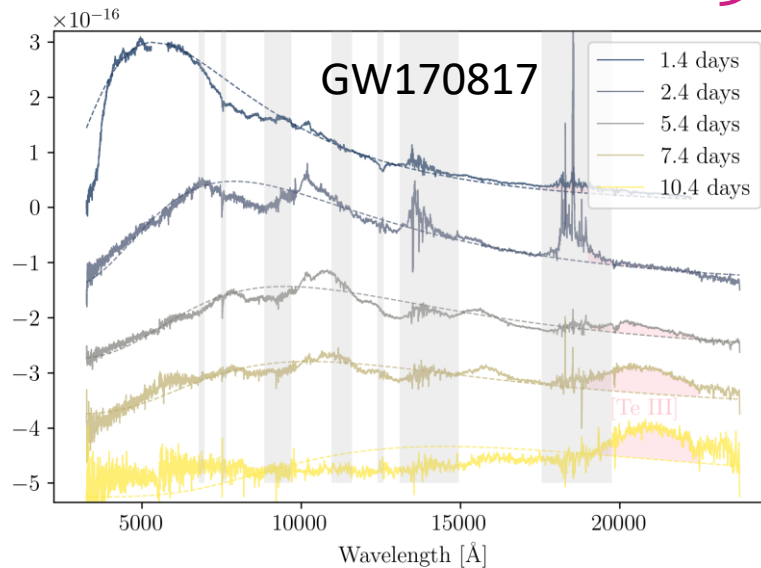
Super-luminous Super Novae

High-redshift Gamma-ray bursts

Kilonovae

Could be used as background sources
alternative to quasars

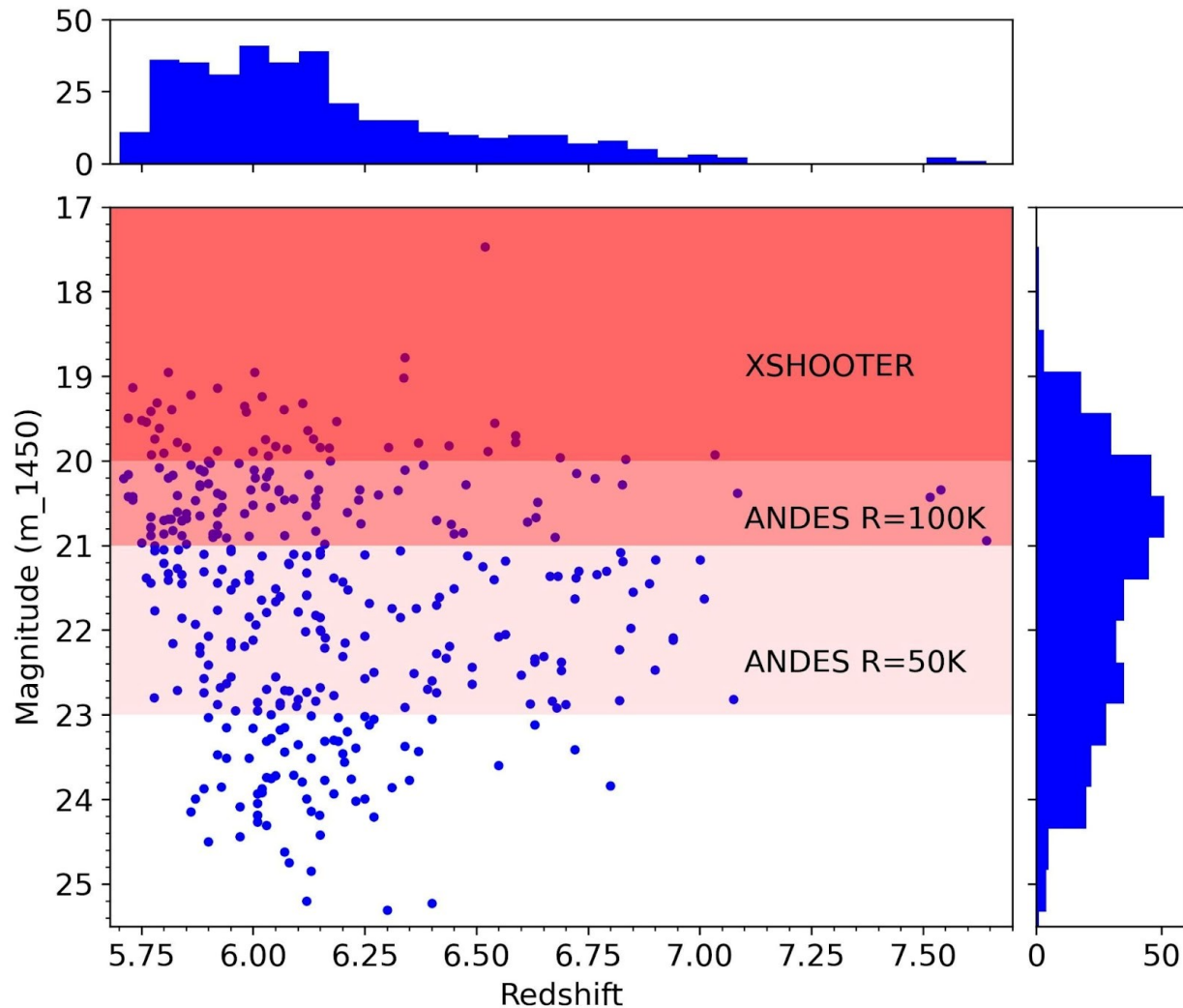
Faint and rare events
(up to few per year)



ANDES is the only spectrograph at a 30-40m telescope with a simultaneous coverage to the NIR

Criticalities

High-z quasars from Fan et al. (2023)



CURRENT DESIGN
we are not going very faint (RON limited)

Low sensitivity in the Z band (930-950nm)

K band not linked to seeing-limited front end but only to AO

UNDER STUDY
YJH possible new design with $R \sim 75000$ and larger wavelength range (covering Z)

Intermediate resolution mode for faint objects (larger fibers, no scrambler)