A Concept of Non-cryogenic NIR High-resolution Spectrograph (WINERED)

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Collaborators

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1. Scientific Motivation

   high-z QSO absorption systems ... most challenging target

2. Motivation from Instrumentation-side

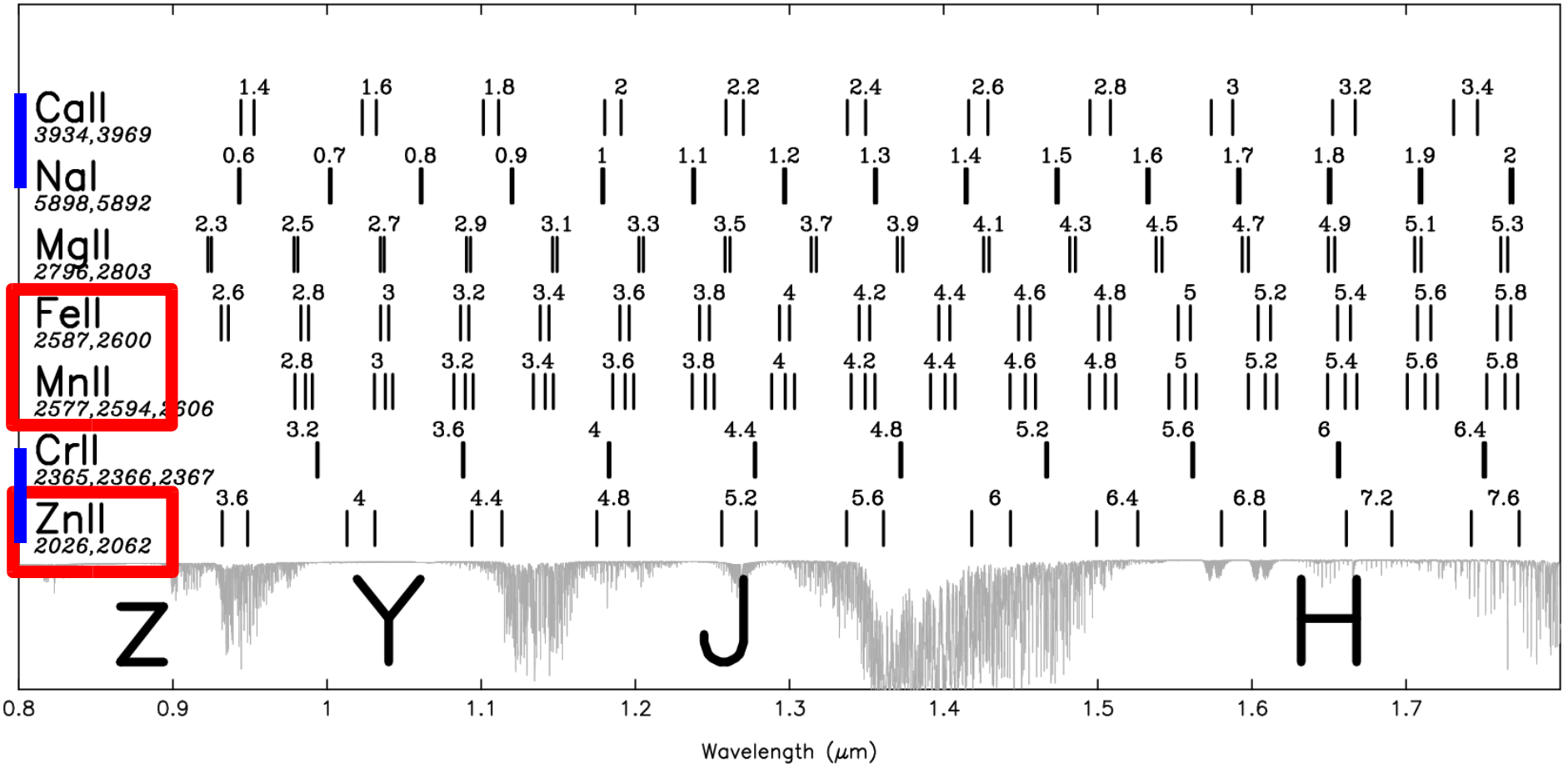
   avoiding huge cryogenic high-res. spectrograph

3. "WINERED"

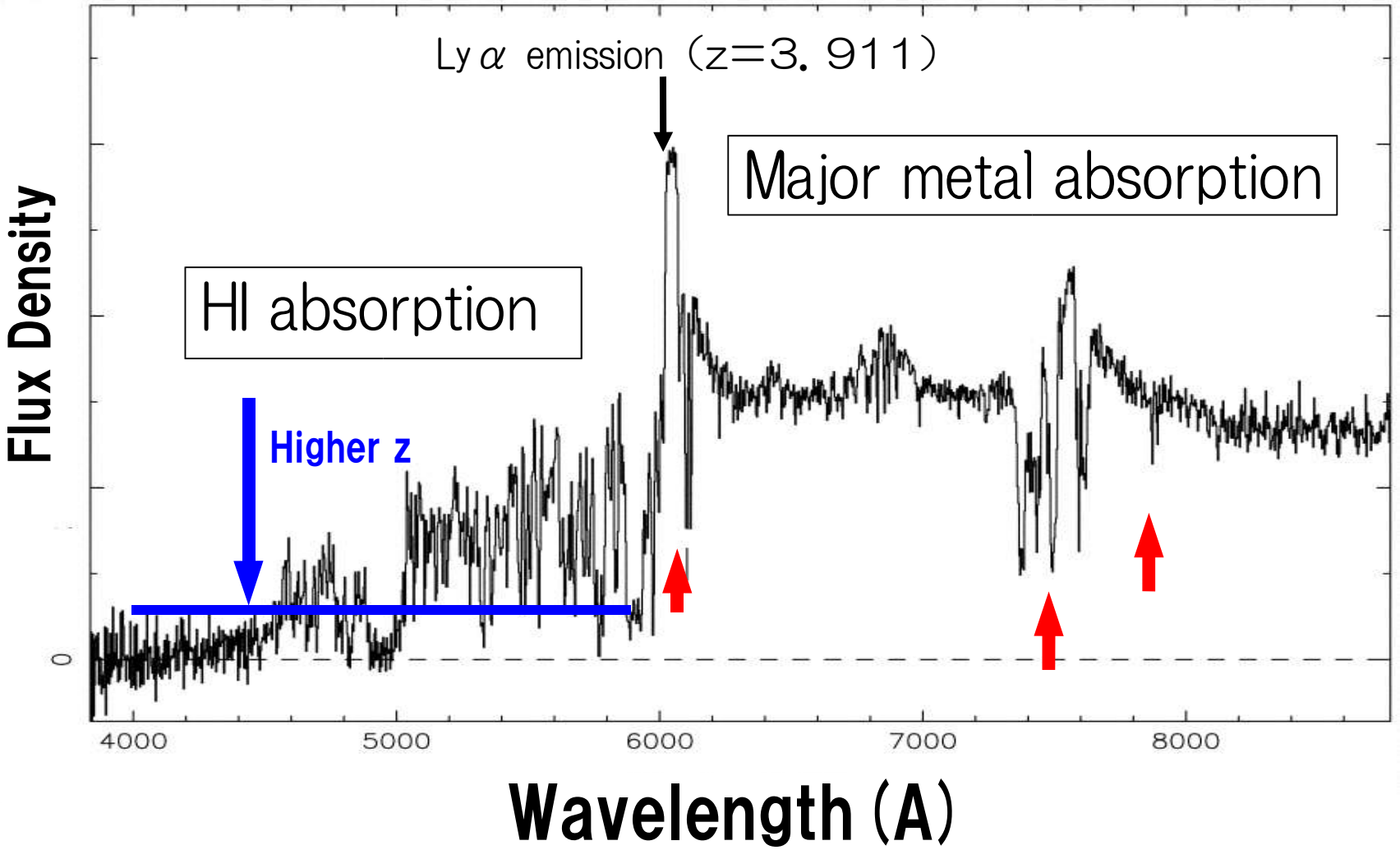
   proto-type next. gen instrument for ELT

1. Scientific Motivation
High-z QSO Absorption Systems

Major metal absorption lines shift into NIR for z > 2.5



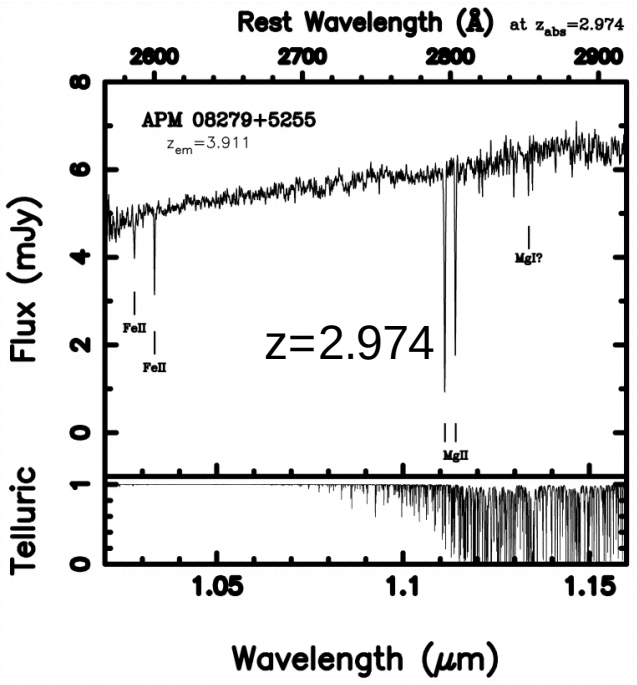
1. Scientific Motivation
High-z QSO Absorption Systems

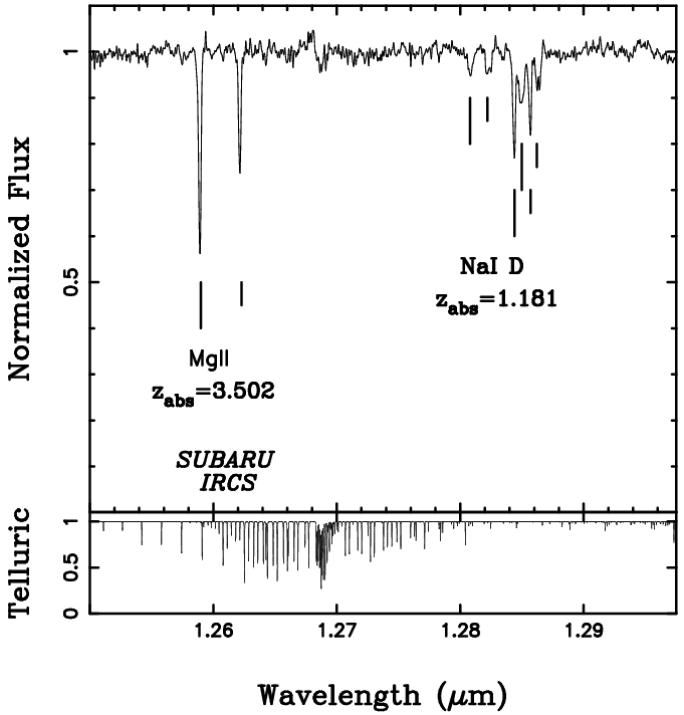


1. Scientific Motivation
Currently available data

facility instruments at 8m-class telescopes

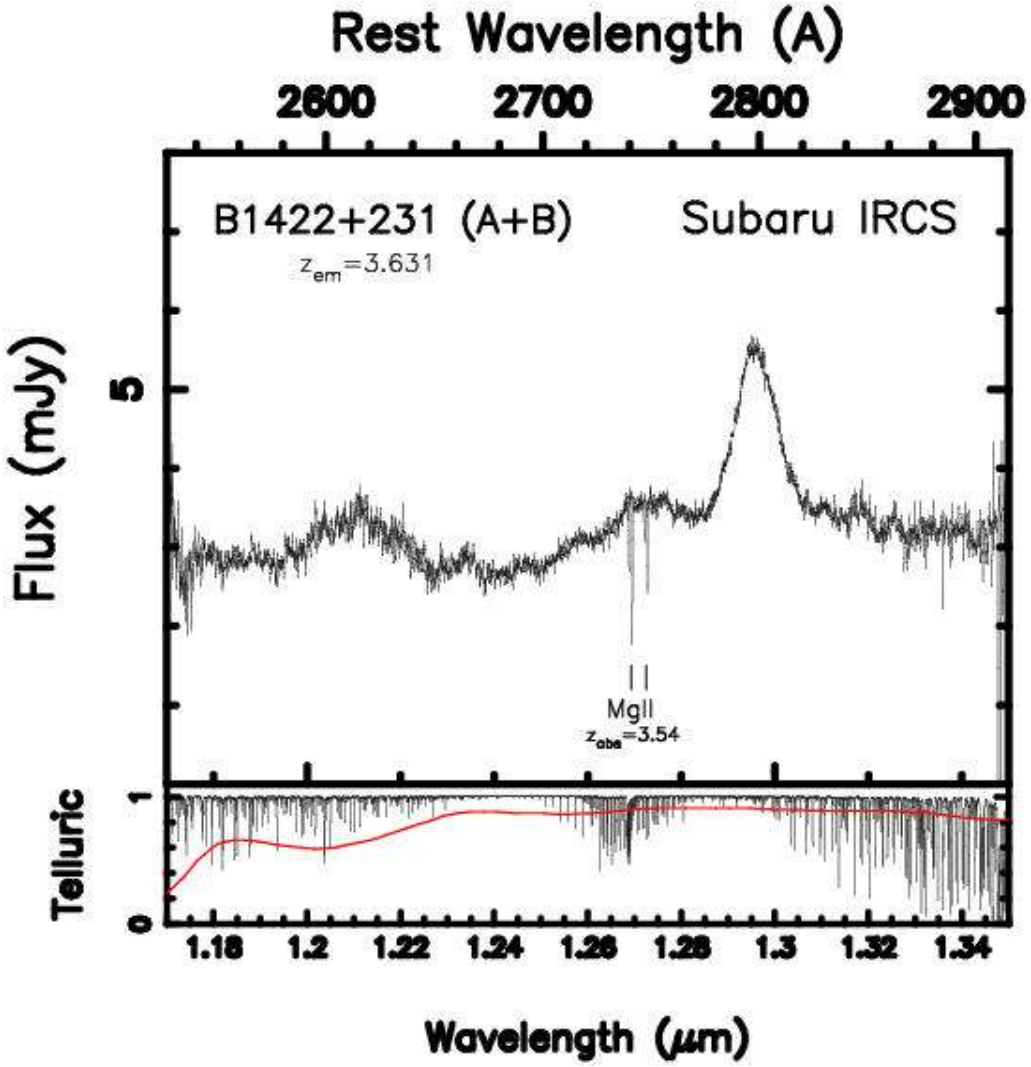
5,000 < R< 20,000 for bright (J<17) QSOs



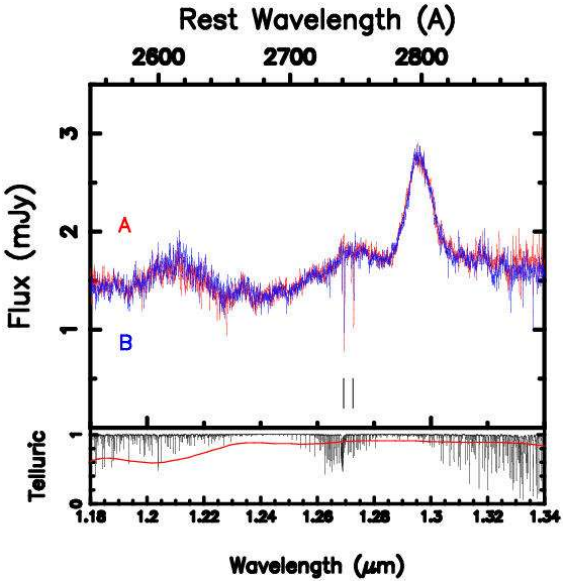


APM08279+5255
(Subaru IRCS w/AO)

1. Scientific Motivation
Currently available data



B1422+231
(Subaru IRCS)



1. Scientific Motivation

What we learned... (or was it obvious?)

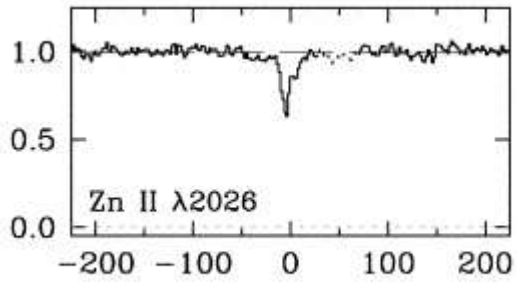
- $W_{obs}=W_{rest} \times (1+z)$ helps quite a bit
- In many cases, S/N is limited by telluric absorption correction

  .... uniform slit illumination is critical

  -> even higher sensitivity is necessary//
- R~20,000 is okay, but unsatisfactory

  -> R > 60,000 is definitely necessary

  for faint absorption lines//



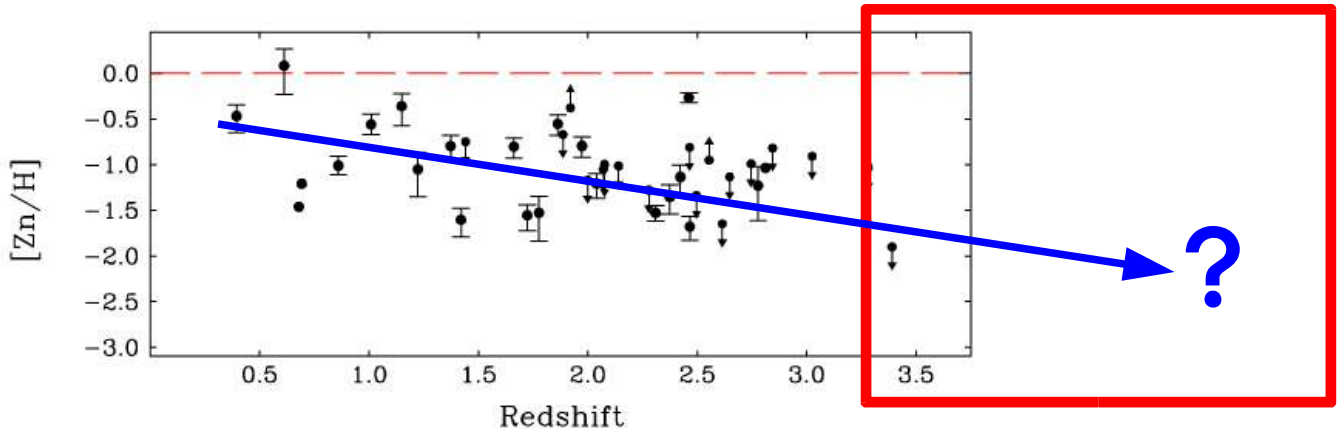
ZnII at z=1.01 [Fe/H]~-1.2
(Pettini et al. 2000)

1. Scientific Motivation

Final Goal

Metallicity evolution at high-z

target



Needs for increasing the No. of QSOs (> 100)

cf. GRBs

2. Motivation from instrumentation side

Avoiding Huge Cryogenic Instrument

Huge cryogenic instrument is required for larger D

Collimator beam size

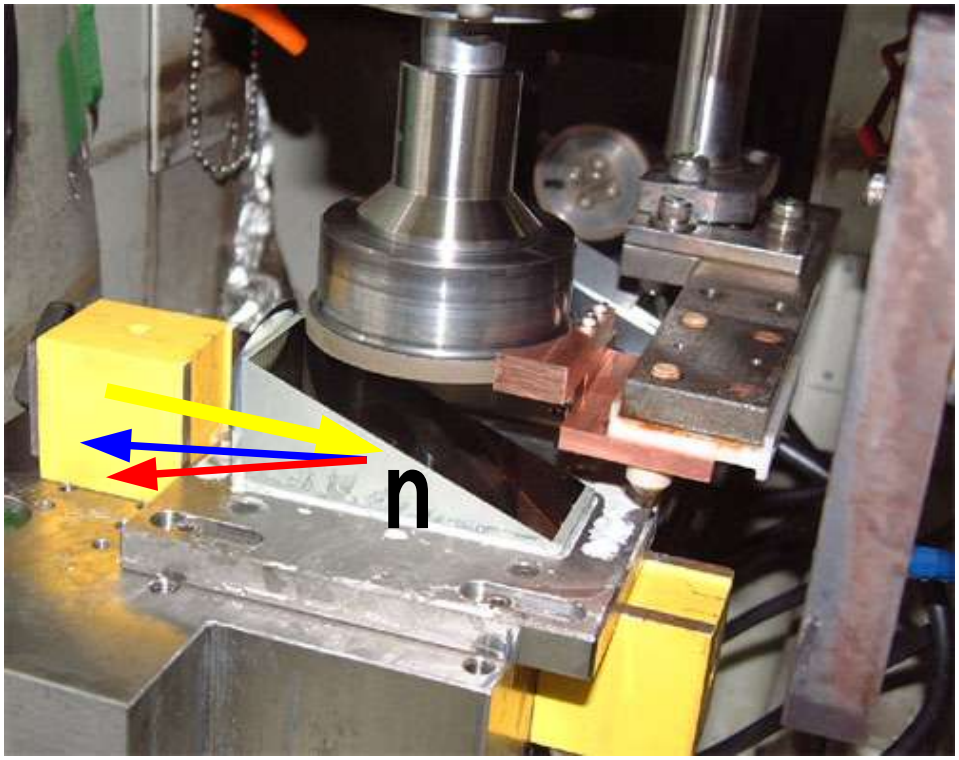
$$\phi = R \times s D / 2n \tan\theta$$

AO

Immersion grating

ϕ :diameter of collimator beam
s :slit width (radian)
D :telescope diameter
θ :blaze angle of the echelle grating
n :refractive index of the grating material

2. Motivation from instrumentation side
Concept (1) Immersion Grating
for avoiding huge instrument



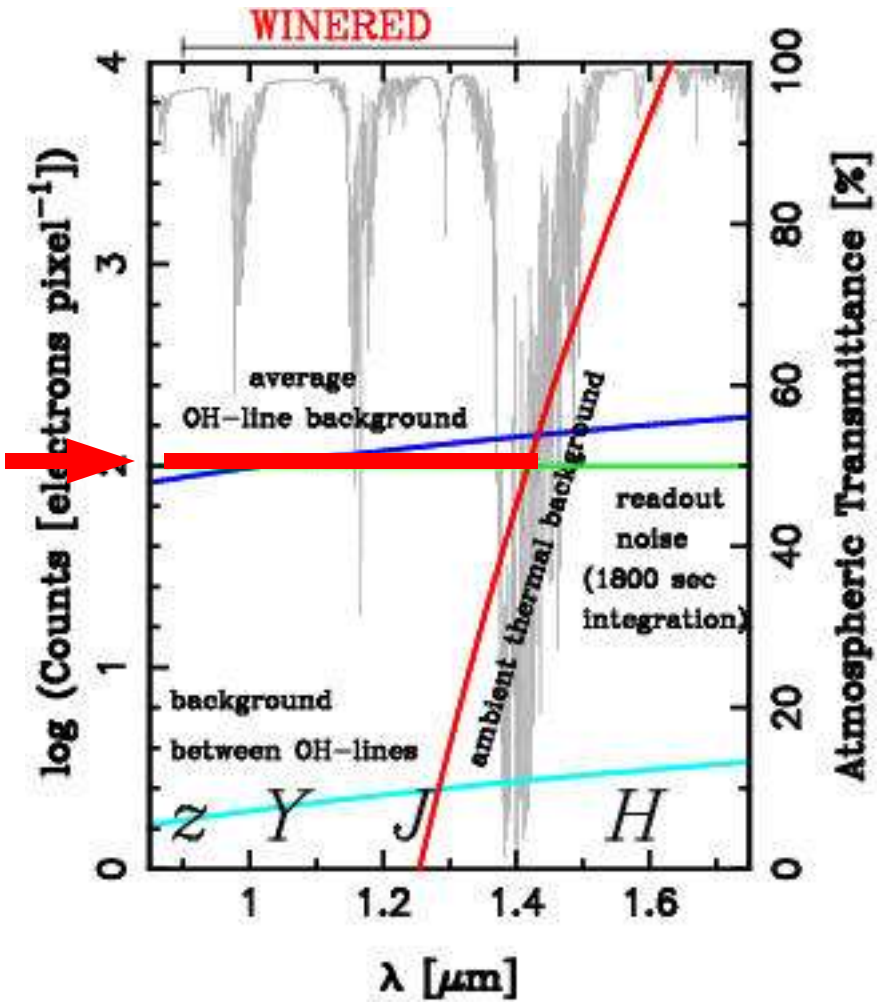
Grinding of Ge immersion grating

- Technology now available
- High-precision milling (grinding) technique
  by "Science Institute" in Japan
- Germanium (for MIR) successfully fabricated
  300um pitch
  roughness < 10nm (rms)
  see Ebizuka et al. 2002
- ZnSe (for NIR) on R&D
  30um pitch
  roughness < 20nm -> 10nm goal
  edge r < 5um -> r<1um goal

2. Motivation from instrumentation side

Concept (2) Non-cryogenic

for avoiding cryogenic instrument



- as long as staying at
  short NIR ($\lambda < 1.4$um)
  no cooling is necessary
- easy to design/build/maintain
  → budget/schedule saver

2. Motivation from instrumentation side

Concept (3) High throughput

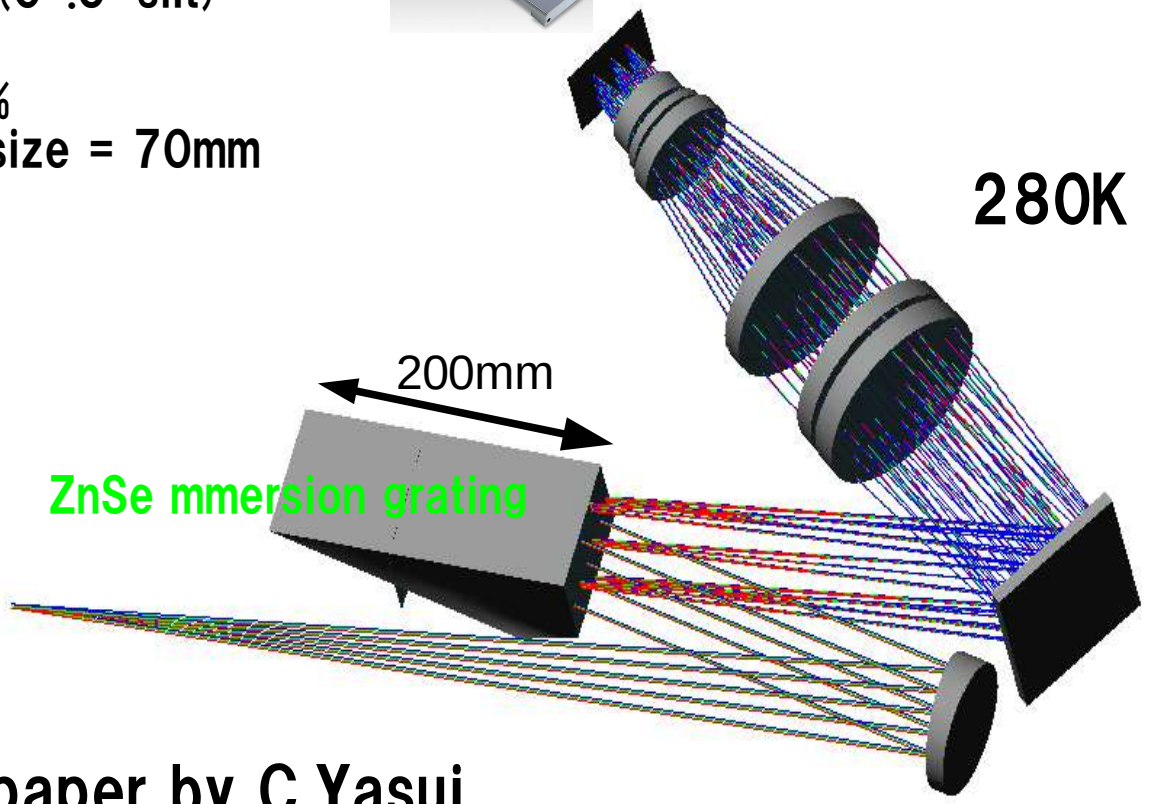
Short NIR ... 0.9-1.4um (z,Y,J-bands)

- Natural result of the limited wavelength coverage
- AR coating R<1% per surface
  (cf. R > a few % for 1-2.5um broad-band AR)
- Short NIR is where CCDs are insensitive and where most IR spectrographs are not designed to observe
  -> literally "niche"
- Short NIR is a good match with high-z QSO abs lines

3. prototype next gen. instrument
Warm Infrared Echelle-spectrograph ("WINERED")

- 0.9-1.4um (3-exposures)
- R_{max} = 100,000 (0".3-slit)
- 0".15/pix
- Throughput ~ 30%
- Collimator beam size = 70mm

Rytheon VIRGO 2048x2048 array

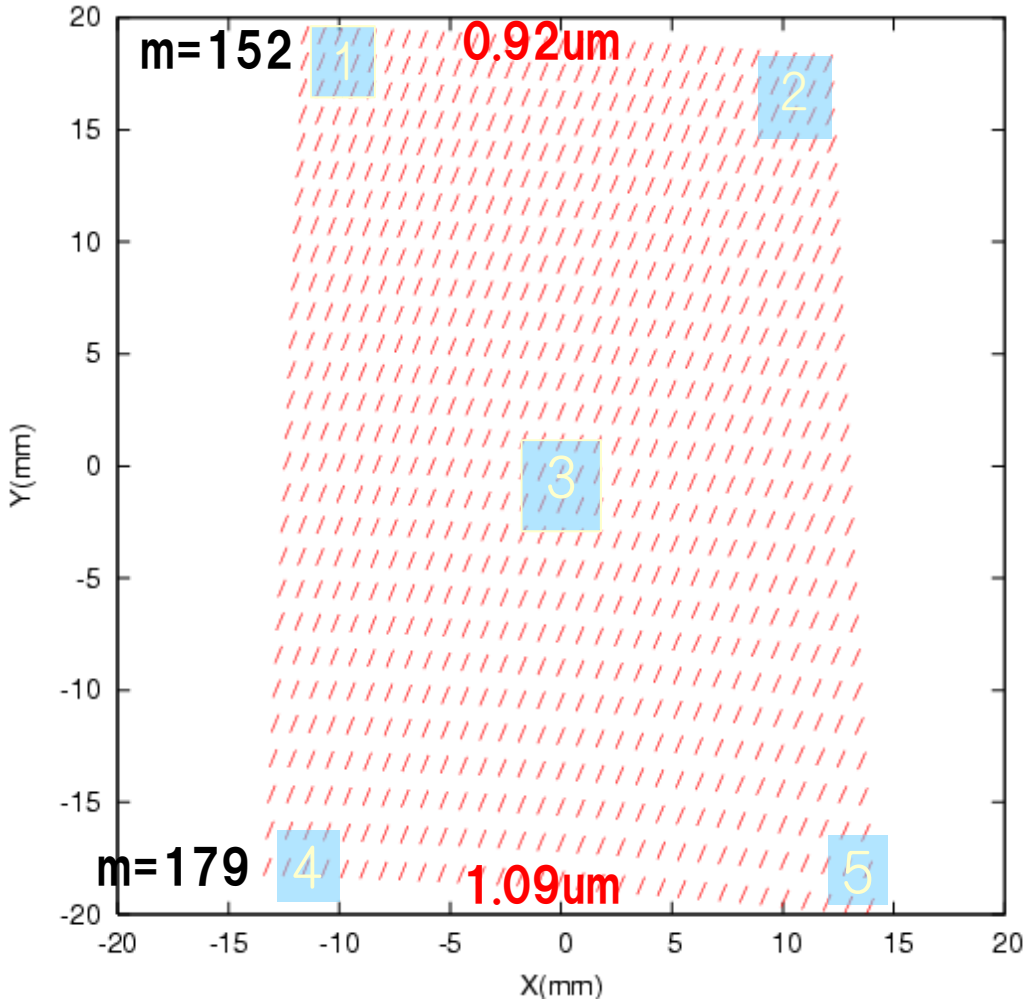


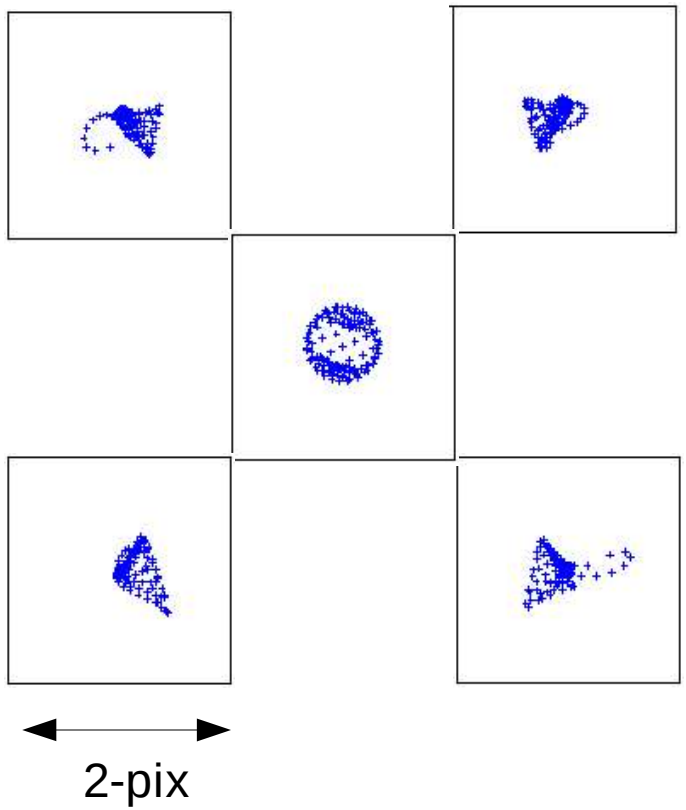
See poster paper by C.Yasui

3. prototype next gen instrument

Warm Infrared Echelle-spectrograph ("WINERED")

Performance in short wavelength mode





3. prototype next gen instrument

WINERED Status

- Japanese NSF funded (+10 man・year)
- FY2006 lab testing
- FY2007 first light

- Telescope TBD...

  3-10m telescopes w/Nasmyth focus are wanted

  if anyone interested, please let us know...

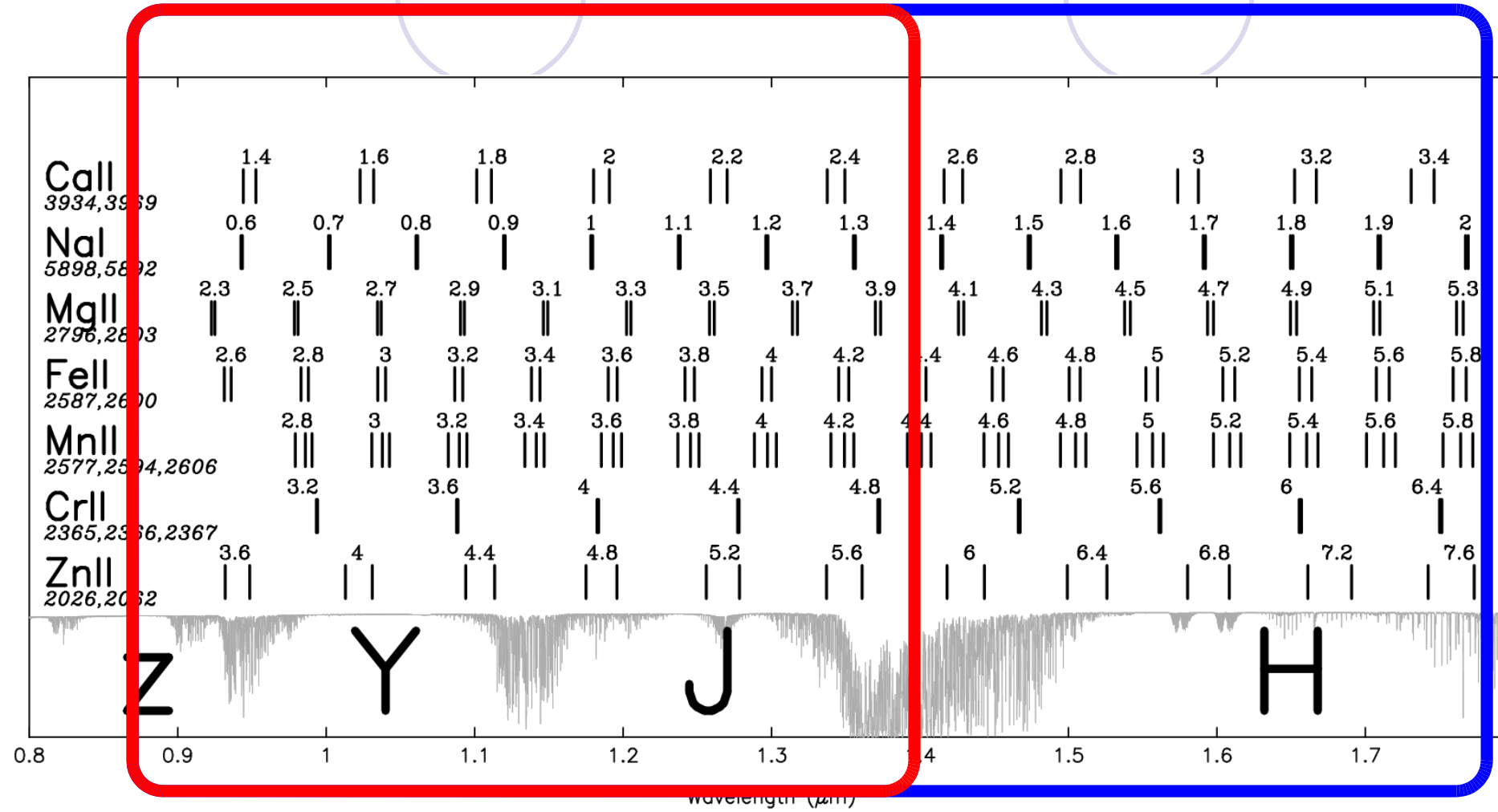
  (naoto@ioa.s.u-tokyo.ac.jp)

4. Roadmap
For NIR study of QSO Abs. Systems

	R=20,000	R=100,000	Targets
	S/N=100 w/8-hrs itime		
2000- 8m facility	J 16-17	J 14-15	bright QSOs
2006- LGS-AO	J 17-18		
2007- "WINERED"	J 18-19	J 16-17	~100 QSOs (z>4)
2015- ELT	J > 20	J 18-19	+ z>6 QSOs

See poster paper by S.Kondo

5. A little cooling for ELT?



short NIR

refrigerator type cooling -> (-70C)

e.g., Subaru FMOS spectrographs