Progress in Developing the Fiber-link of 188 cm Telescope and HIDES

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with
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contents of my talk

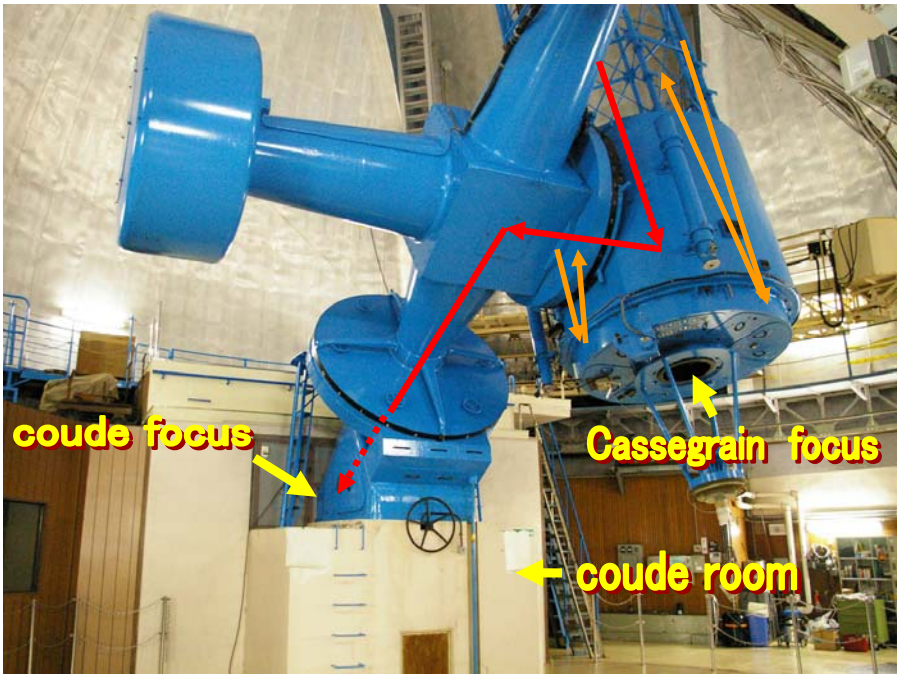
- what is HIDES (+188 cm telescope+OAO)?
- purposes of HIDES fiber-feed project
- features & specifications of HE (high efficiency) fiber-link
- current status of the project

what is HIDES ?

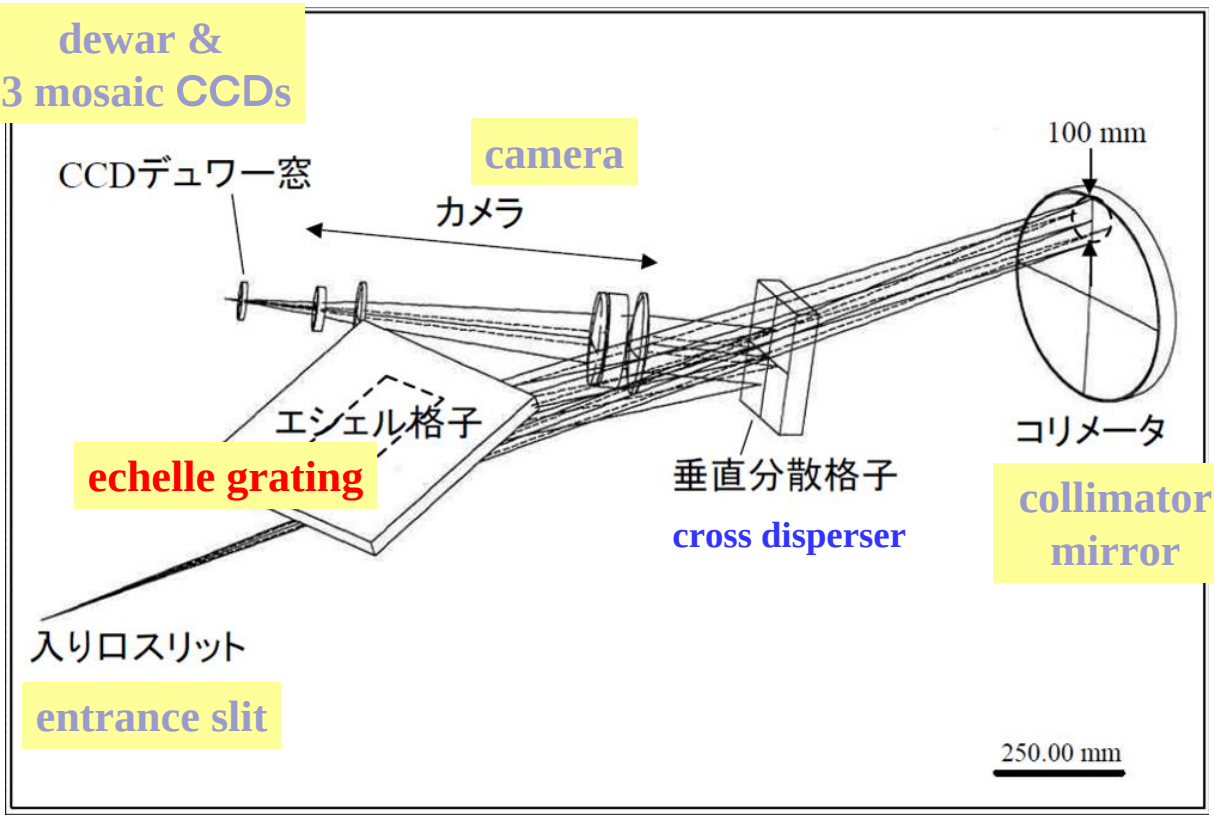
- high-resolution echelle spectrograph attached to 188 cm reflector

  the most favorite open-use instrument at OAO

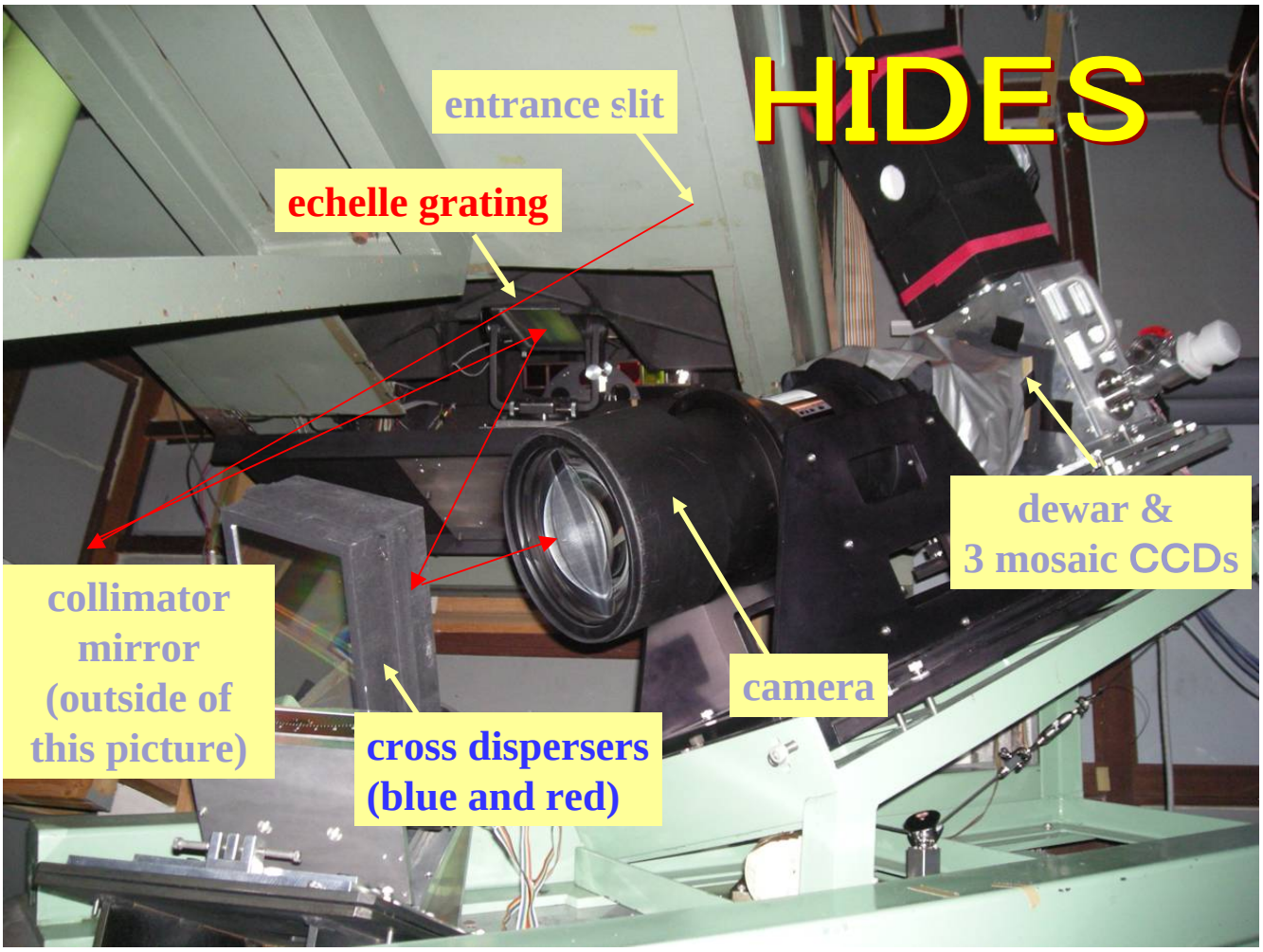
  we just have the tenth year anniversary since its first-light on Apr 1999



dewar &
3 mosaic CCDs



Izumiura (1999)



- some specifications

wavelength region: 360 nm～1000 nm

simultaneous wavelength coverage of about 375 nm (red cross disperser)

thanks to the 3 mosaic CCDs since Dec 2007

R and ϕ: R=69,000（slit width of 200um; ϕ = 0.75 arcsec）

maximum R～100,000

overall efficiency（telescope+spectrograph）: about 3 %@500 nm

but light loss at the entrance slit is quite large for typical seeing size of 1.5 arcsec at Okayama

options

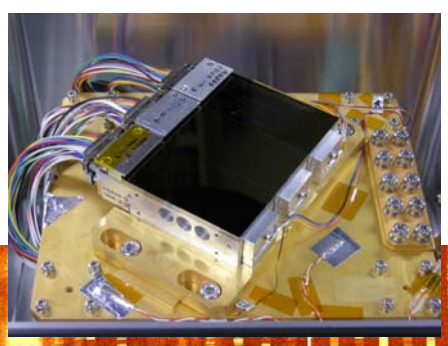
iodine cell（2000.10～）:

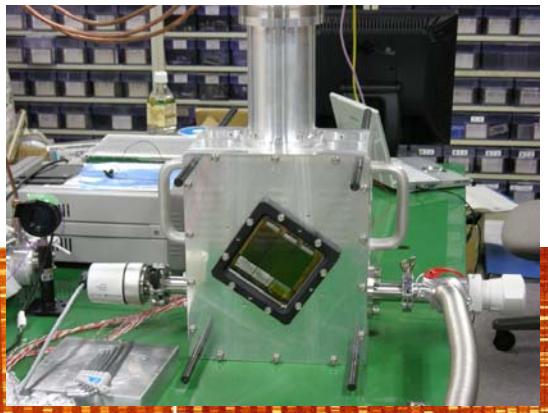
current rv measurement accuracy ～2 m/s（over a few weeks）

6 m/s（over years）

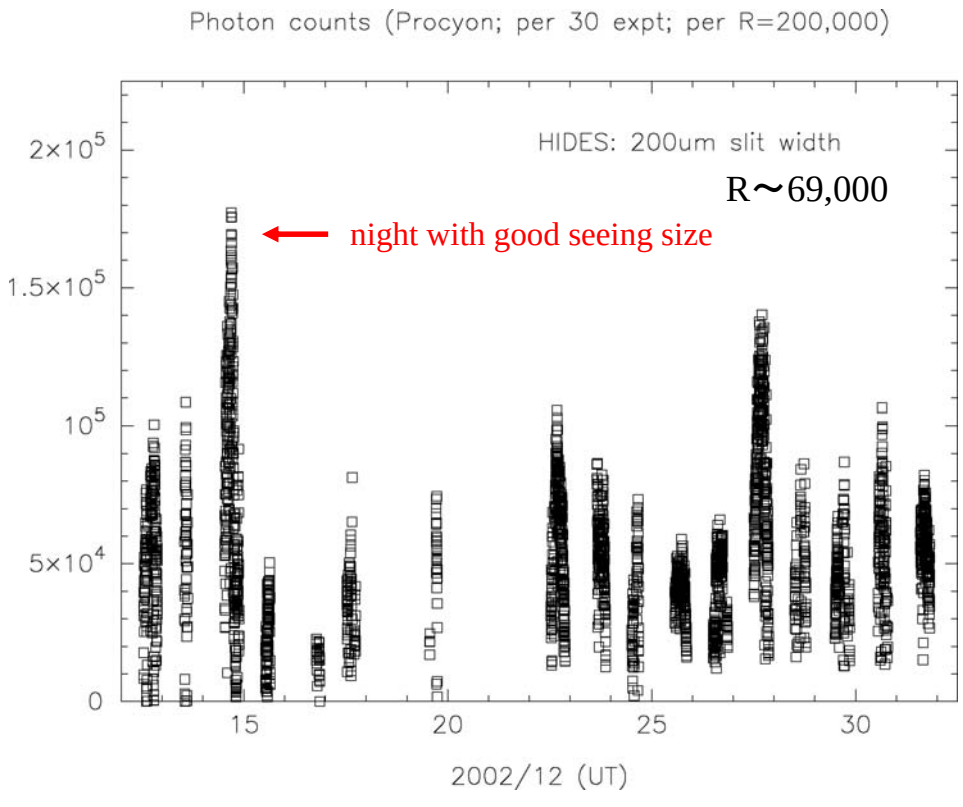
image rotator

HIDES's 3 mosaic CCD's, dewar, and its Th-Ar lamp spectra



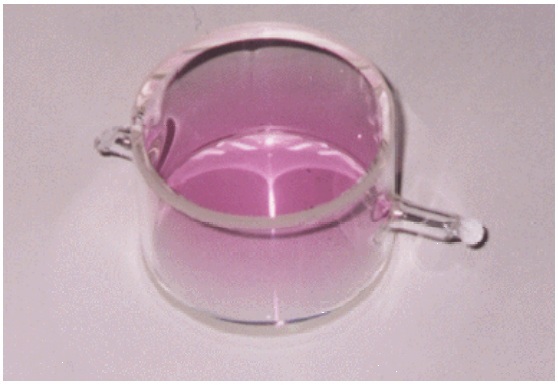


simultaneous wavelength coverage of about 375nm with red cross disperser



HIDES has an iodine cell to measure stellar radial velocity very accurately

currently 2～3 m/s in best case



iodine cell

pre-optics at outer coude room

purposes of HIDES fiber-feed project

• it is one of two major projects in “the HIDES upgrade plan”, which is started in FY2005, to keep its competitive power in astronomy

wider wavelength coverage ➔ 3 mosaic CCD
higher throughput and higher rv measurement accuracy
➔ HIDES fiber-feed

• we aim to improve the throughput of the system by one magnitude

we can monitor four times as many as target stars for exposure time limited observations (2.51**0.5)**3 ～ 4!!

example of sciences :

exoplanet search: monitor more than 1,000 targets
asteroseismology: more than one solar-type stars
early-type nrp stars down to 7 or 8 mag. (enabling more collaborations)

• this project is the basic research for our future instrumentations

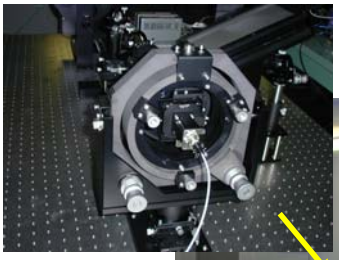
accumulation of know-how on fiber-feed spectrographs

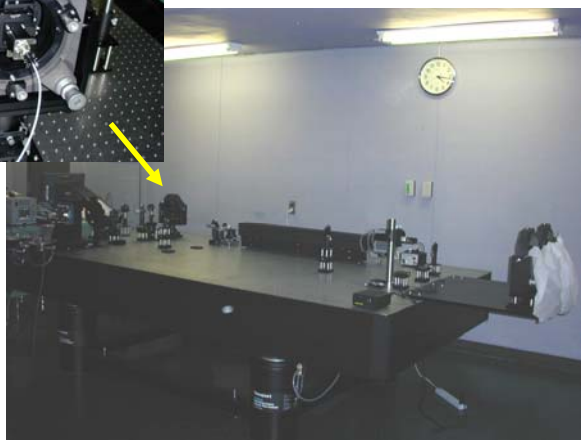
fiber modal noise and throughput for higher SN

high-resolution spectra and also for higher rv measurement accuracy

building infrastructure at OAO

lab, low-cost test spectrograph, clean booth, etc.





features of HE (high efficiency) fiber-link

• to obtain higher throughput for typical seeing condition at OAO while maintaining high resolution, we carefully designed the optics of the fiber-link

link Cassegrain focus to coude focus by optical fiber

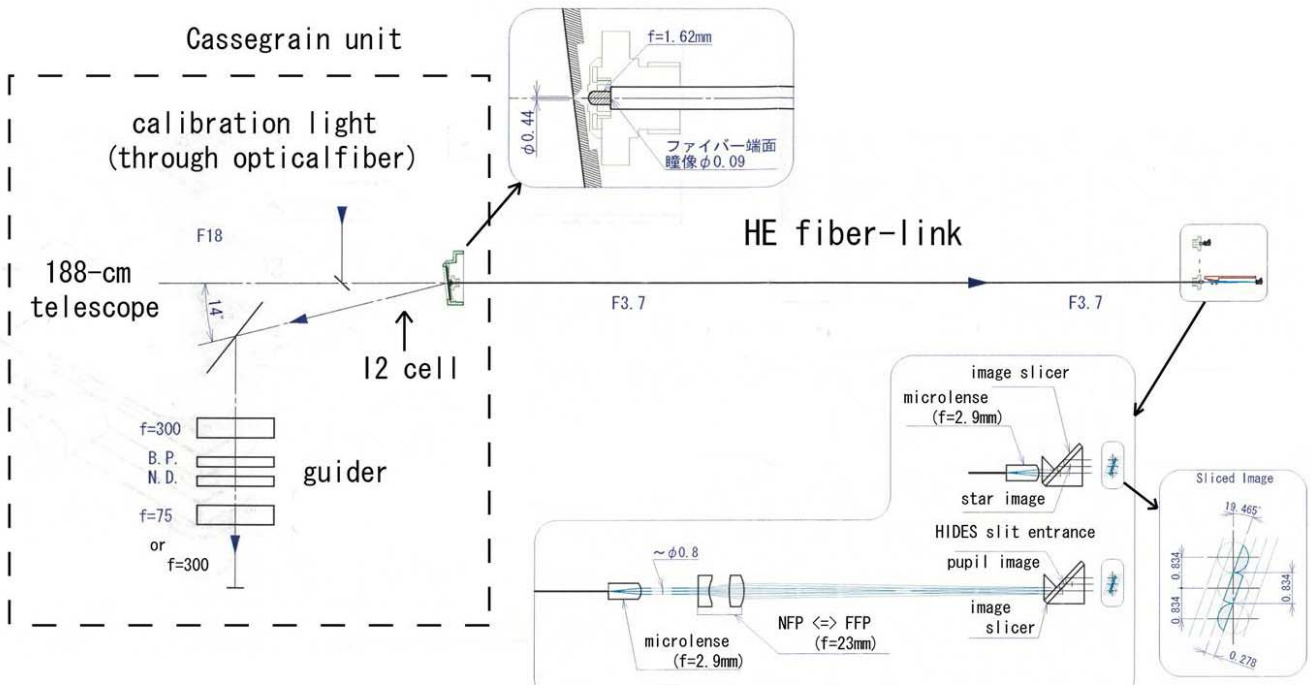
3rd mirror（0.8）x 4th mirror（0.8）x window（0.9）=0.58 ➔ 0.9X

2.7 arcsec FOV and image slicer at the entrance of HIDES

slit efficiency 0.4 (0.75 arcsec, R～69,000）

➔ 0.8X (FOV 2.7 arcsec/3 slices；R～50,000）

(convert F from18 to 3.3 by a microlense at the fiber input to suppress FRD)



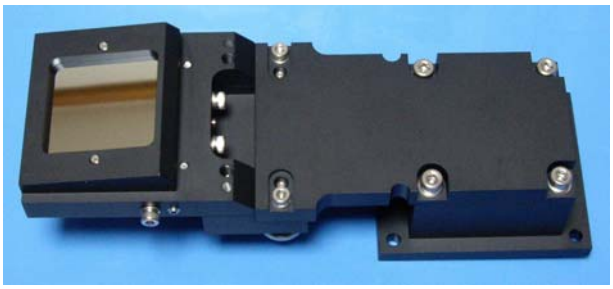
there is a trade-off between resolution/number of slices and wavelength coverage

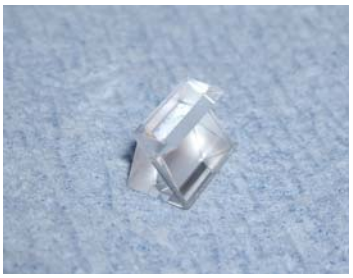
R～50,000 (1 arcsec; 3 slices) but for λ > 450 nm (red cross disperser)

no limitation for blue cross fiber

HE input (cassegrain focus)

HE output（coude focus）





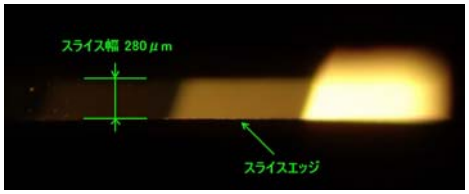
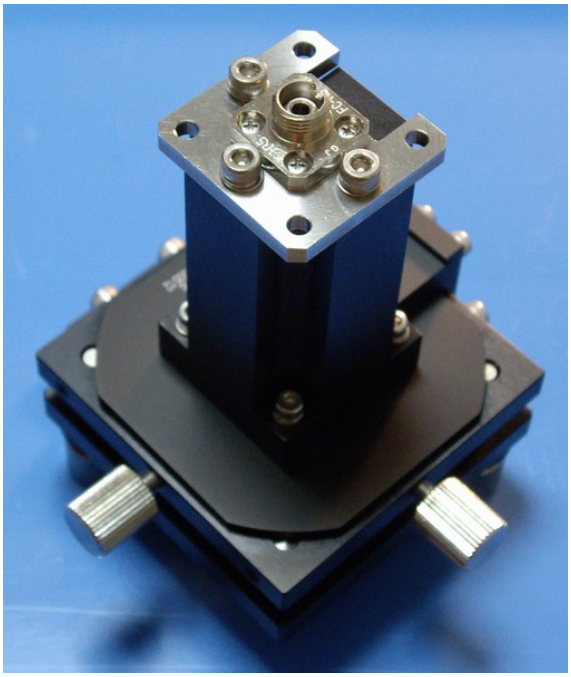


image slicer and sliced image



- efficiency of fiber couplings, FRD, and modal noise property will be examined carefully by a low-cost test spectrograph and a star simulator
  - ➔detailed optics, like star image slice or pupil slice, will be determined after tests at lab

- an iodine cell is installed for radial velocity measurement
  - is independent RV fiber-link (+fiber scrambler) necessary ?
  - examine effects of modal noise, complicated IP by the image slicer, & etc.
  - *important to setup next target of rv measurement accuracy*

current status of the project

- FY2005: conceptual design phase

- FY2006: preliminary design phase
  - preliminary design of fiber-link optics (referring to HARPS's experience)
  - choice and purchase of optical fibers
  - re-designing of current GUI system, preparation of optical lab

- FY2007: start finalizing designing
  - continuous study of fiber-link optics including image slicer, etc.
  - final mechanical design of the Cassegrain unit
  - design and order of a star simulator
  - investigation of fiber-end polishing method and preparation of jigs, etc.

- FY2008:
  - order of the Cassegrain unit (frame and optical components)
  - design and order of the HE fiber input optics at Cassegrain focus

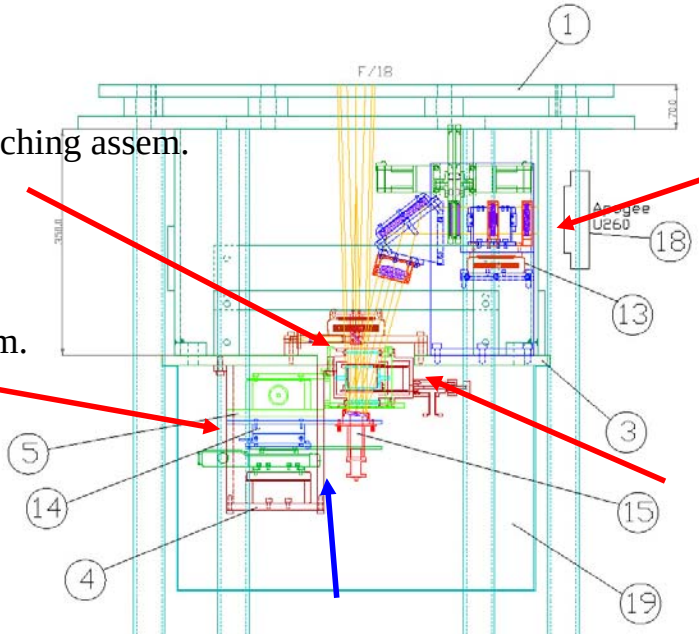
Cassegrain Unit (tentative)

showed last year at Jeju WS

star/cal. lamp switching assem.

guider

fiber switching assem.



iodine cell

Cassegrain focus (HE and RV fiber-links)

and after the Jeju WS …

design and order of HE optics at coude focus including image slicer
design and order of F-ratio convert optics for calibration lights
on Cassegrain unit
preparation for modification of the coude pre-optics for the fiber-links
design of a low cost test spectrograph and order its parts

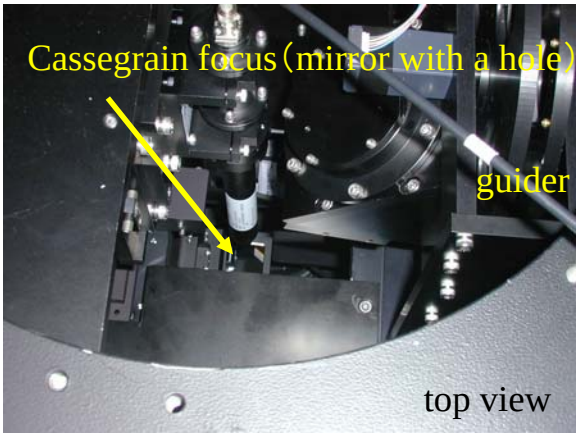
- FY2009:

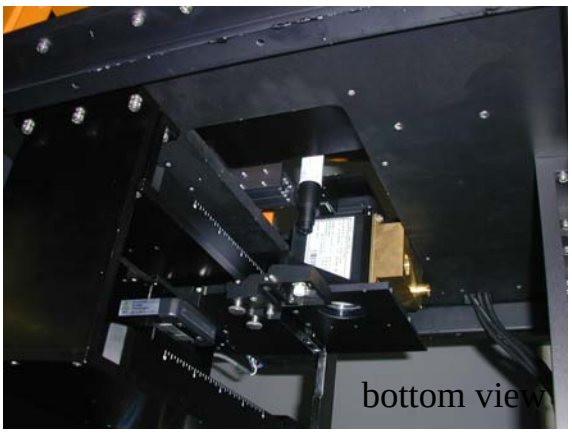
improvement of Cassegrain unit (balance weight, cover)
modification of coude pre-optics assembly (and installation of new WFV)
design, order parts of, and assemble of calibration source unit
design and manufacture of mechanical parts for fiber wiring
adding the fiber-link option to the control software (preliminary version)

at present: making fiber cables (polish and sheath of the bare optical fibers)
overall assembly and adjustment

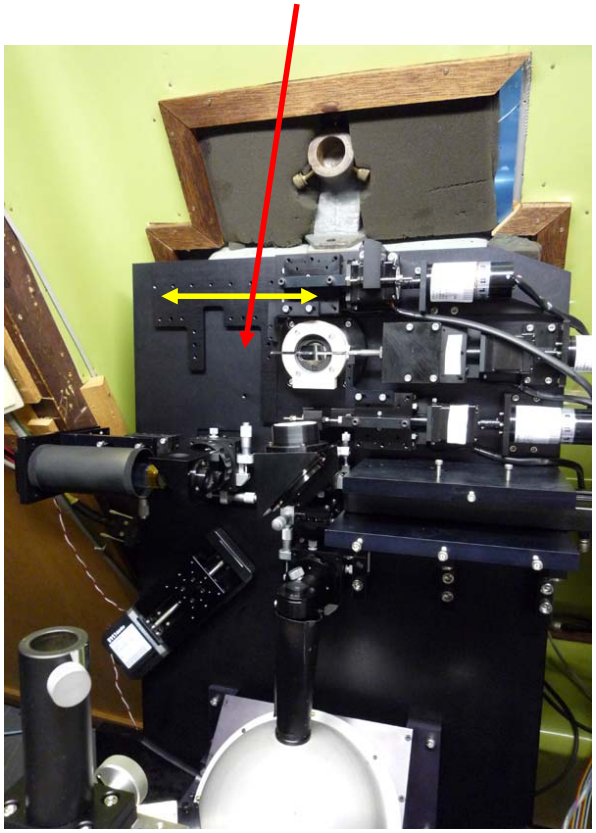
to do: manufacture of iodine cell temperature control system
extensive tests of HE fiber-link, fiber agitator
etc.

Cassegrain unit





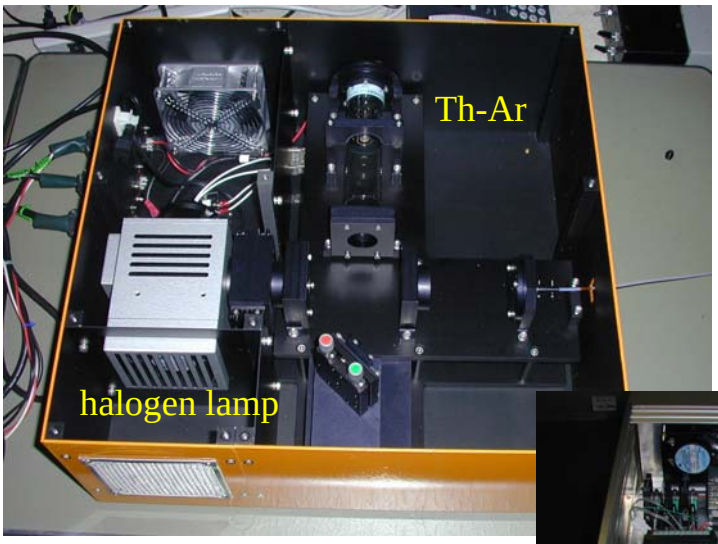
attachment to HE-output assembly



modified coude pre-slit optics

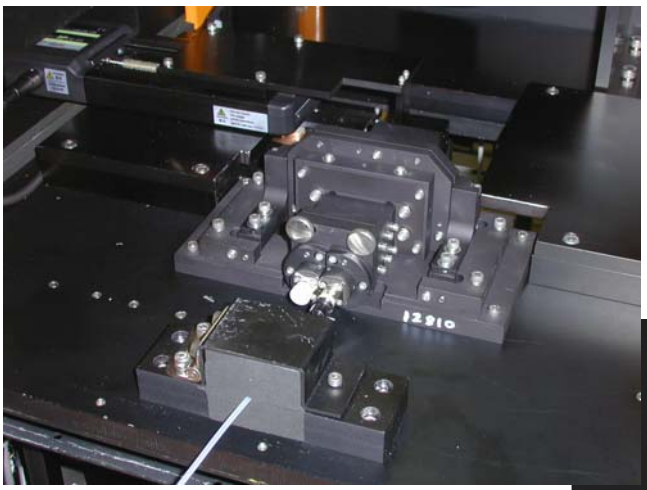
new WFV

calibration lamp unit

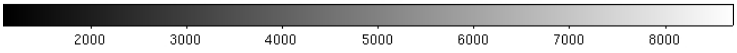


→ to telescope
(Cassegrain unit)

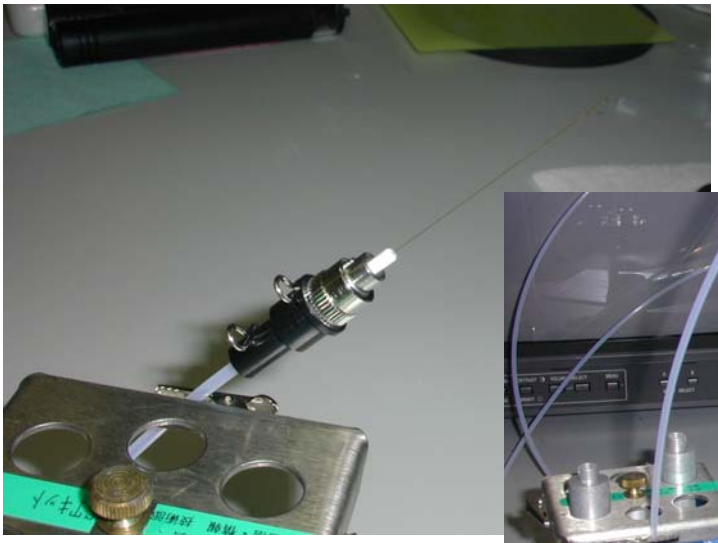
control unit of
calibration lamp source

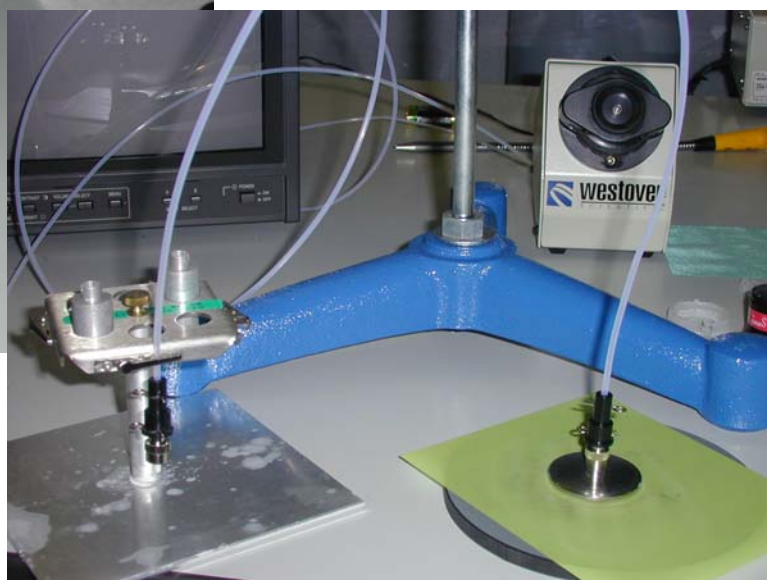


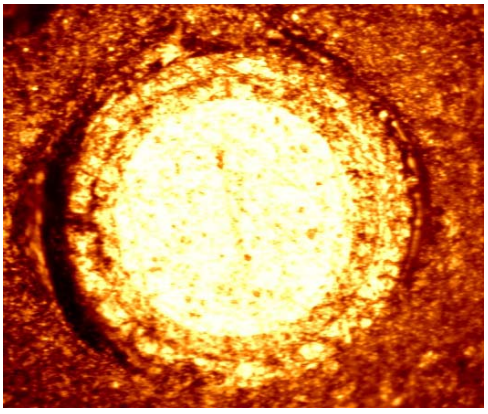
F-ratio convert optics
for calibration lights



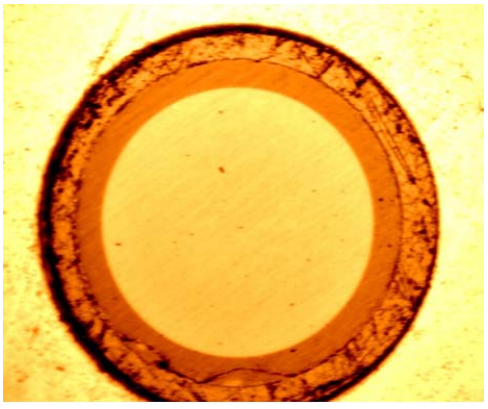
view of the guider



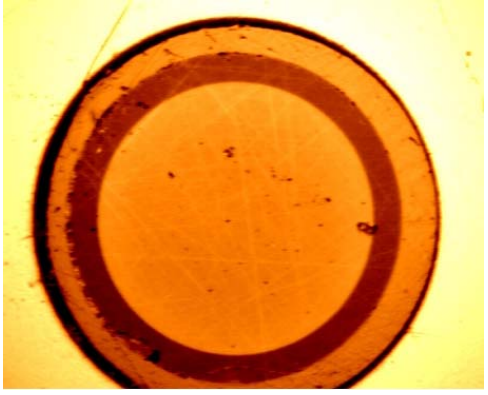




with 5 um polishing sheet



with 1 um polishing sheet



with 0.3 um polishing sheet

close to first light, maybe!