LAMOST-HiRes

Fengshan - September 4, 2006

LAMOST-HiRes

A Fiber-Fed High Resolution Echelle Spectrograph for LAMOST

Outline (1)

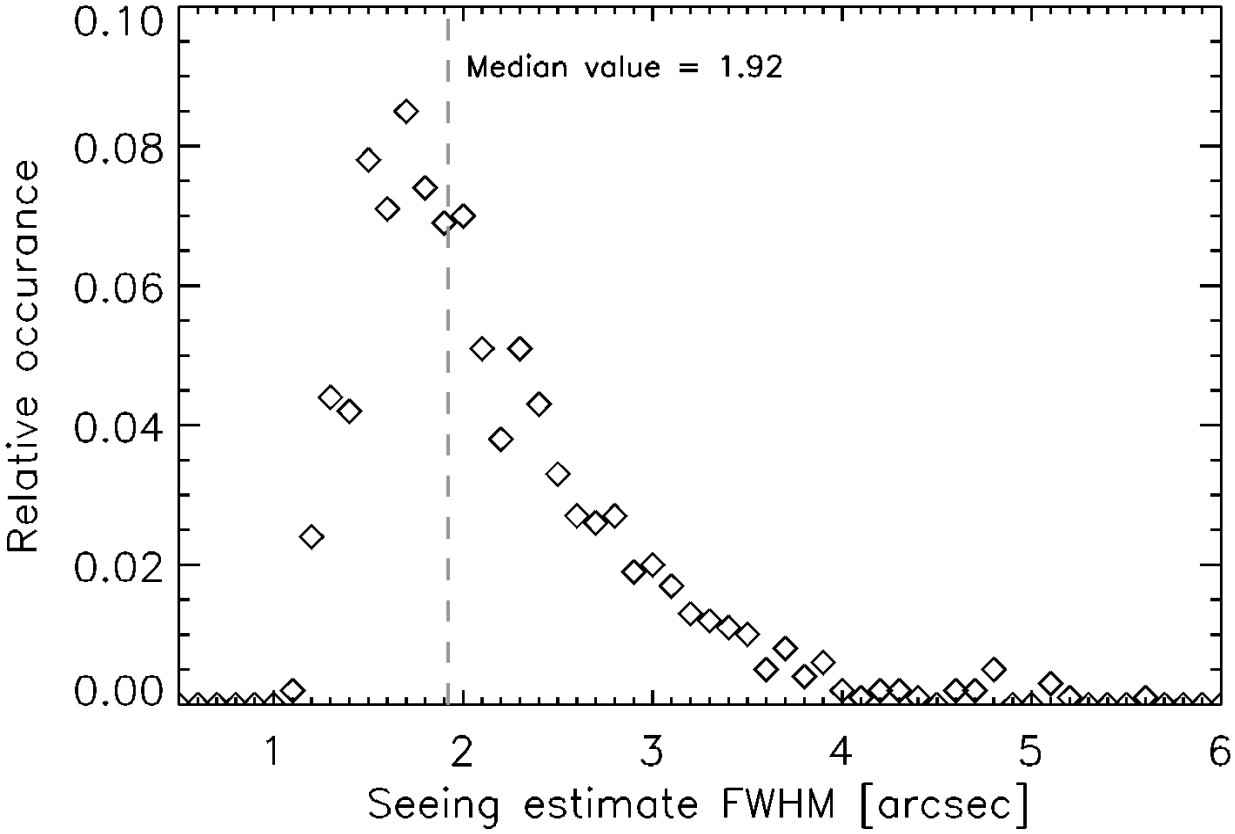
- Project general preconditions
- Scientific preconditions
- HiRes spectrograph design
- Focal plane device
- Observation strategy
- Summary and next steps

General: Participants

- NAOC/Beijing: Prof. ZHAO Gang (science driver)
- USM/Munich: Prof. Thomas GEHREN (sci. driv.)
- USM/Munich: Frank GRUPP (PI, optical design)
- LAMOST/Beijing: LAMOST-Team (project structure, CCD-camera, on-site construction)
- NIAOT/Nanjing: Prof. ZHU and team (opto-mechanical design and construction, manufacturing)

General: Xinglong seeing (1)

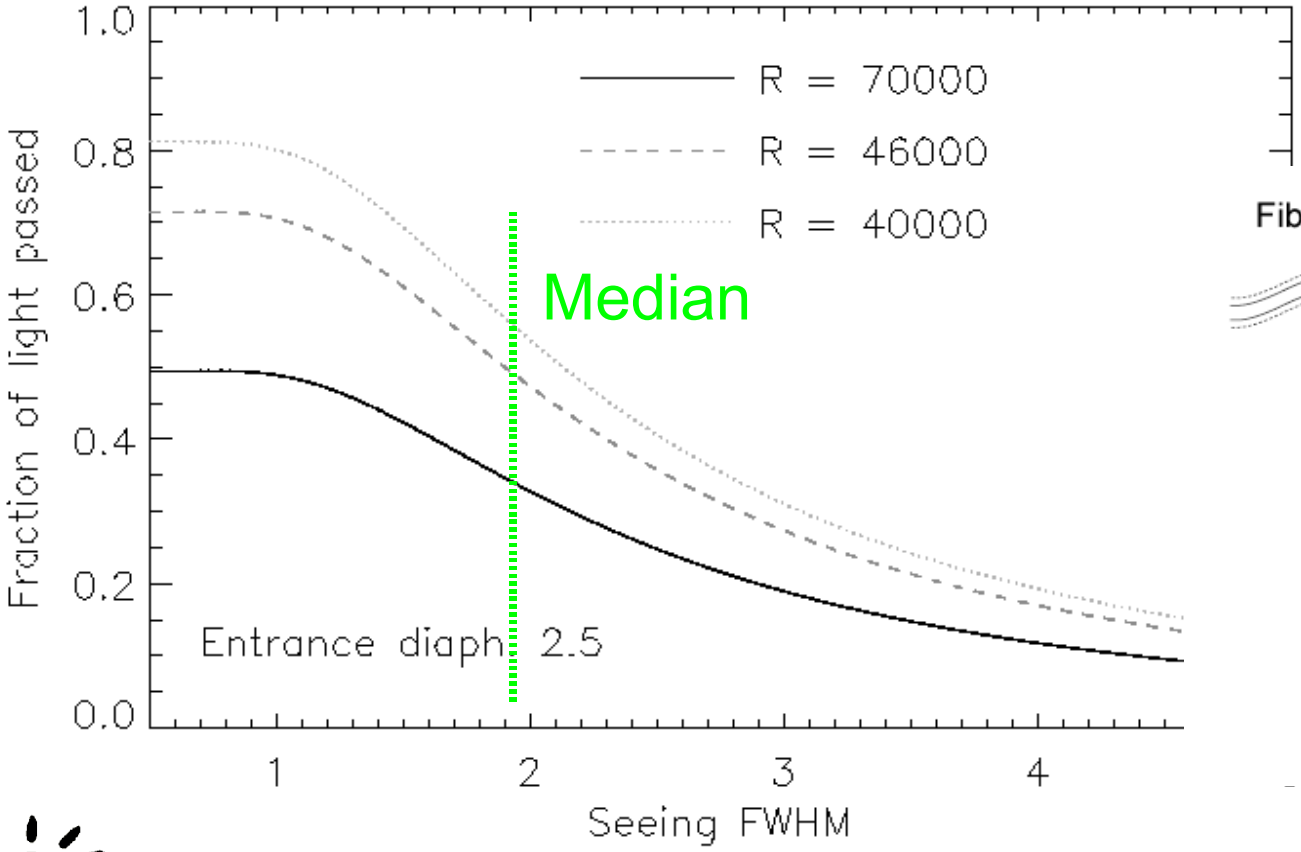
- Data from BATC **imaging**-survey (Liu et al. 2003)
- May be related to place, heigth, dome, telescope, guiding, exp-time, etc.



- BATC survey → Seeing ofthen > 2”
- New **measurements** needed (DIMM)

General: Xinglong seeing (2)

- Large seeing → large slit losses



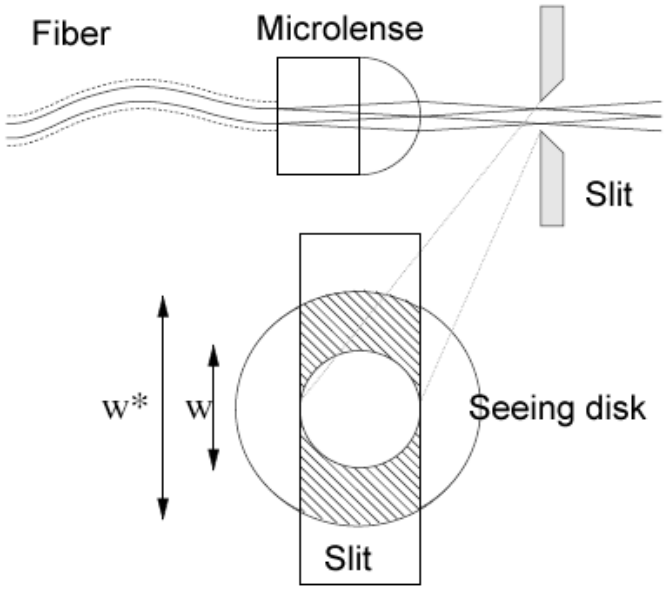
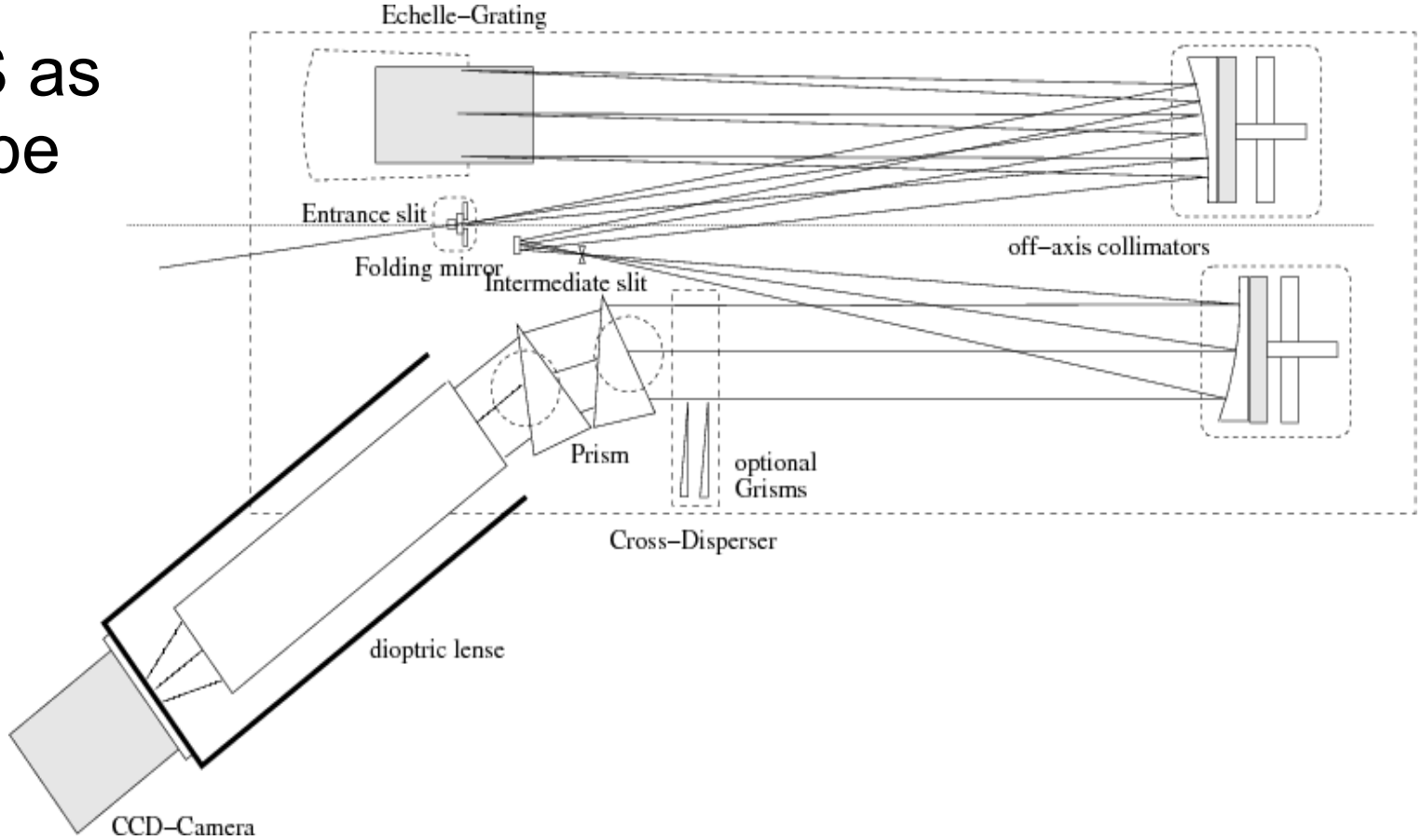


image slicer → reduced λ coverage

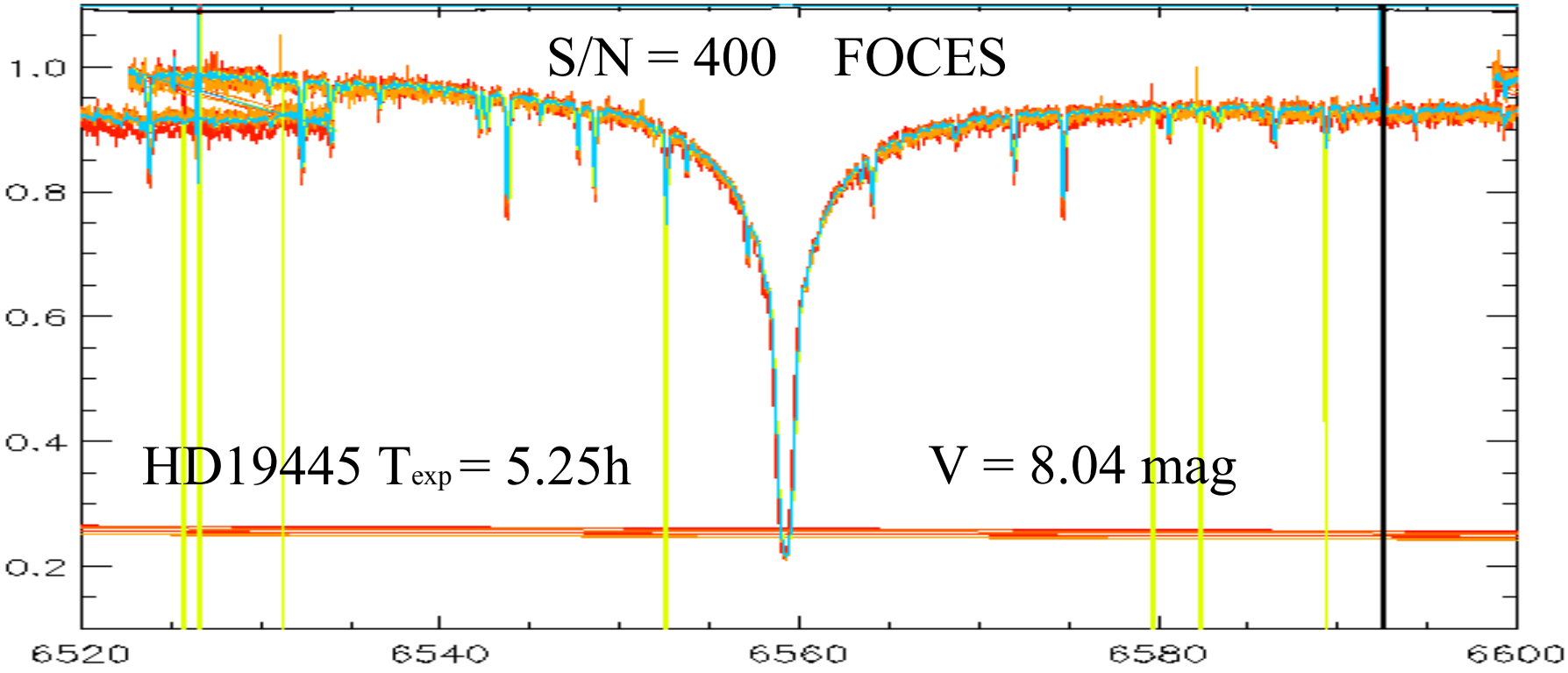
General: Design preconditions

- One arm, one camera design
  - Keep costs reasonable
  - FOCES as prototype



Science: Stability

- High stability of spectrum “on the CCD”
  - Allows for long (multi-exposure) integration times
  - Very demanding in mechanical & thermal stability



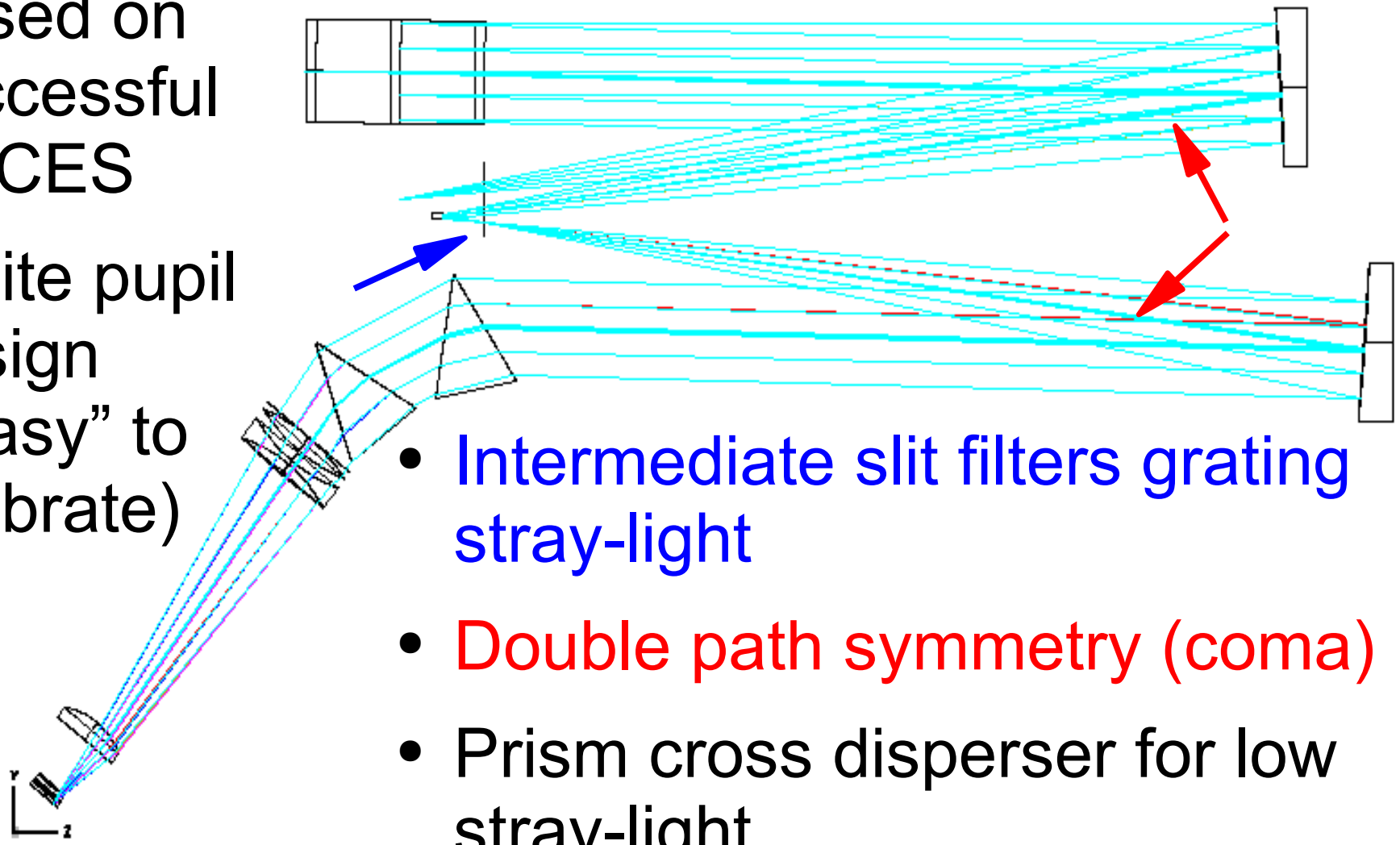
Science: Resolution & λ-coverage

- Resolution: 40000-70000
- Wavelength coverage
  - Ca H&K lines (3800 Å)
  - Mg B lines (5200 Å)
  - Balmer lines (6560,4860,4340,4100 Å)
  - O triplet (7780 Å)
  - ... ...

  → 3800 – 9000 Å

HiRes: Optical layout (1)

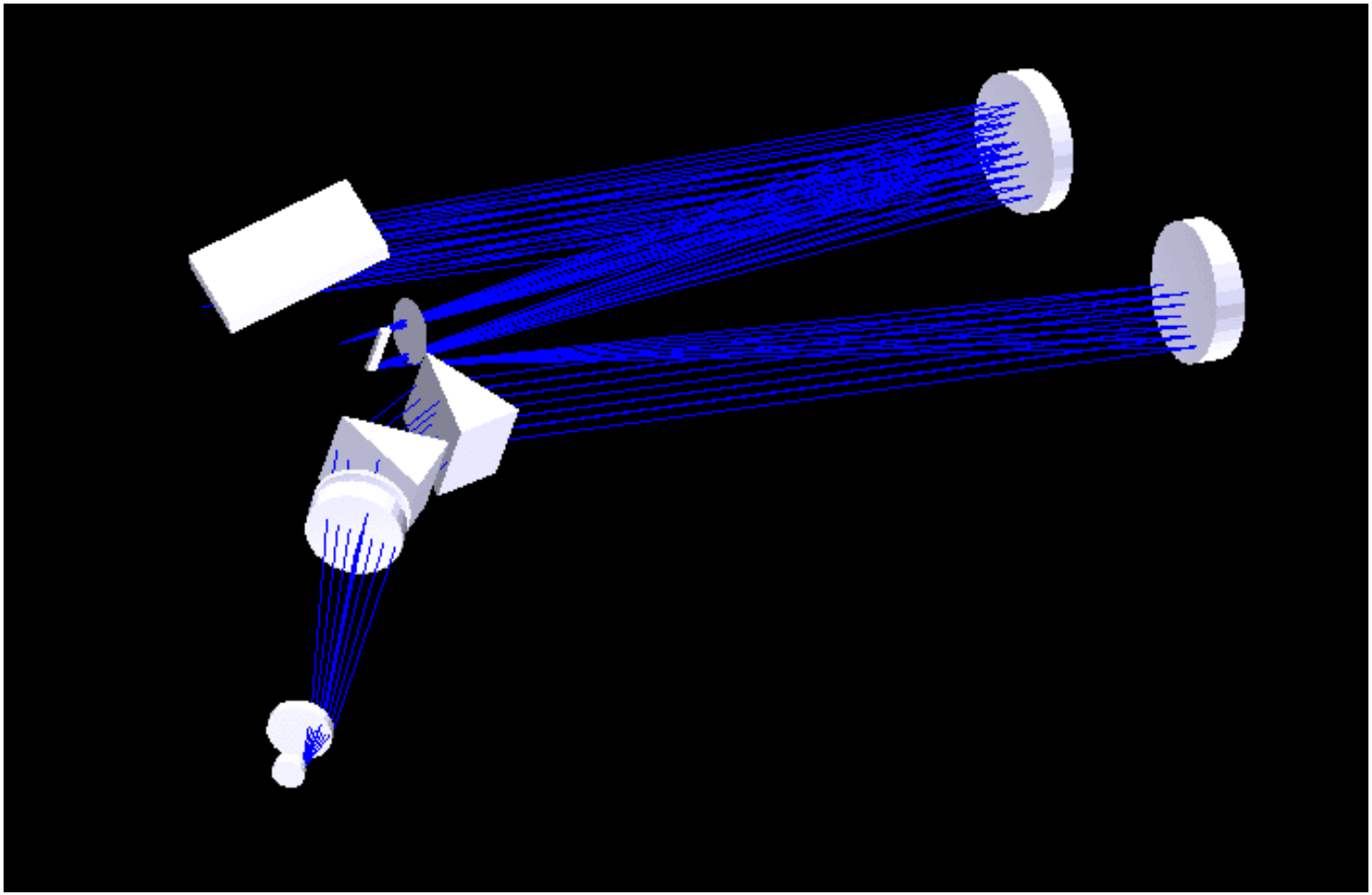
- Based on successful FOCES
- White pupil design (“easy” to calibrate)



- Intermediate slit filters grating stray-light
- Double path symmetry (coma)
- Prism cross disperser for low stray-light

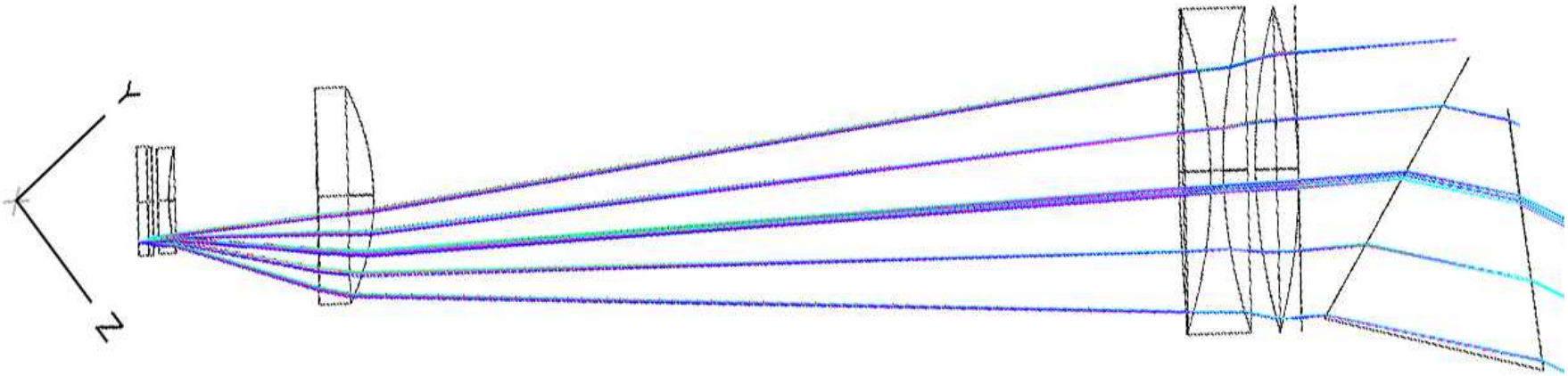
HiRes: Optical layout (2)

- Another view...



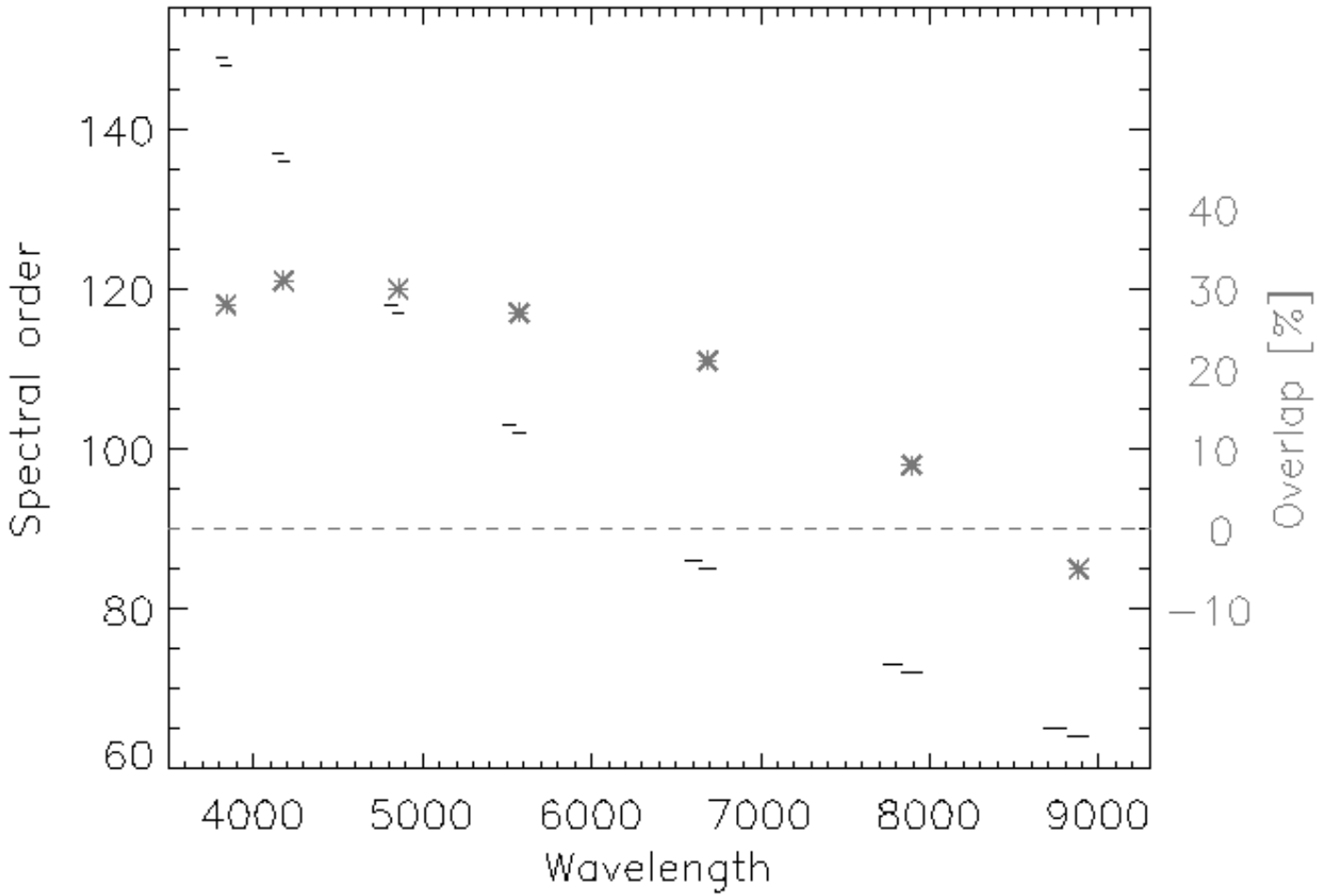
HiRes: Optical layout (3)

- Differences compared with FOCES
  - More cross dispersion due to worse seeing
  - R=70000, i.e. higher demands on image quality
    + usage of Chinese glasses → new camera design
  - Completely different focal plane device



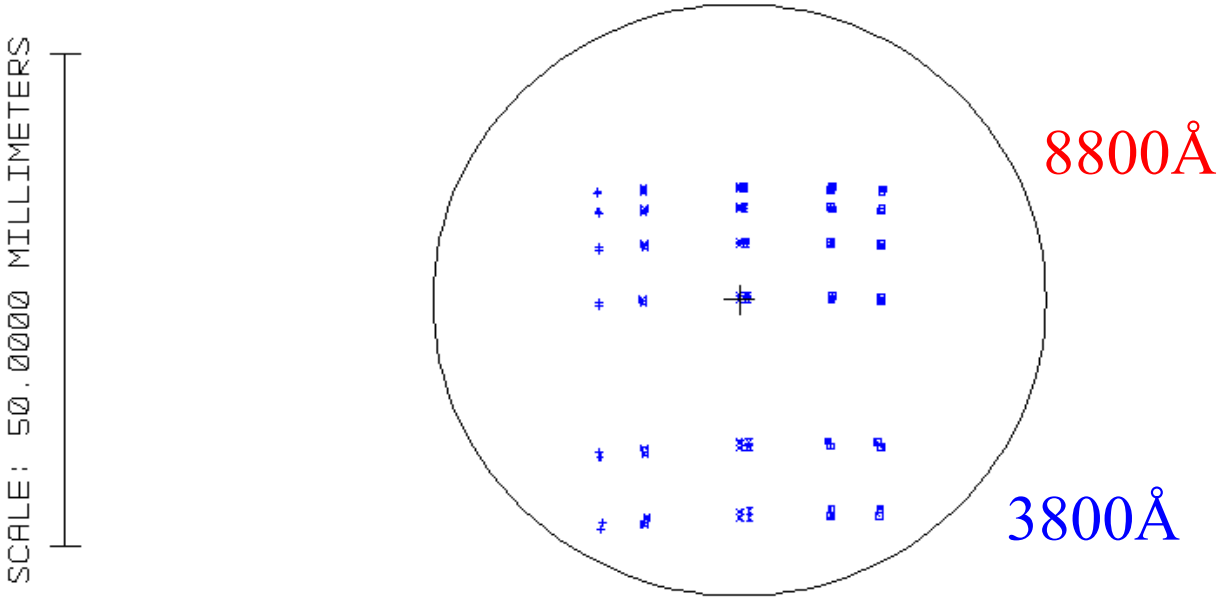
HiRes: Spectral coverage (1)

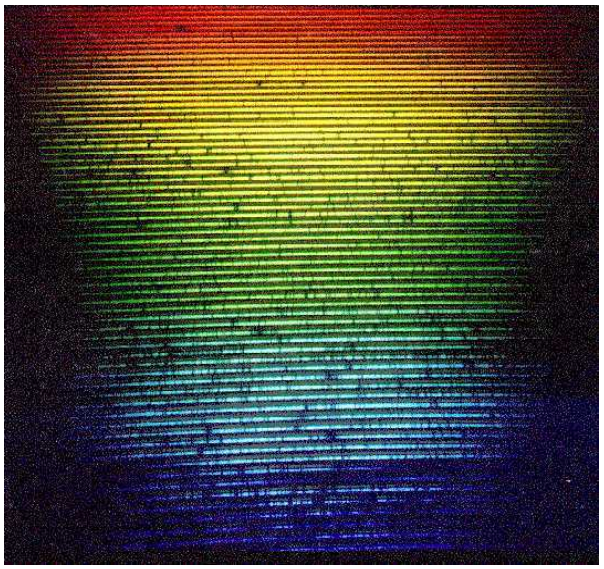
- Orders overlap from 3800 up to ≈8400 Å



HiRes: Spectral coverage (2)

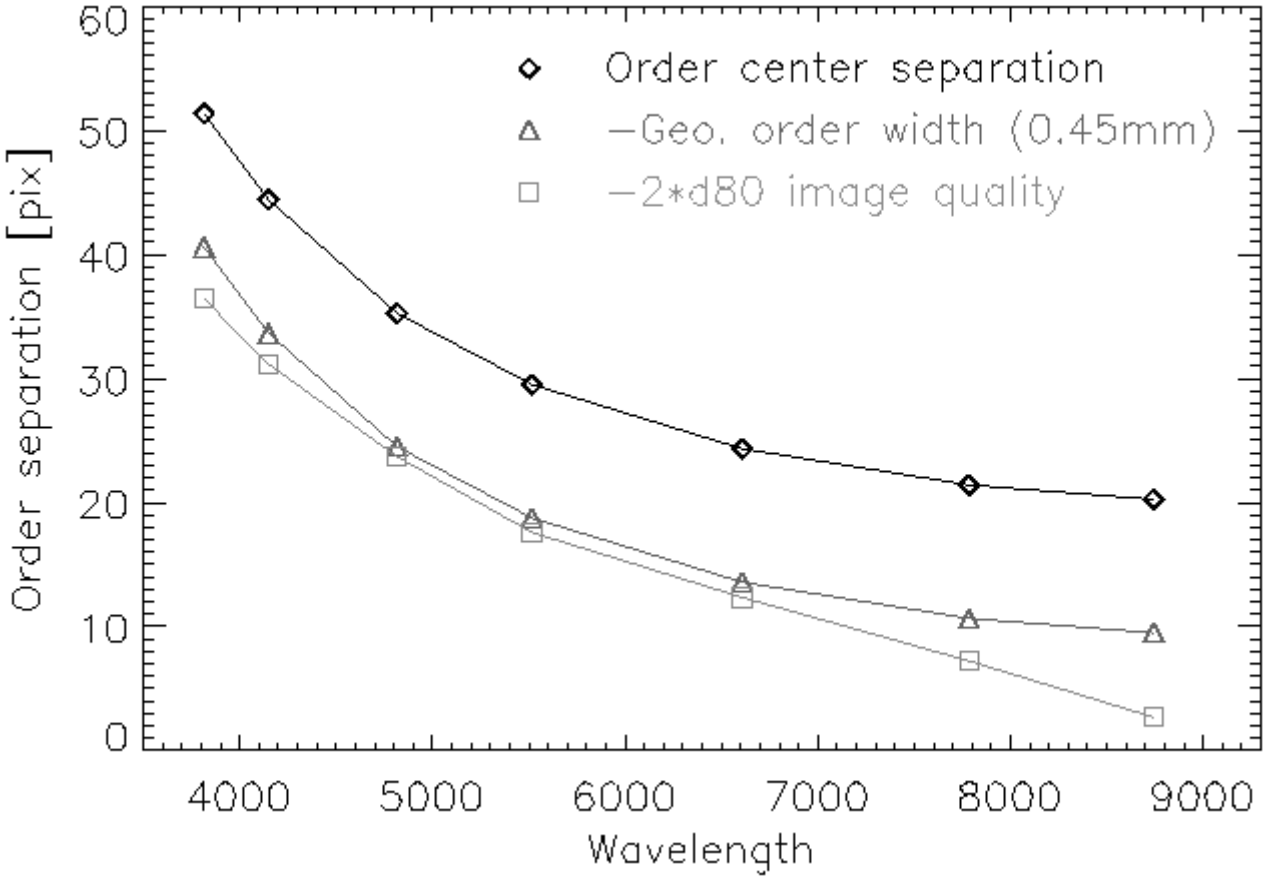
- On CCD: d(image) ≈ 54mm
- 4x4k-12µ: Diagonal ≈ 68mm
- Orders are getting close together in the red

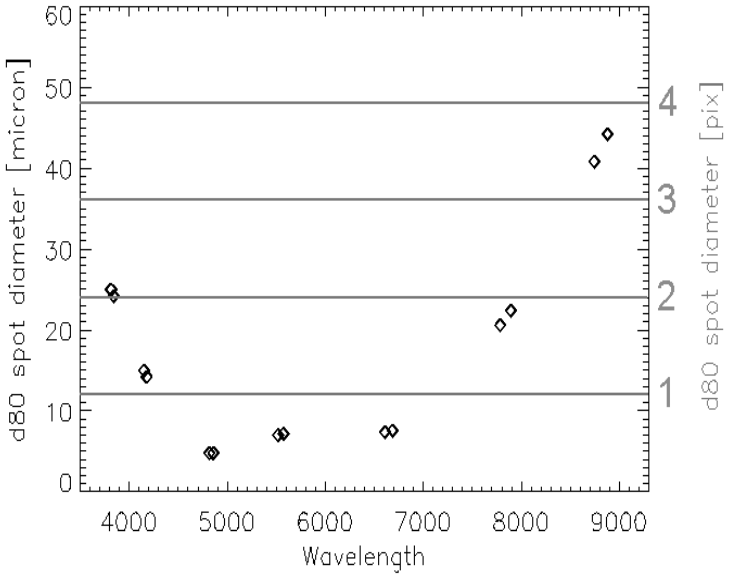




HiRes: Spectral coverage (3)

- Order separation limits spectral coverage



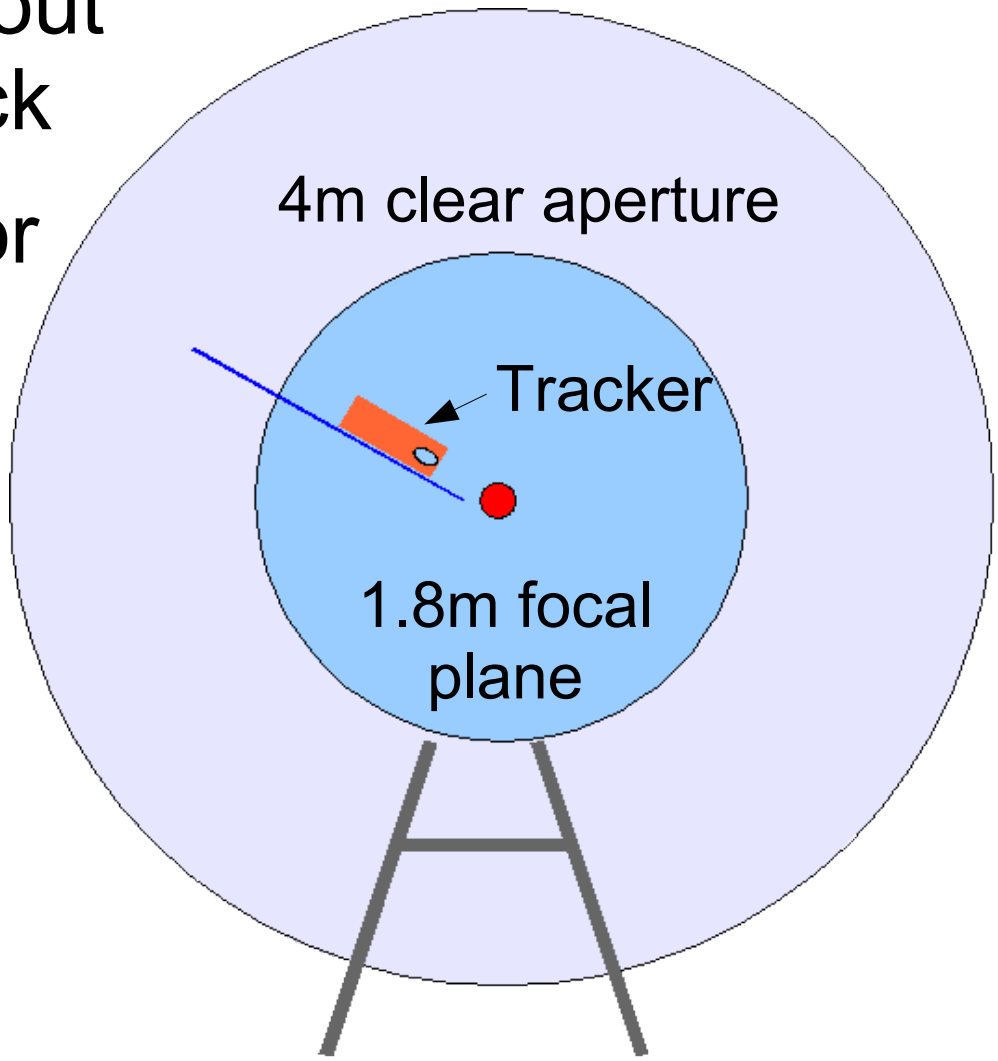


Focal plane device: General (1)

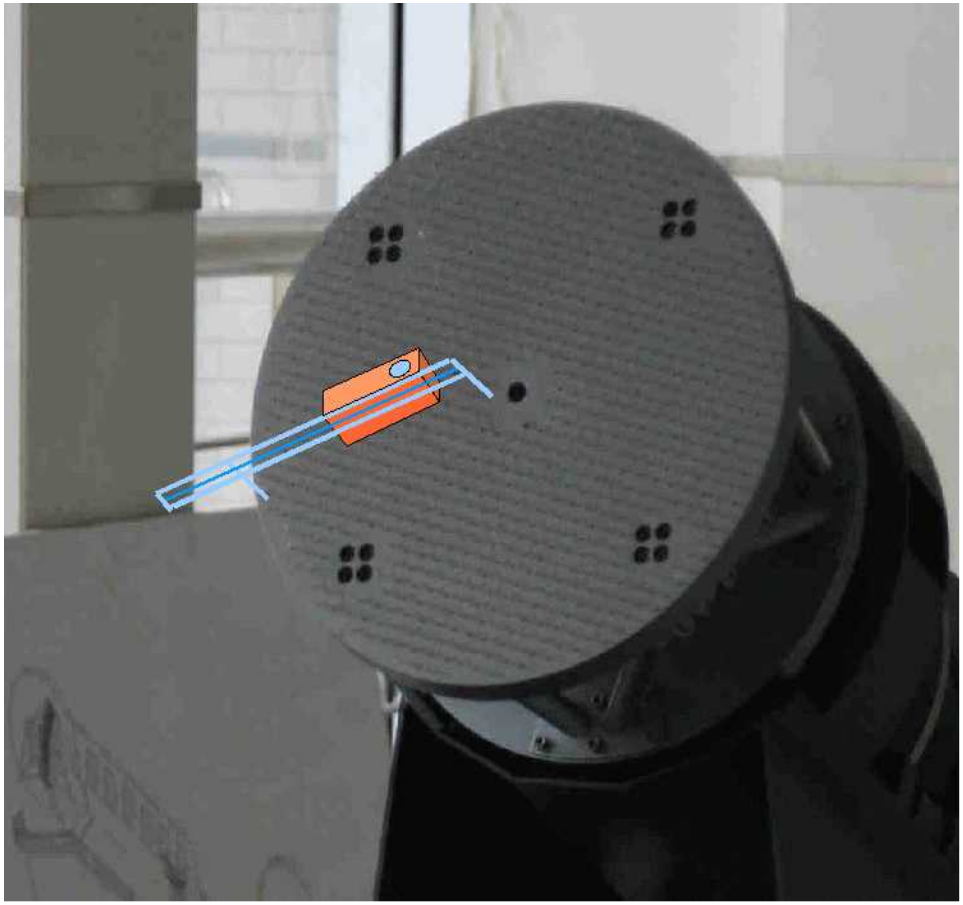
- There is already “some-thing” in the LAMOST focal plane
- This something is > 6m heigh and 1.8m broad
- It carries 4000 fibers to LowRes spectrographs
- Shack-Hartmann sensor in the middle needed for mirror alignment

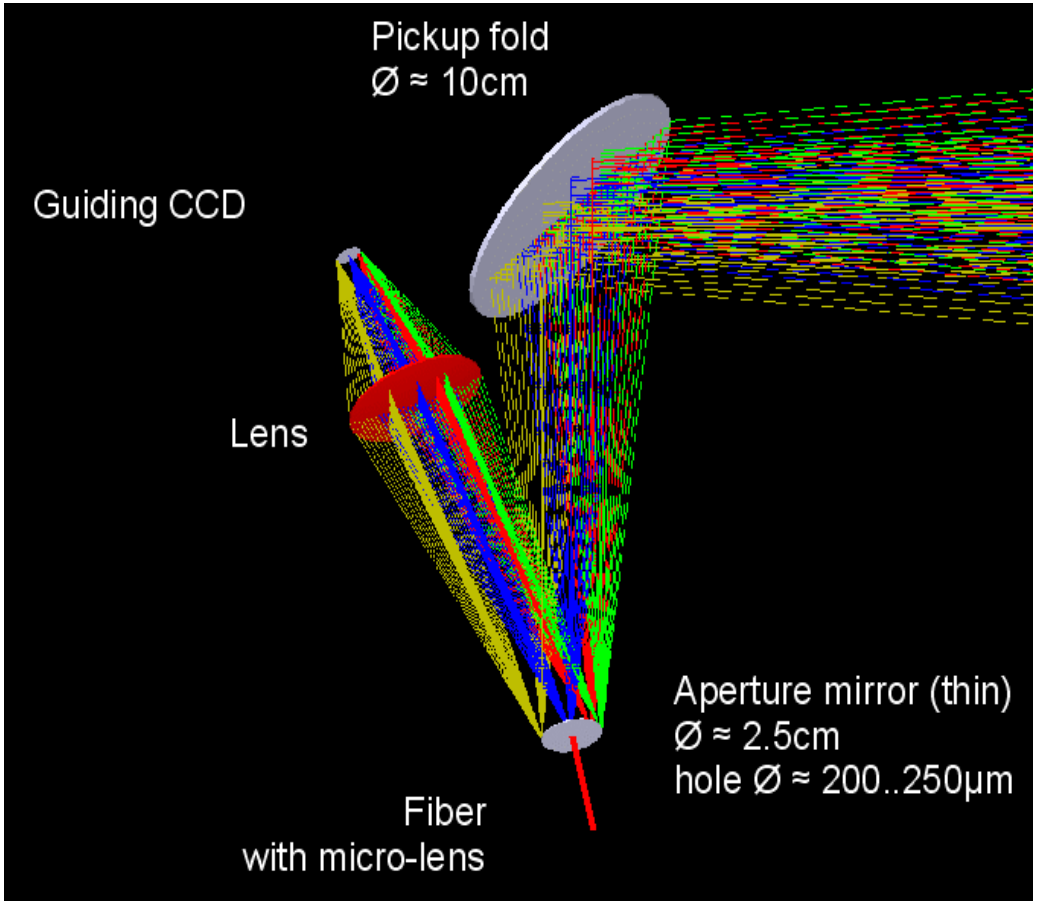
Focal plane device: Design (1)

- Tracker moving in and out on a small-footprint track
- Shack-Hartmann sensor is kept free all the time
- Active optics can continue mirror control
- HiRes and LowRes modes can co-operate

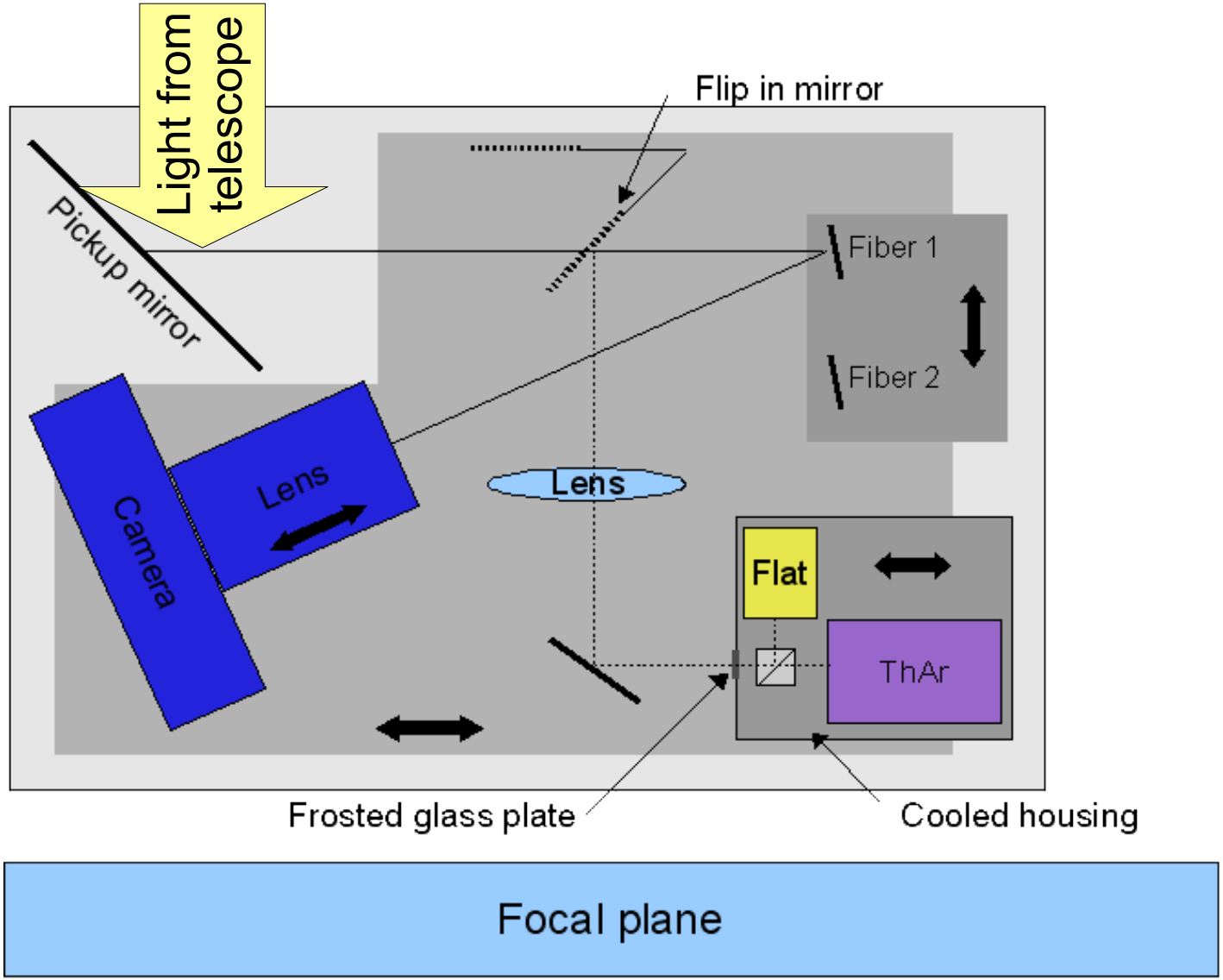


Focal plane device: Design (2)





Focal plane device: Pickup box



HiRes: Configurations

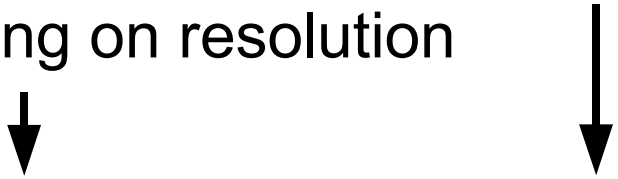
- Configurations depend on target and science:
  - Slit-width → resolution & throughput
  - Slit-height (slicer) → throughput & λ-coverage
- Seeing gives strong boundary conditions

There is no such thing as the universal spectrograph or a universal setup !!!

- Tools for observation planning and scheduling
- Configuration changes without manual interaction (quick and “astronomer proof”)

HiRes: Possible observation strategy

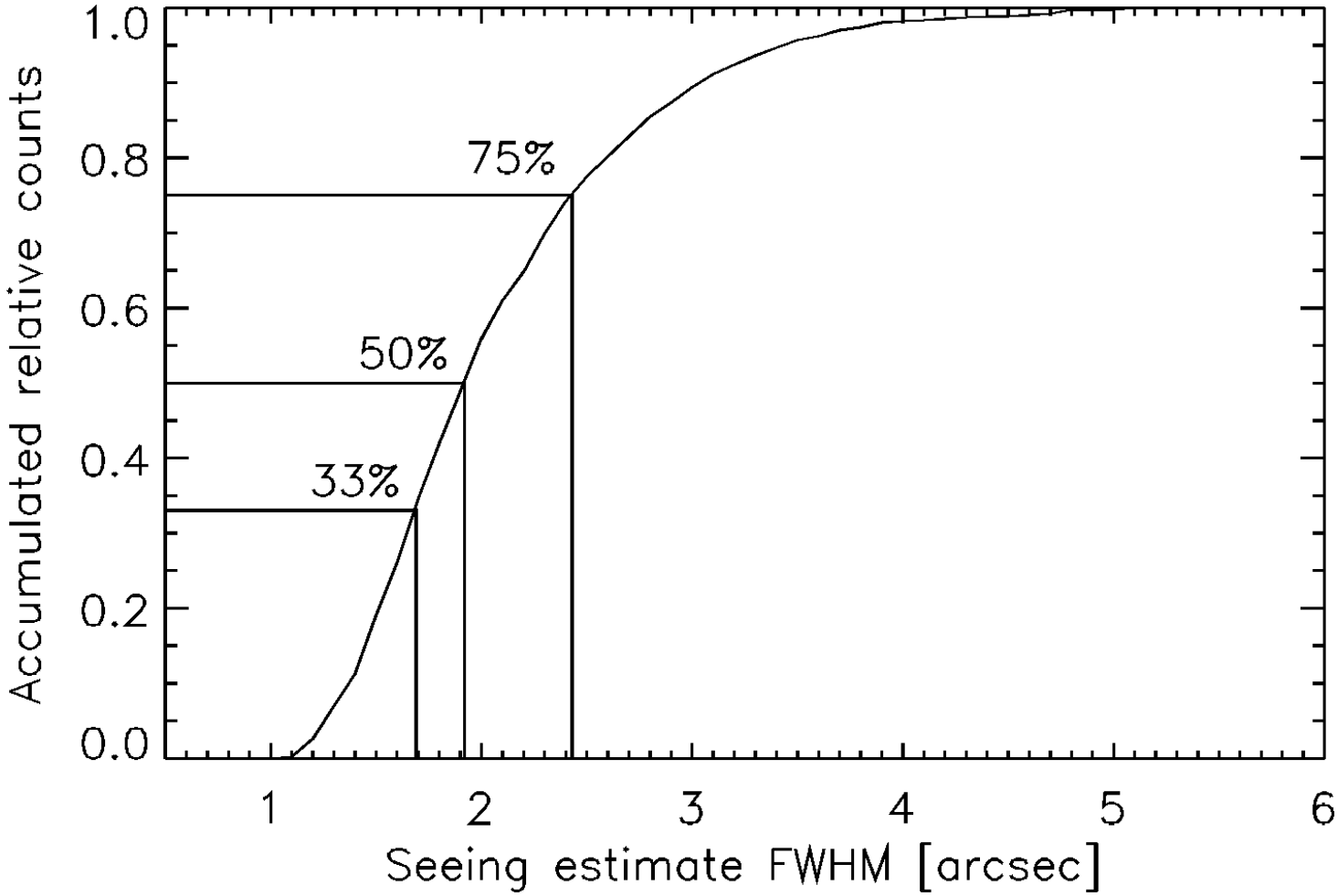
- LRS survey continues while HiRes is working
  - 7-10% of LRS fibers vignetted by pick-up system
  - >3600 LRS channels can be placed on survey targets
  - HiRes observation only if seeing is better than given threshold
    - Depending on object brightness
    - Depending on resolution



Only what can be done - will be done!

HiRes: Threshold for seeing

- “Seeing statistics” (according to BATC data)



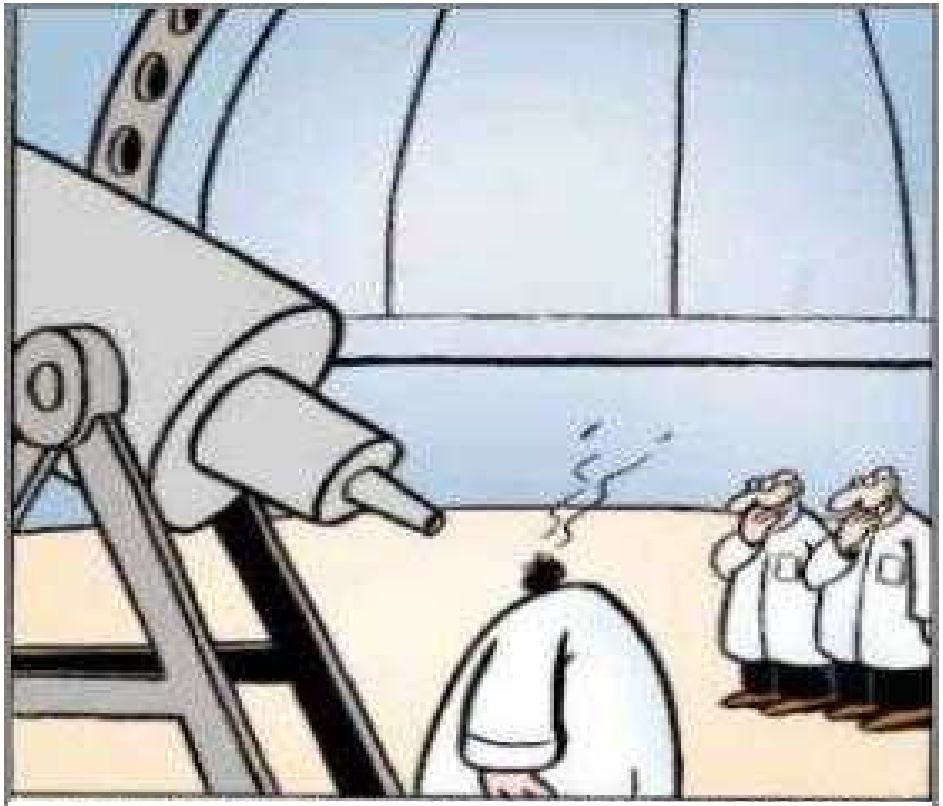
HiRes: Summery

- HiRes basic spectrograph design ready
  - R=40000-70000, λ=3800-9000Å
- Seeing conditions give strong boundary conditions to design and usage
  - Better seeing statistics urgently needed
  - Observations have to be carefully planned
  - Spectrograph alignment has to be (semi-) automatic

HiRes: Next steps

- Seeing measurements
- Final design and manufacturing (start with focal plane unit)

www.grupp-astro/
publications/fengshan.pdf



Again Jone´s colleagues aimed the telescope sneaky at the sun ...

HiRes -online: www.lamost.org/HiRes/index.htm