VIRUS: A giant spectrograph

Nanjing – August 17th 2007

A massively replicated spectrograph

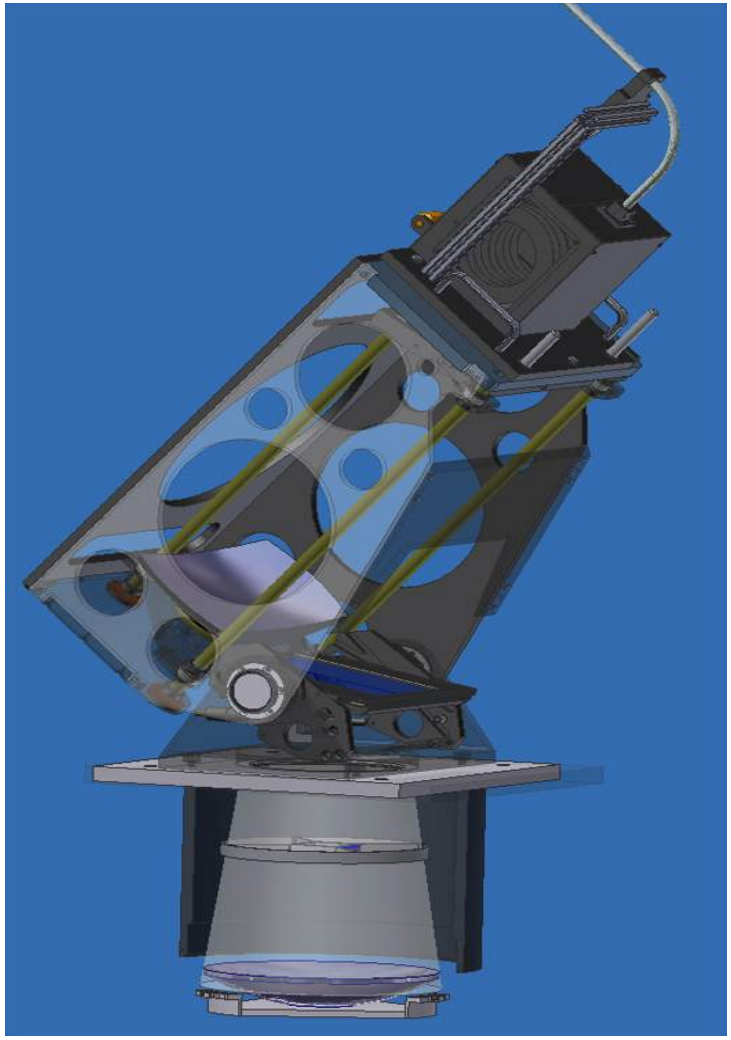
for the Hobby-Eberly-Telescope

VIRUS: Outline

- A few facts about HET
- VIRUS-HETDEX, the experiment
- VIRUS spectrograph
- VIRUS fiberlink and IFU
- The system as whole
- Another VIRUS device

VIRUS = ...

- VIRUS stands for
  - **V**isible
  - **I**FU
  - **R**eplicable
  - **U**nit
  - **S**pectrograph

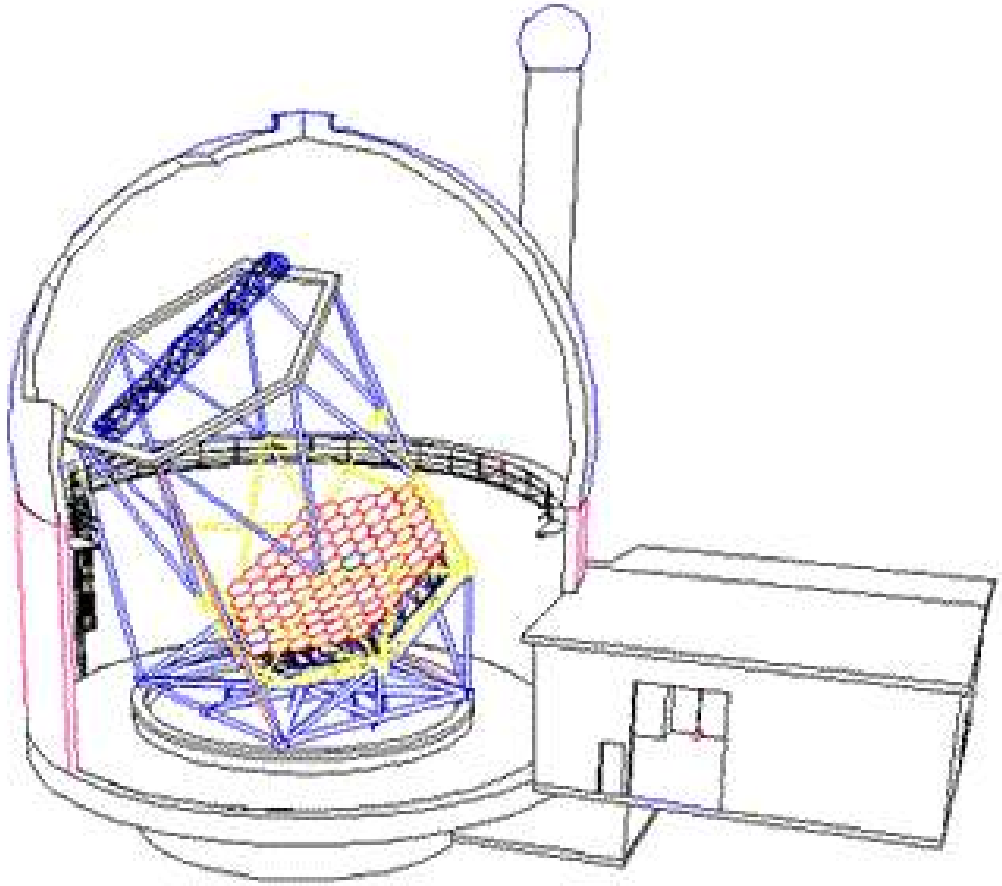


VIRUS: A few facts about HET (1)

- HET = Hobby-Eberly Telescope
- McDonald observatory, Mt Fowlkes, Texas

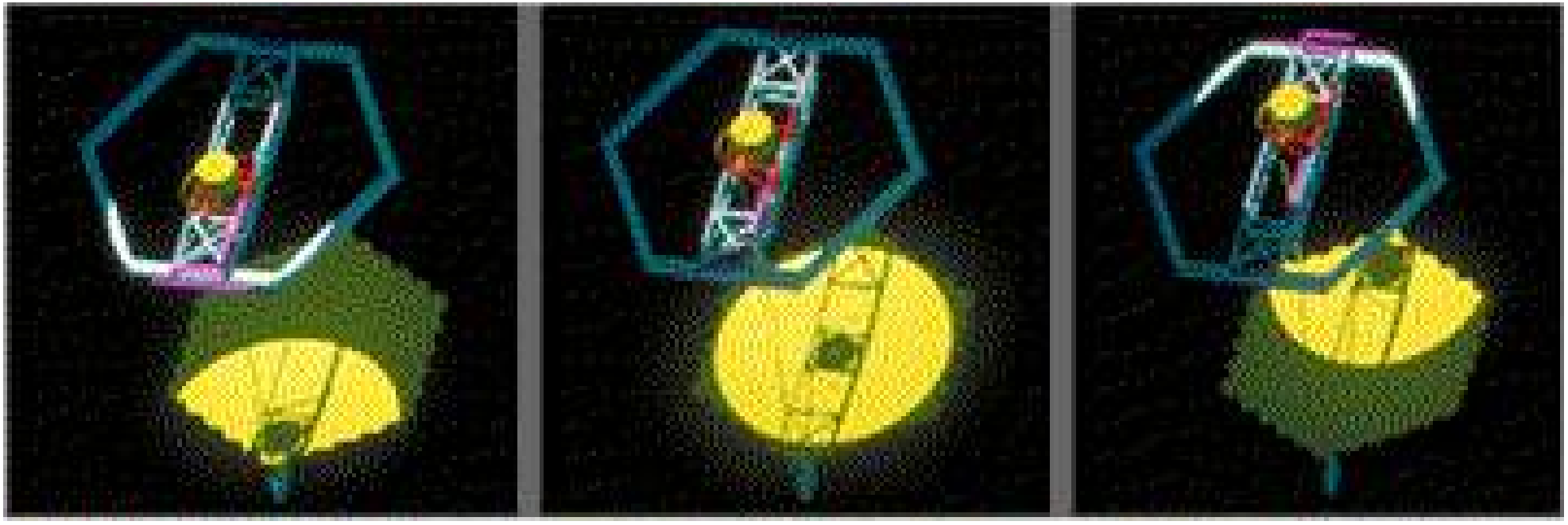
VIRUS: A few facts about HET (2)

- Multi mirror telescope with tracker
- 91 spherical segments
- Reflective corrector on tracker
- 11.1m x 9.8m total mirror size
- 9.2m effective area
- F# = 3.65



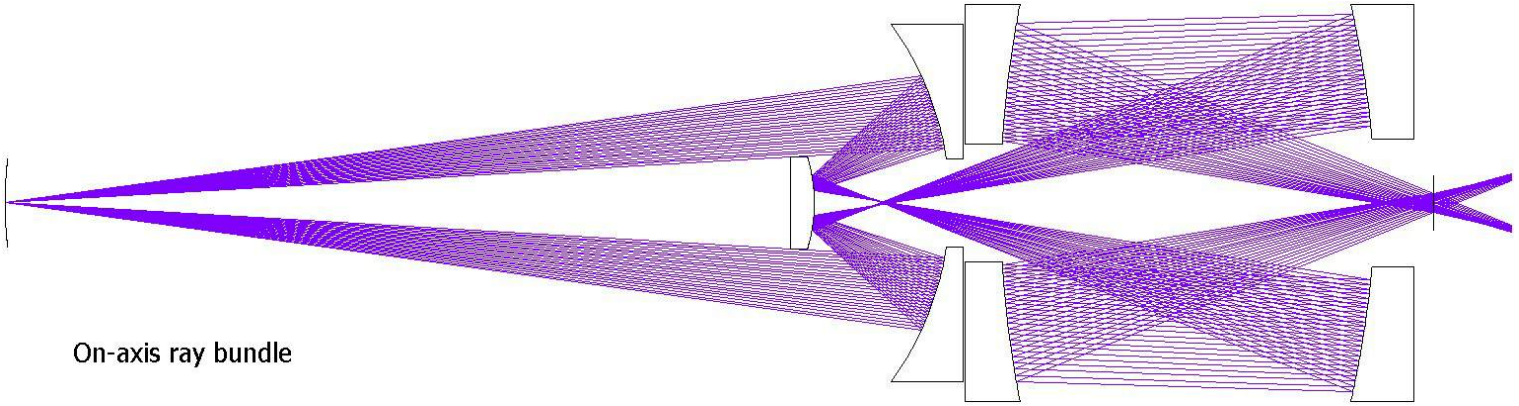
VIRUS: A few facts about HET (3)

- Tracker and telescope pupil are moving during observation (like in some radio telescopes)
- About 2 ½ hours tracking are possible



VIRUS: A few facts about HET (4)

- The corrector on top of the tracker
- Quite complex tracker movement
  - Along tracker
  - Up down
  - Tip - tilt

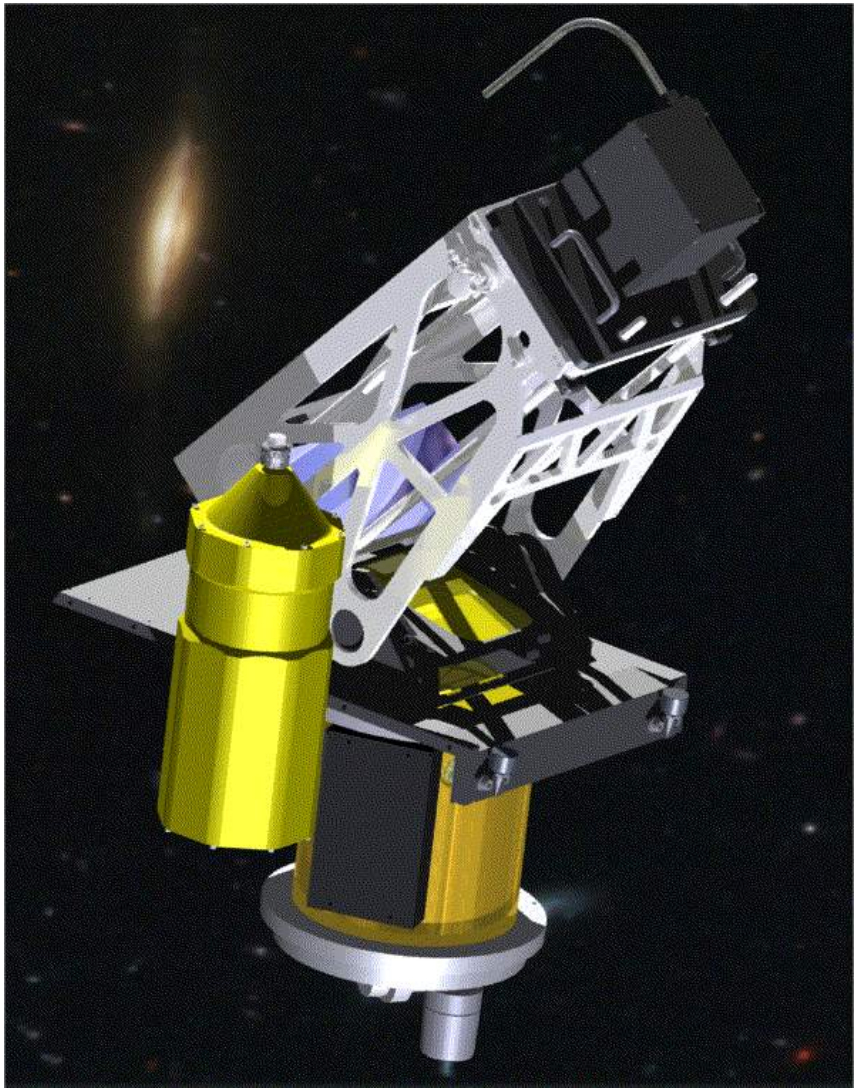


VIRUS: HETDEX experiment

- Scan 200 (300-500) square degrees on the sky within 110 (160-275) nights of observing.
- Search for Lyman-α emitting galaxies with redshifts $2<z<4$.
- Expected to find ≈ 0.6 million Lα targets.
- Determine the fraction of (dark energy)/(dark matter)

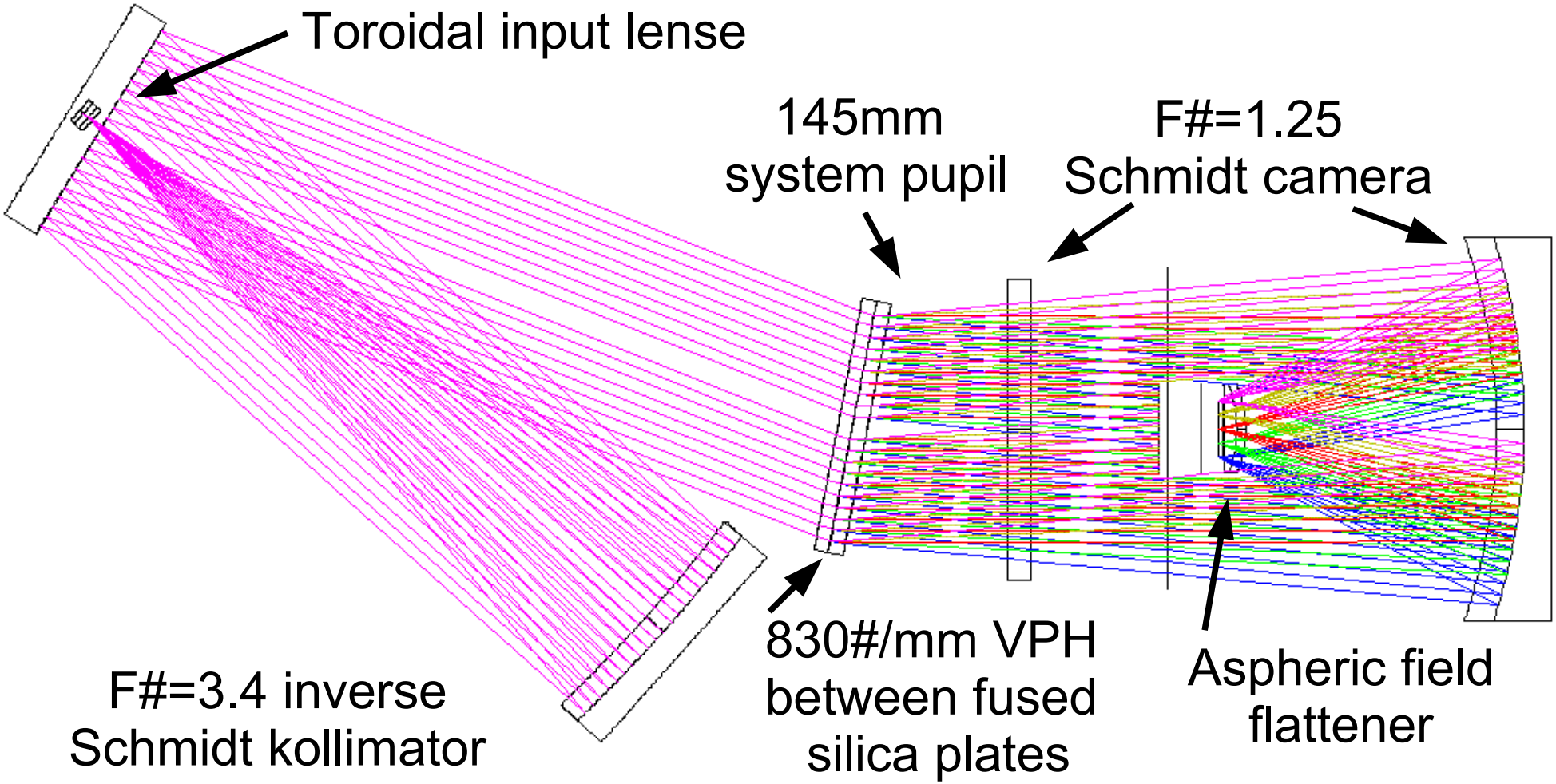
VIRUS: Spectograph unit (1)

- 246 fibers multi object spectrograph
- Resolving power R=850 (2800)
- Wavelength coverage 3400Å < λ < 5650Å
- L-N_2 cooled Schmidt type camera with auto-matic N_2 re-filling



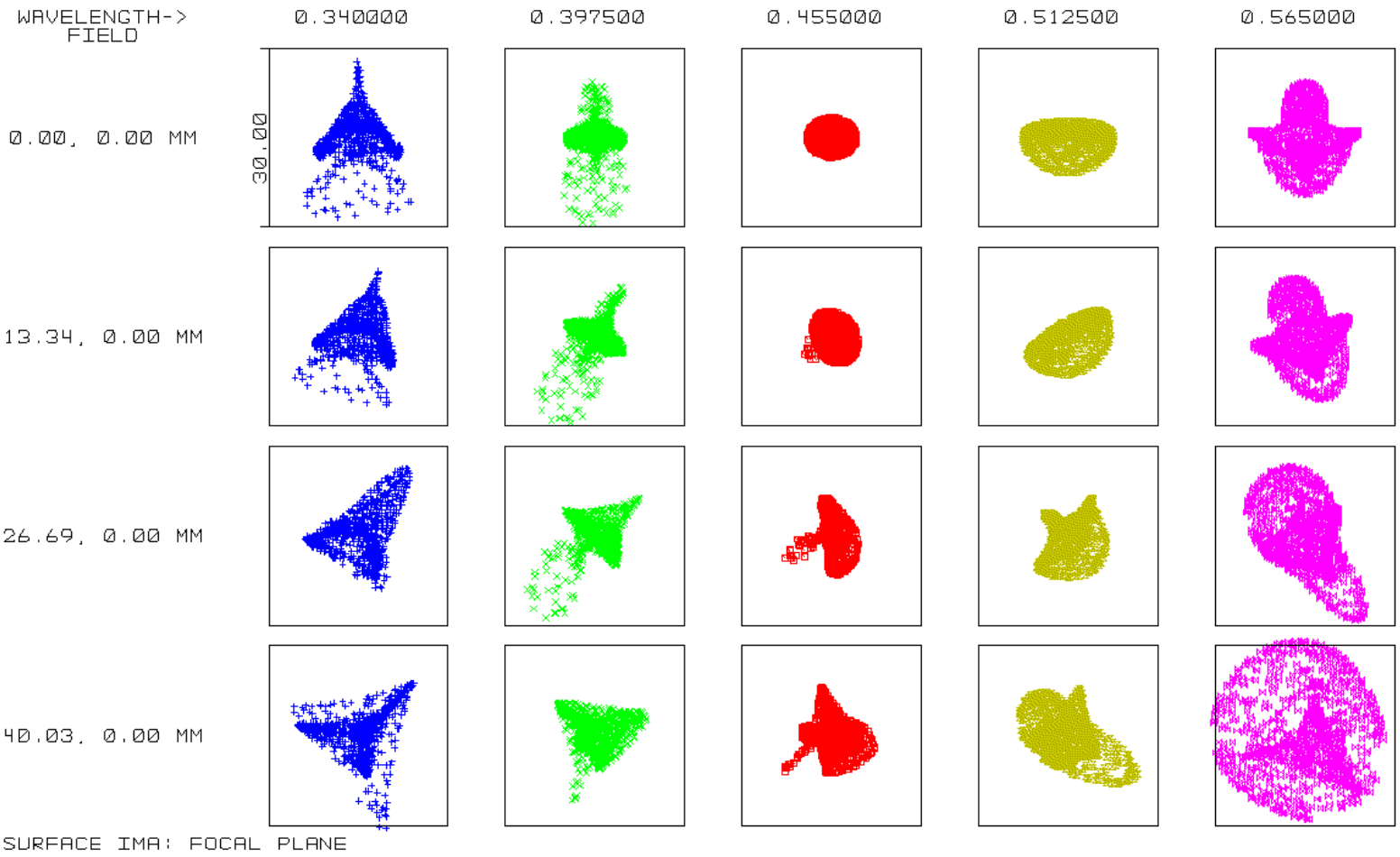
VIRUS: Spectograph unit (2)

- Optical layout: Schmidt + VPH + Schmidt



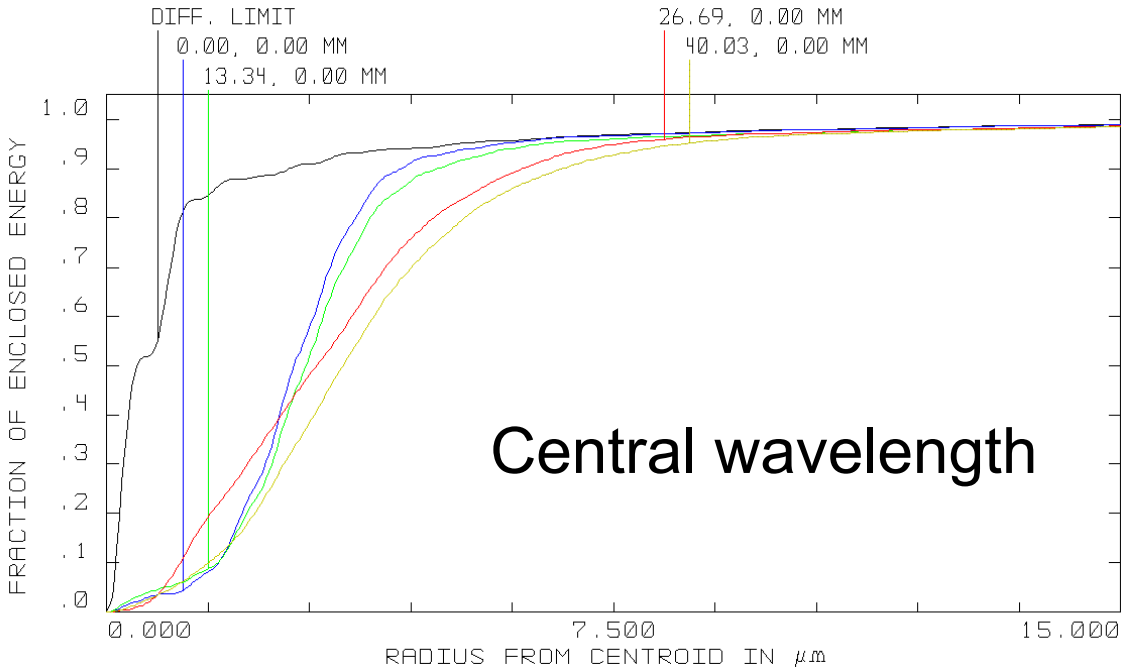
VIRUS: Spectograph unit (3)

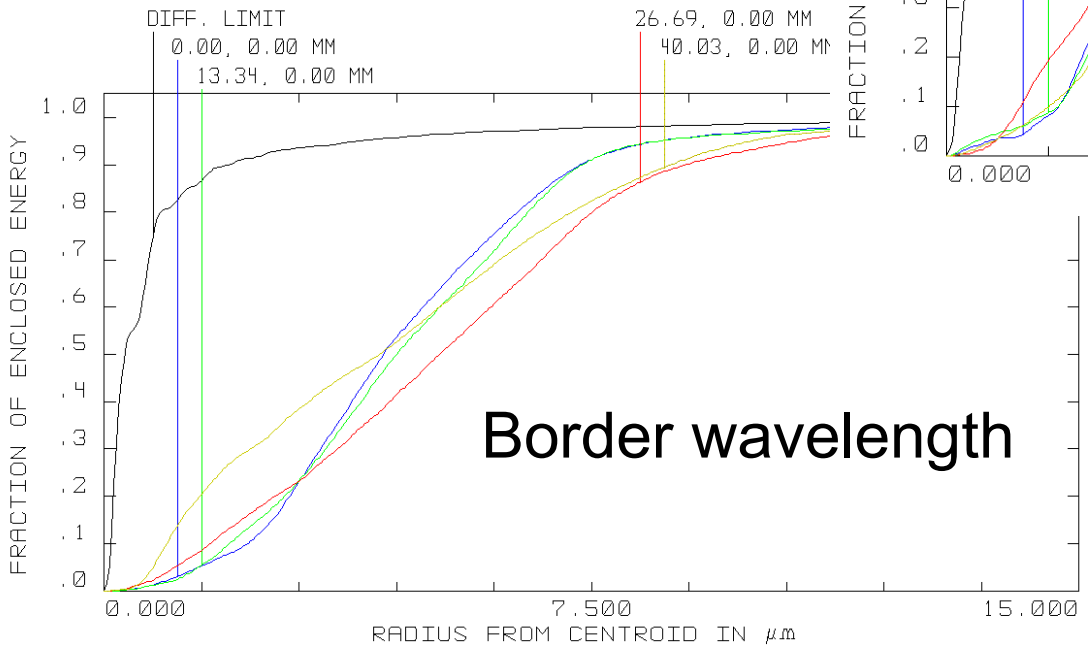
- Image quality (better than 2pix everywhere)



VIRUS: Spectograph unit (4)

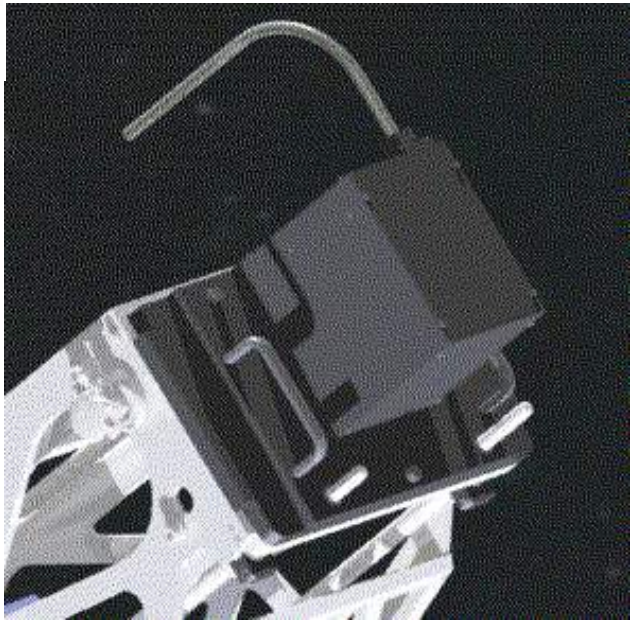
- Encirceled energy 80% in one pixel





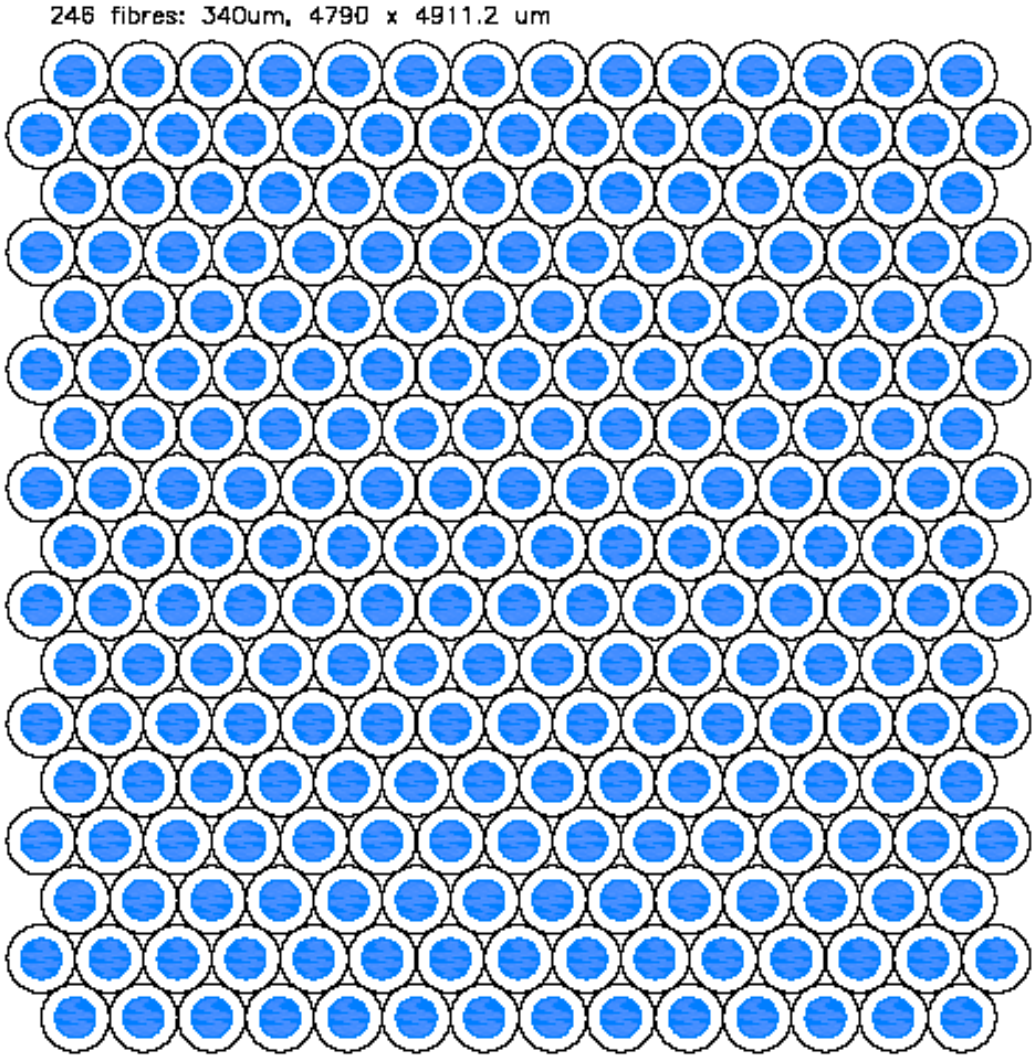
VIRUS: Spectograph unit (5)

- The fiber slit unit
  - The whole unit, including fiber loop, toroidal input lense and mechanical support can be replaced as ONE.
  - 3 point precision support
  - 2 guide cones for handling



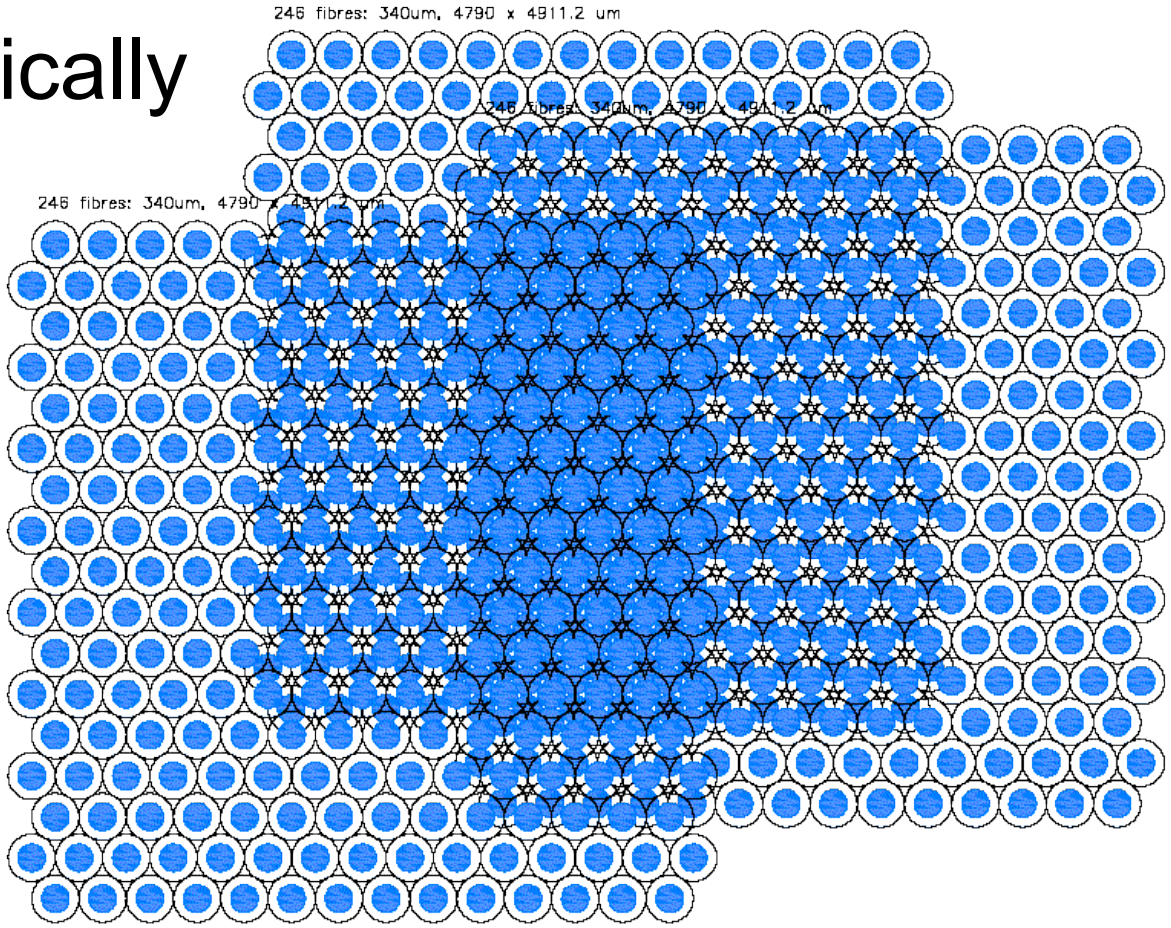
VIRUS: Integral Field Unit (1)

- The unit IFU
  - 14/15 fibers in a row
  - 17 rows
  - 200µm core
- 0.22 square arcmin. Surface
- Full coverage of the sky (98%) with 3 dither movements.



VIRUS: Integral Field Unit (2)

- Dither scheme
- Done mechanically

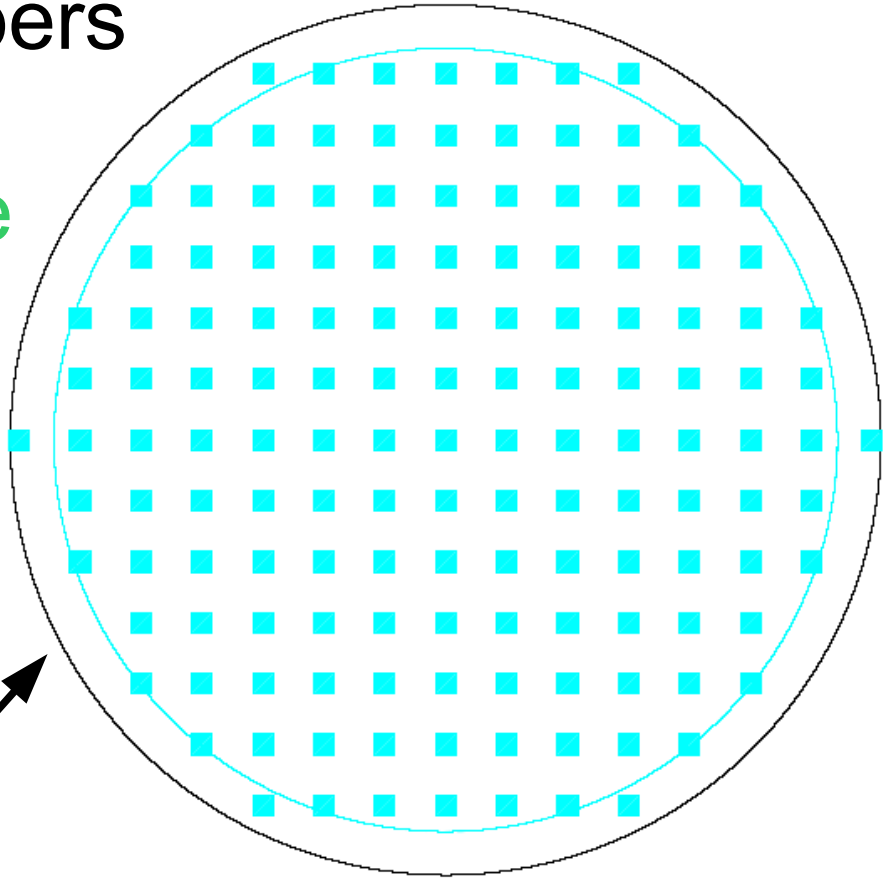


VIRUS: Integral Field Unit (3)

- Remember, HETDEX is to scan 200 square degrees, with 0.22 square arcmin per IFU this would take “for ever”
- The way to solve this problem is: Replication!

VIRUS: Integral Field Unit (4)

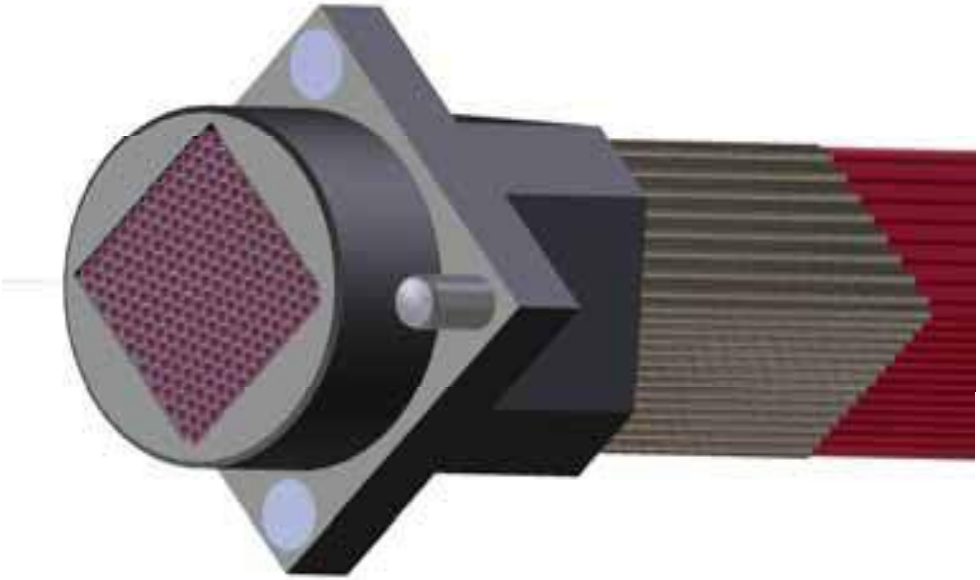
- Curved HET focal plane
- 149 IFU units with 246 fibers each
  → 35554 channels in one exposure!!
- But this also means to have 149 spectrographs

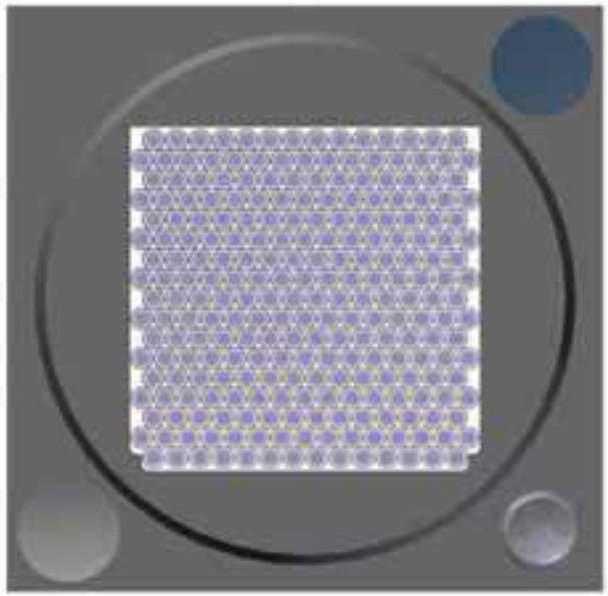


HET field of view
20' in diameter
≈ 30 cm

VIRUS: Integral Field Unit (5)

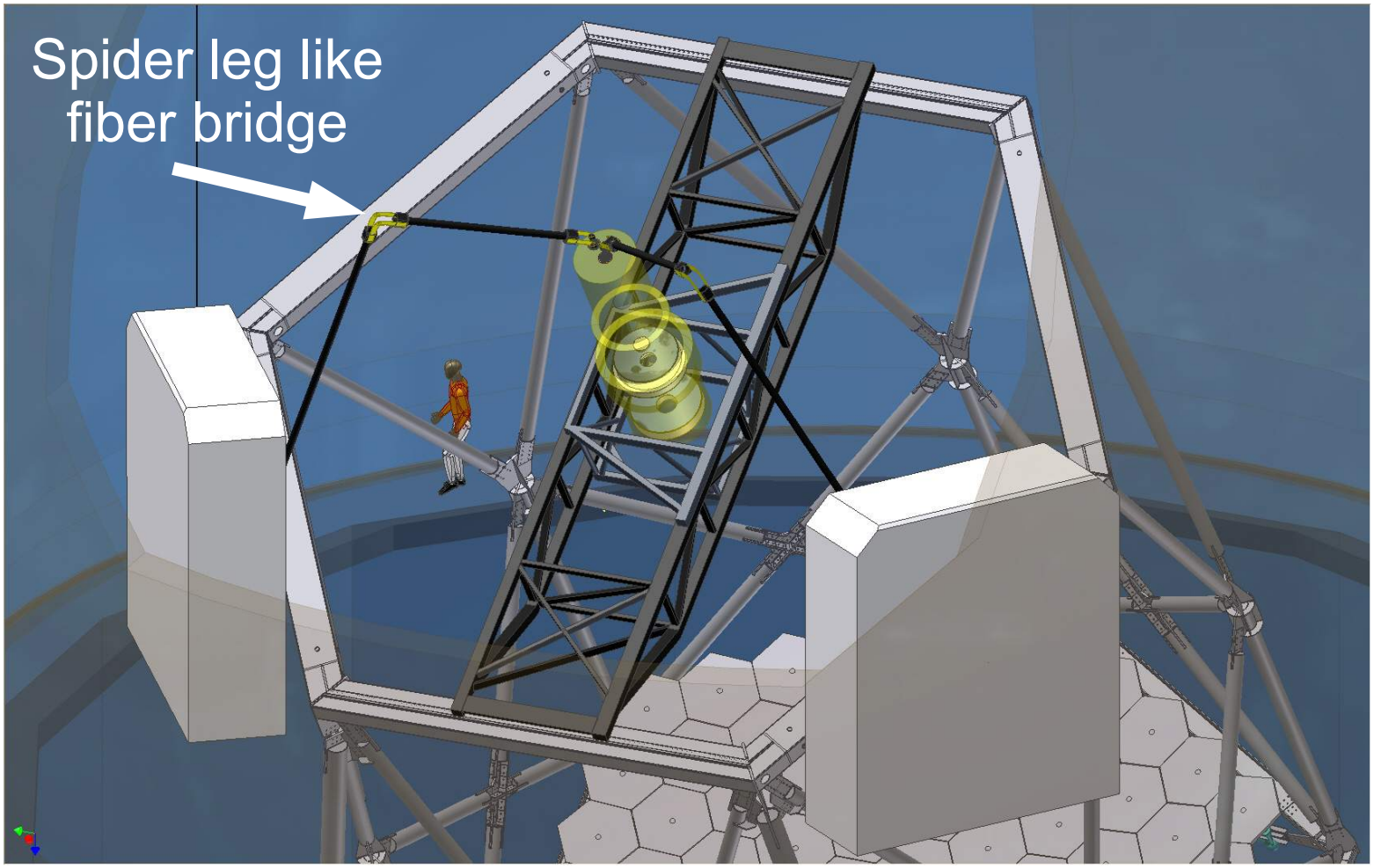
- The IFU plug
- Centered by bolt
- Hold by magnet





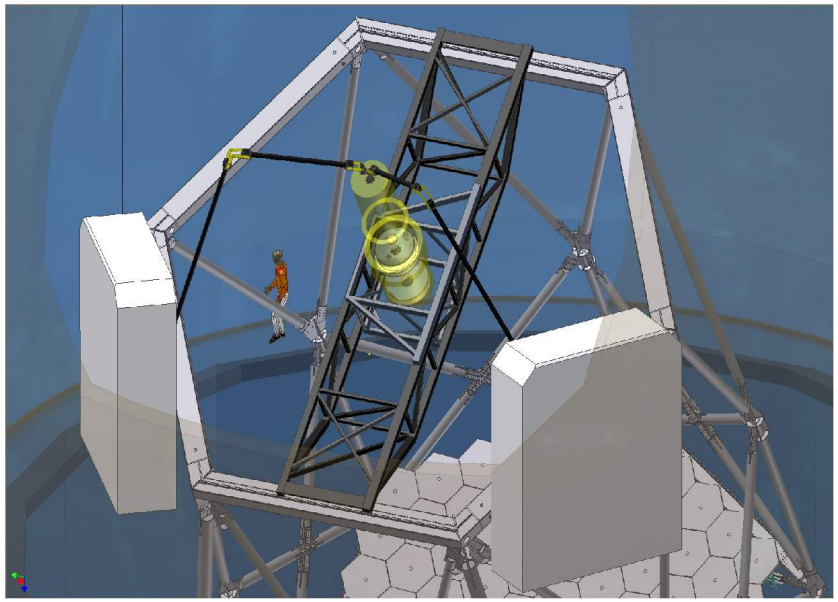
VIRUS: The system as whole (1)

- 149 spectrographs in two enclosures



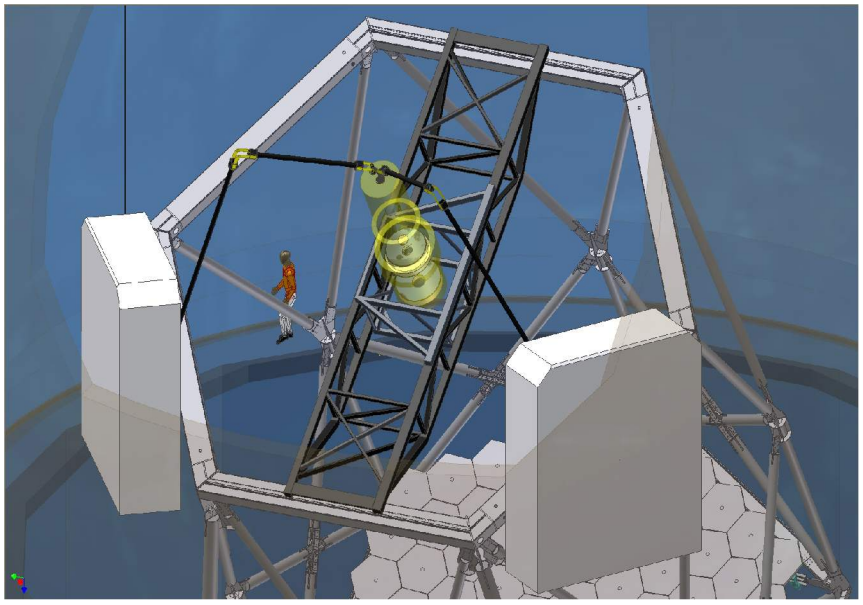
VIRUS: The system as whole (2)

- All components are manufactured in industry.
- Large numbers reduce the price per unit.
- Replication processes are used wherever possible (mirrors).
- Testing the components when they arrive is a real issue (149 times).
- Maintanance is com-plex (drawer like modules).



VIRUS: The system as whole (2)

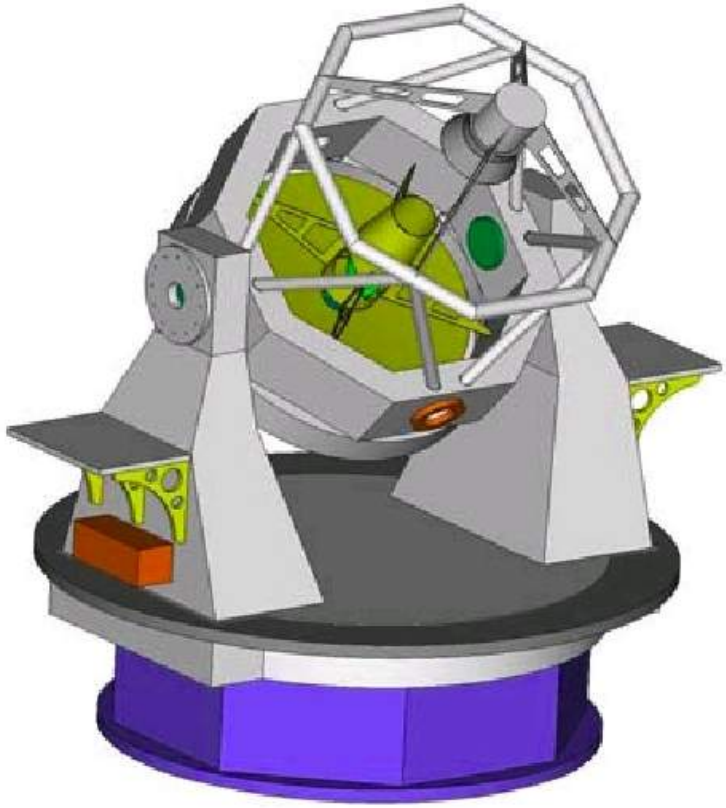
- Liquid Nytrogen is applied by an automated filling system.
- The reduction software “CURE for VIRUS” has two modes:



  - Online: Allowing to check data directly after exposure. (>35000 Spectra therefore auto check)
  - Science: Offline within 8 hours daytime.
  - Both run on a cluster of Linux pc´s

VIRUS: VIRUS-W (1)

- VIRUS-Wendelstein: One modified VIRUS unit for the 2.x m Wendelstein telescope near Munich.

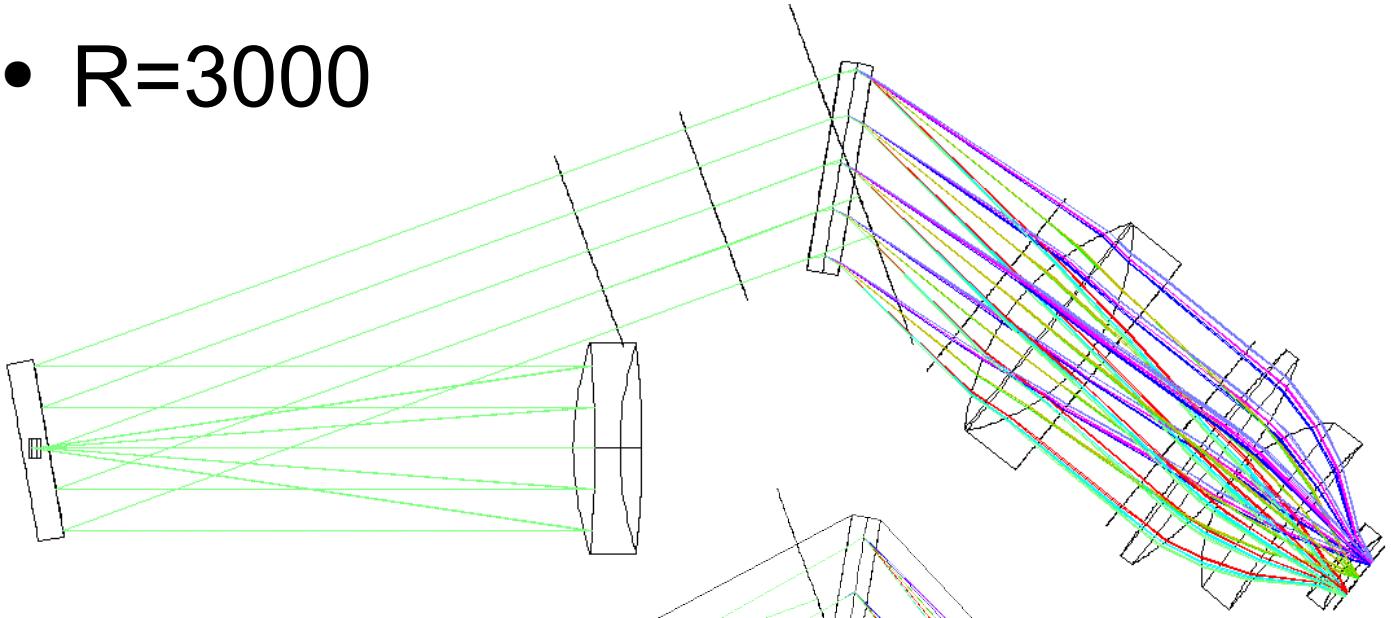


VIRUS: VIRUS-W (2)

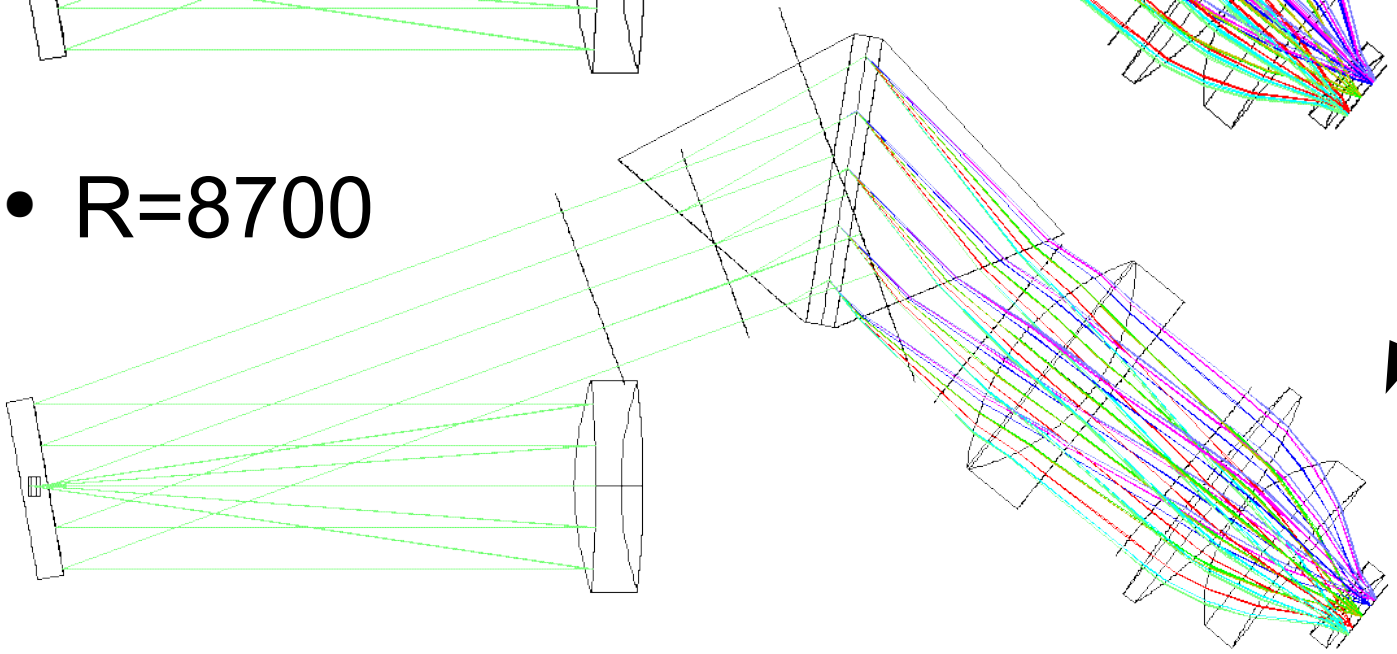
- Intended to be a copy of VIRUS.
- Now:
  - Bench mounted ← internal support frame
  - R=3000/8700 ← R=850/2800
  - Fiber core Ø =150µm ← 200 µm
  - Refractive camera ← reflective Schmidt camera
  - 2x4k 15µm CCD ← 2x2k 15µm CCD
- In fact there is not much VIRUS left in VIRUS-W

VIRUS: VIRUS-W (3)

- R=3000



- R=8700



Camera fixed in angle and position

VIRUS: Thank you!

Thank you for your time and dedication!

This talk is online:

www.grupp-astro.de