Future Observations of AGN
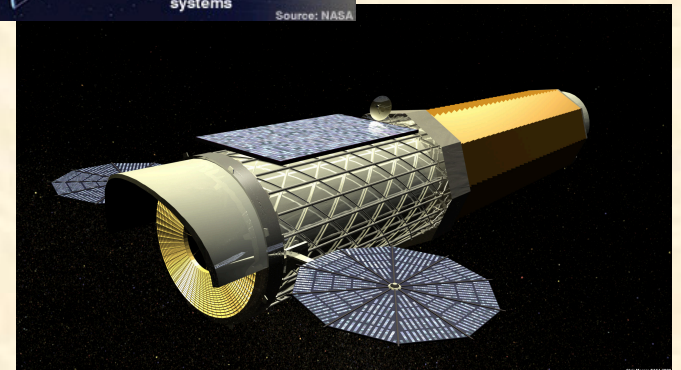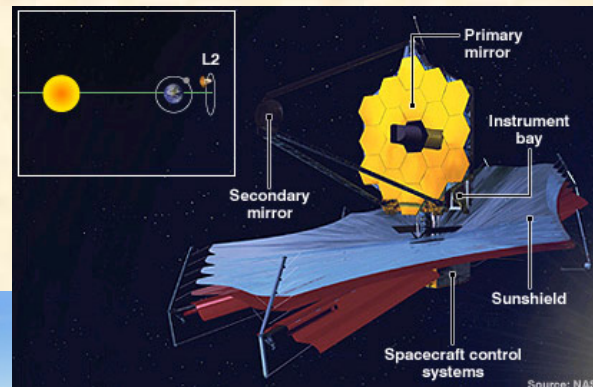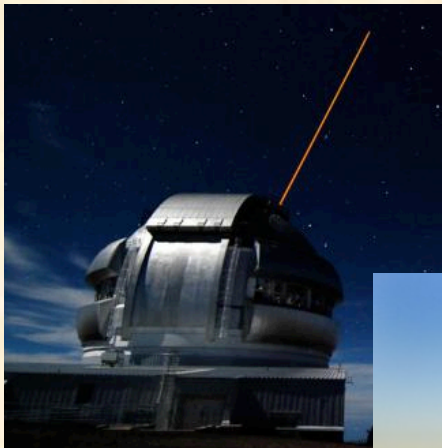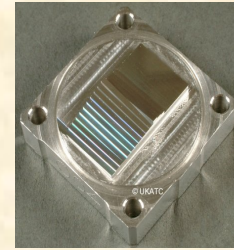
- Integral Field Units (IFUs)
- James Webb Space Telescope (JSWT)
- Giant Segmented Mirror Telescopes (GSMT)
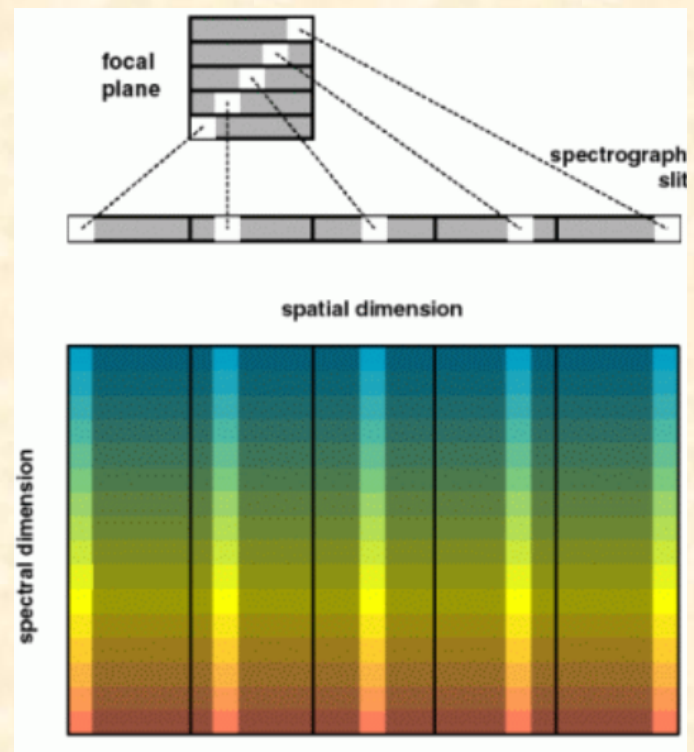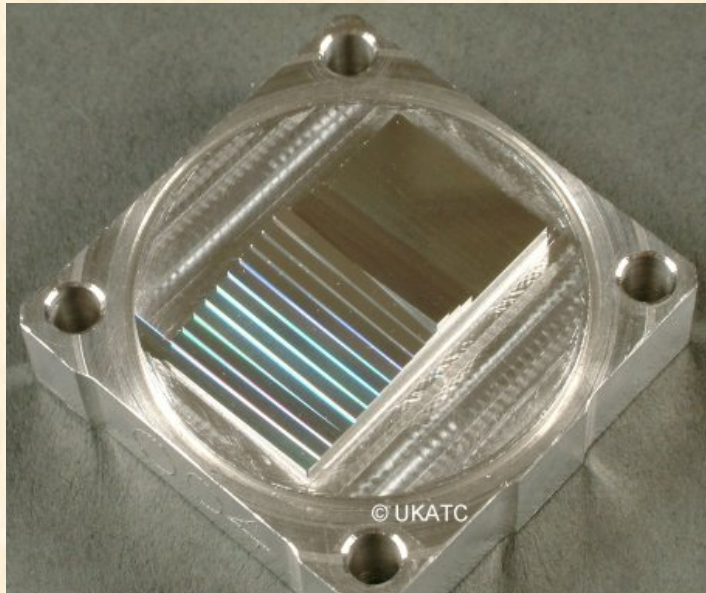- International X-ray Observatory (IXO)

Integral Field Units

- Spectrum for every position in a field of view

- Three Basic Types

  - Lenslets: microlens array can be tilted around the optical axis so that spectra do not run into each other (allowed length of spectra is small) Ex) WHT Sauron

  - Fiber Optics: fibers transfer light to the spectrograph slit (there are gaps between the fibers) Ex) Gemini GMOS

  - Image Slicers: instrument mirror segmented into thin vertical slices that are slightly tilted with respect to each other (difficult to fabricate) Ex) Gemini NIFS

- Best used with adaptive optics (AO) on large telescopes to give angular resolution of ~0.1"

Integral Field Unit – Image Slicer

© UKATC

Gemini North
and NIFS

focal plane

spectrograph slit

spatial dimension

spectral dimension

Data Cube

y

x

λ
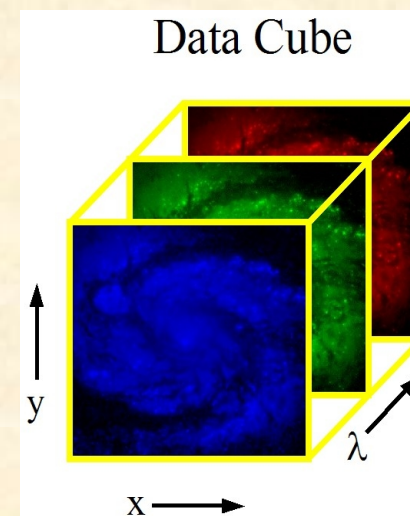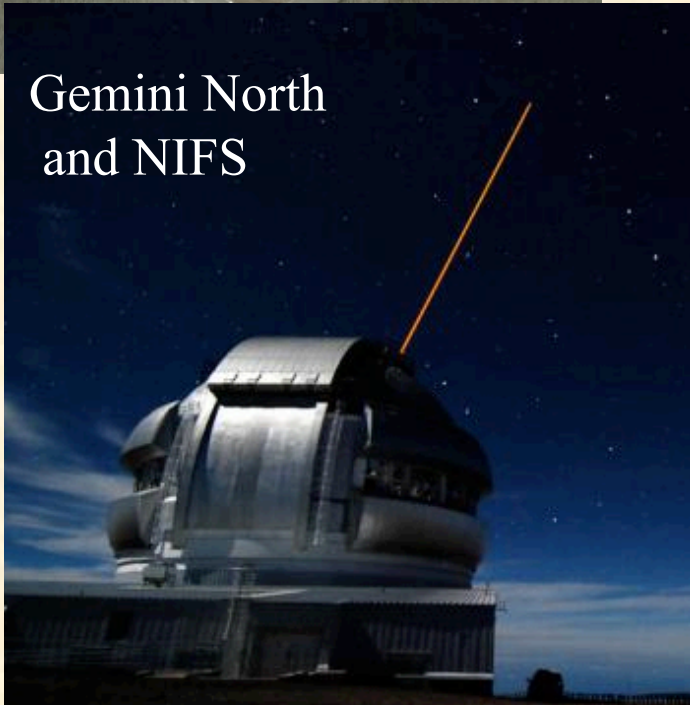
Near-infrared Integral Field Spectrometer (NIFS)

- Only available on Gemini North

- Spectral Resolving Power ~ 5000 over 3" x 3" at ~ 0.1" angular resolution

- Spectra in Z (0.9 – 1.1μm), J (1.1 – 1.3μm), H (1.5 – 1.8μm), and K (2.0 – 2.4 μm) bands

- Works with adaptive optics system ALTAIR using natural or laser guide stars

- For AGN, access to:
  - [S III] emission in Z band to map ionized gas in the NLR
  - H_2 emission lines in K band to map warm molecular gas
  - CO bandheads and other stellar features in H and K bands to map stellar velocities and dispersions for determining black hole masses.

NGC 4151 Observations with NIFS (Storchi-Bergmann et al. 2010)
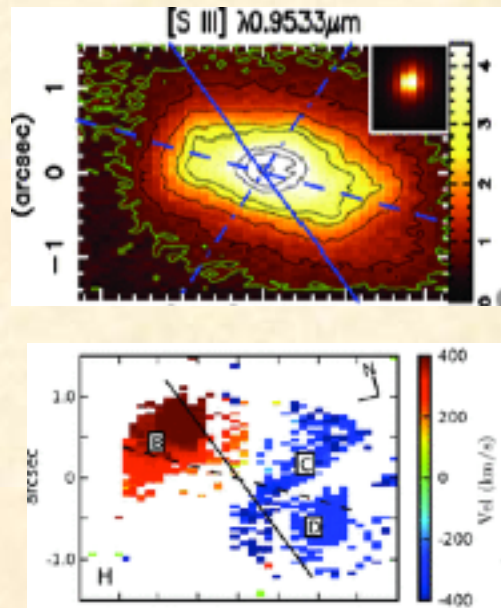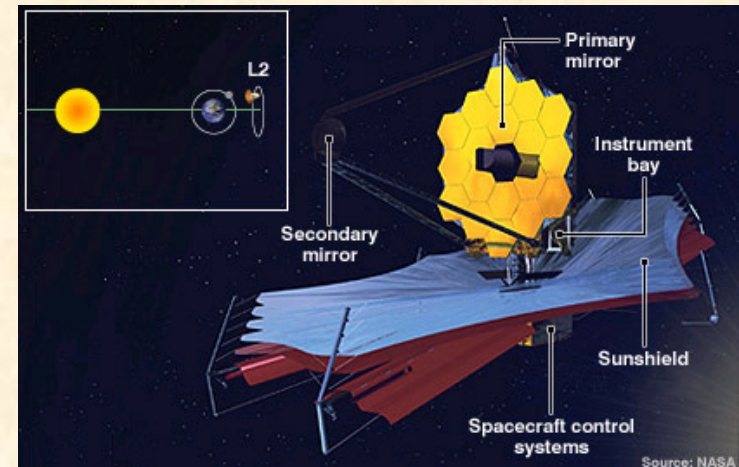

Outflows!

Reservoir of
gas for inflows!
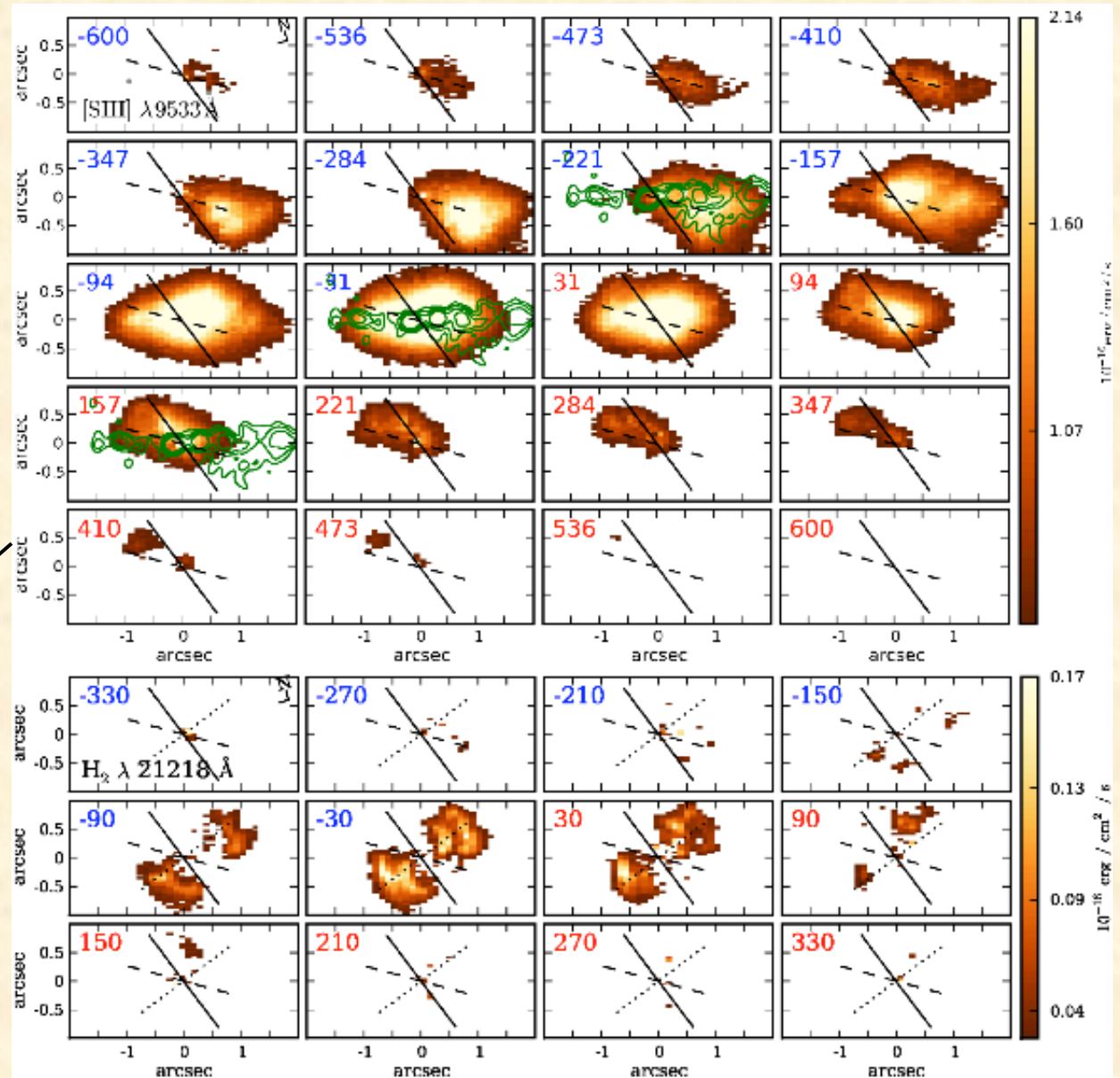
James Webb Space Telescope (JWST)

- 6.5-m IR telescope at L2
- Segmented mirror
- Arian 5 launch (ESA)
- NASA/ESA/CSA sponsors

- Angular resolution ≈ 70 mas at 2 μm
- Four main instruments:
  - NIRCam (near-IR camera): 0.6 – 5 μm (also wavefront sensor)
  - NIRSpec (near-IR spectrograph): 0.6 – 5 μm; R = 1000 multi-object spectroscopy, R = 2700 IFU, or R = 2700 long slit mode
  - MIR (Mid-IR Instrument): 5 – 27 μm, camera and imaging spectrograph
  - TFI (Tunable Filter Imager): 1.5 – 5 μm narrow-band imaging

James Webb Space Telescope (JWST)

AGN Science

- General goals: find first stars and first galaxies; track evolution of SMBHs and galaxies

- Redshifts, luminosities, and AGN fraction for highly obscured sources

- Properties of host galaxies at all redshifts; track morphologies, mergers, and star formation

- Investigate M_{BH} vs. M_{galaxy} relations as a function of z to probe growth and coevolution of SMBHs and galaxies
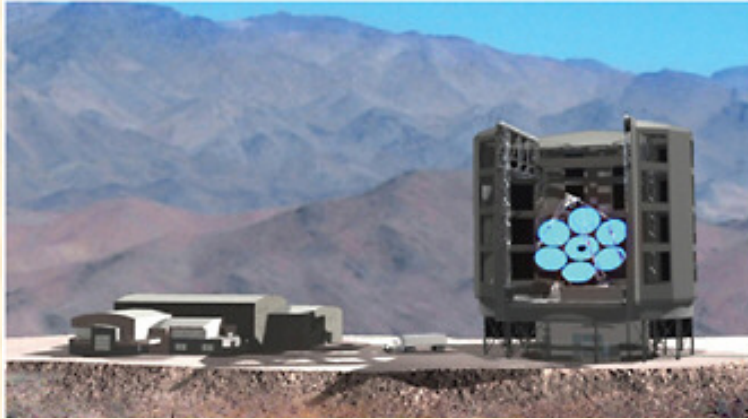
In danger of being cancelled by the U.S. Congress:

Year	Launch	Budget
1997	2007	0.5 Billion
1998	2007	1
1999	2008	1
2000	2009	1.8
2002	2010	2.5
2003	2011	2.5
2005	2013	3
2006	2014	4.5
2008	2014	5.1
2010	2015	6.5
2011	2018	8.7

(see Jane Rigby's presentation at:
https://webcast.stsci.edu/webcast/detail.xhtml?talkid=2607&parent=1)
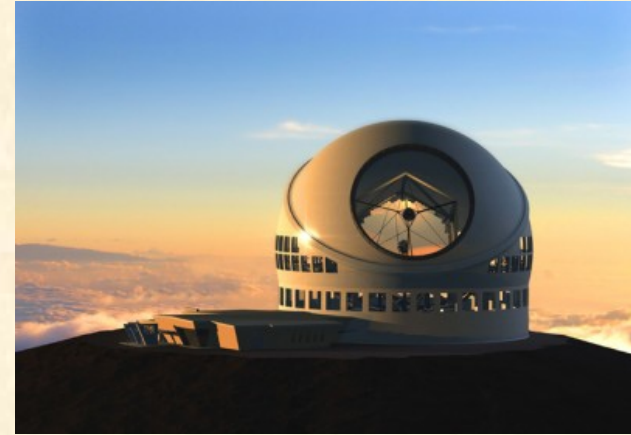
Giant Segmented Mirror Telescope

Giant Magellan Telescope

Thirty Meter Telescope

U.S. 2010 Astronomy Decadal Survey - Ground-based Priorities:

- LSST – Large Survey Synoptic Telescope
- Mid-scale innovations program
- GSMT – Giant Segmented Mirror Telescope
- ACTA– Atmospheric Čerenkov Telescope Array

AGN Science:
- High spatial resolution images and spectra in the IR (much better sens.)
- Spectropolarimetry of many more AGN (currently photon-starved)

International X-ray Observatory (IXO)

U.S. 2010 Astronomy Decadal Survey – Space-based Priorities:

1) WFIRST – Wide Field IR Survey Telescope
2) Explorer Programs
3) LISA – Laser Interferometer Space Antenna
4) IXO – International X-ray Observatory
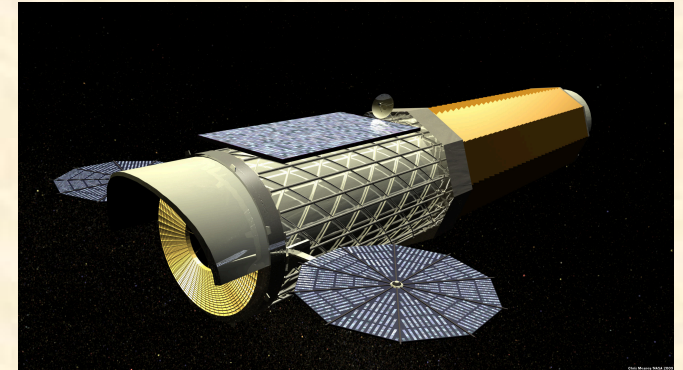
- Collaboration between NASA, ESA, and JAXA
- Grazing incidence telescope with effective area of 3 m^2, 5 " resolution
- Microcalorimeter spectrometer: array covering several arcmin of the sky at spectral reolving power of ~1000
- Other possible instruments:Wide-field imaging, high-resolution timing, and polarimetry

AGN Science:
- Broad Fe Kα emission: black hole spin and accretion disk inclinations
- Nature of the soft X-ray excess
- Warm absorber properties and variability