Some Thoughts on d-IFU Science and Instrument Approaches for Keck NGAO

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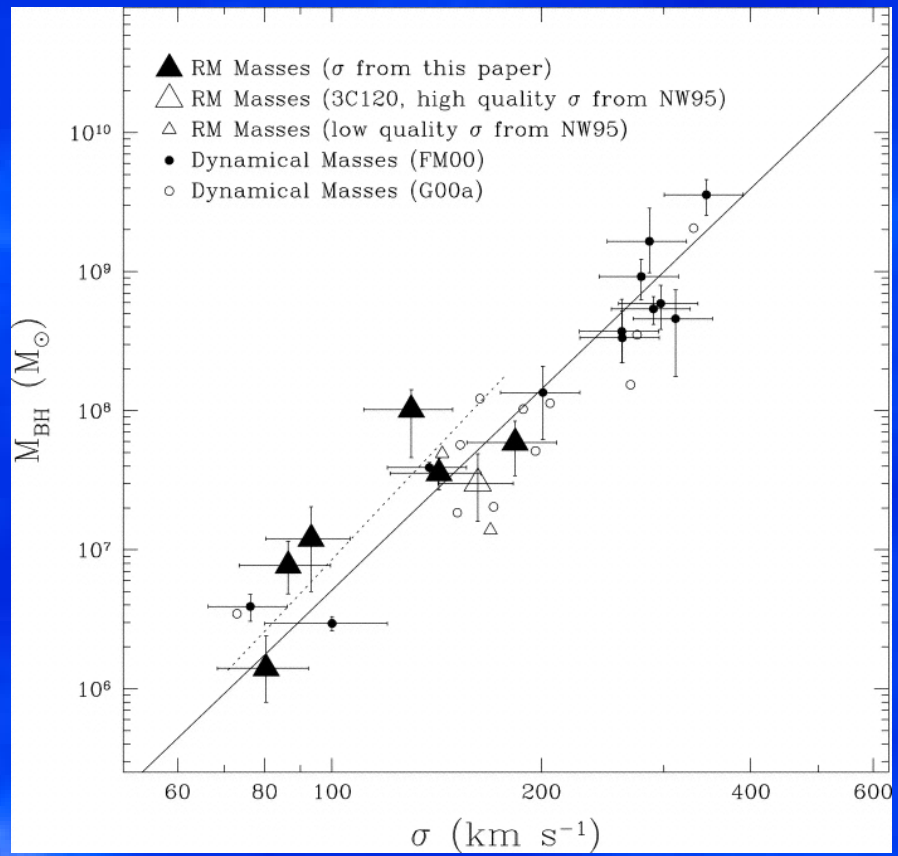
Black Holes – Why Care?

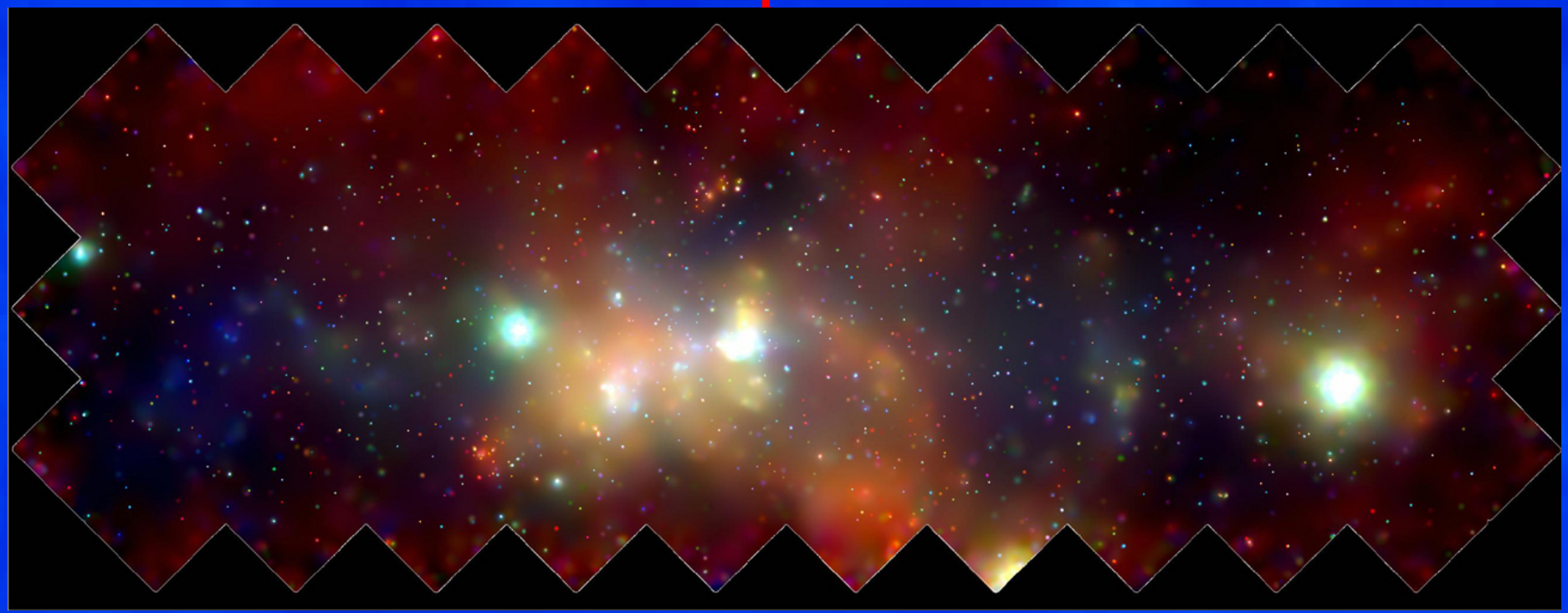
- **Fundamental influence on many astrophysical phenomena**
- **Super-massive BH's now known to be intrinsically linked to galaxy evolution**



Ferrarese et al., 2001

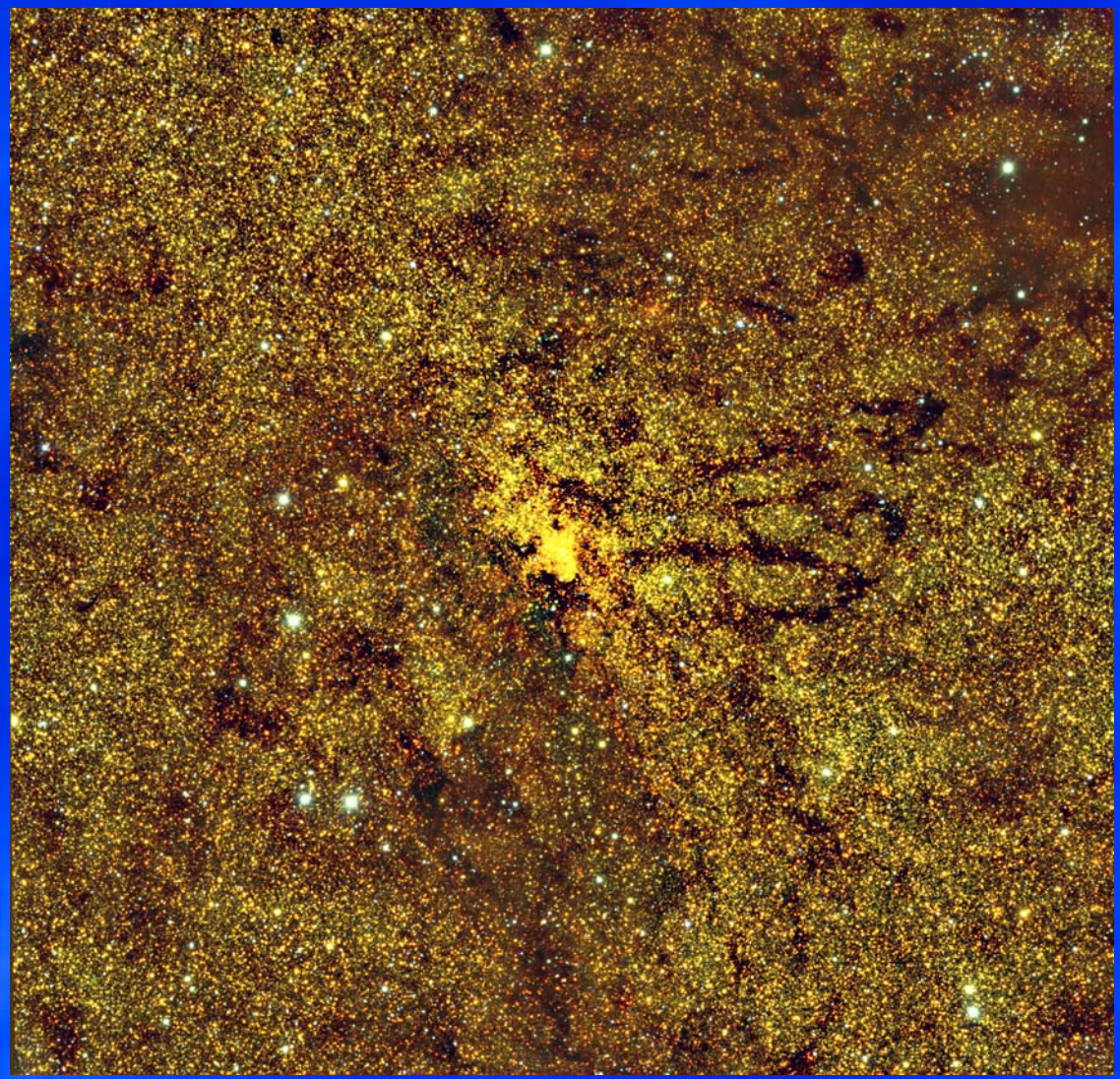
GC Survey: The Promise

- **The Galactic Center is a wonderful & mysterious place:**
  - **~4.5x10^6 M_0 black hole in Sgr A***
  - **Lots of massive stars and clusters**
  - **>2000 X-ray sources -- the "Elephant's Graveyard" for black hole hunters!!**
  - **We want the IR counterparts to these!**



GC Survey: The Problem

- **It's CROWDED in there!**
- **~100% of all X-ray sources have IR counterpart candidates within 1-arcsec at K<15.5 mag**
- **But, stats indicate that ~85% are SPURIOUS**
- **Need to sort the wheat from the chaff!**



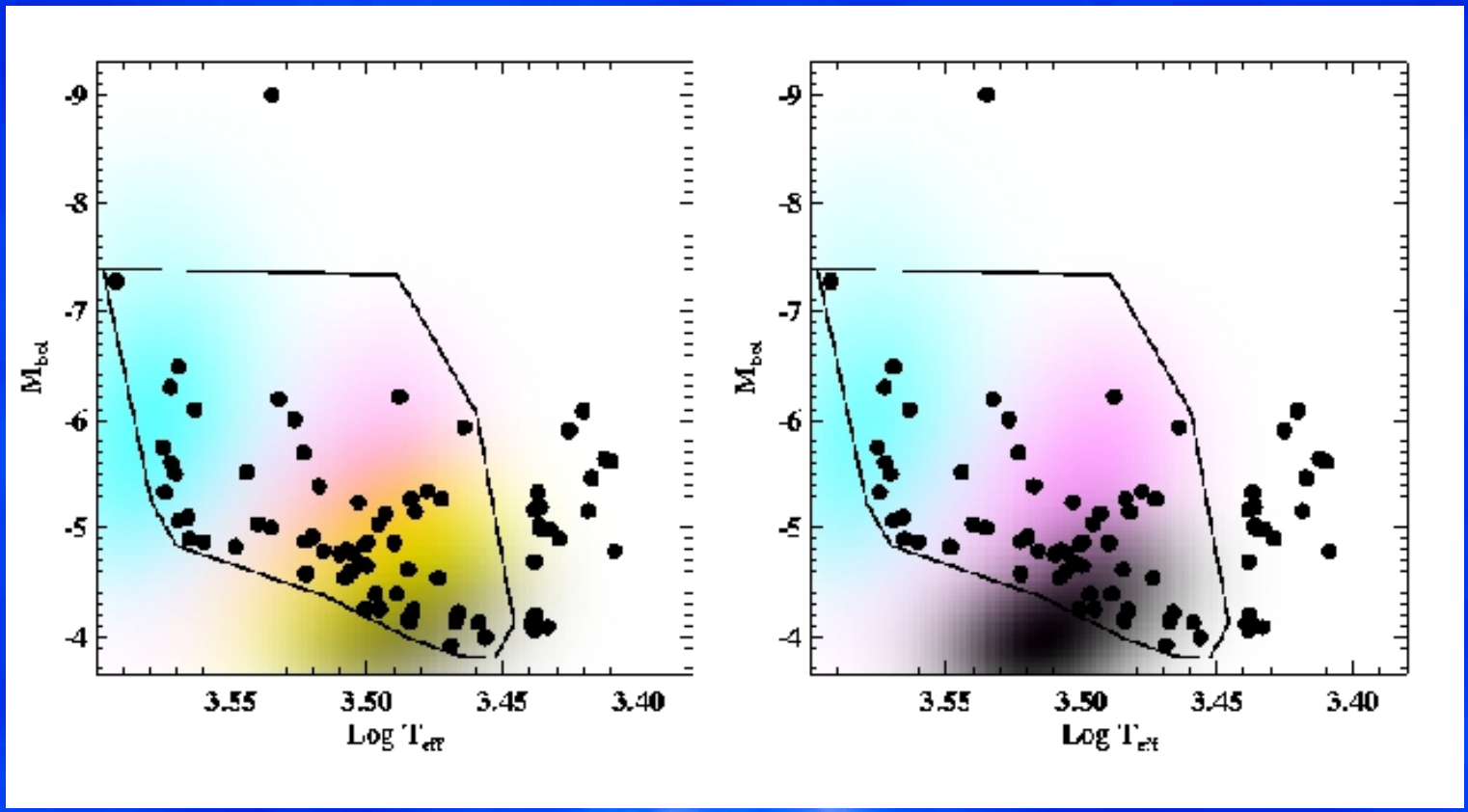
FLAMINGOS-2 GC Survey: The Solution!

- **F2GCS Team: SSE, R. Blum & K. Olsen (CTIO); K. Sellgren (OSU); R. Bandyopadhyay (Oxford); M. Muno (UCLA); etc.**
- **Will use ~15 nights of F2/Gemini time**
- **Will obtain HK spectra of ~5000 stars in GC region (w/ISPI pre-imaging for target selection)**
- **Will target ~2000 X-ray sources to identify ~300 counterparts**
- **What about the other stars?**

FLAMINGOS-2 GC Survey: RGB Heaven

- One person's "chaff" is another person's "wheat"!
- Most spurious IR candidates will be RGB stars
- Will fill out the other ~3000 MOS mask positions with targets selected as likely RGB stars
- Produces a catalog of ~4000-ish RGB spectra ⇒ hurray! (?)
- So what?
- Use H&K steam bands and CO indices to constrain luminosity class and reddening ⇒ M_{bol} & T_{eff}
- Now we can place 4000 RGB stars on an H-R diagram ⇒ hurray! (?)

FLAMINGOS-2 GC Survey: Star Formation History

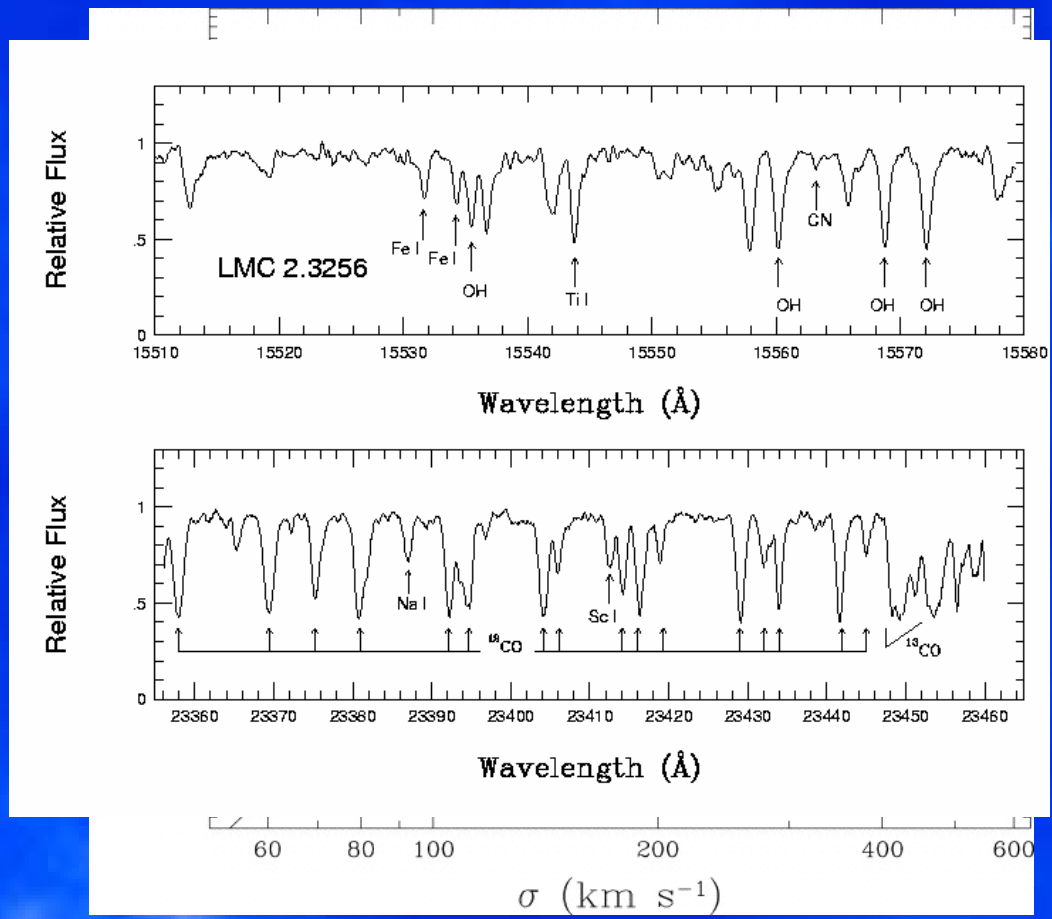


Blum, Ramirez, Sellgren, Olsen 2003

- Combine with model star formation histories ⇒ **we can constrain the SFH of the GC (hurray!)**
- **Can link this to the mass evolution history of the SMBH!!**

NGAO: Bulge/Black-Hole Connection

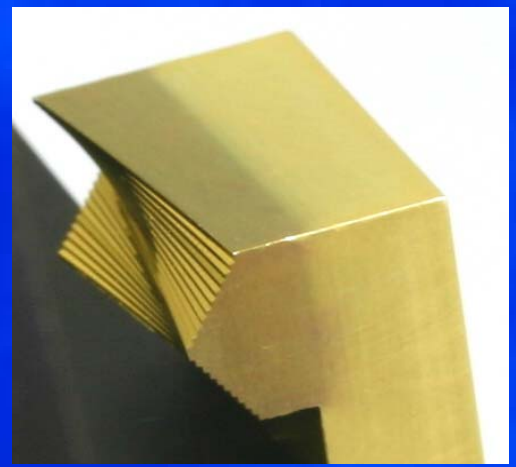
- **Follow-up on F2GCS (Gen 1 & 2) + other inner surveys with Keck NGAO & IR d-IFU**
- **R=20,000 will provide abundances & kinematics**
- **Now know gas mass, kinematics, and composition versus time!**



- **Link SF history to black hole properties ⇒ physics of the Bulge/Black-Hole connection (!)**

NGAO d-IFU: IFU Thoughts

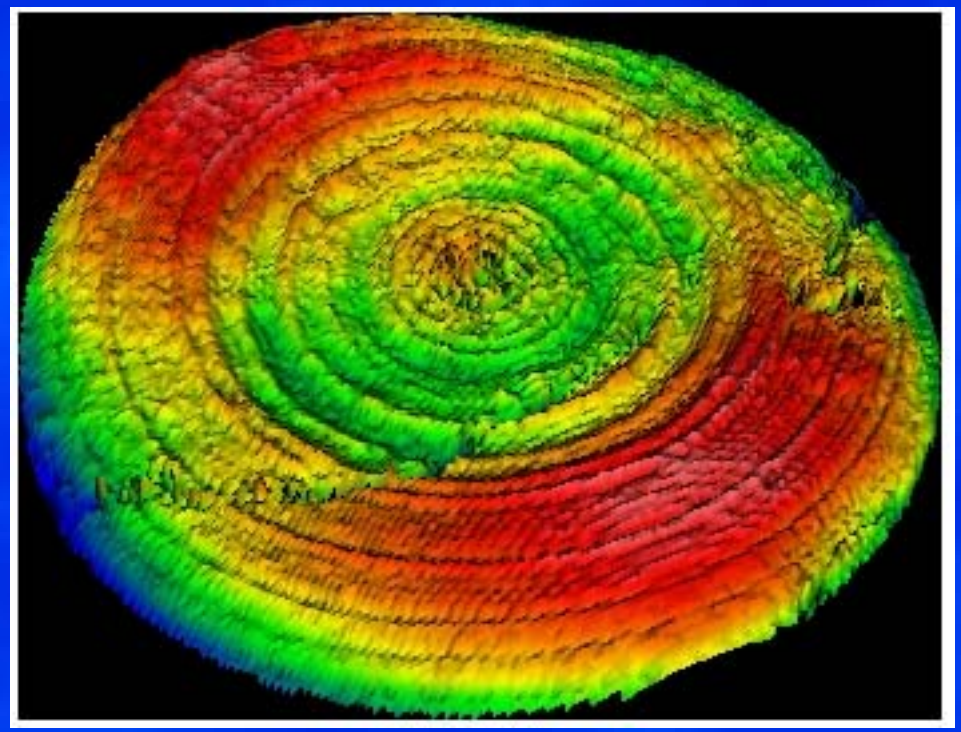
- **Lenslet arrays:**
  - **Sample PSF at initial focal plane**
  - **Very high Strehl + well-understood PSF reconstruction**
  - **Excess diffraction doubles linear dimension ⇒ 2x2 (x2?)**
  - **Each ½-PSF spread over several pixels (quickly detector-limited); inefficient in pixel usage**
- **Slicer mirrors:**
  - **Preserve PSF to detector**
  - **Lower Strehl**
  - **Compact & ½-PSF on 1 pixel (lower noise)**
  - **Visible-IR IFU now possible**



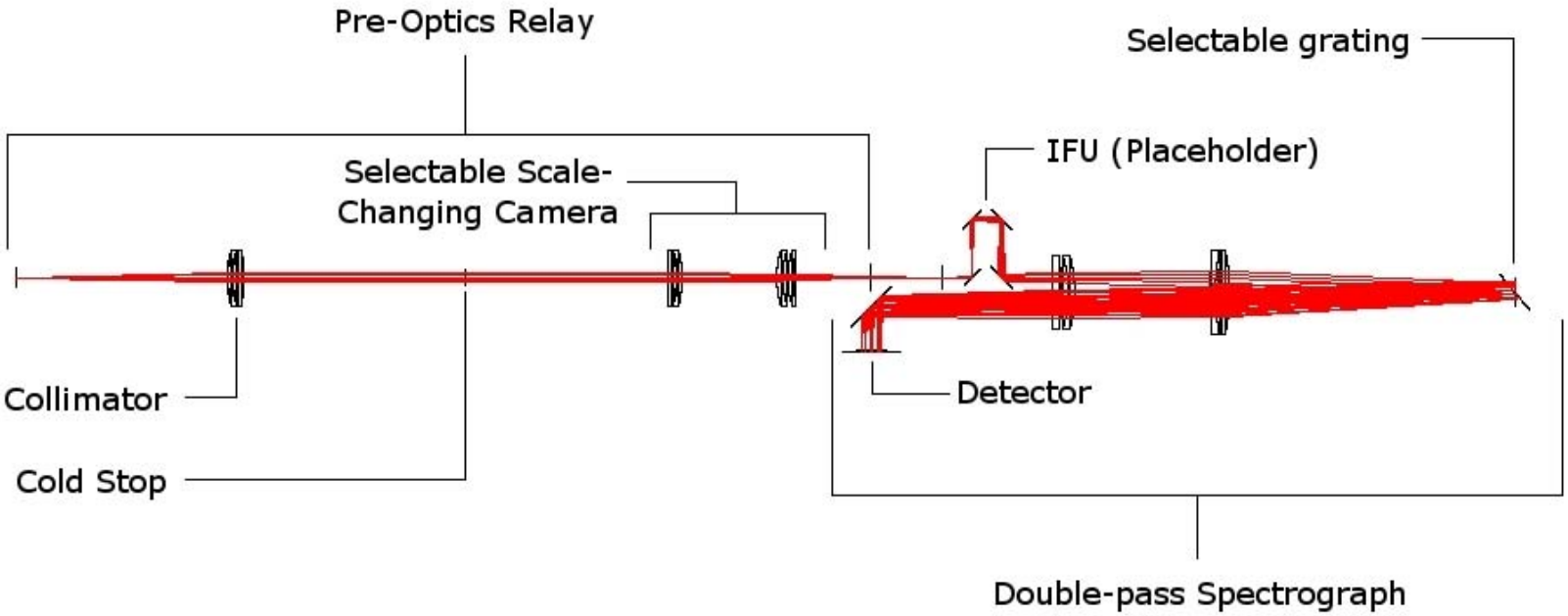
- **Compactness of slicers may be significant advantage for d-IFU instrument**

NGAO d-IFU: Visible-2-IR

- **Diamond-turned slicers "state of the art" for efficient fabrication ("bolt-n-go")**
- **Previously λ_{min} limited by 6061-T6 Al surface roughness (~10 nm rms per surface ⇒ ~15% scatter loss at 600-nm)**
- **New "material X" coating has ~2.5-nm rms AND holds figure from room to cryo temps ⇒ ~0.5% scatter loss at 600-nm**



NGAO d-IFU: Compact Spectrograph



- **FRIDA AO Imager/IFU-Spectrograph for GTC 10-m**
- **Concept by S. Cuevas & S. Eikenberry**
- **Diffraction limit at R=1,000 – 30,000 (0.9-2.5 μm)**