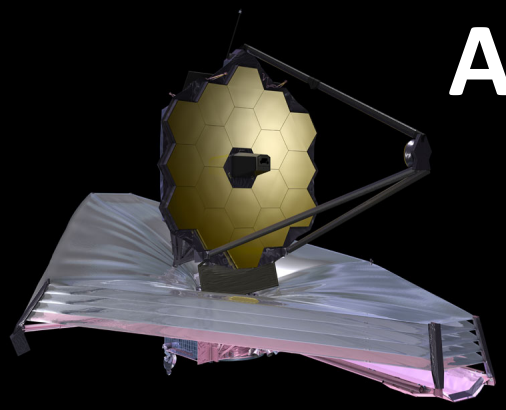
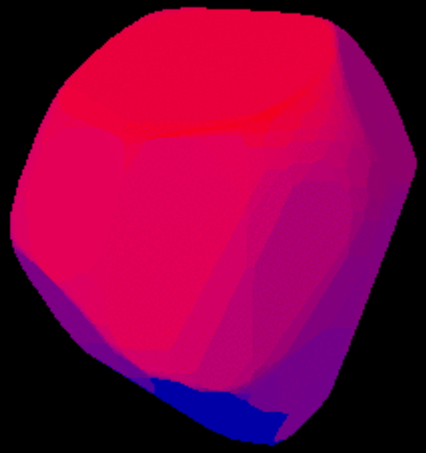
Serendipitous Asteroid Detections With JWST-MIRI





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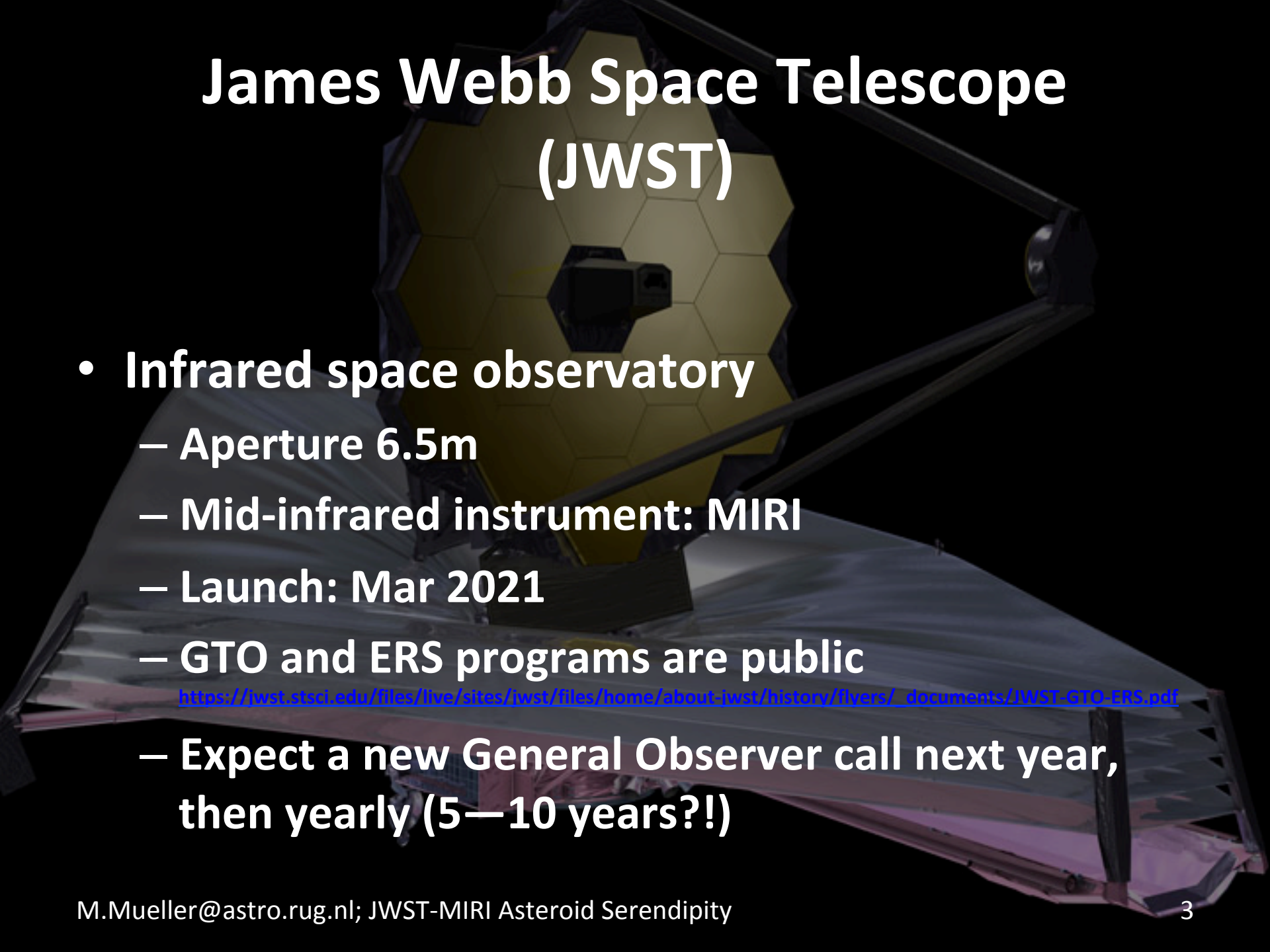
Overview

- **JWST & MIRI**
  - **Capabilities**
  - **Timeline, deadlines**
- **Asteroid Serendipity**
- **Super-WISE? ☺**

James Webb Space Telescope (JWST)



- Infrared space observatory
  - Aperture 6.5m
  - Mid-infrared instrument: MIRI
  - Launch: Mar 2021
  - GTO and ERS programs are public
    https://jwst.stsci.edu/files/live/sites/jwst/files/home/about-jwst/history/flyers/_documents/JWST-GTO-ERS.pdf
  - Expect a new General Observer call next year, then yearly (5—10 years?!)

Mid-Infrared Instrument (MIRI)

- Imaging + spectroscopy, 5—28 µm
  - See https://jwst.nasa.gov/miri.html http://www.miricle.org/
  - Thermal imaging of practically any asteroid…
  - LRS (R~100, 5—12 µm), MRS (R~3,000, 5—28 µm)
  - I'm part of the team – ask me any question!
  - MIRI simulator: http://miri.ster.kuleuven.be/bin/view/Public/MIRISim_Public

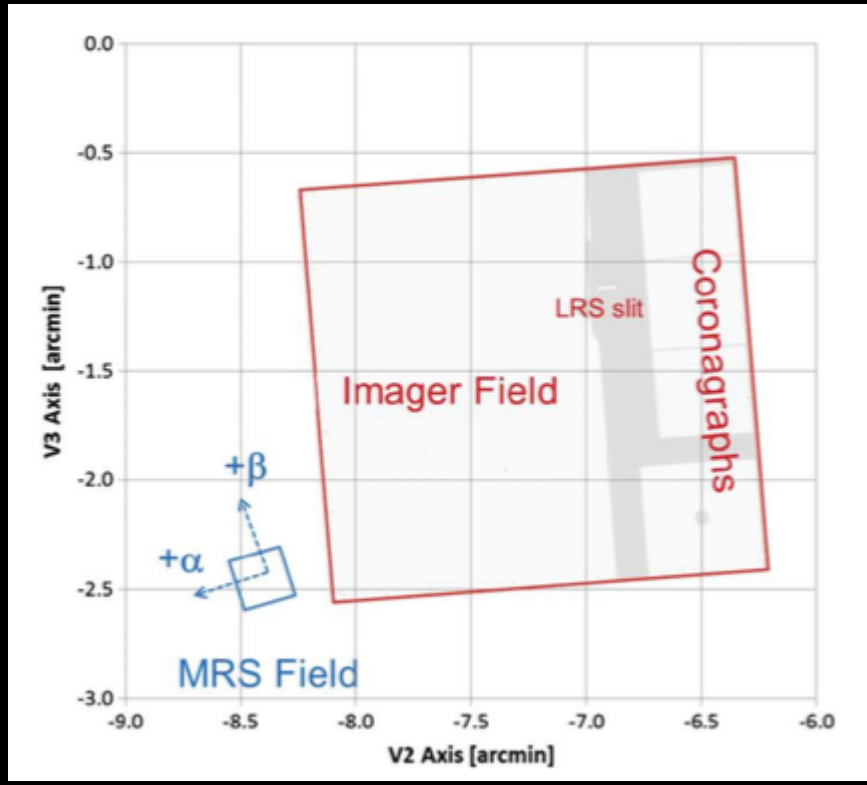
Asteroid Serendipity

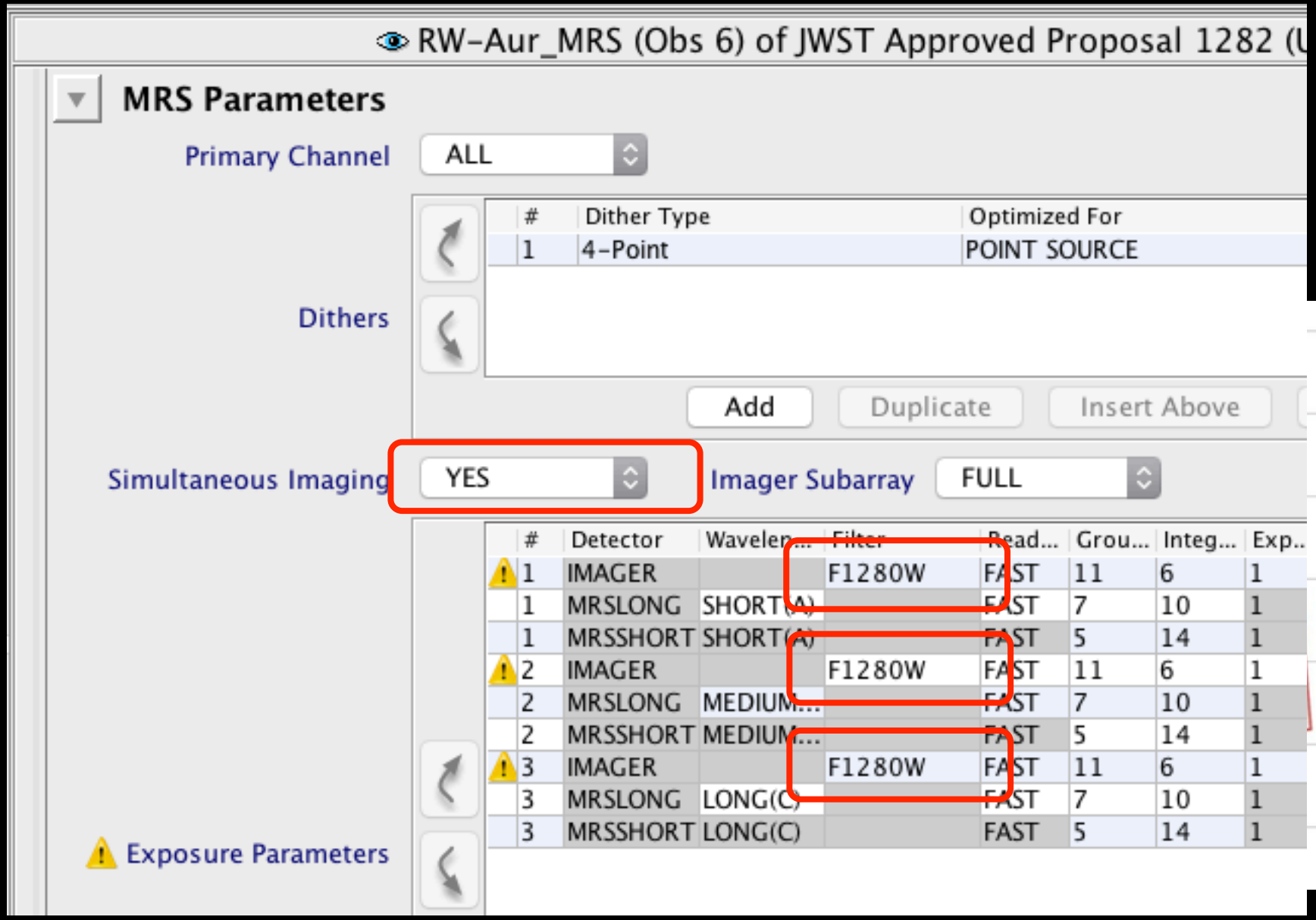
- Asteroids are very bright @ MIR → MIRI will see many, like it or not!
- But then, FOV is only 74”x113”.
- Not a survey telescope, but will go MUCH deeper than, say, WISE.

- Data public after one year.
  But how many asteroids will MIRI see?

SIMO

- **“Simultaneous Imager MRS Observations”**
- **During MRS obs, can image a nearby field at zero overhead (!).**
- **Please use filter 1280W! (best for asteroids)**




RW-Aur_MRS (Obs 6) of JWST Approved Proposal 1282 (U
MRS Parameters
Primary Channel
ALL
Dither Type Optimized For
1 4-Point POINT SOURCE
Dithers
Add
Duplicate
Insert Above
Simultaneous Imaging
YES
Imager Subarray
FULL
Detector Wavelen... Filter Read... Grou... Integ... Exp...
1 IMAGER F1280W FAST 11 6 1
1 MRSLONG SHORT(A) FAST 7 10 1
1 MRSSHORT SHORT(A) FAST 5 14 1
2 IMAGER F1280W FAST 11 6 1
2 MRSLONG MEDIUM... FAST 7 10 1
2 MRSSHORT MEDIUM... FAST 5 14 1
3 IMAGER F1280W FAST 11 6 1
3 MRSLONG LONG(C) FAST 7 10 1
3 MRSSHORT LONG(C) FAST 5 14 1
Exposure Parameters
-6.0

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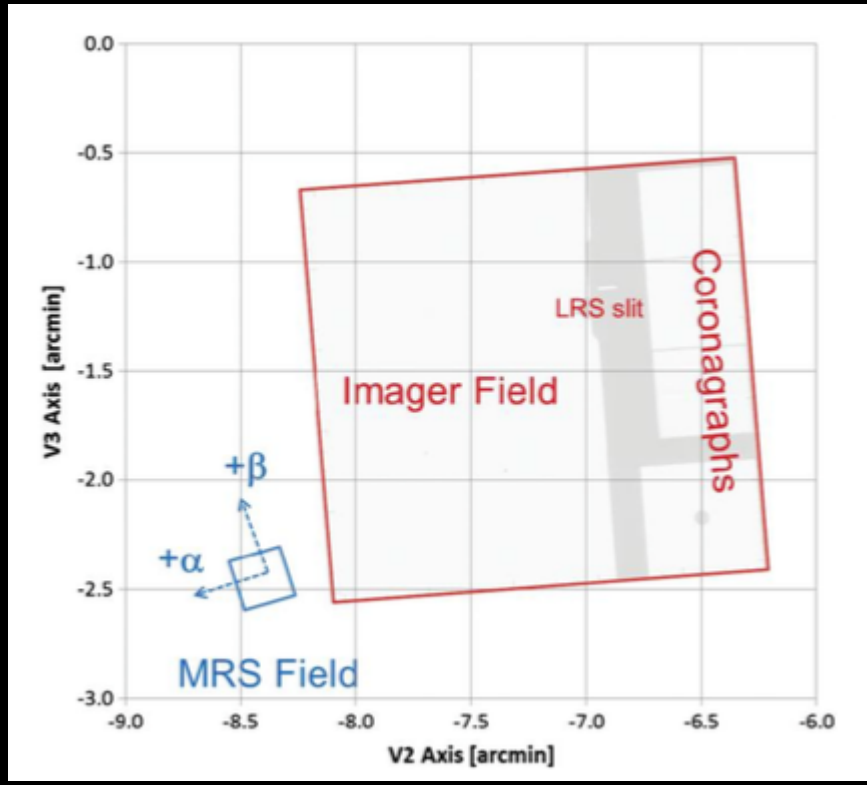

Serendipity: Known Asteroids

- **Picked one GTO program (#1282, targeting debris disks) with 55 MIRI-MRS observations**

- **For times when observable: check which asteroids (if any) are inside MIRIM FOV**
  - **https://ssd.jpl.nasa.gov/x/ispy.html**
  - **MIRIsim**

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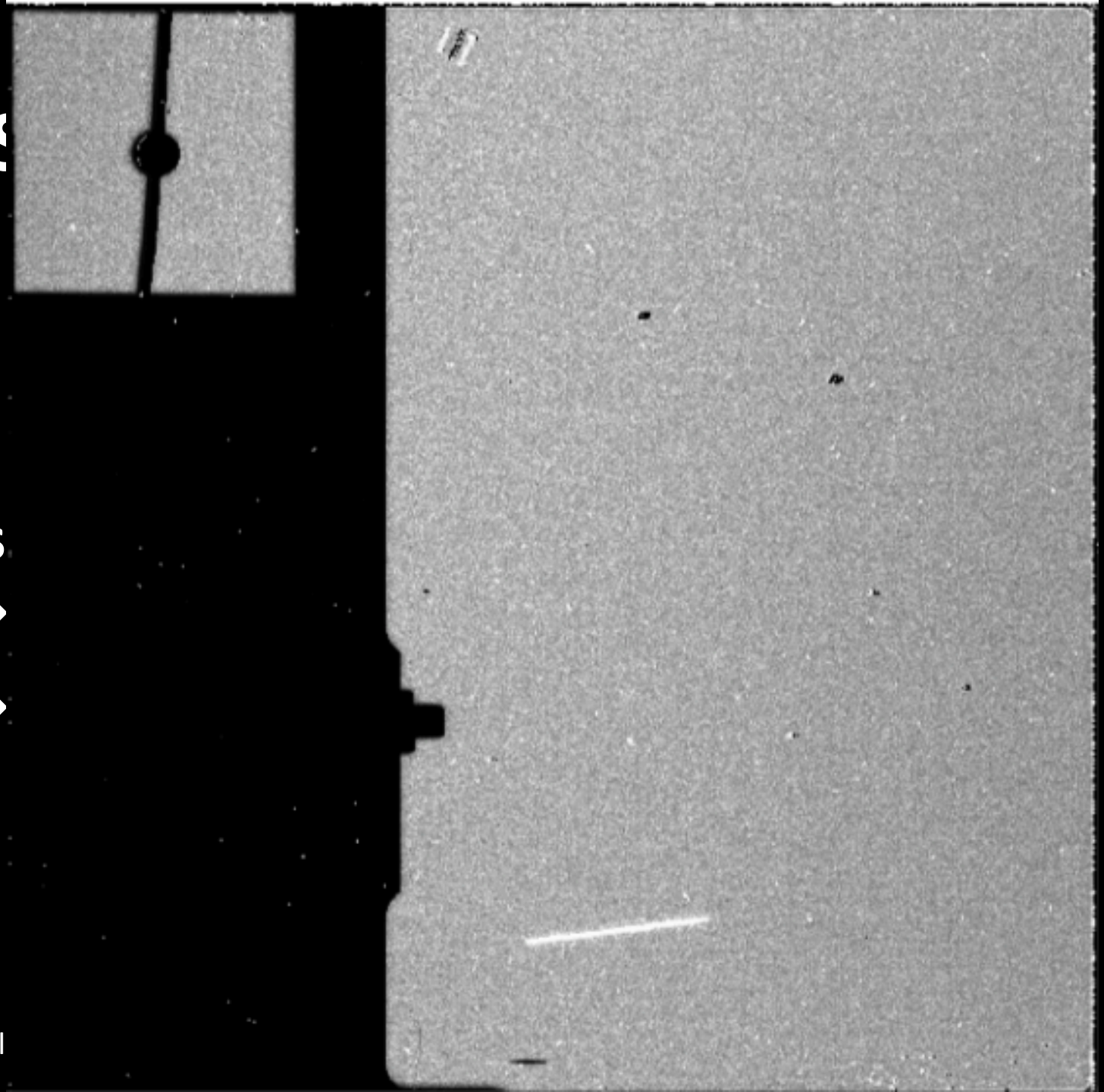
  - **Preliminary result: 4.2% chance of having a currently known asteroid inside FOV.**

Serendipity: Known Asteroids

- Preliminary result: 4.2% chance of having a currently known asteroid inside FOV

- Estimated brightness (NEATM), assumed p_V = 6%, 20%
- → MIRIsim to simulate streaks
- → SNR >> 10 in practically all cases



- Es
  →
- →

Serendipity: Known Asteroids

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- **Total asteroid yield (currently known MBAs):**
  5 years / (1.7 hr/obs) * 25% * 75% * 4.2% ~ 200
  - Assume: MIRI on 25% of time; MIRIM 75% of that

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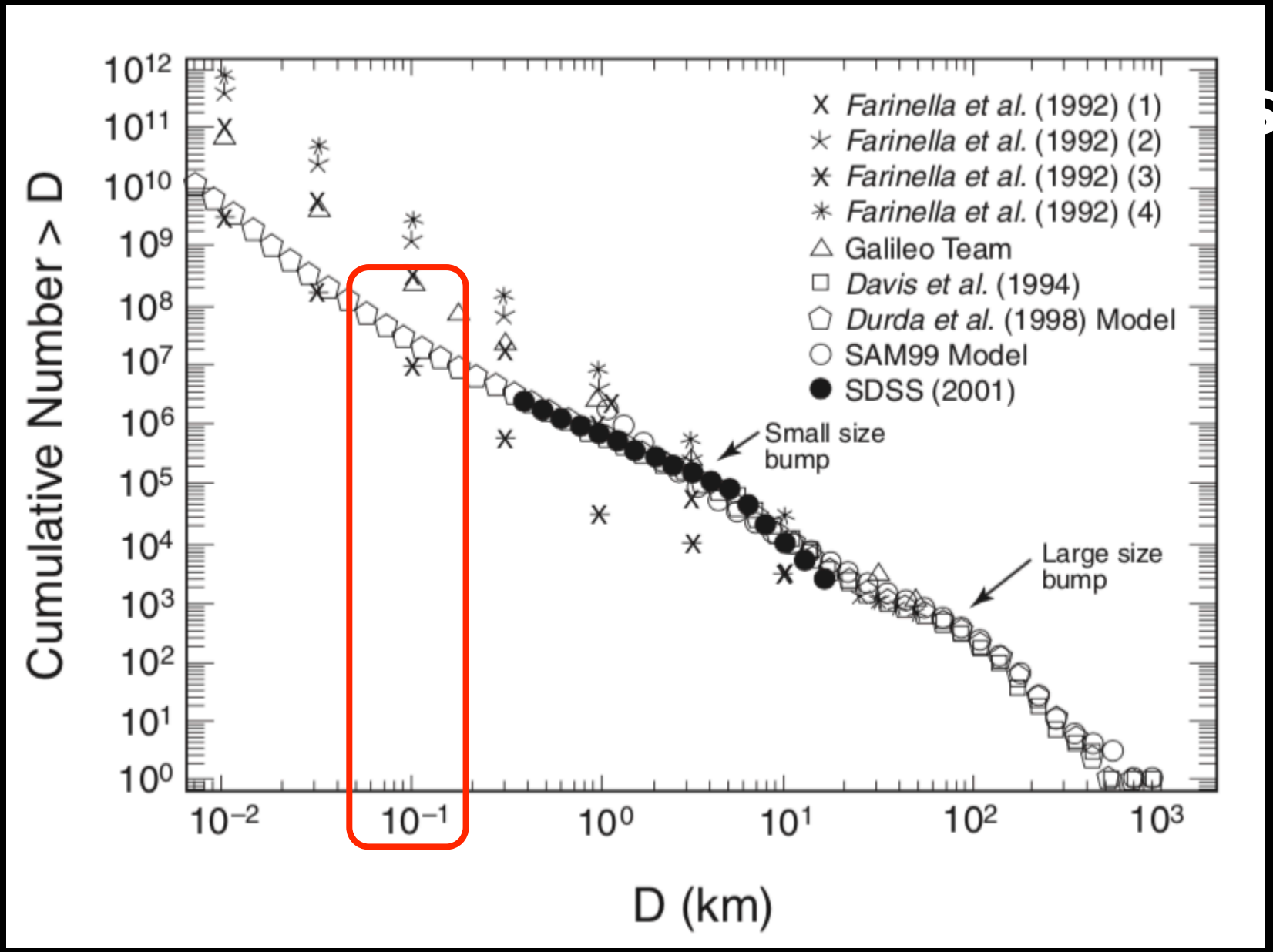
- **This is not super-WISE!**
  It's not the whole story, either.

Serendipity: Unknown Asteroids

- We'll see many more asteroids – those that haven't been discovered, yet!
  - MIRI is much more sensitive to asteroid flux than current optical surveys.

- Extrapolation: we're sensitive to all MBAs down to D~120m (preliminary result)



From Davis et al. (2002; Asteroids III)

Serendipity: Unknown Asteroids

- Sensitive down to D~120m (preliminary)

- Extrapolating SFD: ~30e6 D>120m asteroids
- ~800,000 of them known today
- → ~2.7% complete

Serendipity: Unknown Asteroids

- Sensitive down to D~120m (preliminary)
- → ~2.7% complete
- Total yield expected: 200/2.7% ~ 7,500 MBAs
  - 97% of these currently unknown, sub-km size
- Is this super-WISE?

Conclusions

- **JWST to launch in Mar 2021. MIRI is great for thermal work! Annual GO calls starting 2020.**
- **Over 5 year lifetime (requirement), MIRIM detects ~200 MBAs known today (small FOV)**
- **Will detect ~7,000 more unknown MBAs (D < 1km; high sensitivity)**

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- **Looking into data reduction for trailed observations w/ non-destructive read-outs…**

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JWST = Super-WISE