# JCMT Receiver-A Upgrade

Ming-Tang Chen, ASIAA

# Background

- Lowest frequency band to utilize telescope time in bad weather
- Wet dewar receiver, require LHe and manpower. Need renovation
- Single pixel, with relatively small bandwidth (almost 2 GHz)
- HIA receiver, 20+ year old
  - Tuning ranger 211-272 GHz (gap around 252 GHz)
  - Trx 50-150 K
  - Auto tuning Double sideband (1 IF) - no SSB
- ASIAA/SMA front-end
  - 185 – 250 GHz, work up to 270 GHz with degraded performances
  - Single pixel, DSB
  - Frontend can output 8 GHz IF, but limited by IF and backend
  - Possible upgrade to SMA 240 GHz mixer to cover 272 GHz

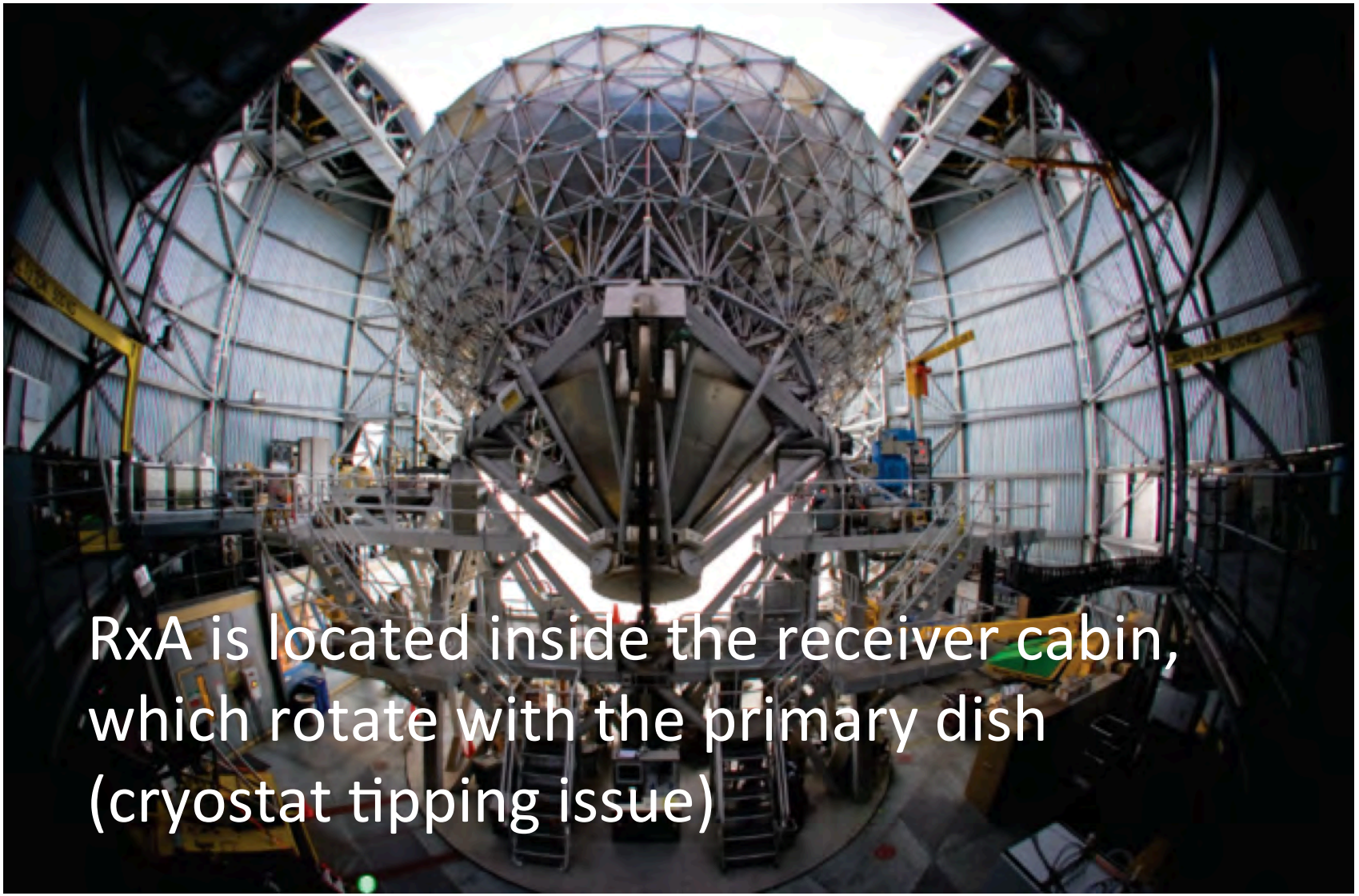
# Objective

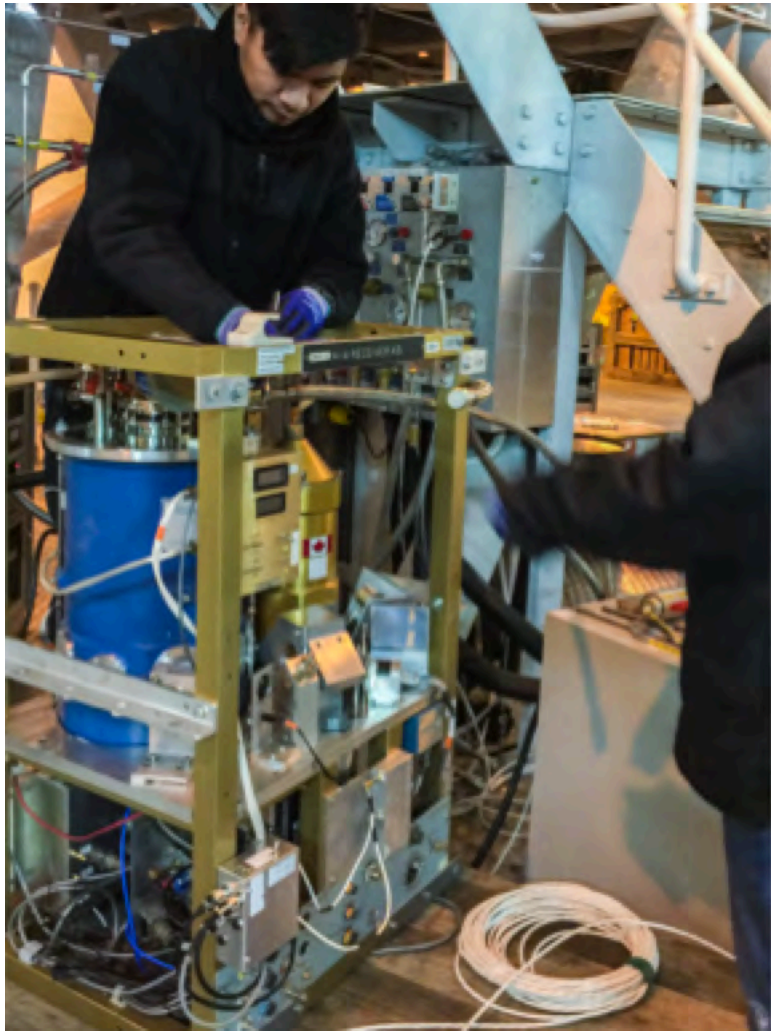
Within limited time frame (2 years?) and within collaborations among EAO regions

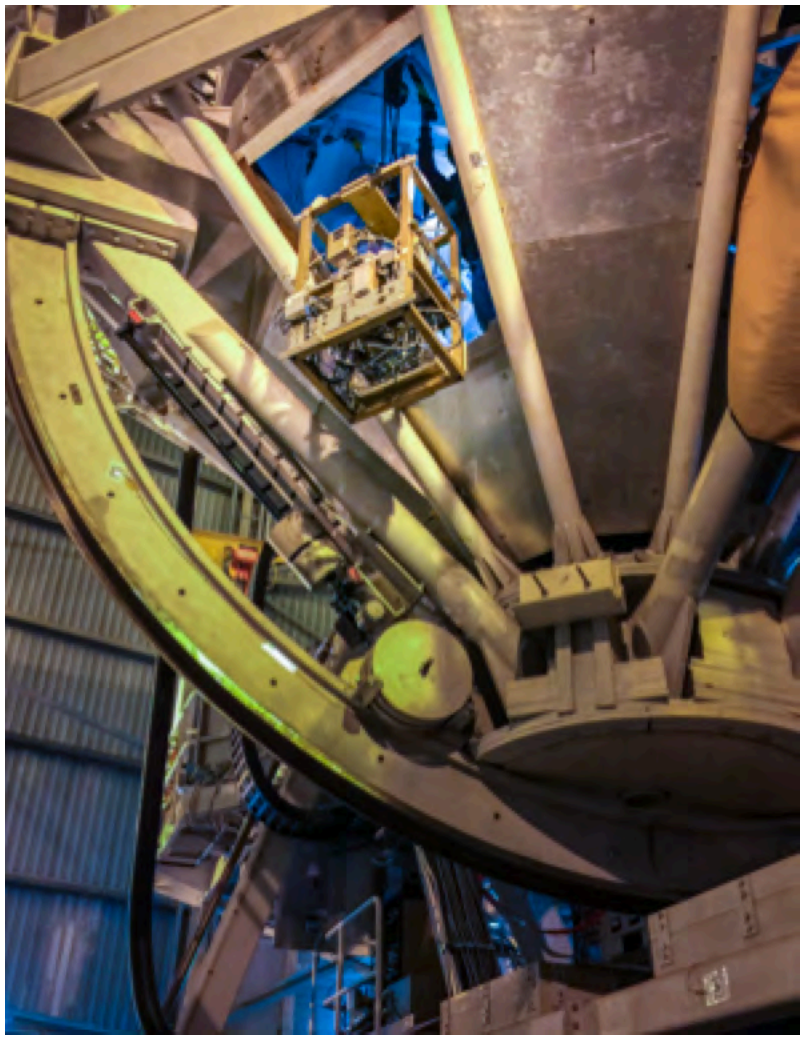
- Upgrade Rx-A with up-to-date technology
- With closed-cycle dewar
- Wider bandwidth 12 GHz
- Dual linear polarizations
- Sideband separation mixer
- More than one pixel
- More than one frequency channels

# Logistics

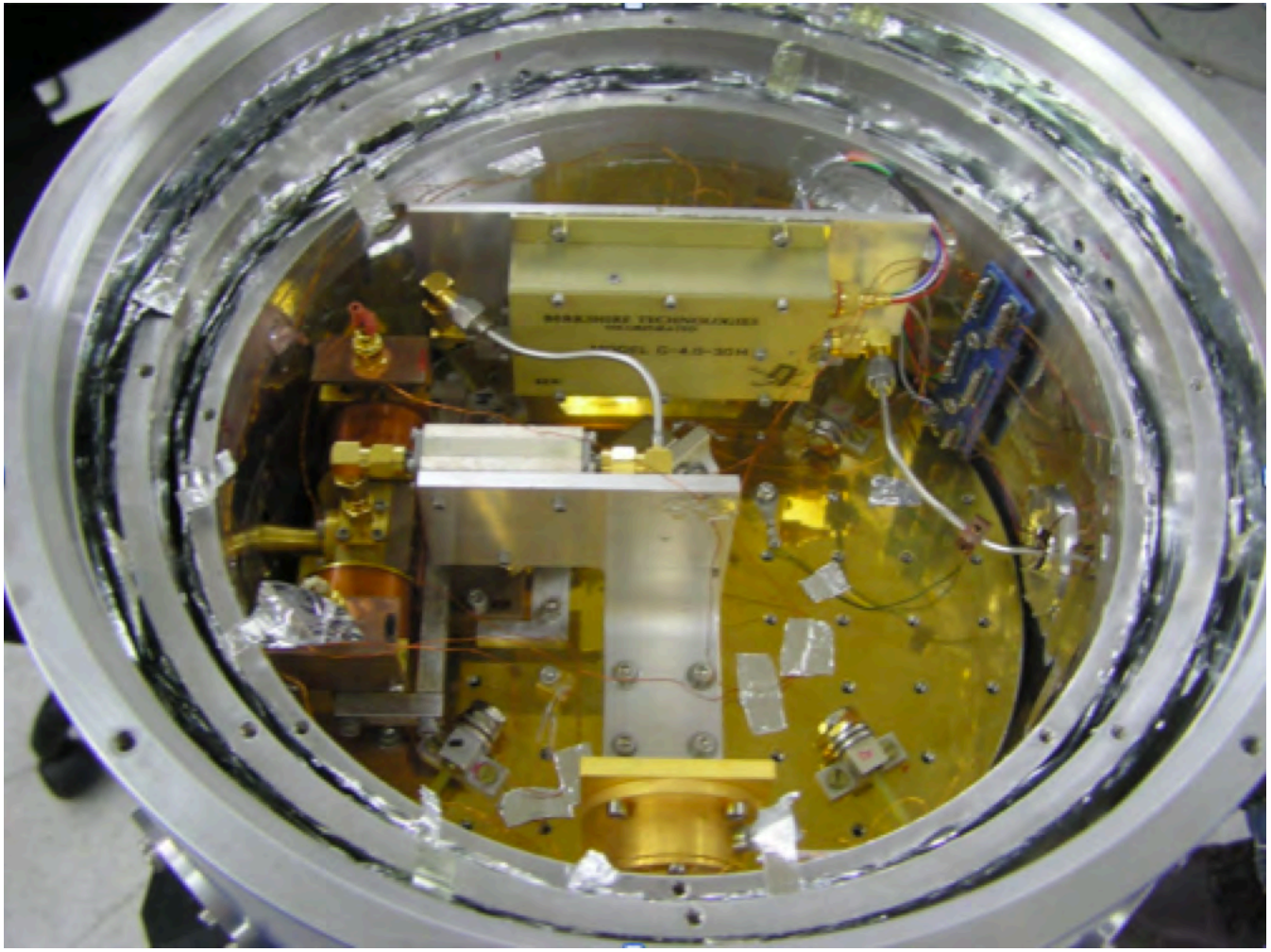
- Where is Rx-A
- How to install Rx-A
- What does Rx-A look like


RxA is located inside the receiver cabin,
which rotate with the primary dish
(cryostat tipping issue)






HIA RECEIVER A3



# RxA Upgrade Options

- Utilize existing space - Overhaul entire configuration; dewar, optics, LO, monitor/control, calibration.
- Utilize existing space - Replacing “blue” cryostat with a custom-made, closed-cycle 4K dewar.
- Dual linear pols receiver; circular polarization?
- Bandwidth goal: 4 – 18 GHz ?
- Single- or double-sideband mixer?
- Two-pixel or dual channel frontend?
- LO injection: Existing setup with new components, or W/G injection using YIG setup.
- Keep calibration setup?
- Reuse as much existing control and monitor interface?

# RxA Upgrade – Front End

- Two DSB feeds/mixers with cold wire grid: (optical LO)
  - Identical feeds for dual pol observation (2 IF)
  - Existing mixer requires optical LO injection. LO source need to be rotated (?)
  - Different feeds for dual-channel, single sideband observation.
- Single feed with OMT: (optical injection still possible)
  - 2 DSB mixers, 2 IF outputs
  - 2 SSB mixers, with one sideband output (2 IF)
  - 2 SSB mixers, with both sideband outputs (4 IF)
- Two feed each w/ OMT: (No optical LO)
  - 2 set of 2 DSB mixers, 4 IF outputs
  - Feeds pointing at different sky; two-pixel, dual-pol (4 IF)
  - Feeds operating at different f; dual-channel, dual pol (4 IF)
  - 2 set of 2 SSB mixers, 4 (8) IF outputs, each with 8 (12) GHz bandwidth.

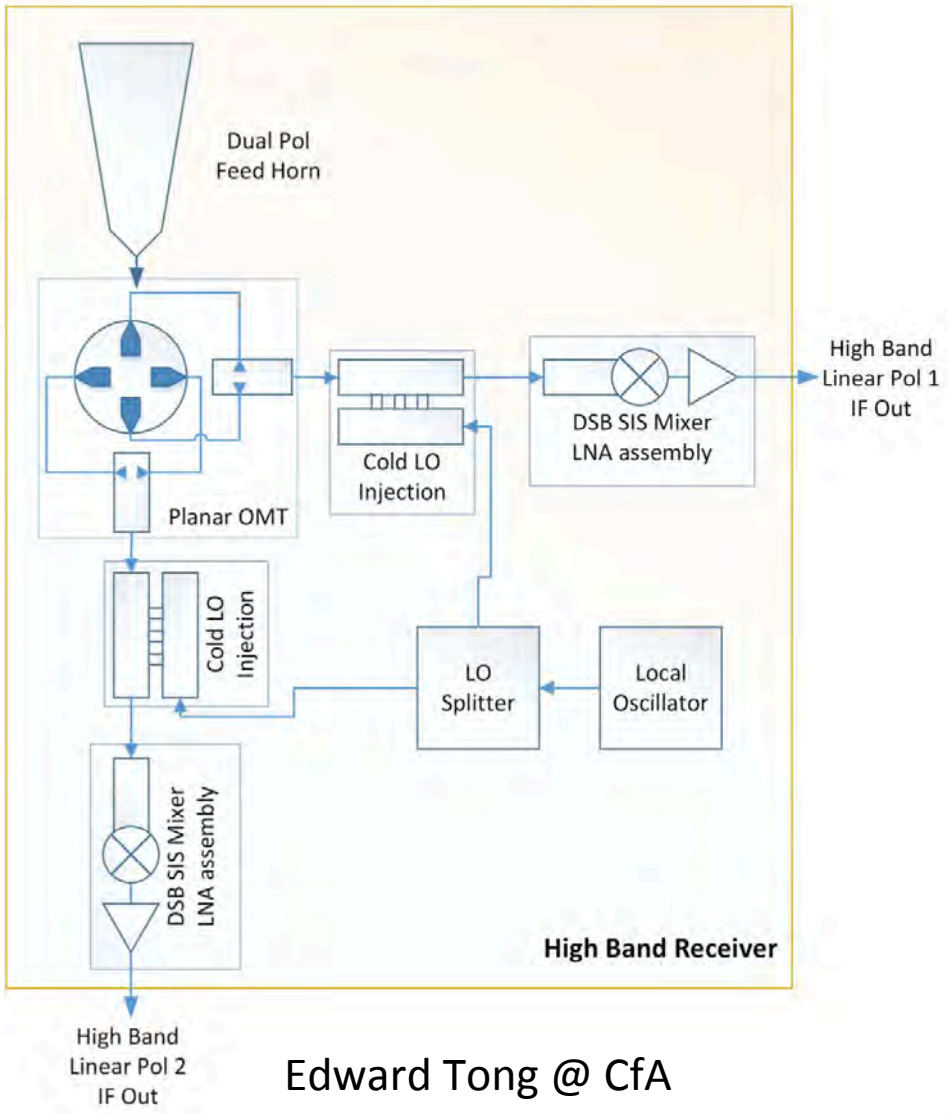
# RxA Upgrade – IF/LO Spectrometer

- Gunn Oscillator is outdated - YIG or VCO based oscillator
- LO injection scheme – optical or cold injection
- IF signal process and transmission network
- IF signal conditioning and digitization
- LO tuning, possible switching, power condition and processing
- CASPER or other technology, eg, GPU.
- 5 GS, 8-bit sampler; 10 GS, 4-bit
- CASPER ROACH2 and upcoming ROACH3
- Scalable for future array receiver?

# Proposed New SMA Rx Front end

With existing and underdevelopment elements

- Smooth wall feed horn
- Planar OMT
- W/G LO coupler
- Wideband SIS
- Wideband isolator
- Low noise amplifier
- YIG based LO




Edward Tong @ CfA

# Example 1: Cost Estimate

| Category | Unit (US$)k | Q't | Cost (US$)k | Description |
|---|---|---|---|---|
| Cryostat | 150 | 1 | 150 | Custom-made, 4K cold head, compressor |
| Front-end | 60 | 1 | 50 | **Single-feed, dual-pol, 2 DSB mixers, OMT** |
| LO Source | 60 | 1 | 60 | YIG, power amplifer, multiplier, WG, tuner, phase lock module |
| Eleco & control | 10 | 1 | 10 | Interface and revision of the existing board and software |
| IF Processing | 50 | 1 | 50 | Possible down conversion, amplification, gain controller, |
| Signal tranport | 30 | 1 | 30 | Fiber transimission with WDM heads |
| ADC 10 Gs | 6 | 6 | 36 | 4-16 GHz, three Nyquist zone samplers, dual pol |
| ROACH 2 | 15 | 6 | 90 | Assume one R2 handles 4 GHz BW, (64Gb of data) |
| Contigen 20% | | | 95.2 | |
| | **Subtotal** | | **571.2** | **Component cost. Lab and labor not included.** |

# Example 2: Cost Estimate

| Category | Unit (US $)k | Q't | Cost (US$)k | Description |
|---|---|---|---|---|
| Cryostat | 150 | 1 | 150 | Custom-made, 4K cold head, compressor |
| Front-end | 60 | 1 | 100 | **Single-feed, dual-pol, 2 SSB mixers, OMT, 1 IF from each mixer** |
| LO Source | 60 | 1 | 60 | YIG, power amplifer, multiplier, WG, tuner, phase lock module |
| Elec & control | 10 | 1 | 10 | Interface and revision of the existing board and software |
| IF Processing | 50 | 1 | 50 | Possible down conversion, amplification, gain controller, |
| Signal trans | 30 | 1 | 30 | Fiber transimission with WDM heads |
| ADC 10 Gs | 6 | 6 | 36 | 4-16 GHz, three Nyquist zone samplers, dual pol |
| ROACH 2 | 15 | 6 | 90 | Assume one R2 handles 4 GHz BW, (64Gb of data) |
| Contigen 20% | | | 105.2 | |
| | **Subtotal** | | **631.2** | **Component cost. Lab and labor not included.** |

# Timeline: 24-month Scenario

- Month 0 – 6:
  - System design
  - Frontend development, LO injection, LO source
  - Develop spectrometer, 10Gs ADC.
- Month 7-12:
  - Acquiring cryostat
  - Prototyping frontend, LO, IF.
  - Build up spectrometer
- Month 13 – 18:
  - Receiving and testing cryostat
  - Testing frontend integration
- Month 19- 24:
  - System integration; test.
  - Final test and deployment