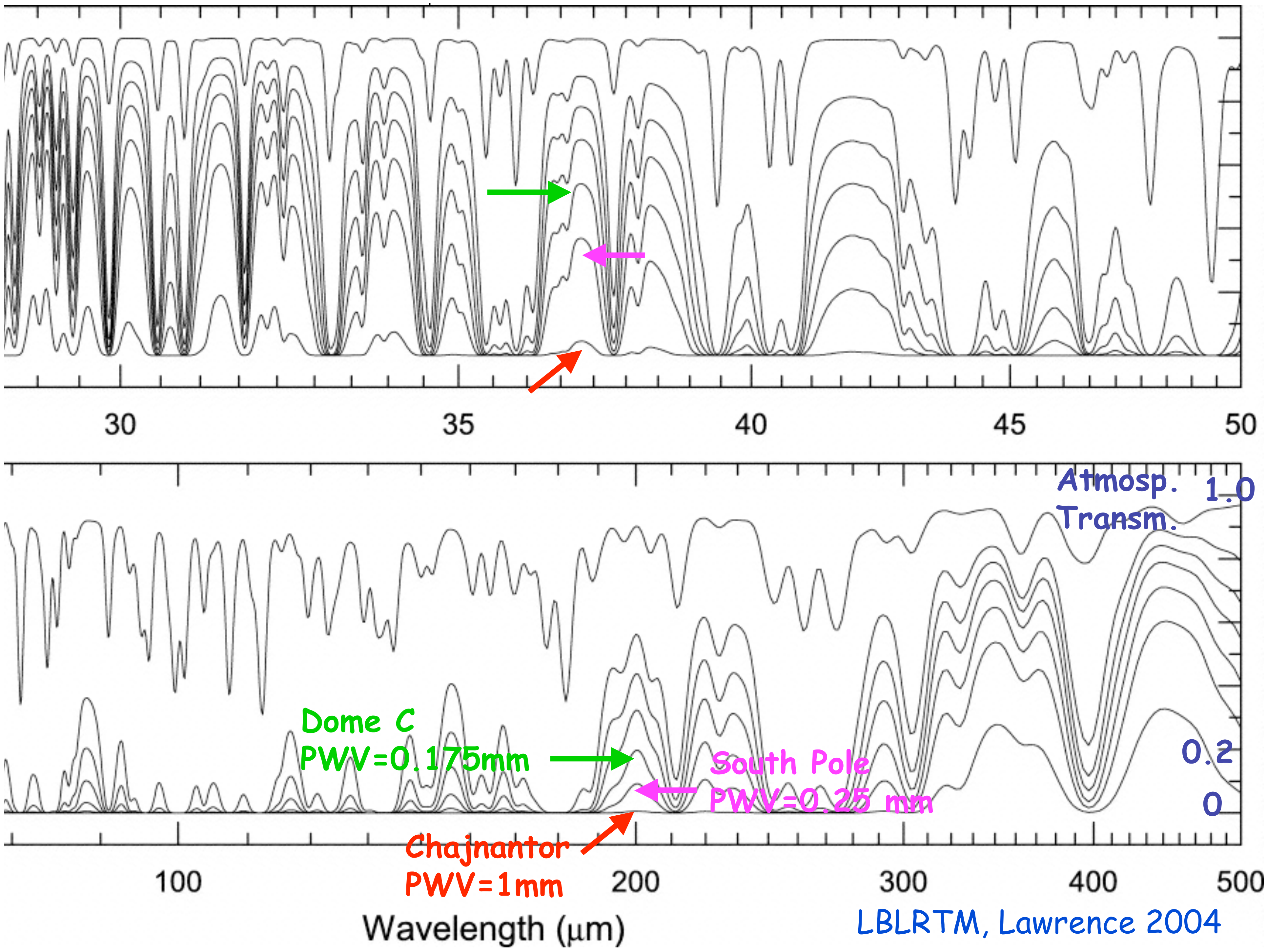

ASO
A proposal for an
Antarctic Submillimeter
Observatory
Luca Olmi (INAF & UPR)
For the
ASO collaboration

- Why Dome C?
- Why 12m?
- What problems at Dome C
- The MIR option

Why Dome C?

Needs confirmation!

- Transp ubmm & MIR): new windows
- Duration of ob nditions in submm/MIR (4-5 hrs at Chajnantor)
- <u>Stability</u> of transparency): calibration, BSW, observing efficiency (co
- Low winds: pointing, radio seeing
- Predictability of weather and transparency: scheduling



30
35
40
45
50
Atmosp. Transm.
1.0
0.2
0
Dome C
PWV=0.175mm
South Pole
PWV=0.25 mm
Chajnantor
PWV=1mm
100
200
300
400
500
Wavelength (μm)
LBLRTM, Lawrence 2004

Why Dome C?

Integration time ratio:
2.4m airborne telescope vs. 12m Dome C telescope

15m Chajnantor telescope vs. 12m Dome C telescope

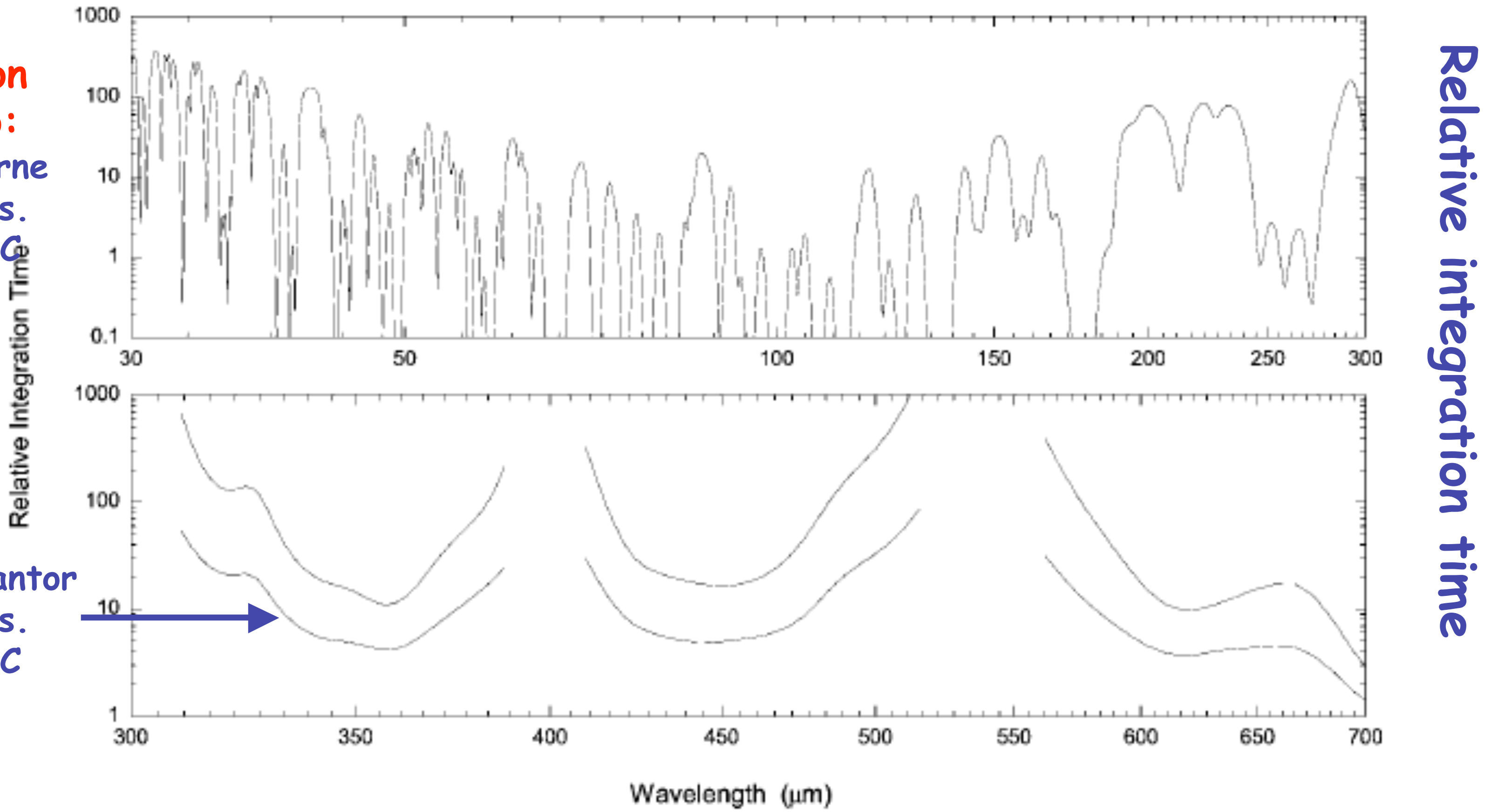


FIG. 10.—Ratio of point-source integration times for a 2.4 m airborne telescope (*top panel*) and a 15 m Chajnantor Plateau telescope (*bottom panel*) to a 12 m Antarctic telescope. In each panel, both Dome C (*lower curve*) and Dome A (*upper curve*) sites are considered. Values are only shown for wavelengths at which the Chajnantor Plateau transmission is greater than 10%.

Lawrence (2004)

Continuum sensitivity of submm telescopes under opacity conditions given by **Lawrence (2004)** at each specific site. The **Noise Equivalent Flux Density** (NEFD) gives the power or flux density for a S/N=1 in 1 sec (EL=45°)

	Telescope	Site	Beam at 350μm [arcsec]	NEFD [mJy $s^{1/2}$]		
				200 μm	350 μm	450 μm
Ground based	ASO 12m	Dome C	7.2	~200	33	28
	SPT 10m	South Pole	10.8	> 2000	100	75
	APEX 12m	Chile	7.2	> 2000	170	140
	JCMT 15m	Mauna Kea	5.8	-	400	180
(Sub) orbital	SOFIA	AIRB.	35	550		
	BLAST	BALL.	45	240		
	HERSC.	SPACE	25	< 20		

Why Dome C?

On high mountain peaks strong (>10 m/s) winds:

Open-air telescope:

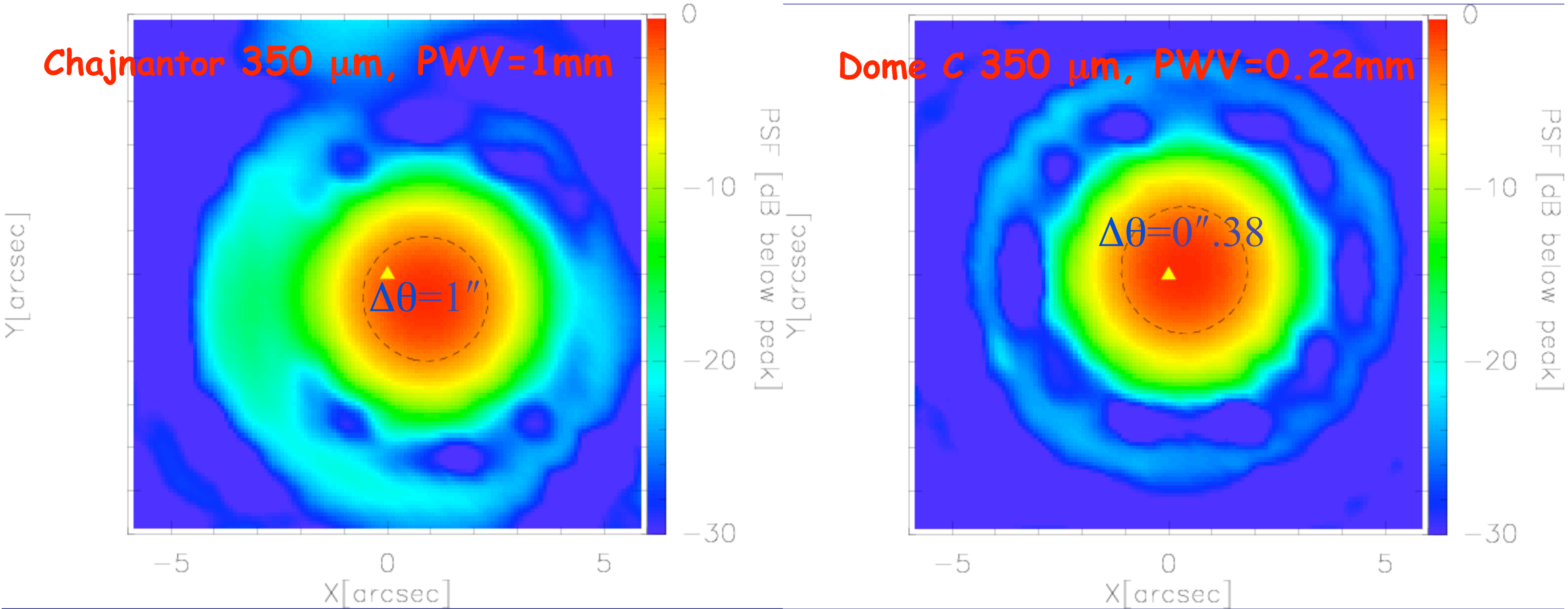
- Require very stiff structures

$$F = \rho v^2 C_D A / 2$$

- Winds deform telescope and exert torques on the base and the soil under the base ⇒ foundations

- Complex pointing in THz wavebands (especially for large apertures) may limit effective THz-time

- Radio seeing critical at subarcsec pointing accuracy



Bad for high D/λ and subarcsec pointing accuracy

Why Dome C?

On high mountain peaks strong (>10 m/s) winds:

Enclosed telescope:

- **No radome. Astrodome may become very large and very expensive.**
- ***Rotating* enclosure must anyway sustain high winds.**
- **Opening mechanism adds complexity and cost**
- **Temperature gradient inside the enclosure may critically affect pointing and surface accuracy**

Why 12m?

SCIENCE

(this Workshop)

Why 12m?

SCHEDULE & COSTS

- Deploy a large aperture using existing design (almost off-the-shelf antenna)
- Best use of logistical and financial resources
- Transportation: vol. of material to be shipped ~ D^3 (two traverses sufficient)

Why 12m?

TECHNOLOGY UPGRADE

- Increase in Precision of antenna ($D/\varepsilon \approx 10^6$)

CSO 10^6 (DSOS), 0.4×10^6
JCMT 0.5×10^6
LMT 0.7×10^6
CCAT 2×10^6

- Technological efforts (and costs) to achieve antenna specs are not a simple linear function of D/ε

- Larger D would require closed-loop active surface

Why 12m?

LOGISTICS & OPERATIONS

- Lower impact on station's power requirements
- Easier access to antenna structure
- Foundations design will be less critical
- Vertical wind-gradient should not be a problem

BUT….

- FOV large enough to accept >10^4 pixels?
- Not an off-axis configuration (continuum)

- F1 = 0.35
- F_{cas} = 6.588
- D_{sec} = 0.8 m
- Bo = 1.2 m
- Abs. point. <2 arcsec
- Track. Err.<0.6 arcsec
- Weight ~ 100 tons

Prototype ALMA (EIE-THALES)

What problems at Dome C?

LOGISTICS & OPERATIONS

- Low temperatures and frosting
- Foundations and telescope stability
- Transportation
- Operations and maintenance w. minimum personnel
- Communications

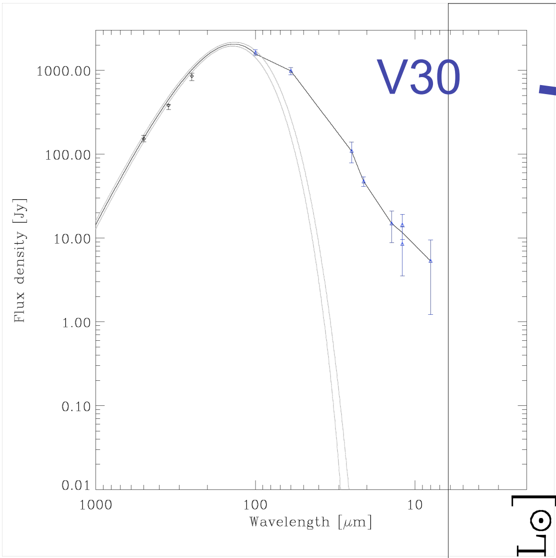
What problems at Dome C?

ANTENNA DESIGN

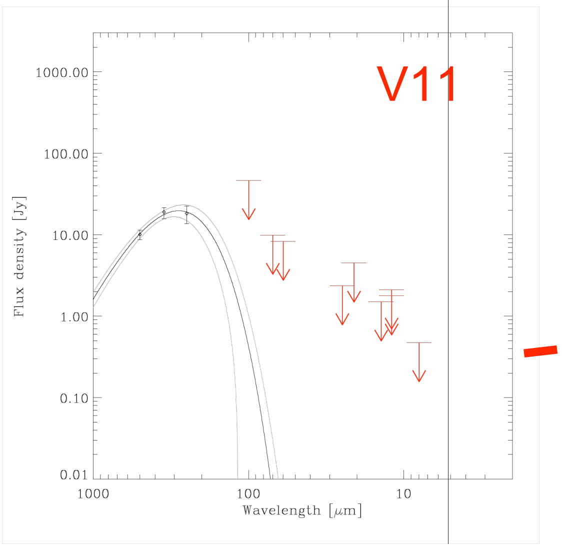
- Materials and joints
- Surface accuracy (maintain current panel design?)
- Subarcsec pointing accuracy. Metrology? (APEX 2."5)
- Wobbling secondary? (⇒ struts & antenna structure)
- Power & cryogenic requirements

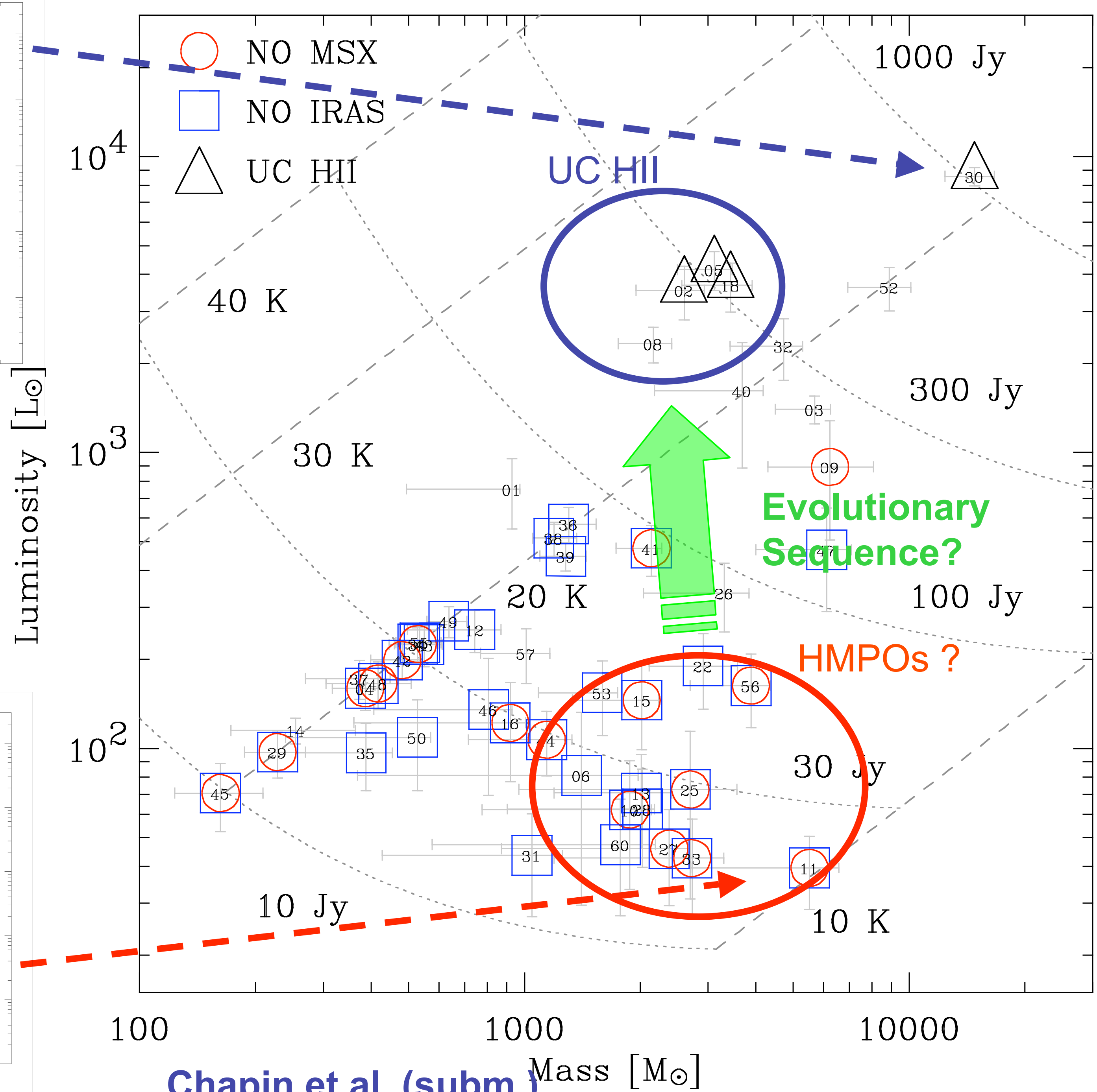
The MIR option

- Science case: this Workshop
- Requires substantial modifications to the original ALMA prototype design
- May also require different transportation techniques
- Unique, simultaneous observations in MIR and submm (maximize THz-quality observing time, IF optical loss are negligible)

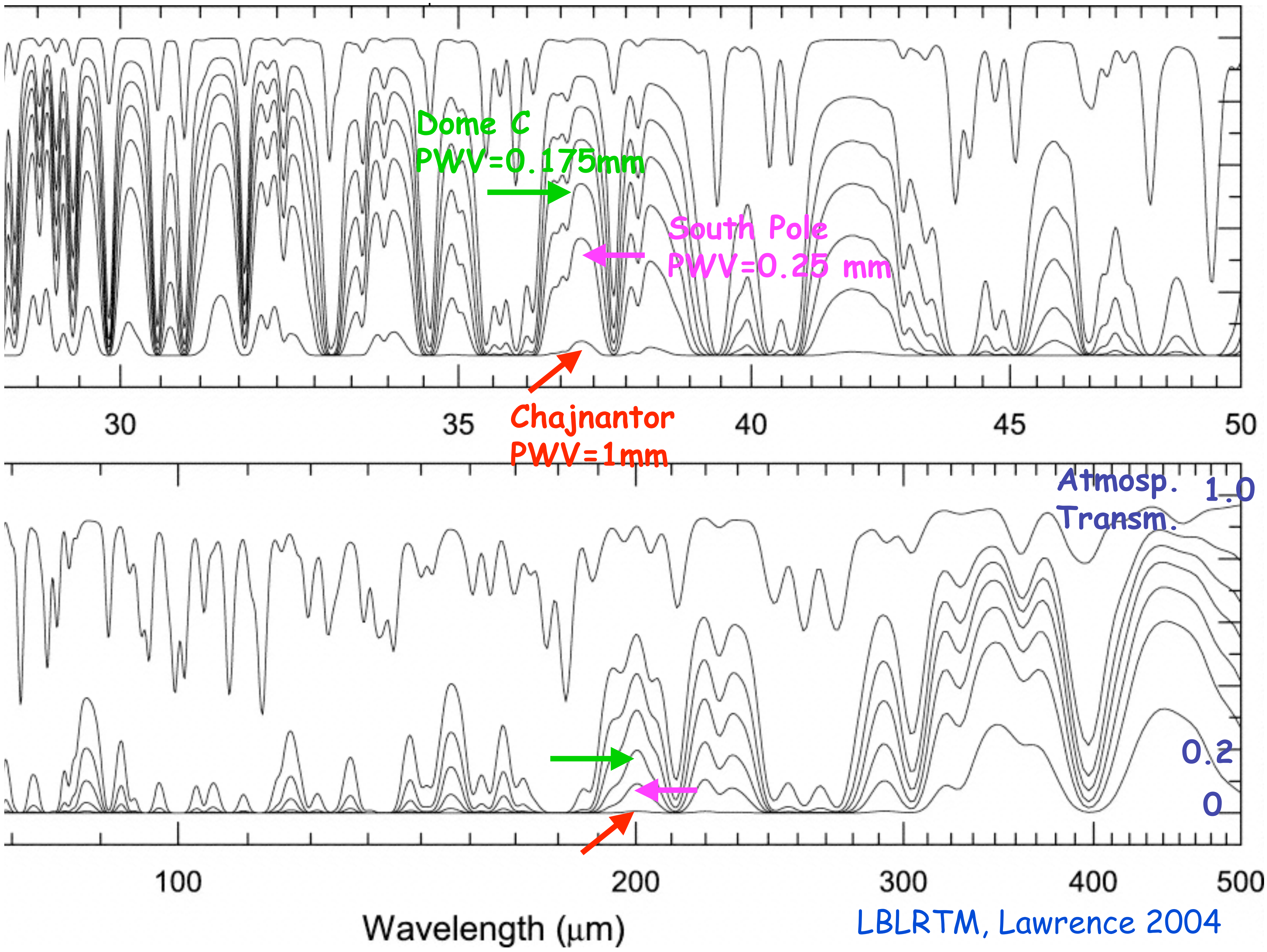


BLAST05





Chapin et al. (subm.)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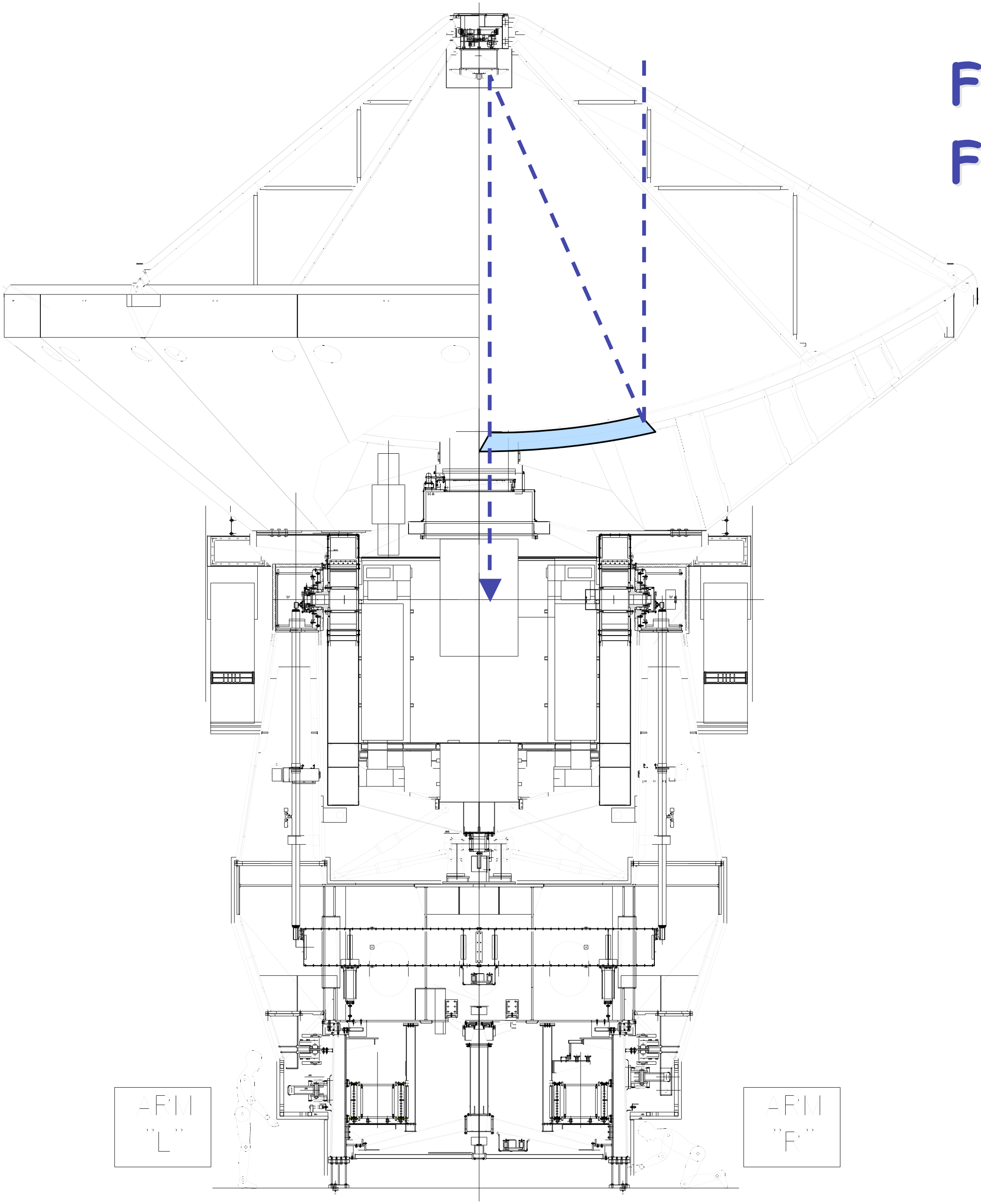
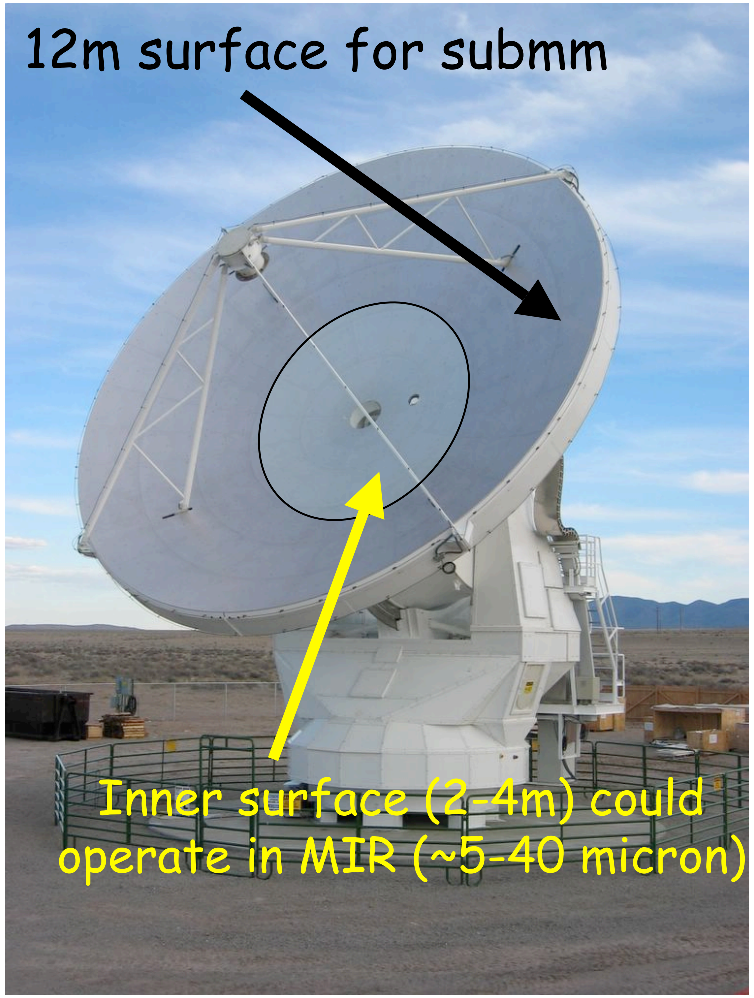


$F_{cas}(\text{submm}) = 6.6$

$F_{cas}(\text{MIR}) = 26.3$



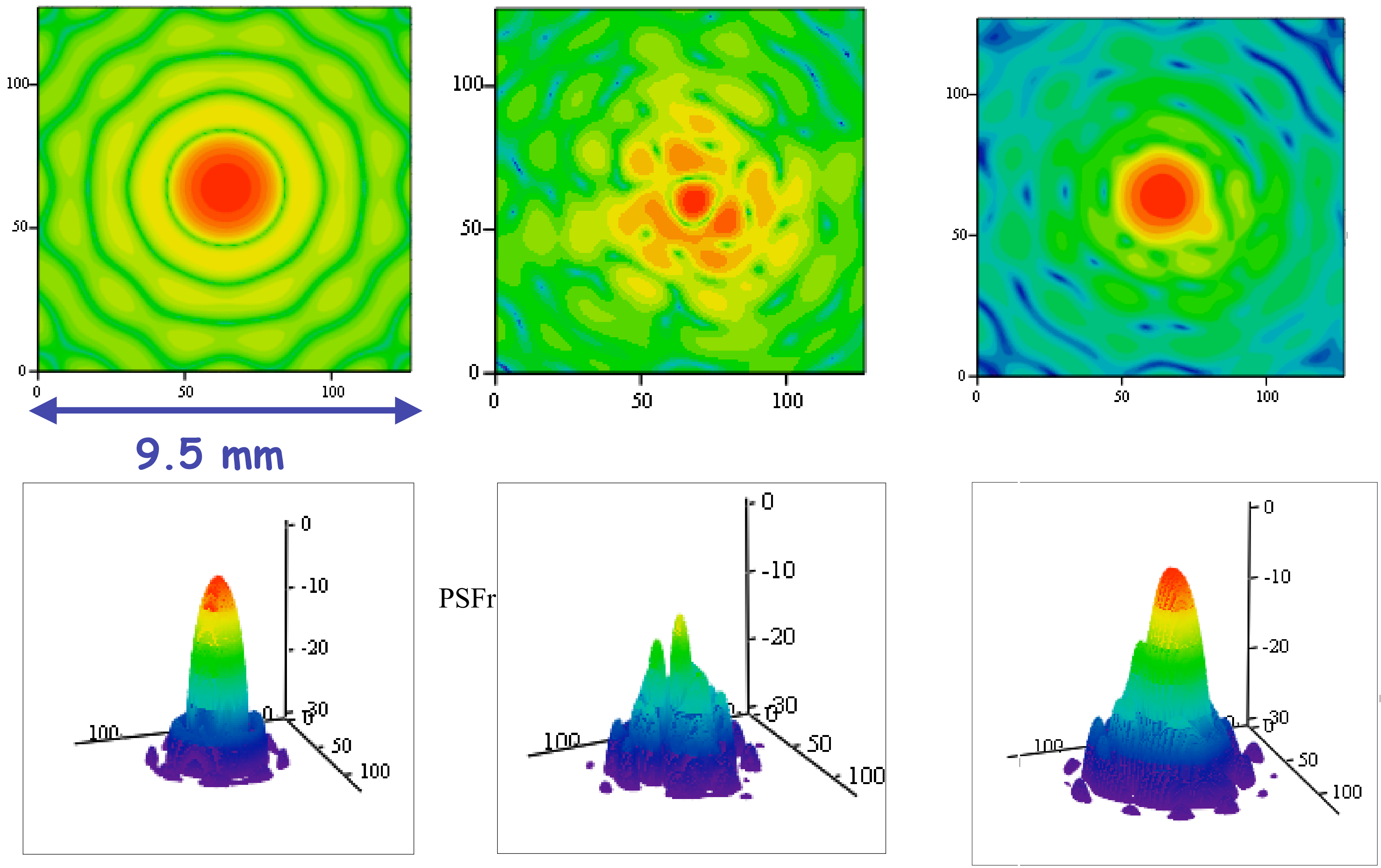
The MIR option: open issues

- Increased surface & pointing accuracy

- Modifications to primary & BUS to insert MIR surface

- Panels or single-mirror surface?

- Use entire 12m surface at MIR wavelengths?



PSF from inner surface

PSF from outer surface

Resulting PSF

λ=40 μm

The MIR option: open issues

- Increased surface & pointing accuracy
- Modifications to primary & BUS to insert MIR surface
- Panels or single-mirror surface?
- Use entire 12m surface at MIR wavelengths?
- Separation of submm and MIR wavebands
- Availability of detectors

What's next?

- Strengthen submm/MIR Science case

- Increase visibility of submm/MIR wavebands within ARENA and Astronomy at Concordia

- Direct measurement of transparency and its stability in THz and MIR windows

- Feasibility study for winterization of ALMA antenna

- Extension of engineering study to MIR