IRAM's Prospects for Submm Astronomy

ARENA Workshop

CEA/Saclay

June 25

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The 30m telescope at Pico Veleta

- Two observatories : Plateau de Bure Array + Pico Veleta 30m
- Three partners: CNRS, MPG, IGN
- Open to the international astronomical community → RadioNet

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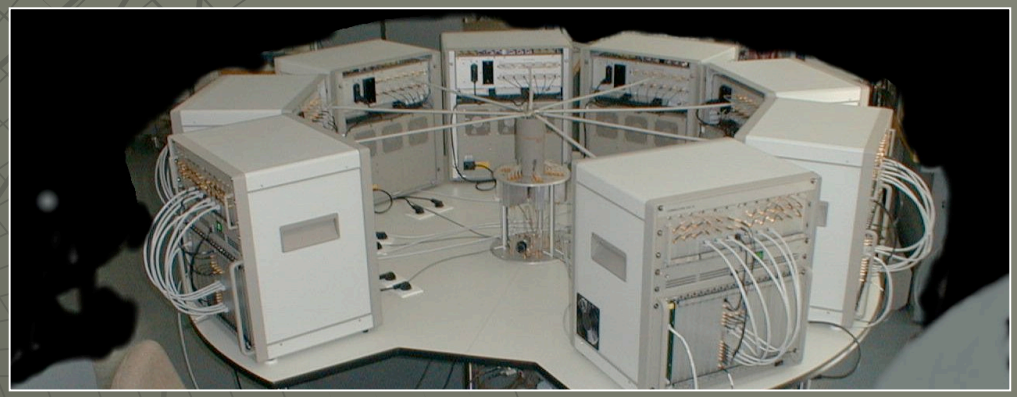
IRAM's expertise: pictures worth a thousand words



- Telescope design (~35 um RMS), construction and operation
- Receiver design and development e.g. ALMA Band7, AMSTAR
- HS-digital backends + LO systems e.g. dual 4 GHz correlator

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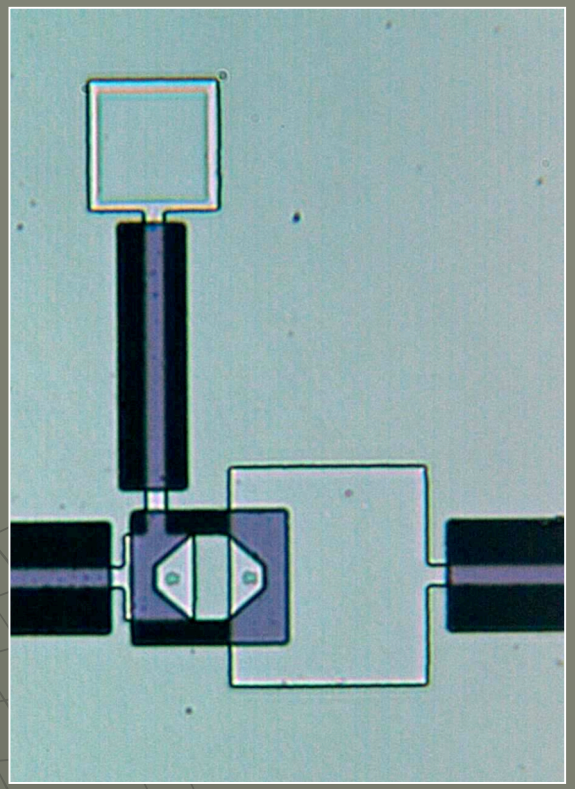

- Class 100 clean room for thin film technology
- Complete mm/THz-wave technology laboratory
- Developments for e.g. SMA, Herschel

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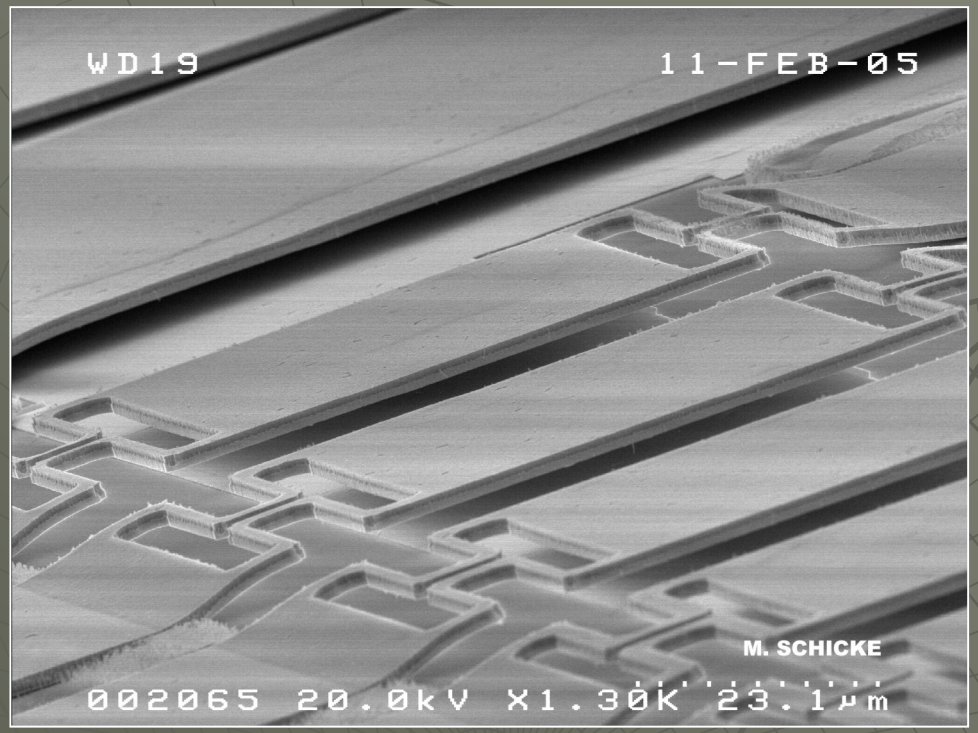

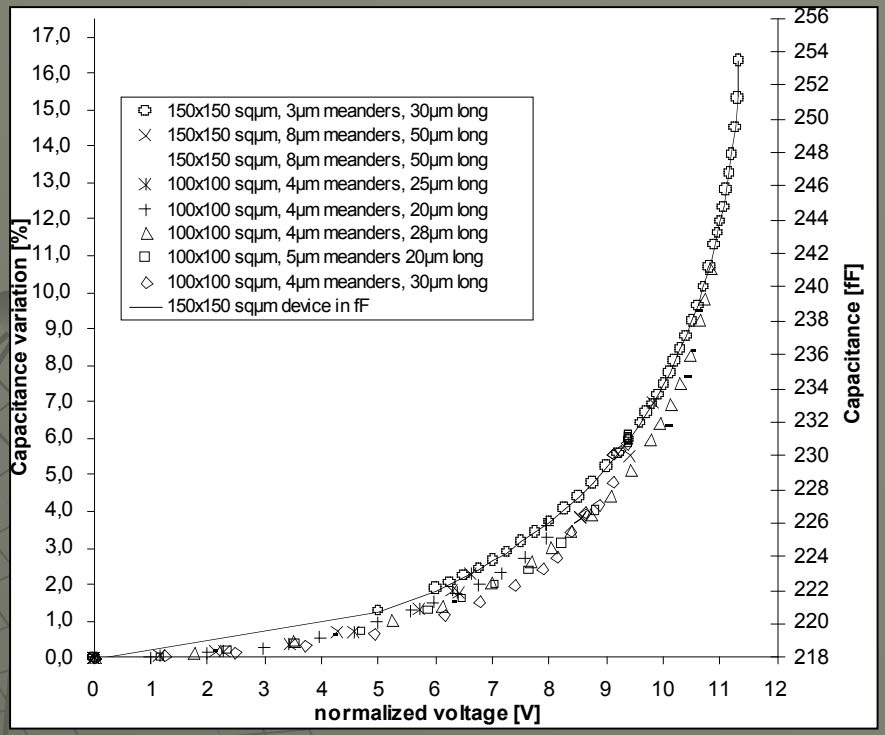

High precision micro-machining + electroforming workshop

- Development of RF MEMS, SupraMEMS

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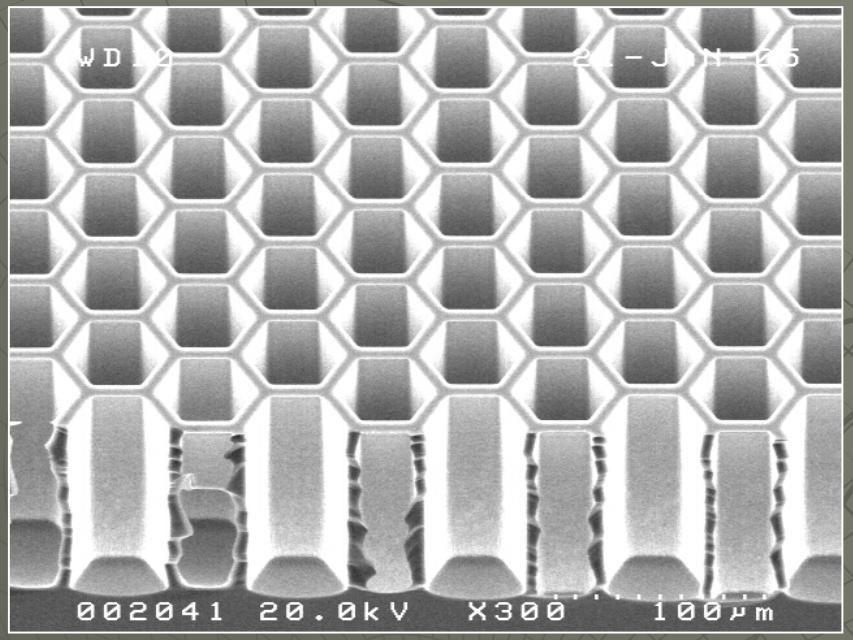

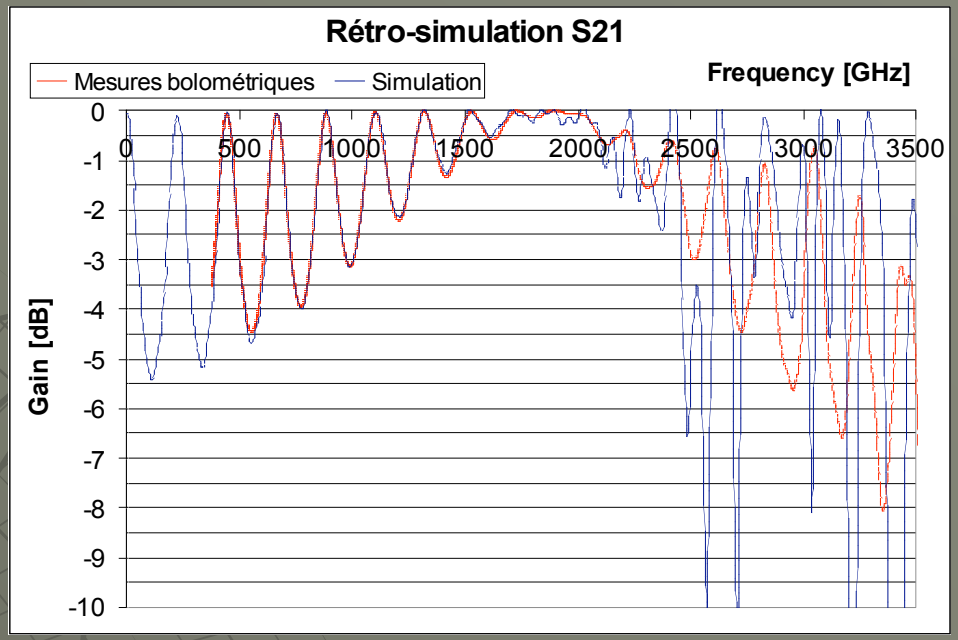

High precision micro-machining + electroforming workshop

- Development of RF MEMS, SupraMEMS
- Development of THz artificial dielectrics

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The Plateau de Bure Interferometer

- Plateau in the French Alps at an altitude of ~2550m
- Staff access by helicopter and ground transport ~ 1 week

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The Plateau de Bure Interferometer

- potentially excellent testbed for future submm instruments
- non-stop operation

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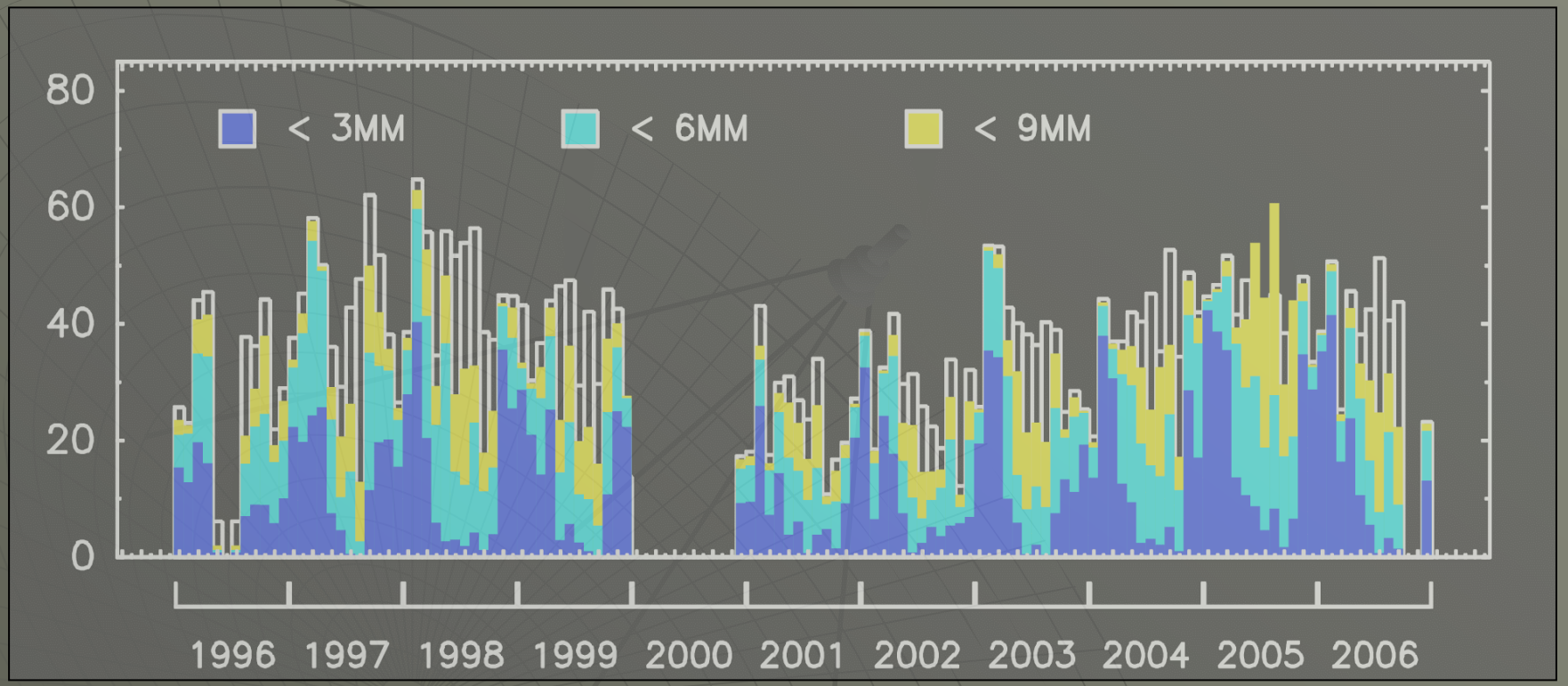
Weather @ PdBI (PWV)



- PWV down to 0.3mm in winter time
- Submillimeter observing conditions ~ 30 days / year

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The NGRx capabilities

Item	Value	Notes
RF bands		
1	80 – 117	
2	129 – 174	fall 2007
3	200 – 267	currently 200 - 257 GHz
4	277 – 371	fall 2008
RF response	SSB	LSB or USB Image Gain <-10dB
IF band	4 – 8 GHz	Available at FE/BE interface
Polarization	Dual linear	Circular also possible
Observing mode	Single frequency Dual polarization	Second band in standby Potential for Dual freq, Dual pol

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State of the Art Receiver Technology
PdBI Sensitivity and Speed Gains

ATM (Cernicharo 1985)

Winter values: Tamb=265K, A=1.4 airmass

	PWV	G	η	Trec	τ	Tsys	Sens Gain	Speed Gain
100 GHz	3	0.02	0.95	40	0.07	88	1.10	1.22
150 GHz	3	0.02	0.92	40	0.10	118	-	-
230 GHz	1	0.02	0.87	50	0.08	131	1.96	3.86
350 GHz	1	0.02	0.84	50	0.28	293	-	-

The submm range goes with more …

- Spatial resolution
- Bright molecular and dust emission

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Sensitivities in mJy et al.
Groundbased Submm Telescopes

Winter values: Tamb=265K, A=1.4 airmass, PWV = 1mm, λ = 850 um

Facility	Surface (m^2)	mJy after 1 hr on-source	Time (yr)	Spectroscopic Efficiency
ALMA	6000	0.04	0.50	0.02
PdBI	1050	0.5	0.08	0.01
PV	700	?	0.12	0.01
SMA	220	2.4	0.50	0.005
[illegible]	[illegible]0	0.6 (2007)		0.005
[illegible]	[illegible]	?		0.01?
[illegible]	[illegible]	-		0.005

Call for Letters of Intent

7" @ 850um FOV=10'

10^3 – 10^4 pxl, Nyquist

NEP ~ 10^{-17}

Spectroscopic Efficiency = Fractional Bandwidth @ 850 um

PdBI = 0.01 = 4 GHz / 350 GHz

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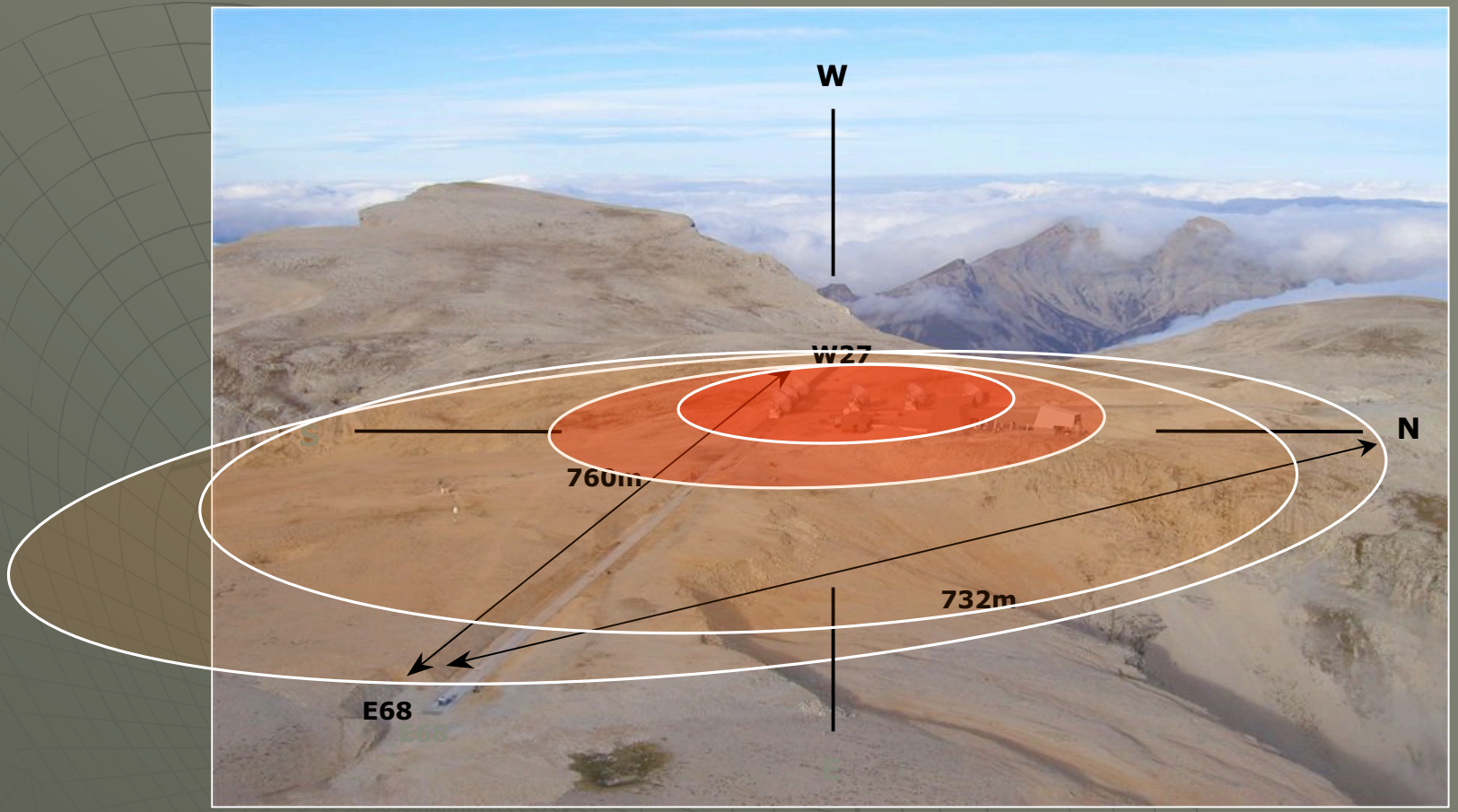
Why higher frequencies ?



Configuration D @ 80 GHz	6″
Configuration A @ 370 GHz	0.2″

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PdBI Science Drivers for 850um ?

Science Drivers 2005 >	Allocated Time	Keyword
Galaxies @ high-z : LBG, SMM, ERO, RG	30%	"CSF history"
Nearby Galaxies : Spirals, (U)LIRGs	30%	"dynamics + structure"
YSO : Prestellar Clouds → T-Tauri Stars	30%	"SF + evolution"
Evolved Stars	5%	"mass loss"
Chemistry, Solar System, …	5%	

Configuration + Frequency	Spatial Resolution
Configuration D @ 80 GHz	6"
Configuration A @ 370 GHz	0.2"

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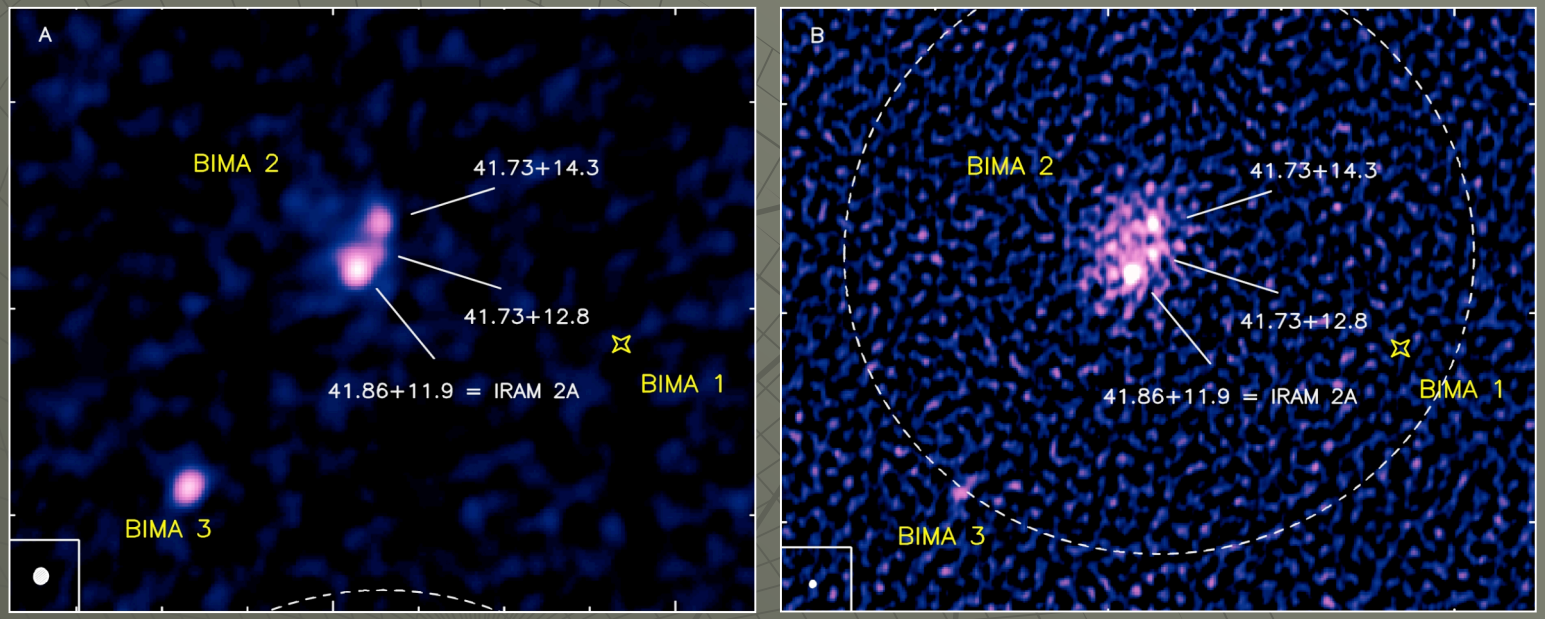
Star Formation Regions e.g. IC1396 N

92 GHz = 3.3 mm → 238 GHz = 1.3 mm → 370 GHz



?

Neri et al. 2007

- Dust properties (β and κ) → formation + processing of dust
- LM/IM stars → cluster formation → spatial resolution

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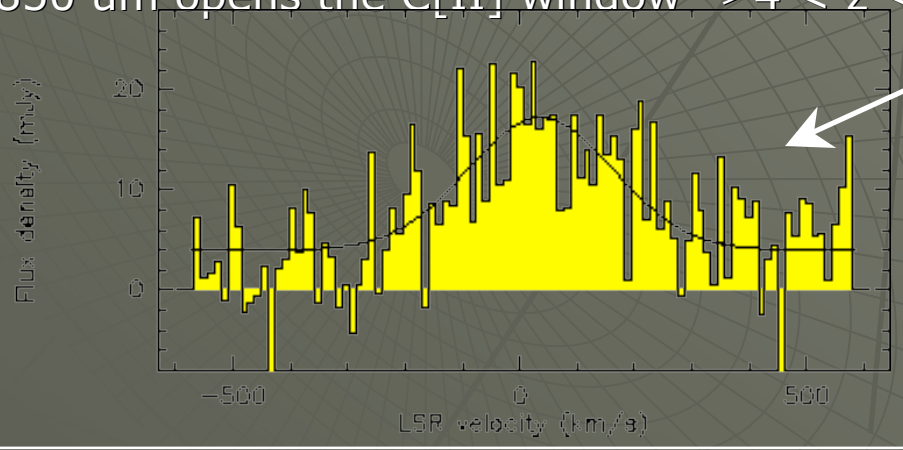
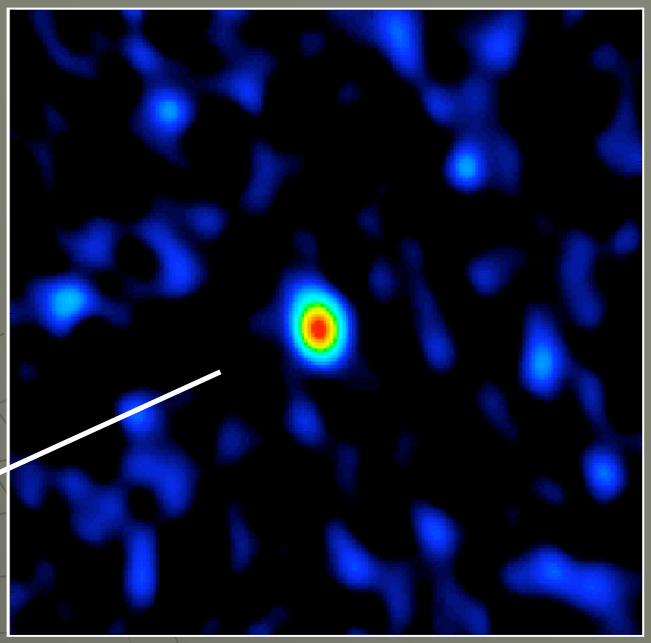
Star Formation @ high-z

- C[II] @ 158 um
- Is produced in PDRs → UV-radiation
- Tight C[II]/^{12}CO correlation
- Tracer of SF in SB galaxies → PDRs ~ 40% M_{Gas}
- J1148 detected @ z =6.42 (!)
- 850 um opens the C[II] window → 4 < z < 6



J1148+5251 @ 257 GHz



Walter et al. 2007

Maiolino et al. 2005

PdBI on Jan 29, 2007

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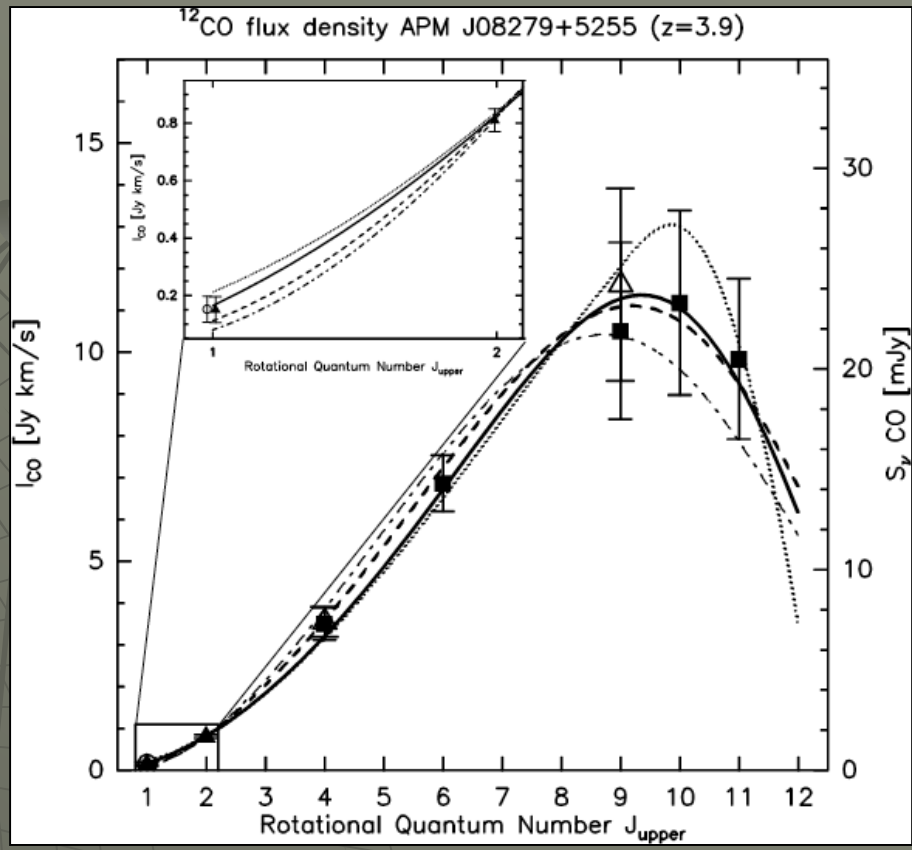
Gas Excitation Conditions @ z > 1

Molecular Lines:

- ^{12}CO(11-10) (!) detected @ z = 4
- ^{12}CO @ high-z traces warm gas and dust
- Limits on virial mass + α(M/L') → M_{Gas}
- 850 um → ^{12}CO-SED @ z = 2.5

- Detected: HCN, CN, HNC, HCO^+, C[I]
- Planned: H_2CO, H_2O, …
- 850 um → complements the ML-SEDs



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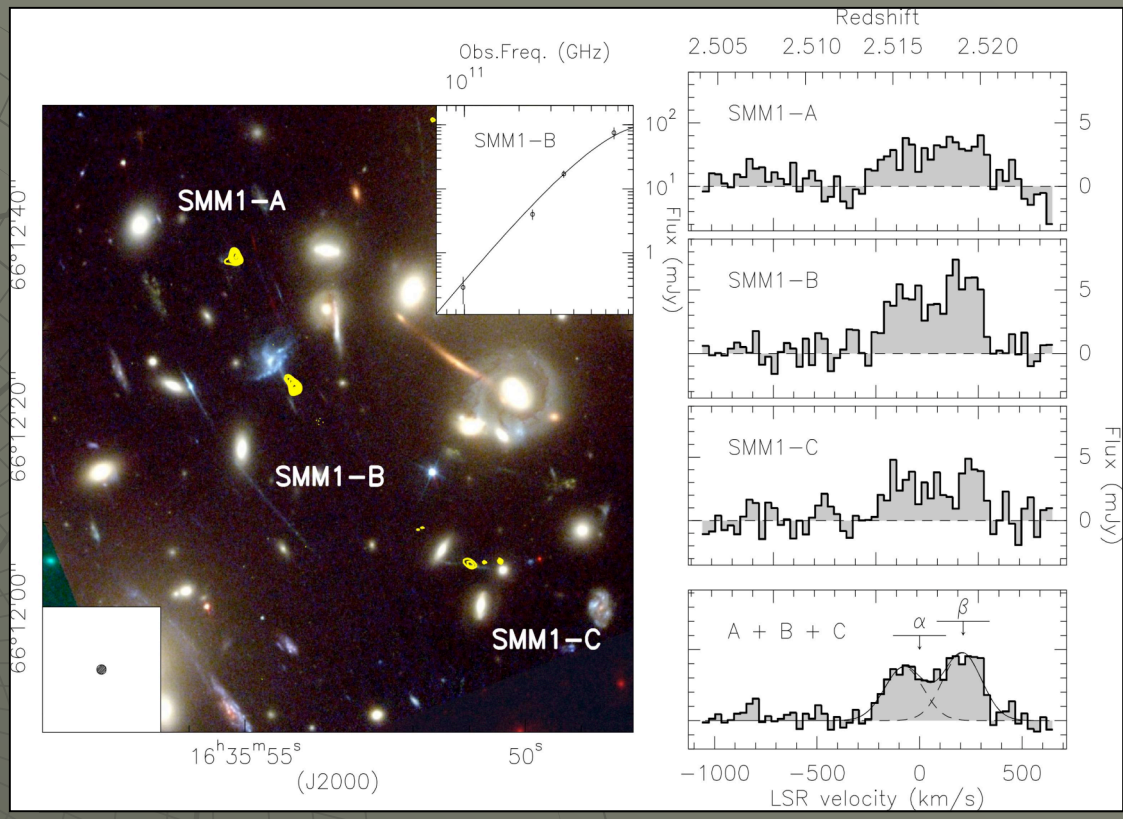
Star formation @ z > 1

- Dust:
  - $M_{Dust} \sim S_{1200}$ for $1 < z < EoR$
  - $SFR \sim S_{1200}$ for $1 < z < EoR$
  - $L_{FIR} \sim S_{1200}$ for $1 < z < EoR$
  - Bright @ 850 um → T_{Dust}
  - 850 um @ 0.2” → ~ 1kpc
  - Uncover mm-weak galaxies



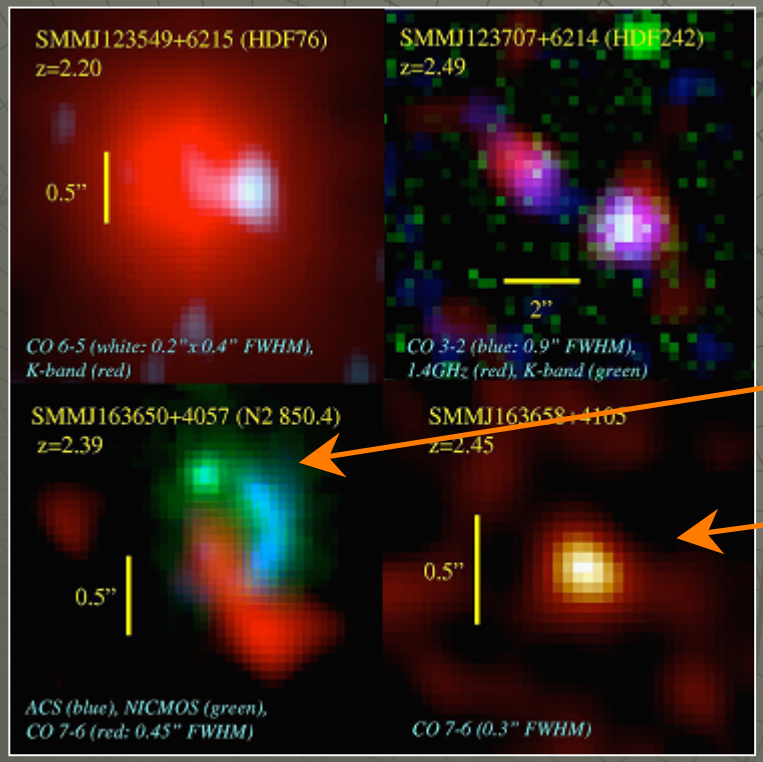
Knelb et al. 2007

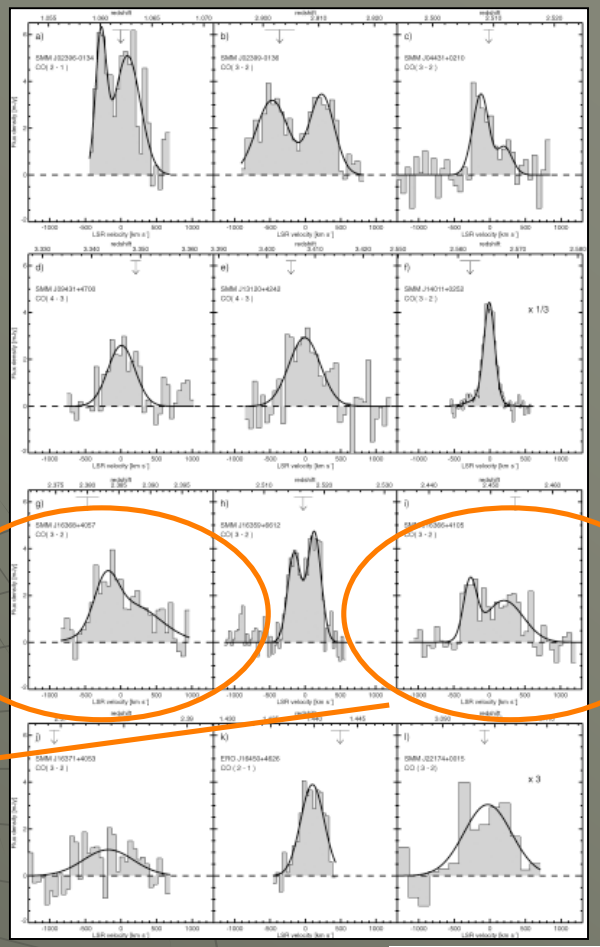
Vnss H. 2003

Star formation @ z = 2.5

Surveys:

- Submm bright Galaxy Population → MSB ?
- Single or merging LIRGs ?





Greve et al. 2005

Tacconi et al. 2007

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