

# STATE-OF-THE-ART HIGHLIGHTS

## Frequency Multipliers

### **JPL - HIFI Mission (currently driving the state-of-the-art)**

☞ *LO Band Plan*

### **RPG - P. Zimmermann (whiskers and tuners allowed)**

☞ *LO Source Plot*

### **U. Mass. - N. Erickson**

- \* Fixed-tuned planar balanced tripler design: 280 GHz, predict 10 % BW
- \* Fixed-tuned, 4-diode doubler: 130-156 GHz, 30 mW out, 25 % eff.  
6-diode doubler: 80 mW out at 140 GHz with 270 mW input
- \* Doubler to 270 GHz: 14 mW out, 25 % eff. - increase to 35 % upon cooling to 77 K
- \* Cascaded pair of doublers: 325-336 GHz out, peak 7.2 mW for 150 mW input  
2nd stage eff. 19 % at 328 GHz
- \* Isolators: Ferrite-type, 85-115 GHz, 0.8 dB loss (0.4 dB at 77 K)  
110-170 GHz, 1.0-1.5 dB loss Up to 350 GHz possible



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## Introduction

Problem:

Provide sufficient drive power for the FIRST LO multiplier chains with adequate bandwidth to support multiplier bands.

| PA bands          | 71-79 GHz            | 80-92 GHz           | 88-99 GHz            | 92-106 GHz           | 106-112.5 GHz        |
|-------------------|----------------------|---------------------|----------------------|----------------------|----------------------|
| x2                | 142-158              | 160-184             | 176-198              | 184-212              | 212-225              |
| x2 x2             | 284-332              | 320-352             | 352-396              | 380-420              | 424-450              |
| x2 x3             |                      | 480-552<br>Band 1a  |                      | 552-636<br>Band 1b   |                      |
| x2 x2 x2          |                      | 640-704<br>Band 2a  | 704-792<br>Band 2b   | 800-840<br>Band 3a   | 848-900              |
| x2 x2 x3          | 852-950<br>Band 3b   | 960-1056<br>Band 4a | 1056-1120<br>Band 4b | 1140-1260<br>Band 5  | 1272-1350            |
| x2 x2 x2<br>x2    |                      |                     | 1408-1584<br>Band 6a | 1584-1696<br>Band 6a |                      |
| x2 x2 x3<br>x2    | 1704-1896<br>Band 6b |                     |                      | 2400-2520<br>Band 7a | 2544-2700<br>Band 7b |
| Module Power (mW) | 200                  | 200                 | 200                  | 300                  | 300                  |

# LOCAL OSCILLATOR SOURCES

## Power output of various multipliers

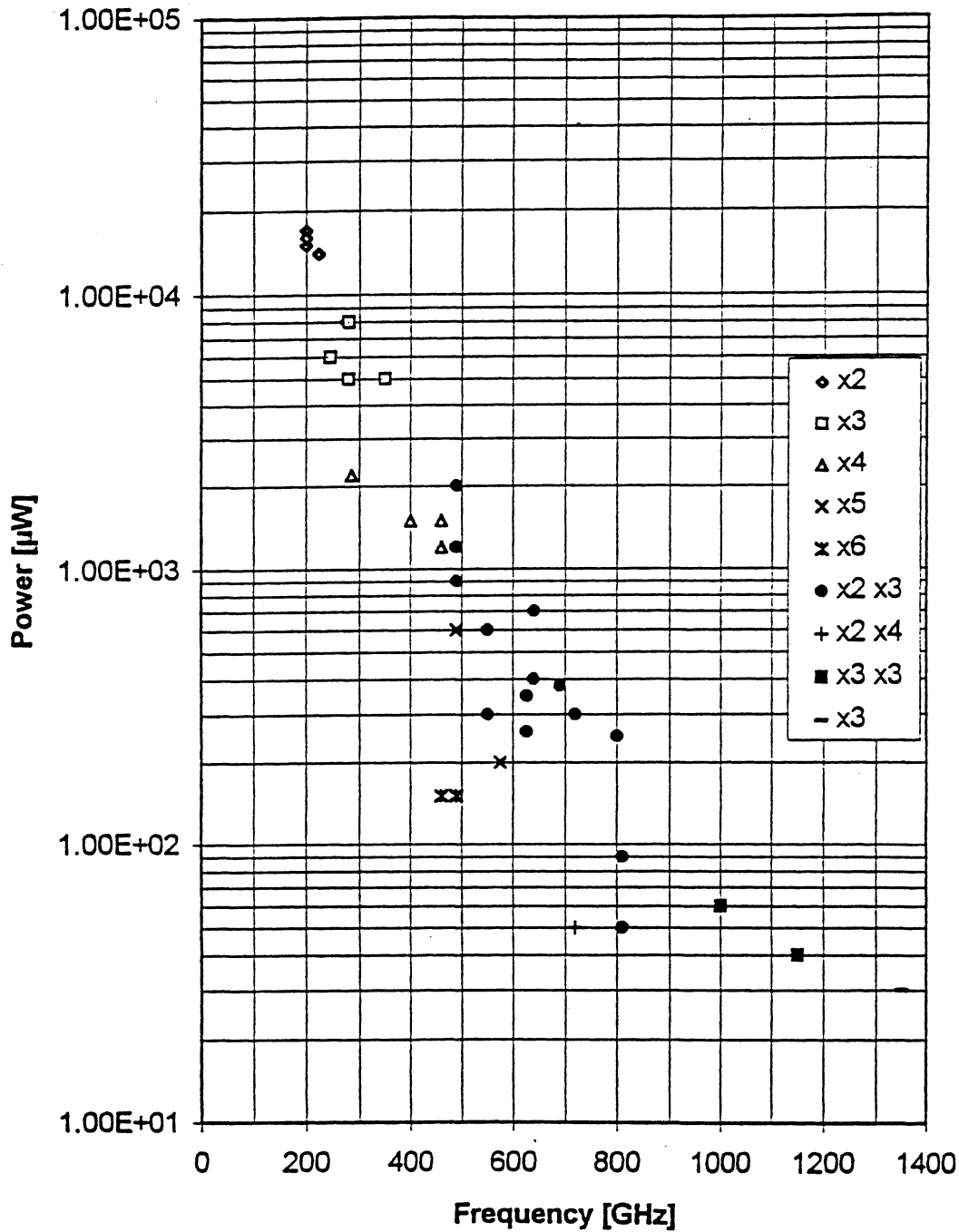


Figure 1 Solid-state local oscillator power outputs to 1.5 THz

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## Frequency Multipliers

### JPL - Siegel, Smith, Mehdi, et al (MoMeD)

- \* Tripler to 2400-2700 GHz using varistor diodes on monolithic membrane  
Preliminary design completed

### Millitech

- \* X2 X2 (300 GHz quadrupler): 5 mW for 100 mW input
- \* Fixed-tuned, whiskered triplers have output power up to 1.0 mW over 20 percent BW

### Virginia mm-Wave Inc. - D. Porterfield

- ☞ *40/80 GHz doubler results*
- \* 80/160 GHz doubler:
- \* 100/200 GHz doubler:
- \* 200/400 GHz doubler (design only)

### RAL - C. Mann

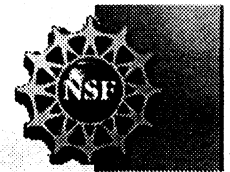
- ☞ *QBV (diode from IEMN, Lille, Fr.)*

### U. Mich. - J. East

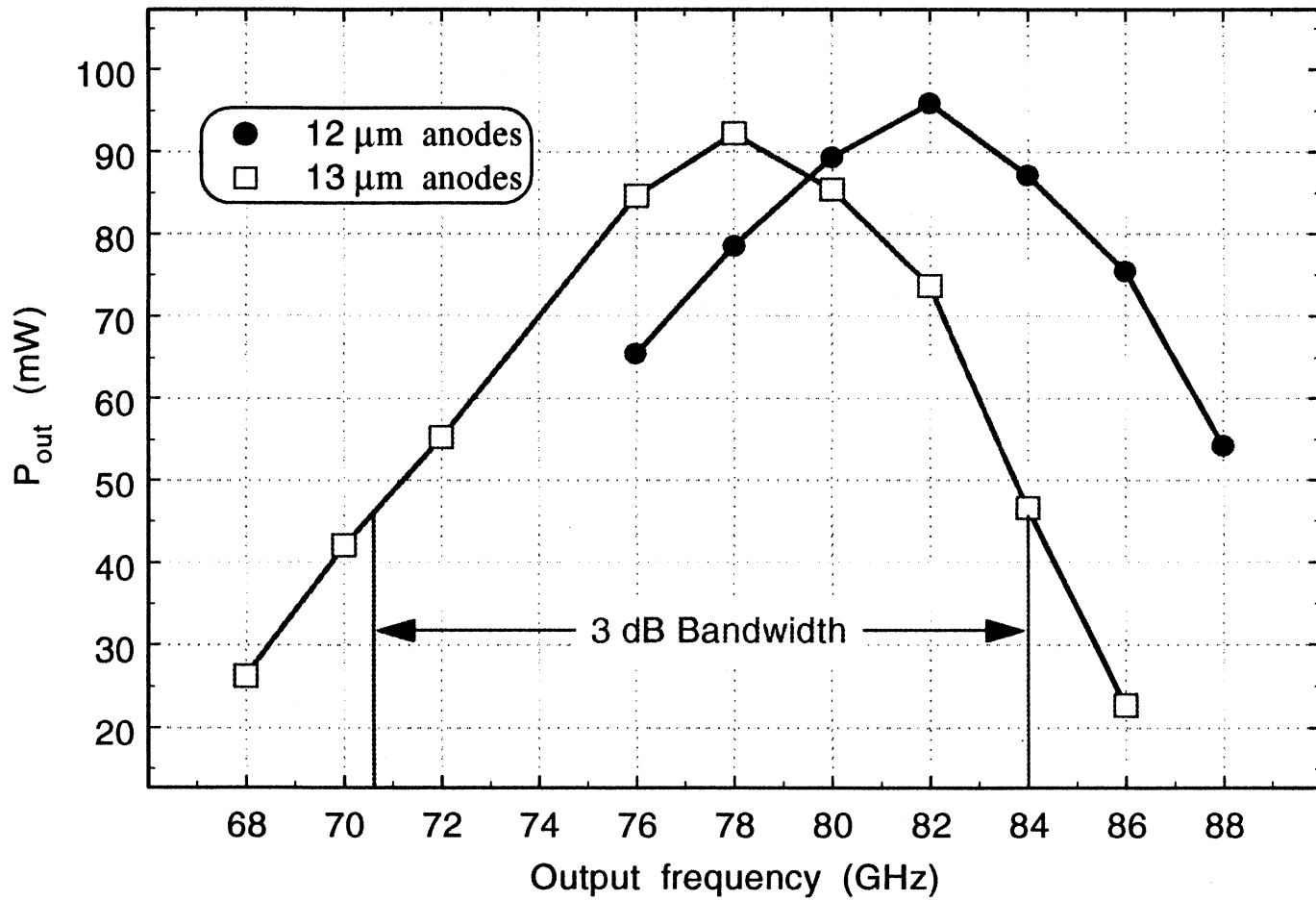
- \* MMIC Doubler: output 70-78 GHz with 10 mW, 10 % eff.

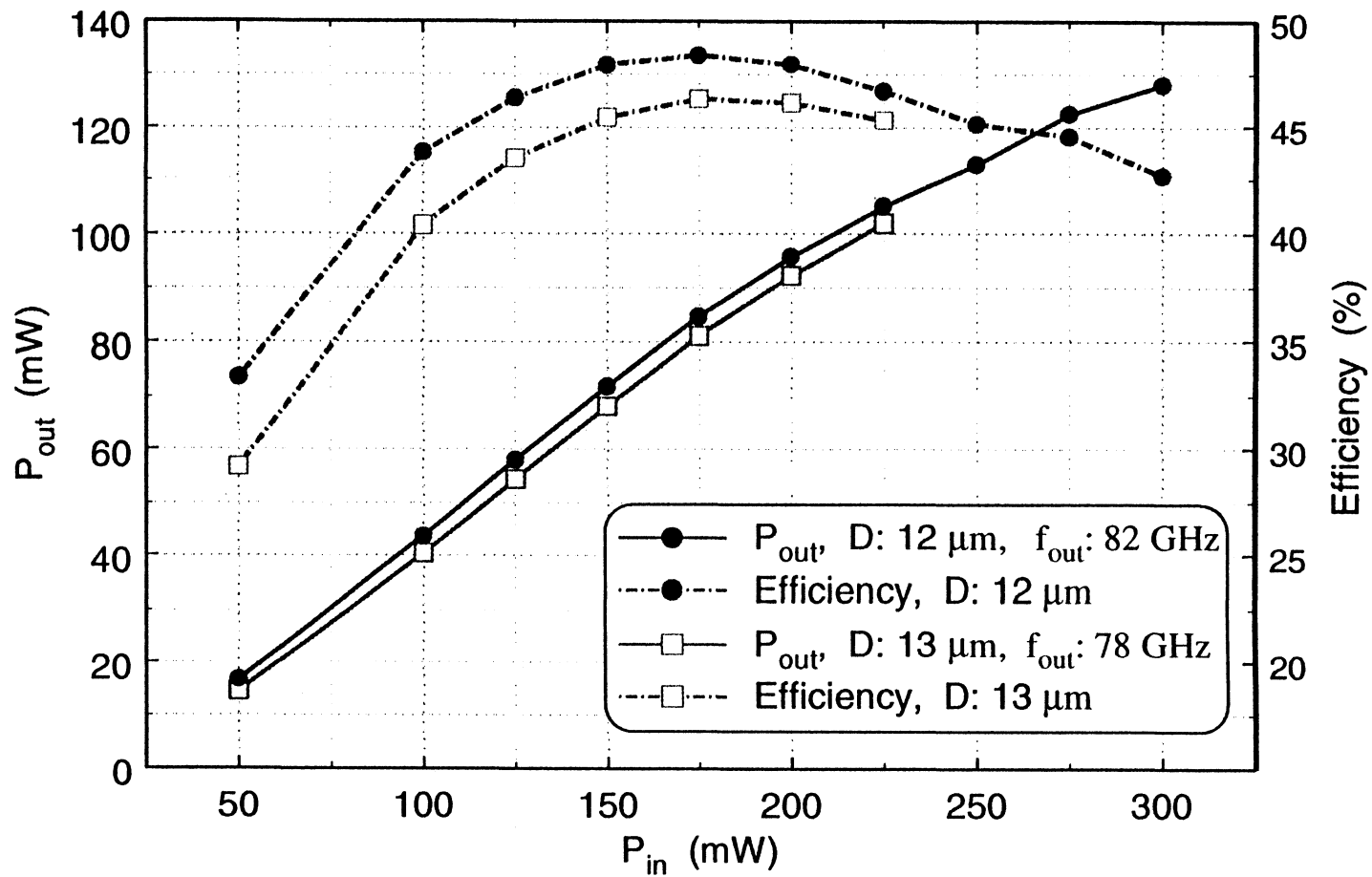


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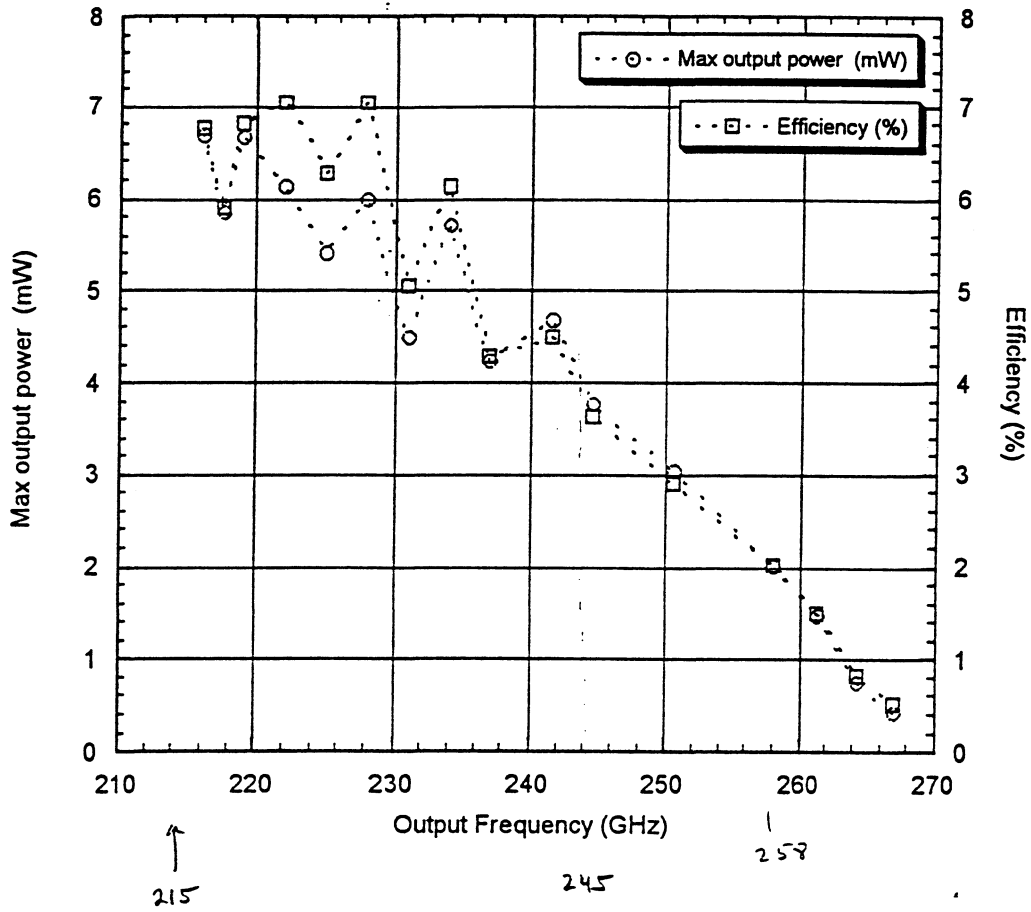
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100 mW  
INPUT

### RAL Tripler DB2a Implementing a Lille InP HBV



50 mW Experimental 185 - 245 GHz 1.32  $\geq$  2 mW 4% eff

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## Amplifiers and YIG Oscillators

**JPL, TRW, et al. - For HIFI**

**MMIC Power Amplifier (PHEMT)**

**Frequency: 86-93 GHz**

**Output Power: >100 mW**

**Gain: ~8 dB**

*Goal: 400 mW for HIFI driver bands from 69-115 GHz (power combine)*

**Sanders**

**InP PHEMT Power Amplifier**

**Frequency: 90-98 GHz**

**Output Power: 140 mW**

**InP PHEMT Power Amplifier**

**Frequency: 58-64 GHz**

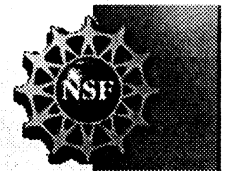
**Output Power: 500 mW**

**Gain: 9 dB**

**Power combined four chips to give 1000 mW**



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## Amplifiers and YIG Oscillators

### MITEQ - Amplifiers

Frequency: 20-30 GHz

Output Power: 100 mW

Gain: 10 dB

Price: \$2500 (Qty: 1-4)

Frequency: 26-40 GHz

Output Power: 100 mW

Gain: 17 dB

Price: \$1350 (Qty: 1-4)

### Micro Lambda - YIG Oscillator

18-26.5 GHz, 40 mW (*can push to 30 GHz*)

17-24 GHz, 40 mW

\*\*\* expecting a quotation \*\*\*



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