John Payne's Contributions to the Front End Local Oscillator Effort

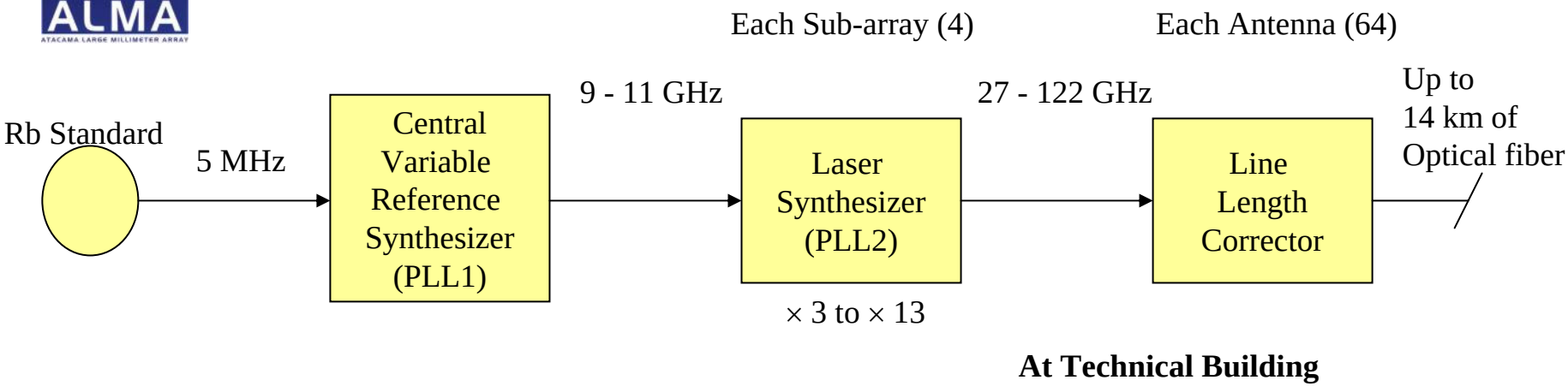
The Golden Year

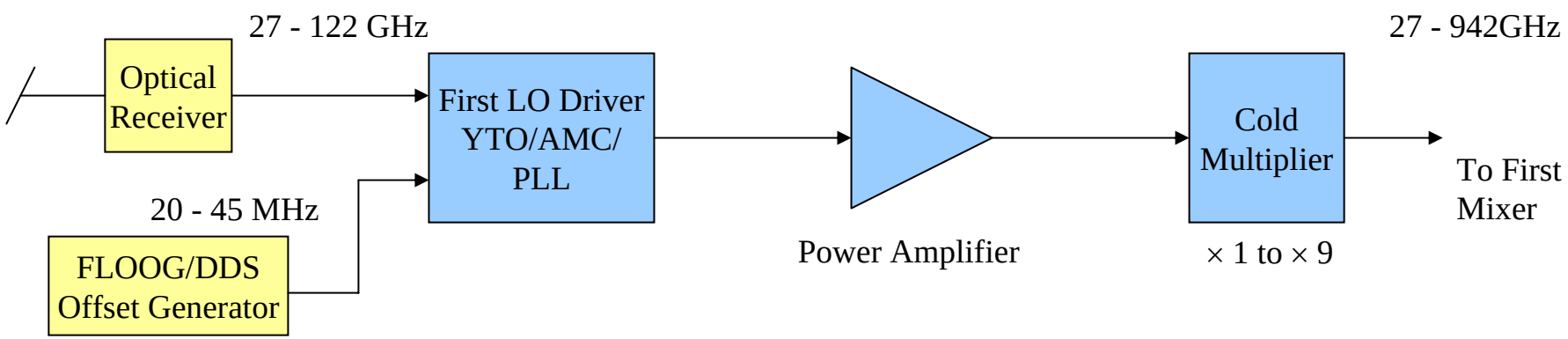
Presented by: Skip Thacker

The Golden Year

- In 2003 John Payne served a one year temporary appointment as “LO Coordinator”
- Coordinated the efforts of Bill Shillue’s photonics group in Tucson, the FELO Group’s efforts in Charlottesville, Clint Janes’ efforts in Socorro and Larry D’Addarrio efforts.
- John put in place a management structure that has allowed the FELO Group to produce what I will describe to you in the rest of this talk.
- I would like to emphasize that everybody at that time, both the upper management and the people who worked for John, agreed that John had done an excellent job of coordinating the LO efforts and had indeed solved many problems.

First LO Overview





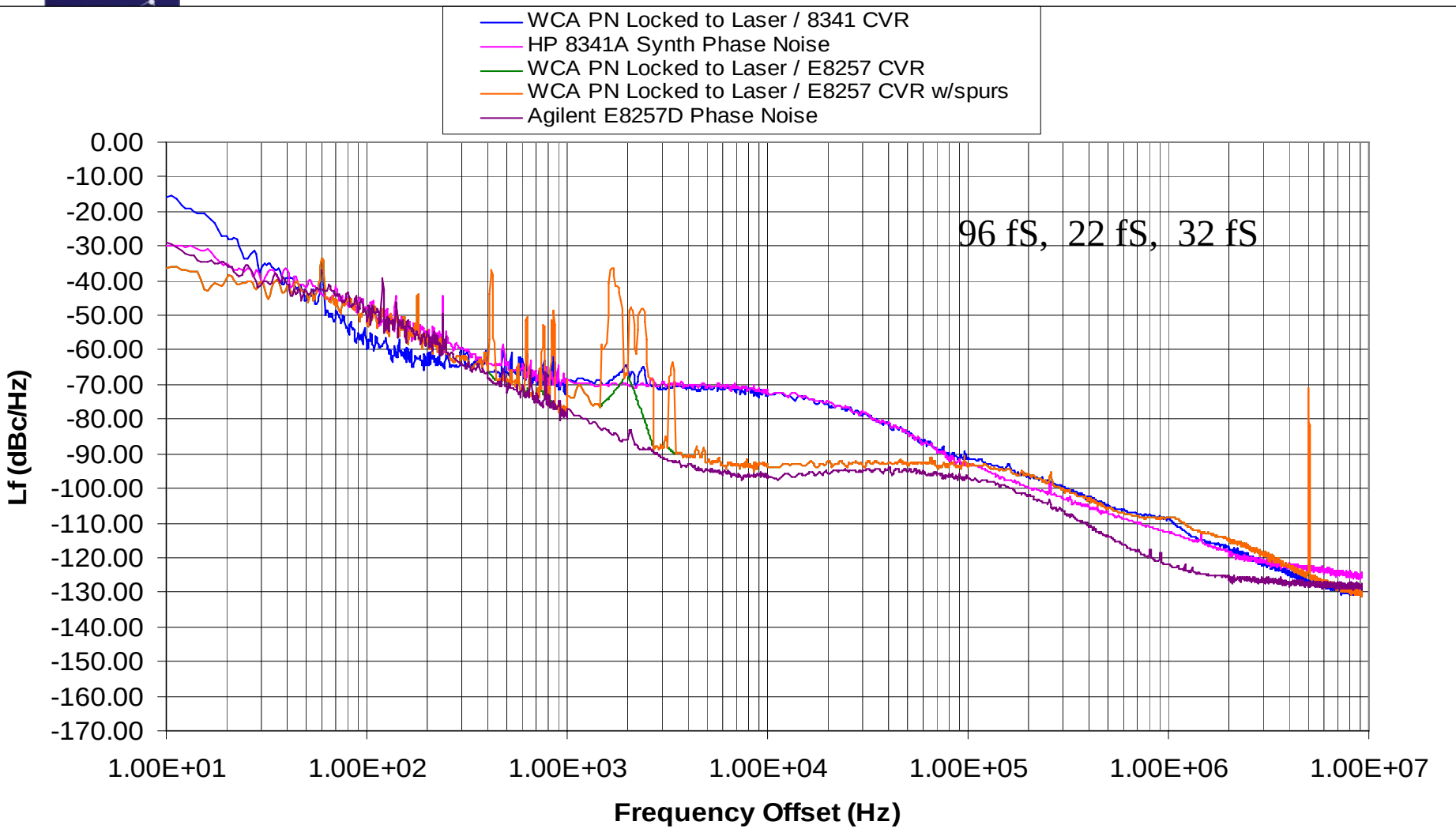
Desired Features

- Photonic reference
  - New Technology
- Highly Coherent
  - 80% Coherent at 950 GHz
  - Usable to 1.2 TeraHertz
- Electrically tunable
  - Major technical consequences
- Amplitude stable
  - Suitable for Total Power radiometry as well as interferometery
- Adequate power at 950 GHz
- Phase stable
  - Factor of 200 better than EVLA
  - Factor of 50 better than SMA

Phase Stability

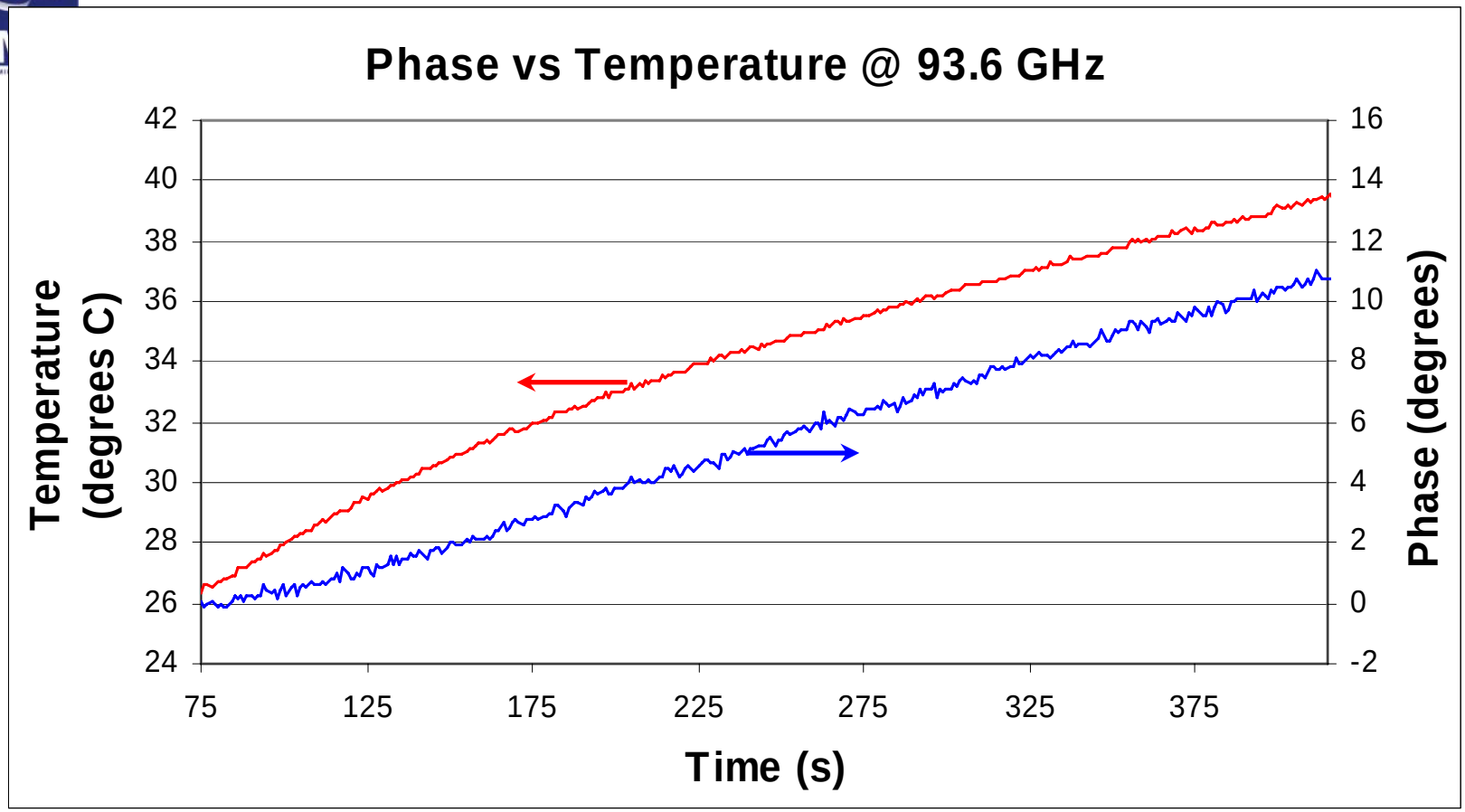
- 12.5 FemtoSeconds over 300 seconds
- 3.75 micron (in air)
  - This is about 0.15 mil for the non-metric folks
- For a 1 degree Centigrade change of temperature the following represent 12.5 fS.
  - Brass Waveguide approx 1.5 cm
  - SMF Fiber 40 cm
  - IF Coax at 12 GHz 35 cm

Test Data through 15 km Fiber



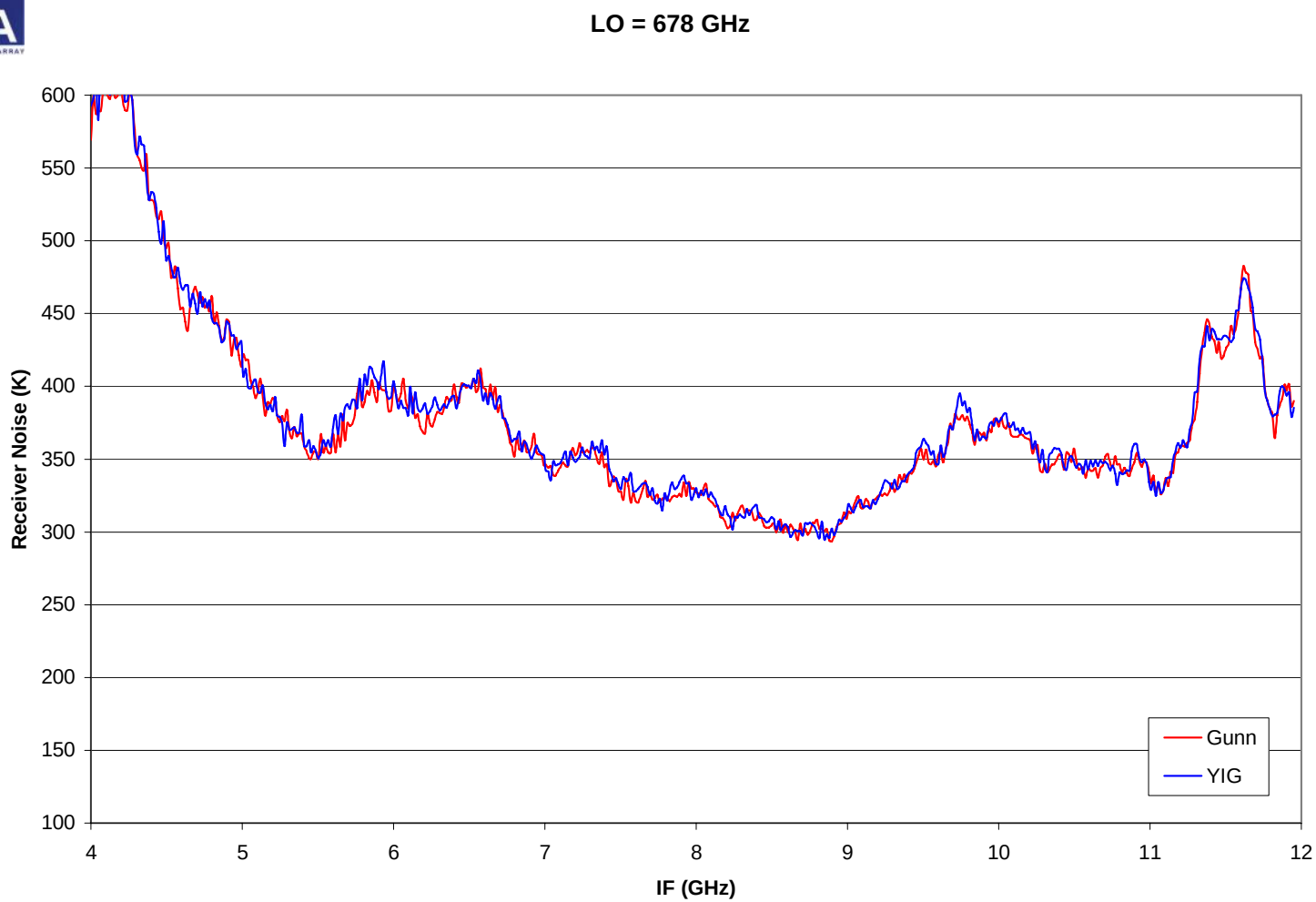
Phase Noise of Various Sources

Phase Drift Measurements

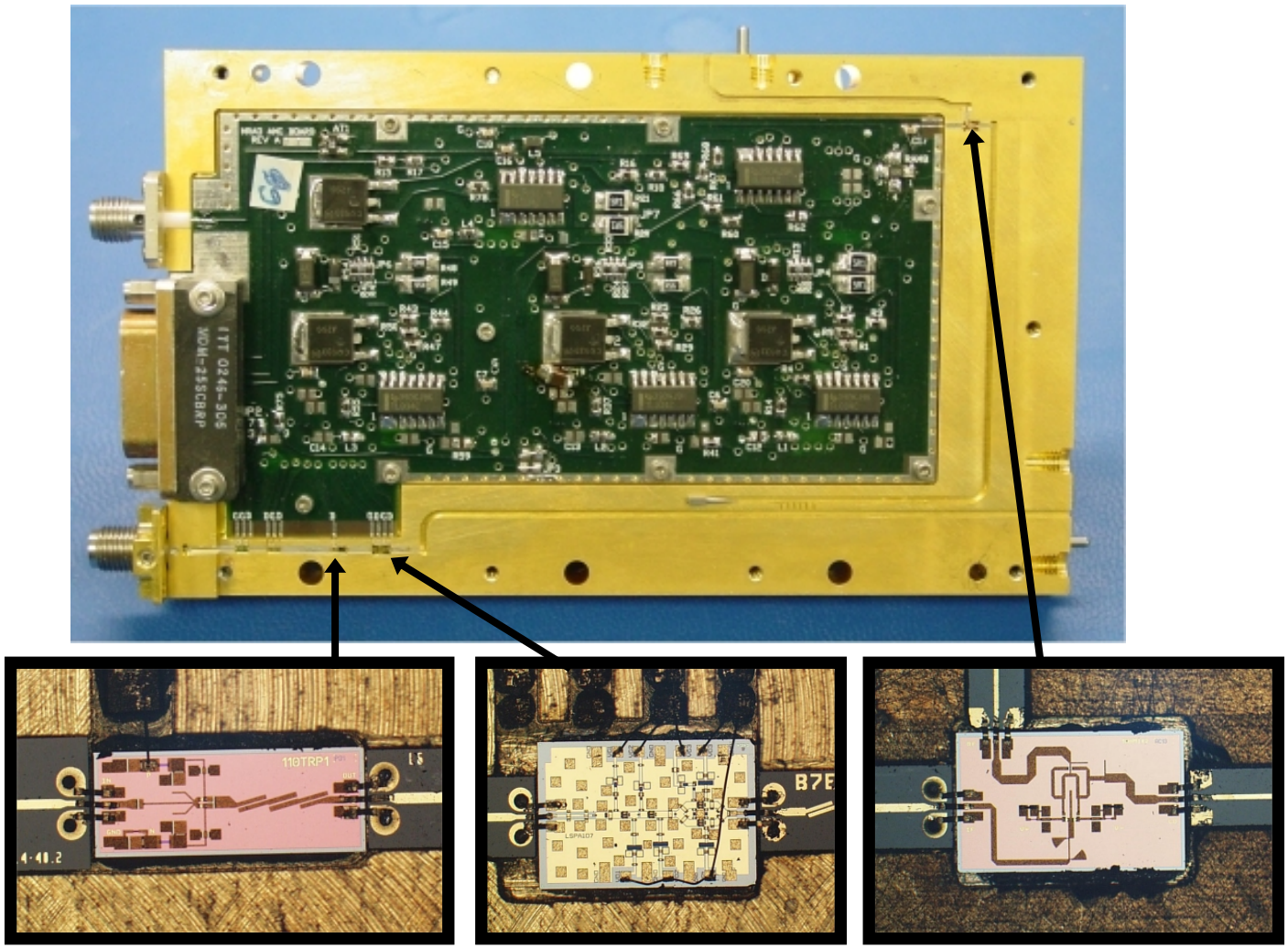


- **Increase T(WCA #1) while keeping T(WCA#2) constant**
- **0.81 degrees/ºC at 93.6 GHz => 24.2 fs/ºC**
- **Max. ΔT(5 minutes) = 0.083 ºC => 2.0 fs max. drift in 5 minutes**

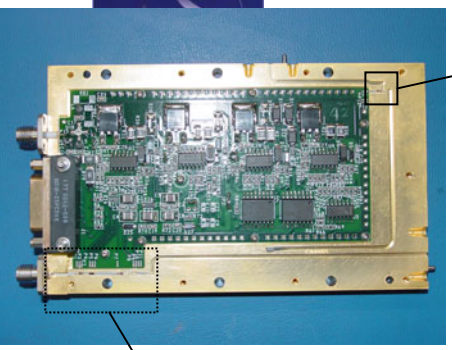
Sideband Noise: Band 9



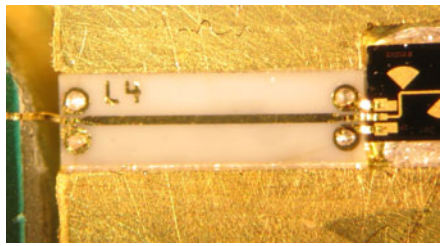
Custom MMICs for the ALMA Local Oscillator Subsystem

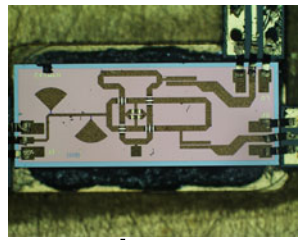


Active Multiplier Chain (AMC)

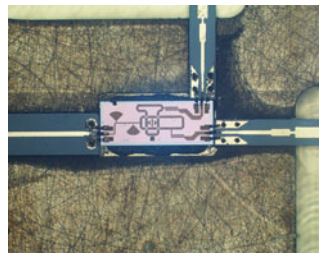


To Bias Card

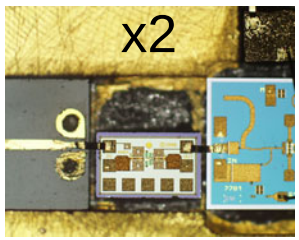




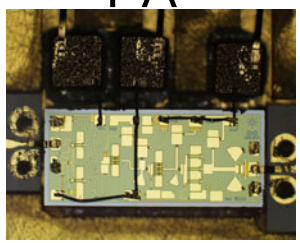
Mixer



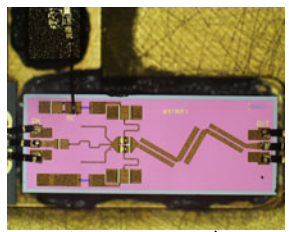
x2



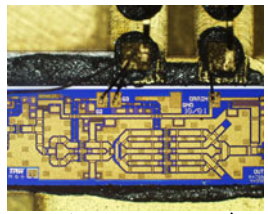
PA



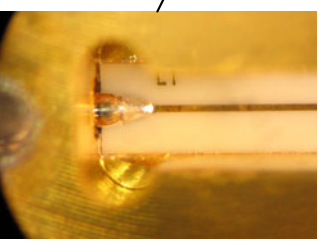
x3

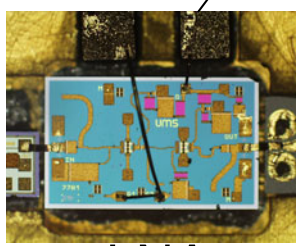


PA

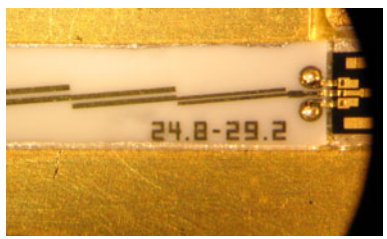


WG Transition

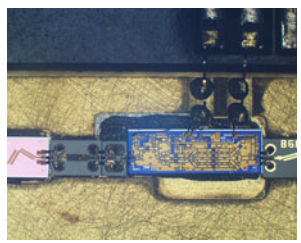




LNA



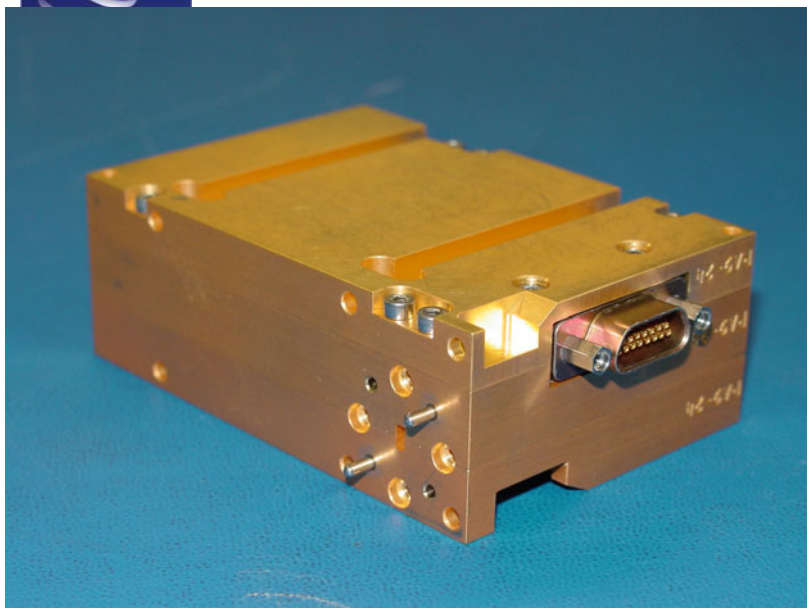
BPF

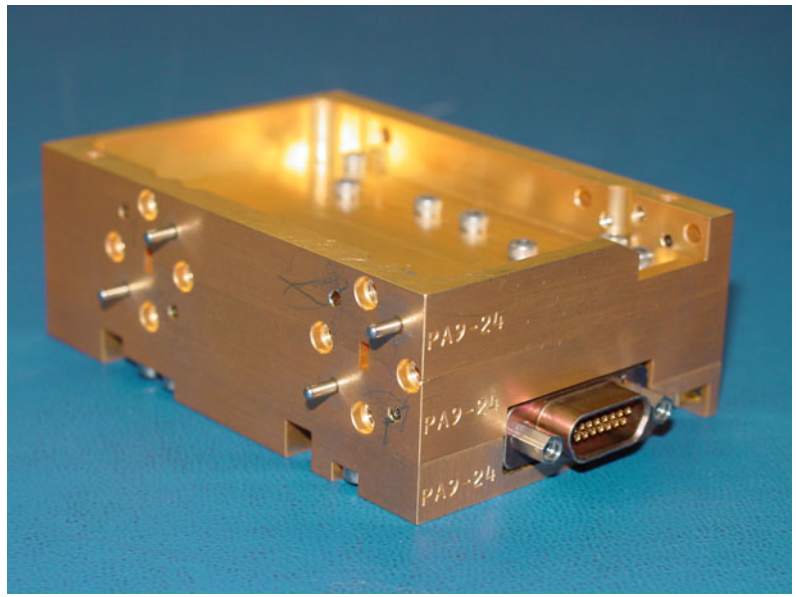


BPF

From FEND-40.10.06.02-002-A-PRO

Power Amplifiers (PA)

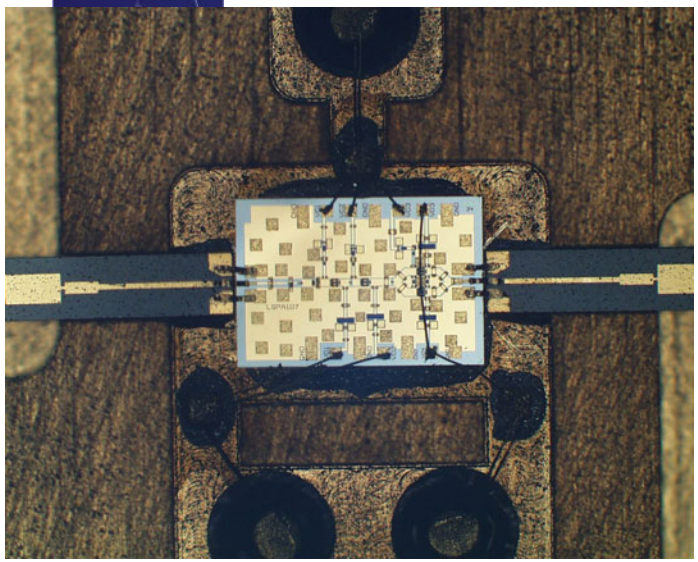


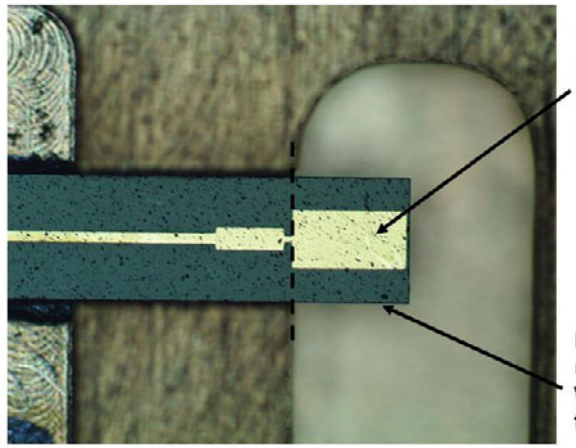


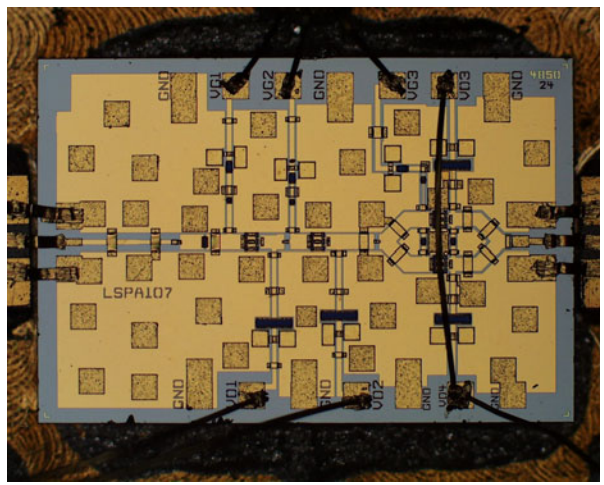
- **Band 3 (92-108 GHz): 0.1 μm InP HEMT**
- **Band 6 (73-89 GHz): 0.1 μm GaAs pHEMT**
- **Band 7 (94-122 GHz): 0.1 μm InP HEMT**
- **Band 9 (67-79 GHz): 0.1 μm GaAs PHEMT**

- **(Band 9 original topology: 121-143 GHz)**
- **0.1 μm GaAs pHEMT gain drops above 100 GHz, usable to 110 GHz**

2-Chip PA

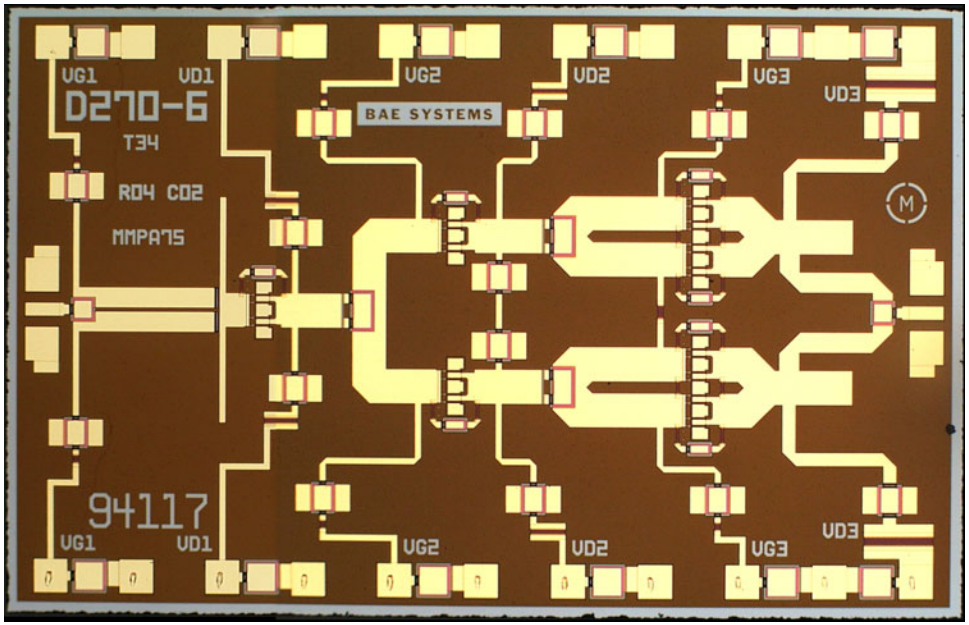






- From FEND-40.10.07.08-002-A-PRO, “Band 7 PA Microassembly Procedures”

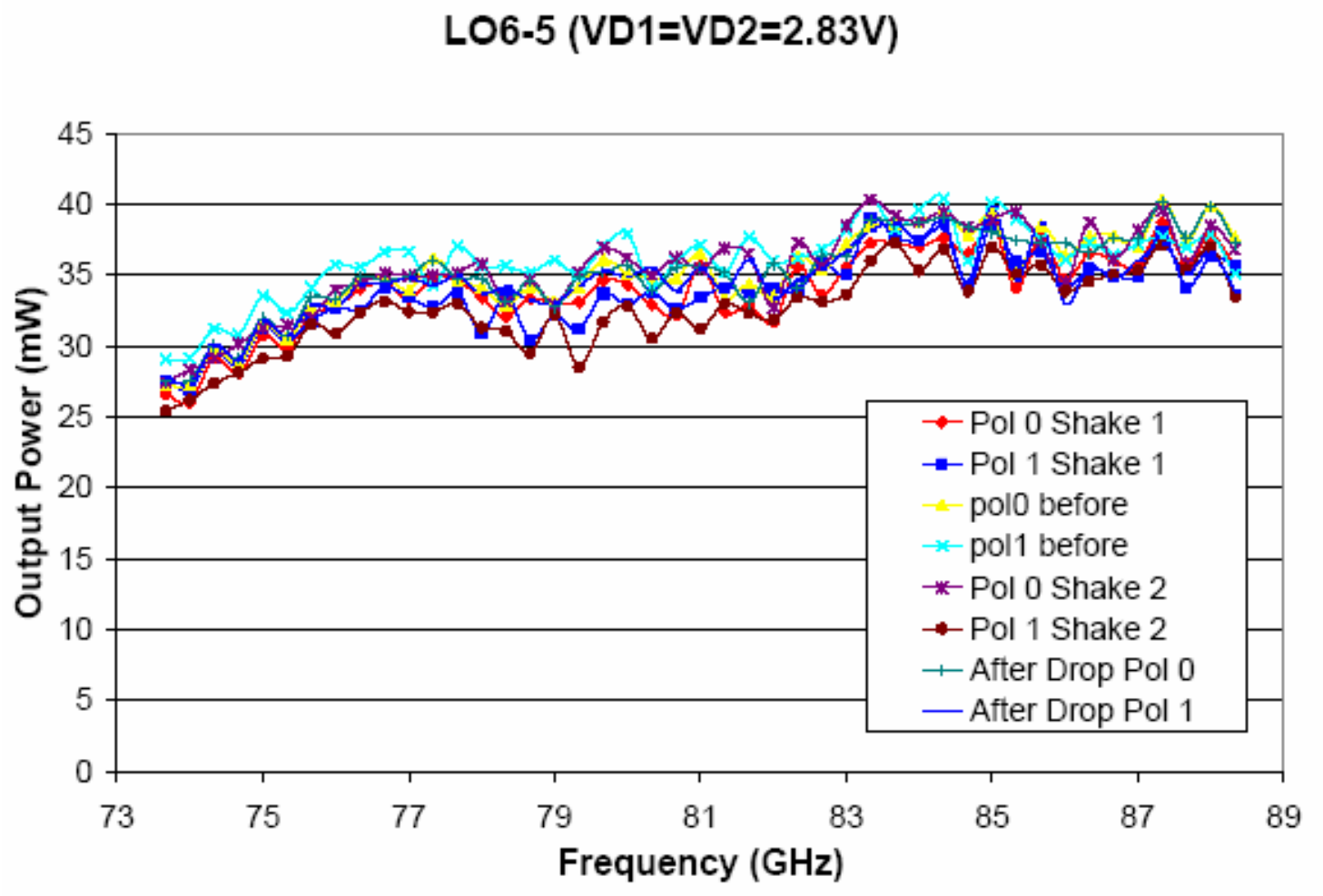
MMIC Power Amplifier for Bands 4, 8, and 9

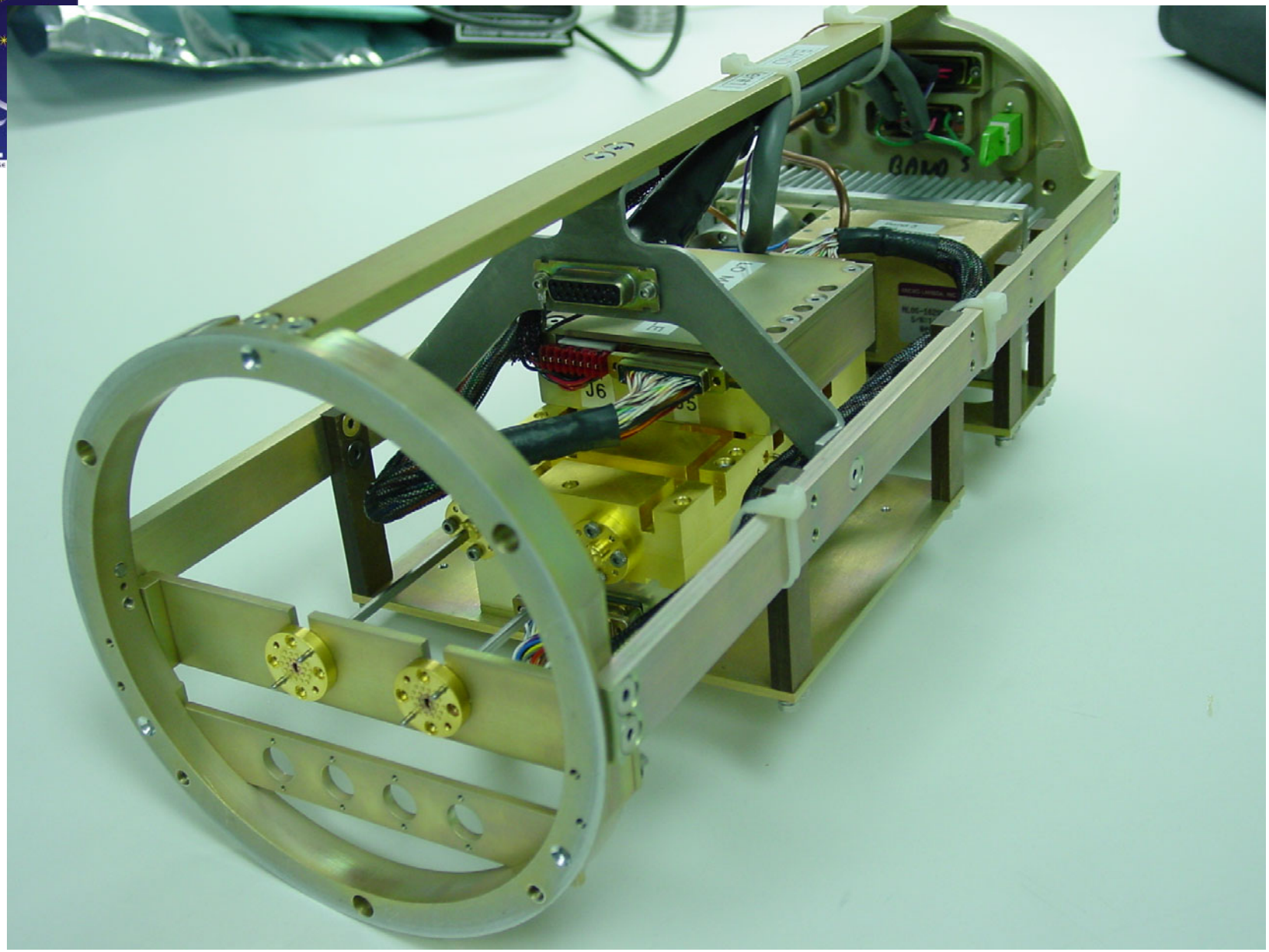


MMIC Chip:	MMPA75
Technology (foundry):	0.1 μm GaAs pHEMT (BAE)
Dimensions:	2.8 x 1.8 x 0.050 mm
Frequency:	65 – 85 GHz
Output Power:	80 mW
Small-Signal Gain:	14 dB
Large-Signal Gain:	9 dB

Output power and tuning range: Band 6-5

- 73.7-88.3 GHz
- 5-20 mW in steps of 0.5 dB or less.




J6

Thank You John