



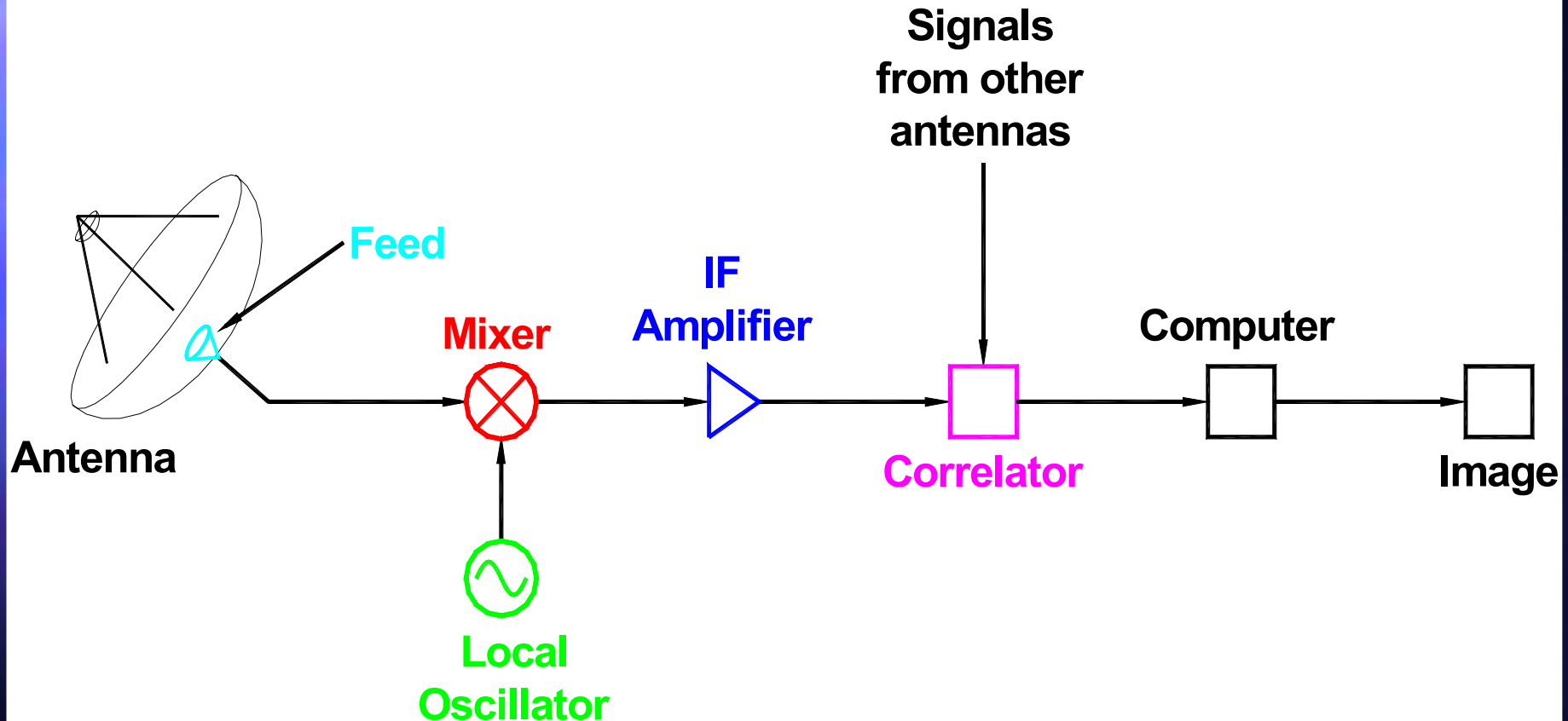
Central Development Laboratory

IEEE Tour
April 2003

(Adapted from **John Webber's** Viewgraphs, April
2002

Presented tonight by Skip Thacker)

Block Diagram



CDL Activities

- Low-noise Amplifiers
- Passive Electromagnetic Devices
- ALMA SIS mixers for Bands 3 & 6
- ALMA Front End LO for All Bands
- ALMA Correlator
- Other Digital Projects
- L-band Array Receiver (with Green Bank)

Amplifier Goals

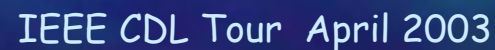
- Keep up with receiver builds
- Improve production efficiency
- Develop InP amplifiers for bands down to 1 GHz
- Start replacement of antiquated test equipment

Production Amplifiers

Band (GHz)	Noise (K)	Comment	Band (GHz)	Noise (K)	Comment
0.3-0.4	2.0	balanced	C	4-6	9
0.4-0.5	2.0	balanced	C/X	3-13	5 InP
0.5-0.7	2.0	balanced	X/Ku	8-18	6 InP
0.7-0.9	3.0	balanced	K	18-26	9 InP
0.9-1.2	3.0	balanced	Ka	26-40	14 InP
1.2-1.7	3.0		Q	40-50	18 InP
1.7-2.6	4.5		V	65-90	45 InP
2.6-4	5.2		W	68-116	60 InP

Electromagnetics

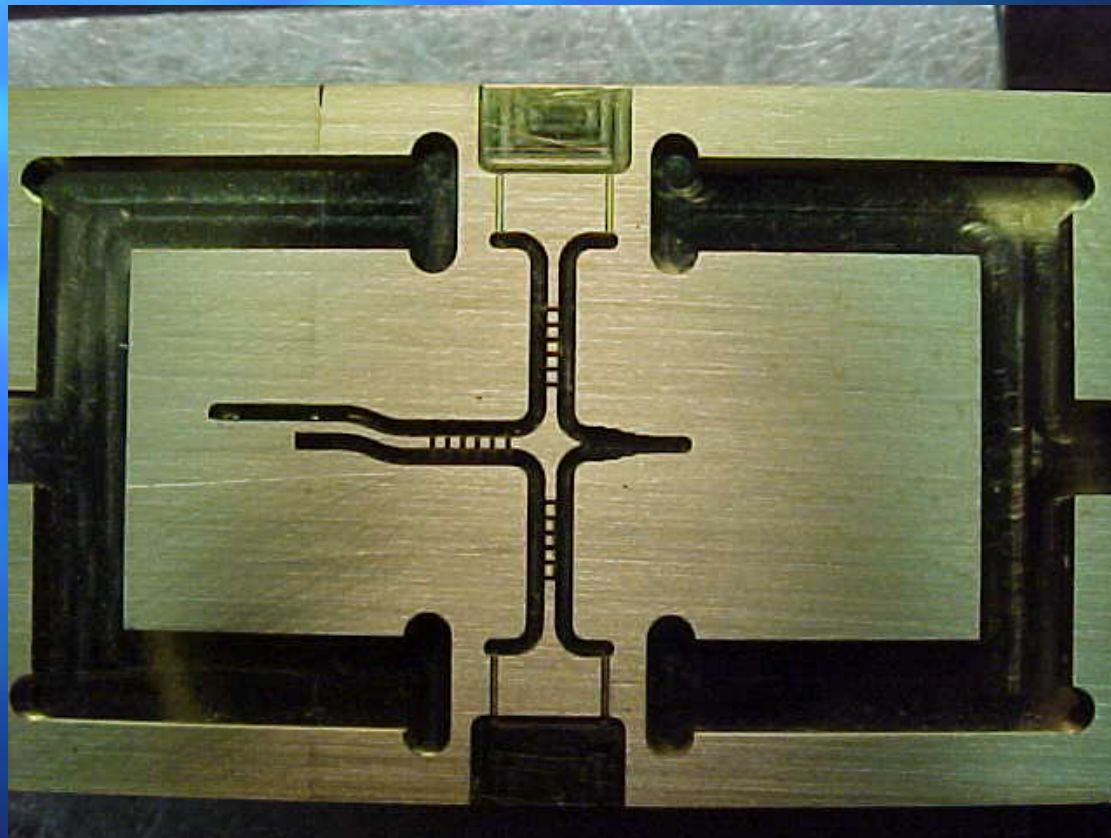
- Feeds for GBT: 26-40 and 68-92 GHz
- Feed for EVLA: 1.2-2.0 GHz
 - G/T slightly worse at zenith
 - G/T much improved integrated over sky
 - Scaled versions for 2-4 and 4-8 GHz
- Optics for ALMA Band 6 (211-275 GHz)



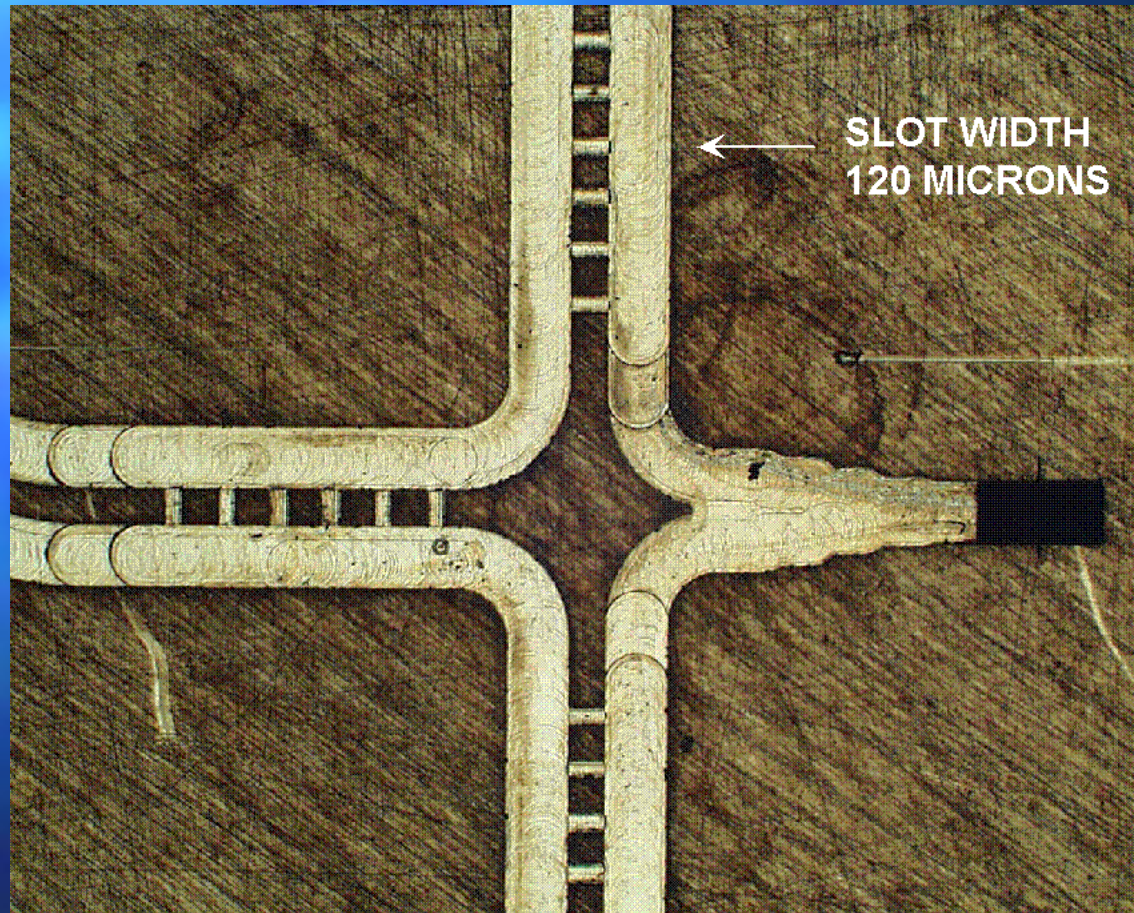
SIS Mixer Objectives

- ALMA Band 6 (211-275) GHz sideband-separating, balanced mixer
- ALMA Band 3 (84-116 GHz) elemental mixer for use by Herzberg Institute
- Internal IF amp for 8 GHz bandwidth
- Band 6 cartridge development
- Automated mixer testing

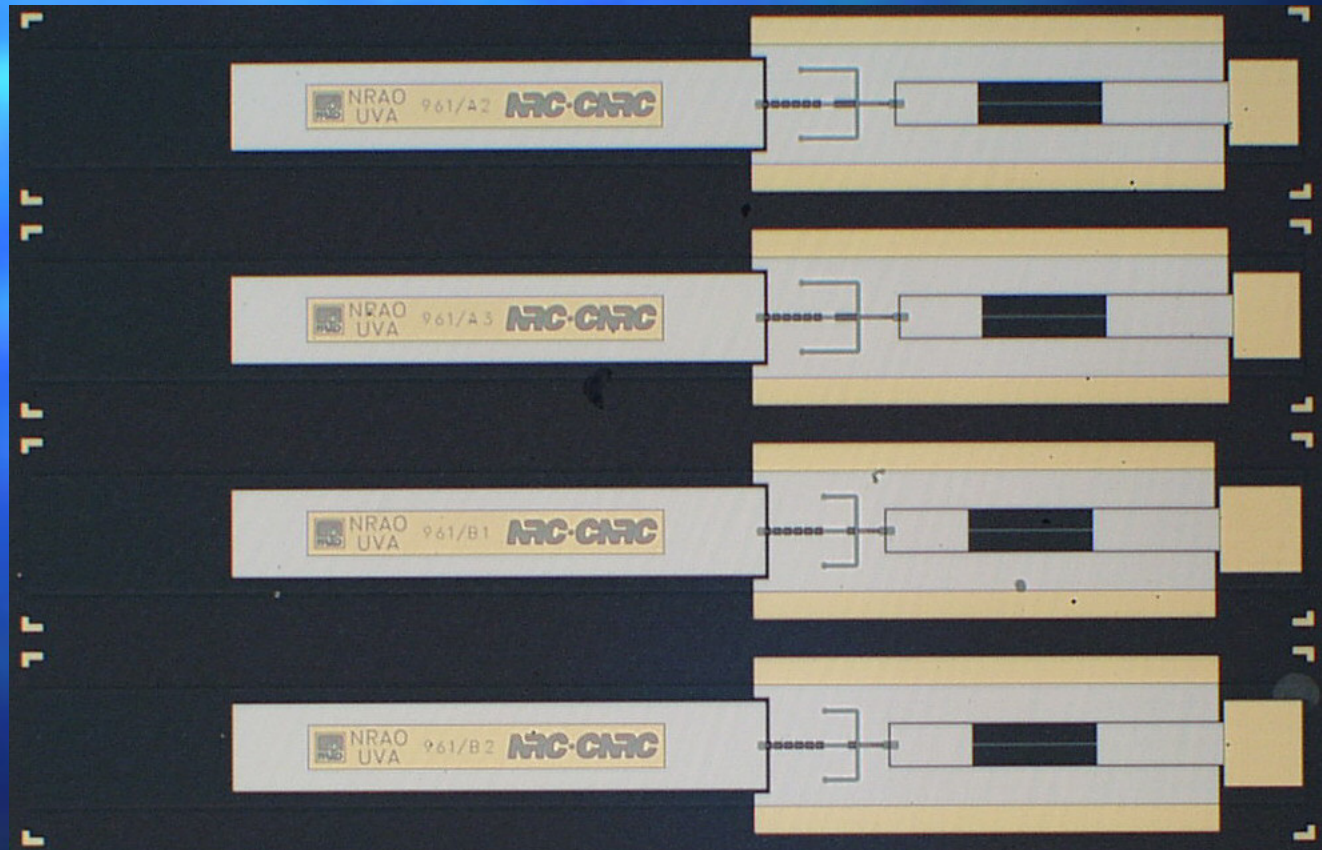
Band 6 Waveguide-Hybrid SIS Mixer Block



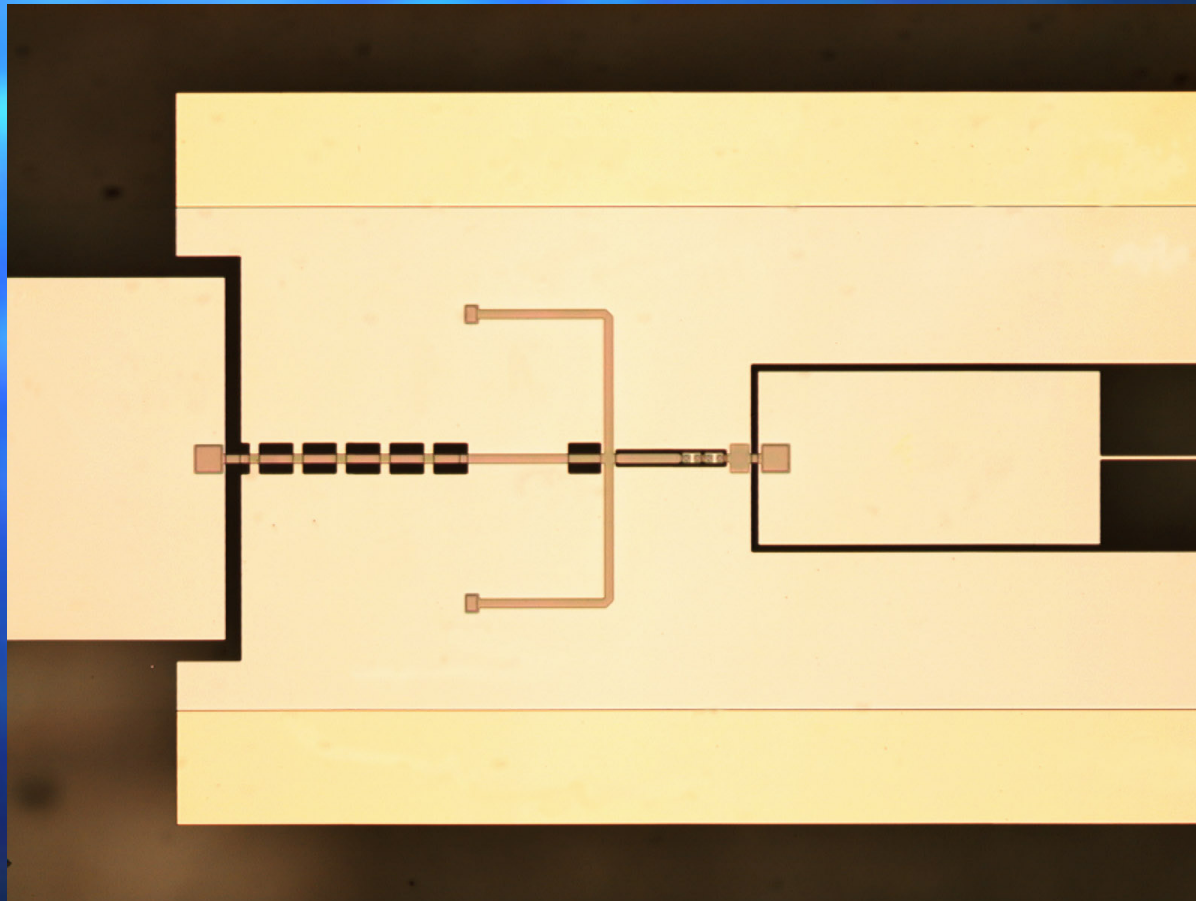
Band 6 Waveguide-Hybrid SIS Mixer Block Detail



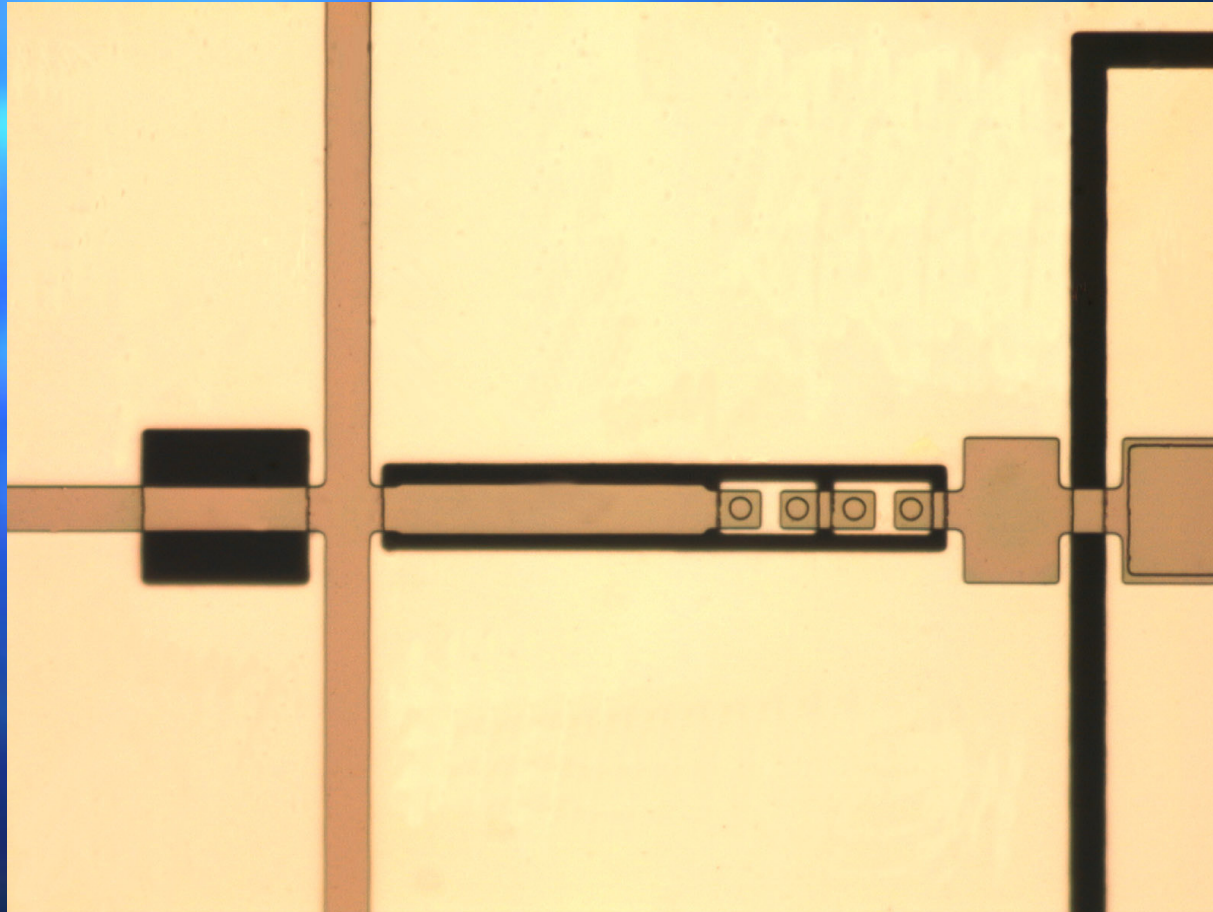
New Band 3 Elemental SIS Mixer Wafer



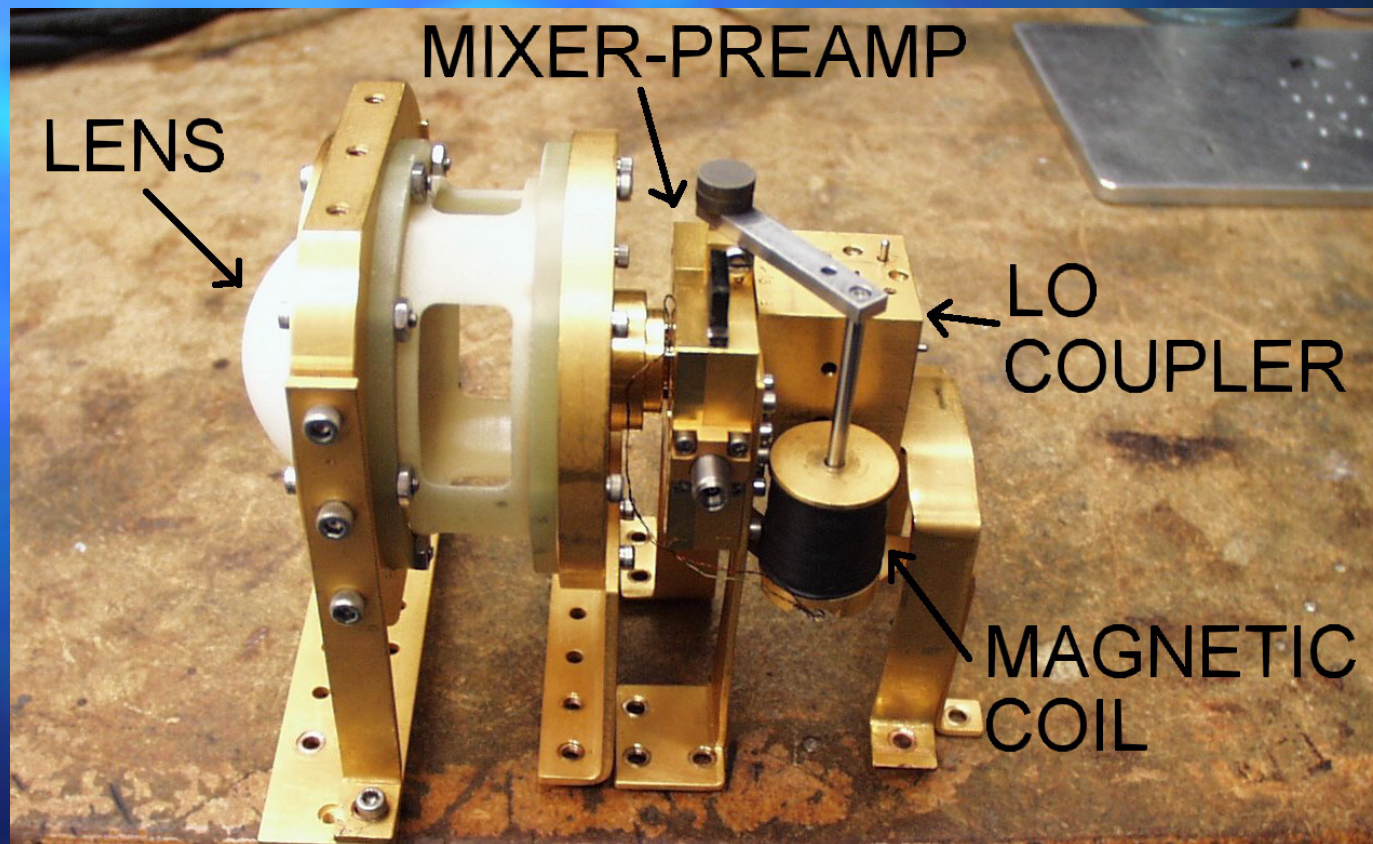
New Band 3 Elemental SIS Mixer Wafer Detail



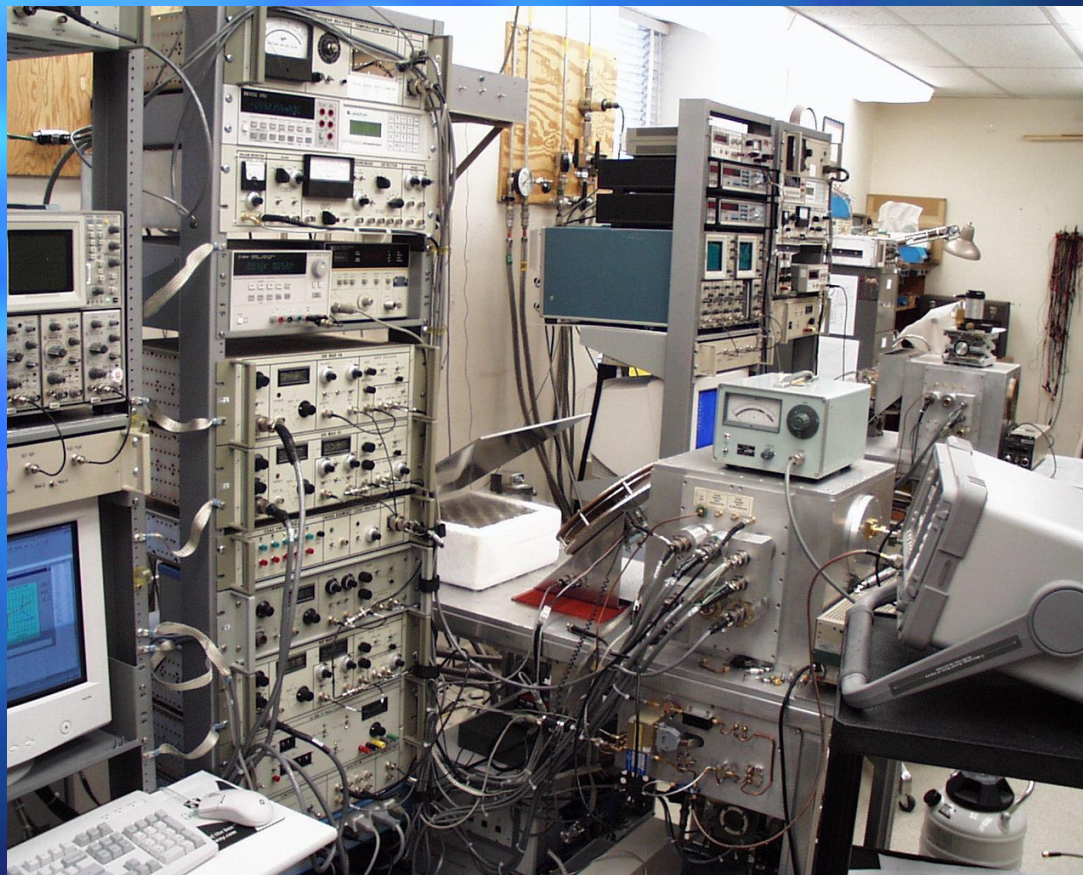
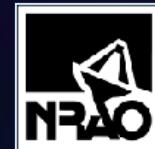
New Band 3 Elemental SIS Mixer Wafer Detail



Band 6 Balanced Mixer-preamp Assembly



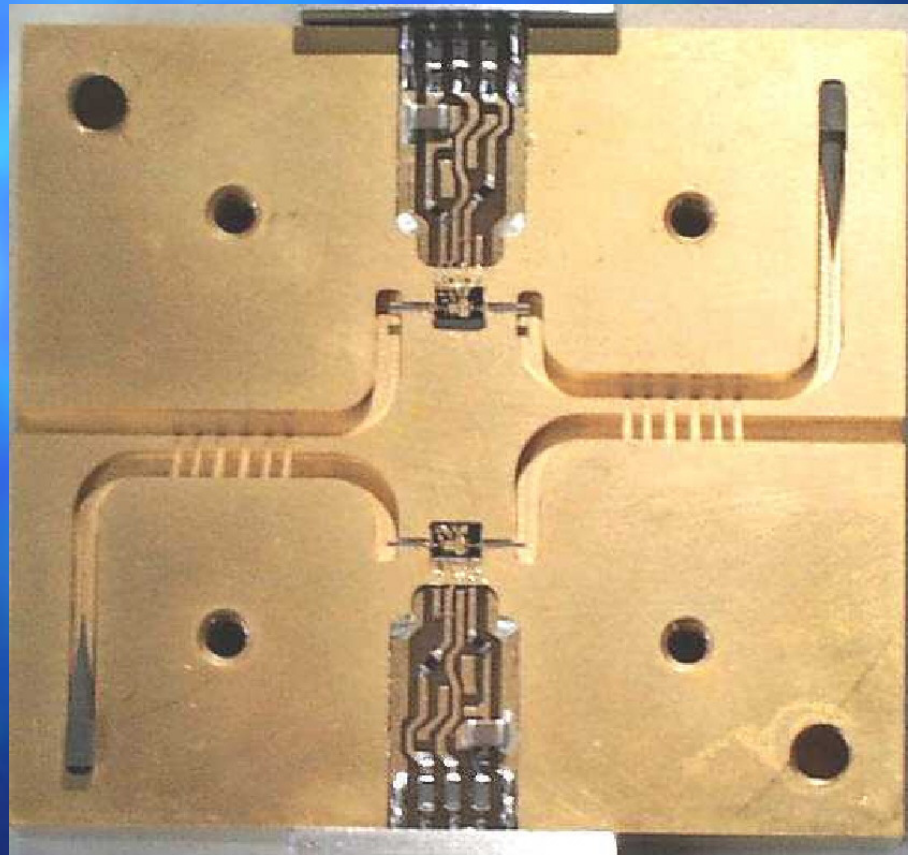
SIS Mixer Test Facility With Two 4K Dewars



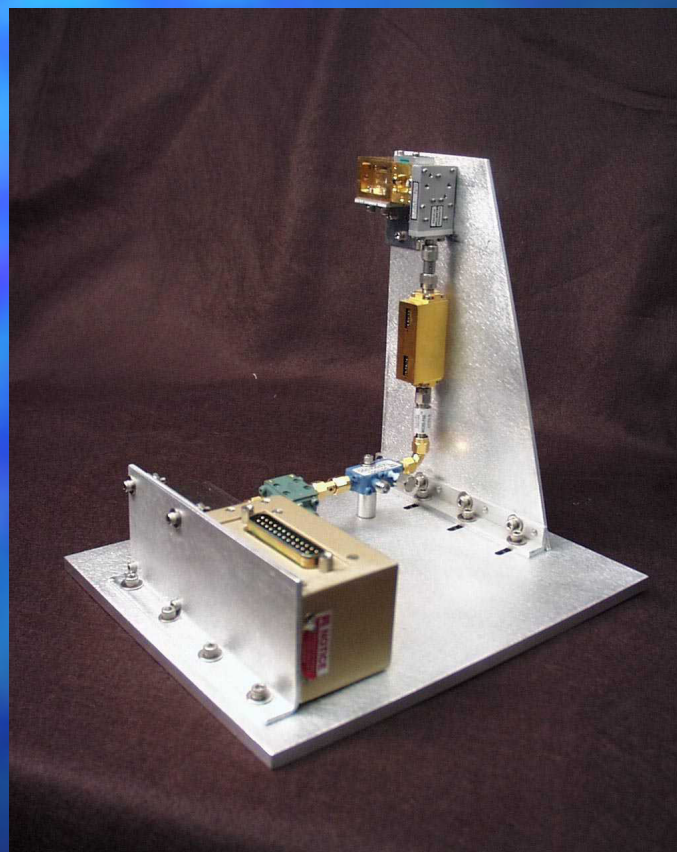
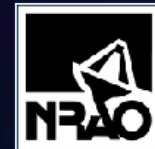
ALMA Front End LO Tasks

- YIG-Tuned-Oscillator-based drivers
- Low phase noise lock loops
- Final power amplifiers
- High-frequency multipliers

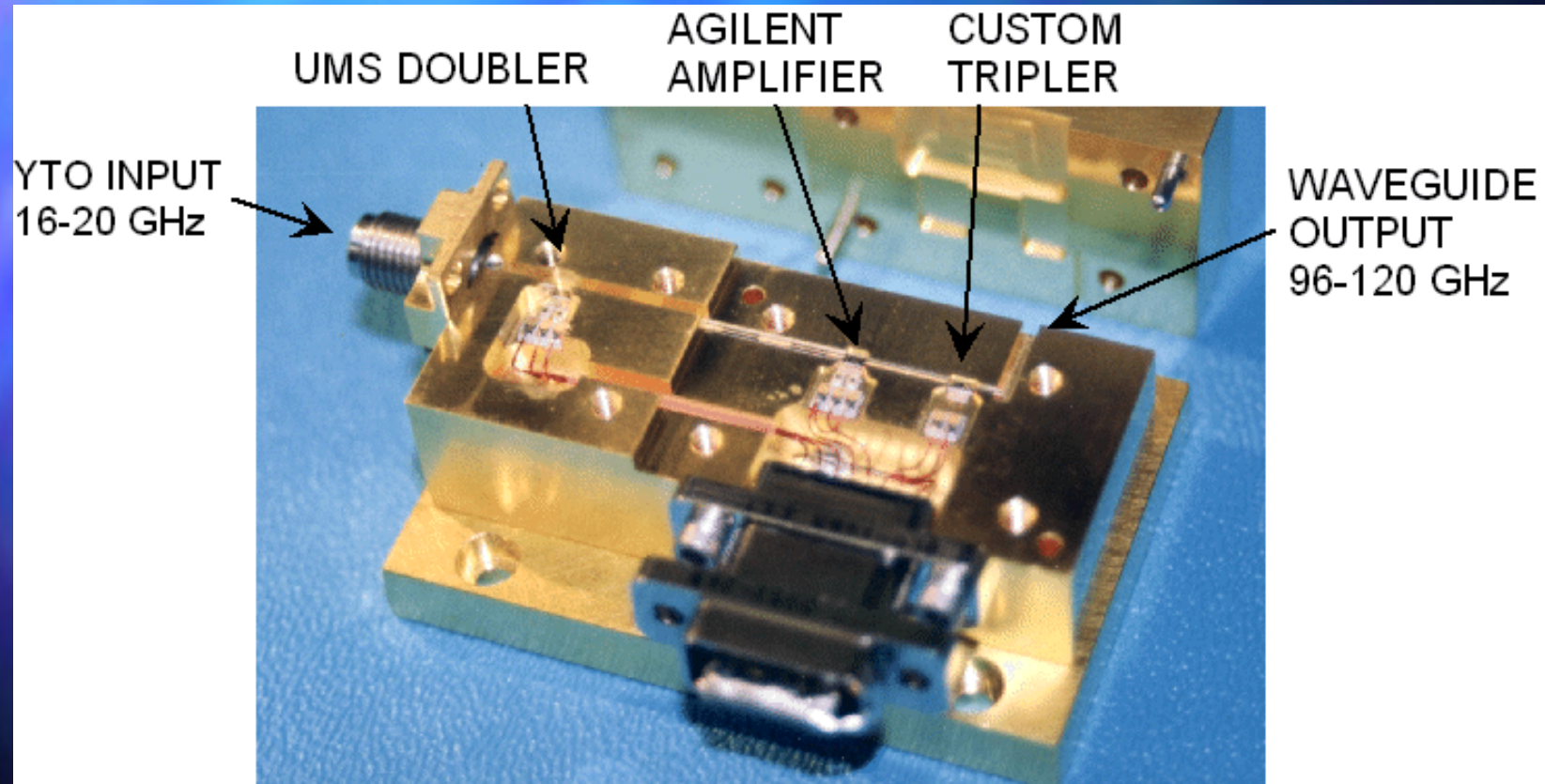
96-104 GHz Power-combining Balanced Power Amplifier



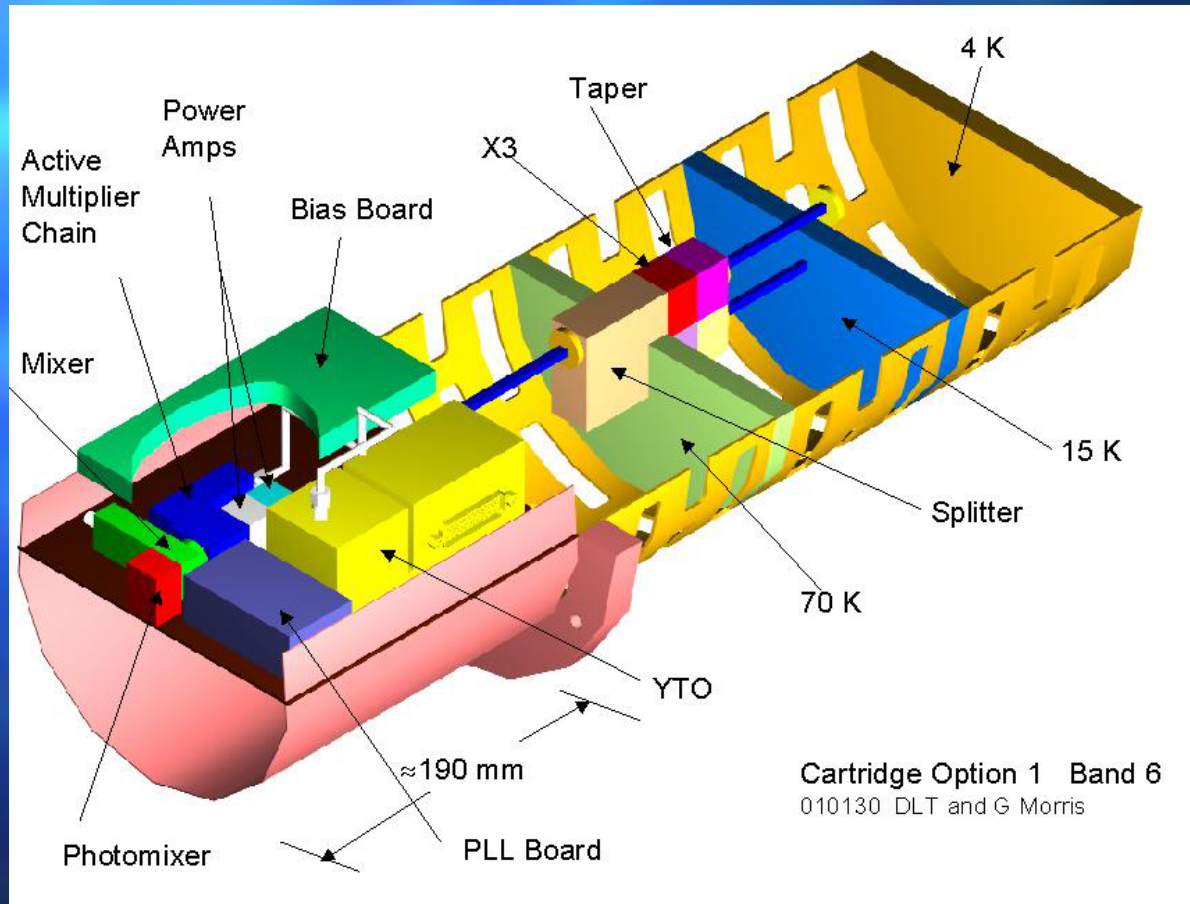
ALMA Band 6 LO Prototype for SIS Mixer Test Facility



Prototype Warm Multiplier Assembly



Band 6 Cartridge LO components

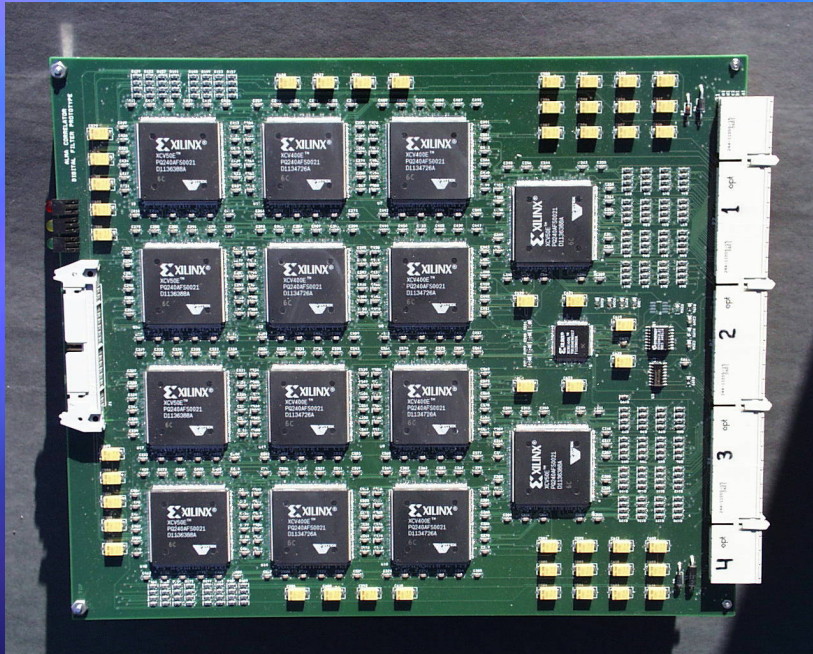


ALMA Correlator

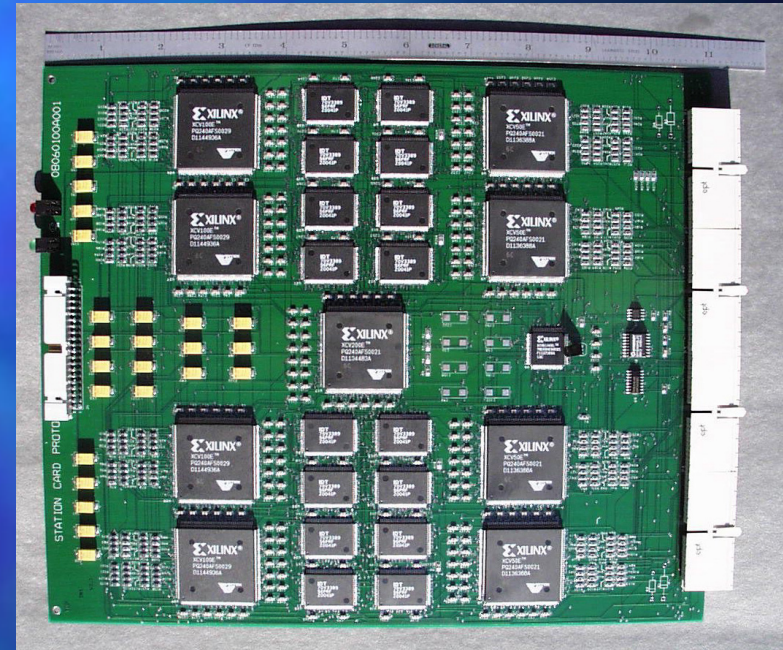
- 64 antennas
- 8 IF bands per antenna
- 4 Gsamples/sec per IF band, 2 bits/sample correlated
- 1024 lead + 1024 lag correlations per baseline
- 30 km maximum baseline delay range
- Full polarization capability plus autocorrelation
- Digital filter for bandwidths <2 GHz
- Switch modes in less than 1.5 seconds

- This requires 4,194,304 multiply-and-add correlators at 4 GHz rate
- Total computation rate is 1.7×10^{16} multiply-and-add operations/sec

FIR Filter Card & Station Card

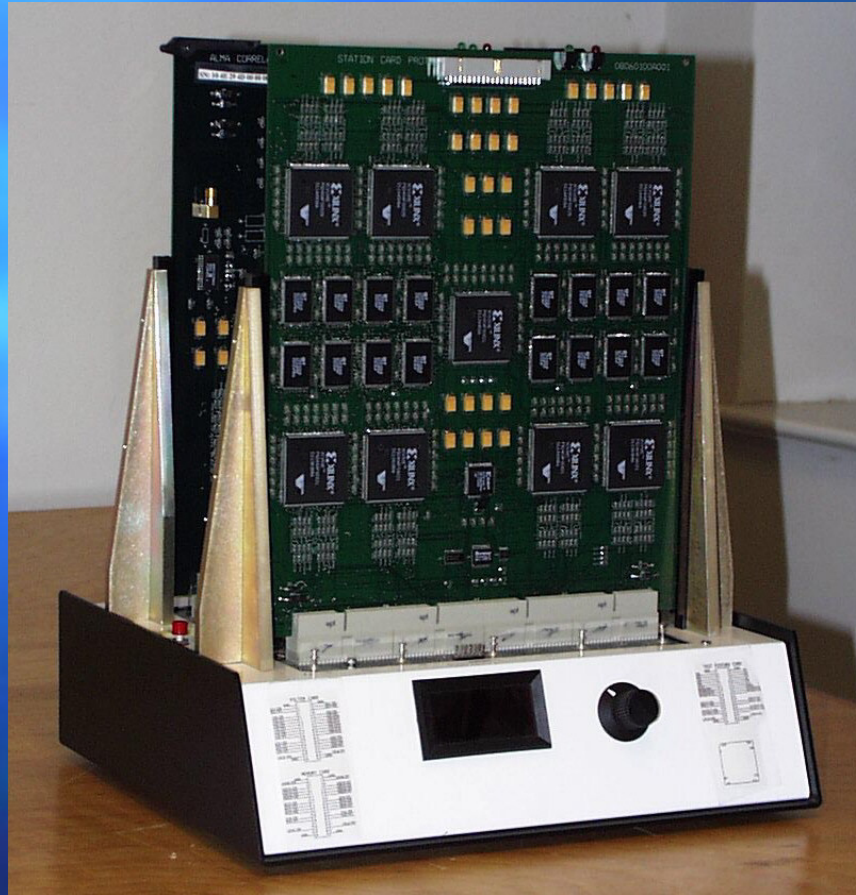


FIR Filter Card

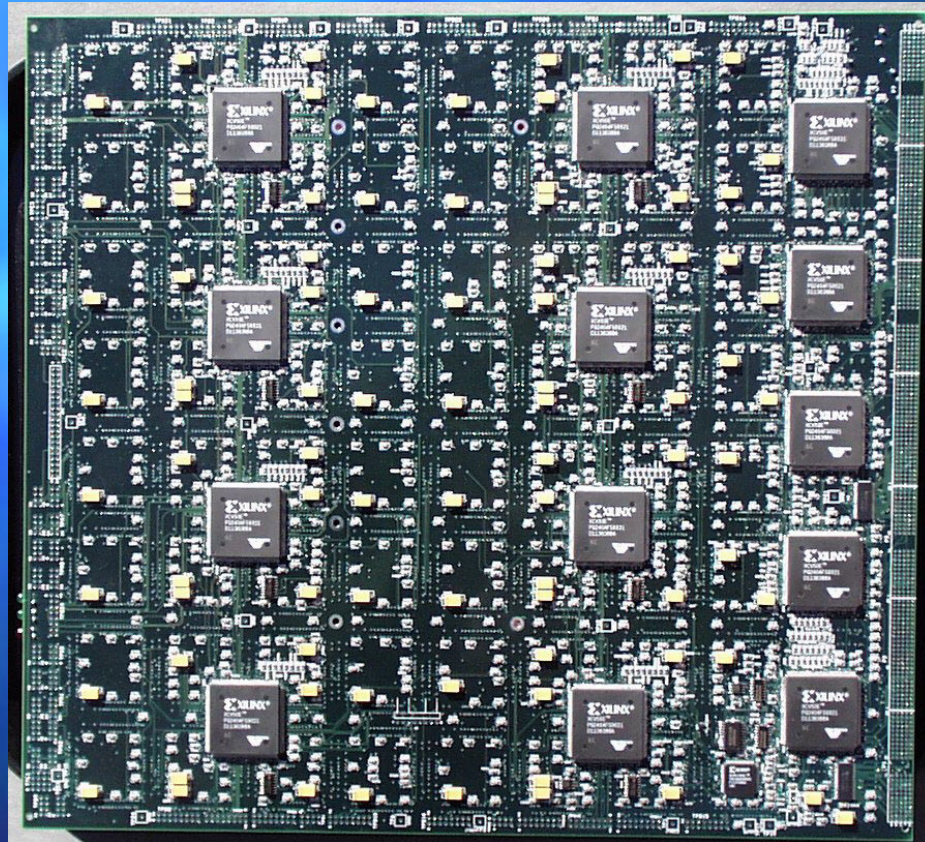


Station Card

Station Card in Test Fixture



Correlator Card Back



Front
and
Rear
Views



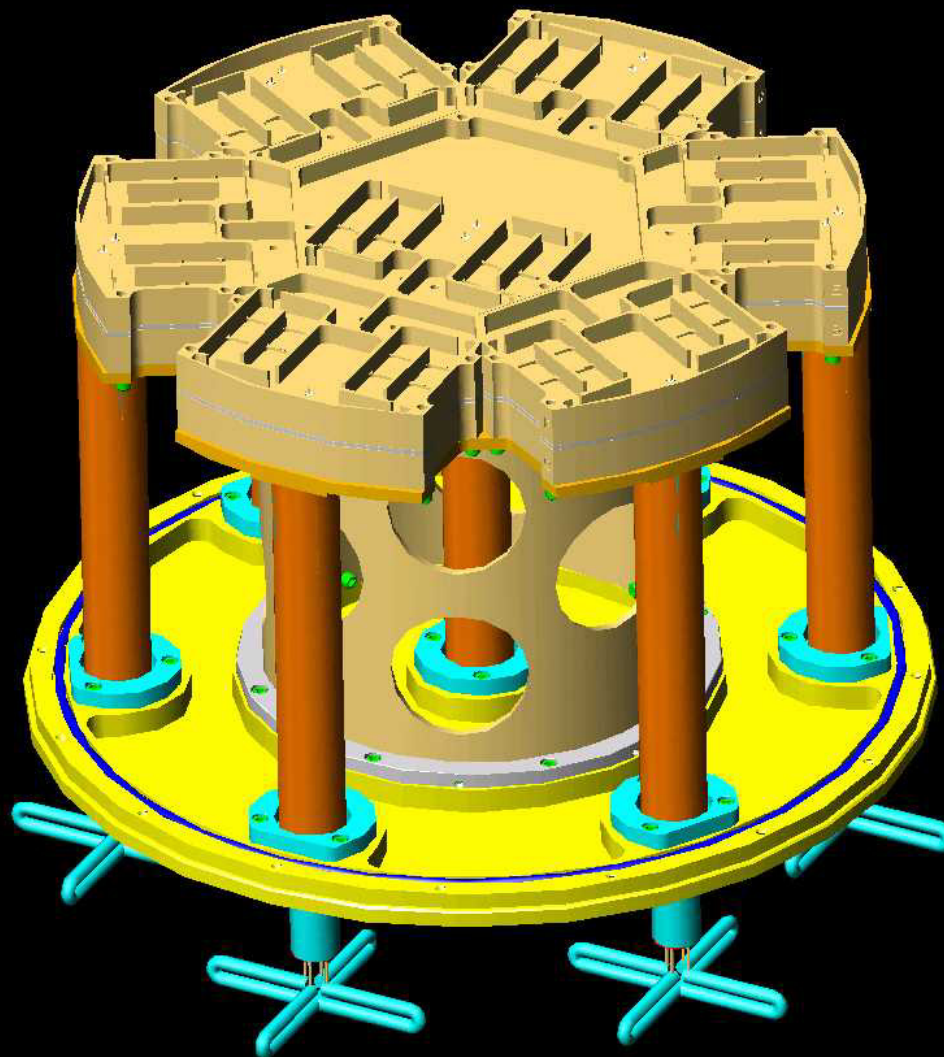
Station Bin



Beam-Forming Array Receiver

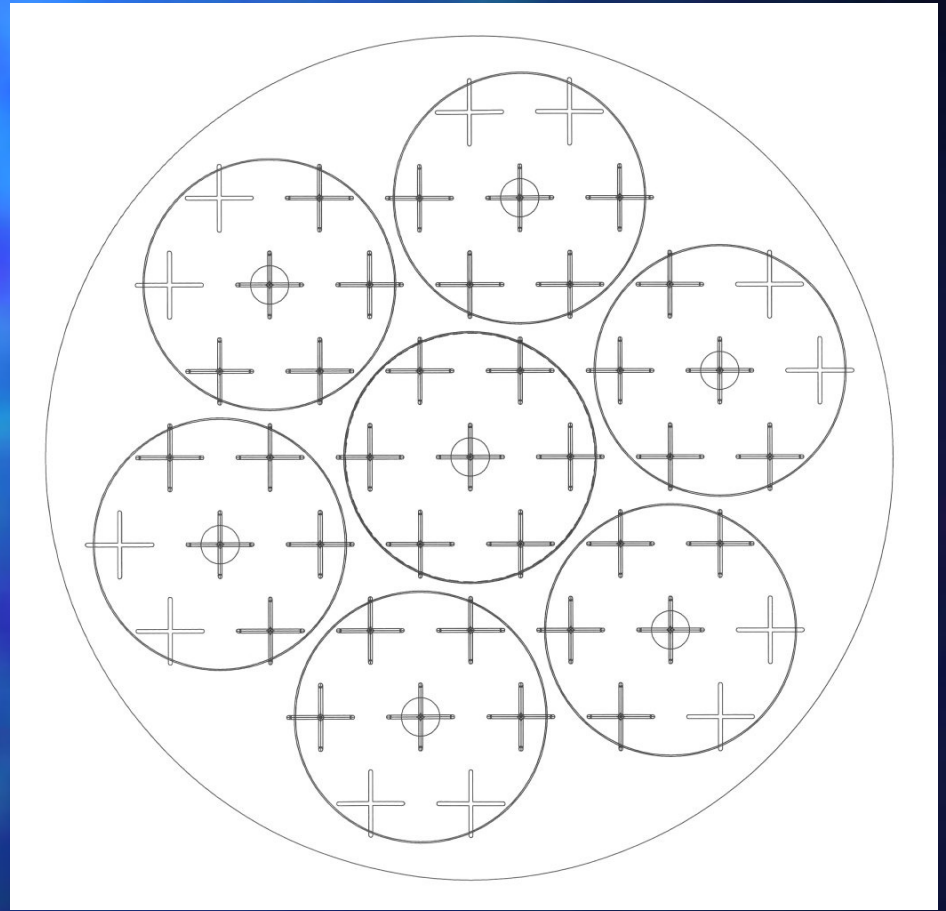
- Objective: synthesize multiple beams for 1300-1750 GHz, where conventional feed arrays are impractical on the GBT
- Approach: oversample e-m field at focal plane with closely spaced feeds
- Challenges:
 - Achieve system noise temperature close to that of a conventional receiver
 - Achieve mechanical and electronic stability sufficient for reliable calibration

Beam Forming Array



Beam-Forming Array Feeds

- Array of dipoles samples focal plane
- Tuned for 1300-1750 MHz
- 37-element prototype provides 7 beams on the sky



Prototype Dipole

