Counter – Unmanned Aerial System (C-UAS) Radar

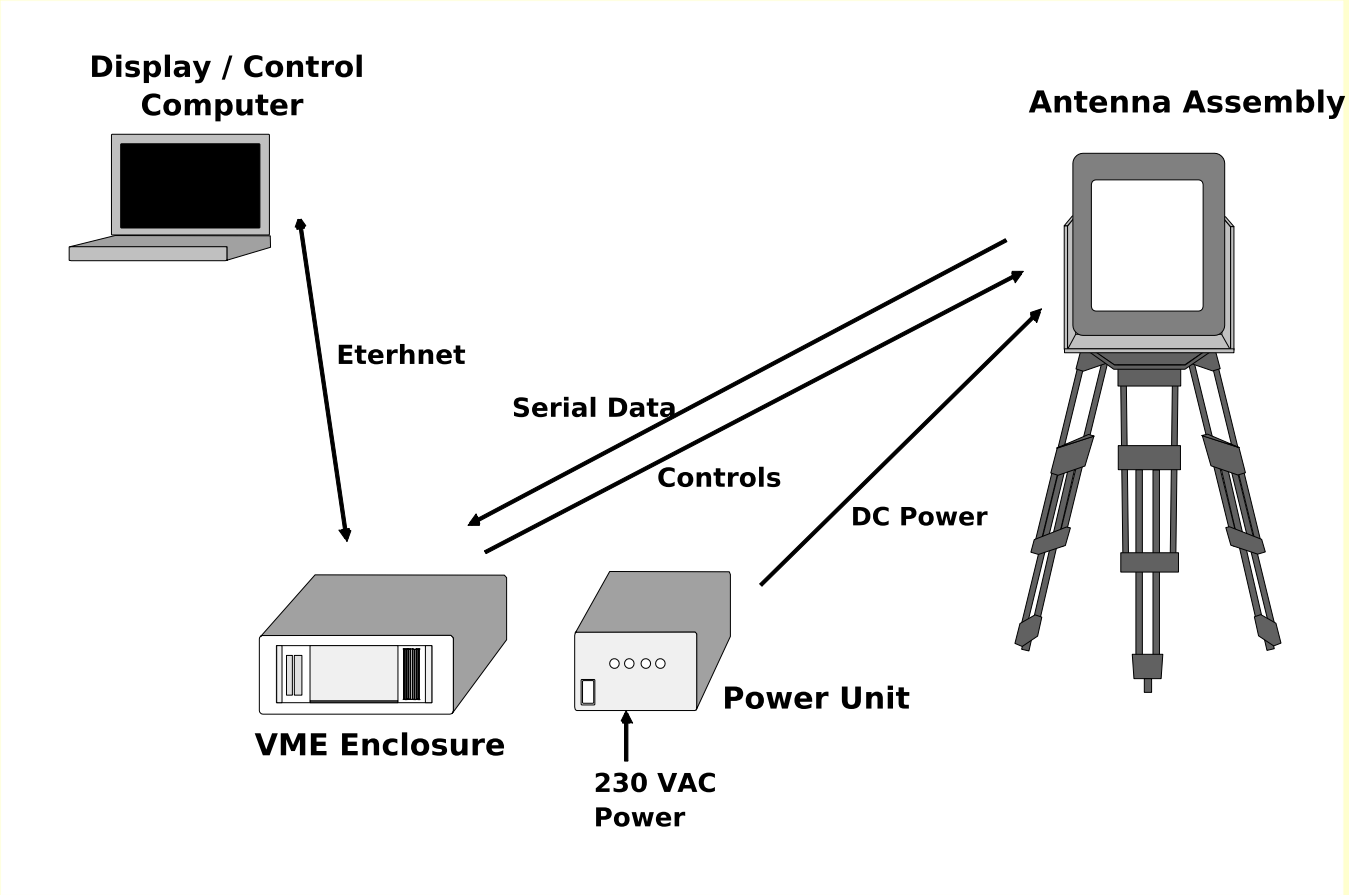
Development Plan

- Use EWA IR&D funds to specify a radar capable of acquiring and tracking multiple low-RCS targets
- Develop a system/unit to demonstrate full capability at reduced range in one quadrant
- Test demonstration system
- Revise system to meet specific customer requirements

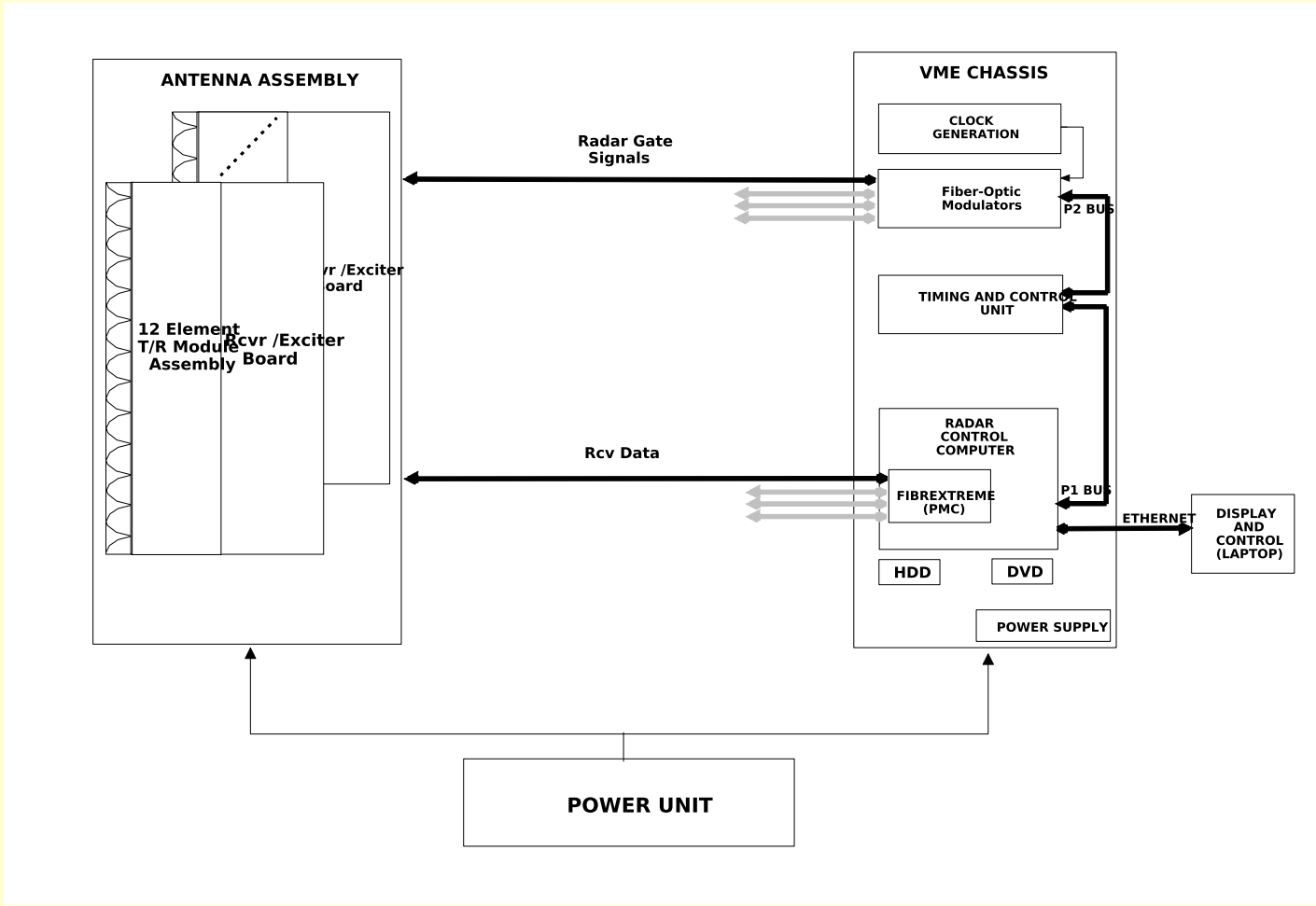
Demo System Objective

- Develop C-band quadrant coverage active electronically steered array with control electronics and user interface. Demonstration system will be one quarter of one face (144 elements)
- Full radar capability in one quadrant except range will be a factor of 2.8 less than complete system
- DDS at each antenna element for waveform generation and phase control
- A/D Converter at each element for digital beam-forming
- Leverage EWA RF printed circuit board (PCB) and Software designs

Demo System Components



System Block Diagram



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Demo System Performance Objectives

Frequency Range: 5400 – 5900 MHz
Coverage: ± 45 deg, Az
0 to 90 deg , El
Beamwidth: 8 deg (Az, El on boresight)
Number of Array Elements: 144
Aperture Dimensions: 13.4” x 15.5”
Operational Range*:

Target RCS(dBsm)	Range (Km)
-25	3.75
-20	5.0
-16	6.3 (3.4 nmi)
-10	8.9
0	15.8

*Based on beam dwell times to meet search revisit, number of tracks and track update rates given on following slides. Can relax the latter to increase operational range at any given RCS..

Demo System Performance Objectives (Cont'd)

Processing: Pulse Compression / Pulse Doppler
Range Resolution (m): 7.5
Velocity Resolution (m/s): <1.5

Search Waveforms:

Waveform	Pulsewidth	Type	LFM BW (MHz)	PRI (usec)	Min Range (meters)	Max Range (meters)
Long Range	10	LFM/CW	20	150	1650	20,850
Medium Range	5	LFM/CW	20	75	900	10,350
Short Range	2.5	LFM/CW	20	50	525	6975

Search Dwell

Waveform	PRI (usec)	CPI (msec) /number of pulses	Number of Beams (Full Quadrant)	Revisit time (sec)
Search LR	150	38.4 /256	105	4
Search MR	75	19.2/256	105	2
Search SR	50	12.8/256	105	1.33

Demo System Performance Objectives (Cont'd)

Track Waveforms:

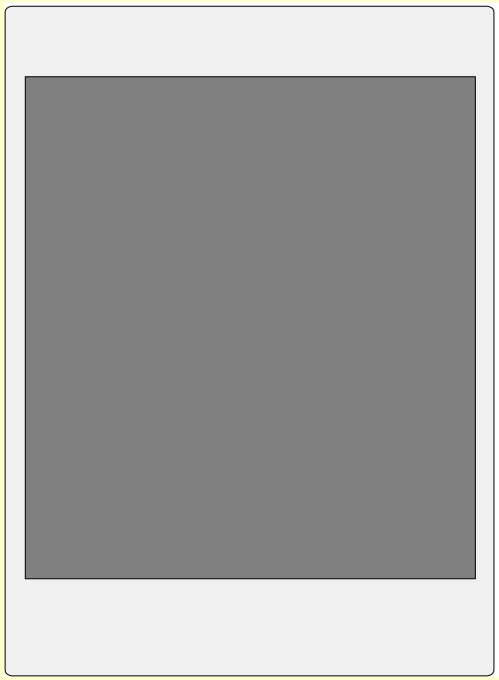
Waveform	Pulsewidth	Type	LFM BW (MHz)	PRI (usec)
High Energy	10	LFM/CW	20	25-45
Medium Energy	5	LFM/CW	20	12.5-22.5
Low Energy	2.5	LFM/CW	20	6.25-11.25

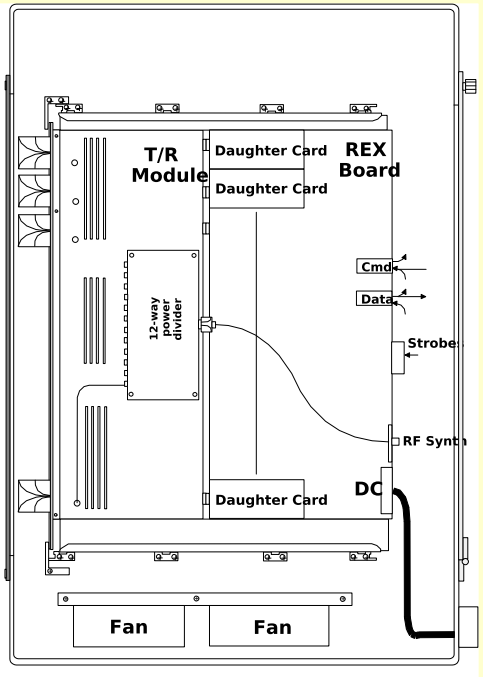
Number of Tracks (with simultaneous LR Search):

Waveform	PRI (usec)	CPI (msec) /no pulses	Number of Tracks @10Hz (with LR Search)	Number of Tracks@1Hz (with LR Search)	Number of Tracks@0.2Hz (with LR Search)
High Energy	45	11.52/256	2	20	100
Medium Energy	22.5	5.76/256	4	40	200
Low Energy	11.25	2.88/256	8	80	400

*Search Revisit Time is 5.25 Sec all cases (can be shorter)

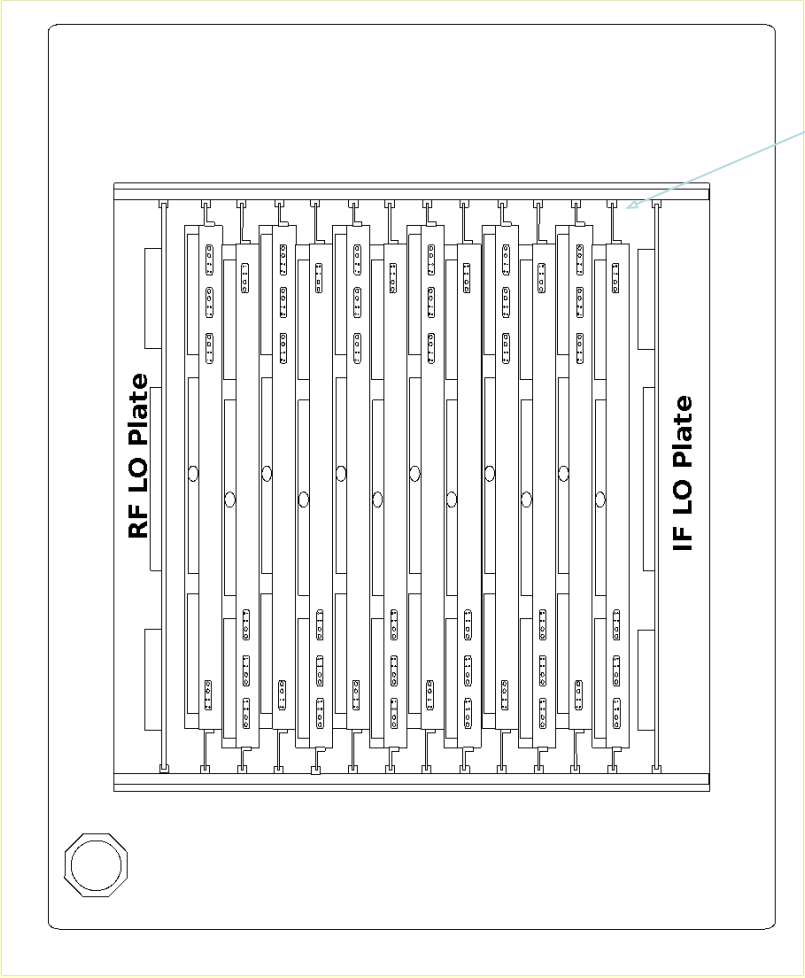
Antenna Assembly





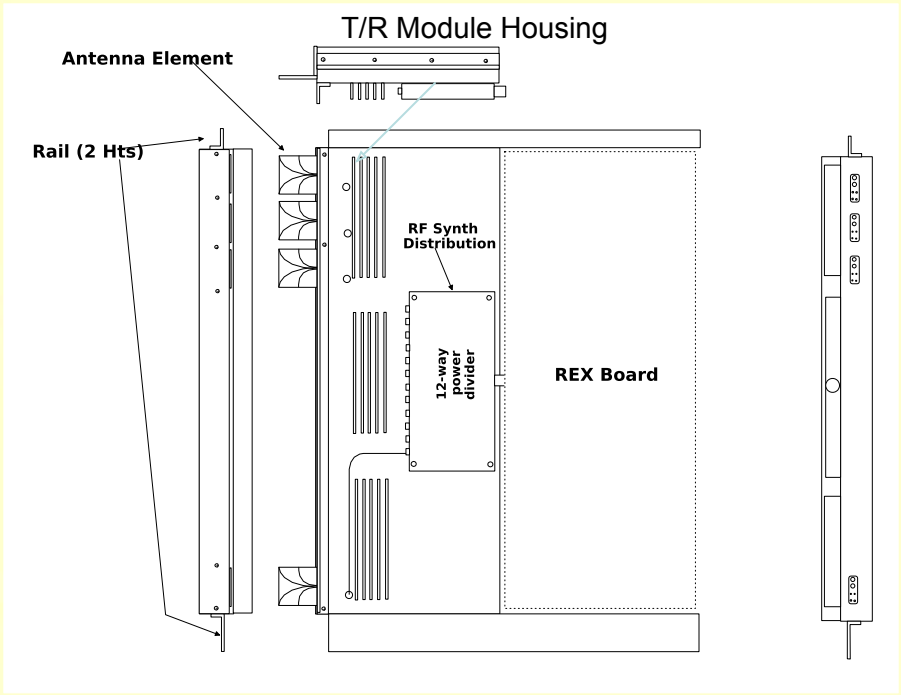
- Aluminum Hsg - 24”x27”x22”
- Weight – 200 lbs
- Planar radome panel
- Modules on rails, removable from rear
- Forced air cooling
- Include Features for Tripod Mtg and Calibration Horn

Antenna Assembly (Rear View)



Staggered Antenna Column Assemblies

Antenna Column Assembly



- 12 Element Assembly consisting of
- T/R Assy and Receiver/Exciter (REX) Board
- Direct mating between REX and T/R Assy

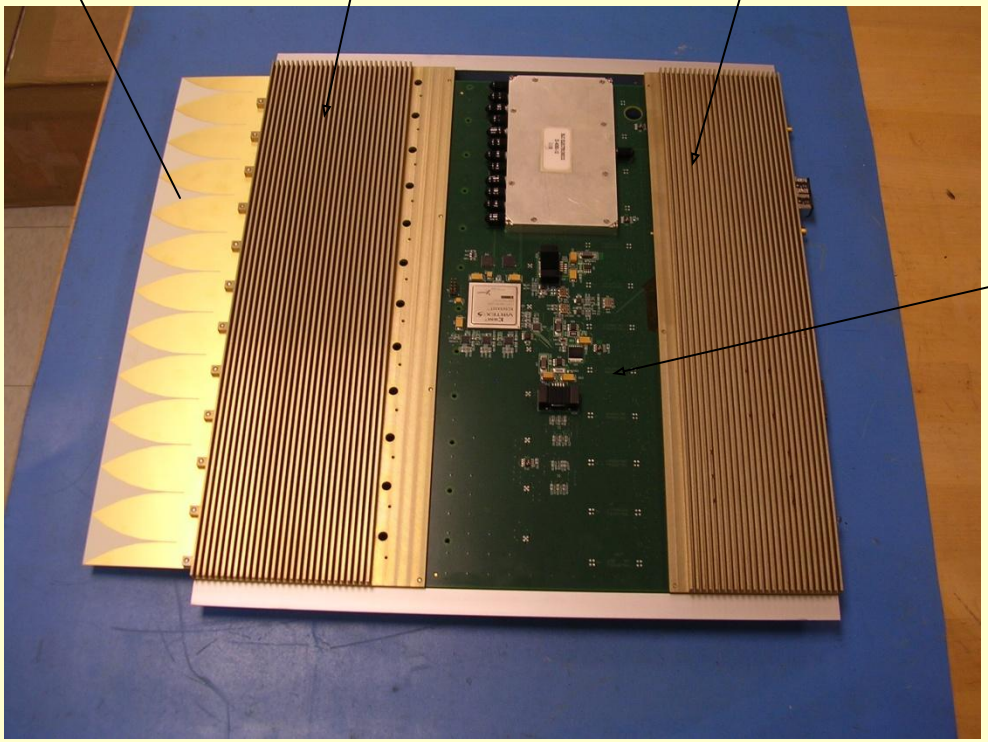
- Printed Antennas (part of T/R boards) extend through T/R Housing

- LO signals generated on separate IF and RF LO distribution assemblies

Antenna Card

T/R Modules Housing

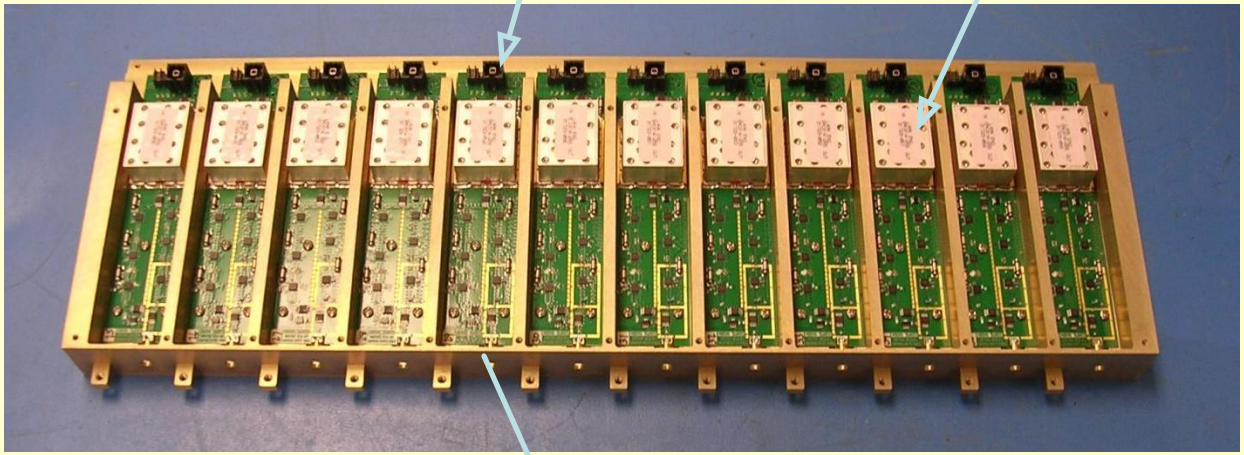
DC/DC Converter



REX (mother) Board

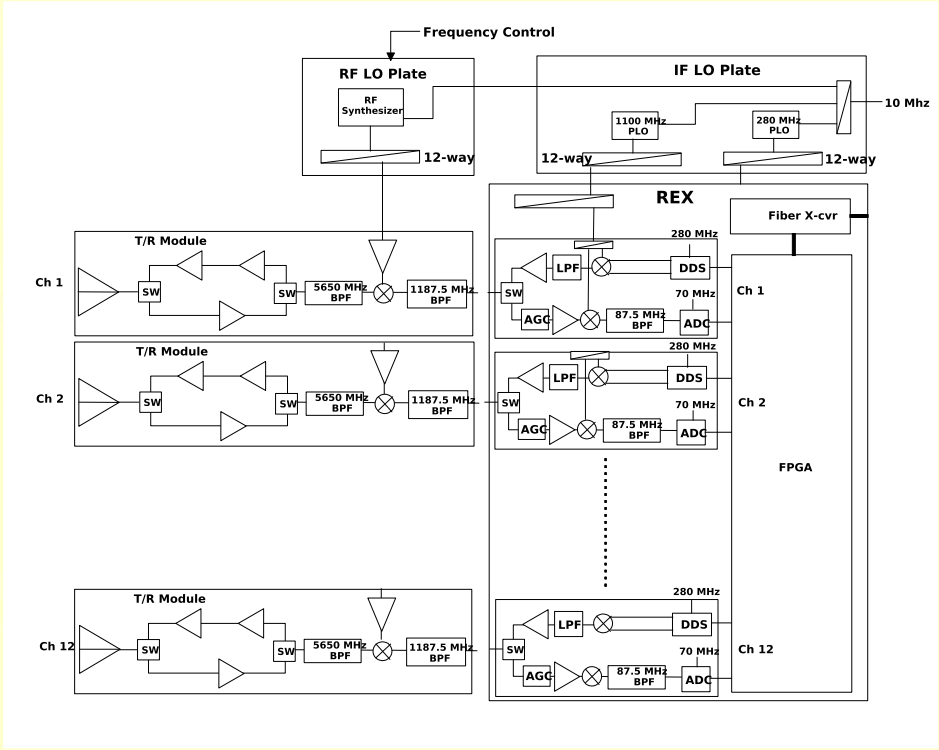
IF Connector
1187. 5 MHz

Surface Mount
RF Filter



RF Connector
5.5 – 5.9 Ghz

Antenna Electronics

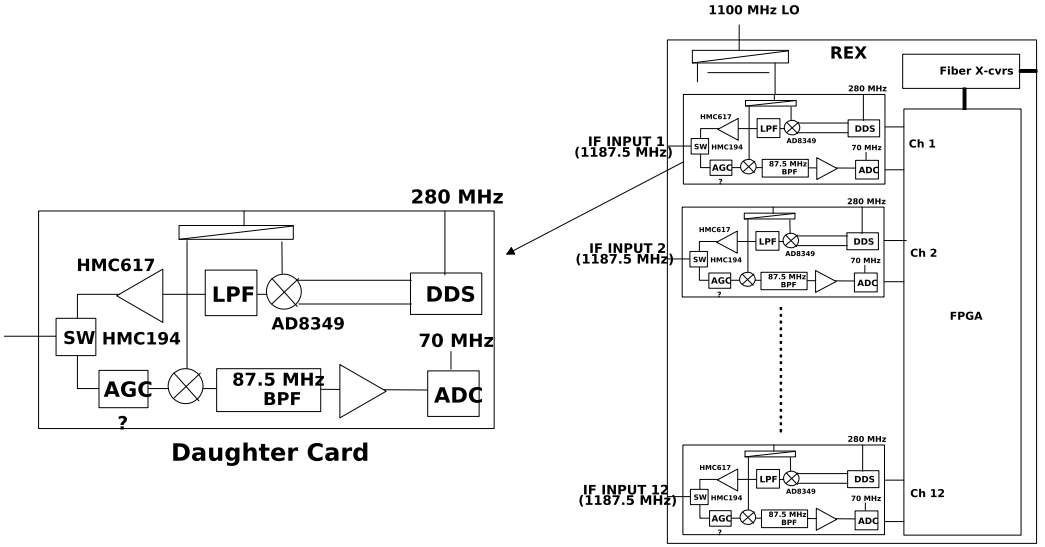


Key Hardware Developments

- 1Watt T/R Module with Integral Antenna
- 12 channels per Assembly

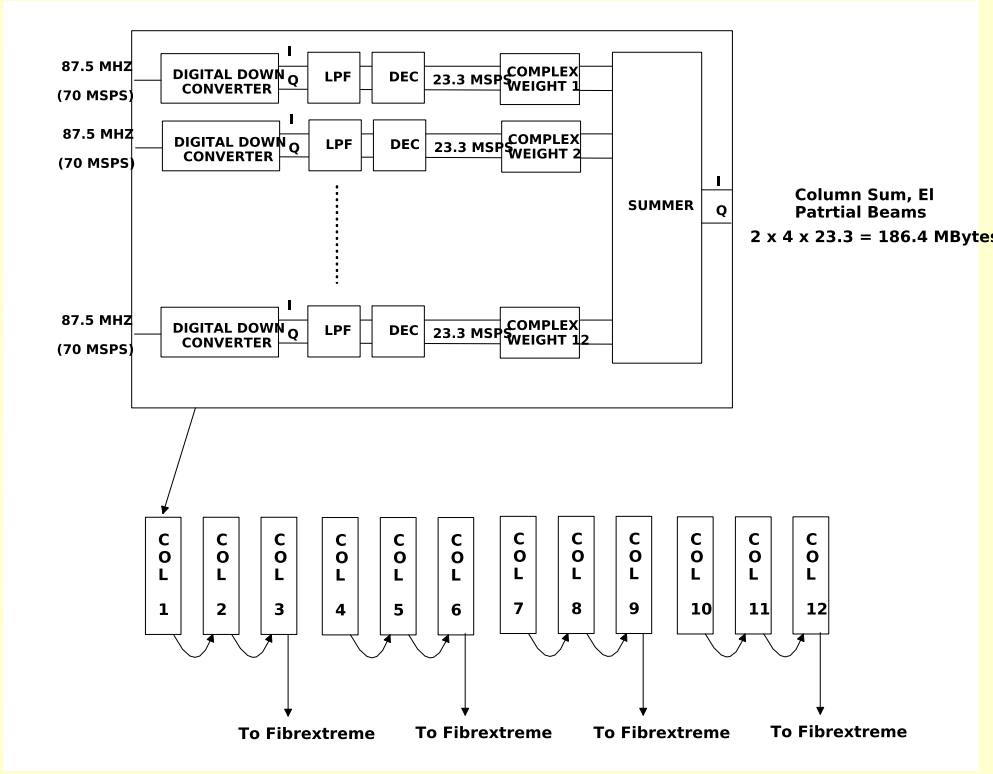
- 12 Channel Receiver /Exciter Board
- DDS with Up-conversion
- Down-converter with ADC s
- FPGA for Control and Digital beam forming

Receiver/ Exciter (REX)



- Design Approach
  - Motherboard with FPGA and I/O
  - Daughter Cards with Specific Functionality
- Daughter Cards
  - DDS waveform generation with IQ mixing to IF (1187.5 MHz)
  - IF down-conversion from 1187.5 MHz with A/D conversion (14 Bit at 70 Msps)
- Fiber-optic data Interface

Digital Beamforming

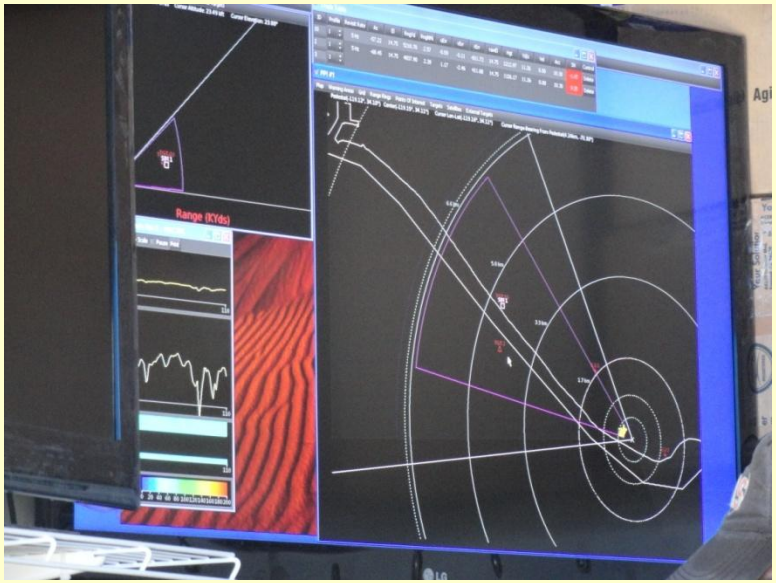


- Digitize receiver data at 87.5 MHz IF
- Digital down-conversion to baseband
- Form multiple partial beams with complex weighting
- Form final (Monopulse) beams in VME RTC

Electronics Enclosure

- Real Time Computer (RTC)
- General Purpose PC
- Linux with Realtime Extension
- Performs Radar Functions
- Control
- Scheduling(Search/Track)
- DSP
- Pulse Compression
- Doppler Processing
- Partial Beam-forming
- VME Chassis
- Radar Timing and Control
- Fiber-Optic controls

Display Control Computer



- Separate Laptop/PC and Monitors
- Ethernet Interface to RTC
- Displays
- PPI
- A-scopes
- C-scope
- Range-height display
- Range-Time Intensity
- Track Table
- Track Residuals
- All controls/displays in windows
- Movable/Resizable

CUAS RADAR STATUS

- Development of Demo System Nearing Completion
- Initial Field Test Experience
- Back in the Factory to Complete/Mod SW
- Anticipate Additional Field Testing Nov-Dec 2011