MWA-LFD Hardware Review & Implications for Science

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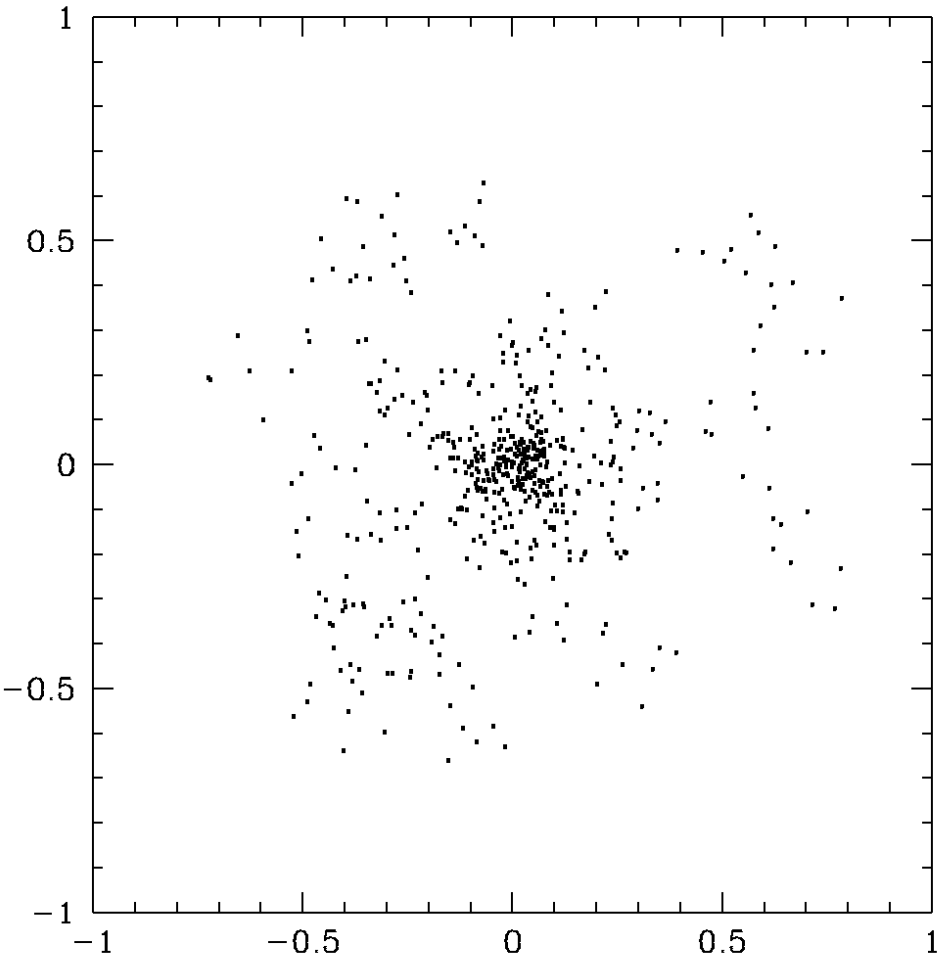
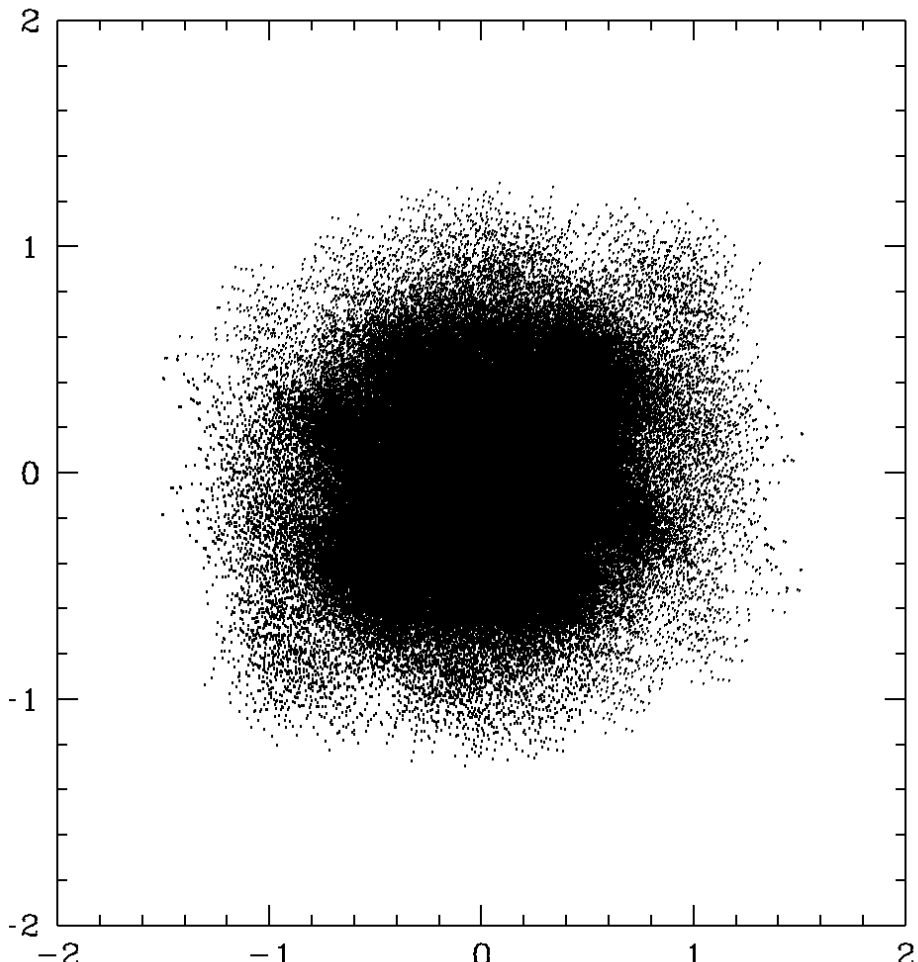
LFD General Properties

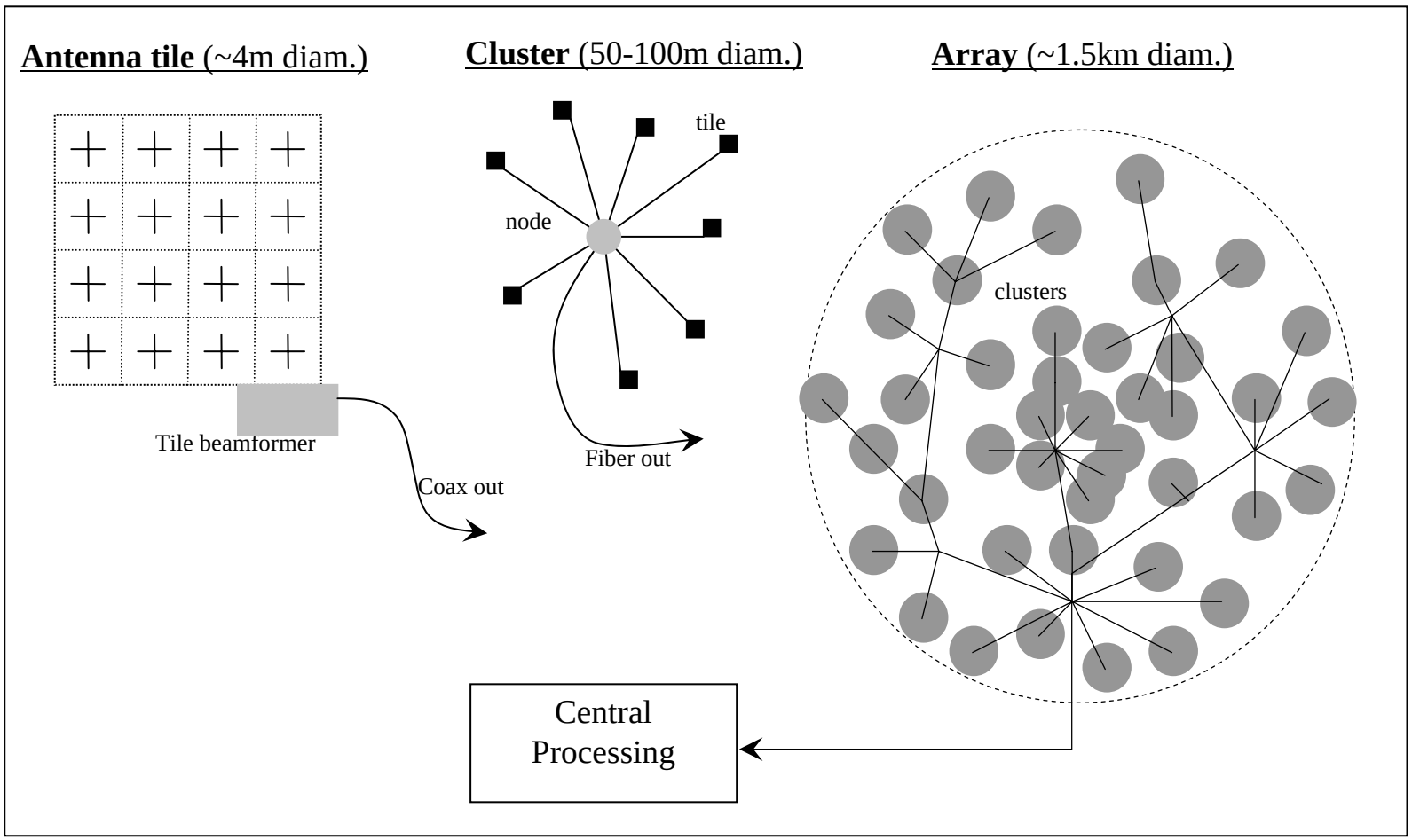
- 500 antenna tiles, 80-300 MHz
  - Each a 4x4 crossed dipole array
  - Electronic analog steering of tile beam
  - Total collecting area ~8000 m^2 at 150 MHz
  - Direct sampling of RF as early as possible
  - 8 bits/sample fine with low RFI environment in Mileura
- Full cross-correlation architecture
- 32 MHz processed bandwidth
- Tiles scattered across 1.5 km region
  - Angular resolution: a few arcmin
  - Superb *instantaneous* PSF characteristics
  - Central condensation for sensitivity at large spatial scales

Configuration and UV Coverage

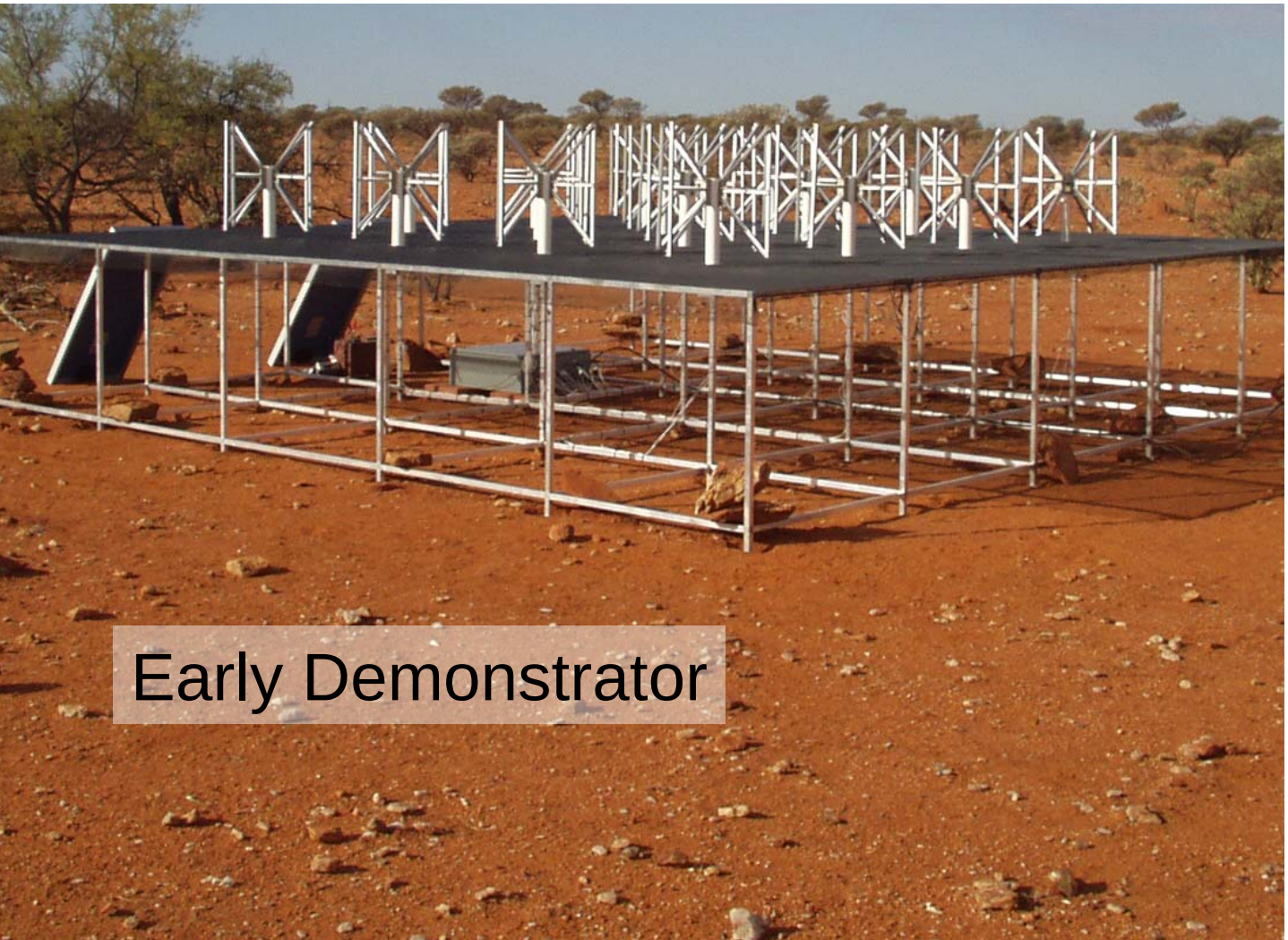




Physical Layout



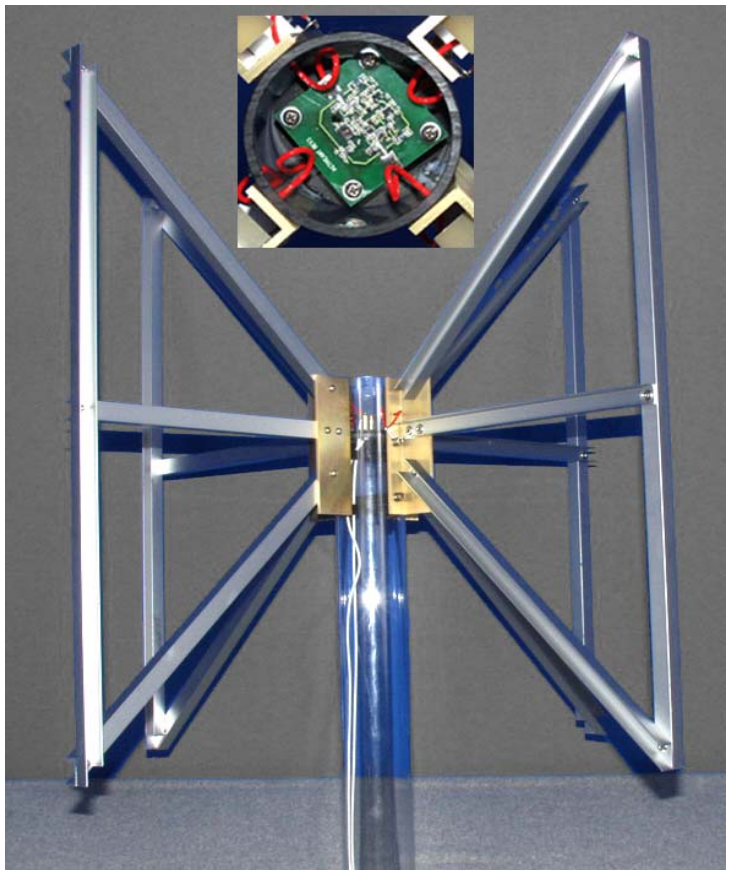
Tile Design

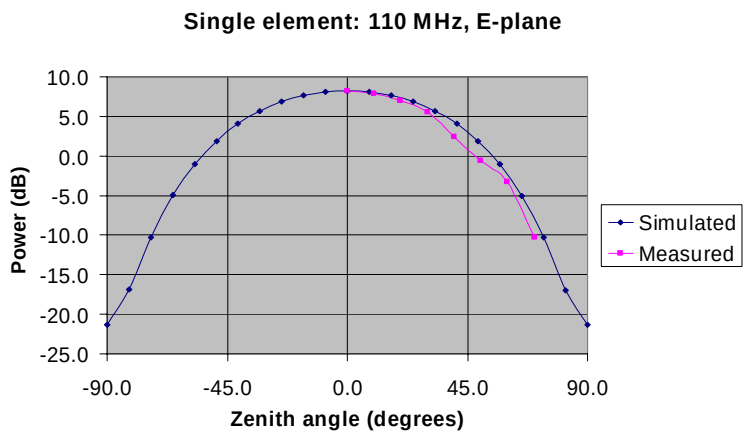


- 16 dipoles
- ~4m x 4m ground screen
- Dual-polarization
- 80-300 MHz
- Analog beamformer
- 30° min elevation

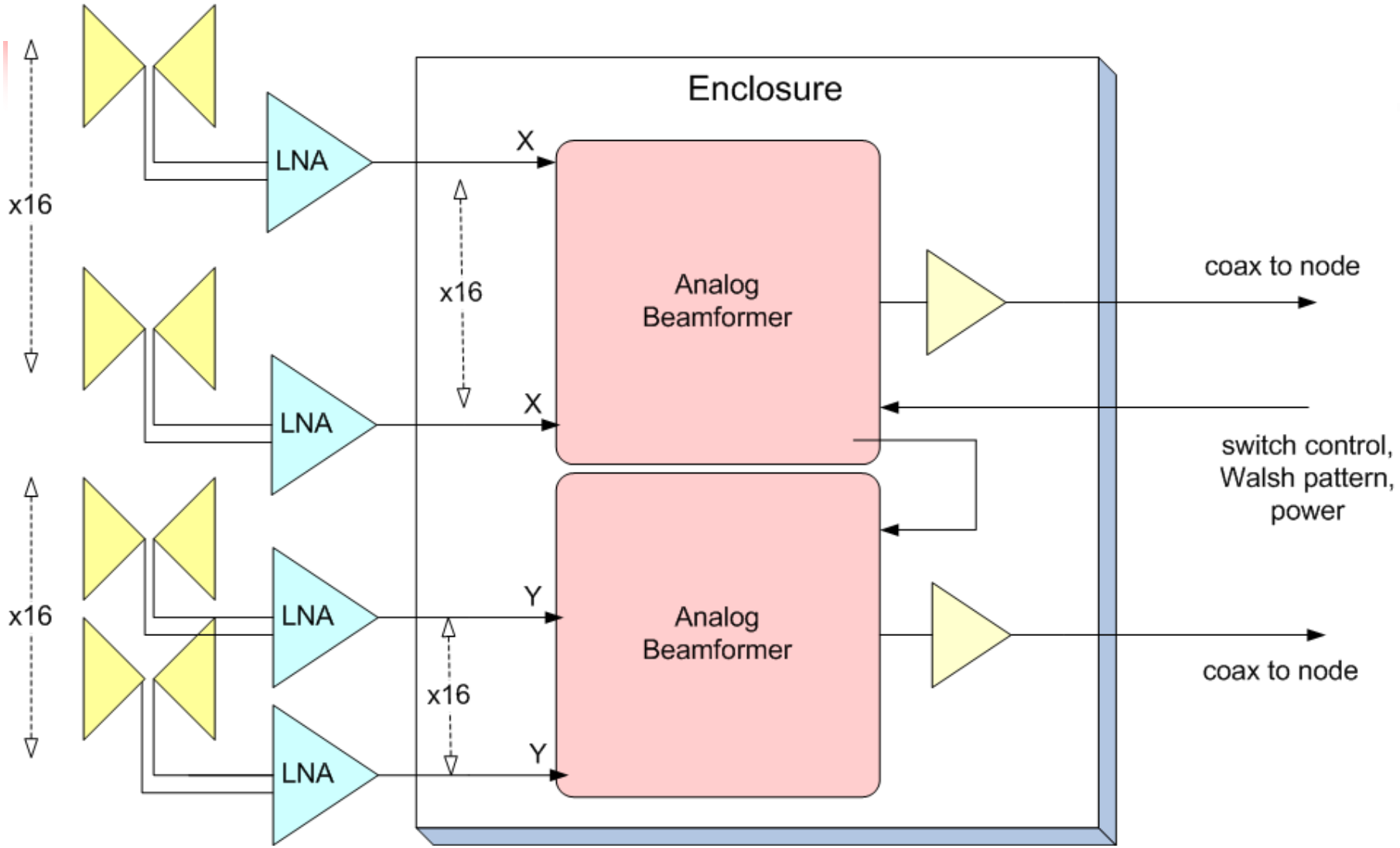
Target cost $2000 each

Crossed-dipole antenna prototype

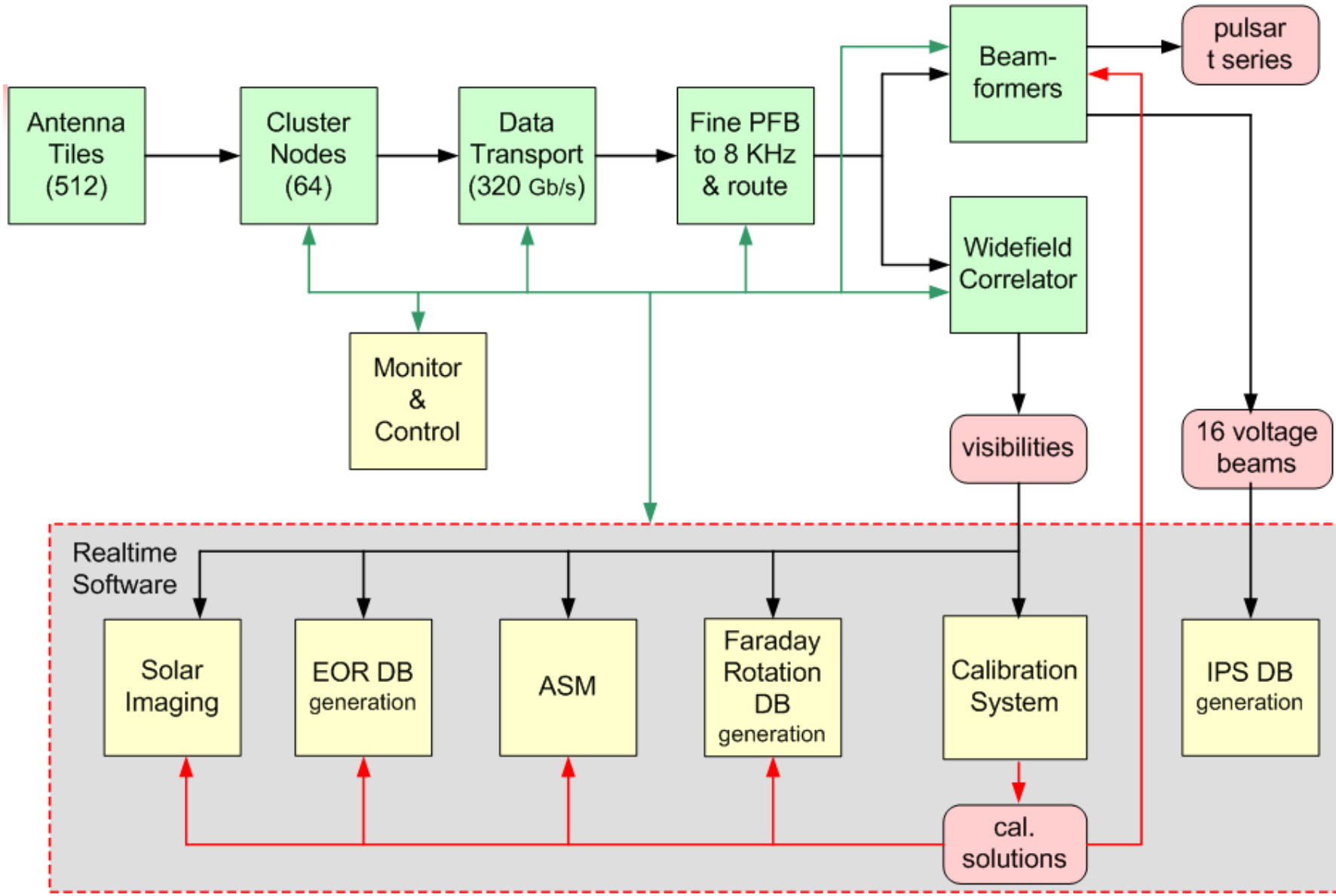




Antenna Tile



MWA-LFD System Block Diagram



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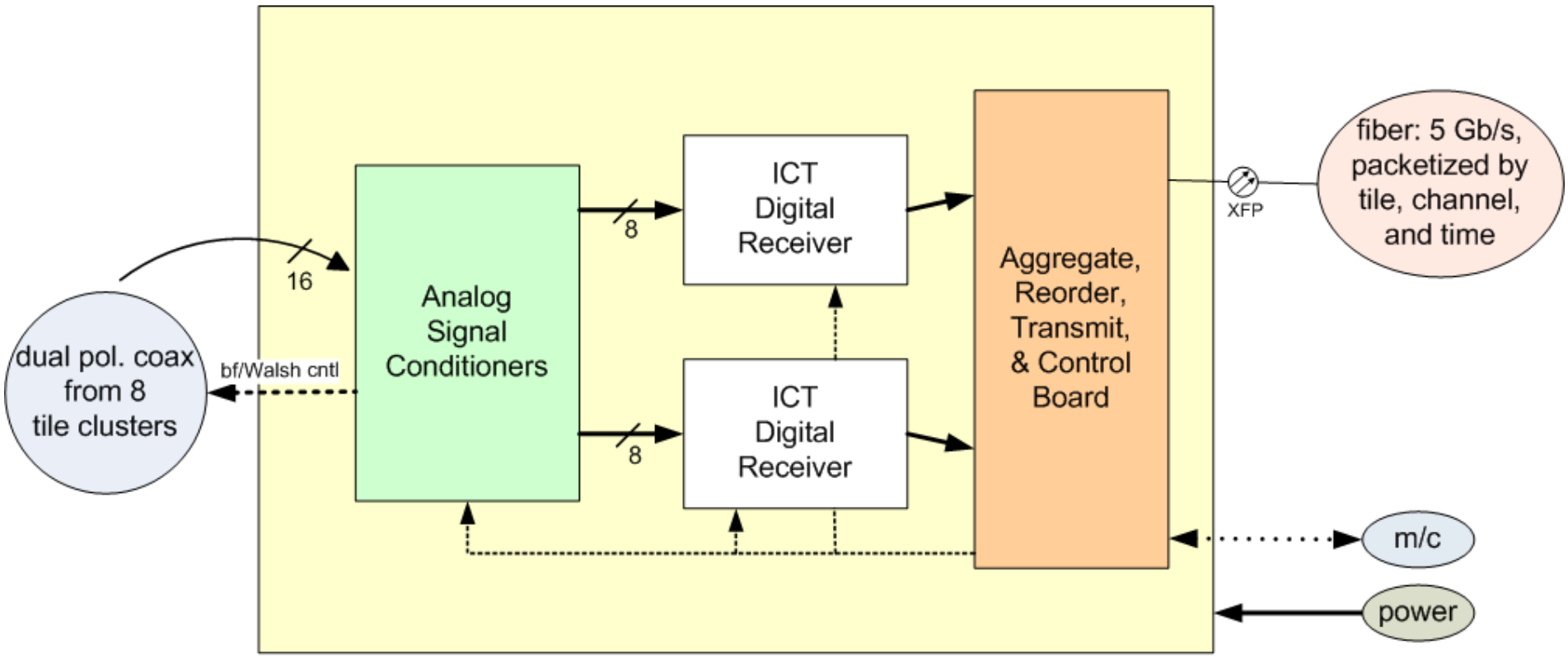
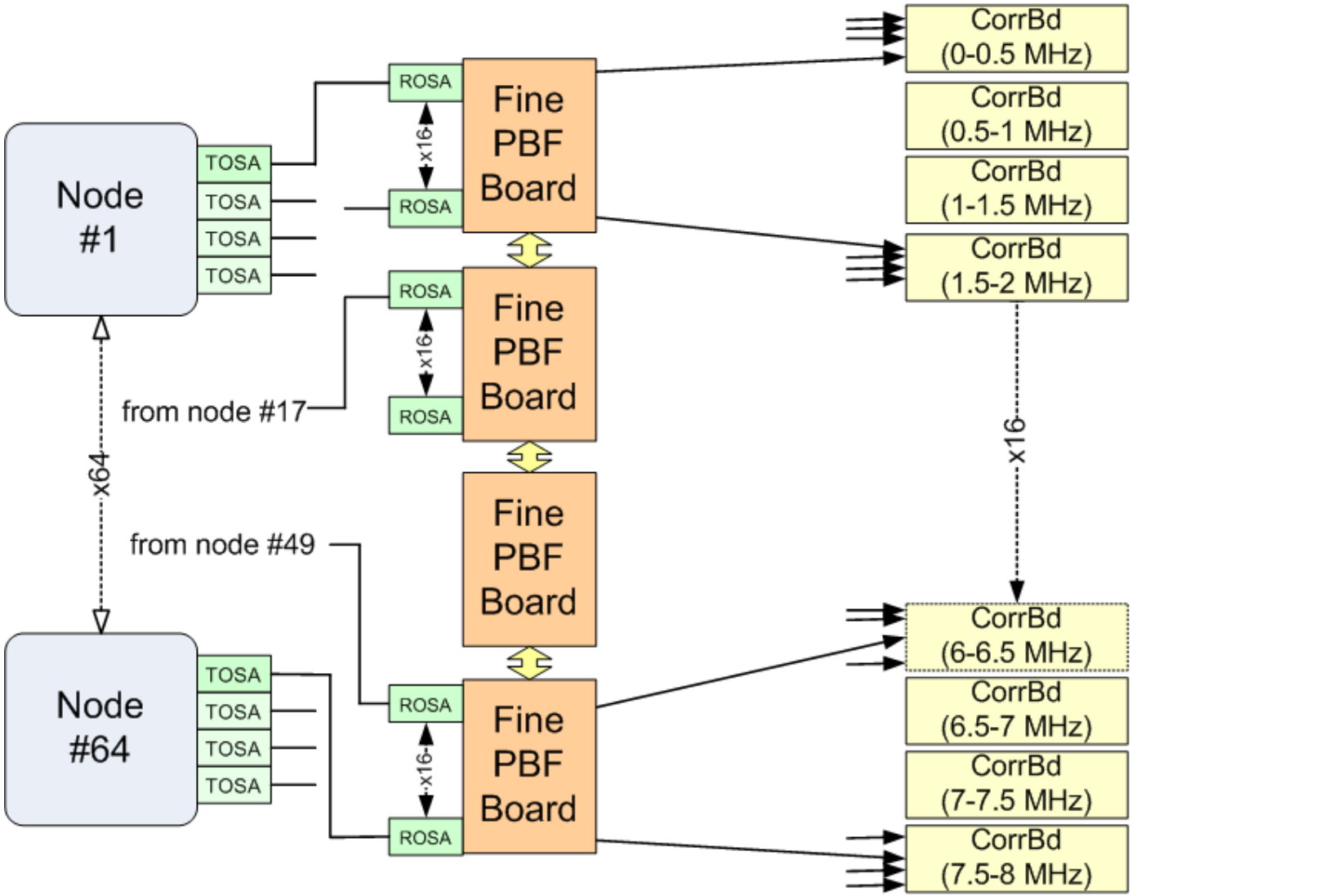
Digital Receiver

- For each of 16 analog inputs, band from 80-300 MHz Nyquist sampled
- Walsh encoding removed when digital
- 1st stage filter bank (running at ~660 MHz) generates ~256 x 1 MHz channels, of which 32 are selected for further processing
- (Later, in the PFB, a 2nd stage filter bank further breaks each 1 MHz channel into 64 channels of 8 KHz)

Cluster Node



Data Transport Layer
8 MHz slice - using 4 fibers per node



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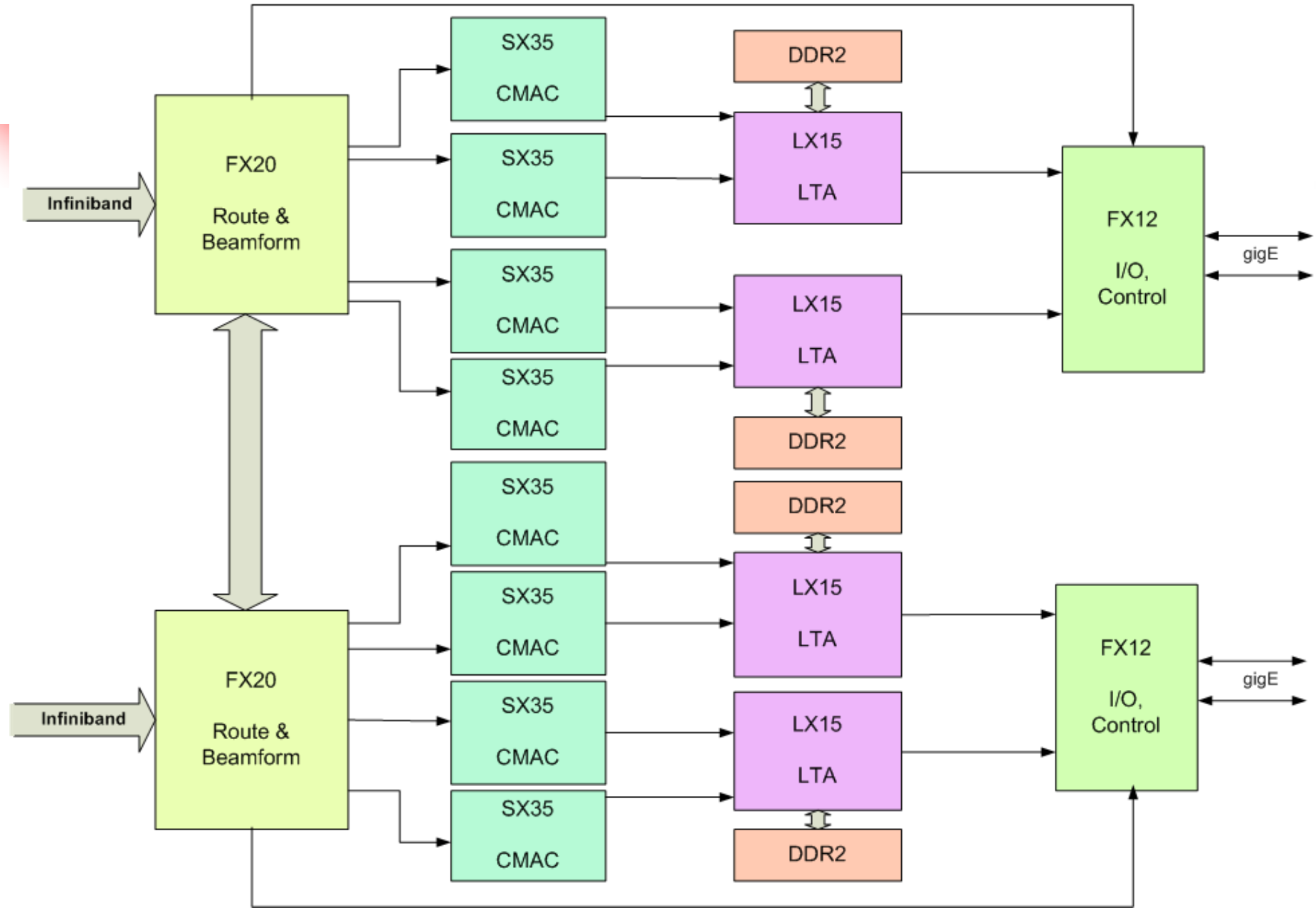
Widefield Correlator

- Cross-multiply of complex voltage spectra, without fringe rotation or gain correction
- 125K baselines x 4 pol's * 32 MS/s requires 16 TCMACs
- Plan to do complex (4bit) multiply in single multiplier
- Correlator is partitioned by frequency slice, into 64 boards, each processing 0.5 MHz of bandwidth, or into pairs processing a 1 MHz slice
- Local accumulation for 128 – 512 pts (16 – 64 ms), then LTA w/ RAM accumulates to 0.5s
- Yields 2×10^9 visibilities per 0.5 s AP dump
- 4×10^9 vis/s transmitted to realtime computer

Beamformer

- Forms 16 independent beams
- Channelization still 8 KHz
- Arbitrary pointing, though sensitivity is uneven, and perhaps 20 or 30 dB lower outside of tile beam
- Linear combination of antenna signals with coefficients based on gains, pointing phase factor, and weighting.
- Total computation ~ 0.5 Top/s
- Distributed across correlator boards

MWA-LFD Correlator PCB



“Tunable” parameters & other design choices

- Central condensation to what degree?
- Processed BW nominally 32 MHz; would 10% reduction limit science goals?
- PFB oversampling is the added complexity and possible BW sacrifice worthwhile?
- 512 antennas how damaging would 10% reduction be, if necessary to save $?
- 16 dual polarization voltage beams what if reduced to 4 for engineering reasons?
- Fine channel resolution nominally 8 KHz; how would factor of 2 up or down affect science?