# EVLA Advisory Panel Mtg.
# System Overview

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# What will be Replaced?

- Most feeds and front end electronics
- All LO/IF electronics
- IF transmission system
- All monitor & control electronics
- Correlator
- Computing systems / software

# Frequency Coverage

| VLA BAND | FREQUENCY | FREQ RANGE | Receiver Temp (K) |
|---|---|---|---|
| 4 | 74 MHz | 73.5 – 74.5 MHz | 1000-10000 |
| P | 327 MHz | 300 – 340 MHz | 150-180 |
| L | 1.5 GHz | (1.0)1.2 – 2.0 GHz | 9 |
| S | 3.0 GHz | 2.0 – 4.0 GHz | 14 |
| C | 6.0 GHz | 4.0 – 8.0 GHz | 19 |
| X | 10.0 GHz | 8.0 – 12.0 GHz | 21 |
| U | 15.0 GHz | 12.0 – 18.0 GHz | 21 |
| K | 22.0 GHz | 18.0 – 26.0 GHz | 28 |
| Ka | 33.0 GHz | 26.5 – 40.0 GHz | 38 |
| Q | 43.0 GHz | 40.0 – 50.0 GHz | 44 |

# LO System

- New hydrogen MASER
- GPS timing reference
- Fiber optic reference distribution
  - Carrier 1: 512 MHz, 128MHz
  - Carrier 2: 32 MHz + Timing
- Round trip phase measurement on 512 Mhz

# LO System

- Three new synthesizer designs:
  - 12 - 20 GHz Synthesizer
    - LO to K,Ka and Q Front Ends
    - LO to UX and LCS Converters
  - 10.8 – 14.8 GHz Synthesizer
    - Primary LO to main downconverter
  - 4.096 GHz Synthesizer
    - Secondary LO to main downconverter (for transition)

# IF System

- Four conversion stages
  - 4P Converter:  4 and P-Band to L-Band
  - LCS Converter:  L, C and S-Bands to X Band
  - UX Converter: Ku-Band to X-Band
  - Main Downconverter: X-Band to Digitizers

# Wideband Digitizers

- 4.096 giga samples / second
- 3 bits / 8 level
- 2-4 GHz harmonic sampling
- 256 MHz LVDS parallel data output
- Being developed for ALMA at the University of Bordeaux in France

# High Resolution Digitizers

- 2.048 giga samples / second
- 8 bits / 256 level
- 1-2 GHz harmonic sampling
- 256 MHz PECL parallel data output
- Two Maxim MAX108 devices interleaved
- Supports high resolution observing and VLA to EVLA transition phase

# IF Data Transmission

- Fiber optic based system
  - Twelve 10 gigabit per second links per antenna
  - Based on SONET/OC-192 technology
  - Using hardware designed for ALMA
    - Slightly modified for longer baselines / VLBI
    - Custom packaging being designed for low RFI

# Transition Interface

- Use digital FIR filters and D/A converters to regenerate 64MHz analog IF signals
- Feed to VLA digitizers via existing baseband filter and  driver modules
- FIR's and D/A converters may be combined with EVLA data transmission system receiver modules

# WIDAR Correlator

- Being developed by HIA/DRAO in Canada

| | |
|---|---|
| Number of Stations | 32 (installed racks for 40; architecture supports up to 256). |
| Max spectral channels/baseline @ max bandwidth | 16,384 (more with "wideband recirculation" and sensitivity losses). |
| Max spectral channels/cross-correlation with recirculation | 262,144 |
| Polarization products | 1, 2 or 4 |
| No. of basebands/antenna | 8 x 2 GHz each (more with narrower bandwidths) |
| Quantization | 1, 2, 3, 4, or 8-bit initial quantization; 4 or 7-bit re-quantization after sub-band filter. |

# WIDAR Correlator

| | |
|---|---|
| Correlator efficiency | ~95% (4-bit initial quantization, 4-bit re-quantization, 5-level fringe rotation) |
| Sub-band bandwidth | 125 MHz, 62.5 MHz, 31.25 MHz, …, 30 kHz (2-stage radar-mode). Each sub-band's width and position can be set independently of any other sub-band. |
| Sub-band tuning | Each sub-band should remain within an appropriate integer slot to minimize band edge SNR loss. E.g. a 125 MHz sub-band should be within 1 of 16 equally spaced slots in a 2 GHz band. |
| Spectral dynamic range | (Initial quantization) 3-bit: ~44dB; 4-bit: ~50dB; 8-bit: ~58dB. |
| Auto-correlations | Wideband (4x2 GHz pairs): 4 products of 1024 spectral channels each, SNR loss of 4. Sub-band: 16,384 total spectral channels per station (widest sub-band), no SNR Loss. |

# Monitor & Control

- Ethernet based system
- 100 Mb fiber in antennas
- 1Gb fiber CEB to antennas
- 100Mb and 1Gb fiber and copper in CEB
- Module Interface Board (MIB) being developed for modules

# Power Supplies

- 48 VDC in antennas and correlator
  - Lower current distribution
  - Components widely used in telecom industry
- Combination of linear and switching regulators
- Backup power on critical subsystems

# Racks/Bins/Modules

- Use a modified version of existing designs
  - Improved RFI characteristics
    - More high speed digital circuits in antennas and CEB
    - Wider bandwidth front ends
  - Improved Thermal characteristics
    - Heat generated by high speed digital electronics
    - RFI sealed modules/racks present greater challenge
    - Greater thermal stability for LO/IF electronics

# Racks/Bins/Modules

- New packaging being design to accomodate:
  - IF Data Transmission System (DTS)
  - 8 Bit digitizers
  - 3 Bit digitizers
- RFI shielded
- Air cooled

# RFI Considerations

- External RFI
  - More RFI sources
    - Ground and space based
    - Cell phones / PCS
    - Satellite radio / television broadcasting
    - DME / military & civilian radar / super doppler weather radar
  - More sensitive front ends
  - Environmental Monitoring System (EMS)
    - Located at VLA site
    - Collecting data for use in system design

# RFI Considerations

- Internal (VLA site generated) RFI
  - High speed digital electronics
    - Digitizers, data transmission system, correlator
  - More and faster computers on site
  - Comb generators in 6 synthesizers per antenna
  - Wider IF bandwidths
  - Switching regulators
  - Alma test interferometer on site

# RFI Considerations

- Solutions:
  - WIDAR correlator design
  - High resolution digitizers at antenna
  - High dynamic range IF system
  - New shielded room for correlator
  - Improved rack/bin/module designs
  - Flexible system design
    - Fast total power measurement, variable gain, test points, etc…
  - Low emission electronic design techniques

# Questions?