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NATIONAL RADIO ASTRONOMY OBSERVATORY
Tucson, Arizona

1999 February 05

MEMORANDUM

To: Distribution (given below)

From: Larry R. D'Addario

Subj: Discussions of interfaces to support evaluation receivers held in Tucson on 1999-01-23

A meeting was held on Jan 23 in Tucson to discuss interfaces among the subsystems being developed at different sites, specifically the receiver, local oscillator, and reference/IF subsystems. The meeting focussed on support of the test interferometer that will use the first two antennas and the Evaluation Receivers. Although all three subsystems of this test setup may be substantially different from those of the final array, it was agreed that as many components as possible should be the same as we expect to use in the array. Attendees of the meeting were: W. Brundage, R. Sramek, D. Emerson, J. Payne, A. Perfetto, G. Moorey, and L. D'Addario.

Our results are summarized by the attached block diagram and the following notes. These describe the plan for the evaluation system as envisioned at the end of the meeting.

1. The frequency coverages of the receivers differ somewhat from those given elsewhere [1,2]. The lowest band is taken to be 33-45 GHz to fit within the WR22 waveguide band, rather than 30-40 GHz. No justification can be found for extension below 33 GHz, neither here nor for the array production receivers. Extension to 45 GHz is needed to cover the SiO line and provide overlap with the VLB/VLBA band, again for both evaluation and production. The next band is 85-116 GHz (vs. 86-115) so as to include the SiO and CO lines near each end. The highest band is unchanged at 210-270 GHz; this is nearly the same as is planned for the production receivers [3,4].

2. All IF outputs from the receivers are 2 GHz wide at 4-6 GHz. This puts them inside the planned production band of 4-12 GHz.

3. The box labeled "MUX" in the block diagram will be half of the 4-channel analog IF processing planned for the production system [5]. It will put one 4-12 GHz band or two 4-8 GHz bands onto a single optical carrier. It will include total power detectors covering the full bandwidth of each channel. The detector outputs will be

available at front panel BNC connectors for initial testing, as well as via a digital interface whose details are TBD.

4. Both HFET receivers are double-conversion (as in [1,5] but contrary to [2]), with first IFs at 20-22 GHz and 30-32 GHz, respectively. The latter falls outside the first IF band planned for the production receiver (14-22 GHz), which has less coverage (89-116 GHz). The corresponding first LOs are 55-65 and 55-84 GHz, to be provided by the same tripler-amplifier from an 18-30 GHz synthesizer. Fringe rotation and phase switching for interferometry ~~is~~ are included in the synthesizer.

5. The second LO for each HFET receiver is at 26 GHz (fixed), which is the same as is planned for production [5].

6. LOs for the two SIS receivers are separate. The first (92-110 GHz) uses a fundamental Gunn oscillator locked to the 4th harmonic of the 18-30 GHz synthesizer with about 100 MHz offset. Fringe rotation and phase switching is included on the offset reference. The second uses a Gunn PLO locked to the 3rd harmonic of the synthesizer (70-90 GHz) plus offset, followed by a commercial tripler. Further details are given in [2].

7. The 85-116 GHz SIS mixer uses mechanically tuned mixers, and each of the Gunn PLOs requires mechanical tuning. This is rather unlike the planned production system, yet we want the interfaces to be as similar to the production system as possible. Therefore, we intend to integrate all necessary drive controls and electronics for these mechanical tuners as closely as possible with their respective devices, and to minimize any external interfaces. Details are TBD, but some of us think that a digital interface to the monitor and control system will be needed to allow remote control of the tuning. In that case, the interface will be kept as simple as possible (one number to specify tuner position) so as to minimize impact on M&C.

8. The 18-30 GHz synthesizer replaces the 10-15 GHz synthesizer shown in [6]. We are under the impression that the latter range was chosen only because of the non-availability of commercial YIG tuned oscillators at higher frequencies. But we are convinced that such oscillators can be obtained on special order from several companies, even if they cannot be ordered from catalogs, and that the cost of this is justified for the MMA. Thus, the higher frequency range should also be adopted for the production. This would simplify the multiplier chain LO by eliminating the first doubler in each of the two tunable oscillator chains [7].

9. Responsibilites for various parts of the system were allocated among different groups as shown in the diagram. The principal interfaces are:

2 IF signals, each polarization:
receiver to IF multiplexer
1 Tunable LO, 18-30 GHz, with optional fringe rotation and phase swithing:

LO reference to receiver
1 Fixed LO, 26.0 GHz:
LO reference to receiver
1 LO reference, 100 MHz plus fringe rotation and phase switching:
LO reference to receiver

It is hoped that the multiplier LO group (Charlottesville) can supply the 55-84 GHz tripler-amplifier, since this is similar to part of the planned 60-90 GHz electronic oscillator [7]; and also the 210-270 GHz triplers, although the latter can be purchased commercially.

Recommended Changes

Various issues came up after the meeting that imply the desirability of modifying some of the plan described above. These are my suggestions only.

1. The instantaneous bandwidth limit of 2 GHz is imposed primarily by the SIS mixers and does not apply to the HFET receivers. Therefore, the evaluation HFET receivers should be made to cover the full 8 GHz bandwidth (4-12 GHz final IF) planned for production. This enables the IF transmission system, total power detectors, and other hardware to be tested at full bandwidth. This also reduces the first LO tuning ranges required to 55-59 and 55-78 GHz, respectively.

2. The 33-45 GHz HFET receiver can be greatly simplified by making it single-conversion, while still allowing good image rejection by fixed RF filters. Then the LO range becomes 45-49 GHz, which would require doubling rather than tripling the synthesizer output frequency.

3. The 85-116 GHz HFET receiver has its first IF at 30-32 GHz (or 30-38 GHz if expanded to full bandwidth as just suggested). This departs from the plan for production [5], where the first IFs of all HEMT receivers are 14-22 GHz.

Open Questions

1. What is the nominal power level at each interface (LO, IF), and the tolerance on that level?

2. What LO tuning resolution (step size) is needed?

3. Monitor and control interfaces: list of controls and monitor points; details of physical layer connections and protocol are all TBD.

4. Total power outputs digital interface: via M&C or separate? Sampling rate, resolution, details of connection and protocol are TBD.

5. This plan covers only the case of analog signal transmission from the antenna. Many things will be very different if digital transmission is used.

6. Do any LO harmonics or cross products fall in observing bands or IF bands in such a way as to cause significant interference? Signals that drive multipliers or harmonic mixers are especially suspect.

7. How will subreflector nutation timing be synchronized with total power integration?

REFERENCES

[1] J. Payne, "Evaluation Receivers." MMA Project Book section 5.1, revision dated 1998-Nov-18.

[2] A. Perfetto, "MMA evaluation receiver LO system." Memo to John M. Payne dated 1999-Jan-11.

[3] J. Payne, "Production Receivers." PB sec 5.2, 1998-Nov-24.

[4] A. Wooten et al., "Frequency band considerations and recommendations." MMA Memo 213, 1998-Mar-13. Note: The recommendations herein have been adopted as the baseline plan for frequency coverage of the MMA.

[5] A. Thompson, "System Design Overview." PB sec 8.1, 1998-Nov-18, Fig 2.

[6] ibid., Fig 7.

[7] R. Bradley, "Local Oscillators: Multiplier System." PB sec 7.2, 1998-09-24, Fig 7.2.3.

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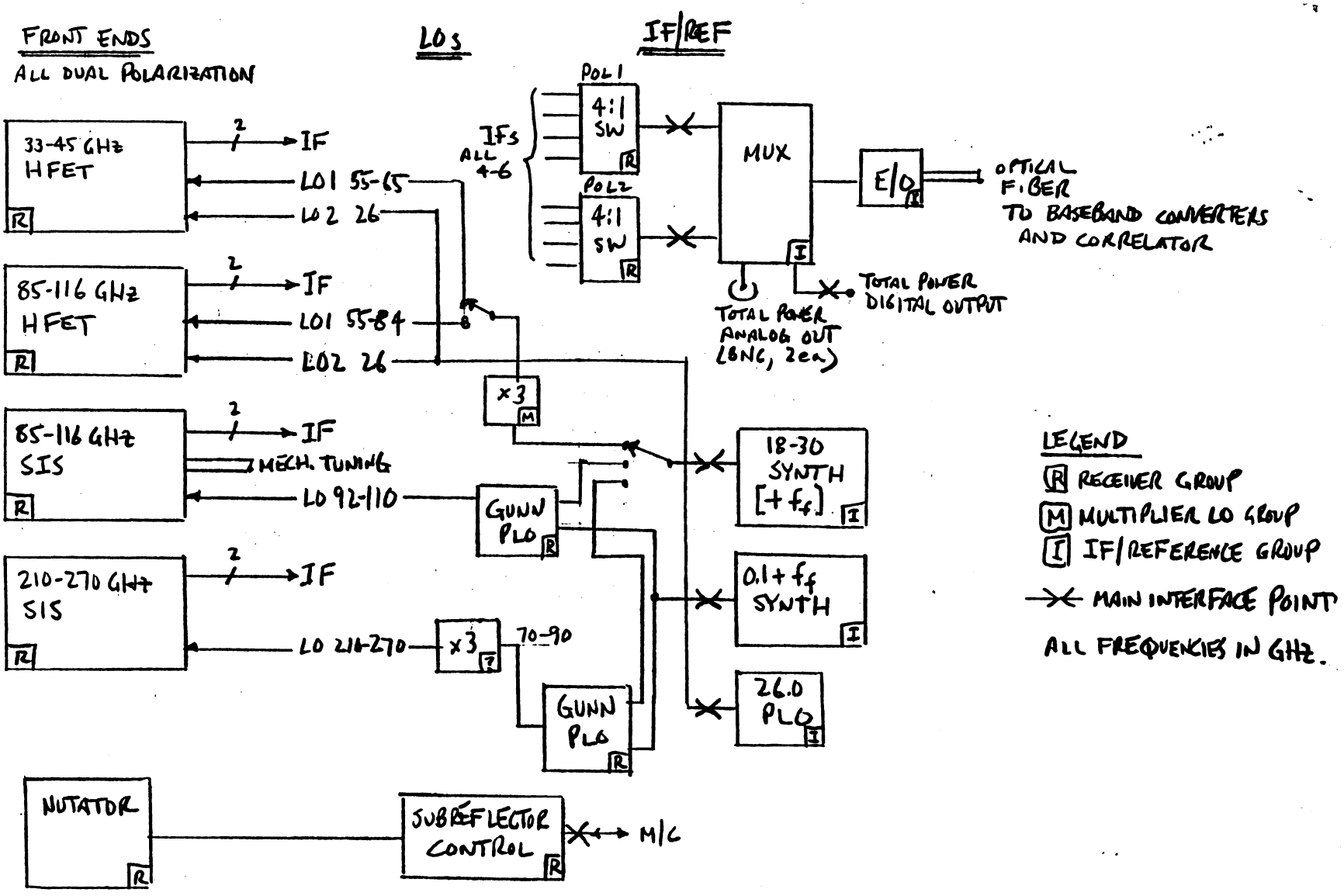

EVALUATION SYSTEM PLAN