

# FIRST LOCAL OSCILLATOR SUBSYSTEM FOR ALMA: ORGANIZATION AND DISTRIBUTION OF RESPONSIBILITIES

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## 1. INTRODUCTION

The ALMA front ends require the support of a local oscillator system that is quite complex and sophisticated. It needs to provide phase-stable signals at frequencies from ranging from 31 to 948 GHz to ten band-specific front end assemblies at each antenna. In the baseline design, each antenna will have several millimeter-wavelength electronically-tunable signal sources with an aggregate range of 31 to 122 GHz, and the output of the currently-selected source will be phase locked to an equal-frequency reference derived by mixing two laser signals sent from the central building. The laser difference phase will be locked to the array master oscillator, and the optical fiber used to transmit them will be actively length-stabilized. When the required LO is at a frequency higher than 108 GHz, the source output will feed one or more frequency multipliers inside the cryogenic dewar (at about 70K).

The arrangement described above results in the use of a variety of technologies, and the ALMA project has them under development in several geographically separated laboratories. The present document explains how the whole First LO Subsystem is organized into its major subassemblies, how these subassemblies will fit together, and who is responsible for each.

## 2. COMPONENT SUBASSEMBLIES

Figure 1 shows a simplified breakdown of the First LO Subsystem into its major parts. Only the parts for a single antenna are shown, but most items must be duplicated for every antenna. Within the antenna, the Front End Assembly contains separate components for each of the 10 receiving bands, but only the typical arrangement of one band is shown.

The major parts are:

Central Reference Generator (CRG): Produces fixed frequency reference signals needed throughout the system.

8-11 GHz Synthesizer: Produces tunable reference to the Laser Synthesizer (one per subarray).

Laser Synthesizer: Phase-locks slave laser to master laser with required frequency difference. Produces dual-wavelength signal on optical fiber (one per antenna).

Line Length Corrector (LLC): Stabilizes the effective length of the optical fiber to an antenna (one per antenna).

Reference Receiver: Produces offset optical return signal for use by LLC; switches dual-wavelength signal to desired band. (Also demodulates and distributes reference signals used outside the 1st LO subsystem.)

Photodetector (PD): Mixes the optical carriers in the dual-wavelength signal so as to recover the millimeter wavelength reference.

Warm Multiplier Assembly: Room-temperature portions of LO signal

source that need to be close to the front end so as to minimize loss. Includes mixing the reference with a sample of the source output. A separate assembly is required for each band. (Except that none is required for band 1.)

Cold Multiplier Assembly: 70K portions of the LO, consisting of final multiplier stages for frequencies above 108 GHz. A separate assembly is required for each band. (Except that none are required for bands 1 through 3.)

Phase-locked source: Room-temperature portions of LO signal source that can be 0.5 m or more from the front end.

LO Controller: Drives source so as to phase lock to mm wave reference, including offset for fine tuning and fringe rotation.

Other assemblies closely related to the First LO Subsystem are:

Front End Cartridge: Sub-assembly of components of the Front End system for a specific band, intended to be removable and replacable as a unit, including both room-temperature and cryogenic portions.

Front End Assembly: Complete rack-level Front End, including cartridges for all bands, closely associated components of the First LO, dewar, cryocooler, and all necessary support electronics.

### 3. RESPONSIBILITIES AND INTEGRATION

The various groups involved in building these components, and the sequence of integration, are as follows. Each item requires a detailed Interface Control Document.

LO Reference Group (Socorro): Responsible for

- Central Reference Generator
- 8-11 GHz Synthesizer
- Reference Receiver
- LO Controller
  - . Delivered to Receiver Integration Group for incorporation into Front End Assembly

LO Photonics Group (Tucson):

- Laser Synthesizer
- Line Length Corrector
- Photodetector
  - . Delivered to LO Multiplier Group

LO Multiplier Group (Charlottesville):

- Phase Locked Source
  - . Delivered to Receiver Integration Group
- Warm Multiplier Assembly
  - . Delivered to FE (sub)Group for appropriate band
- Cold Multiplier Assembly
  - . Delivered to FE (sub)Group for appropriate band

Front End Groups: Responsible for integrating Warm Multiplier and Cold Multiplier assemblies, along with other components, into a Front End Cartridge for one band. The groups involved are band-specific; for the first-priority bands, they are:

- Band 3 and Band 6 FE Groups -- Tucson
- Band 7 FE Group -- Chalmers
- Band 9 FE Group -- Gronigen

Each of the resulting Cartridges is delivered to the Receiver

Integration Group.

Receiver Integration Group: Responsible for integrating FE Insert Assemblies, LO Controller, Phase Locked Sources, and other components into a complete Front End Assembly. Composition and location of this group is TBD.