LCLS Engineering Specification Document # 1.2 - 136	INJECTOR	Revision 0

S-Band Low Level RF Phase Reference System

Ron Akre		3-4-05
Alan Hill (Authors)	Signature(s)	3-5-05 Date
Eric Bong (System Manager)	Signature	3/7/05 Date
Cecile Limborg (System Physicist)	Signature	3/7/05 Date

Brief Summary: The phase reference system will include locking of a low noise oscillator to the linac RF reference. The 476 MHz reference will be multiplied to 2856MHz and distributed to the laser, RF gun, L0-1, L0-2, transverse accelerator, L1-X and L1-S drive and monitoring systems. Electronics for interfacing to the LASER phase lock. The electronics will be housed in a temperature controlled room enclosing penetration 20-17, which all the phase critical heliax cables will be run down.

Keywords: RF Phase Reference Distribution

Key WBS#'s: 1.2.4.3.2

The LCLS injector will reside in an off axis tunnel at the end of sector 20. The main linac RF and Timing signals will be coupled off the Main Drive Line (MDL) at the end of sector 20 in a temperature controlled hut. The location of the hut is shown in figure 4. The system in the hut will control the laser, RF Gun, linac 0, and linac 1 RF. The injector has 4 klystrons. Linac 1 has 1 S-band klystrons and 1 X-band klystron. The LCLS project will use the existing timing system and RF distribution system for the main linac, LCLS linacs 2 and 3. LCLS linacs 2 and 3 are made up of the main SLAC linac sectors 21 to 30, figure 3.

The phase system of the main linac will not meet LCLS specifications for the laser, RF Gun, linac 0, and linac 1. A new system will be added to reduce phase noise levels and eliminate the phase and frequency shift on the main linac. This system is shown in figure 1 and except for the MDL is all new components.

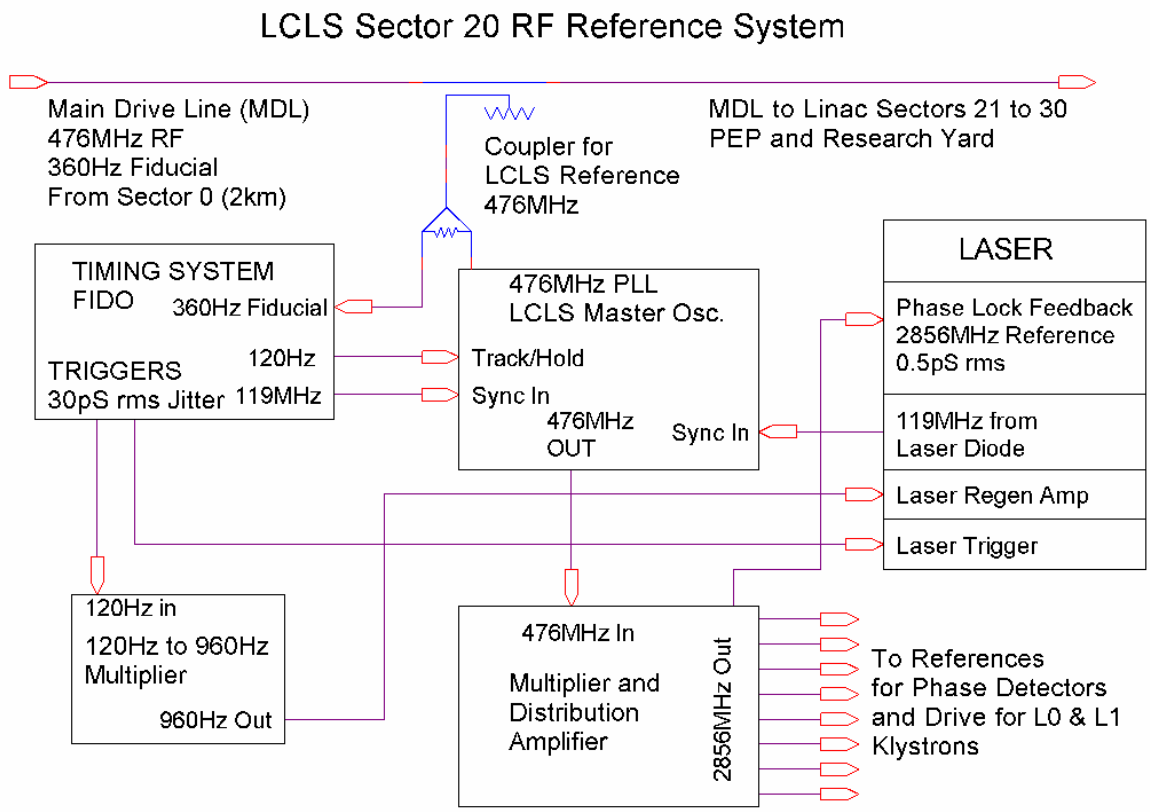

Figure 1. Sector 20 RF Reference System.

LCLS will run at 120Hz. During every 3rd cycle of the 360Hz timing system the RF will be stable for a period of 2.8mS. The PLL must sample and hold at 120Hz during the phase stable time. Outside of the phase stable time the 476MHz RF reference will change by as much as 720º, but will return to the original phase before the next 120Hz cycle as shown in figure 3. The phase noise of this system must be stable to within 50fS rms during LCLS beam time.

A laser pulse must be locked to the timing fiducial for LCLS to operate. With a laser frequency of 119MHz, every 14th pulse will be aligned with the 8.5MHz used to synchronize the fiducial pulse. Every third fiducial pulse will be used to trigger LCLS at a 120Hz rate.

The laser phase lock reference will come from this system. A second PLL will be designed and built to lock the output of the 119MHz laser oscillator to the 476MHz reference. The Regen amplifier on the Laser should run at 960Hz, eight times the 120Hz rate, to insure a laser pulse is synchronized with the timing system.

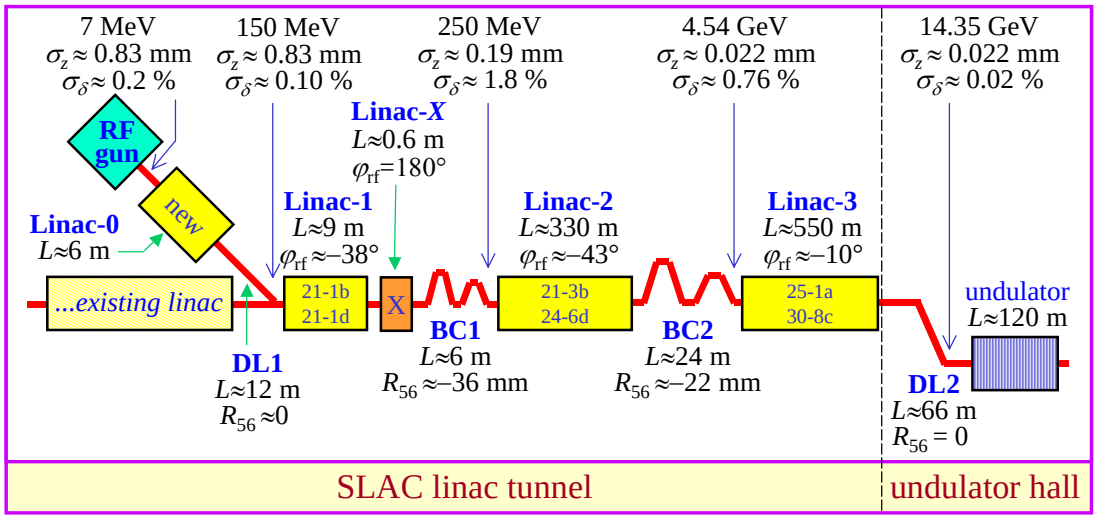

Figure 7.1-1. LCLS compression and acceleration schematic. The 'dog-legs' (DL1 and DL2) are simple transport lines and have no effect on bunch length. The compressors are double-chicanes to better decouple coherent synchrotron radiation (CSR) from horizontal emittance. Acceleration crest is defined at $\varphi_{rf} = 0$.

Figure 2. Taken from LCLS CDR Figure 7.1-1 - P. Emma

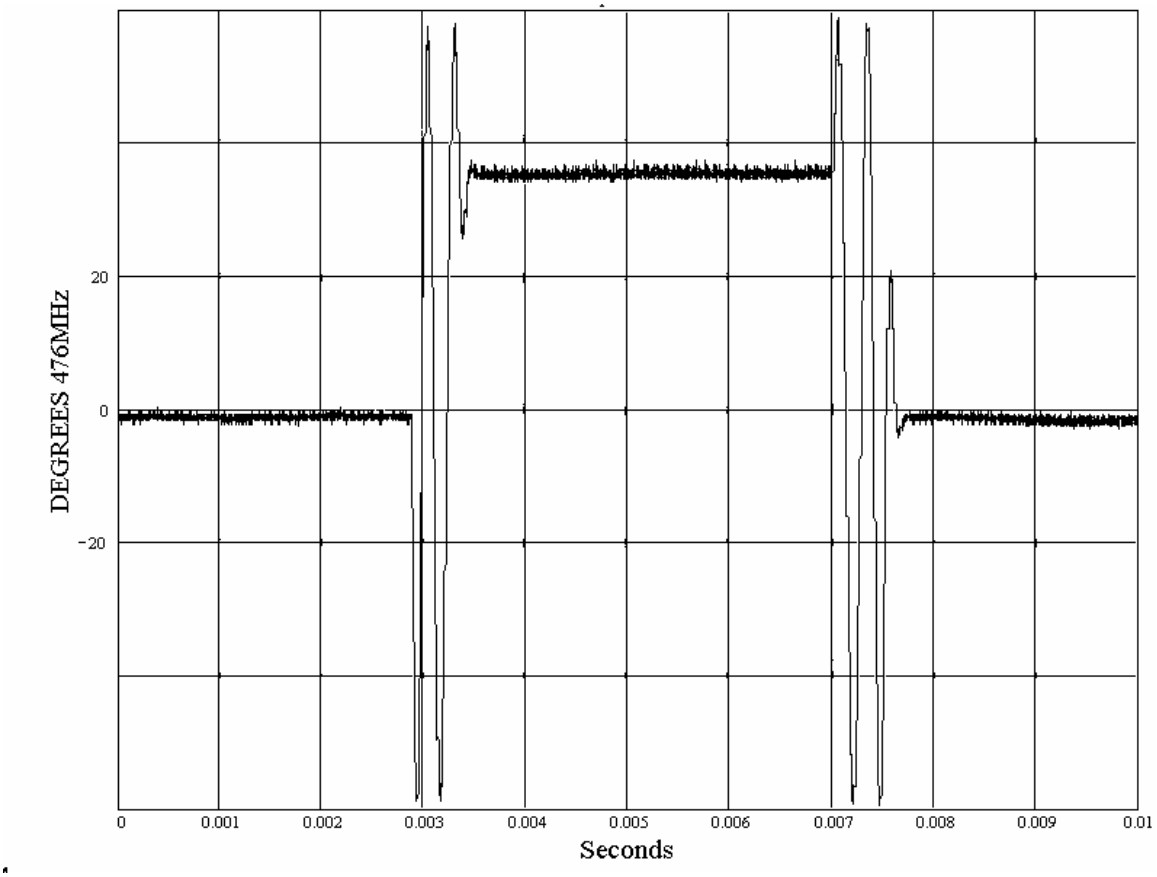

Figure 3. Main Drive Line Phase (Degrees 476 MHz)
2.8mS of 8.33mS (120Hz) cycle will be phase stable.

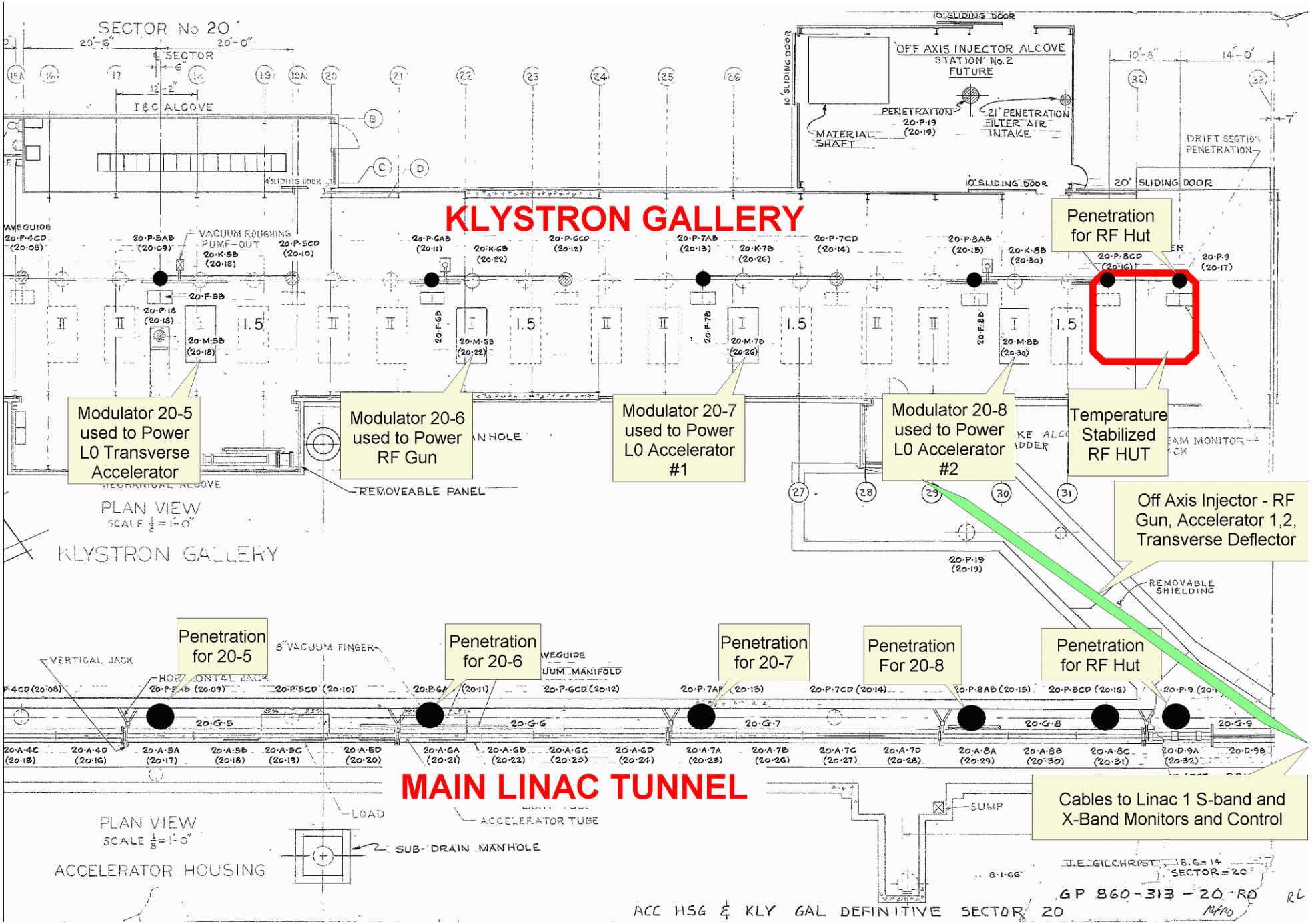

Figure 4. Location of RF HUT