Study of Density and Toroidal Magnetic Field Behavior in NSTX

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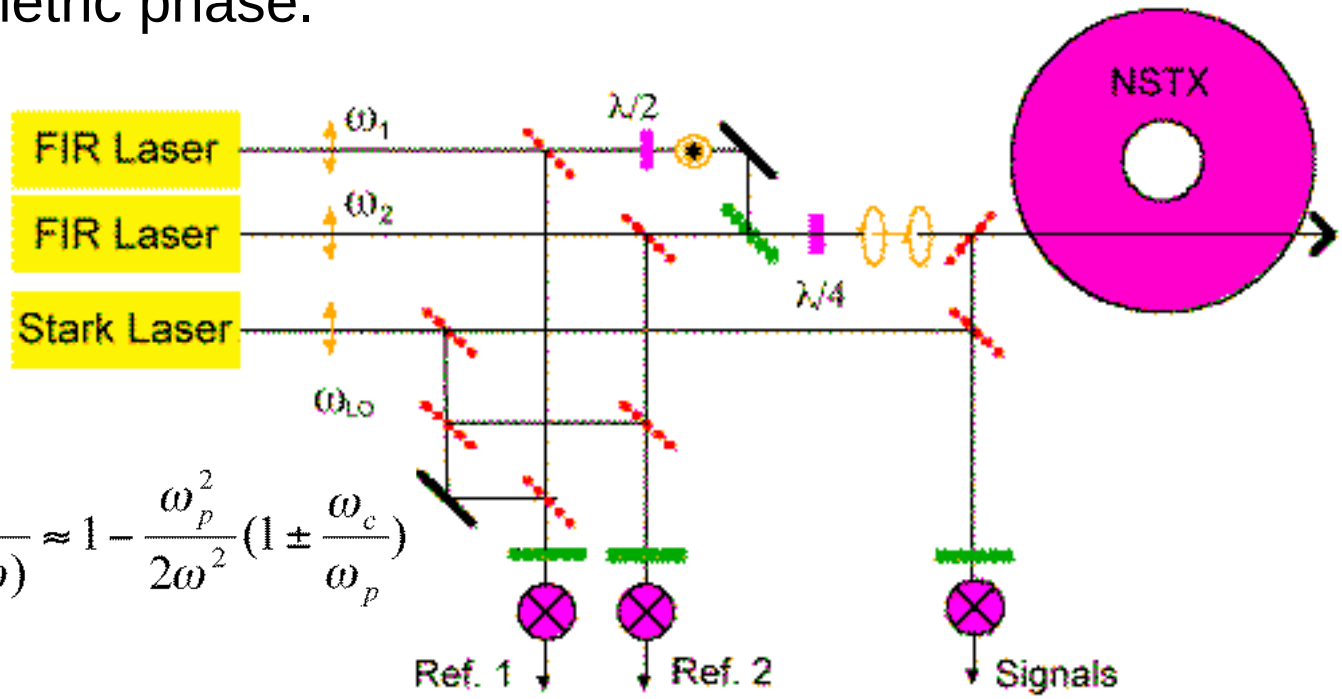
Outline

- Status of FIReTIP system on NSTX
  - The system development and installation
  - The system debugging
- Research Plan for 2001
  - Density measurement
  - Magnetic field measurement

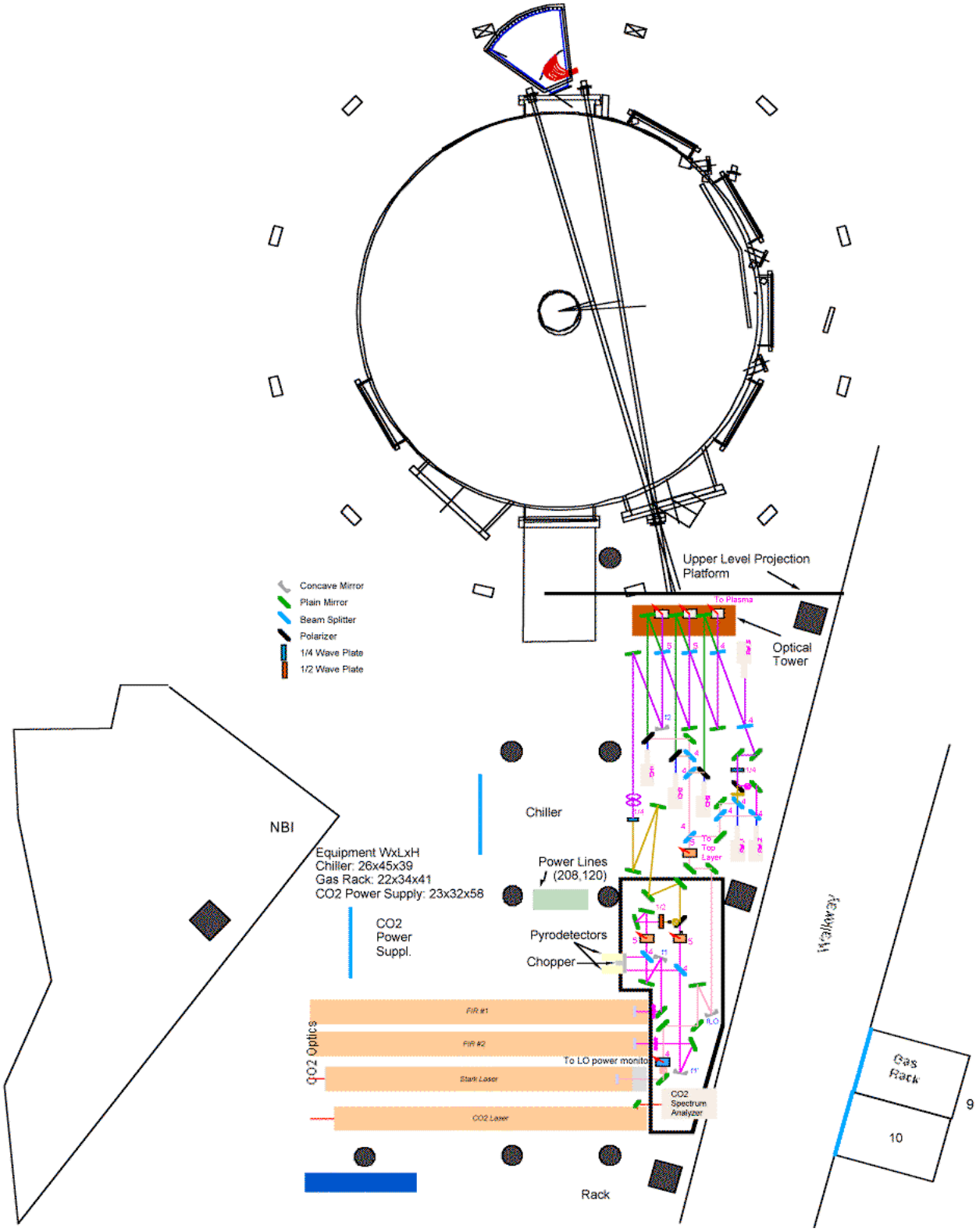
Principle of Diagnostic

- Two FIR lasers provide two circularly polarized eigen state probe beams. The phase difference between the eigen states is twice of the Faraday rotation angle, while the average of the plasma induced phases is the interferometric phase.



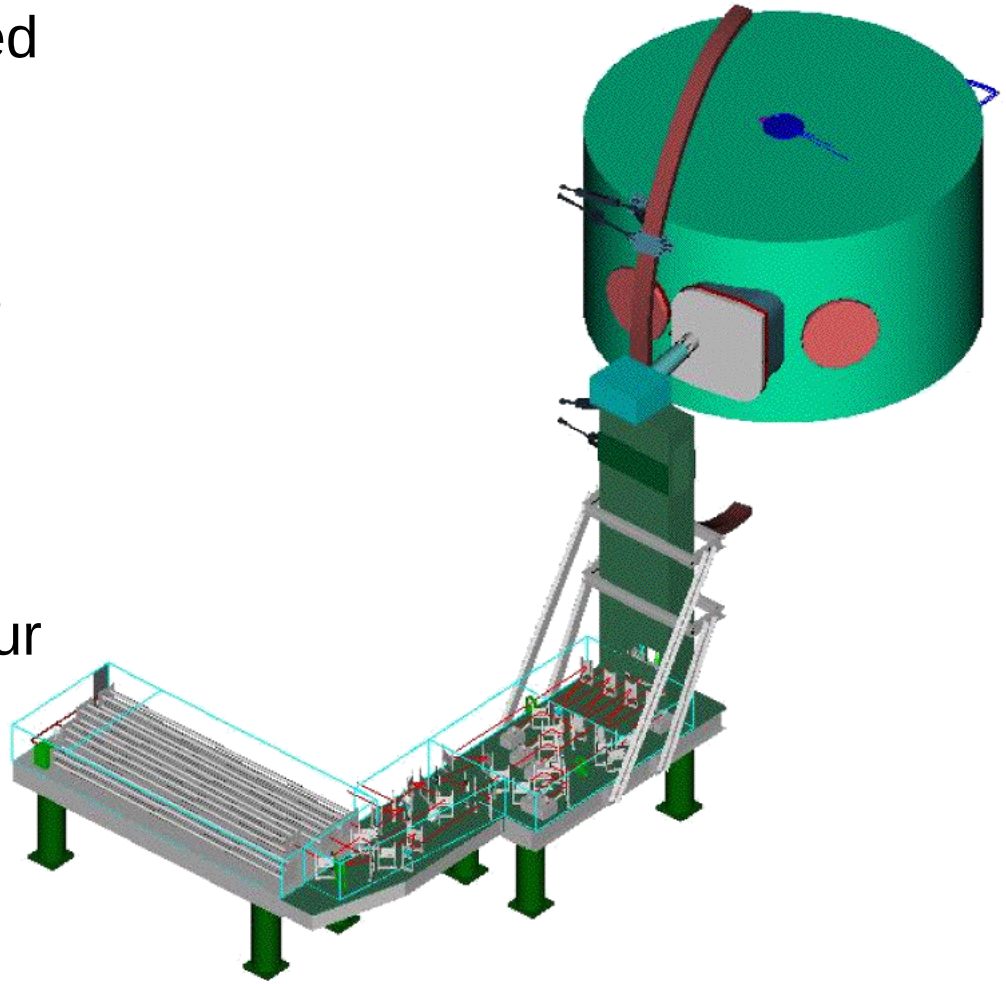
$$N_{R,L} \approx 1 - \frac{\omega_p^2/\omega^2}{2(1 \mp \omega_c/\omega)} \approx 1 - \frac{\omega_p^2}{2\omega^2}\left(1 \pm \frac{\omega_c}{\omega_p}\right)$$

Top View of the FIReTIP System



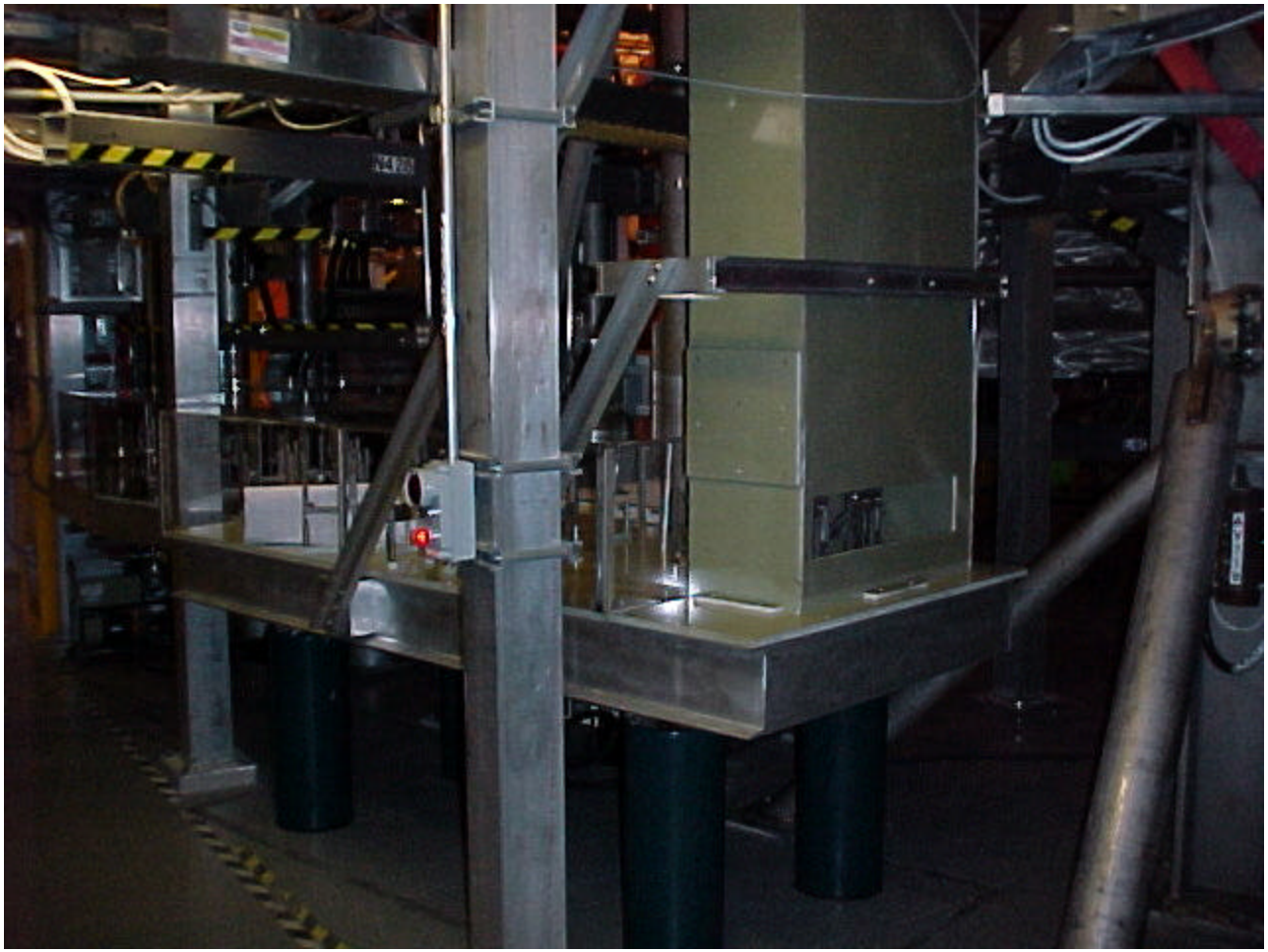
Schematic of System Design

- The main structure is located in the test cell basement.
- The laser system and the optics are connected by the extension table.
- The optics for the first three channels are arranged on the lower level, the other four channels will be added on the upper level.

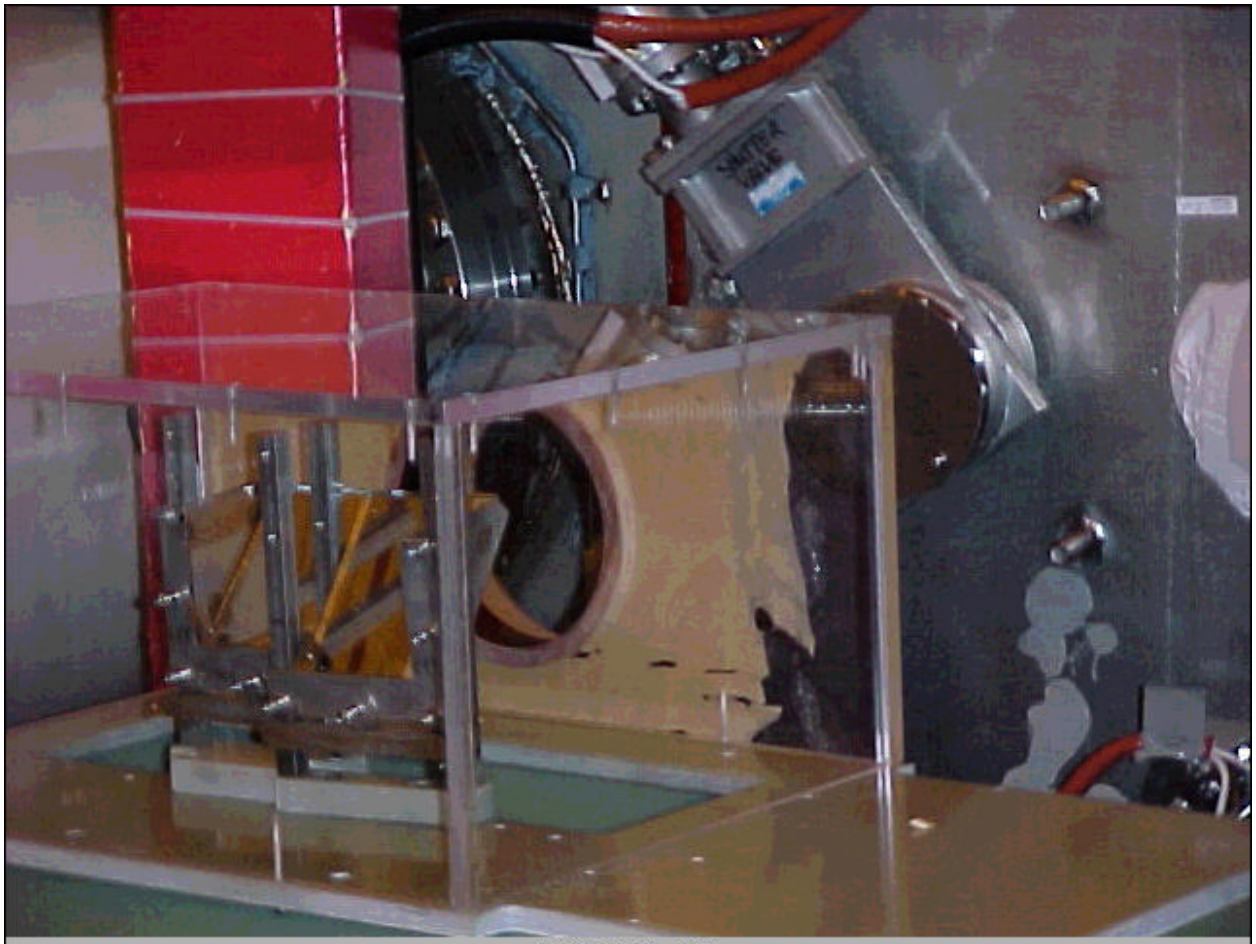


FIReTIP Installation on NSTX (1)

FIReTIP Installation on NSTX (2)



FIReTIP Installation on NSTX (3)



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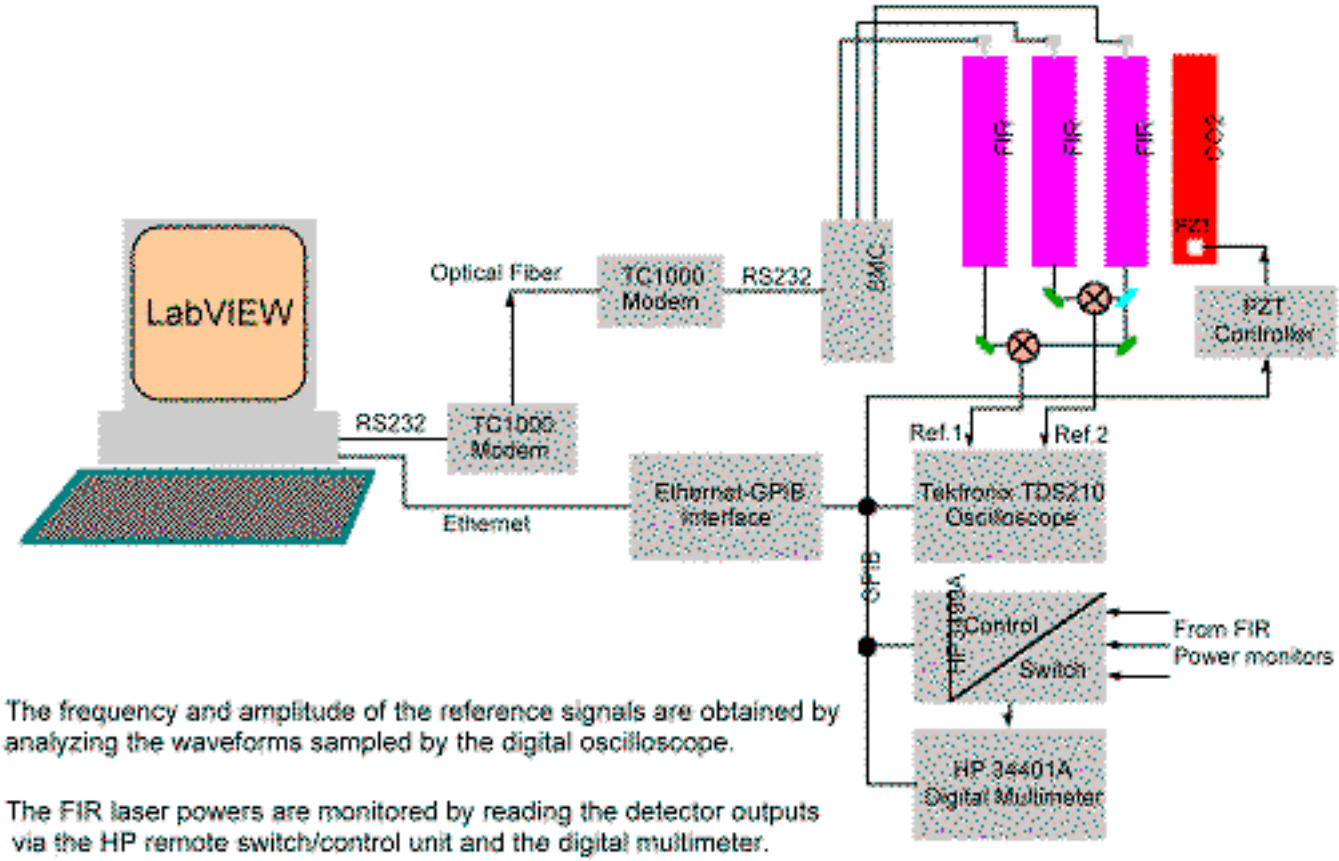
FIReTIP Control System



1). The frequency and amplitude of the reference signals are obtained by analyzing the waveforms sampled by the digital oscilloscope.

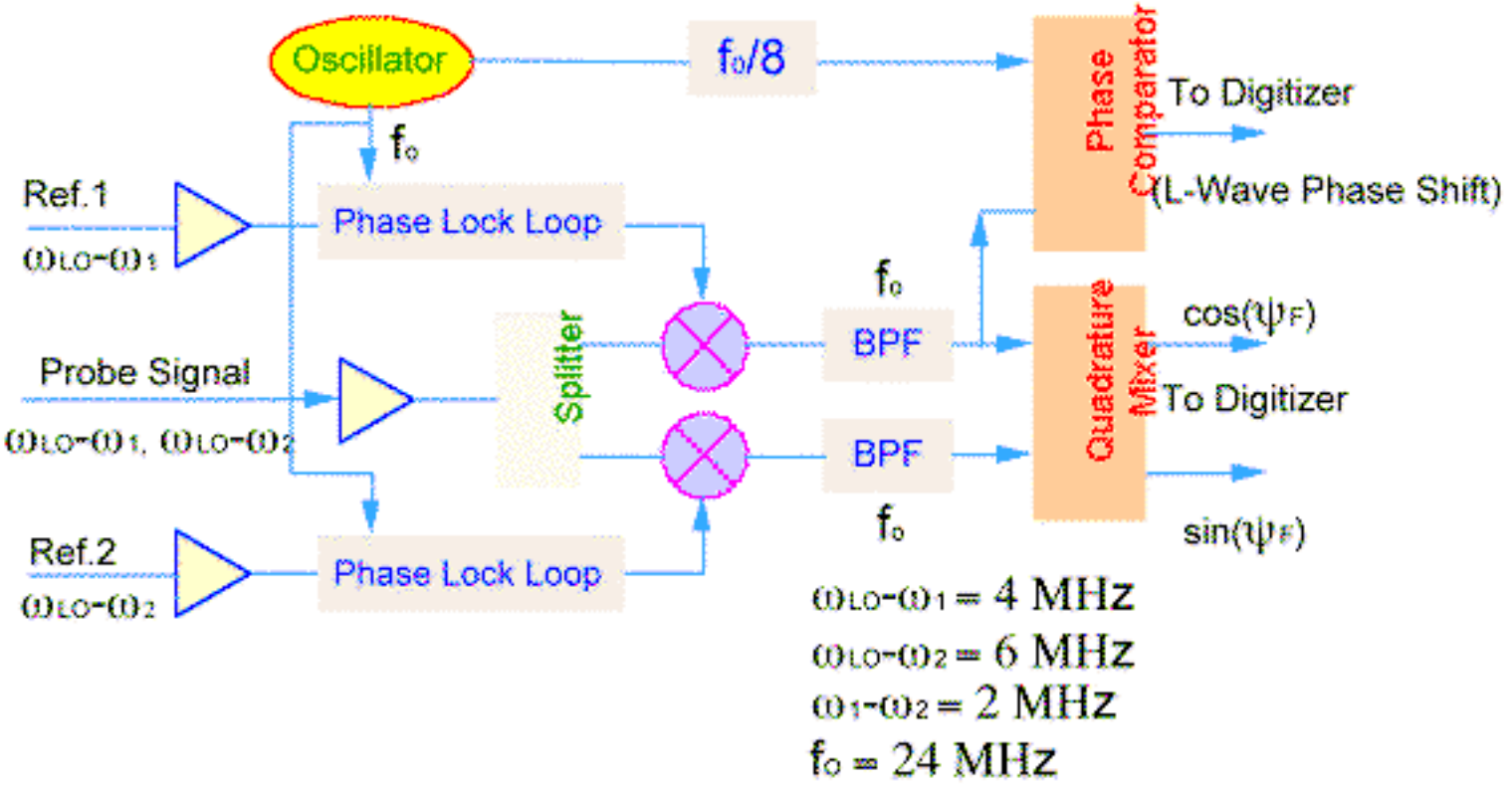
2). The FIR laser powers are monitored by reading the detector outputs via the HP remote switch/control unit and the digital multimeter.

3). From the above information, the FIR laser cavity lengths can be adjusted through the stepper motor controller (SMC). This could be automated later.

4). The CO2 laser cavity will be feedback-controlled by the Lansing lock-in stabilizer.

Phase Detection

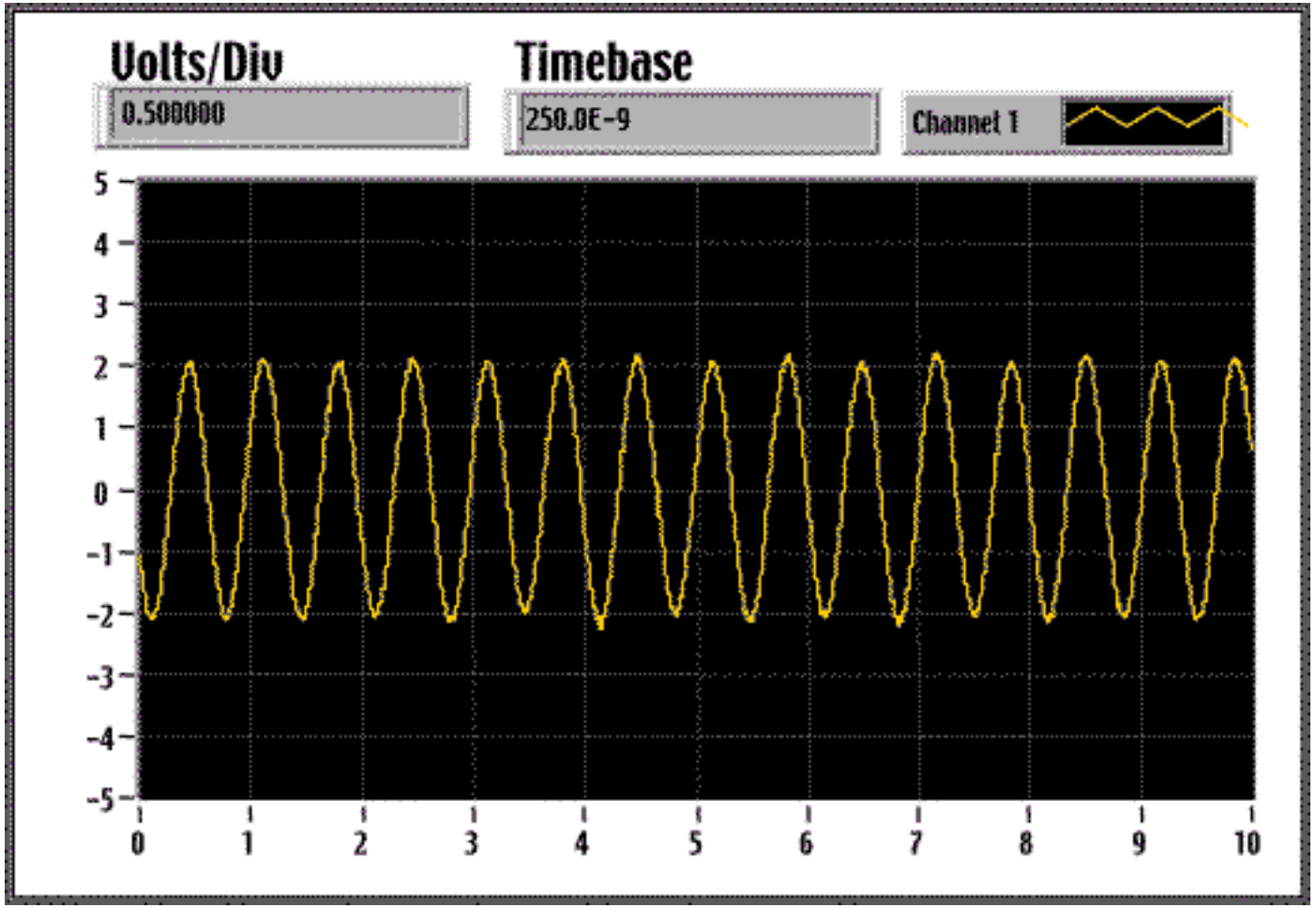
- Using the tracking receiver technique, the frequency drift of the IF signals can be compensated.



System Debugging

- Electro-mechanical system a success
  - Sample IF signal
- Noises and interference in NSTX test cell
  - Strong dB/dt (OH/PF) causing 35 Hz modulation (laser cavity vibration)
  - High frequency pickup (2.5 MHz, 5.5 MHz, etc…) through power lines
  - 60 Hz, still unknown, may not affect the phase detection
- Improvements
  - Magnetic shielding of laser cavities, strengthening the system mechanically
  - Using batteries for IF electronics
  - Cleaning up more ground loops
  - Better filtering of IF signals
- Two channel operation is soon expected

Sample 6 MHz IF Signal



Research Plan for 2001

- Goals
  - Support the physics programs
  - Test the system performance
  - Prepare for seven-channel implementation
- Density Measurement
  - MHD measurement
  - Parameter study
- Magnetic Field Measurement
  - Test the concept
  - Comparison with simulation