The LabVIEW program of high-k scattering system on NSTX-U

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The program comprises both monitoring and control modules. The control module is responsible for managing the launch and receiver optical setup as well as adjusting the formic acid laser. The monitoring module oversees various parameters, including the power supply, laser output, ambient temperature and humidity, cooling liquid flow velocity and temperature, and the formic acid gas pressure within the laser tube.

The Control Module

**1.1 FIR Monitoring and Control**

In the Control Module, as illustrated in Figure 1, the system includes a laser power adjustment interface along with control panels for both the receiver and launch optical setups.

A screenshot of a computer

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Figure 1High-k Scattering System Control panel

The laser power adjustment is facilitated by a Thorlabs stepper motor, which controls the cavity length through a belt-driven micrometer with a resolution of 0.5 µm, as depicted in Figure 2. The cavity length is determined by the position of the coupler, which could be adjusted remotely to optimize laser power output. The motor is controlled via the **FIRLaserAdjustment** interface, as shown in Figure 3. During the motor adjustment, the FIR laser power monitor provides real-time feedback on the laser output, enabling precise identification of the optimal coupler position. The control system allows for movement within a range of 0 mm to 12 mm.

Close-up of a machine

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Figure 2 FIR laser output coupler

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Figure 3 FIR Power monitor and motor adjustment

**1.2 Receiver and Launch Optical Control**  
**1.2.1 Receiver Optical Control**

The Receiver and Launch optical control panel is illustrated in Figure 3. For the Receiver optics, four axes are available for control: the Z axis, Radial axis, Tilt axis, and Toroidal axis, as depicted in Figure 4. The four-axis adjustment determines the focus position of the receiver optics. The relationship between the focus position and the four optical axes has been previously discussed in the presentation.

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Figure 4 Receiver Optical arrangement

The control panel features options for Computer Mode, Manual Mode, and Status Check. In Computer Mode, users can select the antenna input, set the receiver antenna position, and calculate the focus position, referred to as the Interaction Region (IR). Additionally, users can select the IR input, set the IR, and calculate the corresponding antenna position. If the positions are correctly arranged and the results are satisfactory, the "**AutomoveAntenna**" button can be pressed to automatically move all motors to their designated positions. Similarly, the "**AutomoveLaunch**" button adjusts the launch angle based on the IR. It is important to illustrate the installation procedure for the launch mirror, as the available angle range for installation is limited to -6 to 6 degrees. Improper installation will prevent correct adjustment of the launch angle.

In Manual Mode, users can independently select and adjust the position of each stepper motor. The system allows for setting a specific destination and moving the motor to that location, or alternatively, jogging around the destination to identify the optimal position.

In Status Check Mode, users can monitor the position of each stepper motor and verify whether the actual positions correspond with the calculated results obtained from Computation Mode.

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Figure 5 Computation Mode panel

A diagram of a window and a window

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Figure 6 Receive optical(a) and launch optical(b) sketch

*Table 1 Output parameters in Computation mode*

|  |  |  |
| --- | --- | --- |
| Parameters in Pannel | Note in sketch | explanation |
| Interaction Region (IR) | | |
| Height\_IR(mm) | none | The relative height of IR above the midplane of NSTX-U |
| R\_IR(mm) |  | Major radius of interaction region |
| Toroidal\_IR (mm) |  | Toroidal angle of interaction region (refer to plane of vacuum window) |
| SA\_Tor(deg) |  | Toroidal angle between receiver beam and Radius vector |
| SA\_Tilt(deg) | none | The tilt angle between the receiver direction and the midplane |
| Launch Angle | | |
| Psi\_L(deg) | ψL | Toroidal angle between launch beam and Radius vector |
| Theta\_tilt | none | Tilt angle between launch beam and midplane |
| Theta\_horizon |  | Horizontal angle between radius vector and launch beam in the midplane |
| Input Switch/Antenna | | |
| R\_displacement(mm) | Figure4:R motor | R antenna Motor adjustment |
| Tilt Angle(deg) | Figure4:tilt motor | Tilt antenna Motor adjustment |
| Toroidal Angle(deg) | Figure4: Toroidal motor | Toroidal antenna motor adjustment |
| Height(mm) | Figure4:Z motor | Z antenna motor adjustment |
| Input Switch/IR | | |
| Height\_IR(mm) | none | The relative height of IR above the midplane of NSTX-U |
| R\_IR(mm) |  | Major radius of interaction region |
| Toroidal\_IR (mm) |  | Toroidal angle of interaction region (refer to plane of vacuum window) |
| SA\_Tor(deg) |  | Toroidal angle between receiver beam and Radius vector |
| SA\_Tilt(deg) | none | The tilt angle between the receiver direction and the midplane |

The Monitor Module

To be continue…