Commissioning Document for the TITAN Penning Trap Mass Spectrometer

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1. Commission 4T Superconducting Solenoid Magnet.
   I. Install the magnet, verify cryostat integrity, cool down
   II. Charge the magnet
   III. Conduct the test quench of the magnet
   IV. Verify operation of the shimming coils
   V. Conduct NMR probe mapping and shimming of the magnet
   VI. Conduct radial Hall probe mapping to determine location of the central field line
   VII. Test field decay in the persistent mode
   VIII. Check cryogen consumption

Magnet Commissioned by:_____

Signed: _____ Date:_____

2. Commission Vacuum System
   I. Assemble ion trap and optics, place them into the titanium vacuum chamber
   II. Place titanium vacuum chamber into the bore of the superconducting solenoid
   III. Assemble the rest of the vacuum vessels, install vacuum pumps, gauges and valves.
   IV. Leak check the vacuum vessels and joints
   V. Install Vacuum Control System

Vacuum System Commissioned by: :_____

Signed: _____ Date:_____

3. Commission Trap Optics Supplies and Controls
   I. Install optics supplies in the racks
   II. Install optics control system
   III. Turn on the supplies and check operation of the controls and interlocks

Trap Optics Controls System
commissioned by: _____

Signed: _____ Date:_____

4. Install and Commission MCP Detector

I. Install and wire the MCP detector
II. Install detector electronics
III. Bias the detector and verify detector operation

MCP detector installed and tested by: _____

Signed: _____ Date:_____

5. MIDAS DAQ System Installation

I. Install the DAQ system and electronics into the racks
II. Install MIDAS DAQ system and frontend software and verify their operation
III. Verify the programmable pulse generator operation
IV. Verify TDC operation
V. Verify AWG operation
VI. Verify operation of the MSCB RF generator controls

MIDAS DAQ system checked by: _____

Signed: _____ Date:_____

6. High Voltage Pulser Installation

I. Install high voltage pulser
II. Verify its operation
III. Connect the high voltage pulser to the pulsed drift tube electrode
IV. Verify the operation of the pulser with connected drift tube
V. Check and record transient voltages on the adjacent electrodes generated by pulsing of the drift tube

High voltage pulser tested by: _____

Signed: _____ Date:_____

7. Electron Source Installation

I. Assemble and install the electron source
II. Activate the cathode and record the maximum current

Electron source installed by: _____

Signed: _____ Date:_____

8. Penning Trap Tests with Electron Source

I. Extract the beam from the electron source.
II. Detect on the MCP the ions generated by the electron beam in the vacuum chamber
III. Pulse the electron beam by controlling the voltage on the electron source aperture plate and observe the ion signal pulses on the MCP
IV. Verify the ion generation and capture in the Penning trap by pulsing the electron beam and, after a delay, pulsing the trap electrodes open and observing the ion signal on the MCP
V. Set up DAQ sequences for the electron source tests
VI. Conduct time-of-flight (TOF), magnetron excitation, axial excitation, cyclotron excitation tests on the ions captured in the Penning trap.

Penning trap electron source tests
conducted by: _____

Signed: _____ Date:_____

9. RF amplifier system installation

I. Install RF amplifiers, switching and diagnostic components, and cabling
II. Verify the operation of the RF amplifier system
III. At different power levels, check and record the phase and amplitude characteristics of different amplifier channels
IV. Calibrate the RF detector circuits
V. Connect the RF system to the split guard electrode feedthrus and verify system operation

RF amplifier system installed
and checked by: _____

Signed: _____ Date:_____

10. RFQ buncher capture tests

I. Direct the RFQ ion bunches into the magnetic field and detect them on the other side of the magnet with the MCP detector
II. Set up the DAQ sequence for the RFQ capture test
III. Triggering the RFQ extraction from the MIDAS DAQ system, pulse the MPET drift tube. Adjusting the MPET drift tube pulse down delay, observe change in time of arrival of ion bunches onto the MCP detector.
IV. Tune the MPET drift tube delay for correct energy tuning of the RFQ ion bunches
V. Adjust the MPET drift tube voltage so that the ion bunch energy is suitable for the capture in the trap (under 10eV).
VI. Pulse the trap electrodes to capture the ions, and, after a delay, to release them towards the MCP detector.
VII. Verify the ion capture by observing on the MCP the signal generated by the ions captured and then extracted from the trap

Capture of RFQ bunches verified by: _____

Signed: _____ Date:_____

11. Mass measurements on the ions from RFQ buncher

I. Set up the DAQ sequences for the RF excitation tests
II. Triggering the RFQ extraction, verify ion capture
III. Conduct time-of-flight, axial excitation, magnetron and cyclotron excitation tests on the captured ions
IV. Using the MPET beamline optics and the Lorentz steerer, optimize the ion injection into the trap
V. Conduct mass measurements on the ions from the RFQ buncher

Mass measurements set up
and conducted by: _____

Signed: _____ Date:_____

TITAN Penning trap mass spectrometer
commissioned by: _____

Signed: _____ Date:_____