Status of XAL in CSNS

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Outline

• Overview
• Preliminary physics needs
• The progress of application software
• Summary
Overview

• The phase-I CSNS facility consists of an 80-MeV H-linac, a 1.6-GeV RCS, 2 beam transport lines, a target station, and 3 instruments.
• Upgradable to 500kW at repetition rate of 25Hz and 20 instruments.
• The design is almost fixed with the officially start of the project.

<table>
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<tr>
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<th>CSNS-I</th>
<th>CSNS-II</th>
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<tbody>
<tr>
<td>Beam power (kW)</td>
<td>100</td>
<td>500</td>
</tr>
<tr>
<td>Repetition rate (Hz)</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>Target number</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Average current (μA)</td>
<td>62.5</td>
<td>312</td>
</tr>
<tr>
<td>Proton energy (GeV)</td>
<td>1.6</td>
<td>1.6</td>
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<tr>
<td>Linac energy (MeV)</td>
<td>80</td>
<td>250</td>
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Preliminary physics needs

• RFQ
  • Measurement of the transmission efficiency vs. RF voltage.

• DTL
  • Operation mode saving and calling
  • Parameter setting (RF parameters & Lattice)
  • Measurements (Orbit & Transmission efficiency)

• Beam Transport Lines – LEBT&MEBT&LRBT&RTBT
  • Lattice on line matching, Mode saving and calling
  • Measurements (Twiss parameters & Emittance & Orbit)
  • Orbit correction
  • Buncher parameter tuning
• RCS
  • DC Mode
    • Measurements (Circumference, Twiss parameters & tune, COD, Fudge factor, Dispersion, Chromaticity)
    • Parameter correction (COD, Twiss parameters, Dispersion, Chromaticity)
  • AC Mode
    • Mode saving and calling, online matching
    • Measurements (COD, Twiss parameters & tune, Timing jitter, Chromaticity, Dispersion, Response matrix, ICA, Fudge factor)
    • Parameter correction (COD, Timing jitter, Chromaticity, Dispersion)
    • Injection (Injection bump measurement, Orbit correction & adjustment, Painting mode saving & calling, fixed bump correction)
    • Extraction (Extraction orbit display & tuning, kicker online matching)
    • Collimation system tuning
    • RF system tuning (RF curve setting and readback)
Plan for application software development

• The development of application software for commissioning has been started.

• SNS/SLAC version XAL have been used as the base of development.

• Developing XAL to meet the requirement of CSNS
The progress of application software

• With the application of virtual accelerator, many functions have been performed by transplanting XAL or developing.
  • RTBT/LRBT Orbit Correction
  • RCS Closed Orbit Correction
  • RCS Optics Measurement
  • Injection Painting Bump Control
  • Collimator Control
  • RF Curve Setting And Readback
RTBT/LRBT Orbit Correction

Before correction (RTBT)

After correction

After correction, the measured orbit agrees well with the predicted one.
• Comparison of XAL results with AT

Beta functions:

Orbit correction:
RCS Closed Orbit Correction

Measured Orbit

Predicted Orbit

Measured Orbit after Correction
RCS Optics Measurement

- Dispersion Measurement
Tunes and phase advances Measurement

- BPM TBT data is from AT simulation
- The results are consistent with the AT simulations

Getting tunes and phase advances by cosine fitting

Getting tunes by FFT
The CSNS RCS has 5 families of quadrupoles:

- 4 for focusing quadrupoles, with 8 quadrupoles in each
- 1 for defocusing quadrupole with 16 quadrupoles
- 5 independent power supplies
- Finding the 5 quadruple errors by minimizing the difference between the measured phase advances and the model’s
- Simplex method is adopted

Finding quad errors
RCS Injection Painting Bump

- Saving and calling of different injection painting curves.
Collimator Control

- Two stage collimation system
  - 1 primary collimator
  - 4 secondary collimators

- Each collimator consists of four jaws. Each one can be moved independently.

- The collimator jaws need to be adjusted to obtain a high collimation efficiency.
RF Curve Setting And Readback

- The RF system consists of 8 RF cavities.
- The RF setting varies with the beam energy.
- The RF curve setting includes voltage, phase and frequency.
- Readbacks of the RF curves for each cavity are required.
Errors

- During the transplanting, we have found some errors as we have started with a considerably old version of XAL.
- Twiss parameters calculation with decimal tune above 0.5

Comparison of Twiss function obtained by MAD and XAL @ (4.86, 4.78)
Summary

• The preliminary physics needs has been identified.
• The work of high level application software has started. Part of XAL has been transplanted to CSNS, and some new apps have also been developed.
• The application software work will be continued, and the fundamental software package is expected to be available for day 1 commissioning within one year.
Thank you for your attention!