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DYNAMIC COMPARISON WITH XAL AND TRACEWIN BASED ON THE INJECTOR-I OF CHINA ADS TEST STAND*

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Abstract

The injector scheme I (injector-I) of China ADS test stand is a superconducting Linac which accelerates 10mA beam to 3.2MeV, 5MeV, 10MeV, and then transports it to the dump [1]. The dump line is designed to meet the requirement of beam expansion at the three different energies. The XAL [2] from SNS was selected for the commissioning of China ADS. Because the beam current is so high, the nonlinear space charge force cannot be omitted. As we know, XAL calculates the space charge force with linear resolver. So, whether it could display the beam exactly enough is an important issue to consider. As a preparation for beam commissioning, the virtual accelerator in XAL frame was built and tested. Here in this paper, the envelopes of the 5MeV and 10MeV lattices from general XAL mpx application are shown and compared with the multiparticle tracking code TraceWin.

INTRODUCTION

The China-ADS (Accelerator Driven subcritical System) project is a strategic plan to solve the nuclear waste problem and the resource problems for the nuclear power. The ADS driver Linac has very high beam power and reliability requirements which are not possessed by any of the existing accelerators. The test stand of China ADS is one of the experimental efforts for the ADS projects. The Injector-I is a superconducting Linac which is being constructed in hall 1 of IHEP. It is consists of MEBT1, CM1 for 5MeV and 10MeV, CM2 for 10MeV, and MEBT2. After optimizing the lattice and consulting with people of other accelerator systems over and over again, the final lattice is finally determined. Figure 1 shows the 10MeV lattice layout. It contains two cryomodules, each of which contains seven periods. Every period contains one superconducting solenoid and one superconducting RF cavity (single gap spoke cavity).

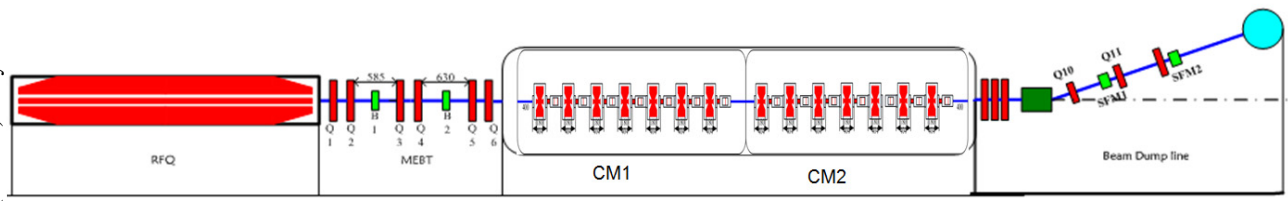

Figure 1: 10MeV lattice layout of injector-I of China ADS test stand. One cryomodule contains seven periods. Each period consists of one superconducting solenoid and RF cavity. For 5MeV lattice, the superconducting section is just CM1, while for 3.2MeV both the CM1 and CM2 are not needed.

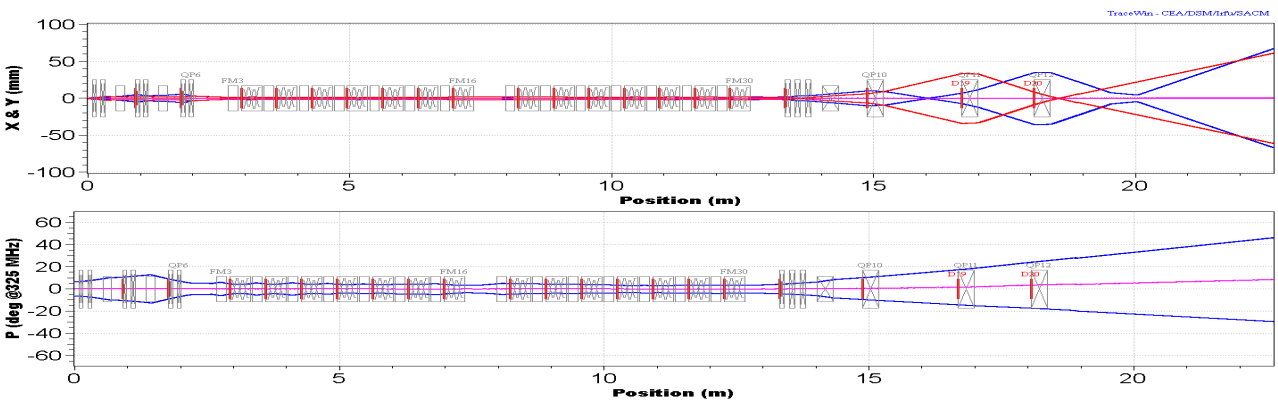

Figure 2: 10MeV beam envelope from Partran of TraceWin. The envelope in MEBT2 is much larger than that in the front section.

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For 5MeV, the superconducting section is just CM1, while for 3.2MeV; both the CM1 and CM2 are not needed. The 10MeV beam envelope from Partran of TraceWin is shown in Figure 2. In the figure, we can see, the envelope in MEBT2 is much larger than that in the front section. So, in the follow parts of the particle, we just compare the envelope before MEBT2.

5MEV ENVELOPE COMPARASION

The fields of superconducting cavities, solenoids and bunchers in MEBT1 are treated as field_map elements in TraceWin code, while as ideal field in XAL. We track the beam in TraceWin with Partran method and matrix method. Similarly, the tracker of the probe in mpx application, XAL frame, is set to be "EnvelopeTracker". For low beta superconducting linac, the velocity increasing in a RF cavity is large and cannot be seen as perturbation. The transit time factor for beam is changing with beta, what means, transit time factors T, S, T', S', isn't enough to display the real affections the cavity to the beam. Here the attributes E, T, L in "RfGapBucket" of XAL are replaced with one attribute ETL [3].

Lattice

Table 1 is the values of the main parameters of 5MeV lattice.

Table 1: Main Specifications of the 5MeV Lattice of Injector-I

Parameter	Value
Input Energy	3.2MeV
Output Energy	6.4MeV
Periods	7
Length Before MEBT2	7.665m

Envelope

As shown in Fig 3, the energy from TraceWin and XAL coincides well with each other. Refers to the suffix, "MA" and "MP" means results from matrix tracking method and multiparticle tracking method with TraceWin, while "xal" is from the frame XAL. Figure 4 and Figure 5 are the transverse and longitudinal envelopes, where the envelope from TraceWin is calculated with Partran and matrix method separately.

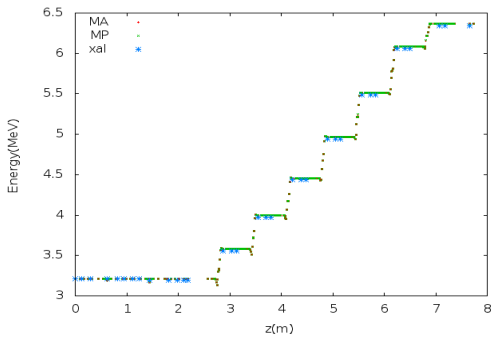

Figure 3: Envelope curve of 5MeV lattice.

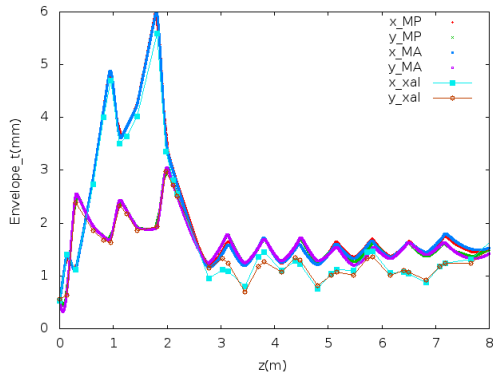

Figure 4: Transverse envelopes of 5MeV lattice.

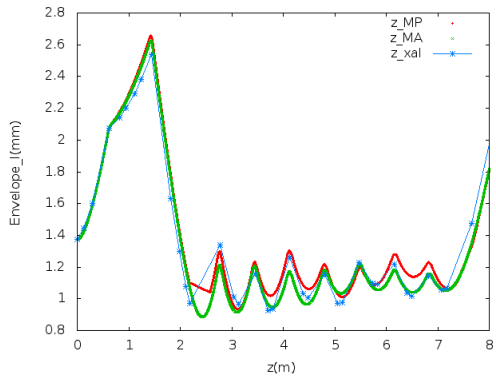

Figure 5: Longitudinal envelopes of 5MeV lattice.

From the Figure 4 and 5, we can see that the results of tracking beam with the matrix and Partran method of TraceWin are coinciding well with each other. The longitudinal envelope from XAL agrees well with that in TraceWin, even though the TraceWin and XAL treat bunchers, superconducting solenoids and cavities in different way. The trends of transverse envelope agree, but the values are not equal.

10MEV ENVELOPE COMPARASION

To reach the 10MeV energy, 2 cryomodules are used.

Lattice

Table 2: Main Specifications of the 10MeV Lattice of Injector-I

Parameter	Value
Input Energy	3.2MeV
Output energy	10.0MeV
Period number	14
Length before MEBT2	12.953m

Envelope

Figure 6 is the energy from TraceWin and XAL. Figure7 and Figure 8 are the transverse and longitudinal envelopes.

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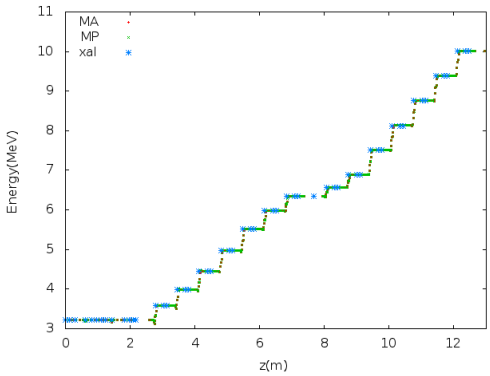

Figure 6: Energy curve of 10MeV lattice.

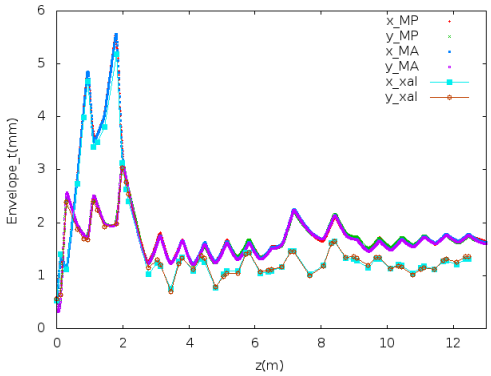

Figure 7: Transverse envelopes of 10MeV lattice.

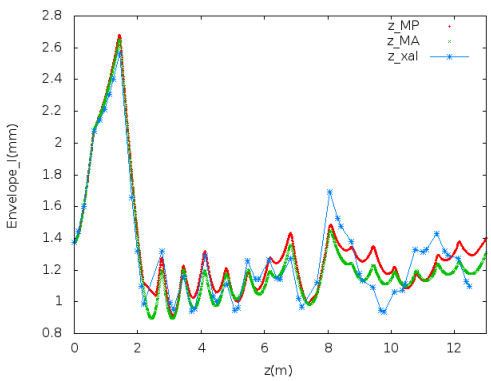

Figure 8: Longitudinal envelope of 10MeV lattice.

From Figure 6, 7, we can get the same conclusion with 5MeV lattice. But, as Figure 8 shown, the longitudinal envelope from XAL deviates a lot from that of TraceWin in cryomodule 2. The reason should be found as soon as possible.

CONCLUSIONS

From the figures above, we can see that for both the 5MeV and 10MeV Lattice, the trends of the transverse envelopes from XAL frame agrees well with that in TraceWin，although the exact value is not equal to each other. The longitudinal envelope deviates a lot which should be paid much attention and find the reason as soon as possible.

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