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HIGH POWER TEST OF THE S-BAND SPHERICAL PULSE COMPRESSOR AT TSINGHUA UNIVERSITY

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Abstract

We designed, fabricated and high power tested an S-band spherical pulse compressor for the high-power test facility at Tsinghua University. The pulse compressor comprises a spherical resonant cavity with an unloaded quality factor of 100,000 and an RF polarizer with two rectangular ports and a circular port. To achieve high efficiency and large power gain, the coupling coefficient was optimized to 8 with input pulse length of 3.6 us and compression ratio of 12. After conditioning the RF system, the pulse compressor generated RF pulses with peak power of more than 500 MW.

INTRODUCTION

There are many kinds of pulse compressors. Among the pulse compressors, the SLED and BOC are widely used. In many cases, they are C-band or S-band ones, which are usually used in test facilities, FELs, and the injectors of the circular accelerator. An X-band pulse compressor with spherical cavity and RF polarizer was designed and fabricated for the deflecting structures at SLAC [1, 2]. This pulse compressor has the feature of compactness and was tested with high power microwave.

We designed and fabricated an S-band spherical pulse compressor following the SLAC version. This S-band one was installed in the S-band high power test facility and tested with high power microwave.

The fabrication, the cold test, and the high power test are described in this note.

FABRICATION

The details of the RF and mechanical designs are described in Ref [3]. The unloaded quality of the pulse compressor is 100,000. And the coupling coefficient is optimized to 8 for maximum peak power. The input and output pulses of the pulse compressor is shown in Fig. 1. The compression ratio is 12 and the peak power gain is 7.

Figure 2 shows the components of the spherical pulse compressor. The spherical resonant cavity was divided into two hemispheres. A circular waveguide connects the RF polarizer with the resonant cavity. At the top of the resonant cavity, a hole with diameter of 10 mm was reserved for the frequencies of the fields with different polarizations. On the surface of each hemisphere, 4 dunning holes are designed for the final tuning after brazing the pulse compressor.

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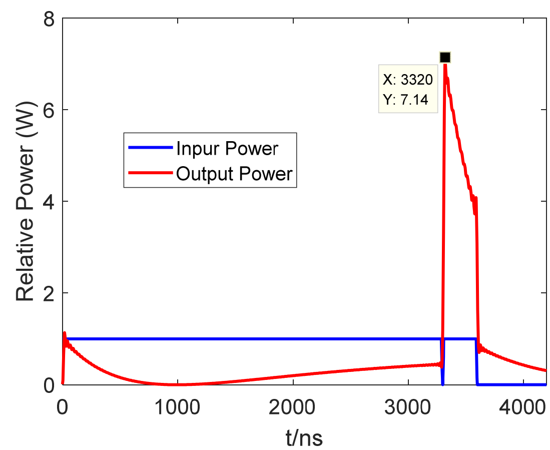

Figure 1: Input and output waveforms of the pulse compressor with compression ratio of 12.

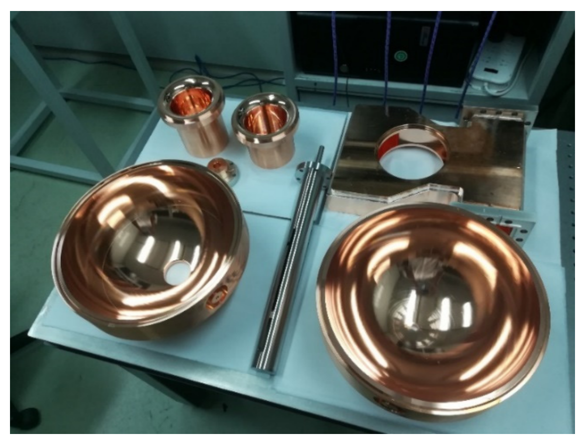

Figure 2: Components of the pulse compressor.

COLD TEST

Before brazing the pulse compressor, it was measured for many times as is shown in Fig. 3. And every time, the measuring result was different from the results measured before. However, we found that a good result can be obtained by fine adjustment of the relative position of the two hemispheres. Then we brazed the pulse compressor (see Fig. 4) and measured the S-parameters of it (see Fig. 9). The results are shown in Fig. 5. The S_{11} and S_{22} of the pulse compressor after brazing are too large at the operation frequency. The reflected pulse in this case is shown in Fig. 6. If the input power is 50 MW, the peak reflected power is up to 20 MW which too large for the klystron. However, the output pulse of the pulse com-

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pressor is very close to the calculated one as is shown in Fig. 7. We measured the two frequencies of the fields of the two polarizations. The frequency difference of the two frequencies is about 100 kHz.

Figure 3: Cold test of the pulse compressor.

Figure 4: Pulse compressor after brazing.

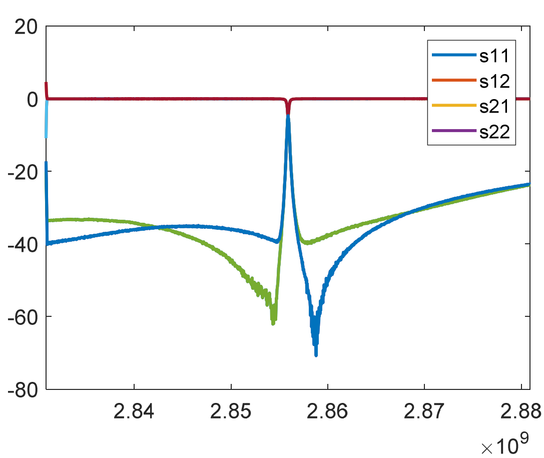

Figure 5: S-parameters of the pulse compressor after brazing.

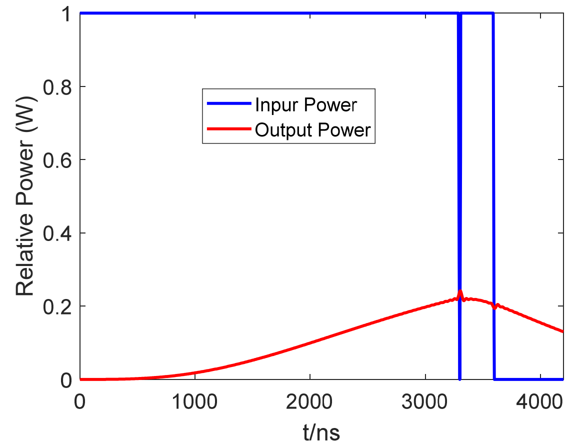

Figure 6: Input and reflected powers of the pulse compressor after brazing.

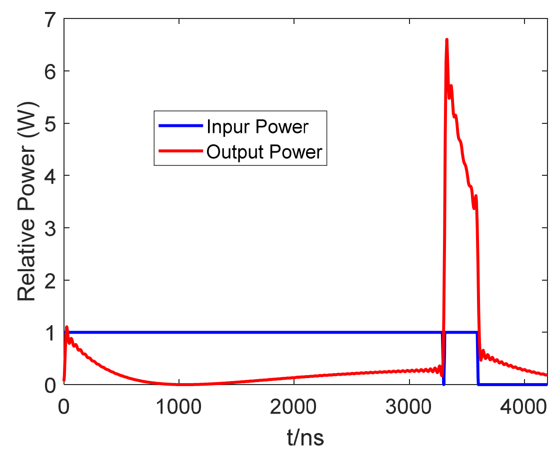

Figure 7: Input and output powers of the pulse compressor after brazing.

The pulse compressor under tuning is shown in Fig. 8. After tuning the pulse compressor, both the S_{11} and S_{22} are below -28 dB and the S_{12} is the same as the designed one. In this case, the reflected power of the pulse is reduced to nearly zero. And the output waveform (see Fig. 10) is nearly the same as the calculated one as is shown in Fig. 1.

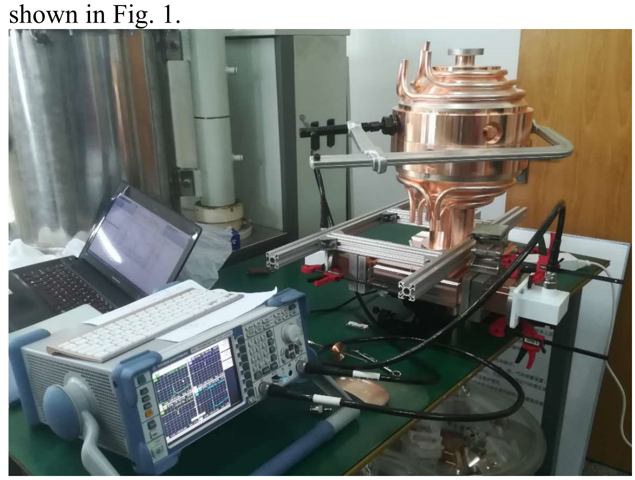

Figure 8: Tuning of the pulse compressor.

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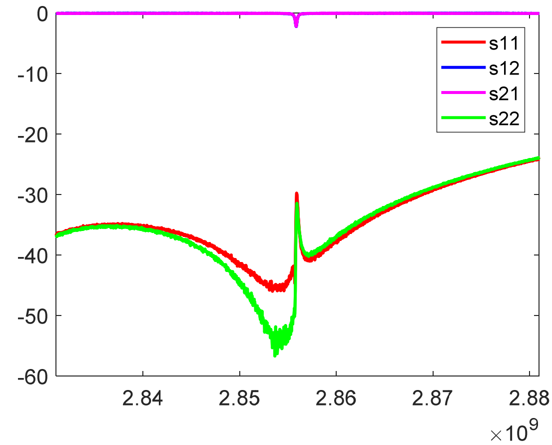

Figure 9: S-parameters of the pulse compressors after the tuning.

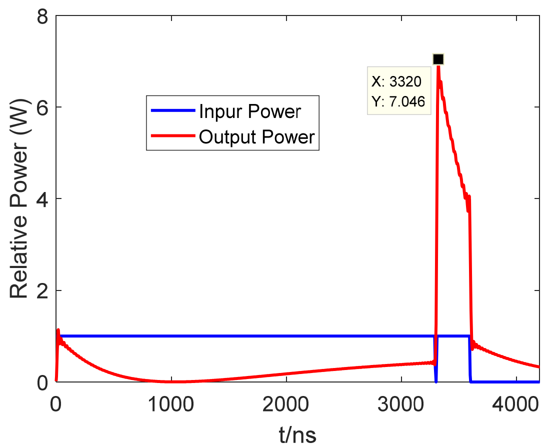

Figure 10: Input and output powers of the pulse compressor after the tuning.

HIGH POWER TEST

Figure 11 shows the high power test facility with the pulse compressor installed. A 3-dB hybrid combines the powers from two klystrons. The peak power of each klystron is 50 MW. The maximum power which can be used to feed the pulse compressor is up to 100 MW. The conditioning of the pulse compressor was conducted with two input lengths of 3000 ns and 3600 ns. At the first stage of the conditioning, the input pulse length is 3000 ns and the compression ratio is 6 with output pulse length of 500 ns. And at the second stage, the input pulse length is 3600 ns which is the same as that in Fig. 1.

After conditioning pulse compressor for 3 days, the input power is up to more than 75 MW and the output power is more than 500 MW.

Figure 11: The pulse compressor under high power test.

CONCLUSION

We fabricated and tested the spherical pulse compressor for S-band high-power test stand at Tsinghua University. Both the cold test and the high power test show that the pulse compressor is of excellent performance.

We hope that the pulse compressor can be widely used in the future facilities, such as FELs and the injectors for circular accelerators.

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