CSNS CHINESE ACADEMY OF SCIENCES

散裂中子源 China Spallation Neutron Source

BEAM INSTRUMENTATIONS AND COMMISSIONING OF LINAC IN CSNS*

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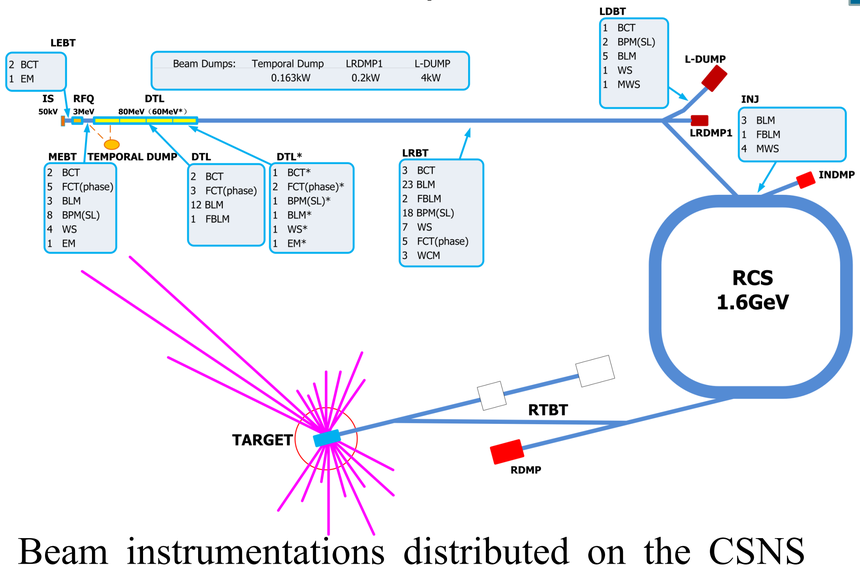
Abstract

China Spallation Neutron Source (CSNS), the biggest platform for neutron scattering research in China, will be finished built and run in the end of 2017. It mainly consists of an 80MeV H- linac and an 80MeV to 1.6GeV Rapid Cycling Synchrotron, two beam transport lines, one target station and relative ancillary facilities. The linac beam commissioning with beam loss monitors, current transformers, BPMs, beam profile monitors and beam emission measurement has been the main task since last year. Beam instrumentations, commissioning of the temporary 60 MeV linac will be discussed in this paper.

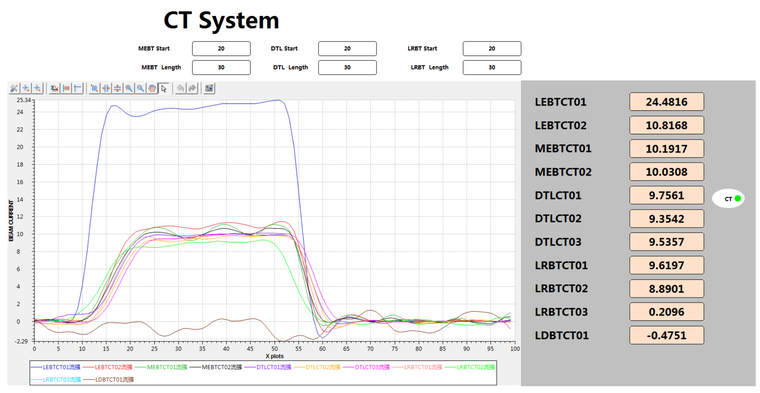
Introduction

CSNS: Project Phase	I	II
Beam Average Power, kW	100	500
Proton Energy, GeV	1.6	1.6
Linac Energy, MeV	80	300
Repetition Rate, Hz	25	50
Macro Duty Factor, %	1.1	1.7
Macro Average Intensity , mA	15	40

Beam Instrumentation Systems of CSNS Linac



Beam instrumentations distributed on the CSNS linac are presented above. After the 50keV H- source, there are 2 beam current monitors and an emission monitor installed on the low energy beam transport line (LEBT). At the middle energy beam transport line (MEBT) there are 2 self-made FCTs to monitor the beam current, 7 strip-line beam position monitors and 4 wire scanners to monitor the beam profile for measuring the Twiss parameters of the RFQ output beam. The 4-tank 324MHz drift tube linac (DTL) is designed to accelerate the H- beam from 3MeV to 80MeV. At the exit of the 4th tank of an 80MeV DTL, 5 Bergoz FCTs are used to monitor the beam phase for energy measurement by means of time-of-flight (TOF). At present commissioning period, only 3 of the 4 klystrons are available to feed 3MW power into the corresponding DTL tank, therefore tank 1 to 3 have been commissioned and the beam was successfully accelerated to 61MeV. After that, the beam was transported through the last DTL tank and the linac to RCS Beam Transport line (LRBT), and finally directly to the linac to ring dump (LRDMP1). Until May 2017, four runs of linac beam commissioning have been performed.

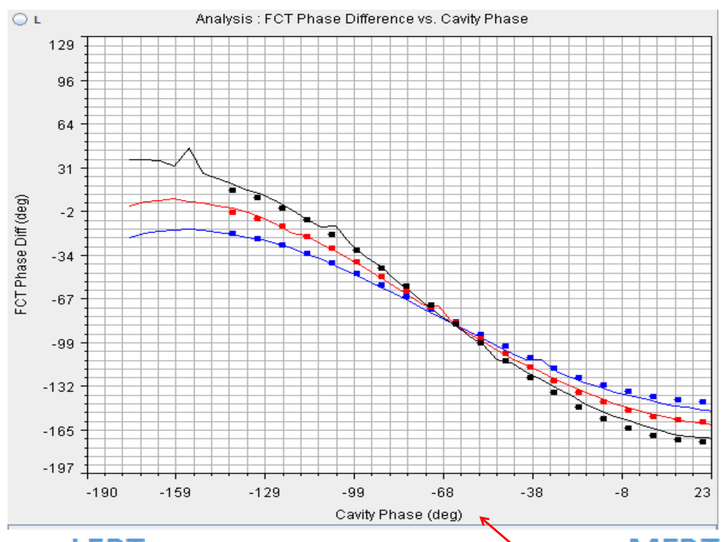


A Bergoz FCT located at the exit of DTL tank 1 can also work as a BCT for phase detection, by using an RF switch to connect it to different electronics.

Beam transmission	April 24	May 10
RFQ	92.2%	94%
DTL	97%	99%
LRBT	99%	100%
LDBT	97%	100%

	Design [MeV]	Phase scan [MeV]	TOF [MeV]
DTL1	21.669	21.802	21.685±0.01
DTL2	41.415	41.52	41.566±0.14
DTL3	61.072	60.917	61.09±0.34

Measured phase differences (deg.) between two FCTs as functions of the buncher01 cavity phase.

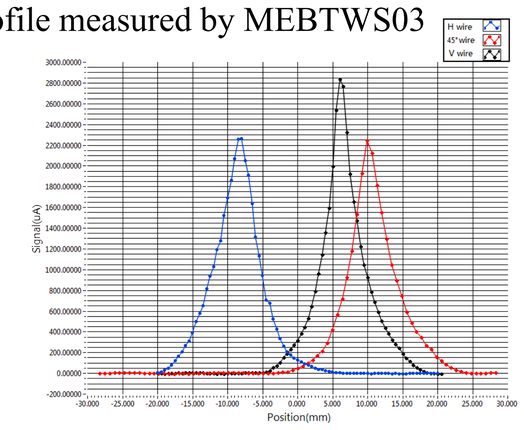


4 wire scanners (WS) on MEBT measure the beam size and emittance for Twiss parameters calculation

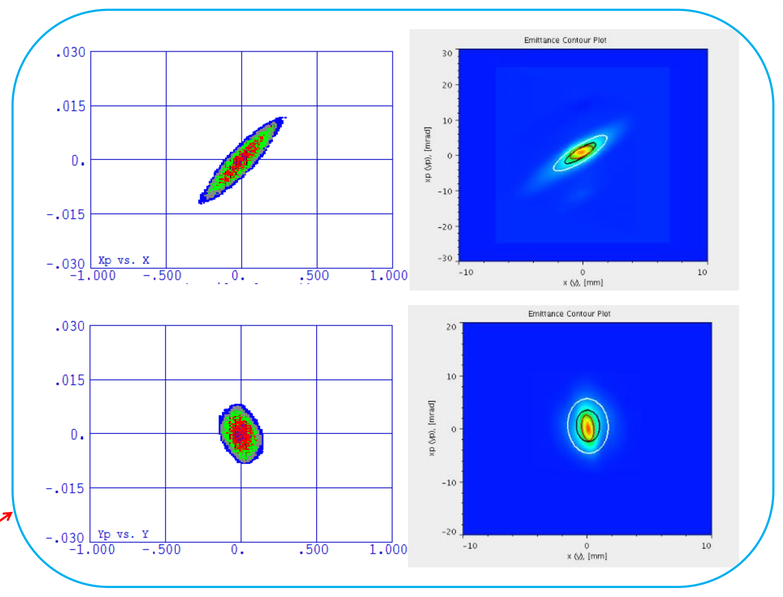
	Twiss parameters	α	β [mm/mrad]	Emittance rms, normalized [πmm mrad]
H	Measured	-1.716	0.256	0.215
	Simulated	-1.773	0.233	0.215
V	Measured	1.944	0.173	0.211
	Simulated	0.639	0.074	0.212

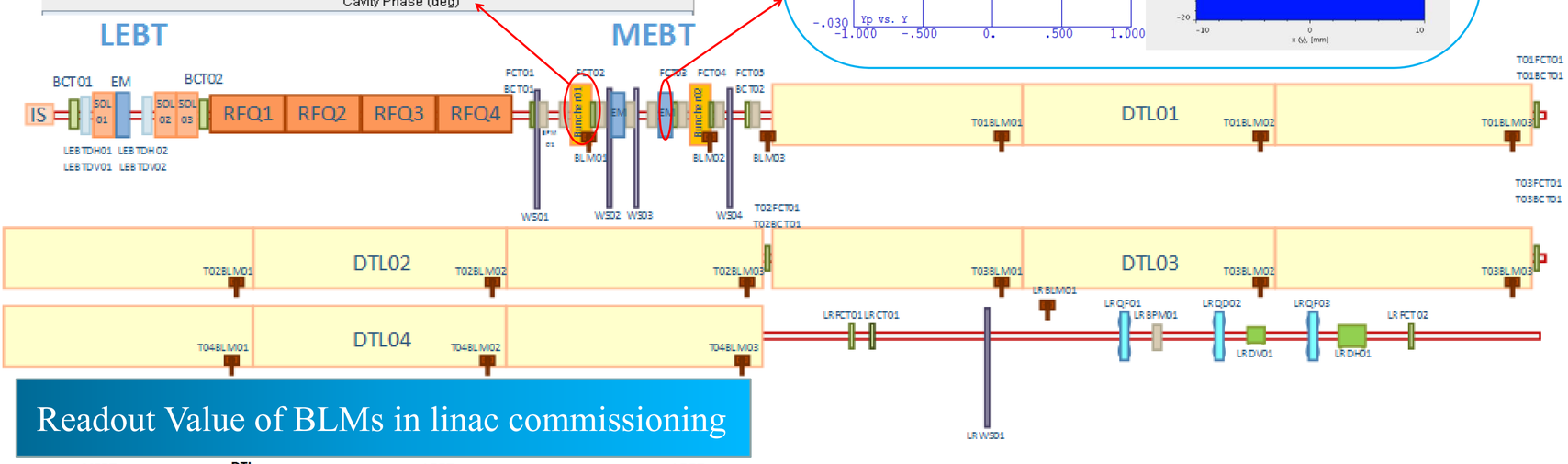
(Ref. : J. Peng et al. *in Proc*. IPAC'17, paper TUOBA1)

Beam profile measured by MEBTWS03



Comparison of the simulation and measurement of the beam distribution at EM in MEBT

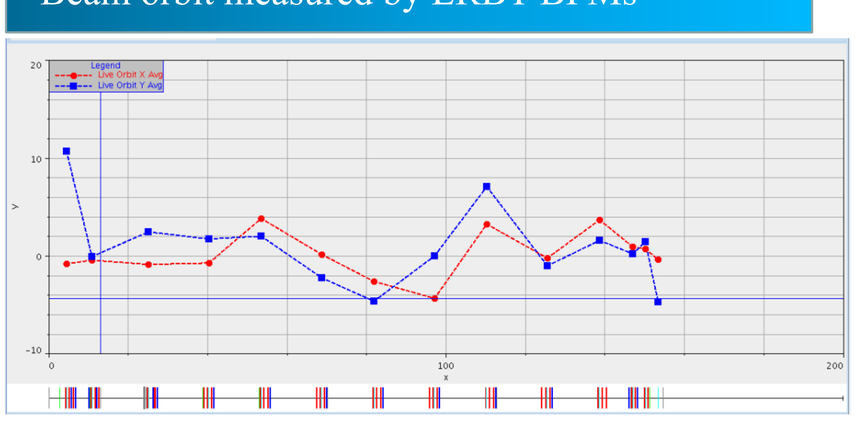




Readout Value of BLMs in linac commissioning

MEBT		DTL		LRBT		LRBT		LDBT	
BLM01	-1.9063	BLM01	-31.8807	BLM01	-13.1406	BLM13	-21.2909	BLM01	-256.9442
BLM02	-11.1338	BLM02	-53.8234	BLM02	-12.2612	BLM14	-19.7021	BLM02	-931.6843
BLM03	-292.6408	BLM03	-67.9274	BLM03	-28.2996	BLM15	-108.4243	BLM03	-419.9133
		BLM04	-41.7554	BLM04	-15.7209	BLM16	-83.1172	BLM04	1500.1513
		BLM05	-47.0486	BLM05	-65.3327	BLM17	-54.2007	BLM05	-102.9656
		BLM06	-223.8986	BLM06	-29.0587	BLM18	-33.1906		
		BLM07	-246.6098	BLM07	-22.2750	BLM19	-15.0461		
		BLM08	-565.0581	BLM08	-20.4656	BLM20	-17.5317		
		BLM09	-817.3717	BLM09	-21.4153	BLM21	-17.6775		
		BLM10	-6.8100	BLM10	-21.2796	BLM22	-24.8989		
		BLM11	-14.9136	BLM11	-13.2508	BLM23	-19.5230		

Beam orbit measured by LRBT BPMs



Conclusion

The beam instrumentations of CSNS linac were tested fully in the commissioning on RFQ, MEBT, DTL and LRBT. The beam peak current, and energy have been achieved to the design value. The beam transmission efficiency of DTL tank 1# to 3# reached nearly 100%. The last DTL tank will be commissioned in autumn this year.

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