Advanced Injection System of Light Ions (AISLI) for Dielectric Wall Accelerator

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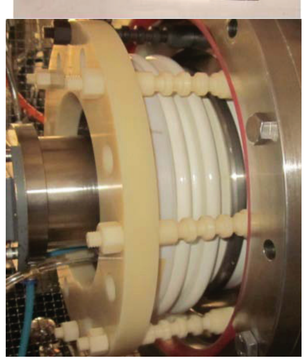
Abstract: Dielectric wall accelerator (DWA) is a kind of acceleration system with high electric field gradients up to 400 MV/m and very compact dimension, for example ϕ30 mm x 50 mm, which has the ability to accelerate the particles with any charge to mass ratio. To demonstrate the high gradient tiny acceleration system, a compact injector is required, which should deliver a 50 mA/40 keV pulsed H^+ converging beam to the entrance of DWA. Based on the experimental results obtained on the test bench, a six electrodes injector was developed at Peking University (PKU). In this paper we will describe the preliminary experimental results as well as the details of the new compact injector which named as Advanced Injector System of Light Ions (AISLI).

Status of ECR Ion Source at PKU

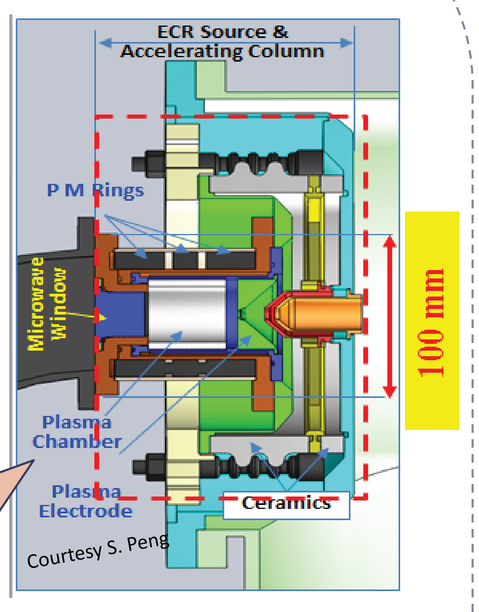


Source body: ϕ100 mm x 100 mm

Total weight: less than 5 kg

Life time (AlN): >200 h, still working

In PKU source and accel column are located into the vacuum chamber just in front of Sol1.



Ions	Gas Flow [sccm]	Energy [keV]	Current Imax [mA]	Remarks
H^+	2.0	50	120	Extraction aperture: ϕ6 mm Average RF power: ~200 W Emittance: <0.2 π mm.mrad
D^+	1.5	50	83	
O^+	0.28	50	50	
N^+	0.43	50	63	
Ar^+	0.38	50	70	
He^+	0.56	50	65	

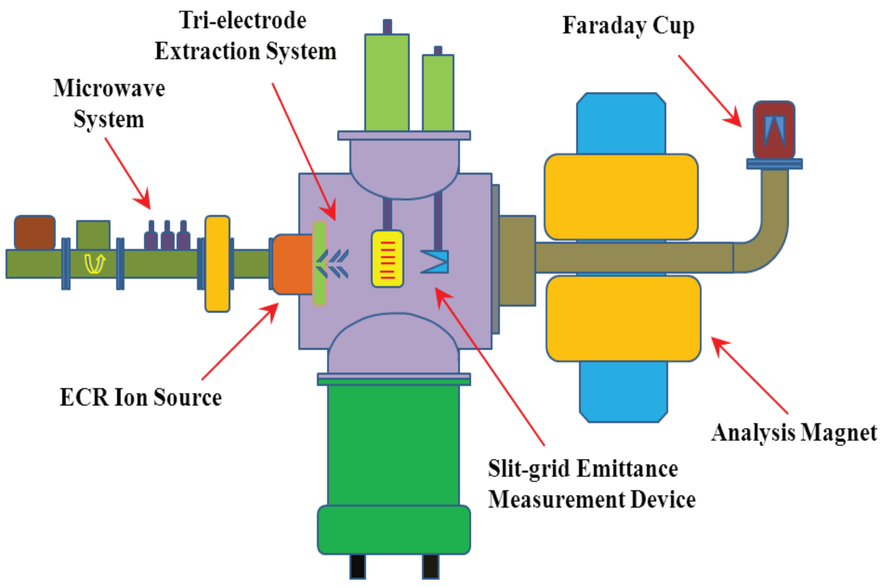
DWA and Proton Injector

Dielectric wall accelerator (DWA) is a new acceleration concept that can generate an extremely high gradient up to several hundred MV/m for a short pulse beam with any charge to mass ratio particle.

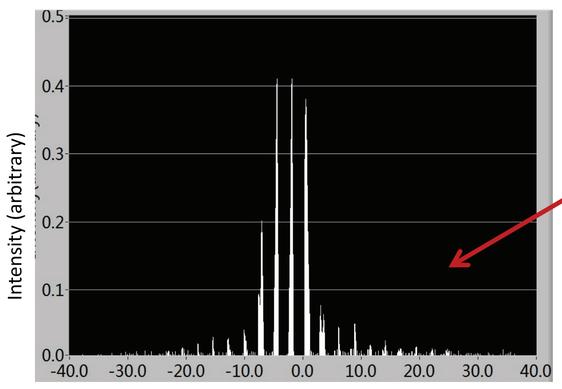
Peak Current	mA	50
Energy	keV	40
Emittance	π mm.mrad	≤0.2
Radius at entrance of HGI	mm	5
Frequency	Hz	50
Pulse width	ns	200
Space for adaption	mm	80

The proton injector of DWA, named Advanced Injection System of Light Ions (AISLI), is developed at Peking University.

Preliminary Experiment on PKU Ion Source Test Bench

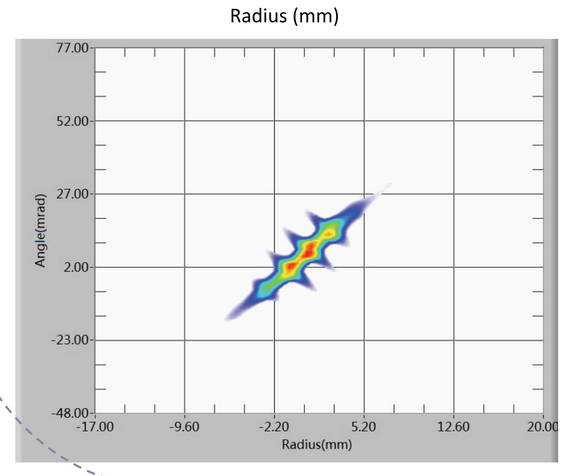


The skeleton diagram of PKU Ion Source Test Bench.



The transverse distribution 50mA/40 keV H^+ beam was obtained using slit-grid emittance measurement device.

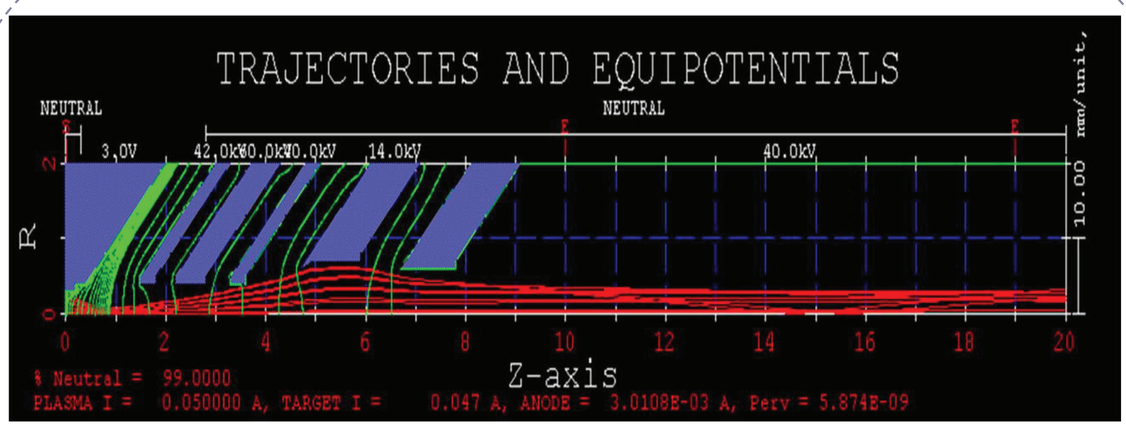
The distance between each two neighbor slits is 2 mm that locates 200 mm away from the ion emit aperture.



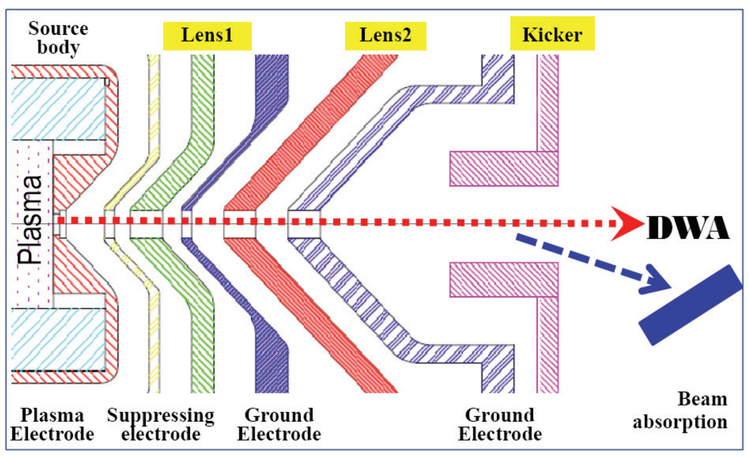
The beam diameter is about 5 slits that equal to 10 mm, and its rms emittance is only about 0.1 π mm.mrad.

This result proves that our preliminary experiment satisfies the requirement of DWA.

Injector Design for DWA



The LEBT electrodes basically form two electrostatic einzel lenses that provide two-parameter matching into HGI at its entrance plane.



The central electrode of the second lens is split into two isolated quadrants, and electrostatic voltages can be superimposed on the main potential to provide angular steering in the horizontal and vertical directions.

The kicker that follows the second lens is used to chop the 50Hz/0.5ms H+ beam generated by microwave power into 50 Hz/200ns shape.

Summary and Anticipation

According to the preliminary experimental results, a novel design of the proton injector (AISLI) for DWA has been developed. Two electrostatic einzel lenses are adopted to adjust the proton beam for matching with DWA. The commissioning of AISLI will be done in the near future, and we expect to obtain a 50 mm/40 keV proton beam with the diameter less than 10 mm at the entrance of the dielectric wall accelerator.