激光等离子体加速器
COMPACT LASER PLASMA ACCELERATOR

北京大学
PEKING UNIVERSITY

Design and Construction Status of the diagnostic system for the Compact LAser Plasma Accelerator II

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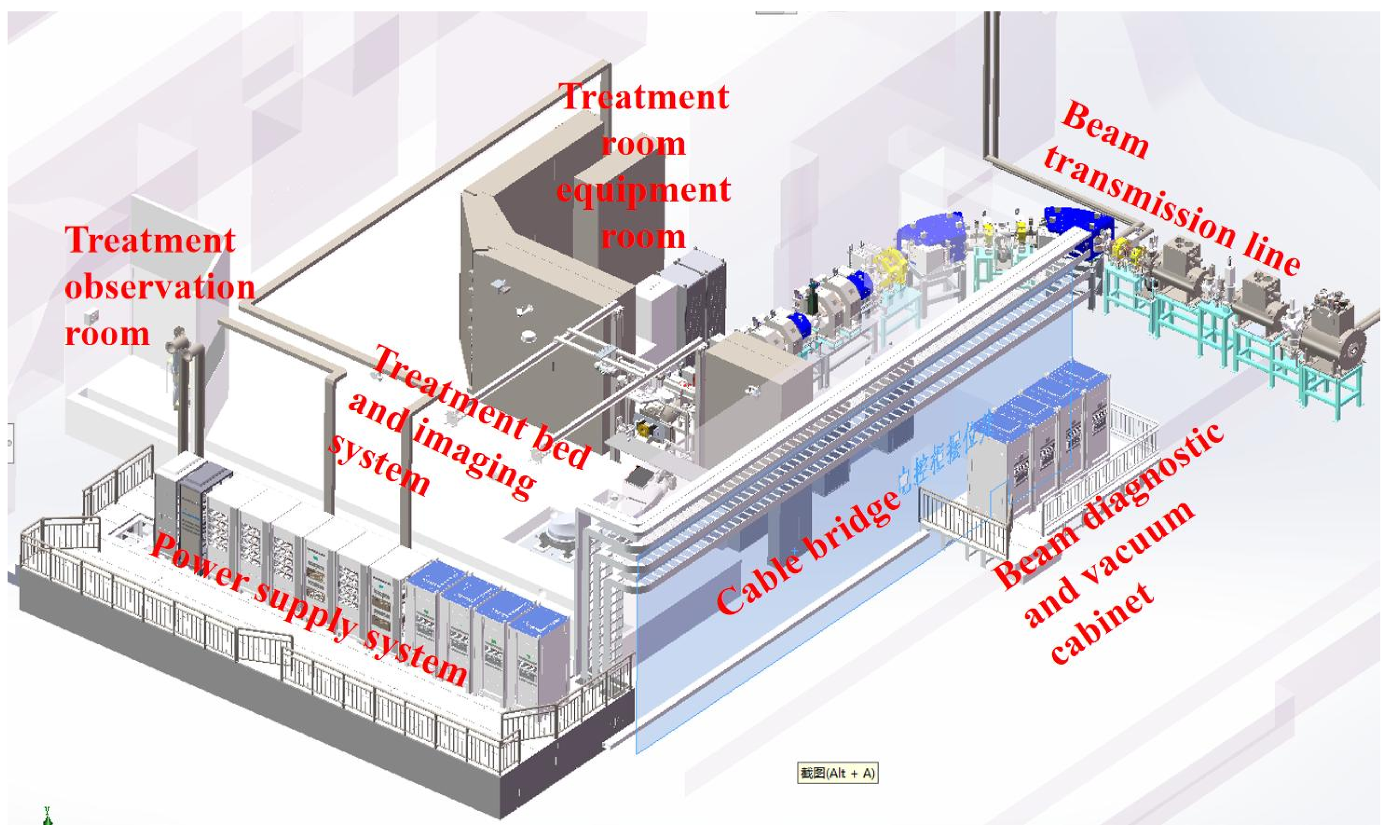
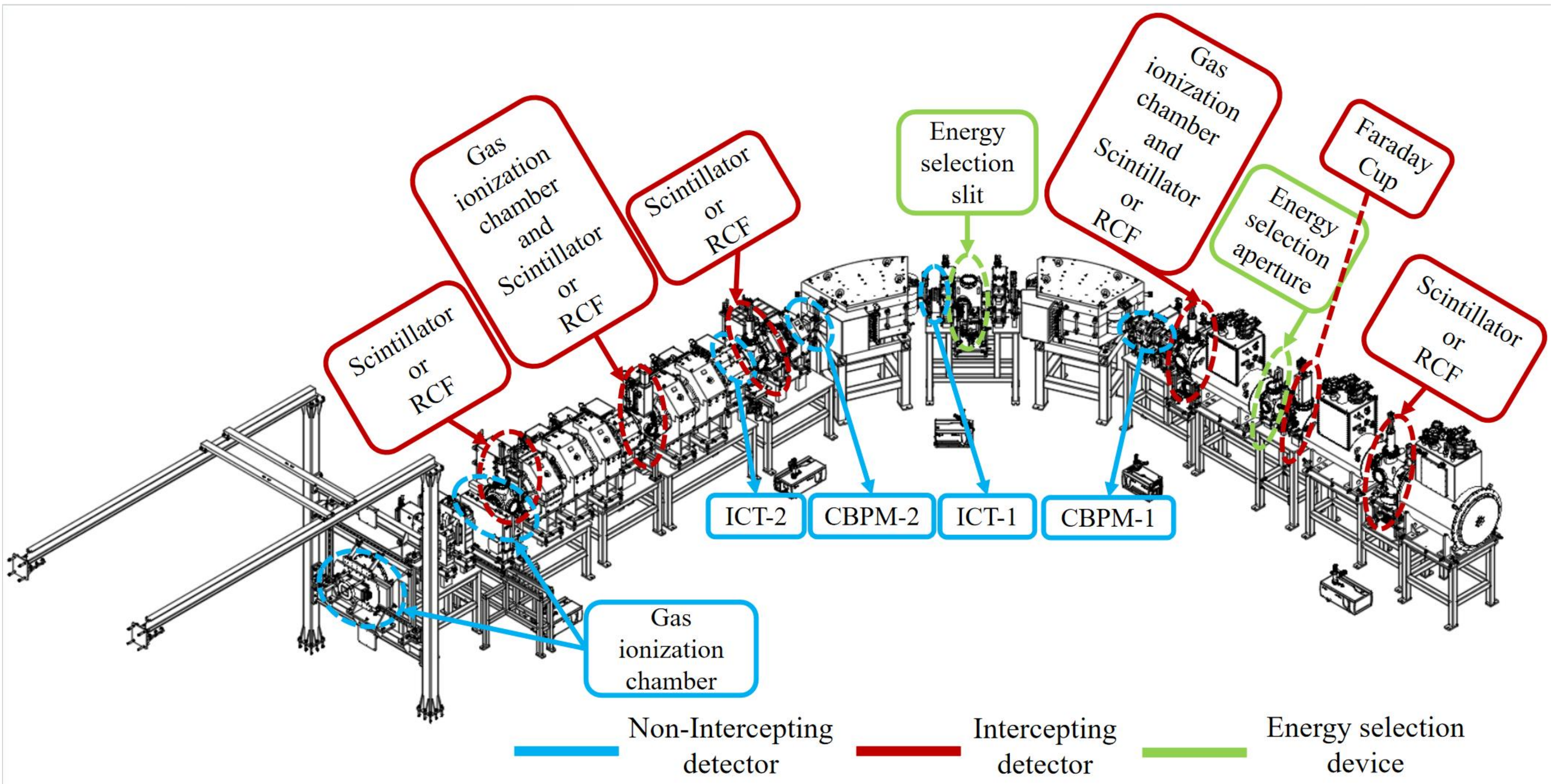
CLAPA-II beam transmission system introduction

Peking University is engaged in the construction and development of CLAPA-II (the Compact LAser Plasma Accelerator II), a proton therapy facility which utilizes a laser-plasma acceleration scheme. This facility comprises two horizontal and vertical beam transmission lines, operating at a repetition rate of 1Hz, capable of delivering 10^8-10^10 protons per second. We have implemented both interceptor and non-interceptor detectors for precise measurements of proton beam. This is the first instance where an ionization chamber and cavity BPM have been integrated into a laser proton therapy accelerator. To validate the performance of our beam diagnostic system, we have established an offline test platform that simulates the laser proton beam. The results indicate that the offline test resolution of the cavity BPM has achieved 0.2μm in the range of ±3mm. This paper provides an overview of the beam diagnosis system's overall layout, accompanied by a detailed description of the detector design and corresponding measurement results.



Overall parameters of beam diagnosis system



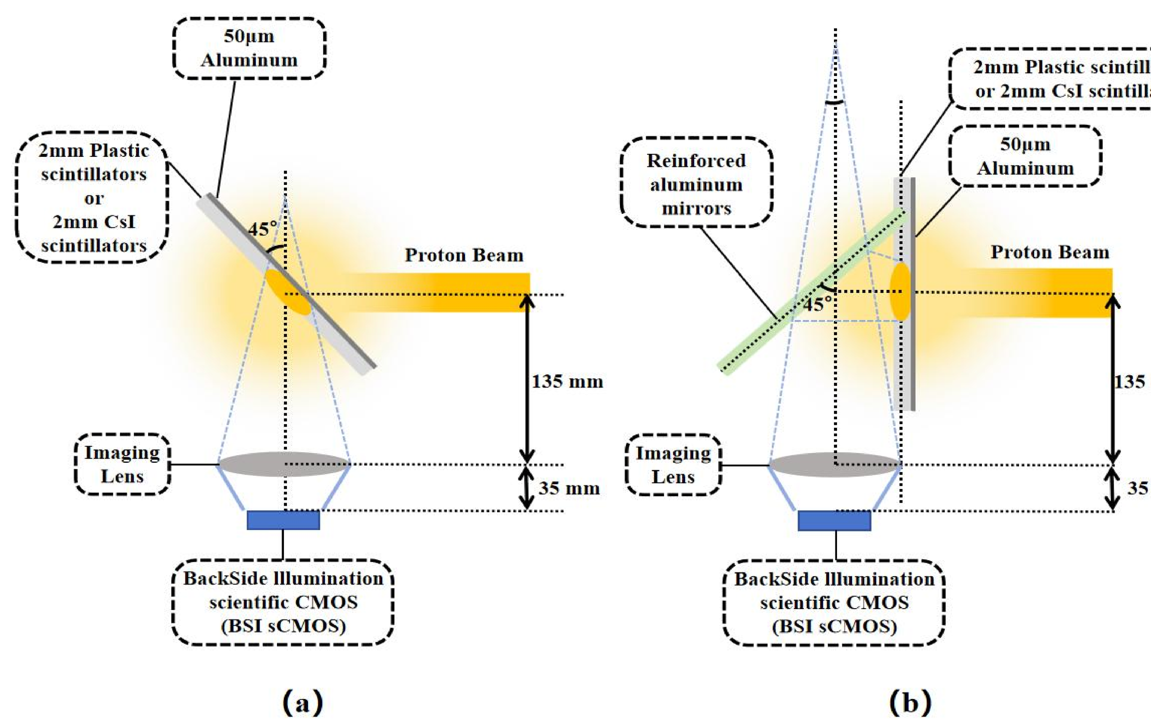
Intercepting detector：

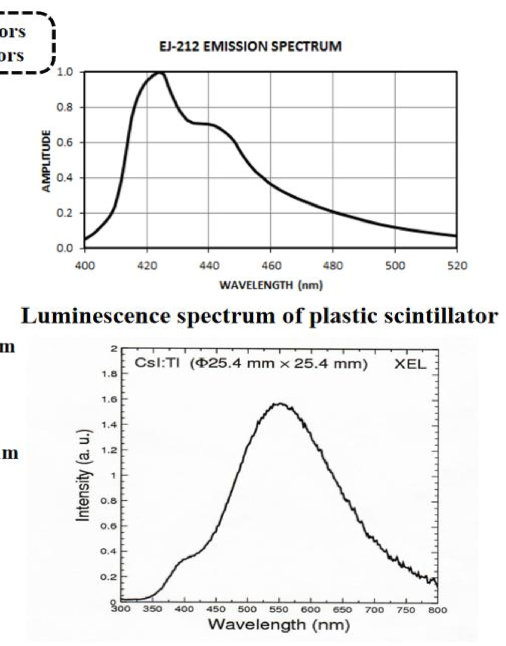
- **fluorescent detector**
  Plastic scintillator/CsI scintillator
  Radiation-changing flim (RCF)
  Industrial/CCD camera
  Dose measurement accuracy ＜5.2fC/mm²
  Position measurement accuracy＜0.5 mm
- **Faraday Cup**
  System resolution ＜0.1pC in vacuum

Non-intercepting detector：

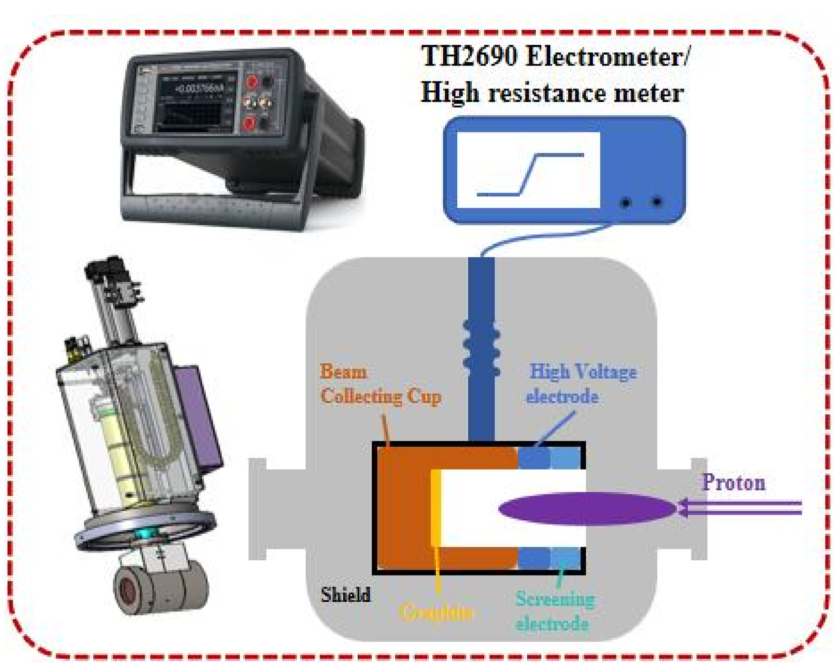
- **Cavity Beam positon monitor（CBPM）**
  The system resolution ＜0.2 mm
- **Integral current transformer（ICT）**
  Reserved installation position
- **Gas ionization chamber**
  Dose measurement accuracy ＜0.5pC
  Position measurement accuracy＜0.2 mm

Intercepting Detector

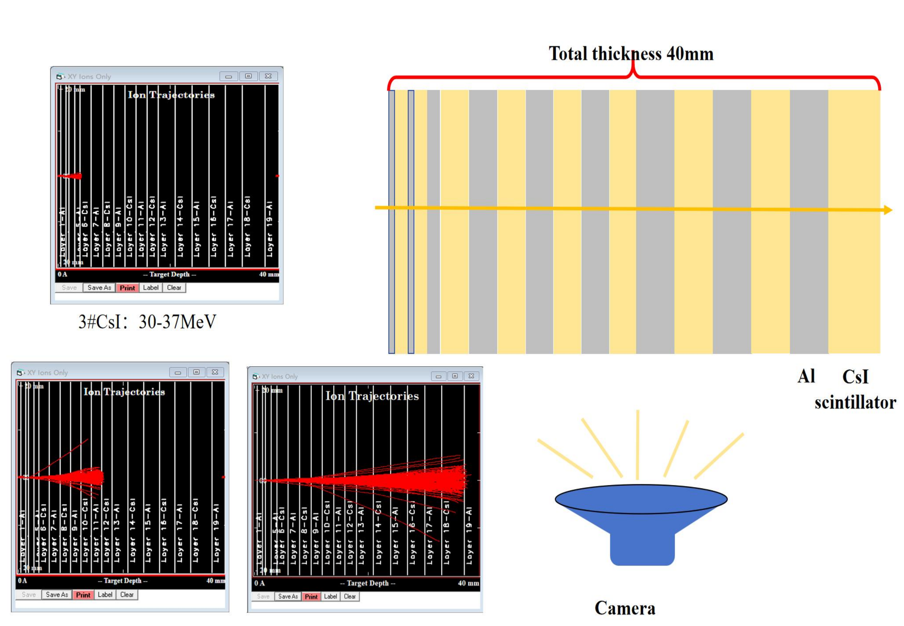




Beam profile measurement scheme with scintillators



Fast Faraday Cup System for beam cunrrent measurement



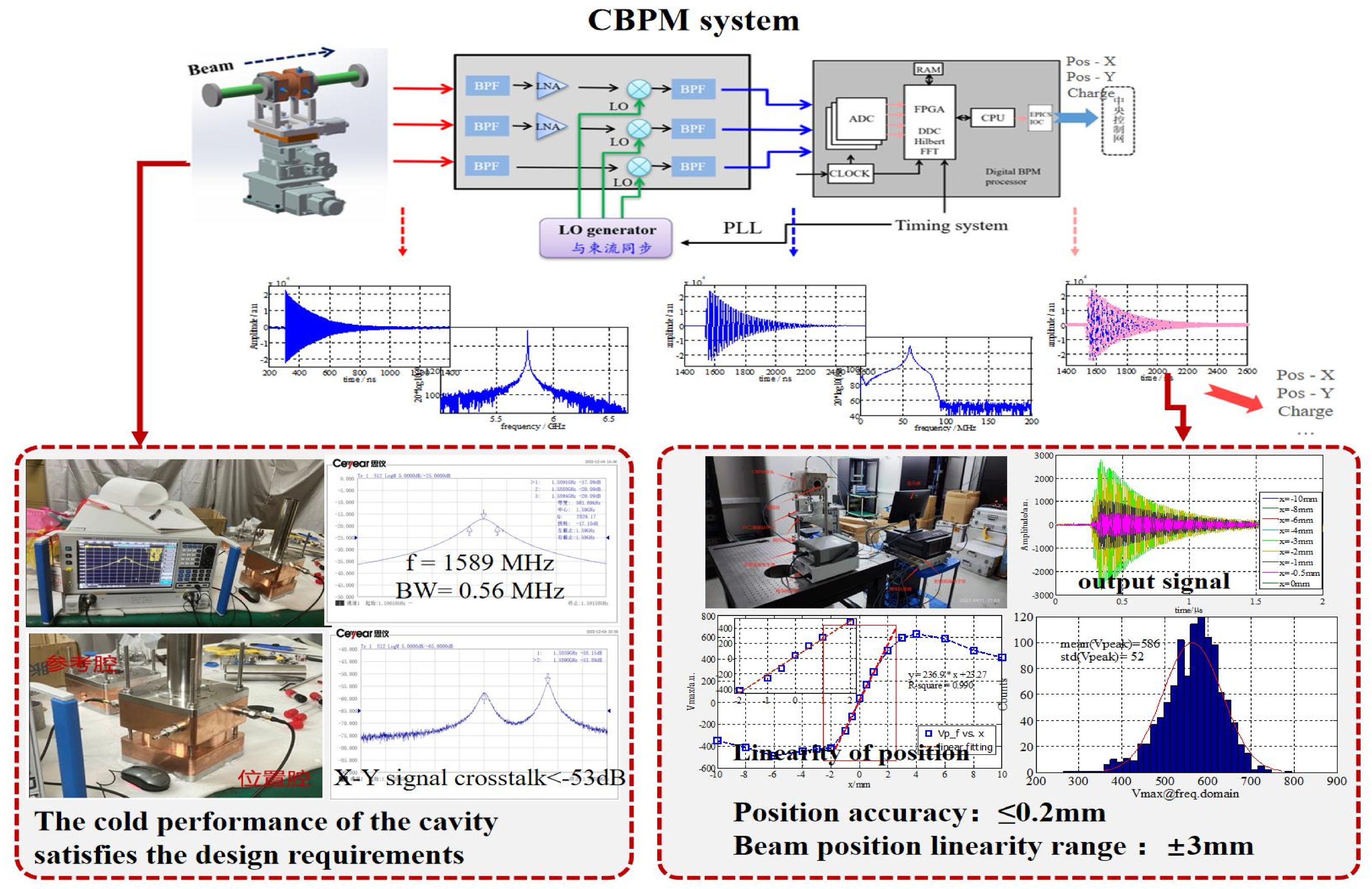
The scintillator stack measures the beam energy spectrum

- The detector can complete beam profile and energy measurement.
- In order to better monitor the beam parameters during the debugging phase, 5 sets of fluorescent target systems are evenly distributed on the beam line.
- It can detect the laser proton beam of 40-200MeV, 107~1010ppp and ±3.5% energy dispersion.

Non-Intercepting Detector

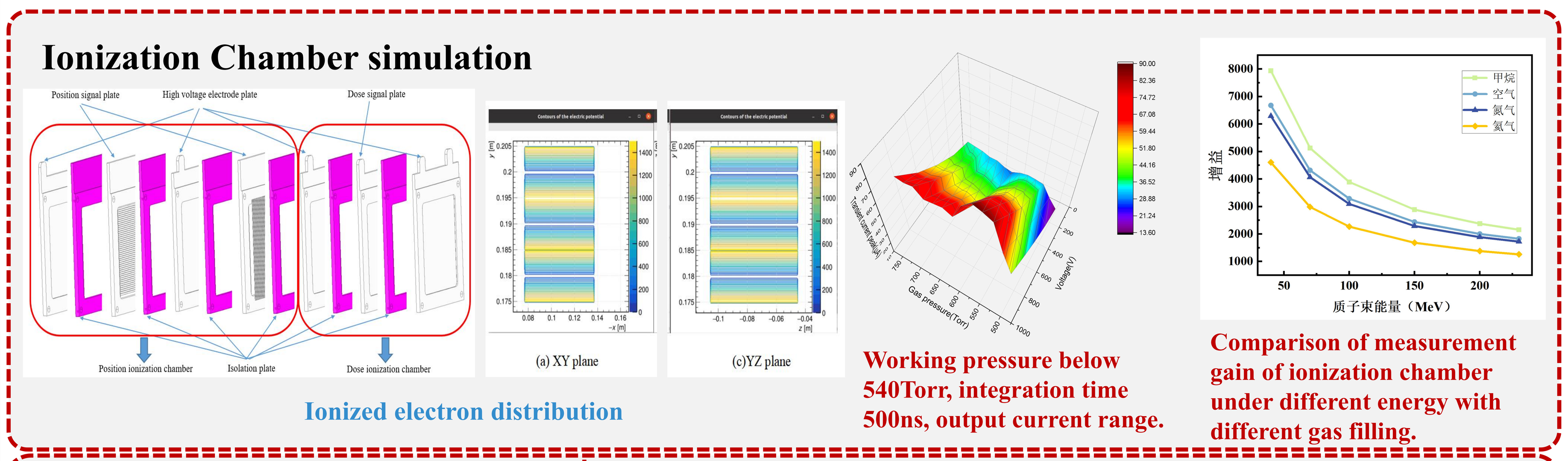
For proton radiotherapy equipment, non-interceptor detectors are needed for real-time detection of position and dose to ensure the safety of irradiated patients. Therefore, non-interceptor detectors are important equipment for industrialization of laser proton radiotherapy equipment.

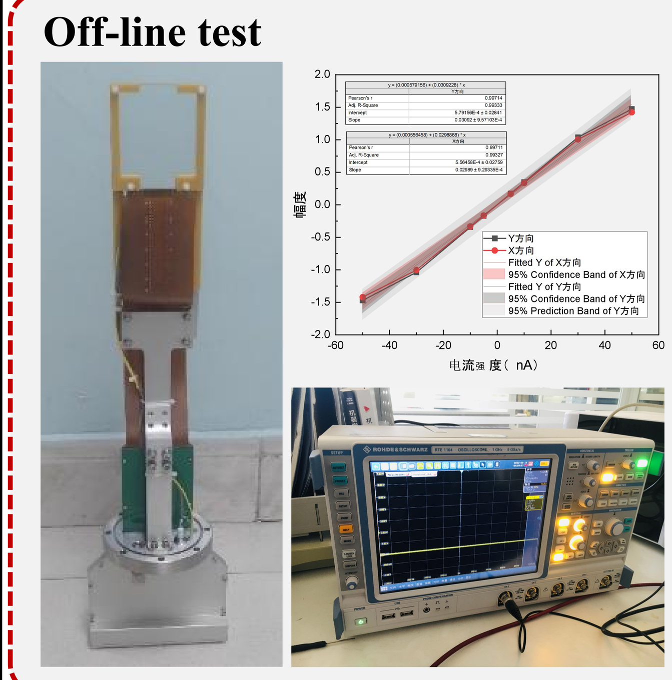
Cavity Beam Position Monitor (Coorperate with CAS SARI)

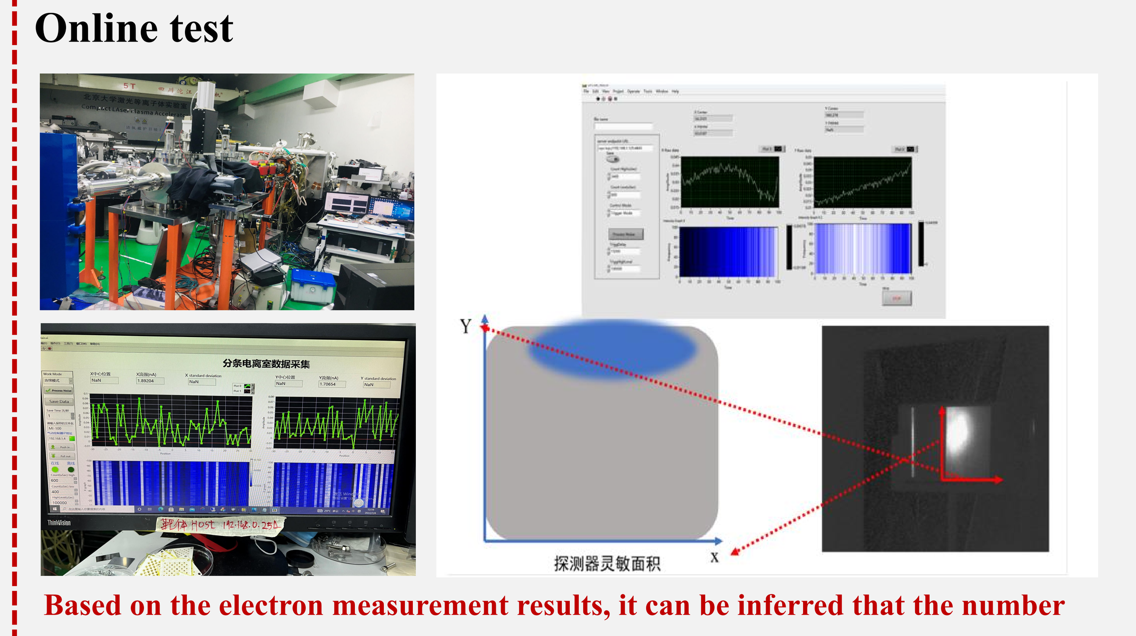


Ionization Chamber (Coorperate with CAS IMP)

- It can detect the beam position and dose, which is a common detection equipment in cancer treatment accelerator







Based on the electron measurement results, it can be inferred that the number of proton particles that can be measured is 2*10⁵~2*10⁸ ppp.

Conclution

- the electronic equipment in the beam line will face a more complex working environment due to the lack of specific beam operation parameters and machine operation parameters.
- The basic construction of the device has been completed, and the testing and installation of each system equipment is being carried out

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