

Iranian Test Stand Electron Linear Accelerator

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- 1. IPM Linac project**
- 2. Commissioning activities**
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1. IPM Linac project

IPM Linac project

➤ Parameters

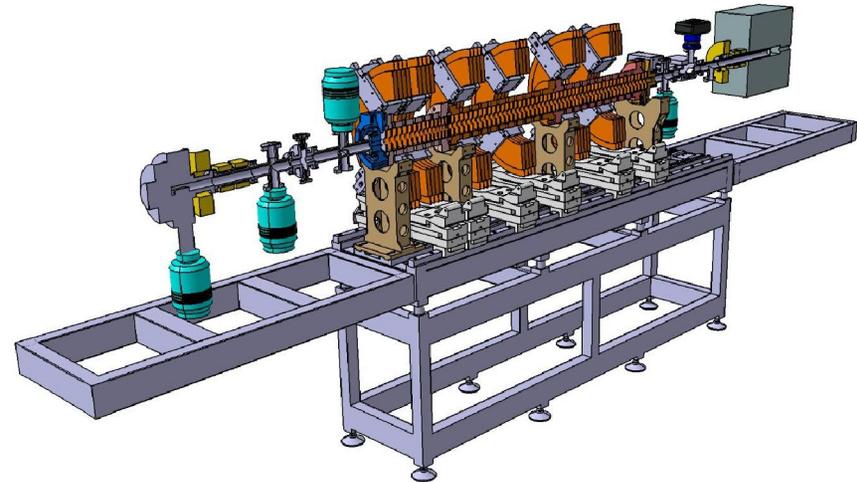
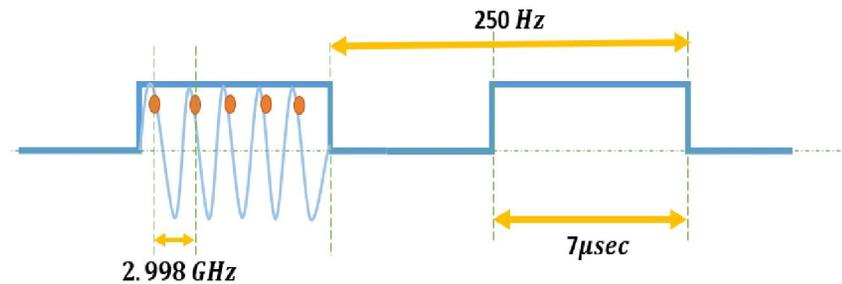
- ✓ Beam energy: 8 MeV
- ✓ Beam current: 10 mA
- ✓ Pulse length: 7 μ s
- ✓ Repetition rate: 255 Hz

➤ Goals

- ✓ R & D in Accelerator physics
- ✓ HR Training
- ✓ **Feasibility study**

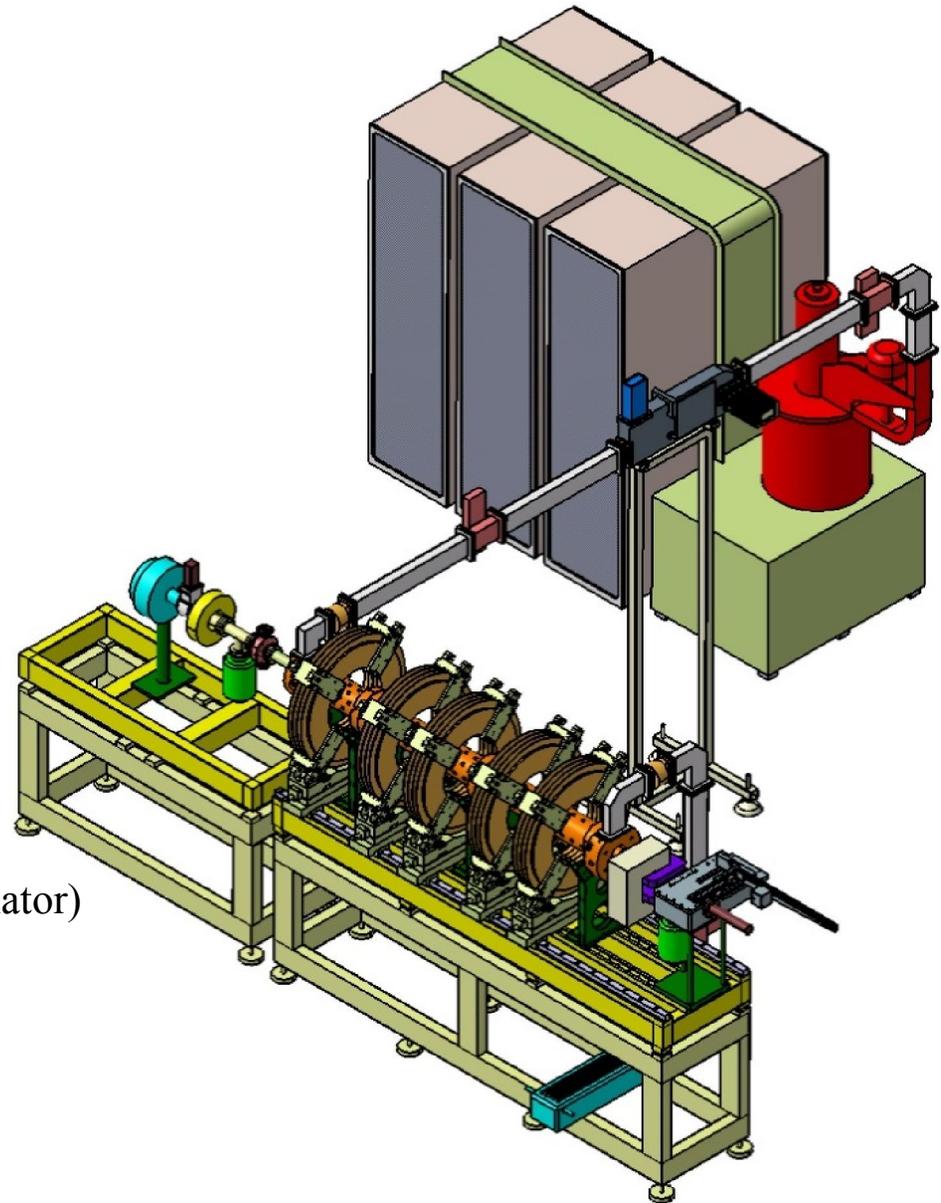
➤ Applications

- ✓ Medical
- ✓ Industrial
- ✓ Injector of a larger facility.



IPM Linac project

- The structure
 - ✓ Low energy injector
 - Electron gun
 - Steerer magnets
 - Matching solenoid
 - Pre-buncher
 - ✓ TW structures
 - ✓ Focusing solenoid
 - ✓ Diagnostics box
 - ✓ RF source
 - Generator
 - Amplifier (klystron & modulator)
 - Wave guide system



IPM Linac project

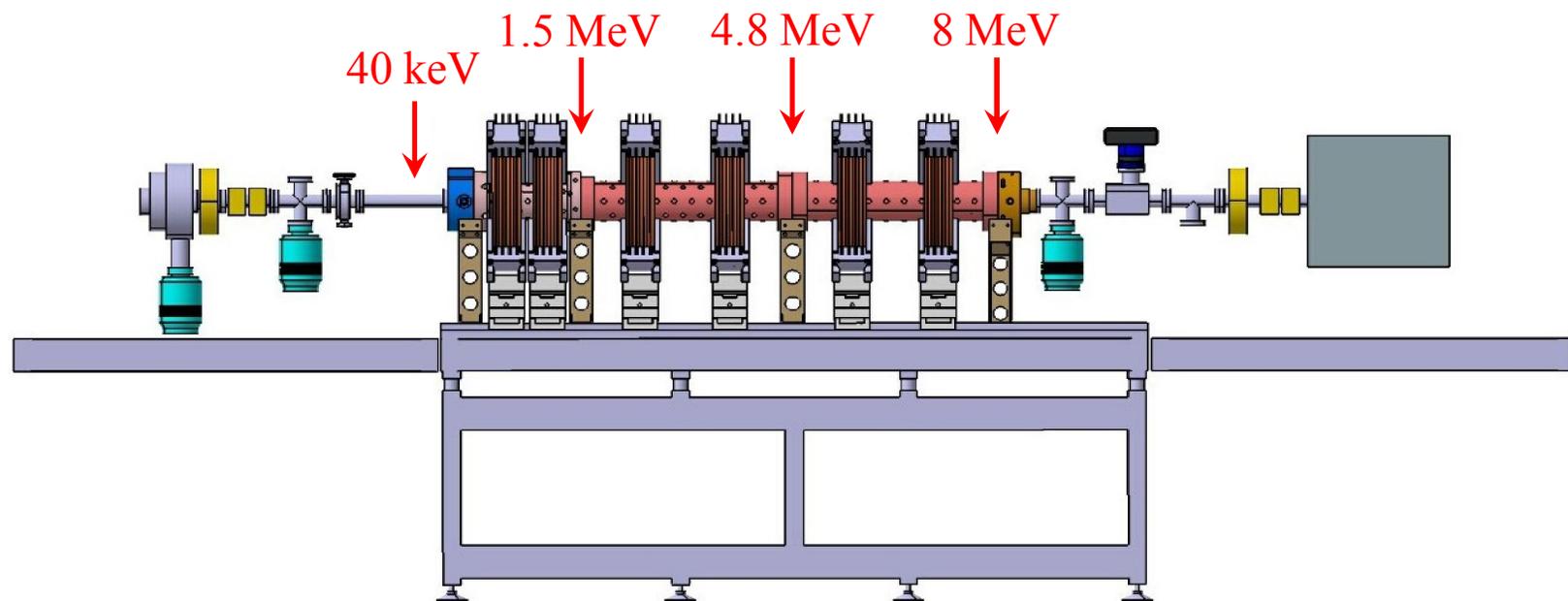
- Iran's first Linac
 - ✓ Fully designed and constructed within the country.

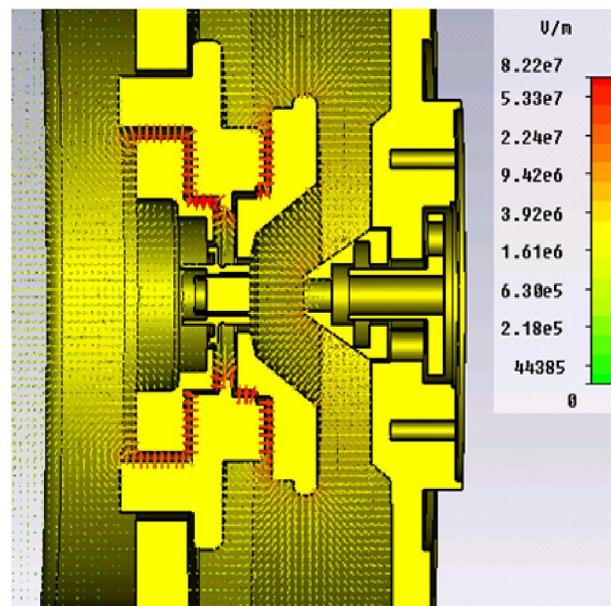
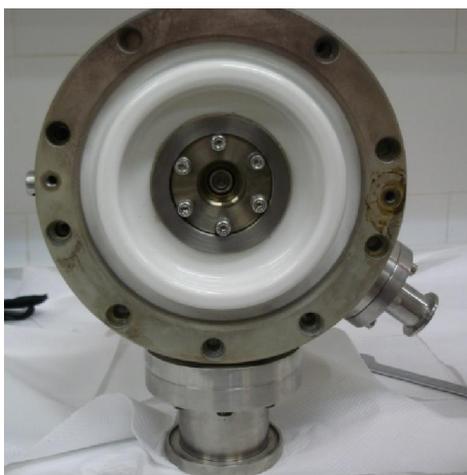
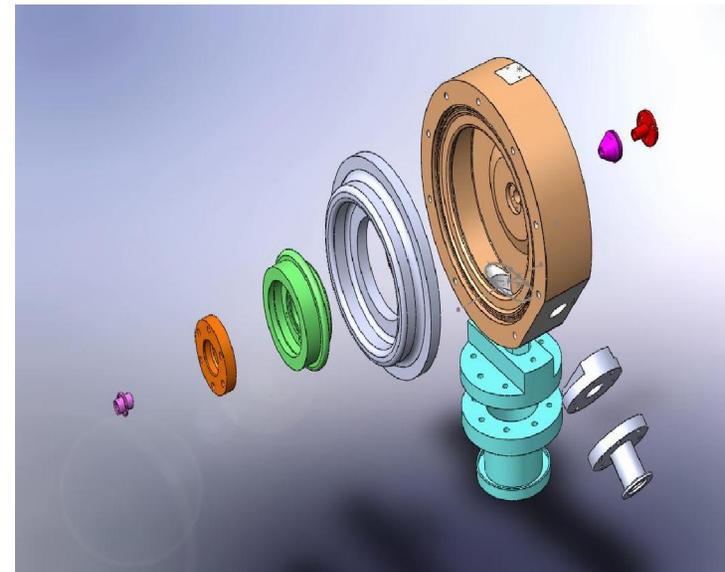
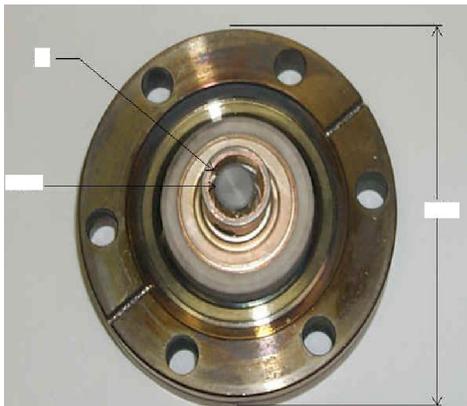
- Human resource training: **25**
 - ✓ Graduated M.Sc. Student: 14
 - ✓ Graduated PhD student: 4
 - ✓ Post-doctoral research fellow: 7

- Publications: **51**
 - ✓ In the international peer-viewed journals: 7
 - ✓ In the internal peer-viewed journals: 11
 - ✓ In international conferences: 13
 - ✓ In internal conferences: 20

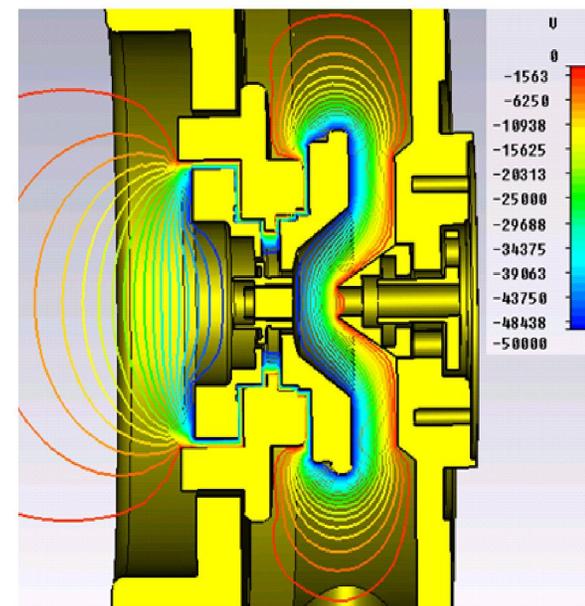
Commissioning phases

- Low energy injector (40 keV)
- TW buncher (1.5 MeV)
- 1st acc. Tube (5 MeV)
- 2nd acc. Tube (8 MeV)



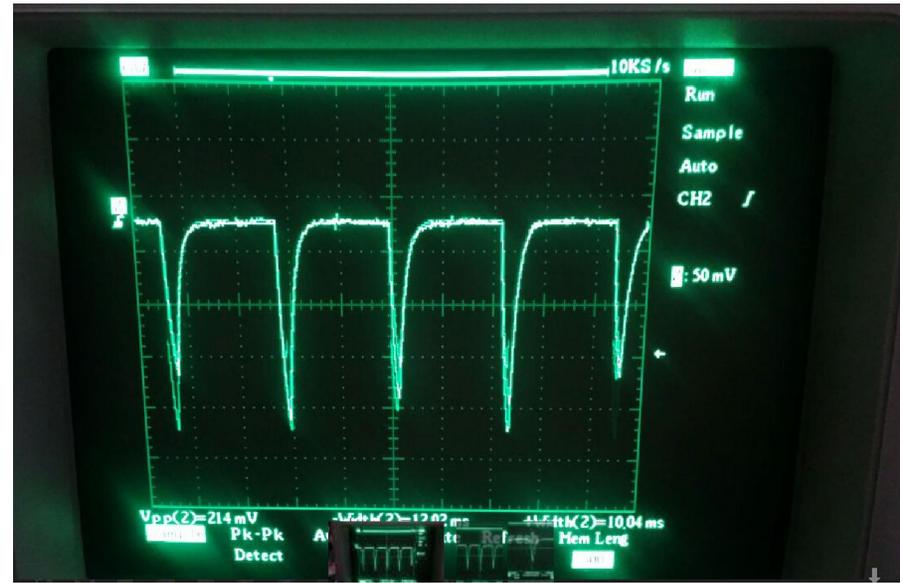


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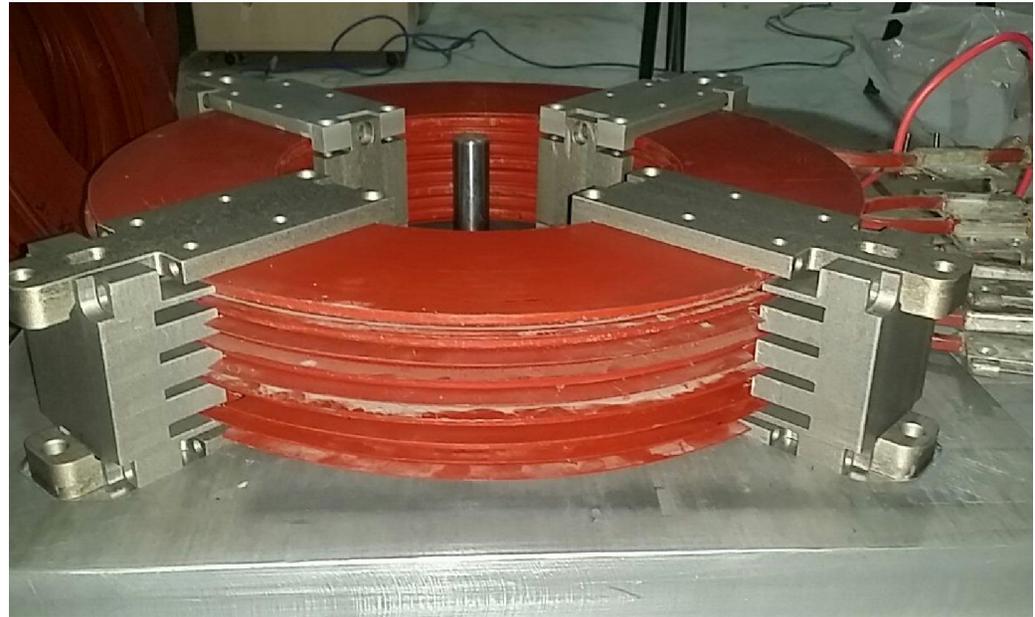
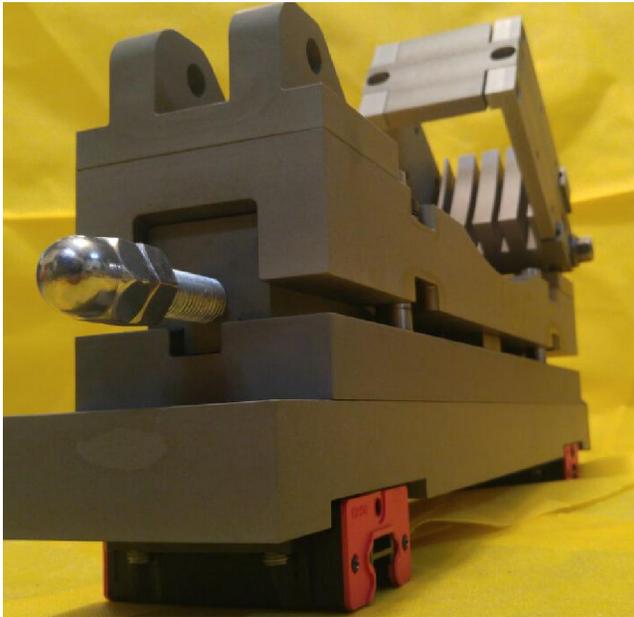
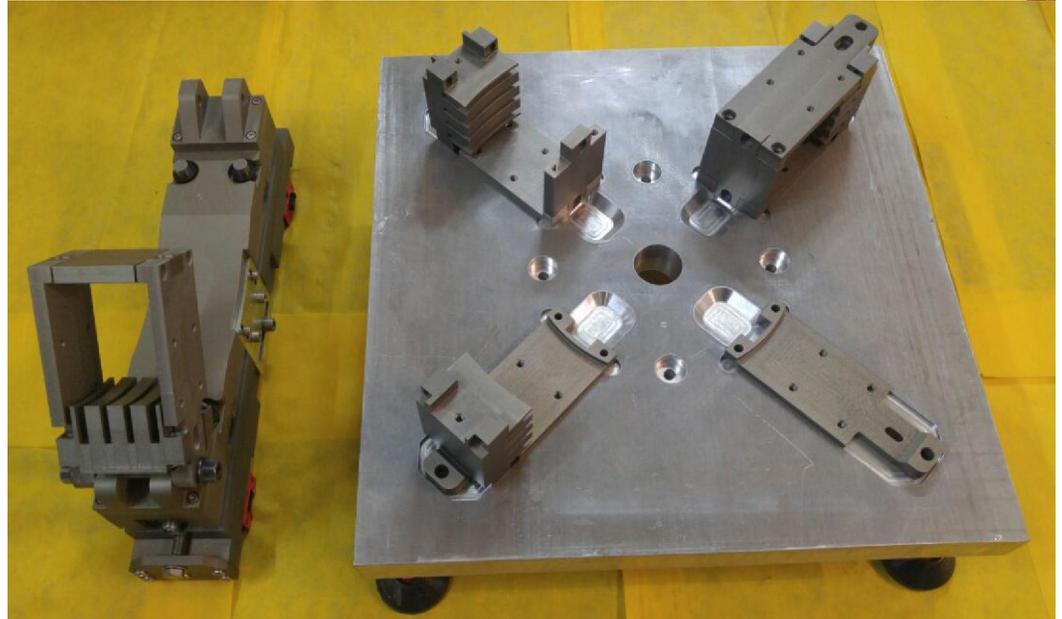
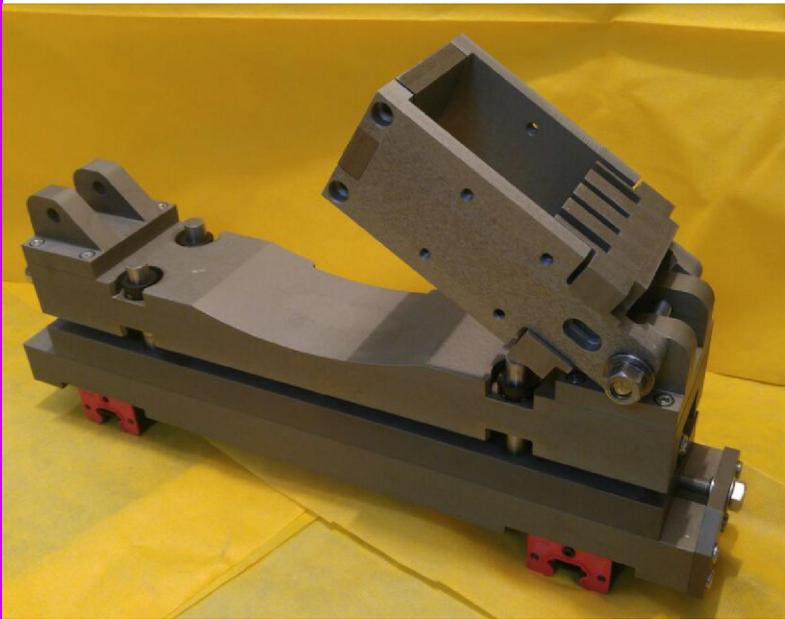


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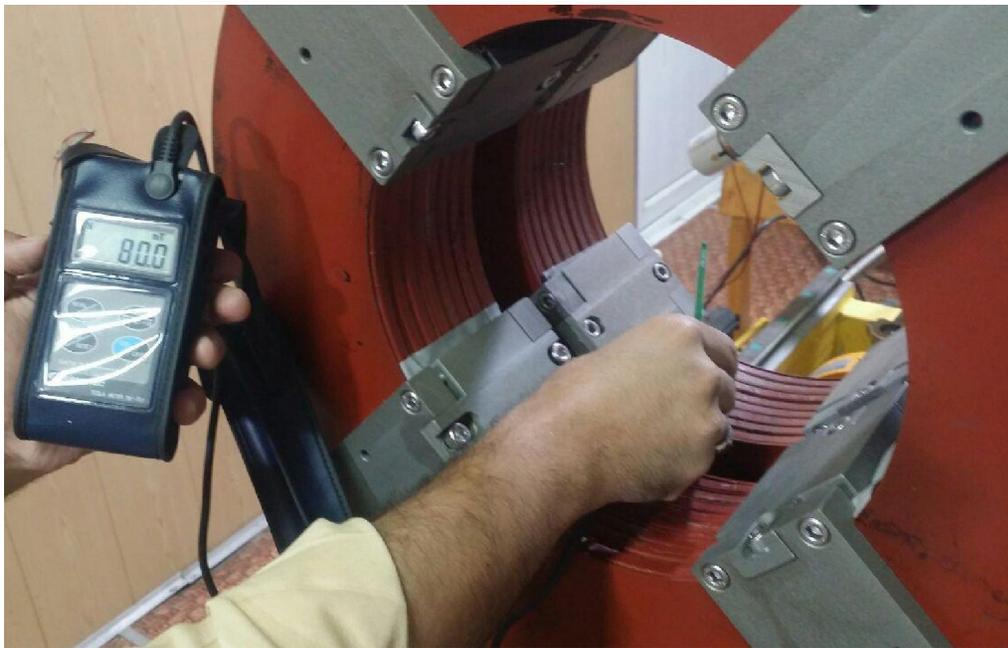
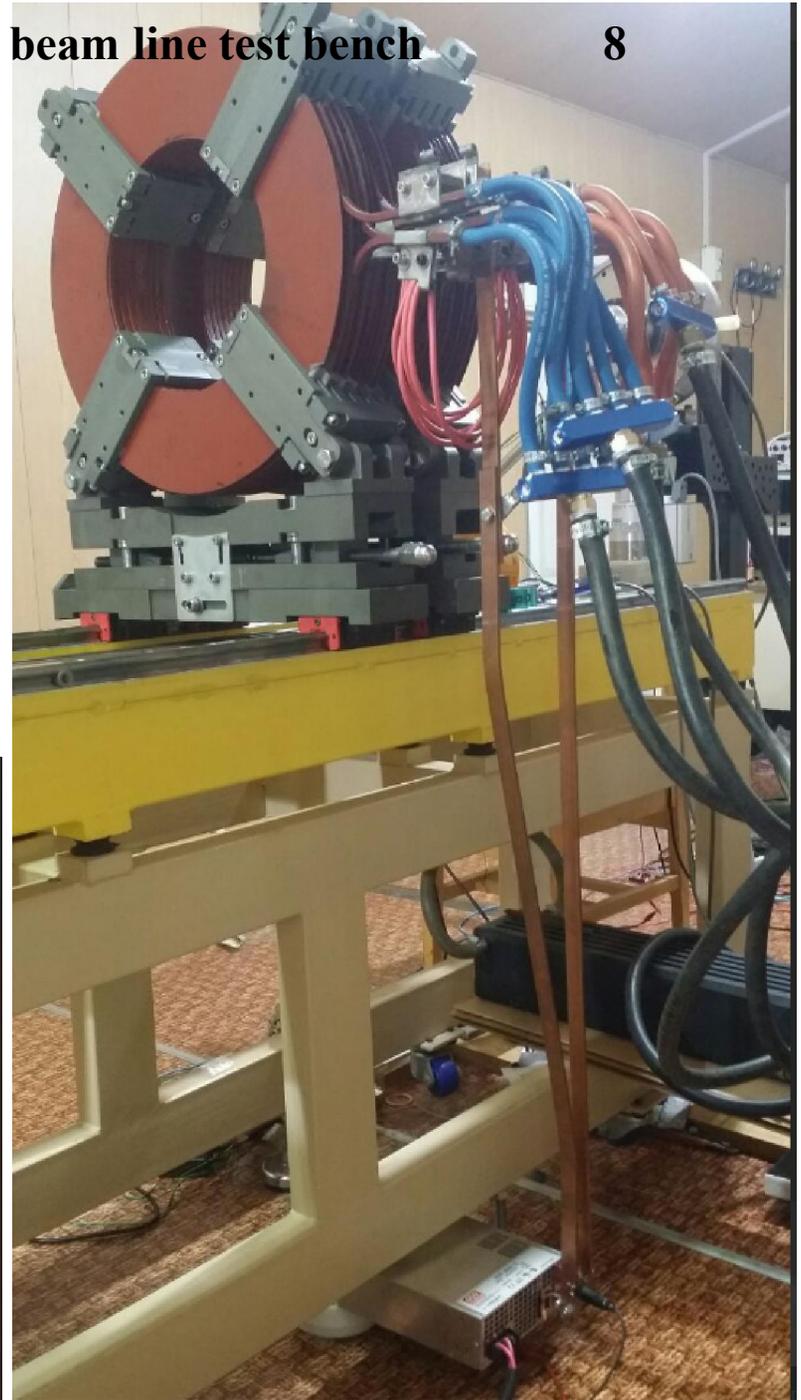
Assembling and first days of operation of electron gun 6



Fixture and hollow conductors for pancake type solenoid around buncher cavity

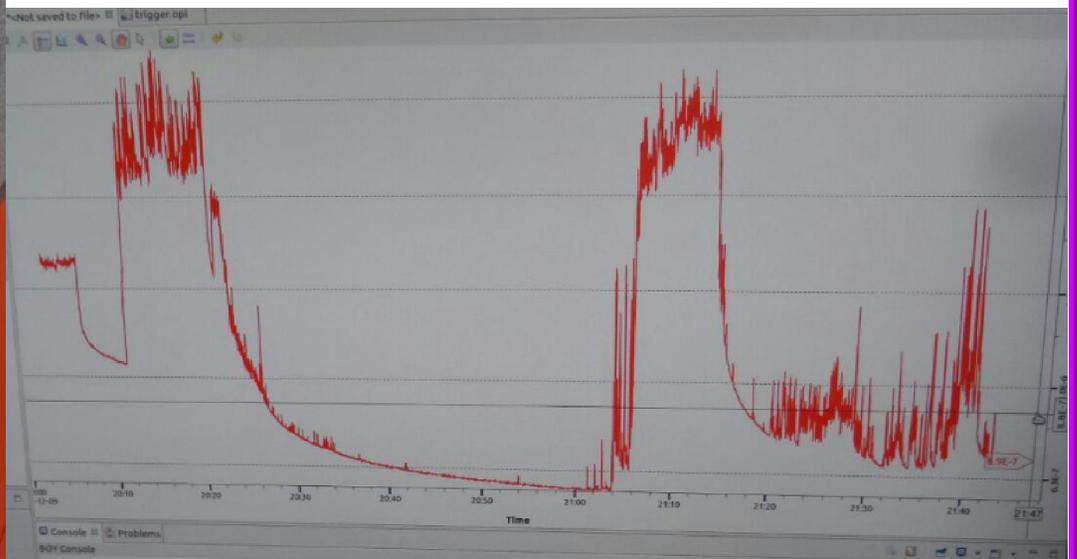
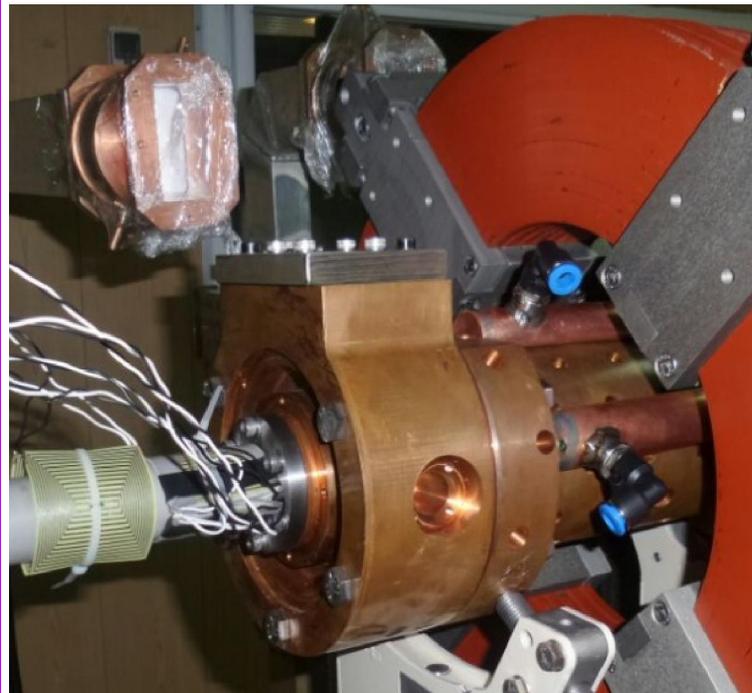
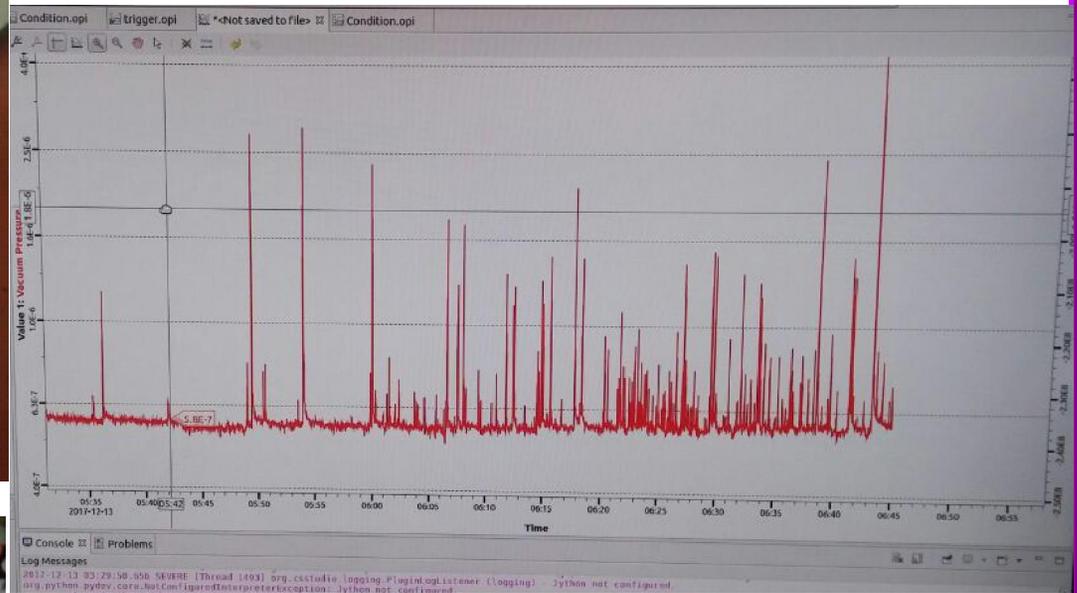
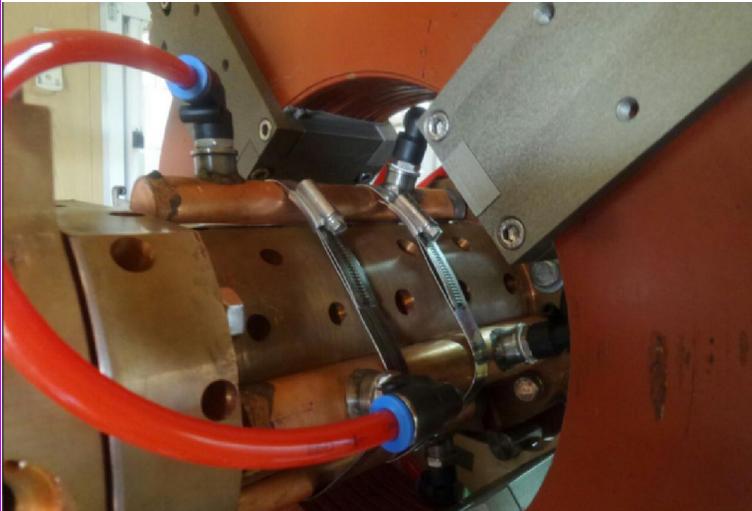
Installation and measurement of solenoids on the beam line test bench

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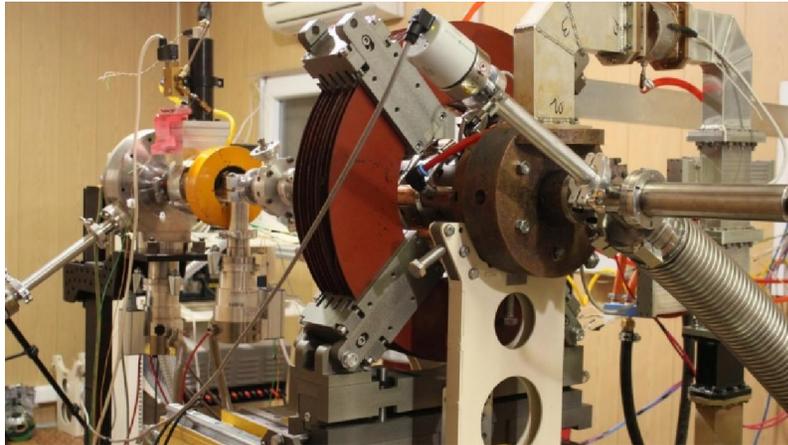
Installation and RF conditioning of buncher cavity

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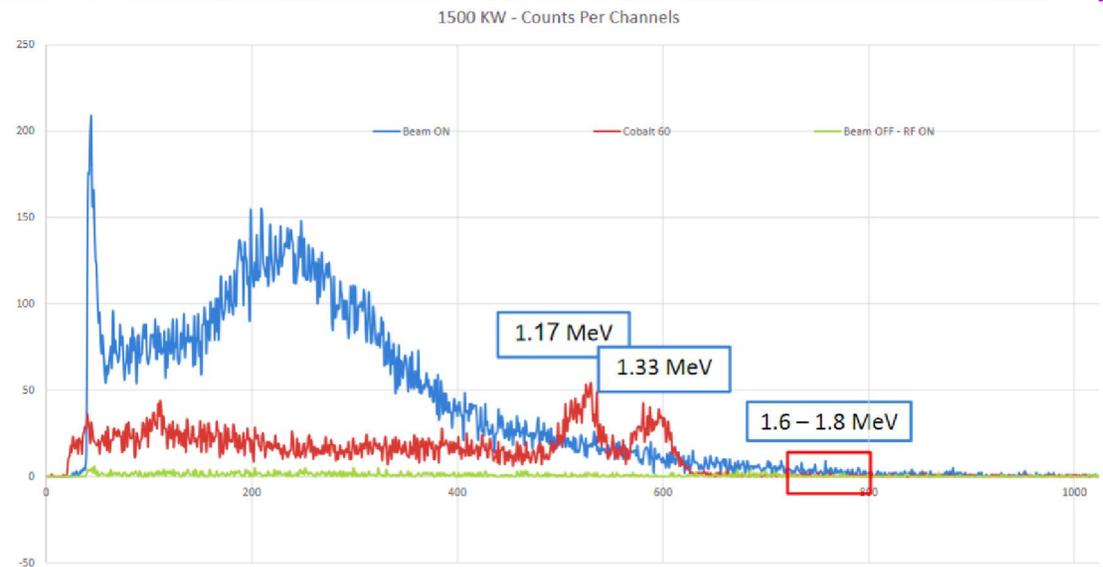


Detection of 1.5 MeV beam (Azar 96)

- RF source
- Linac

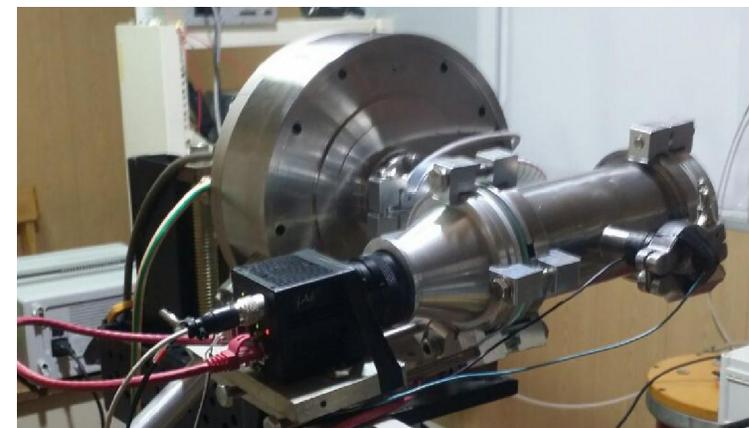
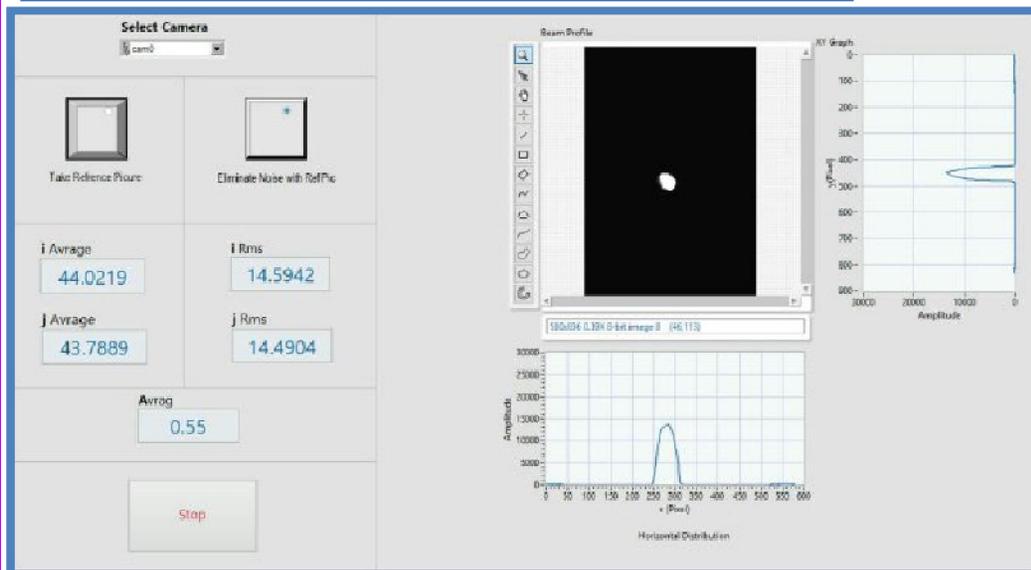
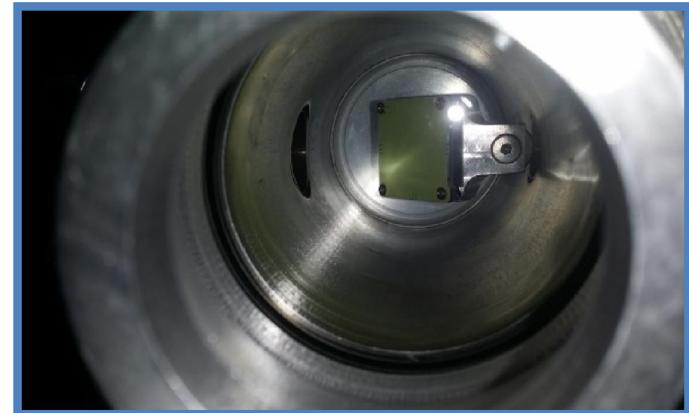
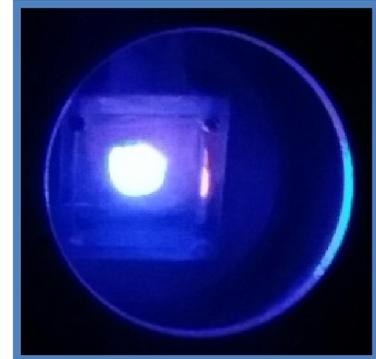
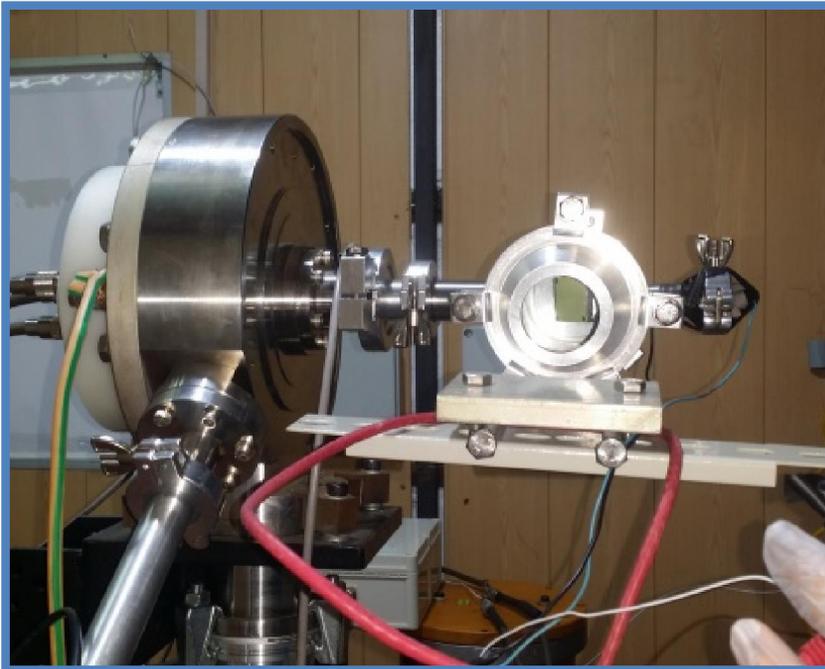


- Bremsstrahlung spectrum

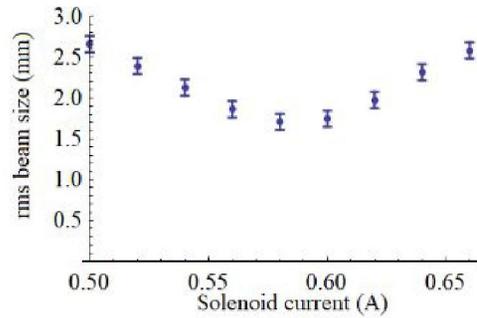


Beam profile measurement with YAG and ZnS Scintillators

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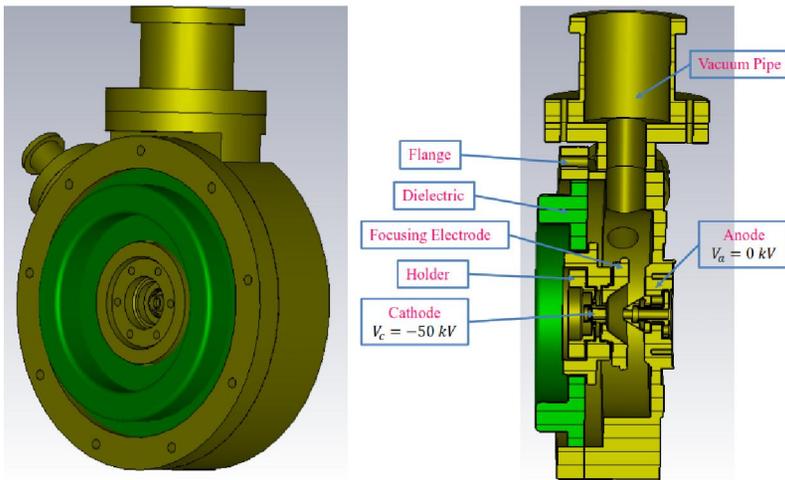


Beam profile measurement and Emittance measurement with sol-scan method

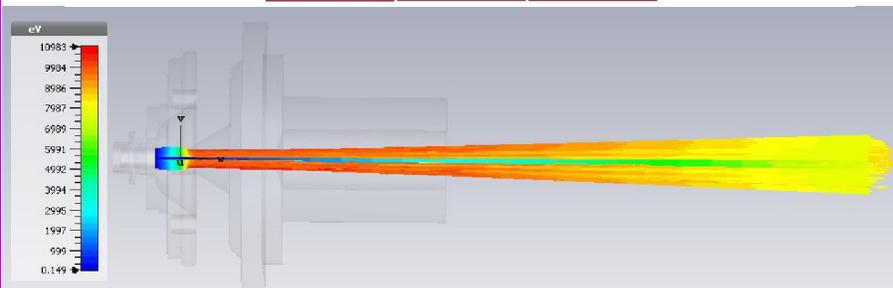
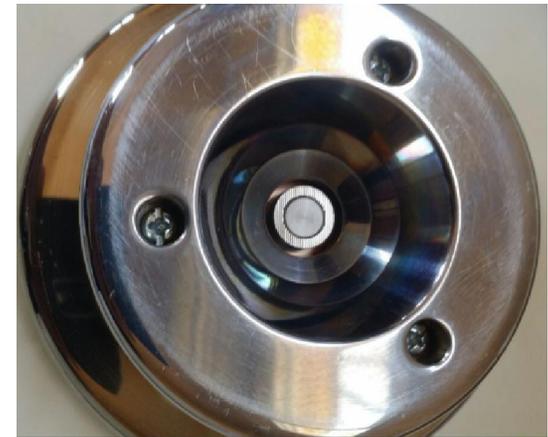
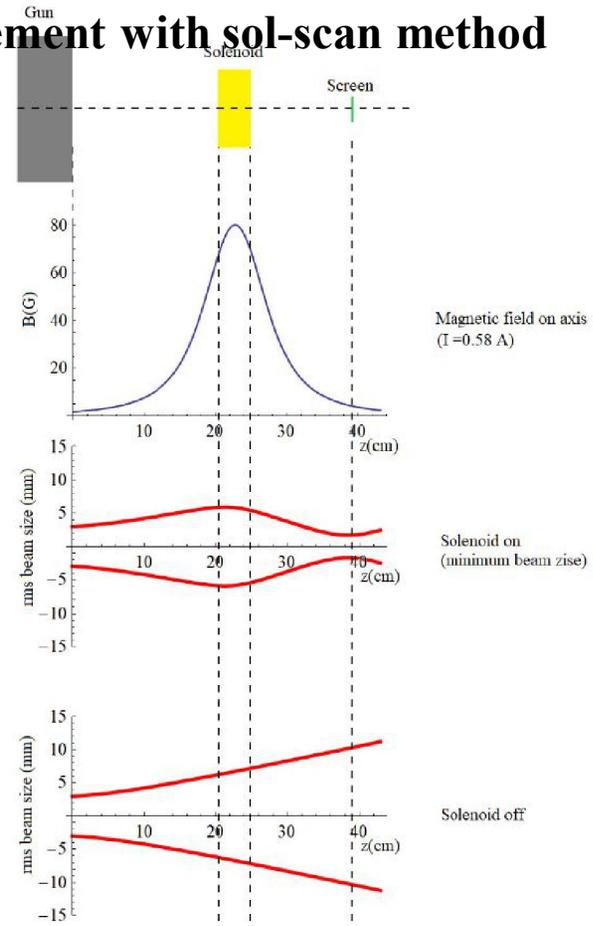


Measured data
Gun energy = 10 keV

Calculated Beam Parameters at the gun exit:
 rms beam size = 3.0 ± 0.1 mm
 Derivative of rms beam size = 5.3 ± 2.1 mrad
 Geometric emittance = 68.3 ± 4.4 mm-mrad

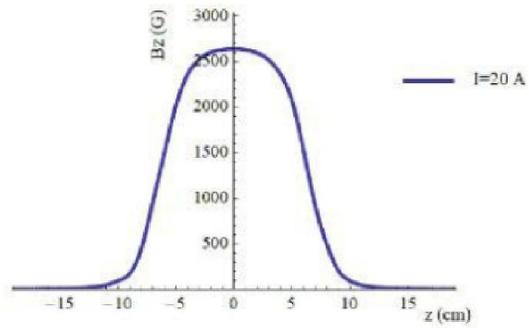


$V_c = -50$ kV $r_c = 3.9$ mm $I_c = 0.01$ A

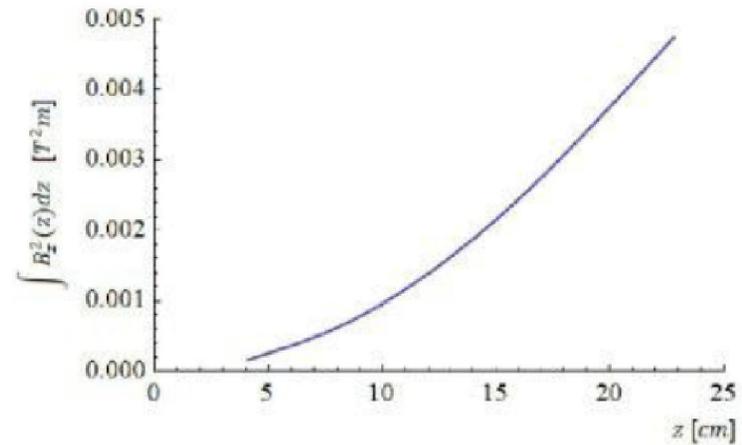


Solenoid magnet measurement in different currents for Sol-Scan measurement at the end of linac 13

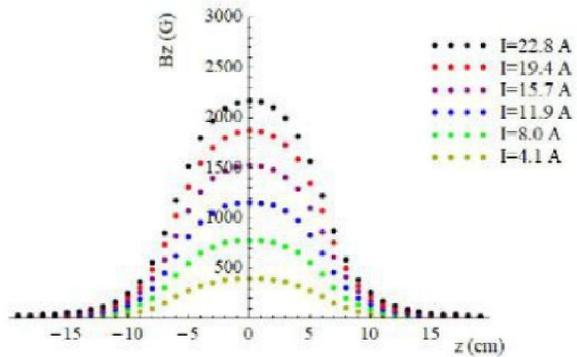
Simulation result



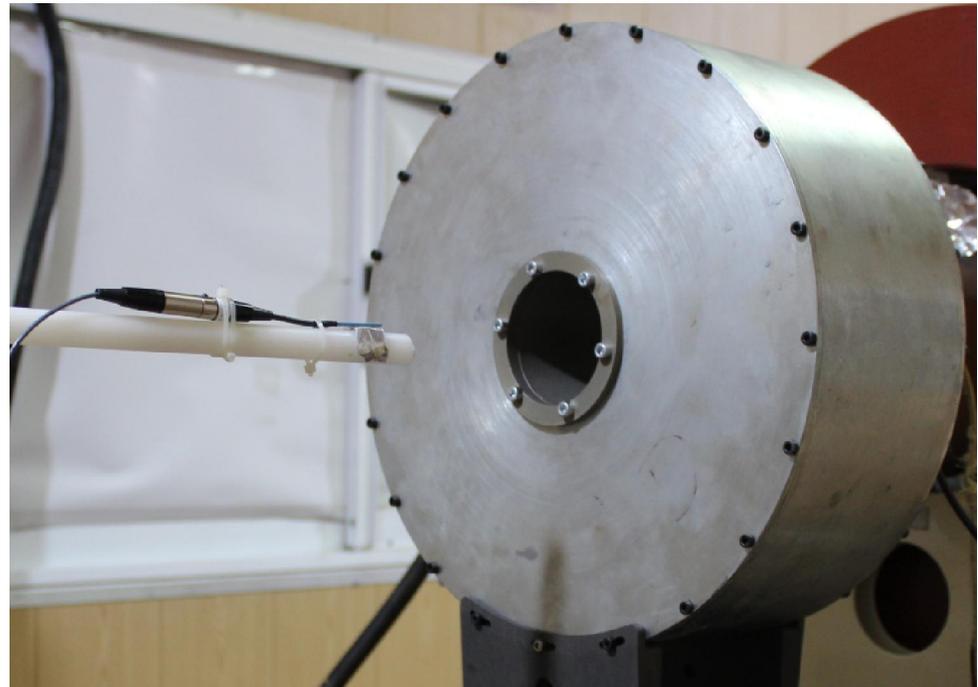
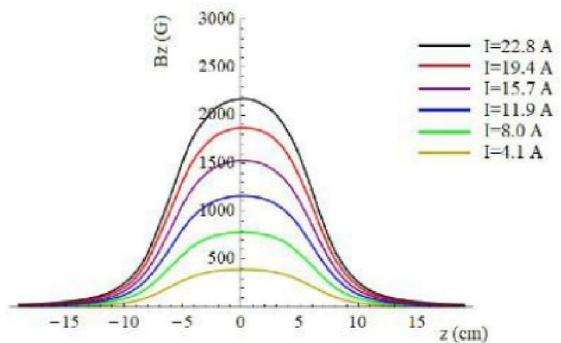
Squared field integral (Measured)



Raw measured data

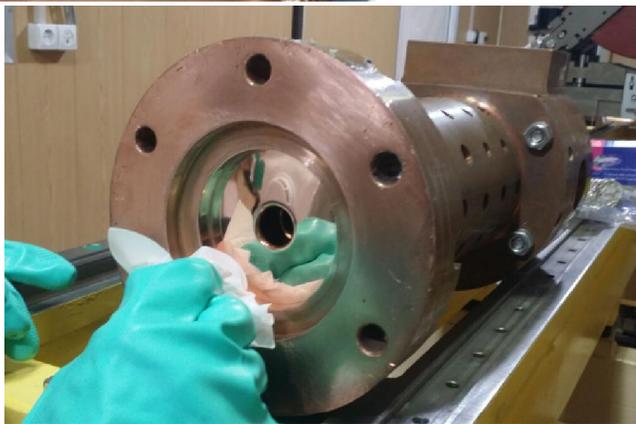
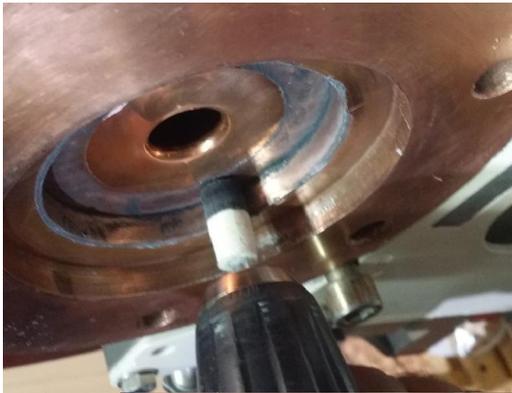


Interpolated measured data

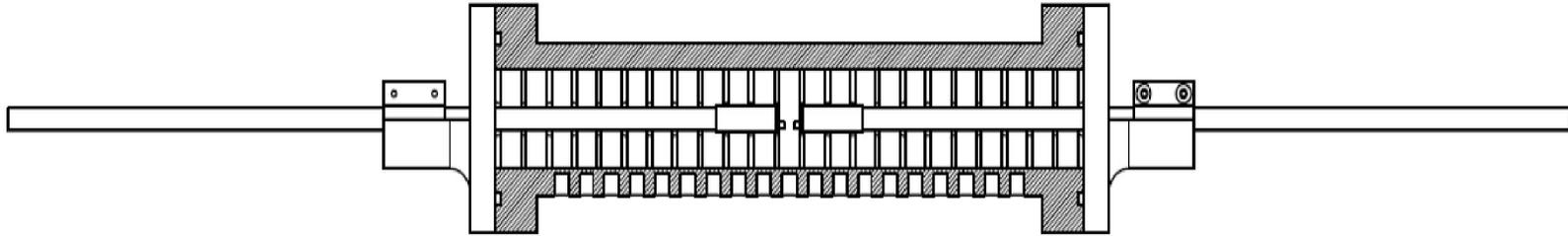


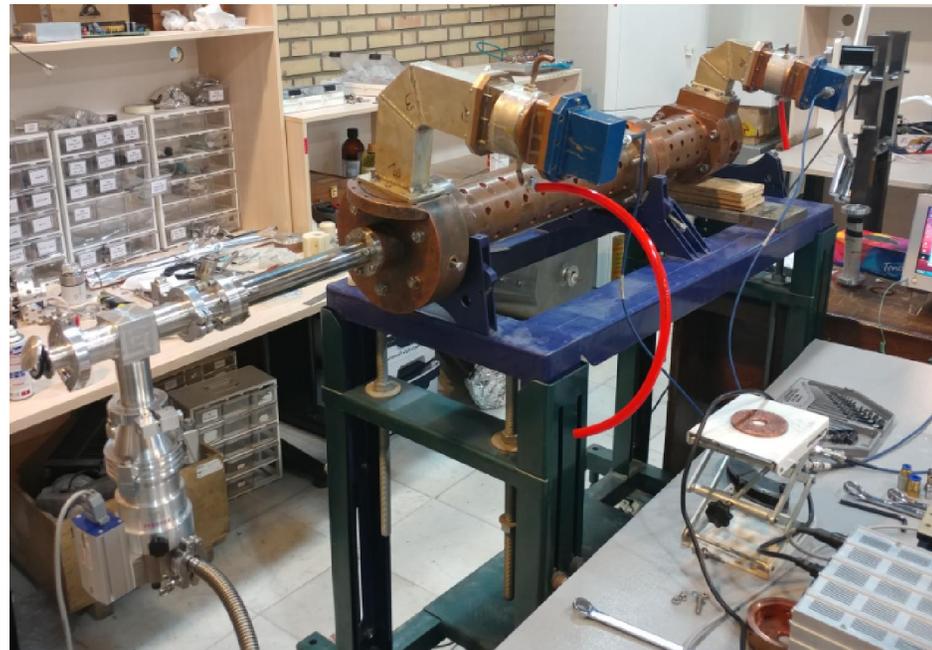
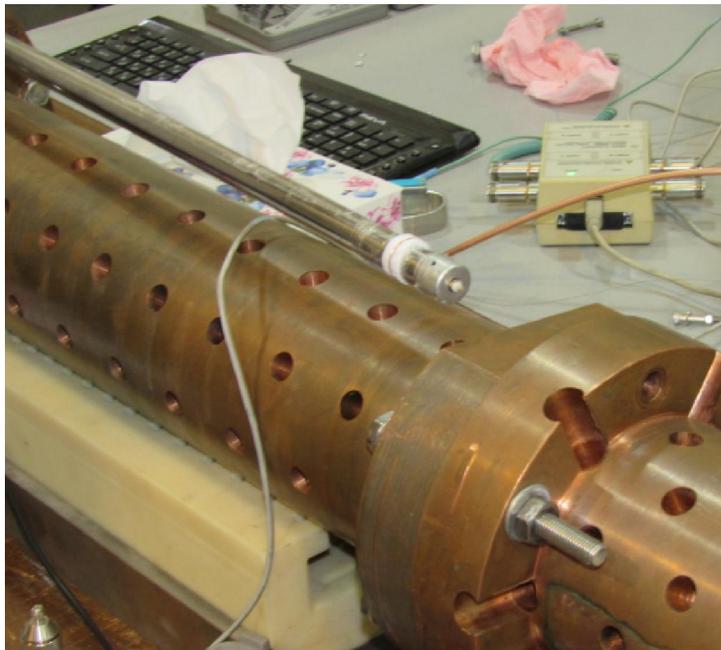
Polishing and Ice cleaning Before assembling

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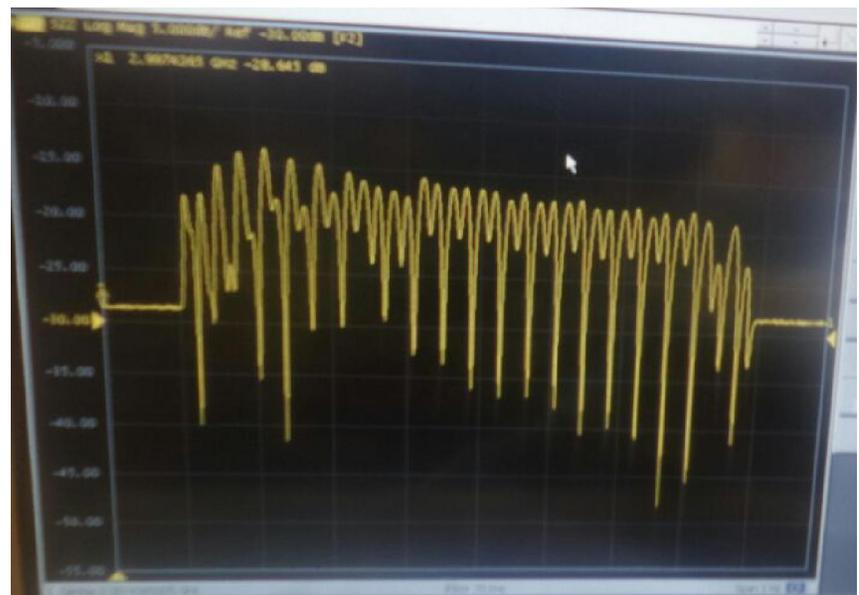
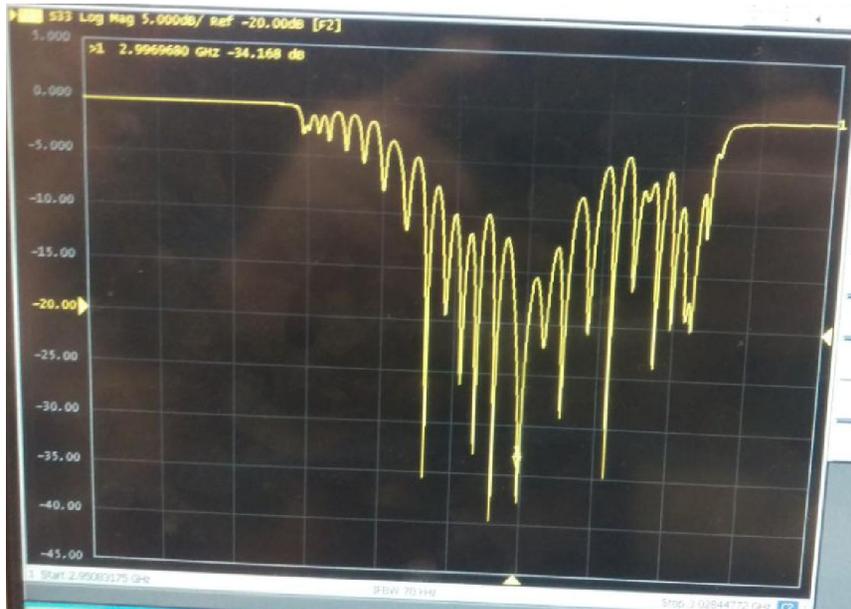


Plunger Setup for frequency measurement and tuning

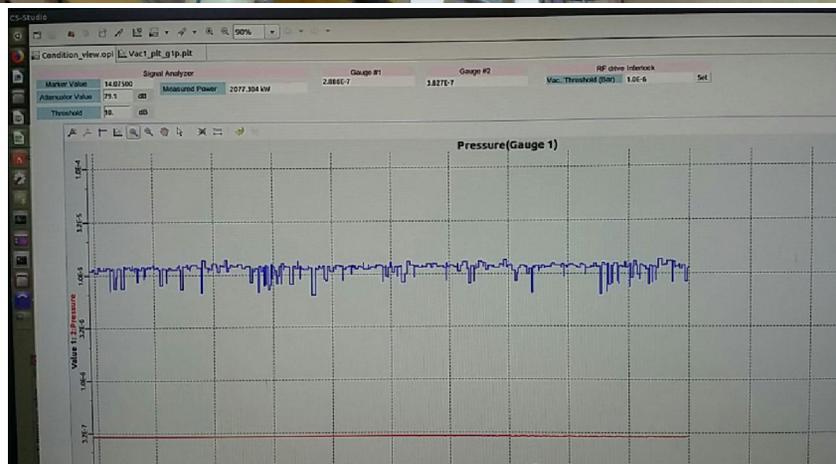




Frequency Spectrum and electric field profile

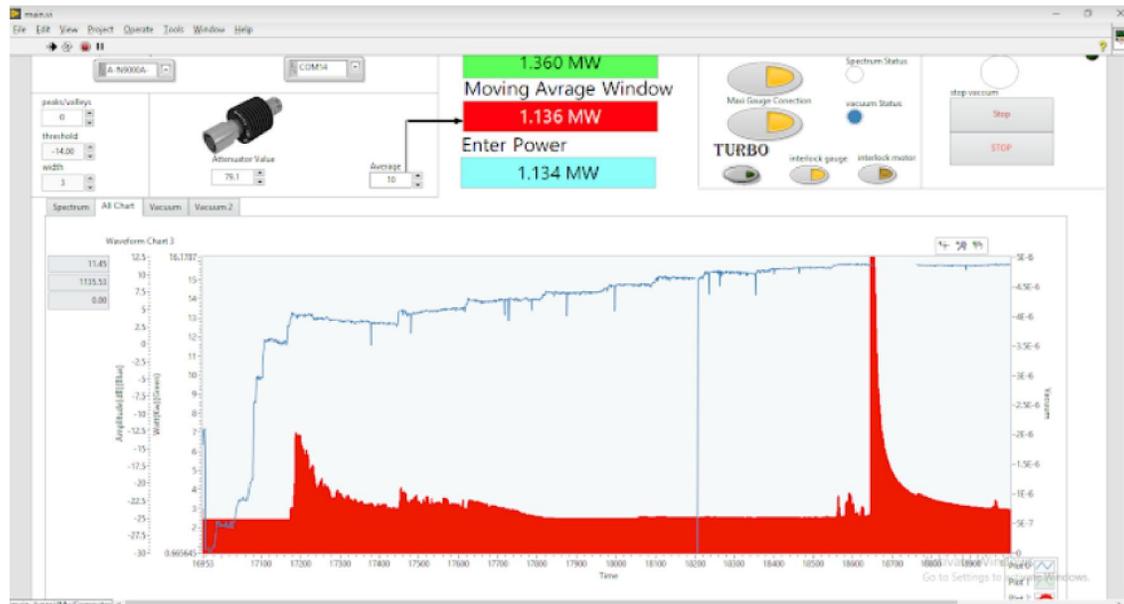
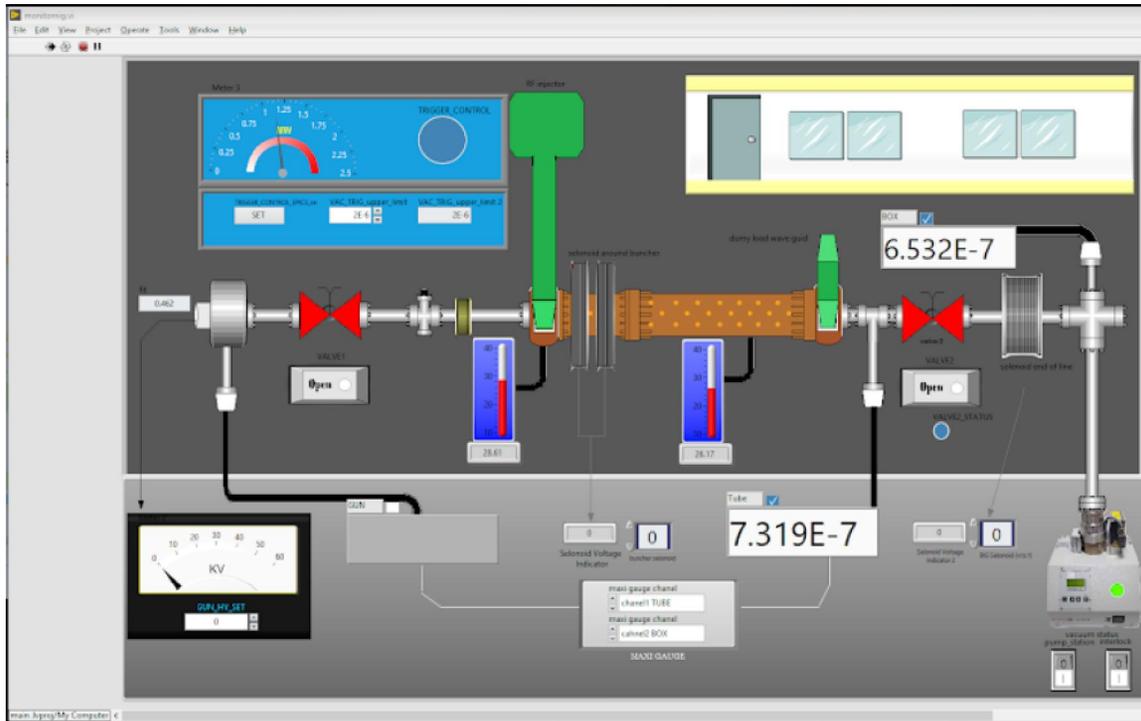


Control room and cavity conditioning for second phase with 4 MeV 18



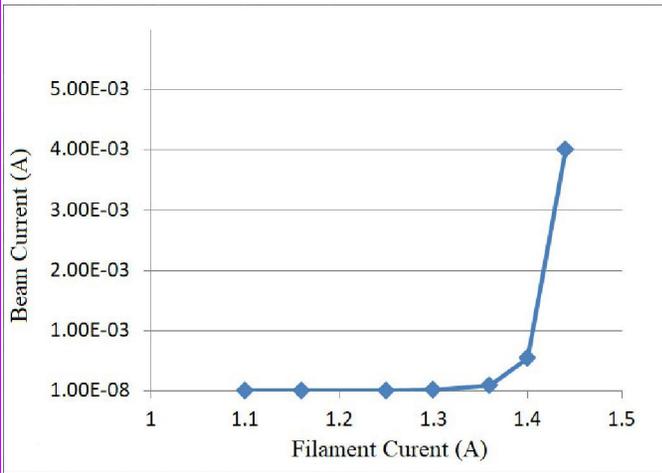
User Interface

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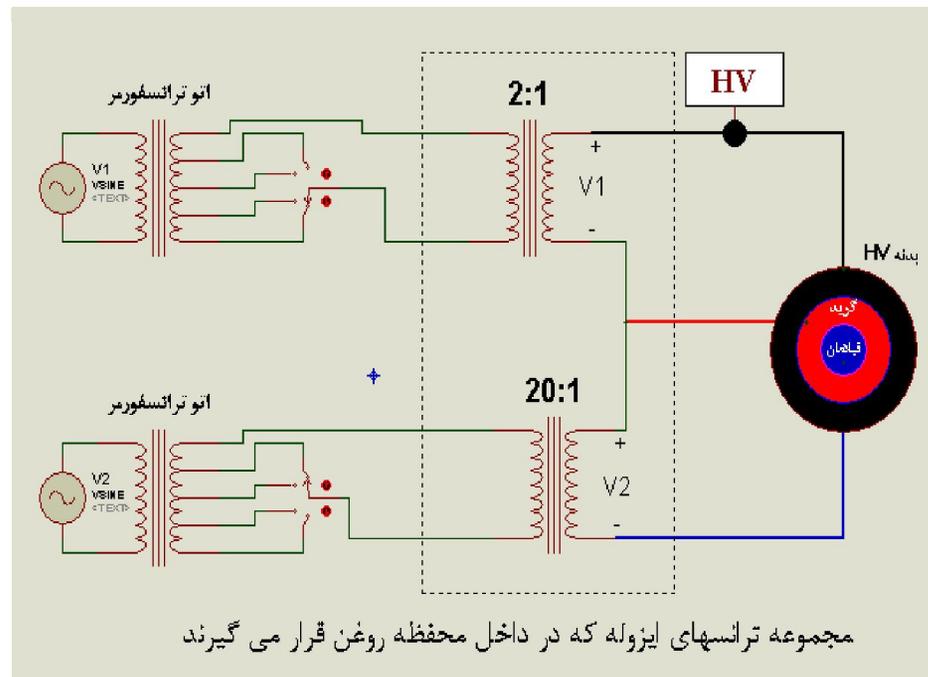


Gun Filament conditioning

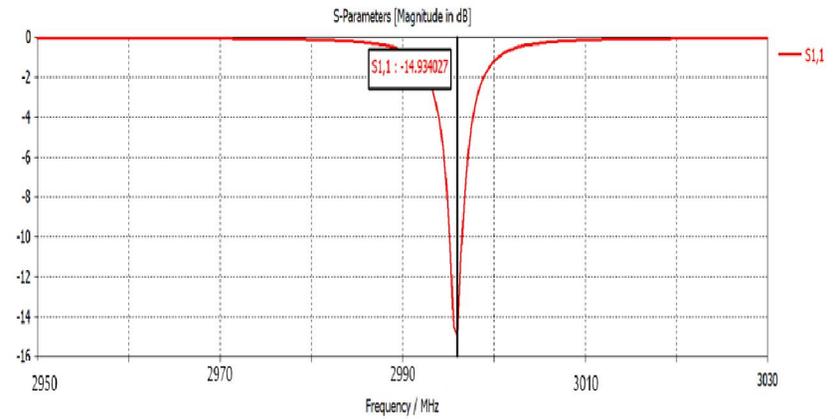
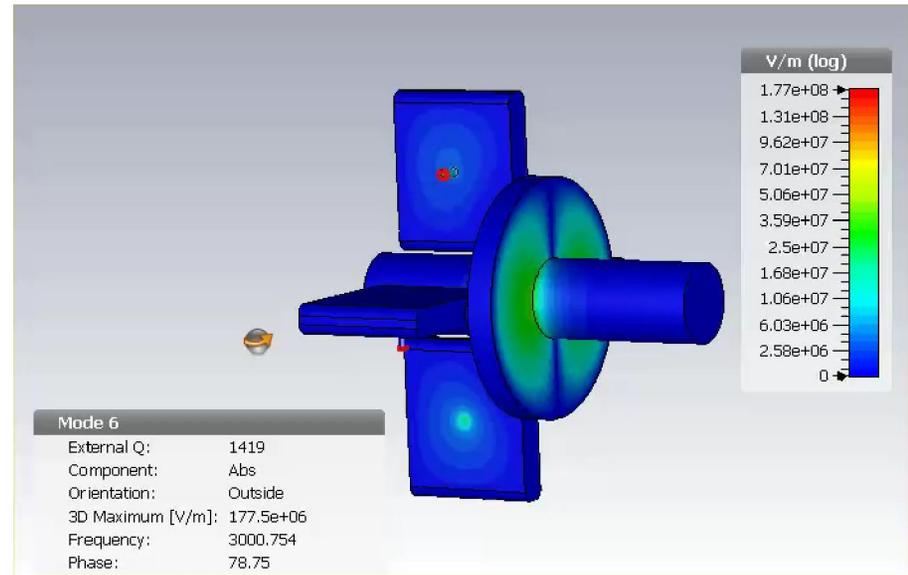
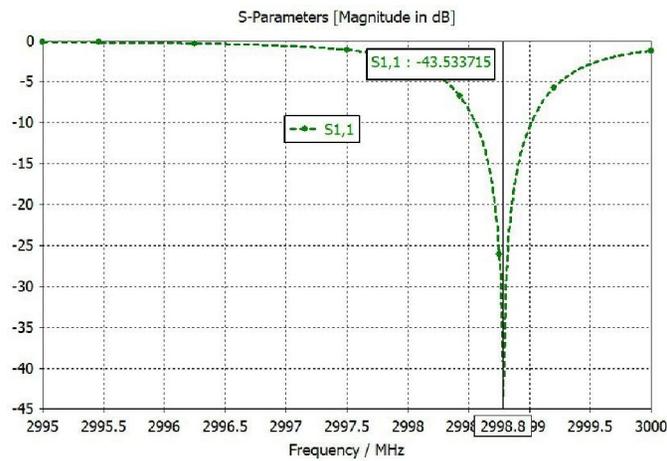
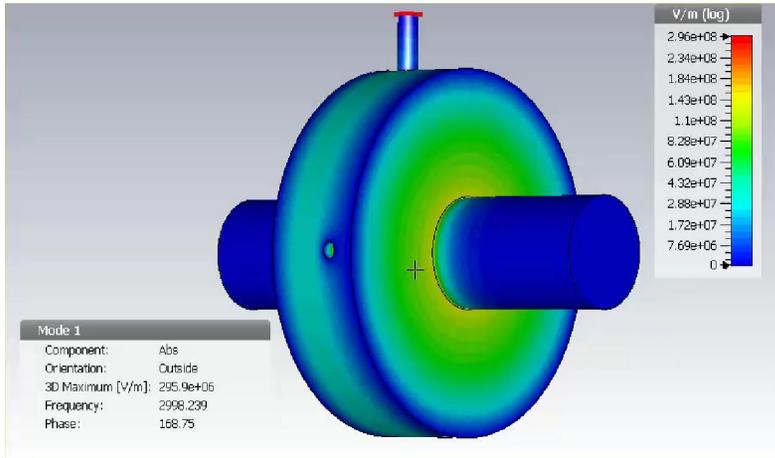
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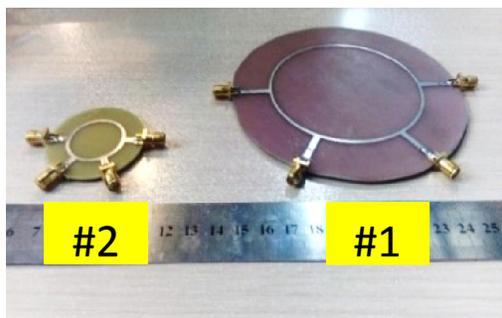
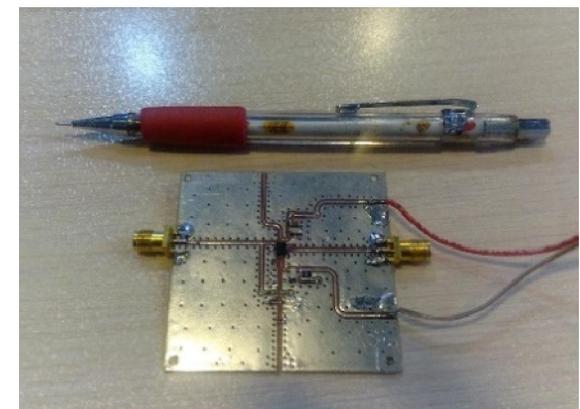
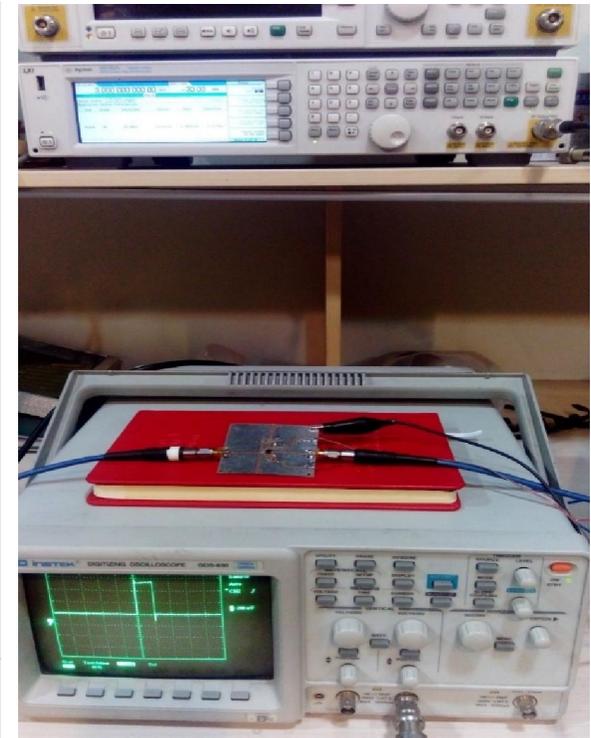
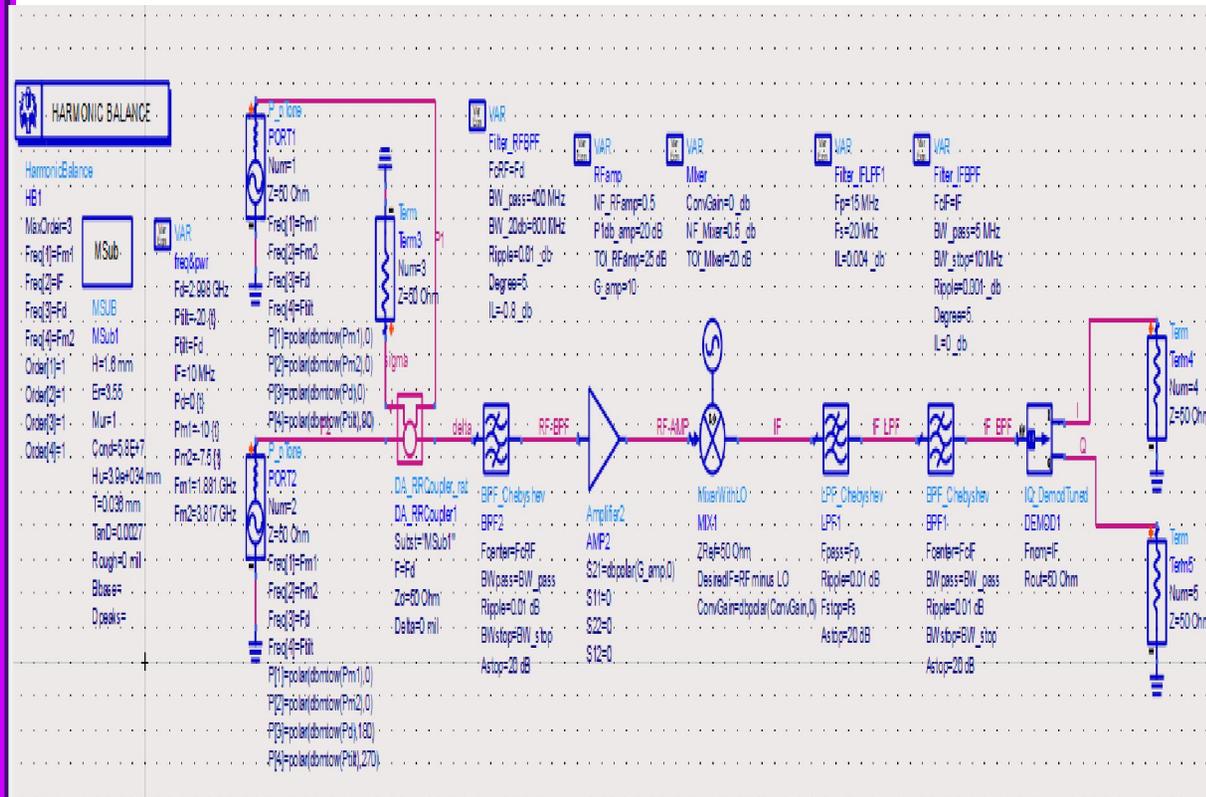
Autotrans Voltage (V)	Filament Current (A)	Beam Current
112.5	1.10	16 nA
125	1.16	120 nA
137.5	1.25	2.3 μA
150	1.30	10 μA
162.5	1.36	90 μA
175	1.40	550 μA
187.5	1.44	4 mA



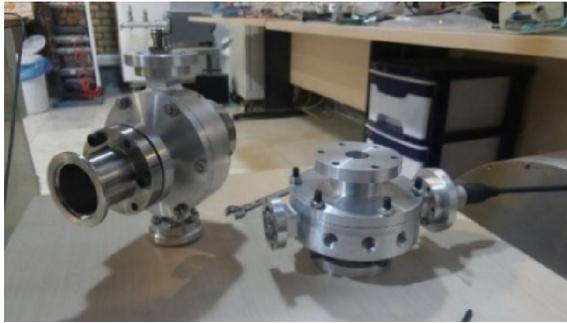
Development of Cavity BPM for IPM e-Linac



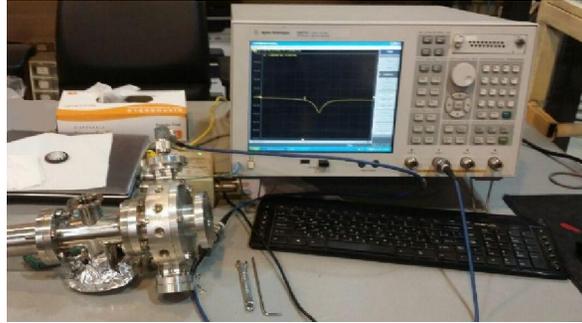
FRONT END ELECTRONIC FOR BPM AND PASSIVE PROTOTYPES



PRACTICAL MEASUREMENT OF PICK-UP CAVITY AS A CURRENT DIAGNOSTIC



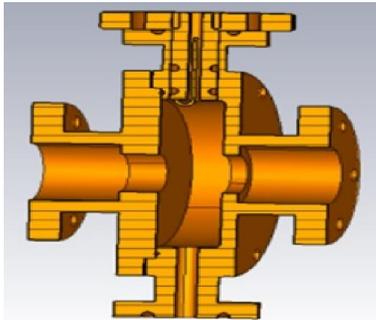
Pick-up and pre-buncher cavity



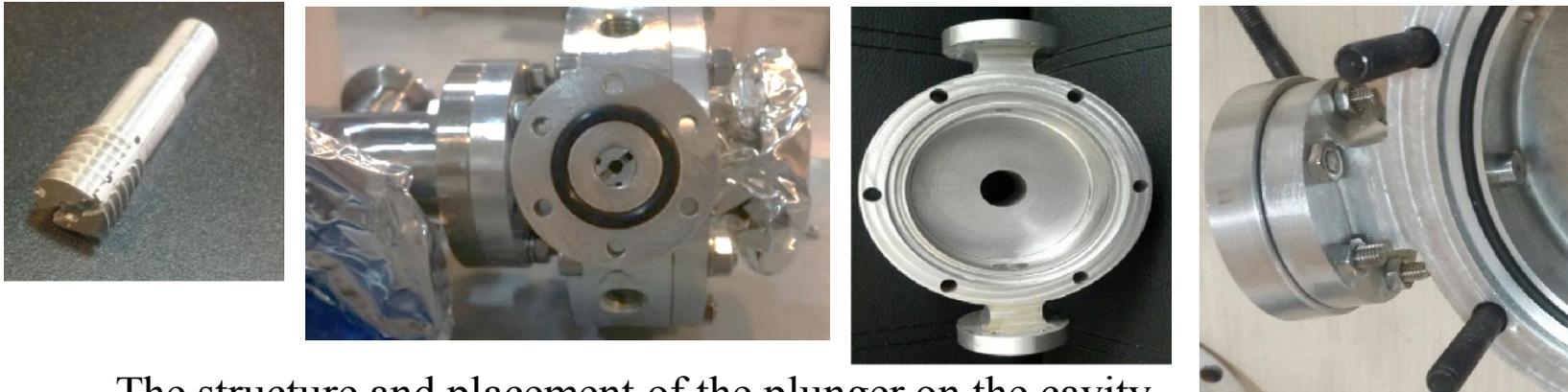
Experimental setup



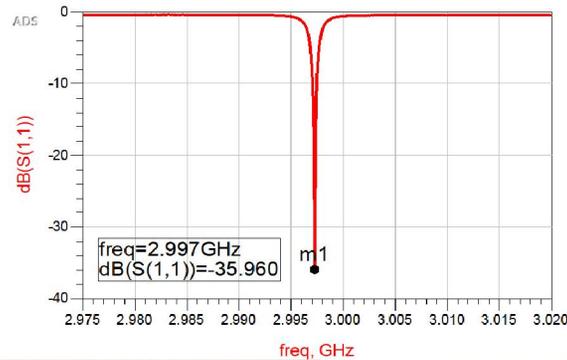
Tested antenna



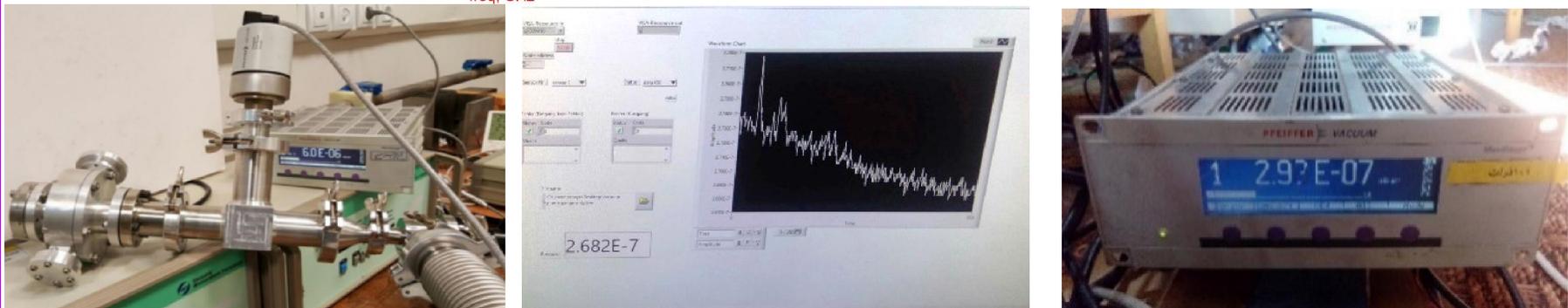
Internal structure of cavity with antenna



The structure and placement of the plunger on the cavity

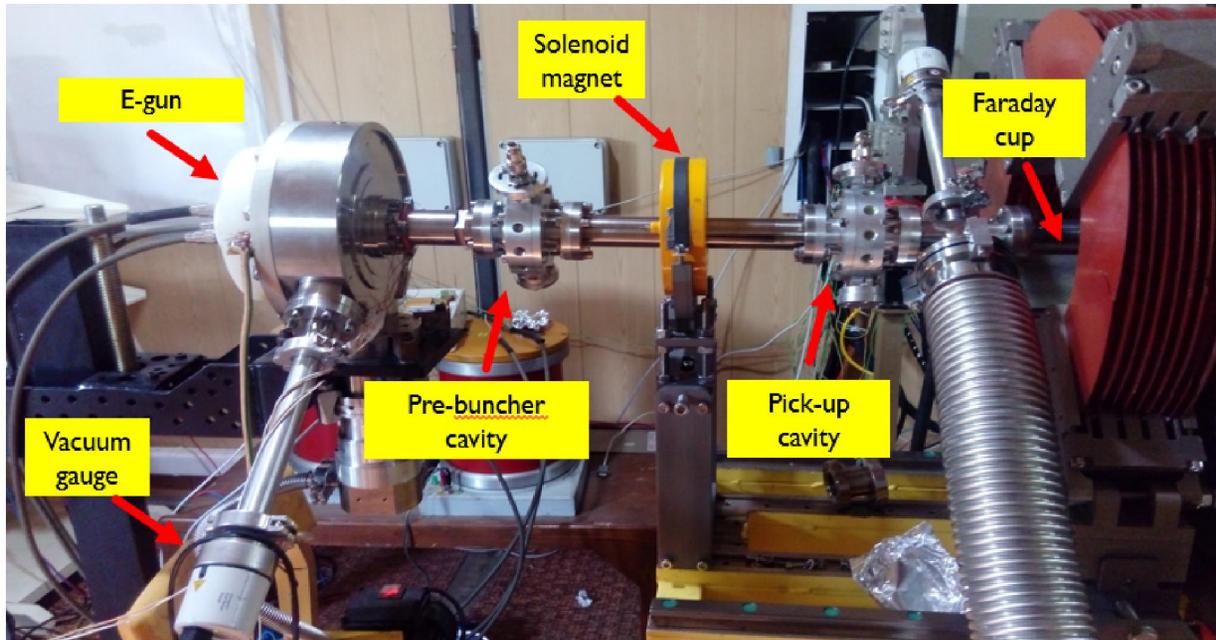


pre-buncher s-parameter

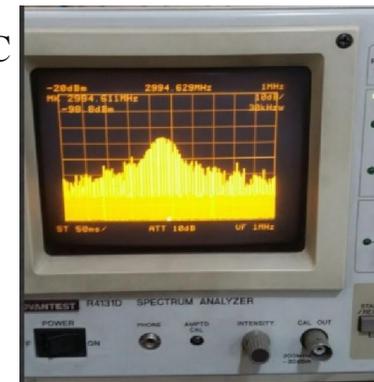


Vacuum measurement setup, gauge and LabView software output

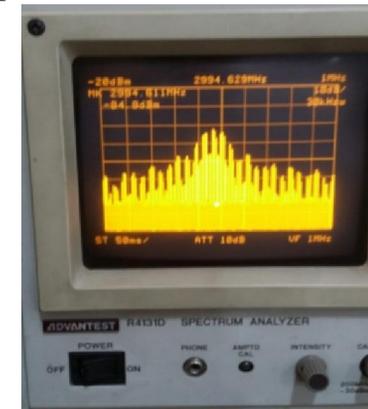
PRACTICAL MEASUREMENT OF PICK-UP CAVITY AS A CURRENT DIAGNOSTIC



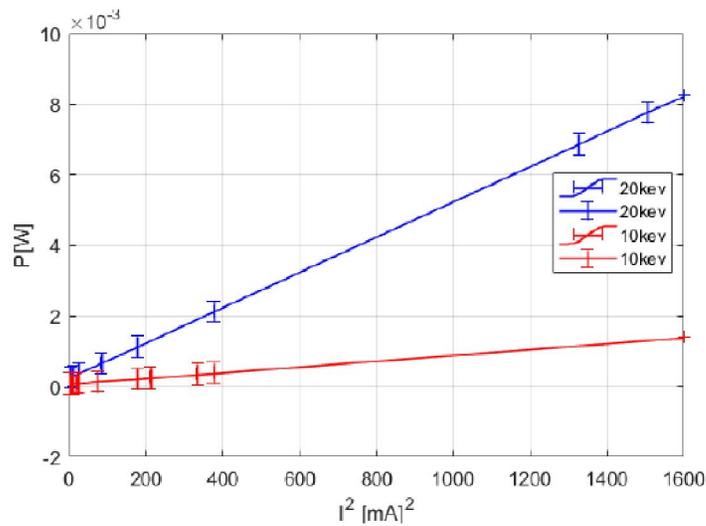
Experimental setup



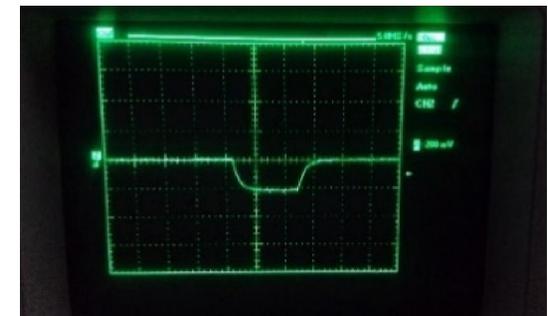
spectrum w/o beam



spectrum with beam

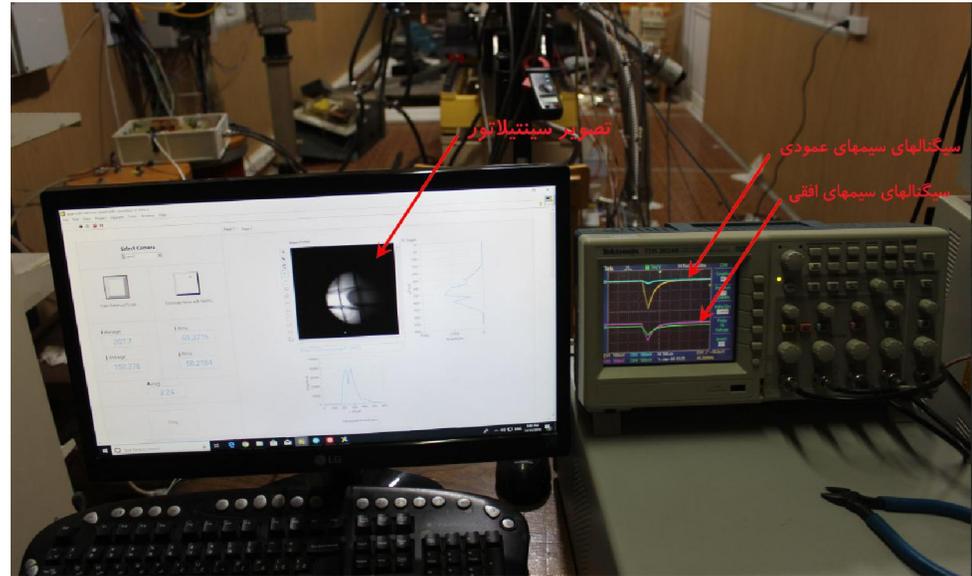
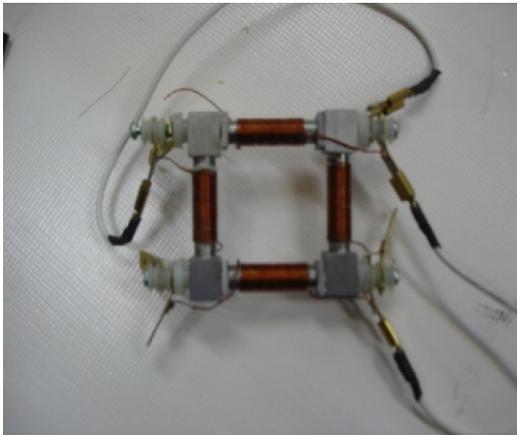
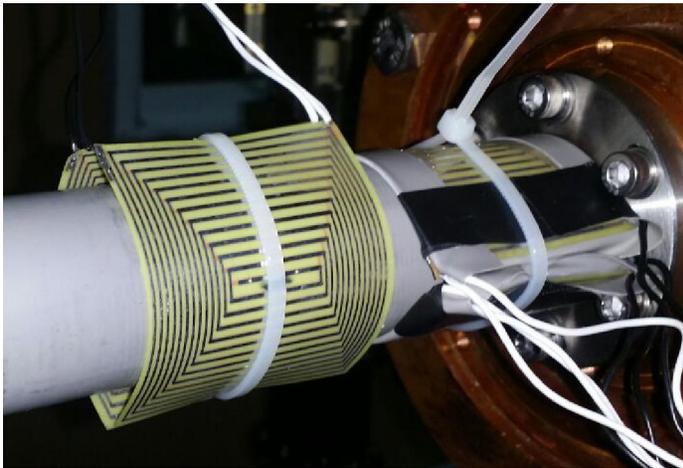
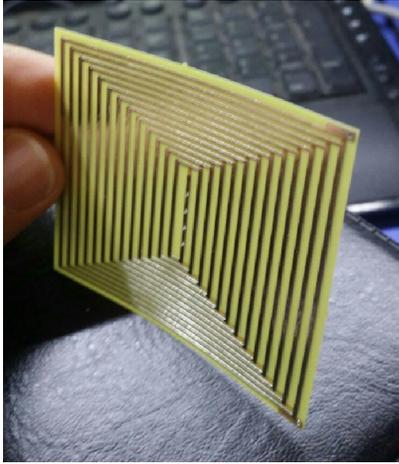


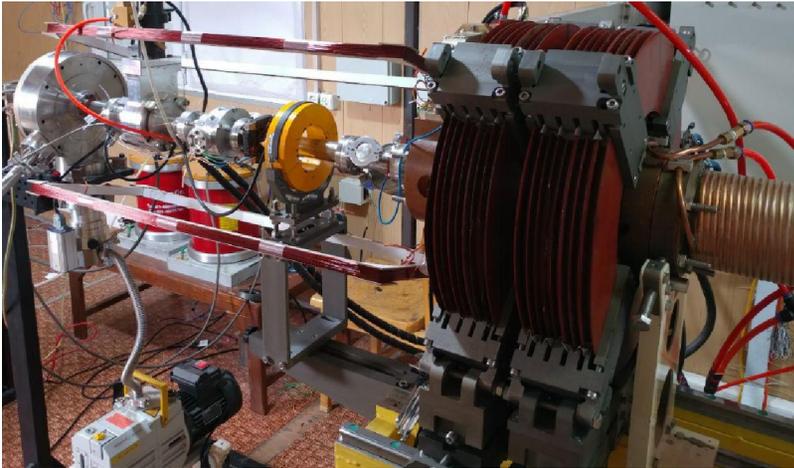
for 10 and 20 electron volt beam energies



Faraday cup output oscilloscope

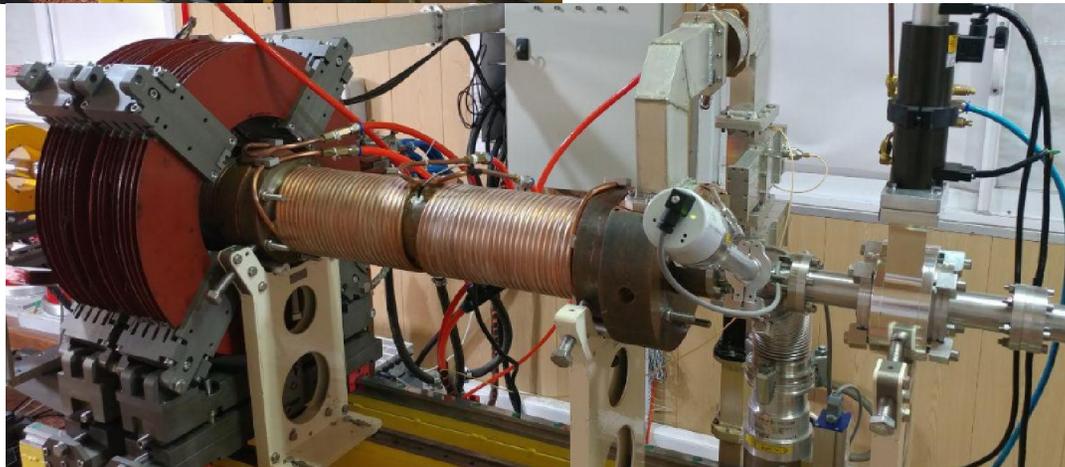
TWO TYPES OF STEERER MAGNETS AND HARP DETECTOR





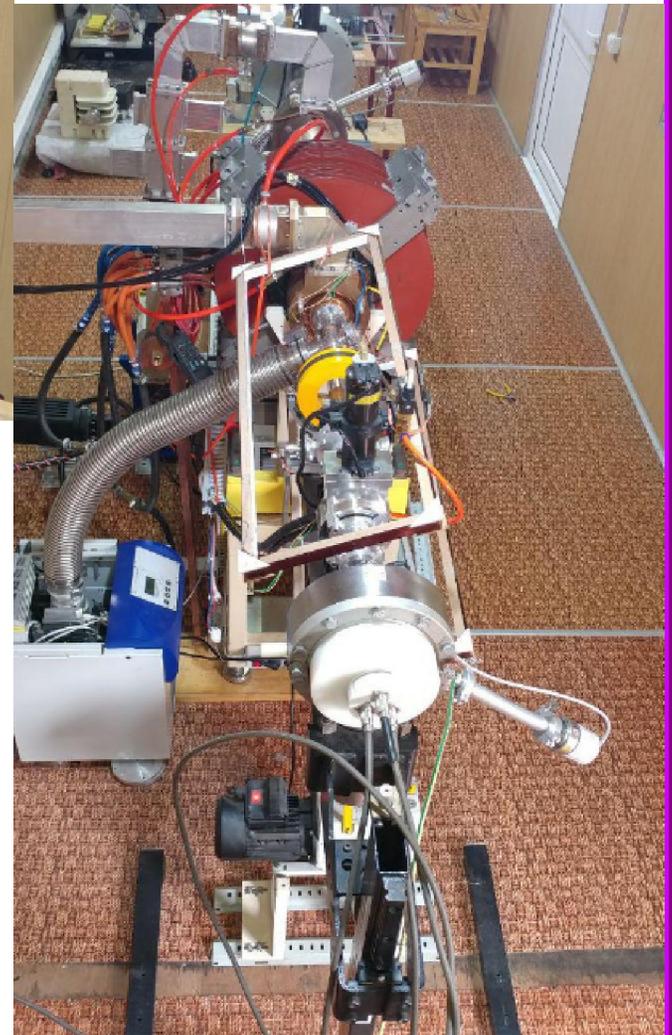
THREE PART OF LINAC ASSEMBLY

1. ELECTRON GUN AND MATCHING SECTION
2. CAVITY AND SOLENOIDS
3. OUTPUT OF LINAC WITH SOLENOID MAGNET AND DIAGNOSTIC BOX

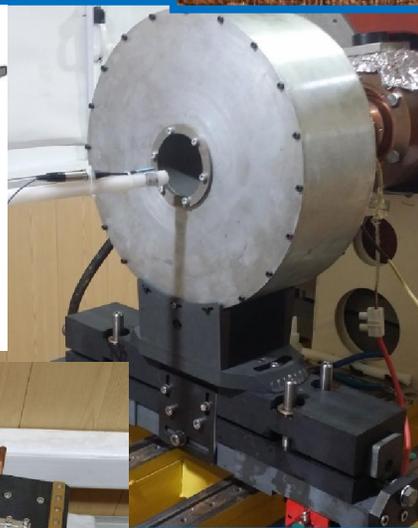
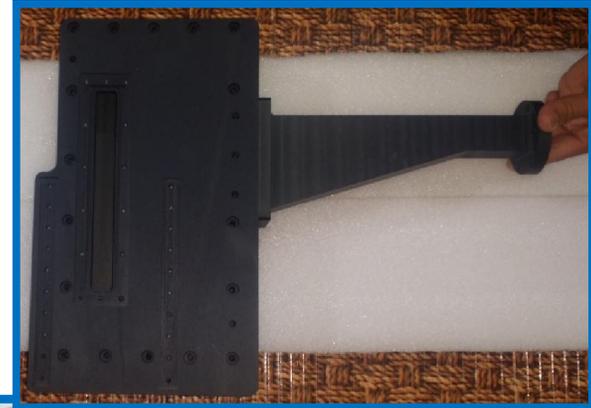
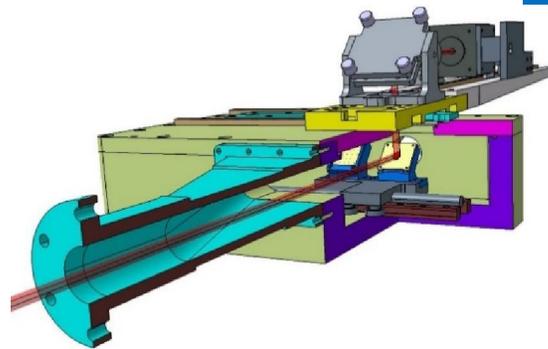
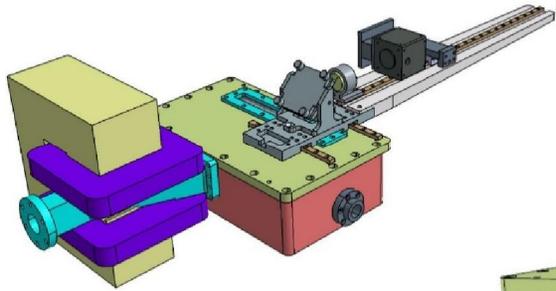
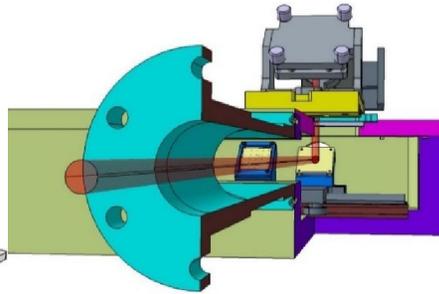
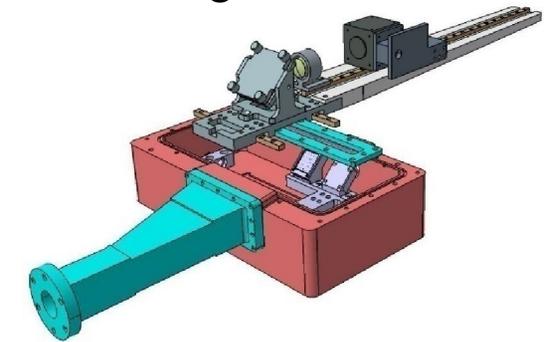


WHOLE OF STRUCTURE (DIFFERENT VIEWS)

25

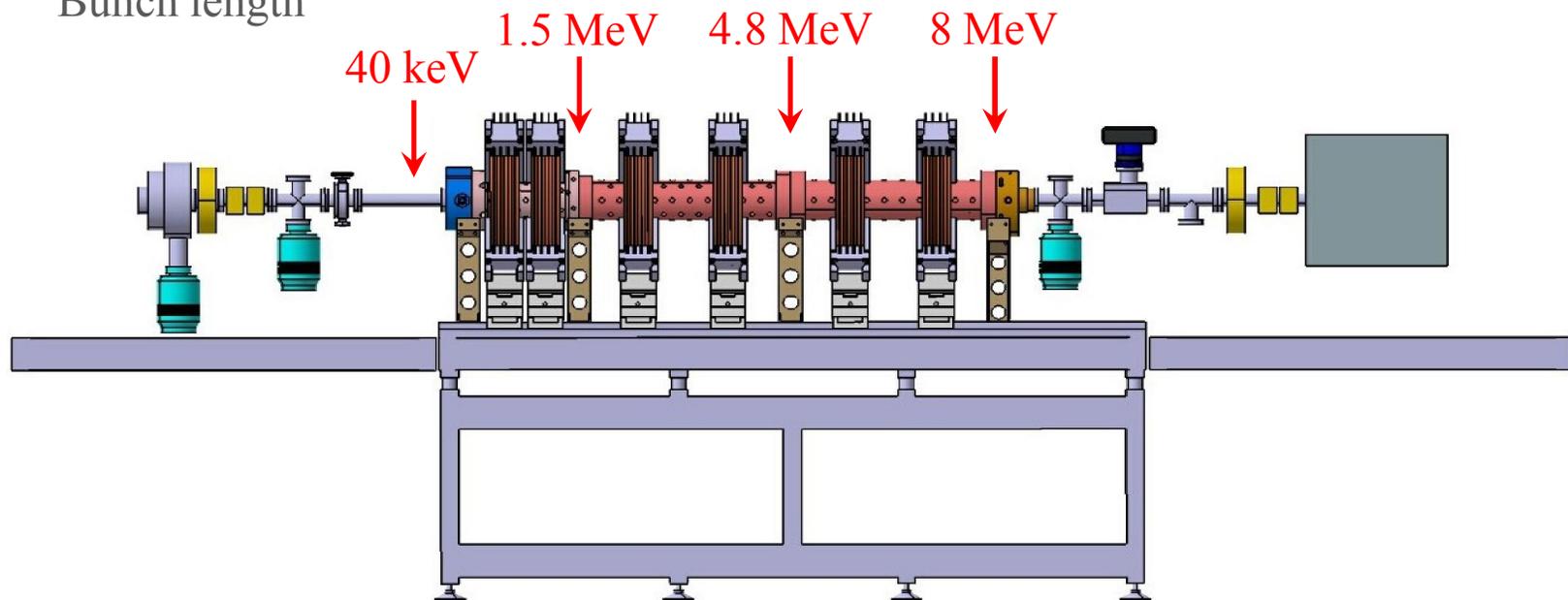


Combined function diagnostic box



Parameters to be measured and the energy range

1. [Current](#)
2. Energy
3. Energy spread
4. Transverse Profile
5. Beam size
6. Derivative of the Beam size
7. Emittance
8. Position
9. Bunch length



The project current status and the future plans

Second phase of the Linac commissioning

- Main characteristics of the second phase
 - ✓ Increasing of the beam energy from 1.5 MeV to around 4 MeV
 - ✓ Increasing of the beam current from 0.1 μA to at least 10 μA
 - ✓ The opportunity of direct measurement on the beam and hence the accelerator performance

- **A unique facility in the country**
 - ✓ The first successful project on design and construction of linear accelerators
 - ✓ The access to a controllable and measurable electron beam of 4 MeV energy

Future plans

➤ Short term

- ✓ Completing the Linac commissioning
→ Reaching the maximum possible energy for the beam (~ 7 MeV)

➤ Long term

- ✓ Moving towards **High Power Electron Linacs**
 - Extracting the maximum power for the beam (available RF power = 3.9 kW)
 - With the current electron gun
 - ❖ $I = 1 \text{ mA} \rightarrow P_{peak} = 7 \text{ kW} \xrightarrow{\text{Duty cycle} \cong 0.002} P_{av} \cong 14 \text{ W}$
 - Replacing the electron gun
 - ❖ $I = 100 \text{ mA} \rightarrow \begin{cases} P_{av} \sim 1.2 \text{ kW} \\ E \sim 6 \text{ MeV} \end{cases} (14\% \checkmark)$

Thanks for your attention!

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