Central region studies

C400 cyclotron

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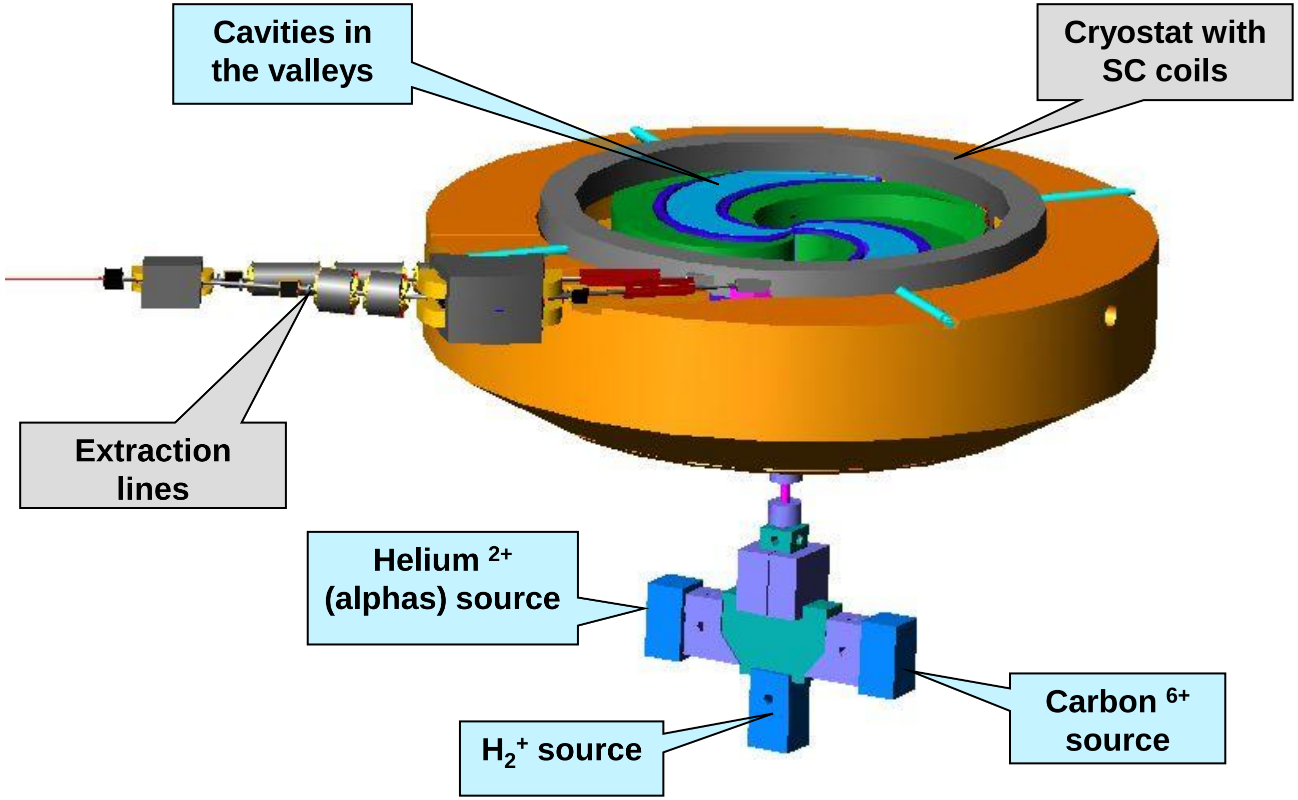
- The compact superconducting isochronous cyclotron C400 has been designed by the IBA-JINR collaboration. It will be the first cyclotron in the world capable of delivering protons, carbon and helium ions for cancer treatment. The cyclotron construction is started this year within the framework of the Archade project (Caen,France). $12C^{6+}$ and $4He^{2+}$ ions will be accelerated to 400 MeV/u energy and extracted by the electrostatic deflector, H_2^+ ions will be accelerated to the energy of 265MeV/uu and extracted by stripping. The magnet yoke has a diameter of 6.6 m, the total weight of the magnet is about 700 t. The designed magnetic field corresponds to 4.5 T in the hills and 2.45 T in the valleys. Superconducting coils will be enclosed in a cryostat; all other parts of the cyclotron will be warm. Three external ion sources will be mounted on the switching magnet on the injection line located below the cyclotron.

View of the median plane in the C400 superconducting cyclotron



Main parameters of the C400 cyclotron

type	compact isochronous
accelerated particles	H_2^+, $^4He^{2+}$, ($^6Li^{3+}$), ($^{10}B^{5+}$), $^{12}C^{6+}$
ion sources	ECR
injection	axial with spiral inflector
injection energy	25keV/Z
final energy of ions, protons	400 MeV/amu 265 MeV/amu
extracted ions, protons	by deflector by stripping
extraction efficiency	70 % (by deflector)
number of turns	~2000

Central region design

A spiral inflector, placed at the centre of cyclotron, will bend the beam from the axial direction to the median plane of the machine. The goals of the central region design study are:

to find out the position of the beam coming out from the inflector;

to find out the position and size of each RF electrodes

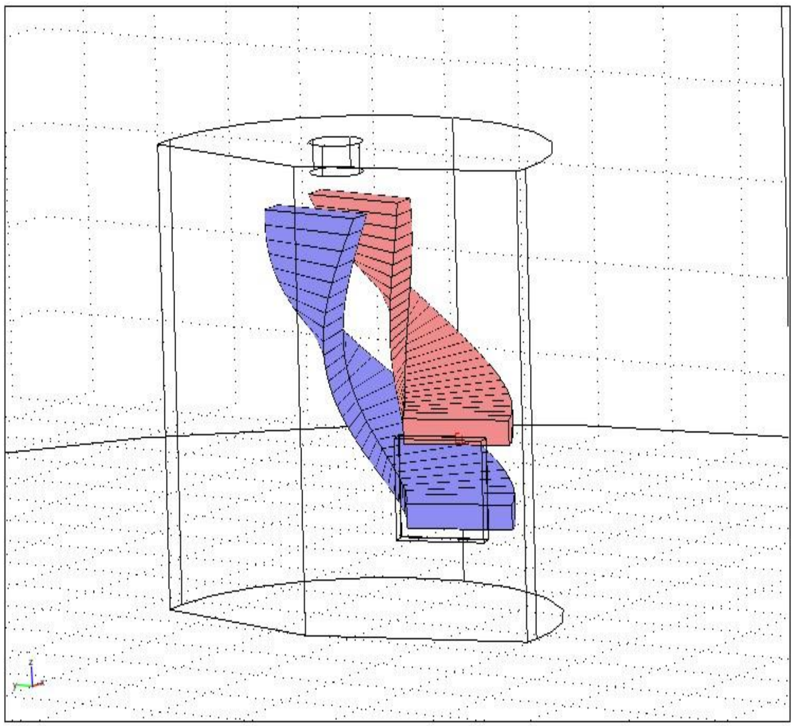
Spiral inflector design
Analytical approach

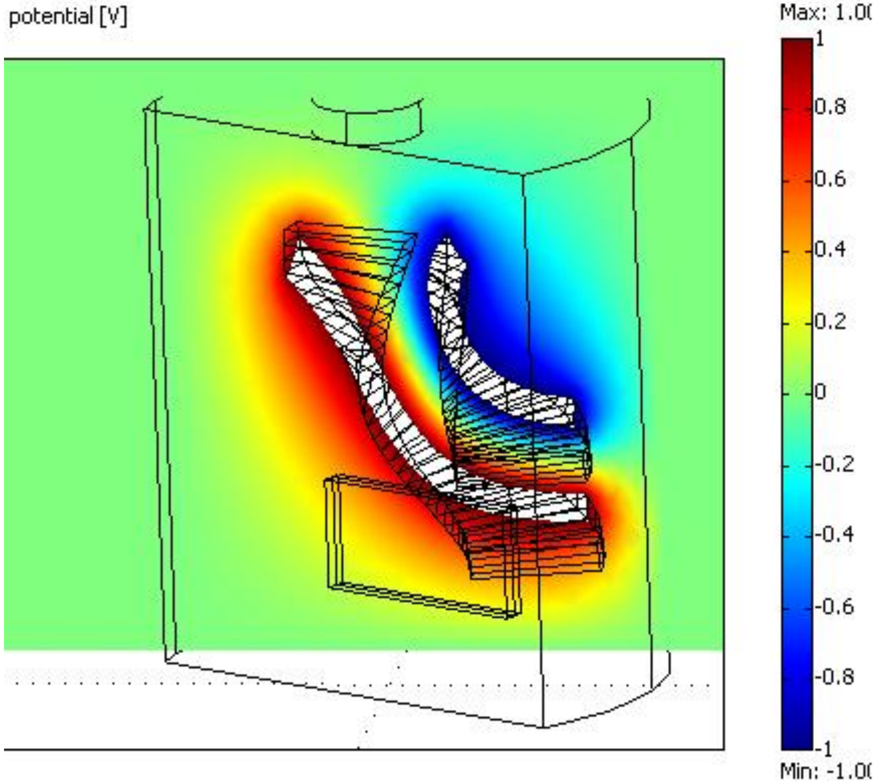
Ion energy per charge is equal to 25 keV/Z. The electric field was chosen to 20 kV/cm. Height of the inflector (electric radius) was equal to:

$$a = \frac{2W}{e\mathrm{E}} = 2.5cm$$

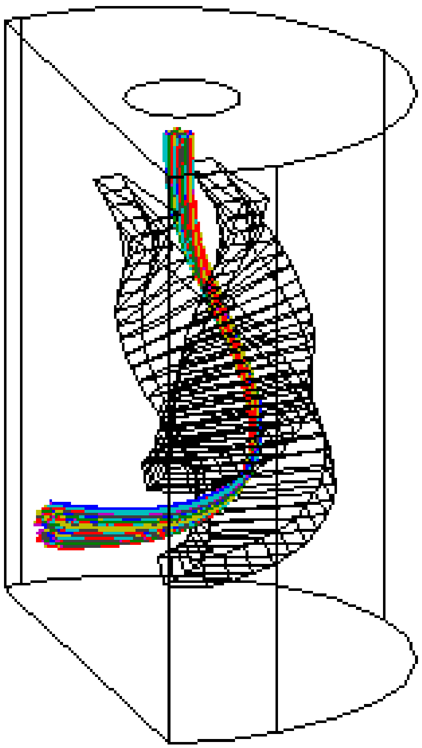
The 6 mm gap between electrodes (in the entrance) was chosen. The aspect ratio between the width and the spacing of the electrodes was taken equal 2 to avoid the fringe field effect and to tolerate shifts in beam trajectories inside the inflector.

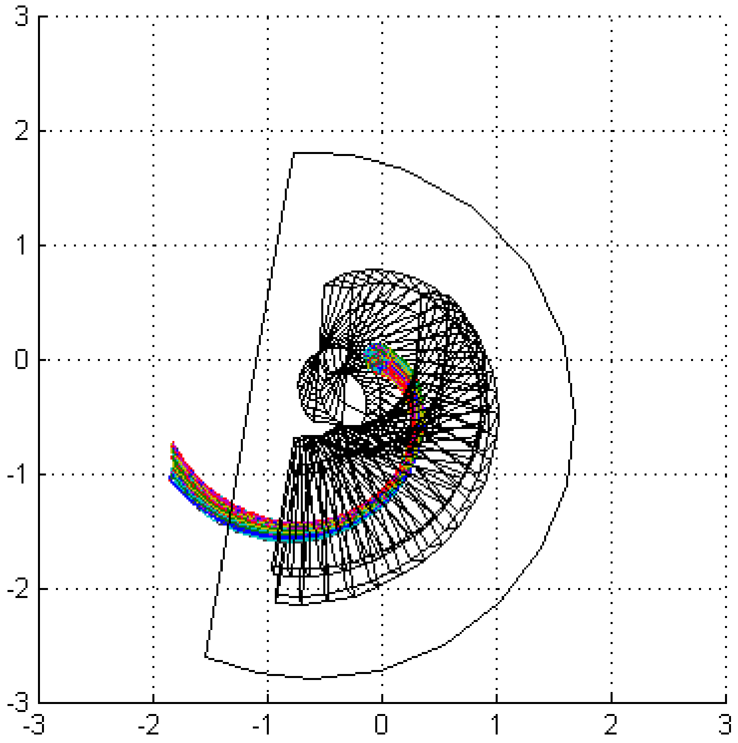
Electric potential distribution inside the inflector



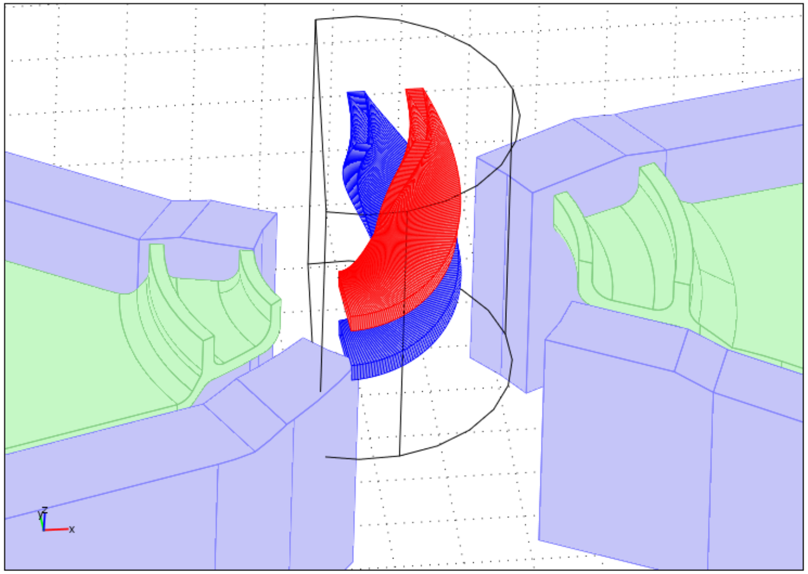


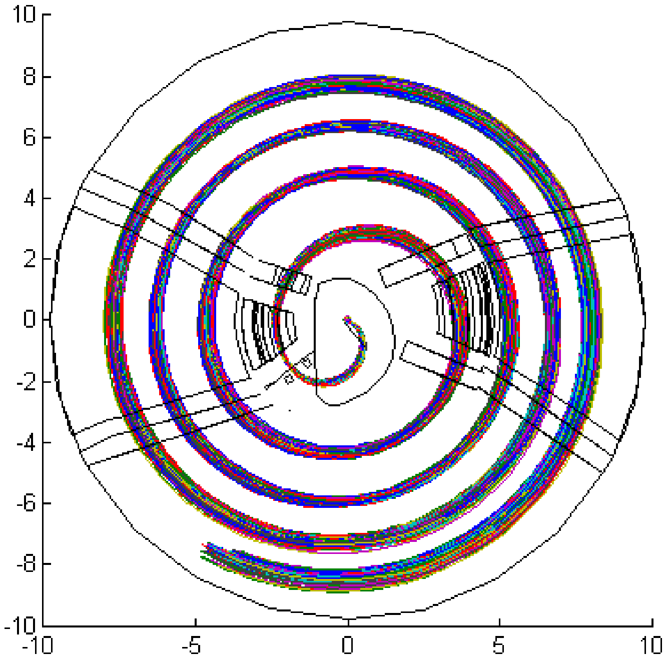
The paths of ions in the inflector



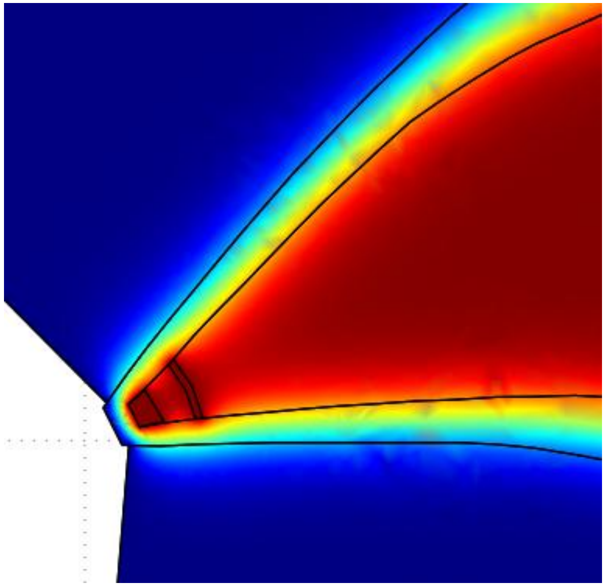


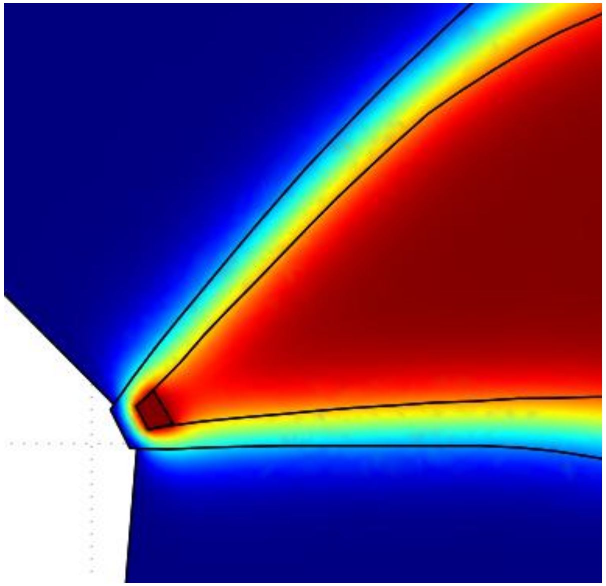
Central region with the spiral inflector model





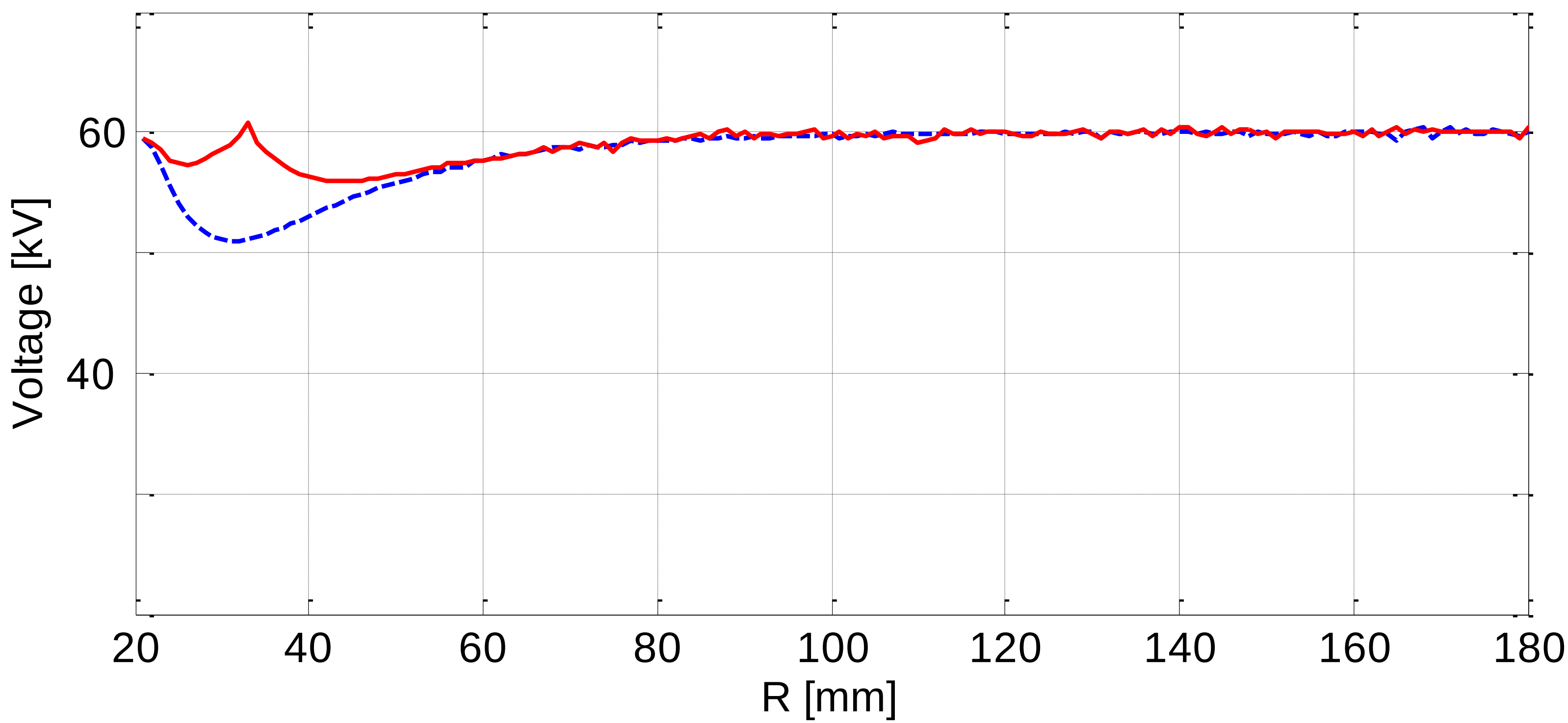
Electrostatic approach





Dee tips with channel (left) and without channel (right)

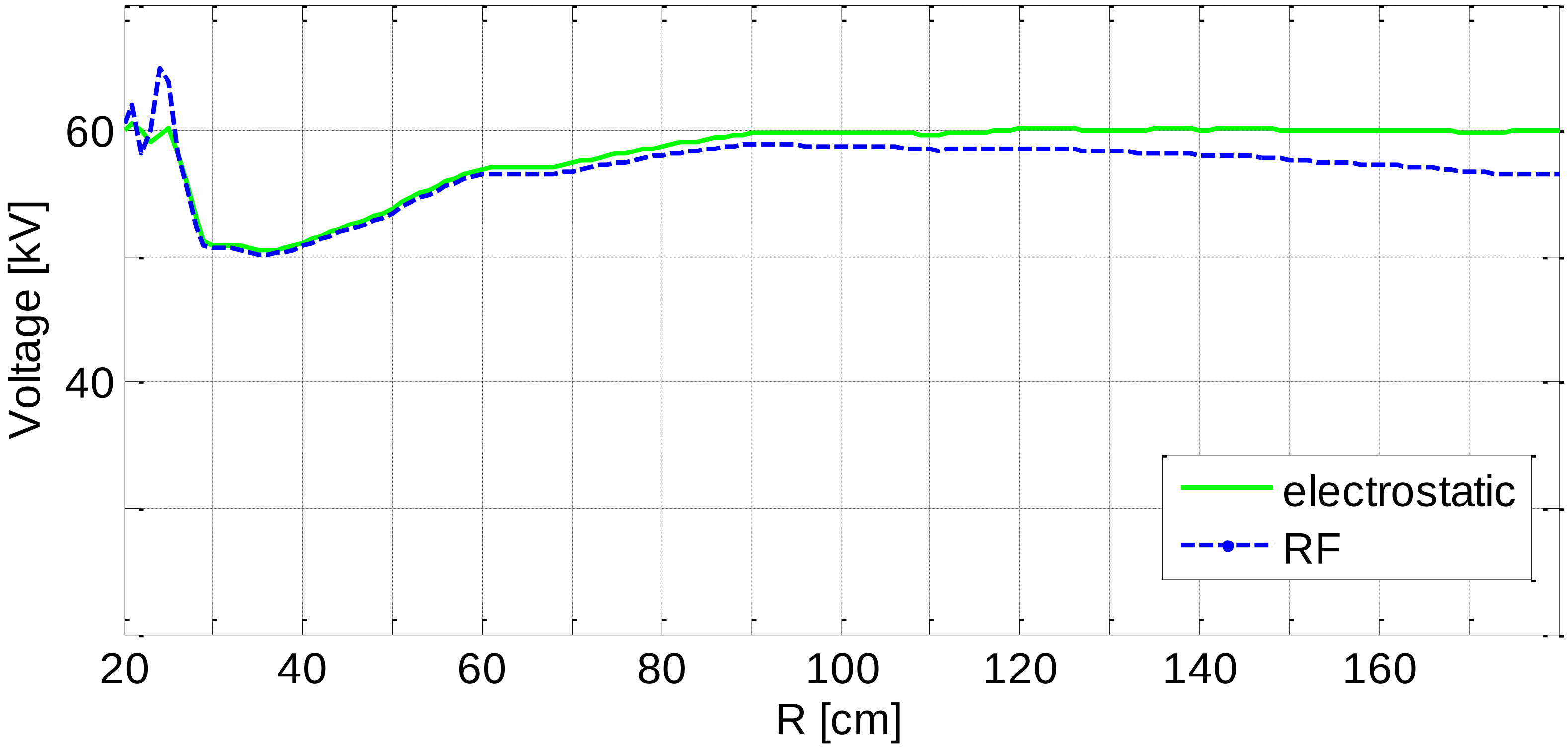
Electrostatic approach



Voltage distribution along radius, red line - with channel, blue line-without channel

The voltage value was obtained by integrating the electric field in the median plane of the resonant cavity.

Comparison between RF and electrostatic approach



Voltage distribution along radius