

# Study of transverse beam profile with the applied E-field on the IPM

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# Introduction to IPM

- Ionization Profile Monitor (IPM) is a **non-invasive instrument** (detector) to measure the **transverse beam profile** of an intense (especially the heavy ions or hadrons) beam.
- **Wire scanner** is an **invasive equipment** to measure the transverse beam profile for low intensity beam.
- However, for an intense (high power) beam the wire can be destroyed.
- We need IPMs in **both planes** (horizontal and vertical) to measure the complete beam profile.

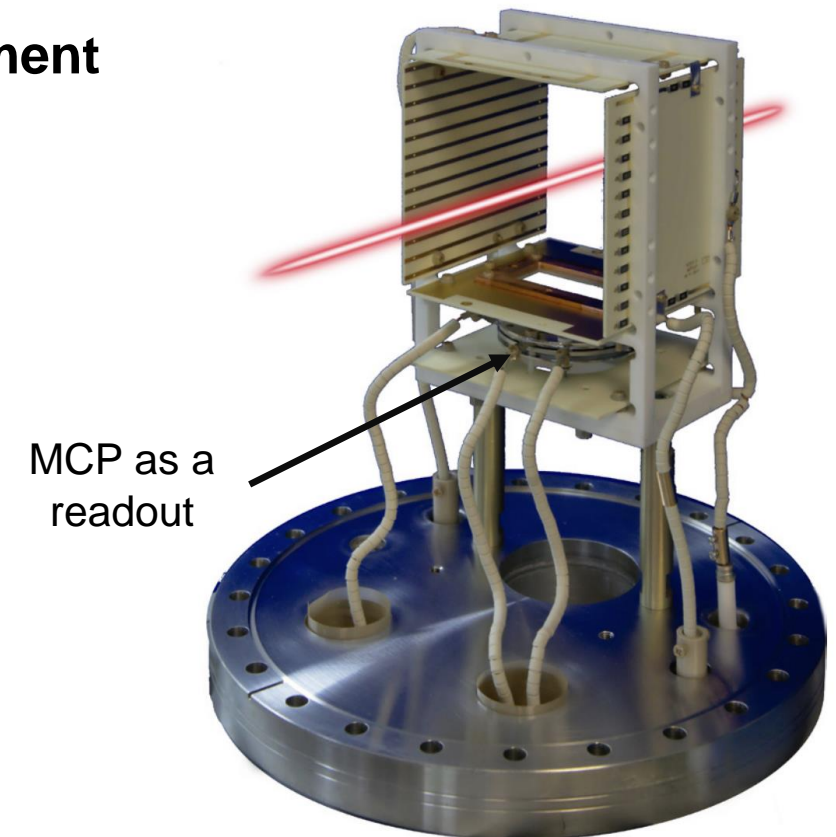


Image source: F. Benedetti, IPM for ESS Linac, 2020 paper



# How does IPM work

- A particle beam ionizes a small fraction of residual gas molecules inside the vacuum chamber.
- We use strong electric field inside the IPM to extract the ionized particles (electrons and ions).
- These electrons and ions are deflected in the opposite polarity of the electric fields.
- In general, the number of ionized particles is smaller. In this case, we use a **multi-channel plate (MCP)** to increase the number density of the ionized particles.
- A position sensitive detector (such as wire array or phosphor) is used to detect the ionized particles from which the **transverse beam profile** is determined.

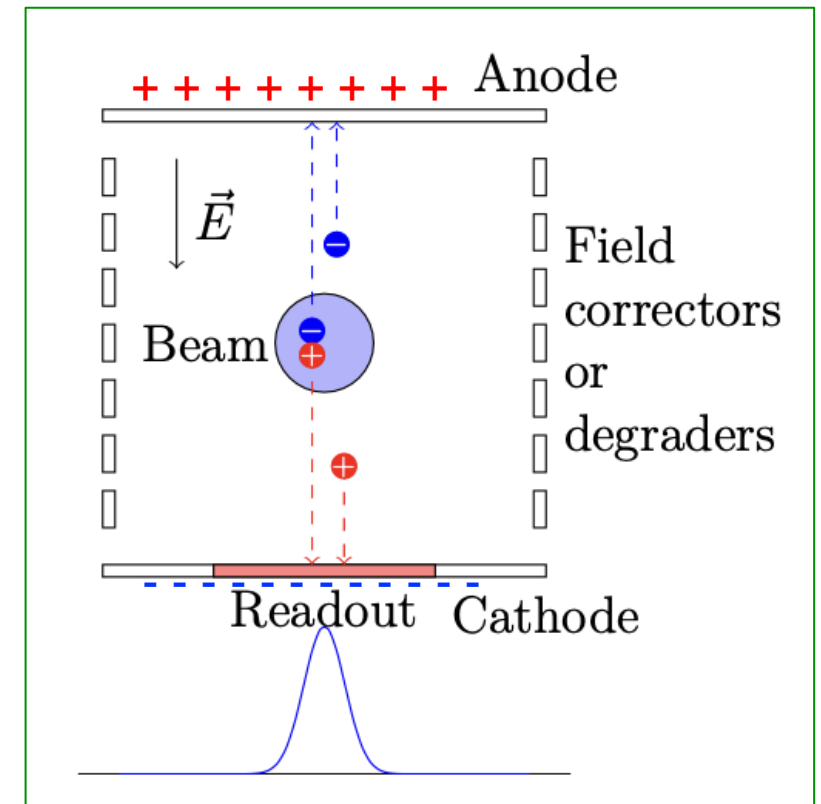
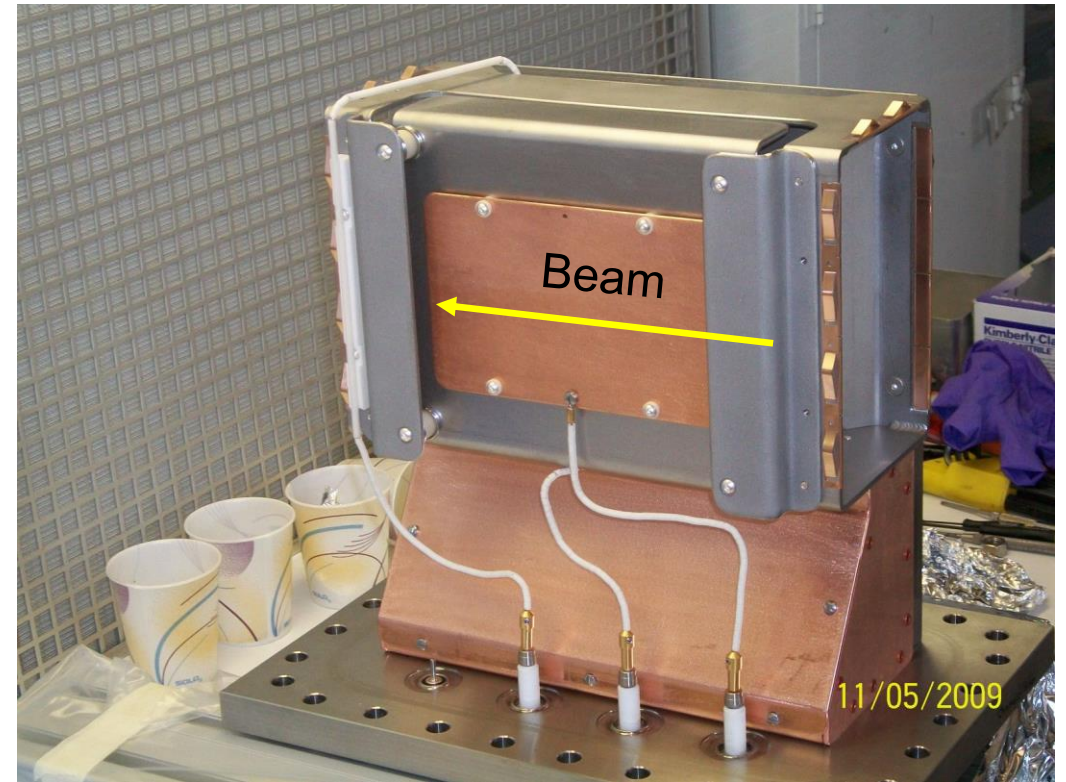
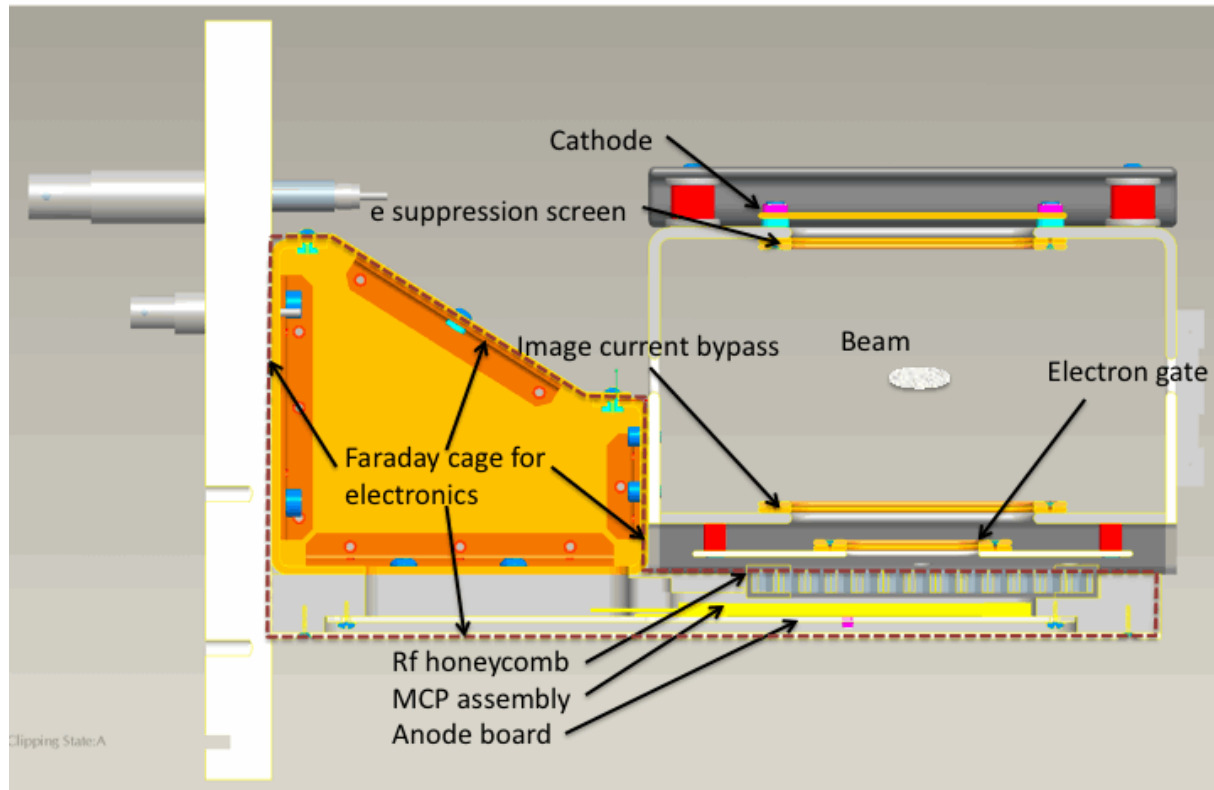


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# RHIC IPM



[https://www.cadops.bnl.gov/Instrumentation/InstWiki/index.php?title=RHIC\\_Ionization\\_Profile\\_Monitor](https://www.cadops.bnl.gov/Instrumentation/InstWiki/index.php?title=RHIC_Ionization_Profile_Monitor)

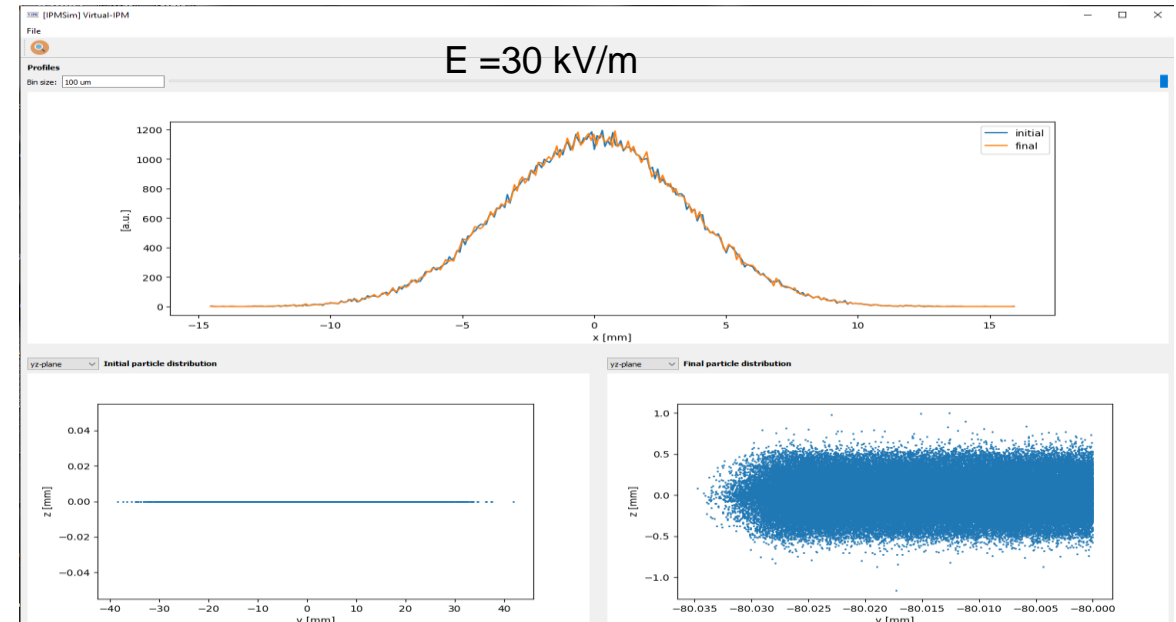
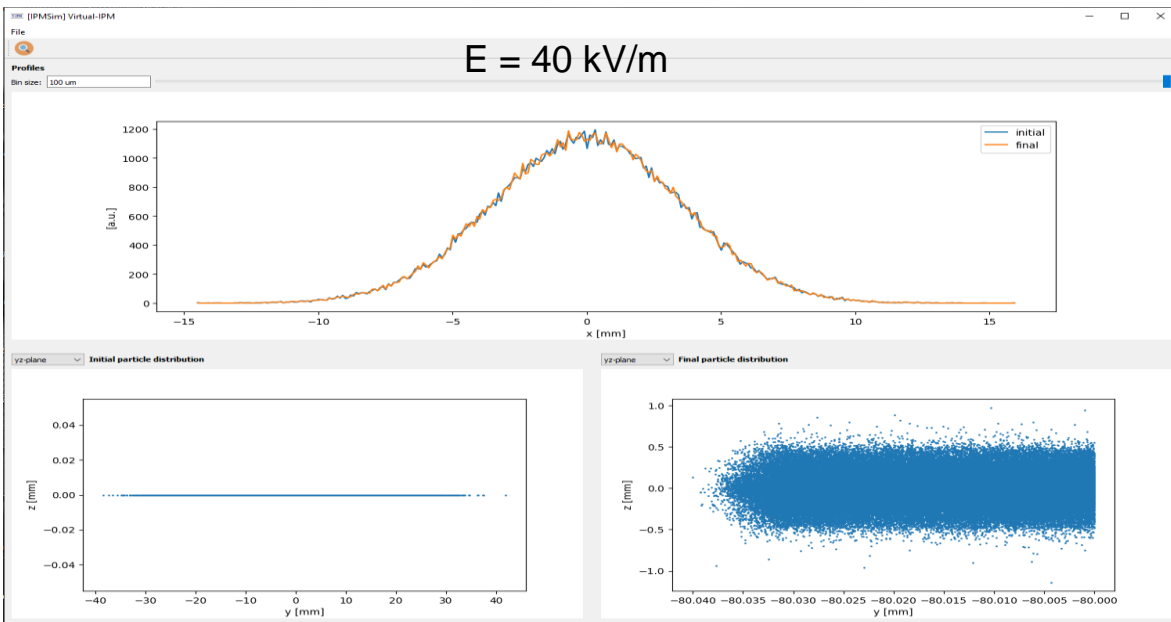
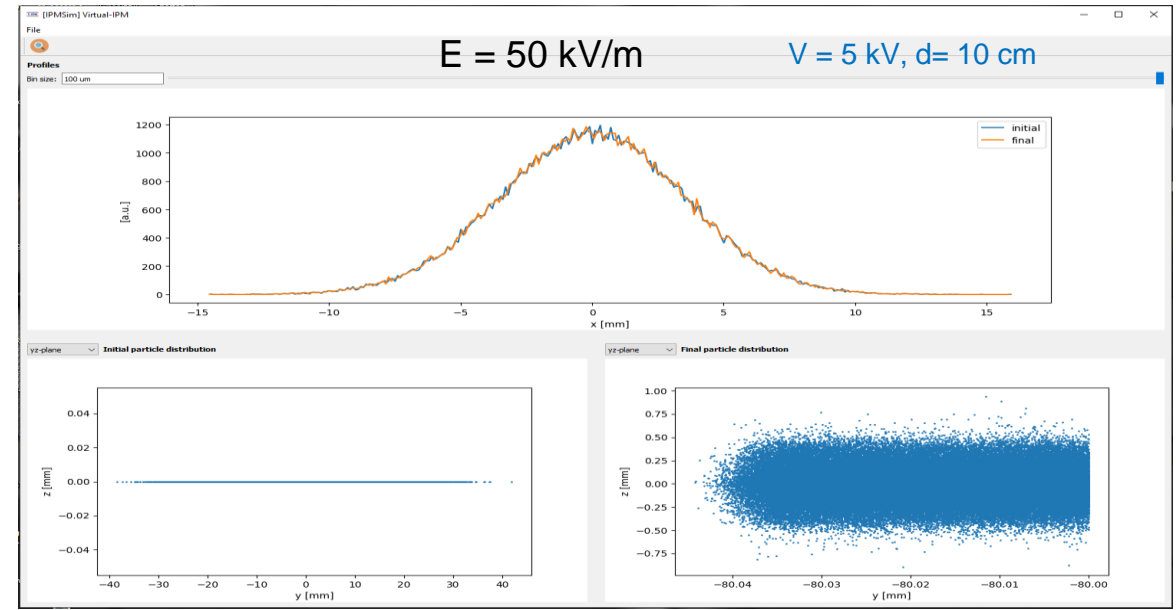
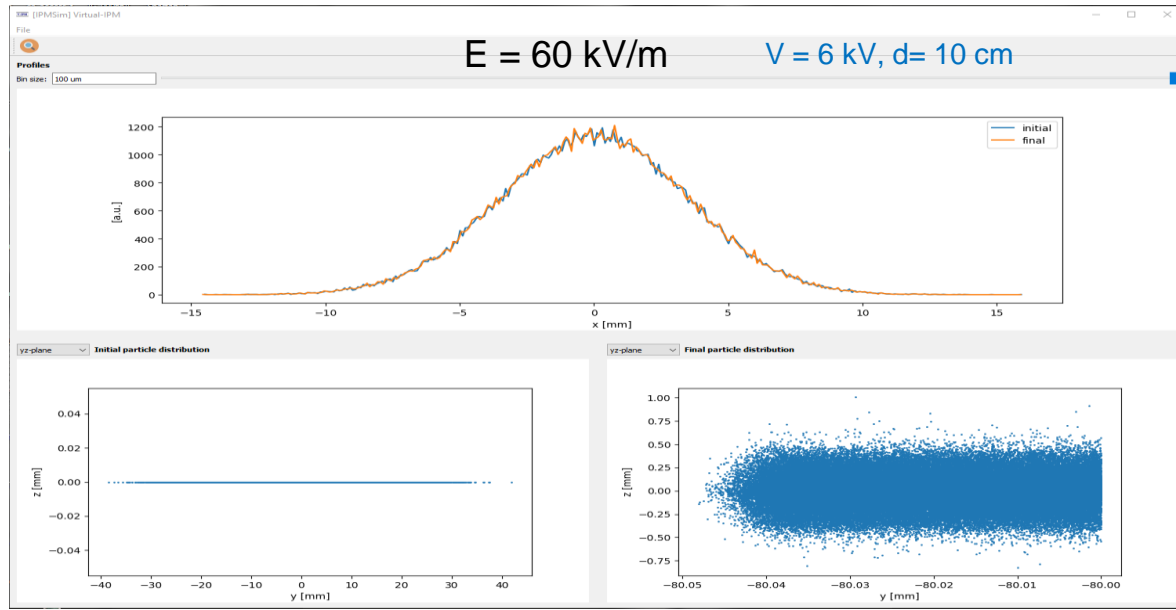
# Motivation

- The virtual IPM simulation software showed that variation of the applied electric field doesn't show any effects on the beam profile.
- We want to test this simulation results and to have a better understanding of the IPM performance.
- It may provide some guidance to optimize the future IPM design for the EIC HSR.

Beam parameters used for IPM simulation

Particle type	Store Mode	Au Bunch Intensity (nC)	No. of Bunches	Beam energy (GeV)	RMS Bunch length at Store (cm)	RMS horizontal beam size range (mm)	RMS vertical beam size range (mm)	Bunch Spacing (ns)	RMS emittance, h/v (nm)
Au -ion	1	1.25e9	56	27.2	34.7690418 (1.1597704 ns)	3.5127229	9.145081	10	

# Horizontal multi-bunch simulations for the HSR Au-ion beam (with $B = 0.1$ T): Syed



# Experimental description

- The virtual IPM simulation software showed that variation of the electric field doesn't show any effects on the simulated beam profile.
- We would like to test this experimentally using Au-ion beam at injection with 56 bunches in blue ring.
- We take IPM measurements with nominal IPM configurations as baseline and then vary electric field strength from 6 kV down to 4 kV in step of 500 V.
- We will repeat the same measurement in horizontal and vertical IPMs.
- Finally, we plan to perform the same measurements in yellow ring as well.

# Experimental description

- **Hazard Analysis:** No, we would like to watch the beam loss monitor closely even we don't expect any impact on the beam lifetime.
- **Instrumentation:** IPM application, Beam loss monitor, beam at the injection
- **Time:** 2 hours (1 hour for set up, and 1 hour for data)
- **Personnel:** Medani Sangroula, Syed Hafeez, Chuyu Liu, MCR crew to tune the machine



Thank you!