An Iris Diaphragm Beam Detector for Halo or Profile Measurements

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Abstract

Non-Gaussian beam distributions around the beam core can be formed in an accelerator. Previously, multiple destructive or non-destructive techniques have been developed and tested at various accelerator facilities.

Most of these techniques require complex and expensive setups, like in a gas sheet monitor, or a digital micromirror array.

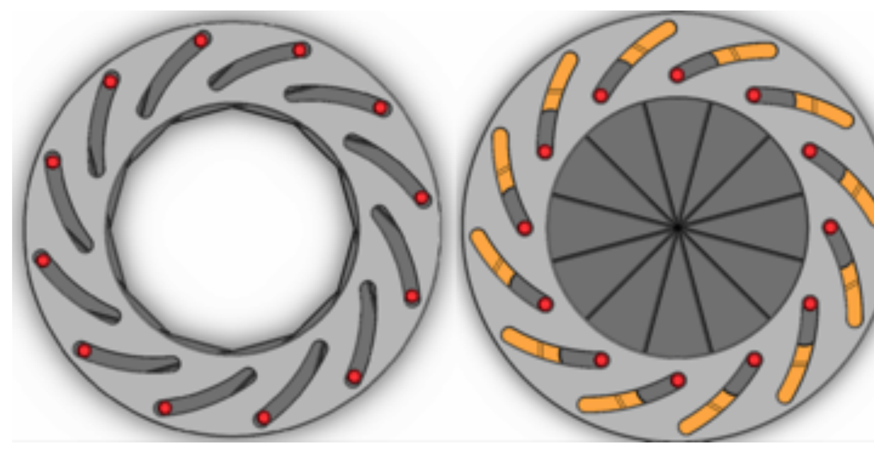
We present a novel device that adopts an **iris diaphragm structure for transverse beam halo or profile measurement**.

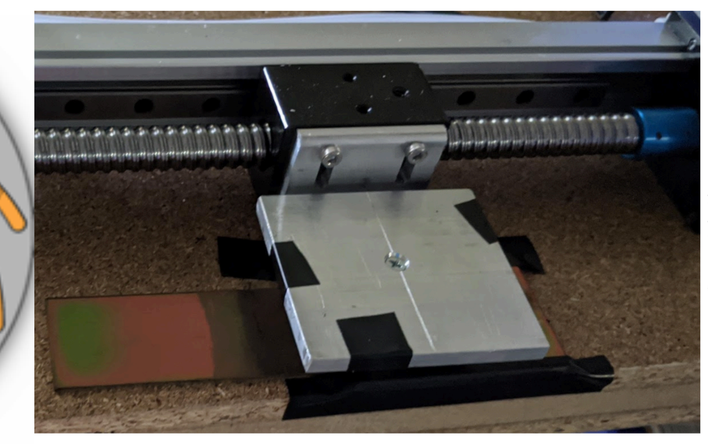
The iris diaphragm detector can **also work as an adjustable collimator**.

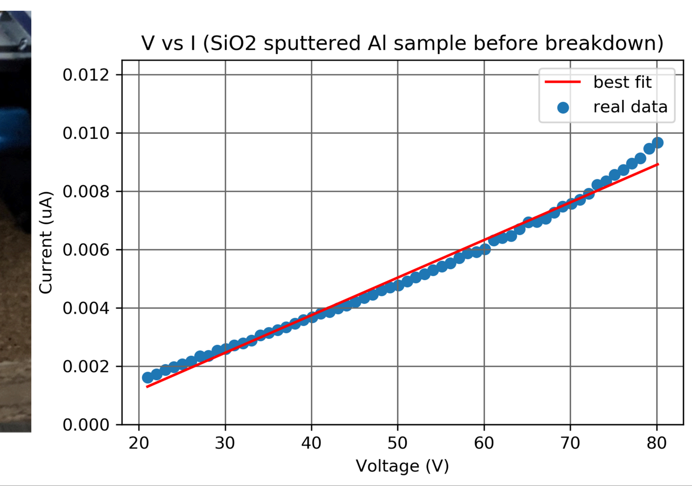
Advantages: high-portability, cost-effectiveness, high-configurability, fast-response, etc.

Design concepts

- Q: How to obtain signals? A: The most direct measurement of the charge: collect and output current (like a Faraday cup).
- Q: So the beam is intercepting? A: The iris opens to be non-invasive, closes to be invasive.
- Q: How do you control it? A: Using a UHV-compatible linear actuator or piezoelectric actuator (depending on the travel and accuracy needed).
- Q: How many iris blades needed? A: Customizable, depends on how finely the distribution needs to be mapped. For now, 4 blades in our test versions.
- Q: How are signals between blades isolated? A: Ceramic or non-conductive coating

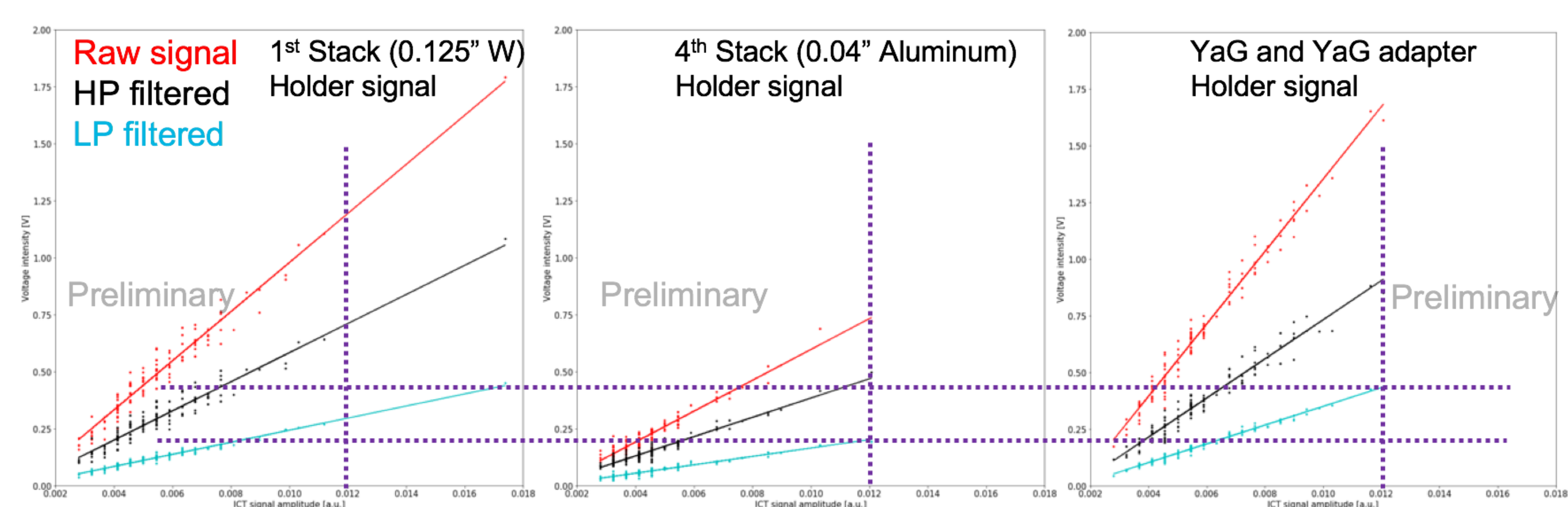


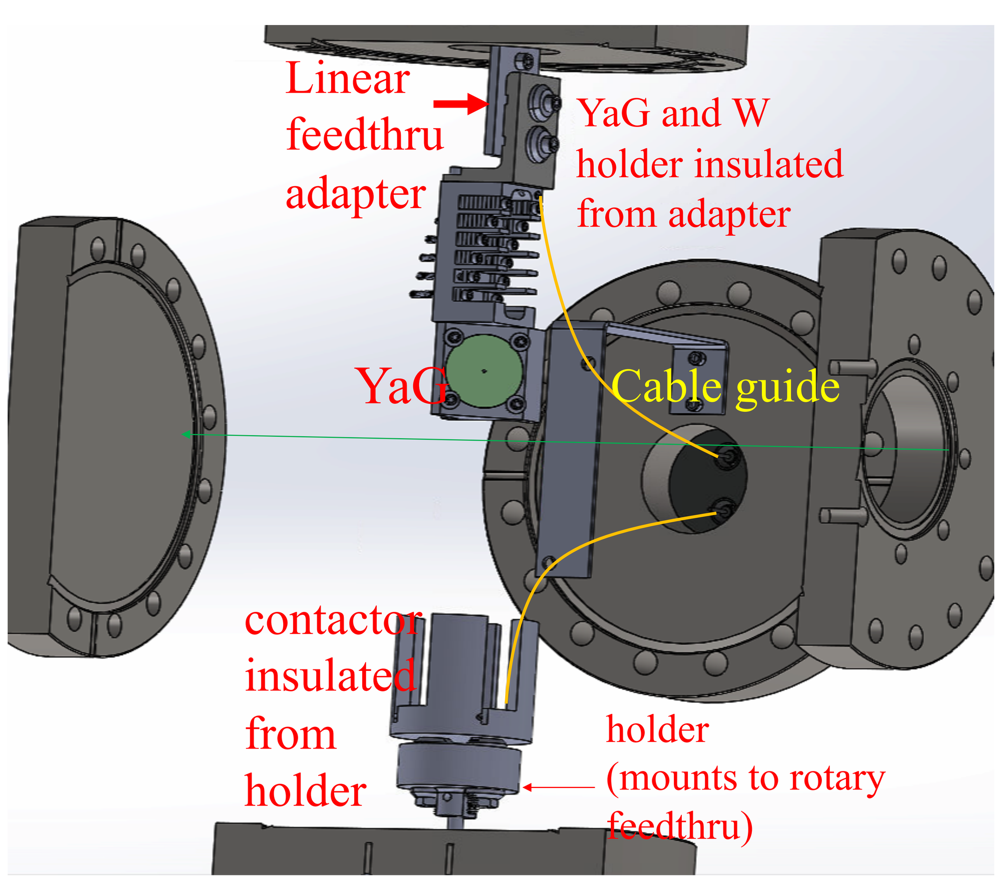


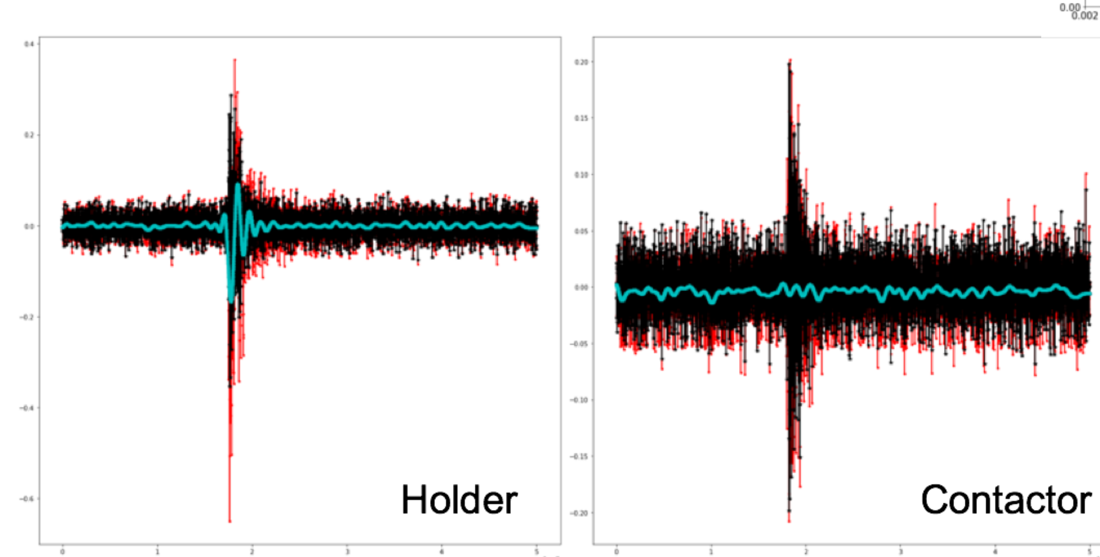


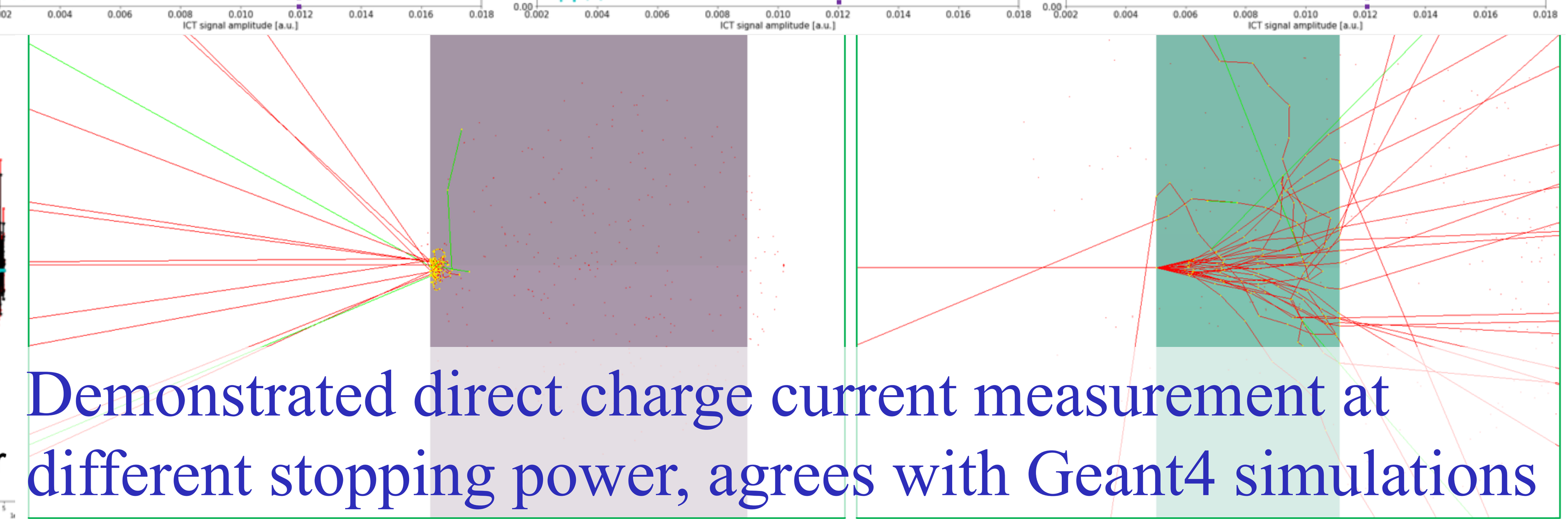
Tested versions

- **Version-alpha**:
  - ✓ 1-2 MeV electron beam bombarding the iris blades at various thickness made of different materials;
  - ✓ Current signal extraction from the blades using coax cables;
  - ✓ Ceramic insulation of signals from conductors;
  - ✓ Vacuum compatibility of the system at 1e-8 Torr;

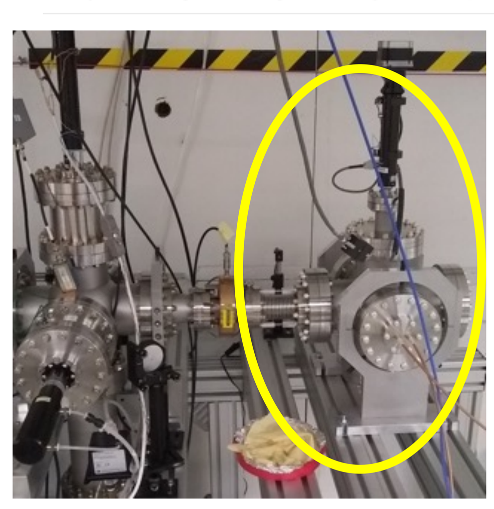


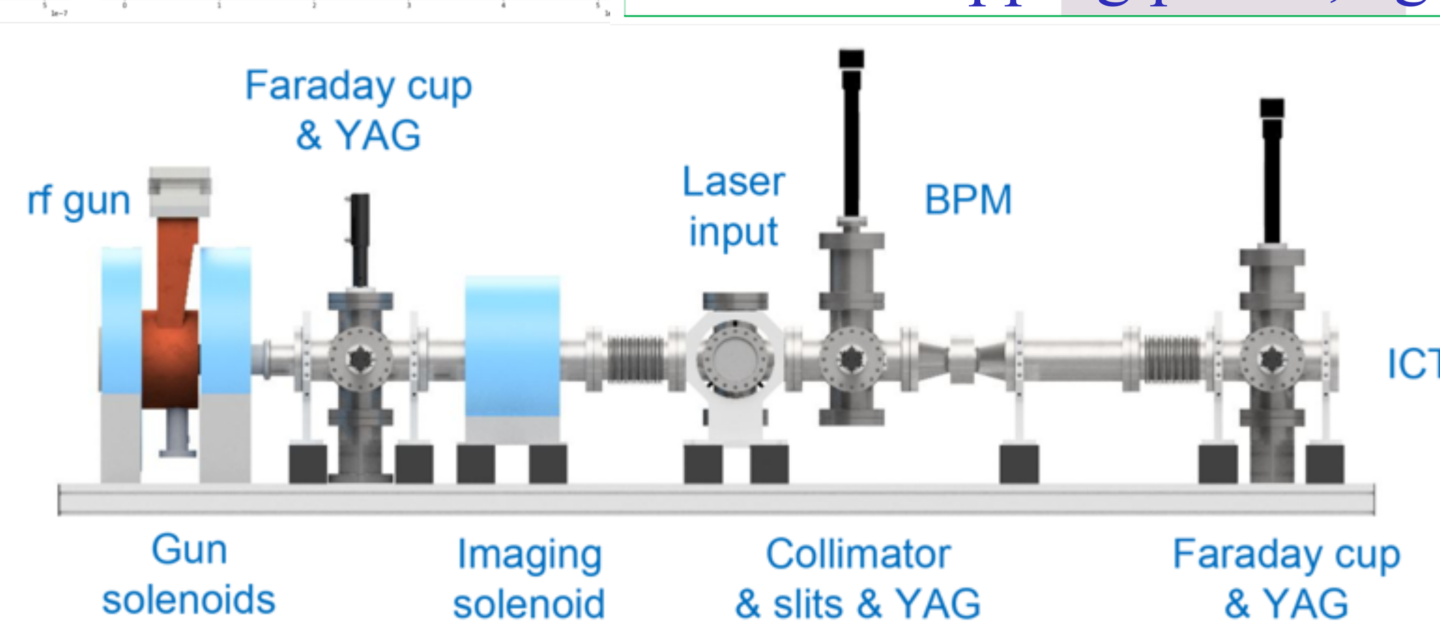


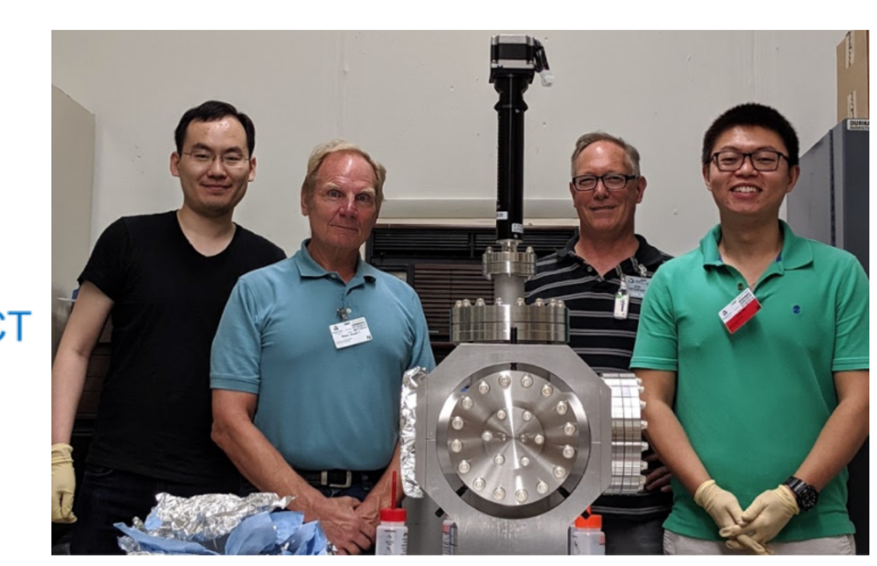




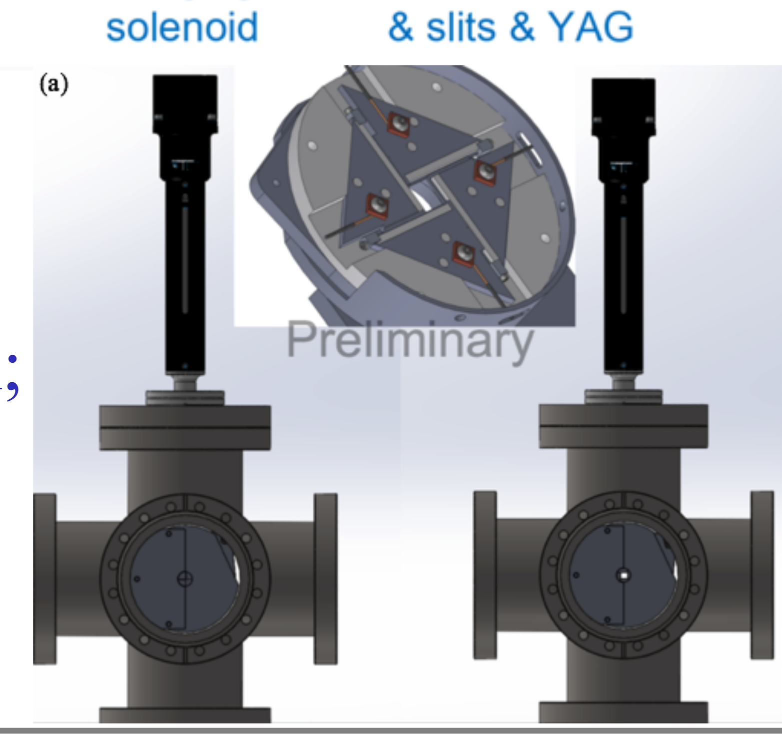
Demonstrated direct charge current measurement at different stopping power, agrees with Geant4 simulations

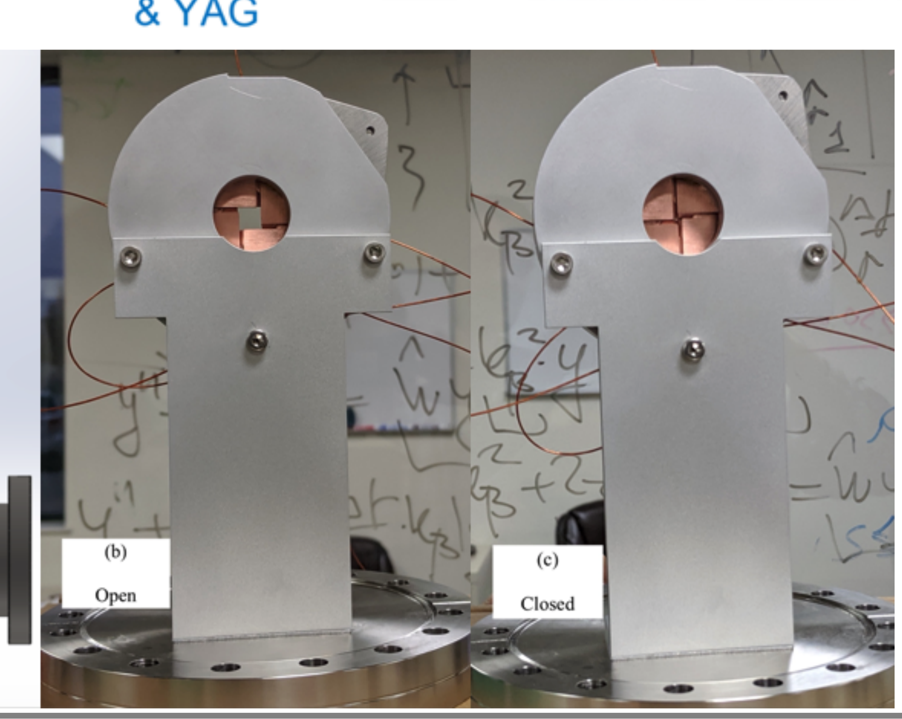






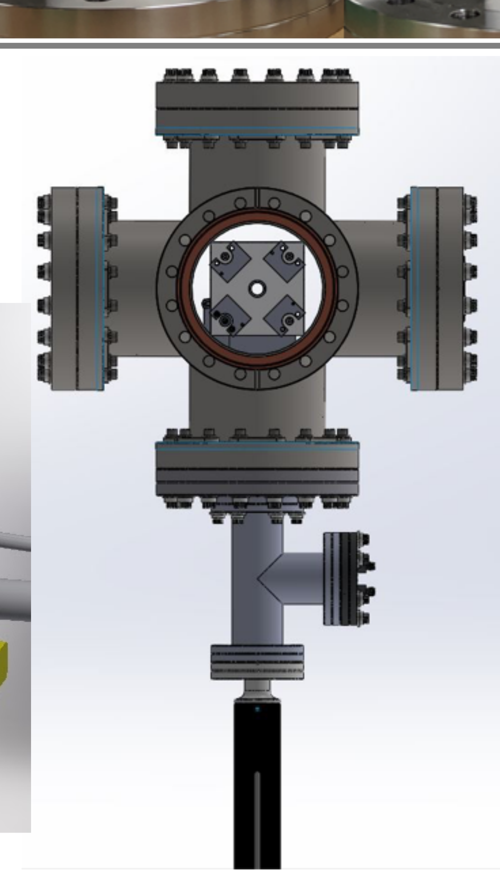
- **Version-beta**:
  - ✓ Fully UHV-compatible: tested at 1e-10 Torr;
  - ✓ 4-blade iris design;
  - ✓ Iris motion in air demonstrated;
  - ✓ 2 independent signals from blades via ceramic insulation;
  - Needed upgrade: iris motion in UHV;
  - Needed upgrade: thin-film insulation between blades

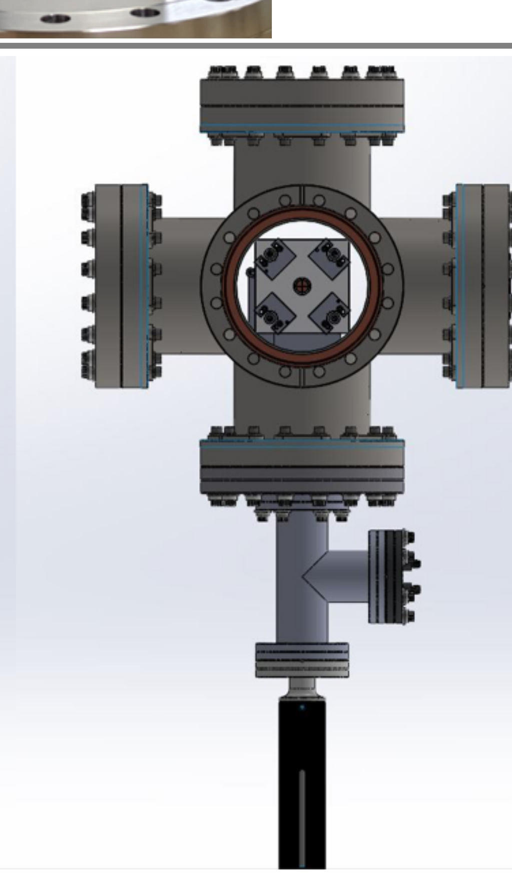




Version-beta coming in Sep.

- → An even simpler assembly – apparatus inserted through one 6" CF port;
- → Improved iris motion and insulation mechanism;
- → Separate signal readouts from all 4 iris blades;
- → Thin-film insulator (strong and stable, i.e. no oxidation);
- → Two future test sites: AWA and Duke U





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