# Survey of RFAs

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# Goal

- To see what other people have done
  - Especially RFAs with microchannel plates or electron multipliers.
- Some preliminary design and requirements
  - What calculations do we need to do
    - Efield profile of retarding field and analyzer.
    - Parameters required for microchannel
  - What do we want to measure?

# Microchannel Plate/Electron Multiplier RFAs

- This is really not new. People have designed this type of RFAs before circa 1971!
  - Reference: P. Stalb, “An Improved Retarding Field Analyser”, J. Phys. E, 484, **5**, 1972.
- People have used Electron Multiplier Tube (EMT) rather than Microchannel plate for detector. c.f. mass spectrometer. MCPs have higher gain. This also depends on geometry, will the design have a small hole?

# 1971 Design with Channeltron EMT

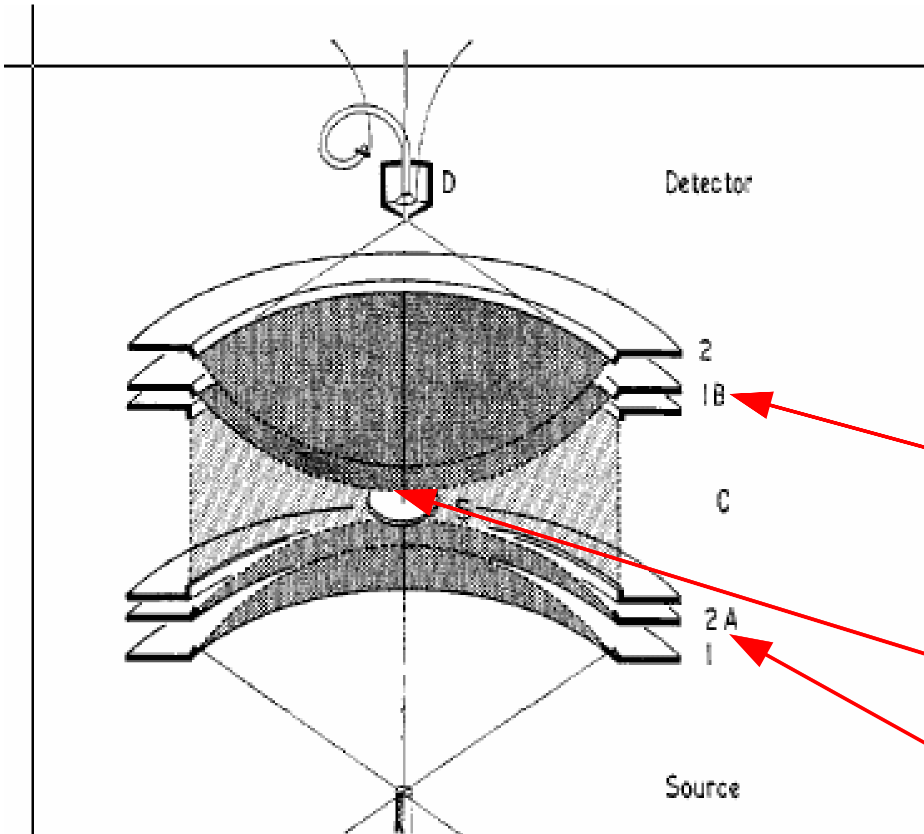



**Figure 1** View of the energy analyser showing the two sets A and B of spherical concentric grids, the cylindrical grid C and the screen S

A sophisticated design with focusing and defocusing grids for energy selection.

# CERN Design (used for IPM)

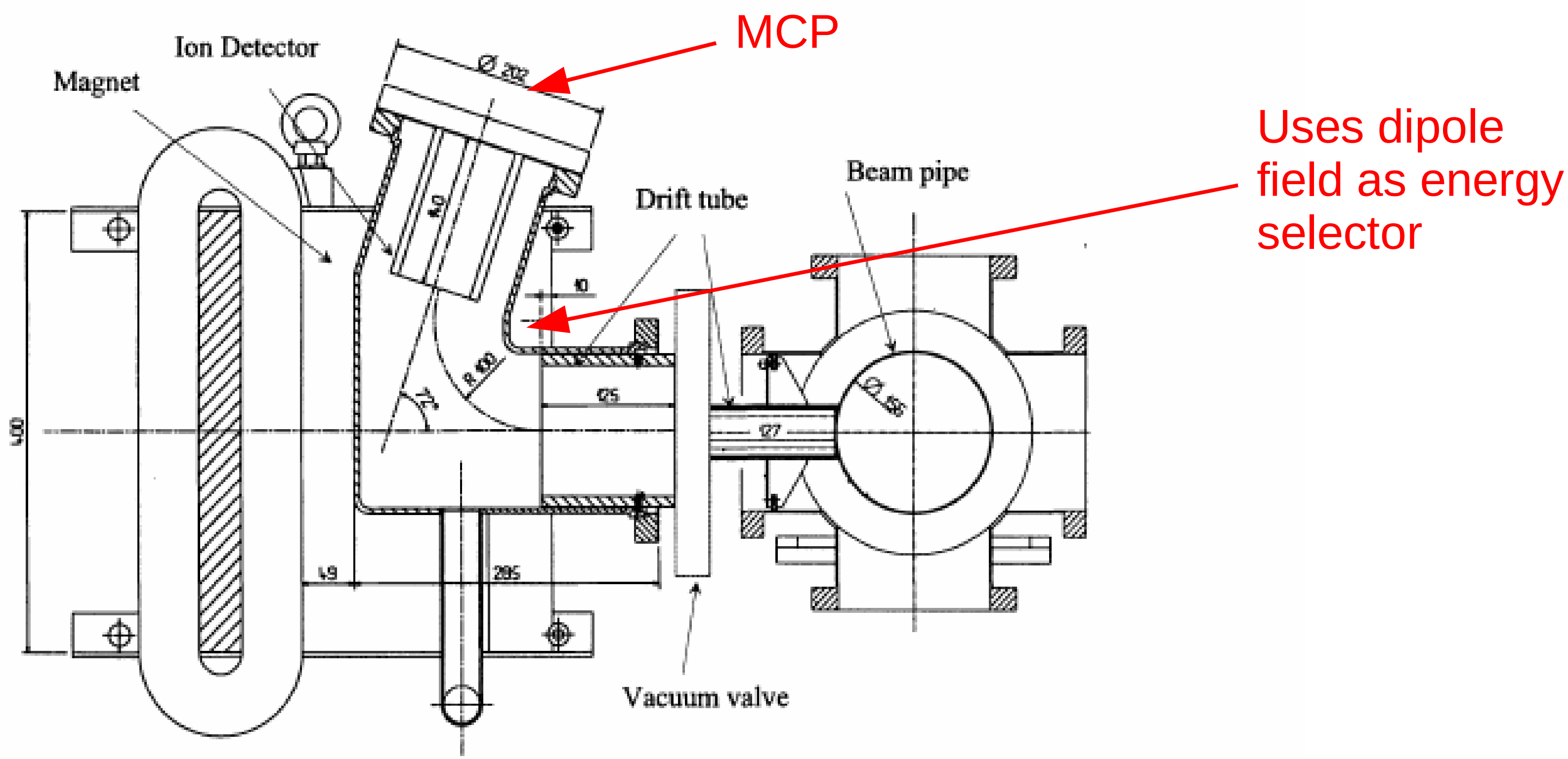



**FIGURE 3.** Experimental set-up of the BGIP first prototype built for the SPS ring. In the right part, the tank containing the beam pipe and the first section of the drift tube are shown. In the left part are drawn the second section of the drift tube and the ion detector inside its vacuum chamber placed in the magnet gap. The theoretical trajectory of an ion is shown with a perfect curvature radius of 10 cm. Units are given in millimeters.[2]

A. Arauzo, “First results of the Beam Gas Ionization Profile Monitor (BGIP) tested in the SPS ring”, BIW2000.

# BNL Design (APS)

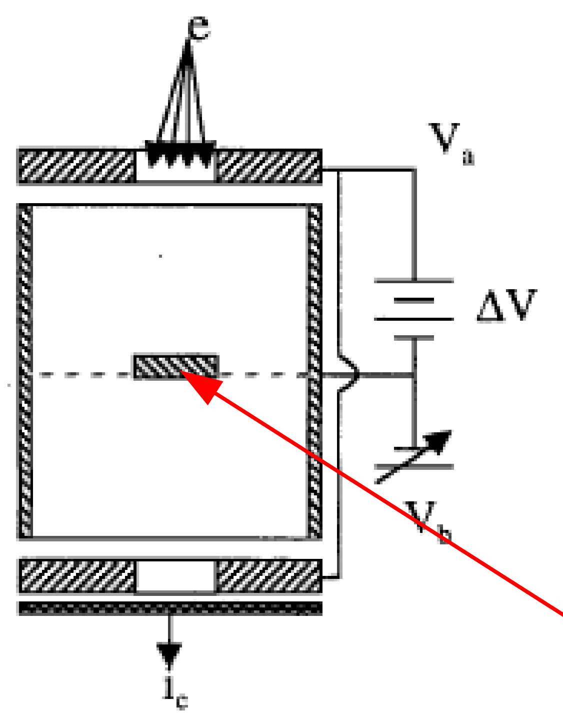


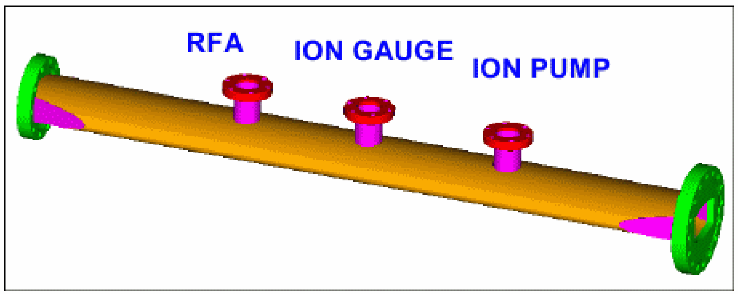

Figure 2: Schematic diagram of the Bessel Box analyzer. (Symbols are described in text.)

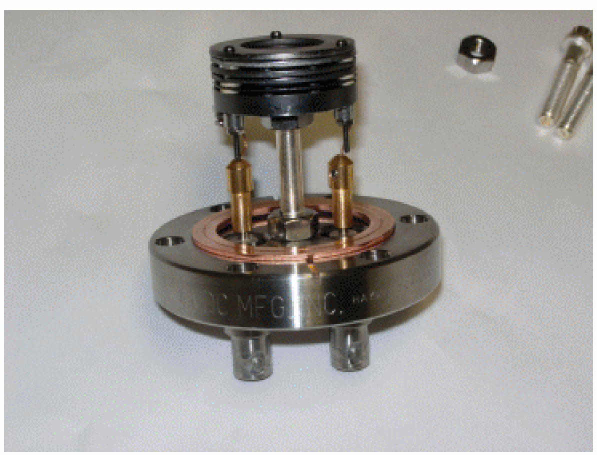
Called pillbox or bessel box analyser. All parts coated with graphite to reduce SEY.

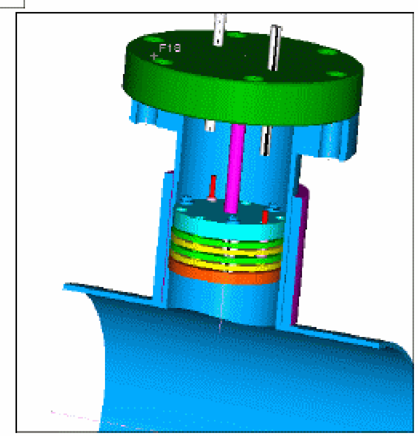
Circular Stop

# Present RFA in MI

## RFA Testing Beam Pipe in Tevatron and MI





Very noisy if retarding fields used because of lower signals.

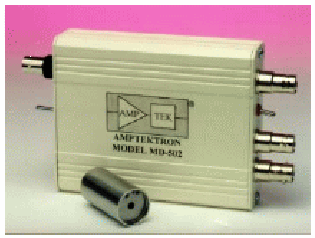
# Commercial EMT

**ELECTRON AND ION DETECTOR FOR ULTRA-HIGH VACUUM** | **MD-502**

A complete CEM detector system for ultra-high vacuum use

**ULTRA-HIGH VACUUM PACKAGED CEM FEATURES:**

- Ceramic channel electron multiplier
- Stainless steel faraday housing
- Bakeable to +300 °C
- Operational from cryogenic to +200 °C
- Ceramic and gold UHV connector



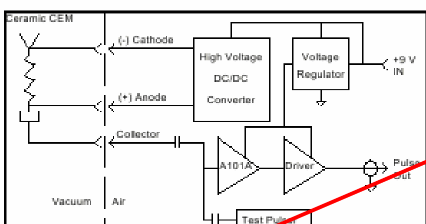

**REMOTE ELECTRONIC SYSTEM FEATURES:**

- Low voltage supply (AC/DC converter)
- High voltage supply
- Charge sensitive preamplifier & discriminator
- Test pulse
- Line driver

Designed for vacuum use. Cost is $3700. This is called "Channel Electron Multiplier" by the manufacturer Amptek. Gain is about $10^7$ per electron.

3.6 to 10mm hole

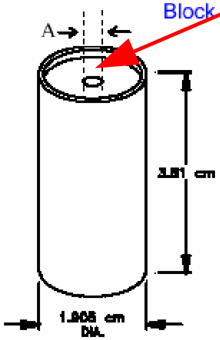
The **AMPTEKTRON MD-502** is a compact, easy to use electron multiplier system capable of detecting electrons, ions, vacuum ultra-violet, soft x-rays, and other nuclear particles at rates greater than $10^6$ events per second. It is configured in a pulse counting mode and operates from a single low voltage supply.




Block Diagram

The **AMPTEKTRON MD-502** is designed for direct applications in the field of mass spectrometer, laboratory and research experiments, vacuum proce monitoring and beam diagnosis, particularly in syster requiring ultra-high vacuum operation. It requires thr high voltage connections to the UHV CEM.

The aperture (A) is normally 3.6 mm diameter, whi can be increased up to 10 mm diameter.

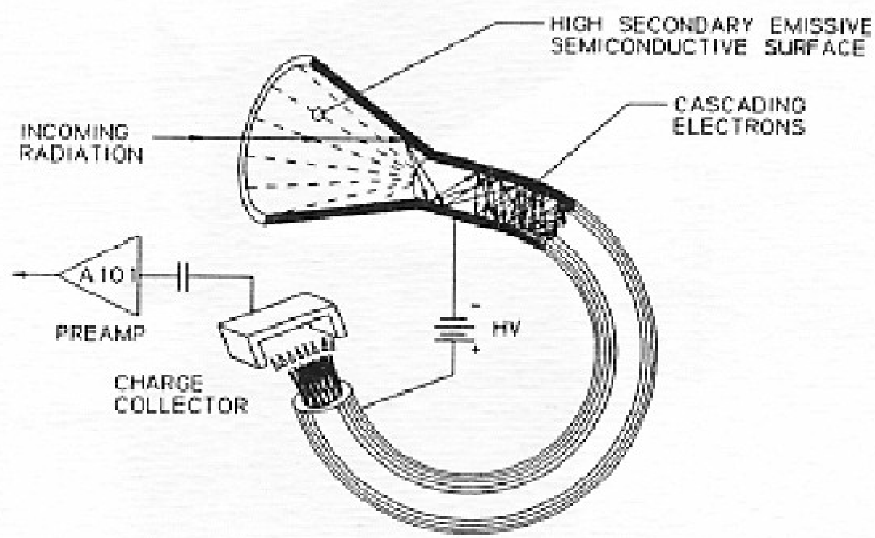



MD-502 CEM Housing

| | Ion mode | Electron mode |
|---|---|---|
| Cathode | -2400 VDC | +500 VDC |
| Anode | Ground | +2900 VDC |
| Collector | Virtual ground | +2900 VDC |

The three CEM electrical connections are supplied via SHV connectors on th MD-502 electronics box. The CEM contains a self-biasing resistive strip that crea a +100 VDC potential between the output of the CEM charge cloud and the colle This ensures efficient collection of the charge cloud output. The voltage of the bi potentials depends upon the mode selected for the MD-502. The cathode potenti appears on the CEM cone and serves as a rejection potential for deselected spe and an acceleration field for the selected species. Thus, thermal ions will be stro attracted to the -2400 VDC in the ion mode, but will be repelled by the +500 volts encountered in electron mode. Electrons experience the opposite effects, being attracted by the +500 volts and strongly repelled by the -2400 volts in the ion mo Particles with energies in excess to these rejection fields will be able to penetrate and be counted.

*Refer also to specifications for MD-501.*



# What we need to decide/discuss

- I think having an EMT or MCP is the way to go.
- Do we need sophisticated lens geometry a la 1971 design? Or simpler geometry like APS.
- What I'd like to measure
  - Energy distribution as function of beam intensity and bunch pattern.
  - Can this form base line for answering whether changing RF frequency will fix problem. This will probably need computer simulation, so what are the input params?