

Planar Technologies for Optimized Realisation of Quadrupole IonGuides and Quadrupole Ion WaveGuides



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 Ralph Pulwey, Michel Aliman: Carl Zeiss NTS GmbH, Oberkochen, Germany

Introduction

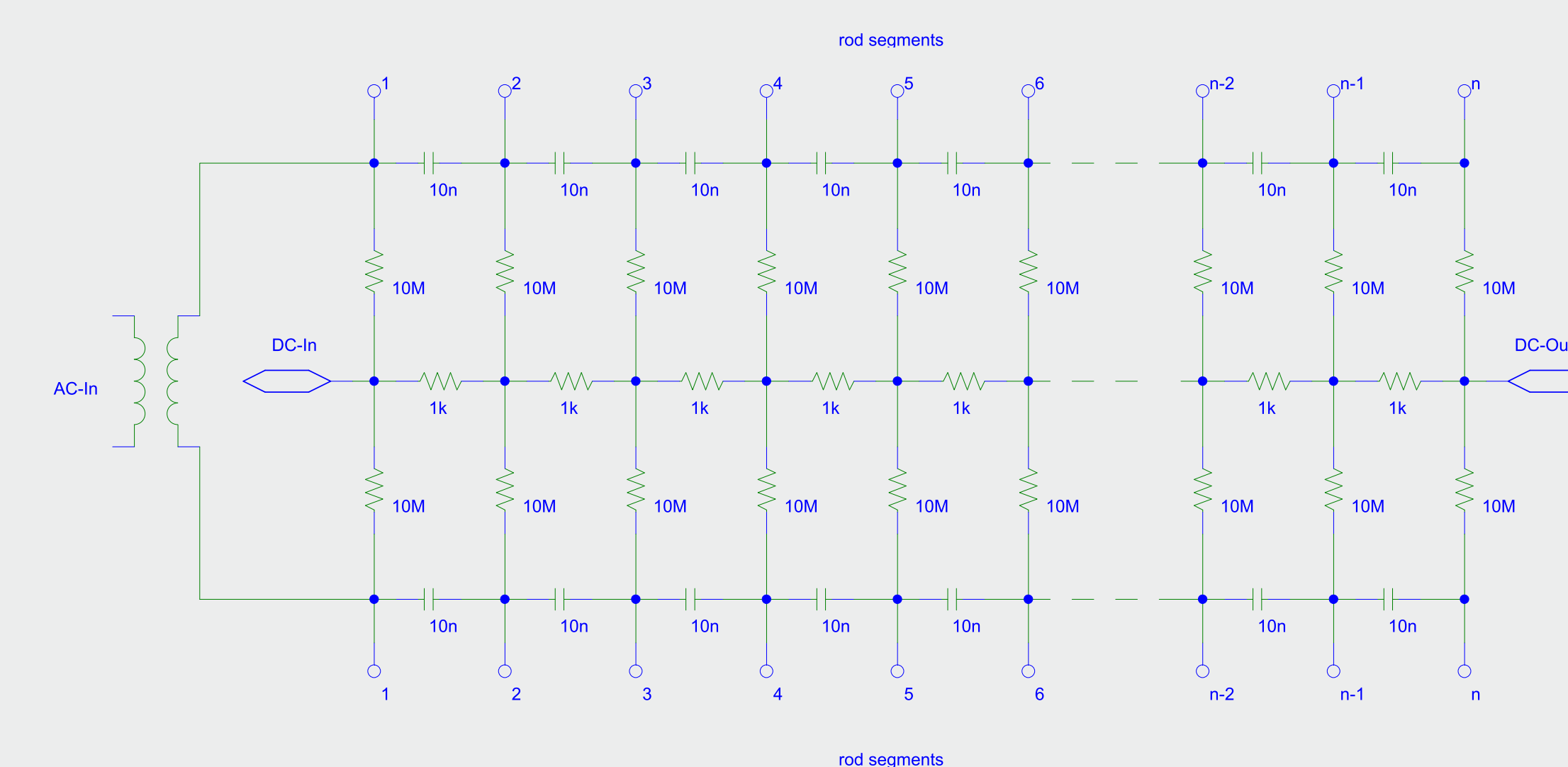
For mass spectrometry there are several process steps like ion generation, collection, cooling, fragmentation, selection and analysis which are often performed in specific stages. Between these stages the ions have to be transferred with high efficiency, high spatial and timing precision and with minimal ion energy spread. For these tasks structures with radial storage fields (ion funnels or linear multipoles) and axial transport fields (dc gradient for ion guides or moving potential wells for ion wave guides) have been developed in different variations. All of them require precise segmented mechanical parts wired to a lot of electronic components. For classical realizations with high numbers of segments and/or small diameters the system becomes complex and expensive. By use of planar technologies which are standard for electronic circuits many of these problems can be solved.

Novel Aspects and Applied Methods

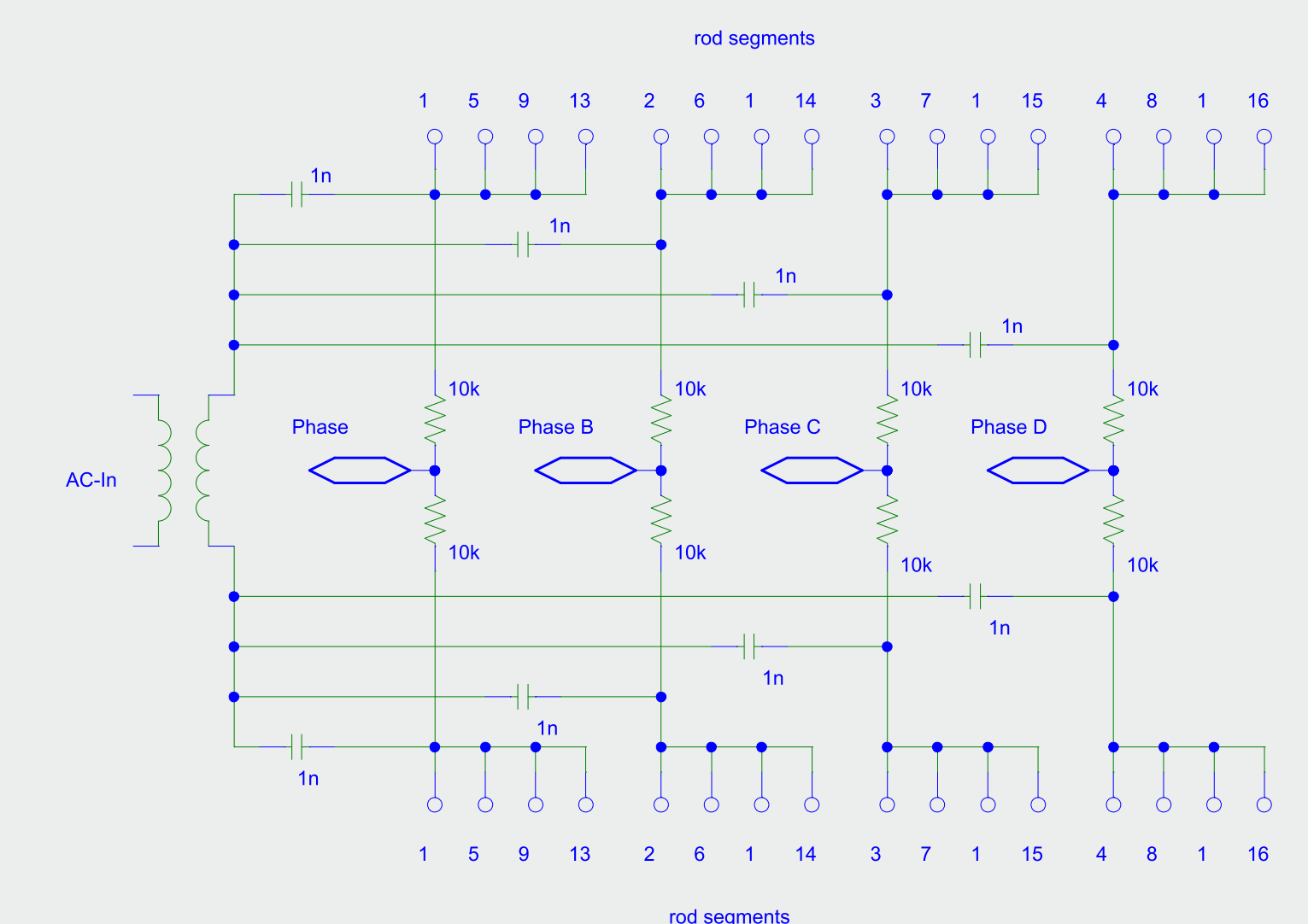
- Integration of mechanical structure and electronics
- Assembling of electronic components by classical planar PCB-technology with high reliability
- No extra (fault-prone) wiring between quadrupole rod segments and electronics
- Optimized technologies for different (even very small) diameters

Electrical and Mechanical Requirements

- Superposition of RF quadrupole storage field and ion transport field
- No isolating parts near the inner zone to prevent field distortion by charged surfaces
- Combination of mechanical structure and electronic circuit
- If possible: integrated design of mechanics and electronics



electronic circuit for a quadrupole IonGuide

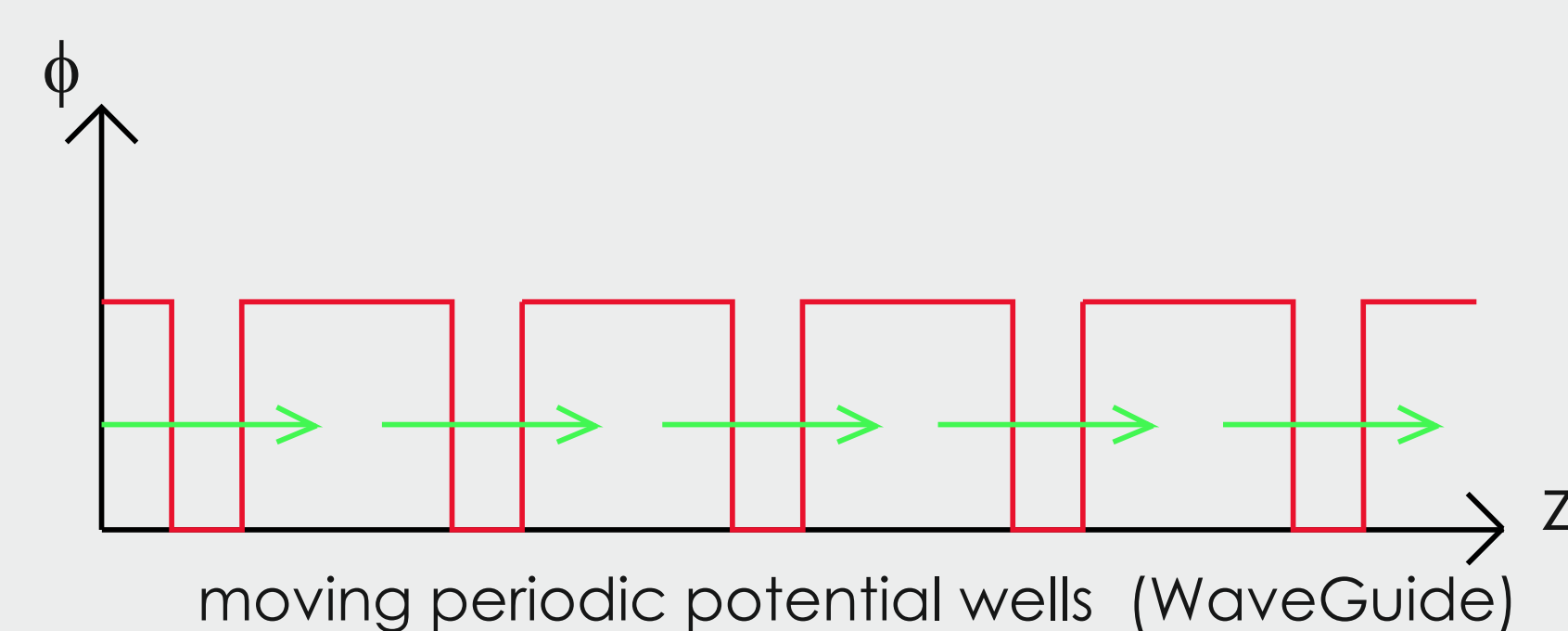
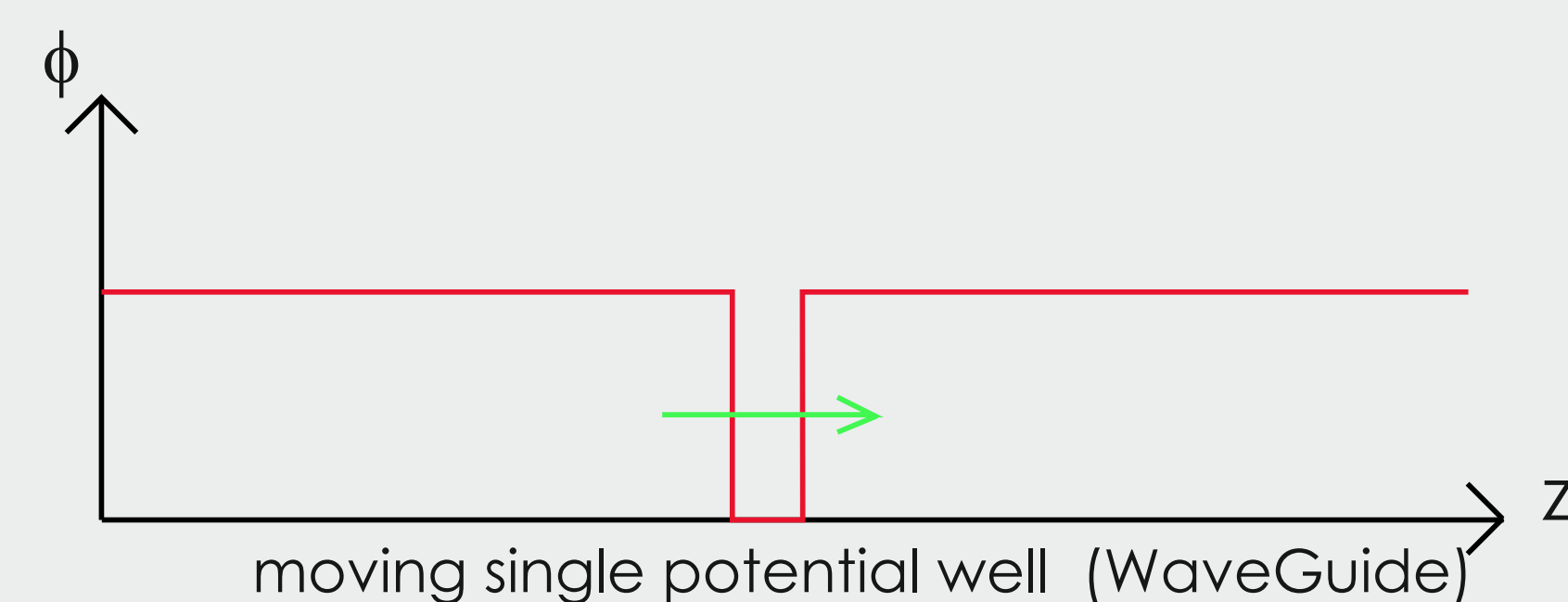
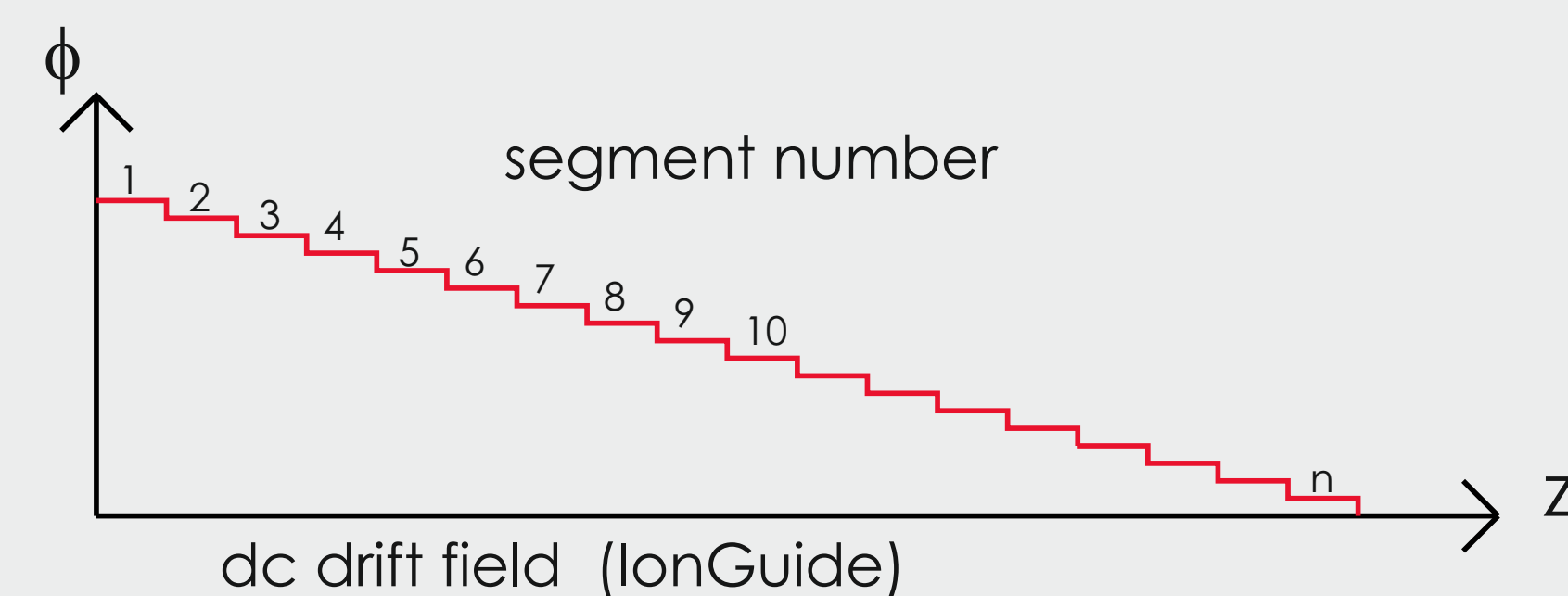
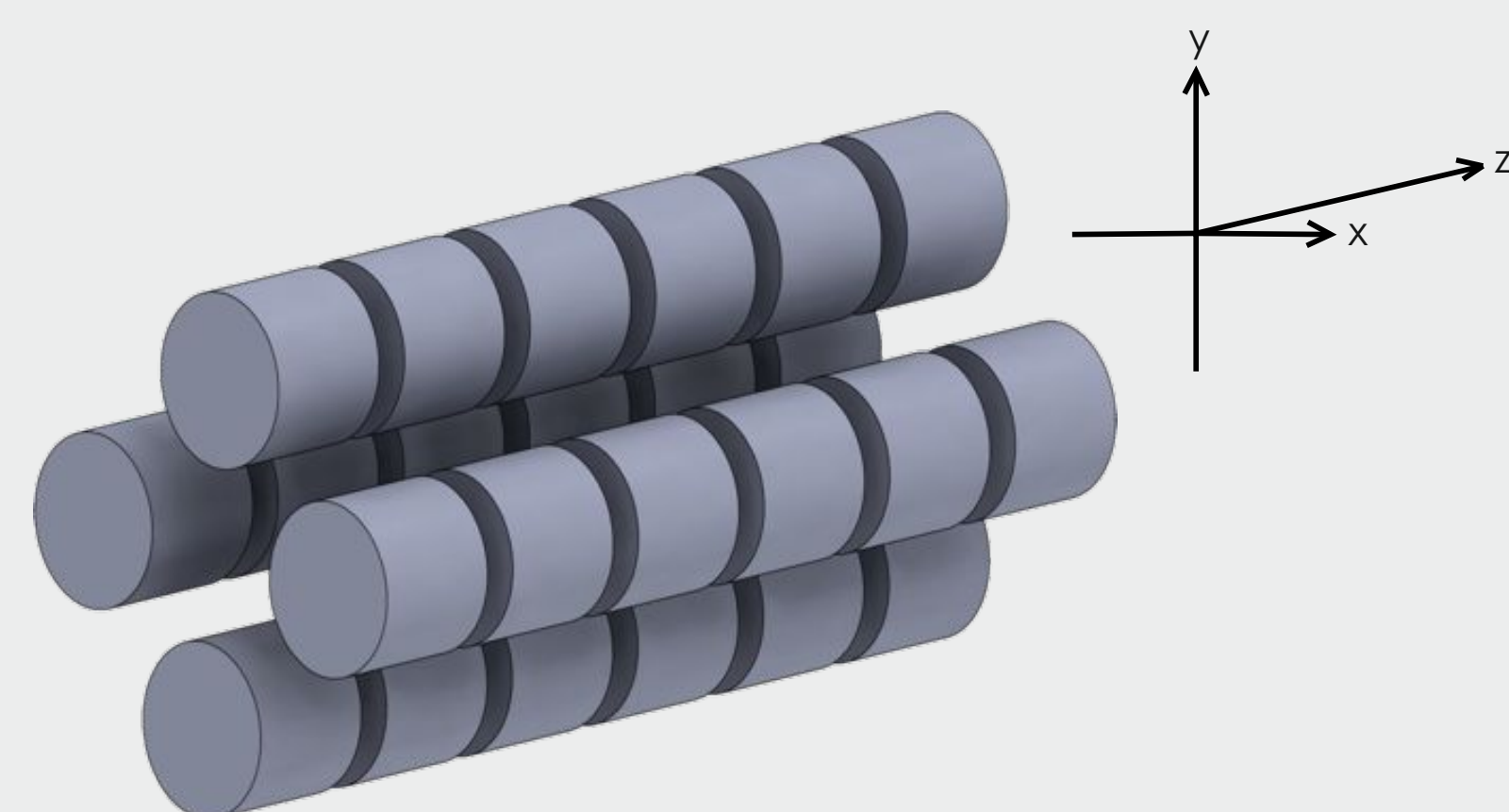


electronic circuit for a 4 phase periodic quadrupole ion WaveGuide

IonGuide and Ion WaveGuide

Segmented quadrupole rods with:

- rf quadrupole field in the xy-plane
- additional drift field in z-direction



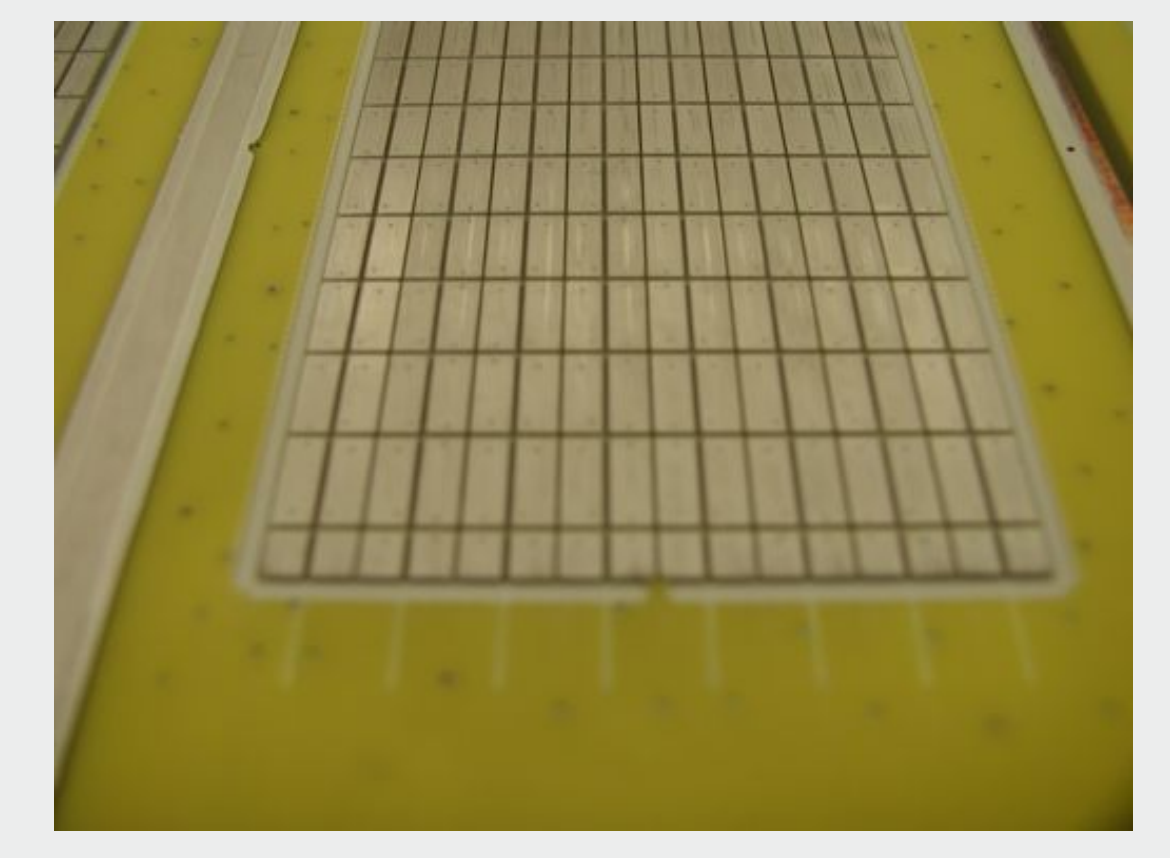
Materials for Planar Circuits

substrate	conductors	surface	structuring	outgassing	price
epoxy filled with glas fibres (e.g. FR4)	copper	tin or gold	milling	high	low
epoxy filled with ceramic powder (e.g. RO3000)	copper	tin or gold	milling	medium	medium
foil (e.g. polyimid)	copper	tin or gold	milling or fast laser	medium	medium
ceramics (Al2O3)	thickfilm	silver or gold	slow laser	low	high
ceramics (Al2O3)	thinfilm	silver or gold	slow laser	low	high

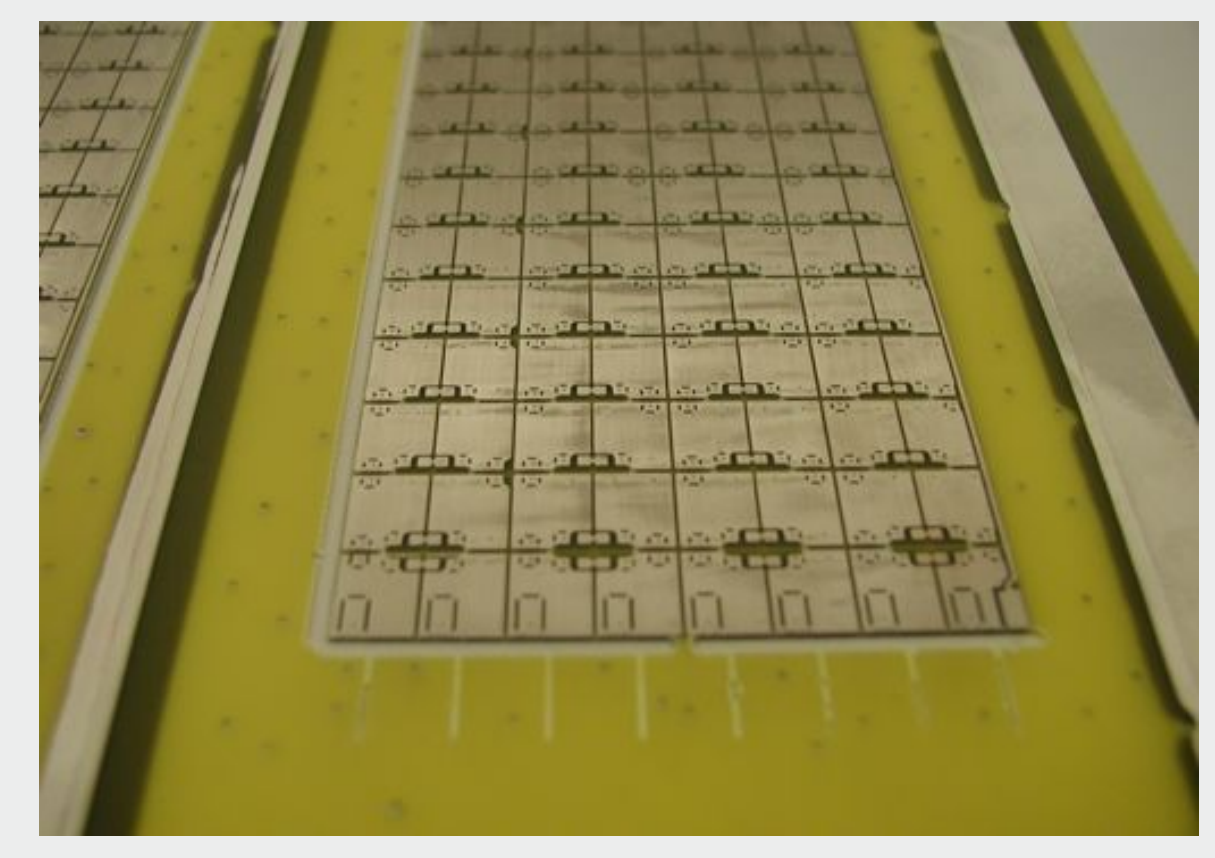
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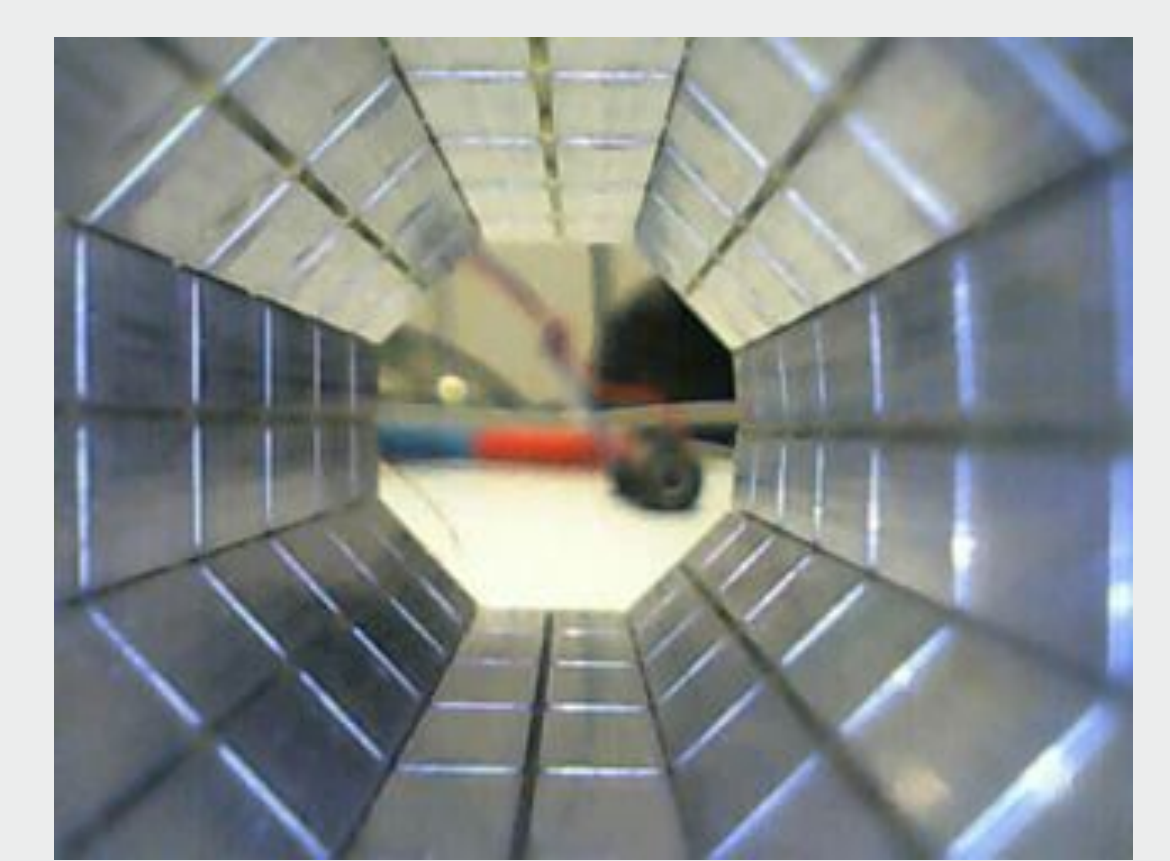
Example of Quadrupole IonGuide with Semiflex PCB



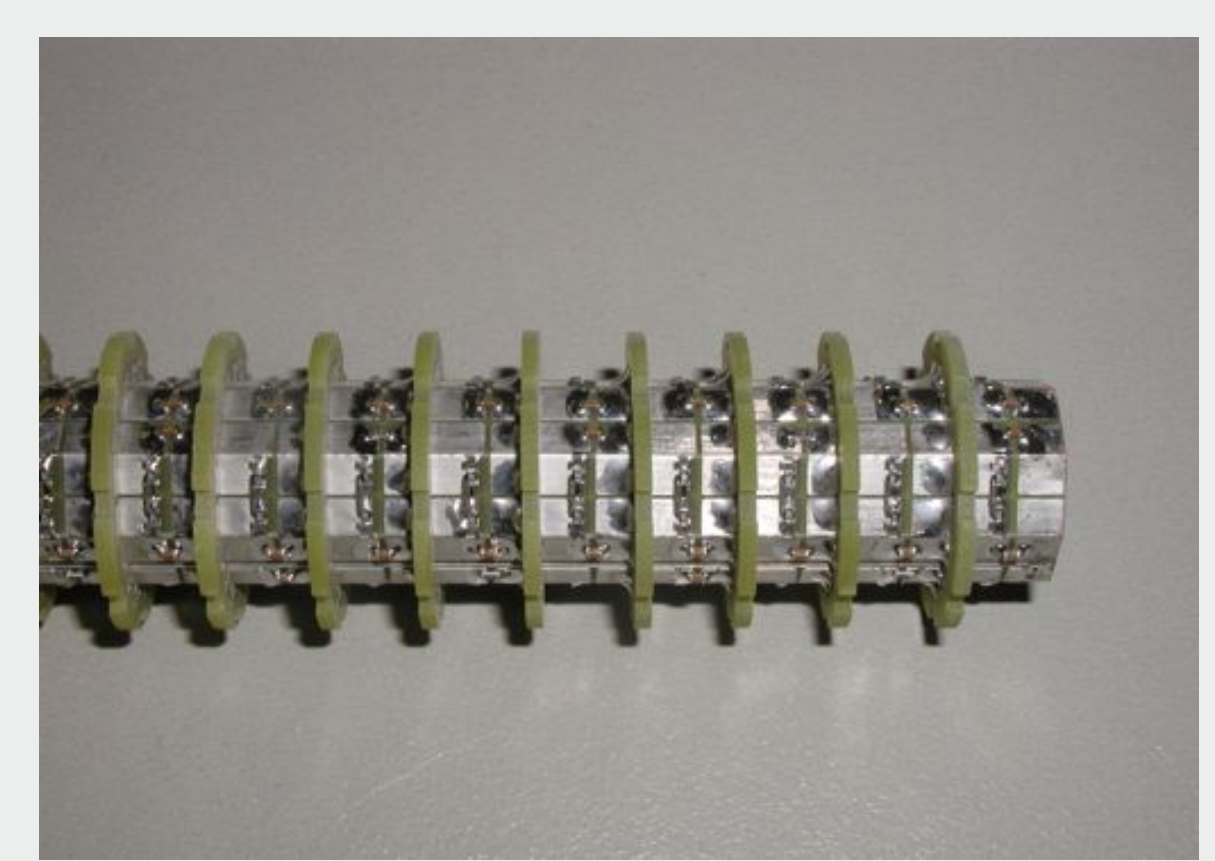
PCB bottom side (for field planes)



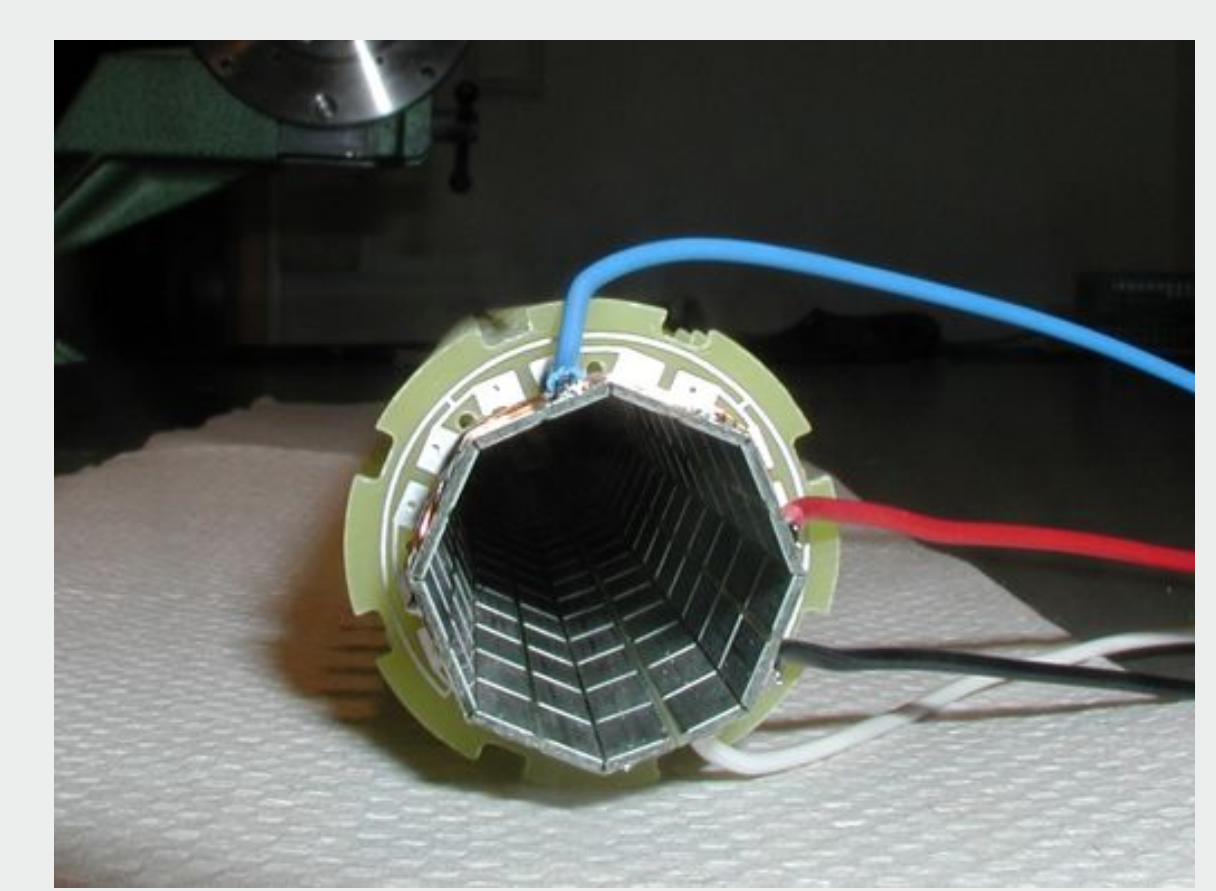
PCB top side (for components)



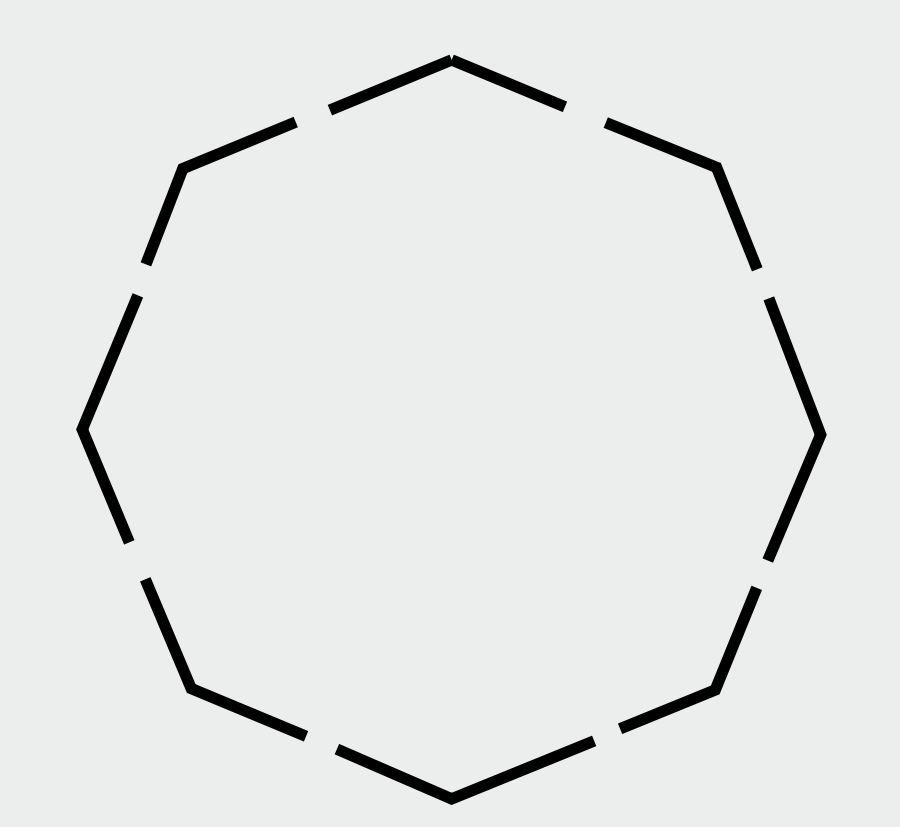
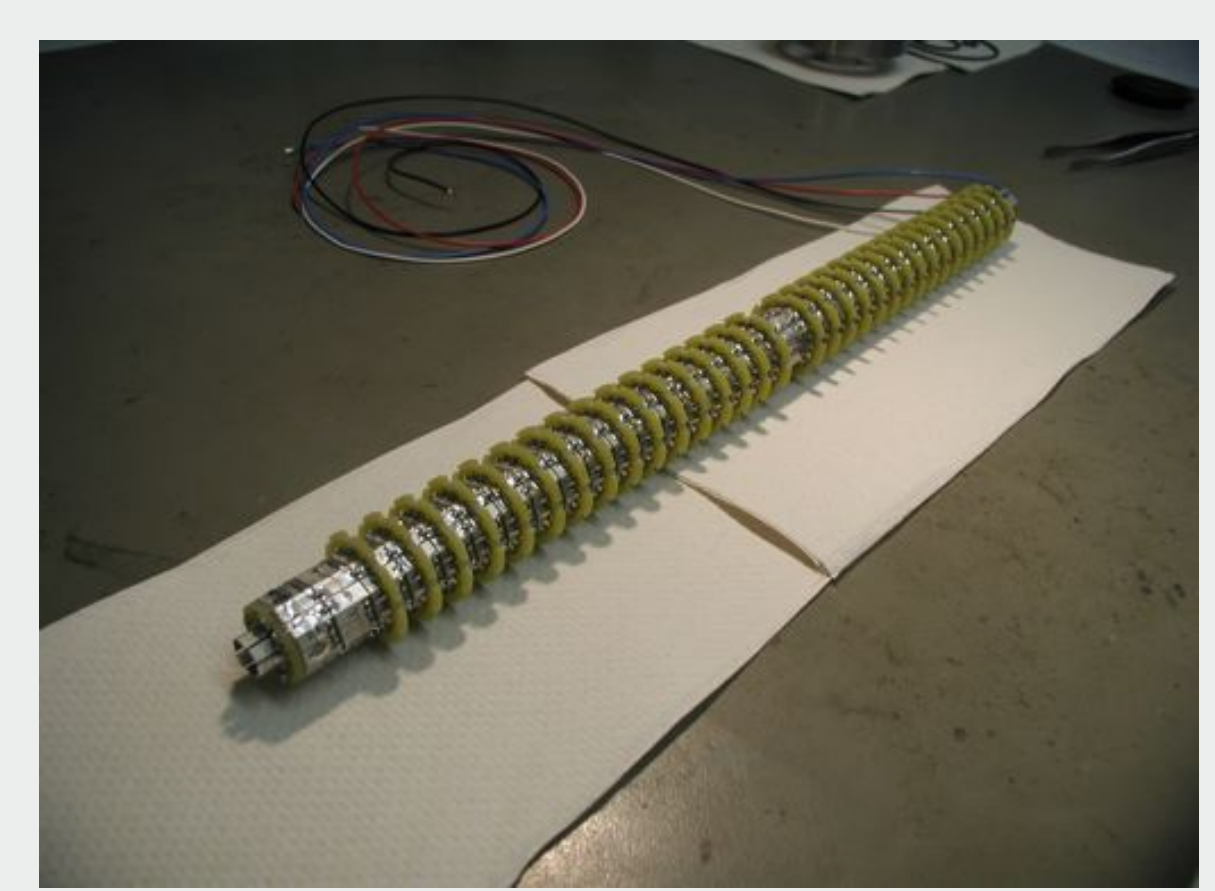
inner view of the IonGuide



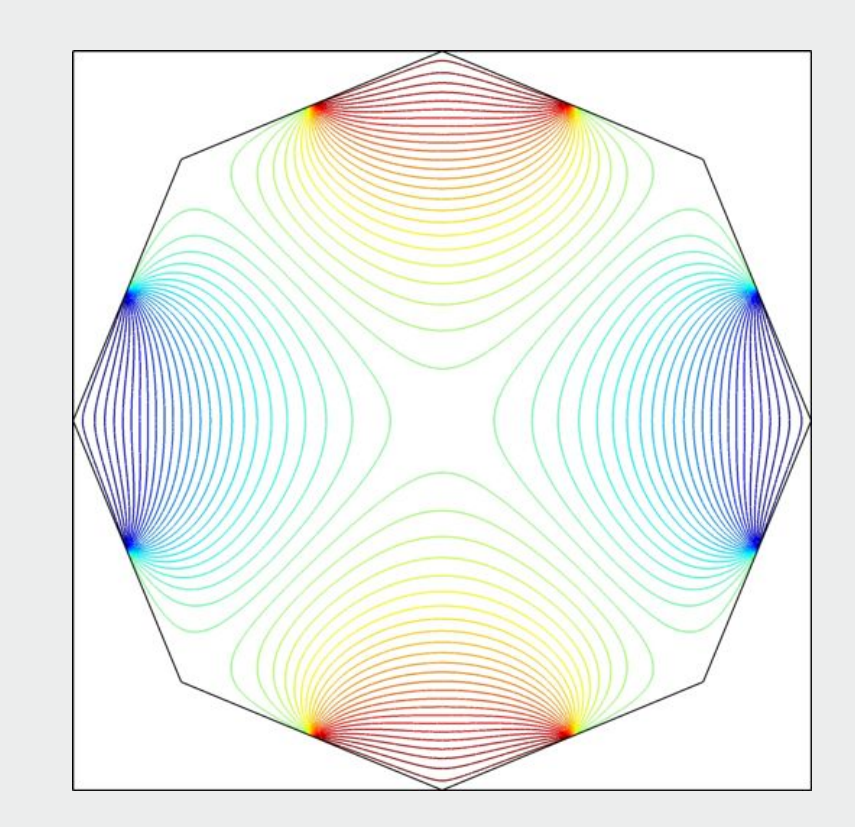
outside view with components



complete IonGuide with 36 segments



electrode arrangement

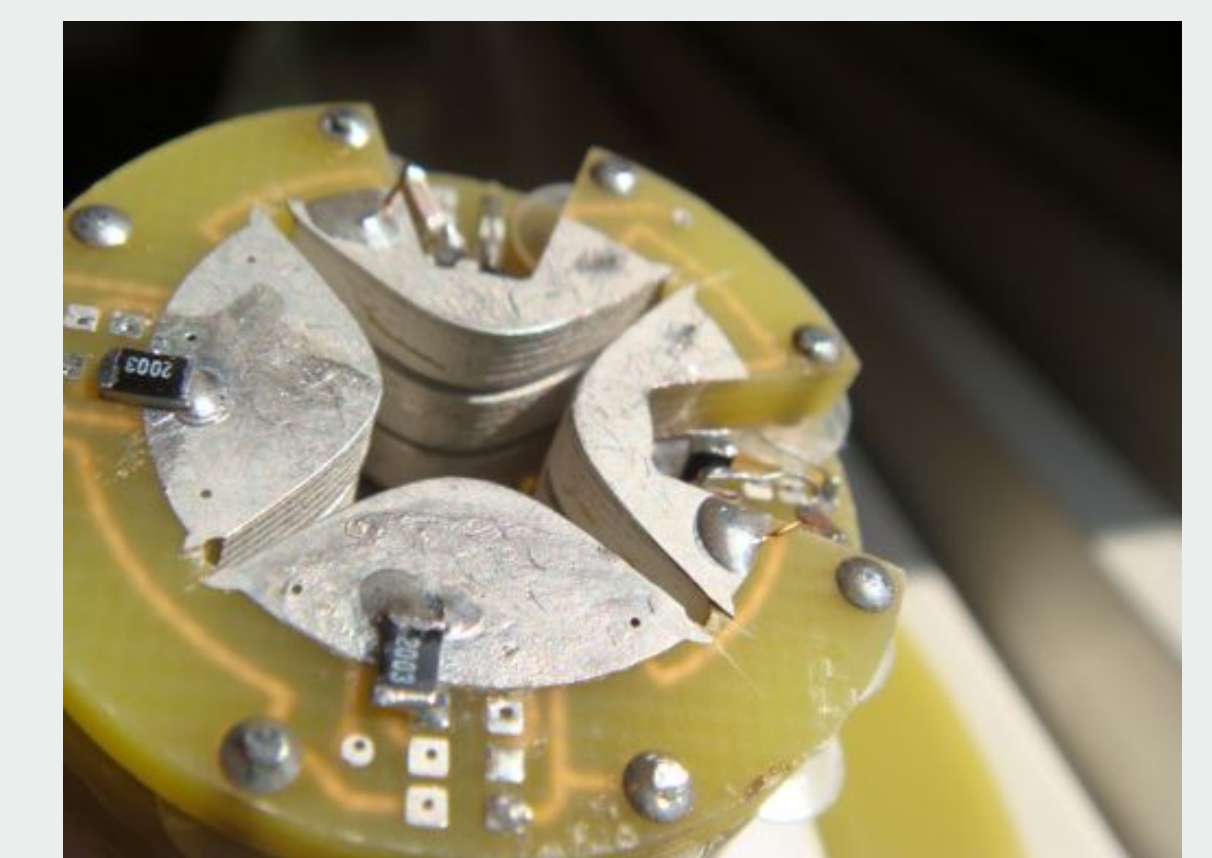


RF potential within the IonGuide

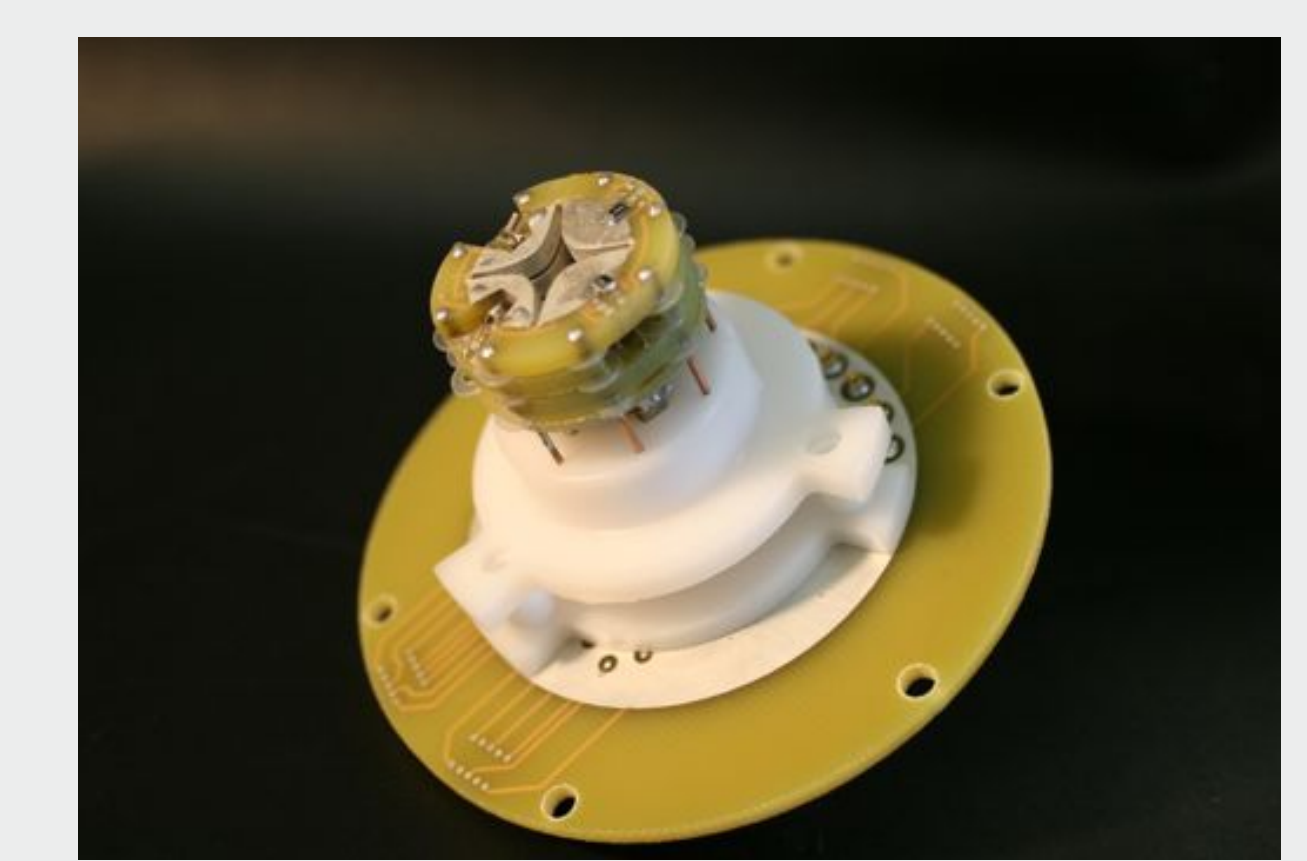
Example of Quadrupole Ion WaveGuide with PCB-Stack



Single slice with hyperbolic electrodes



slice stack

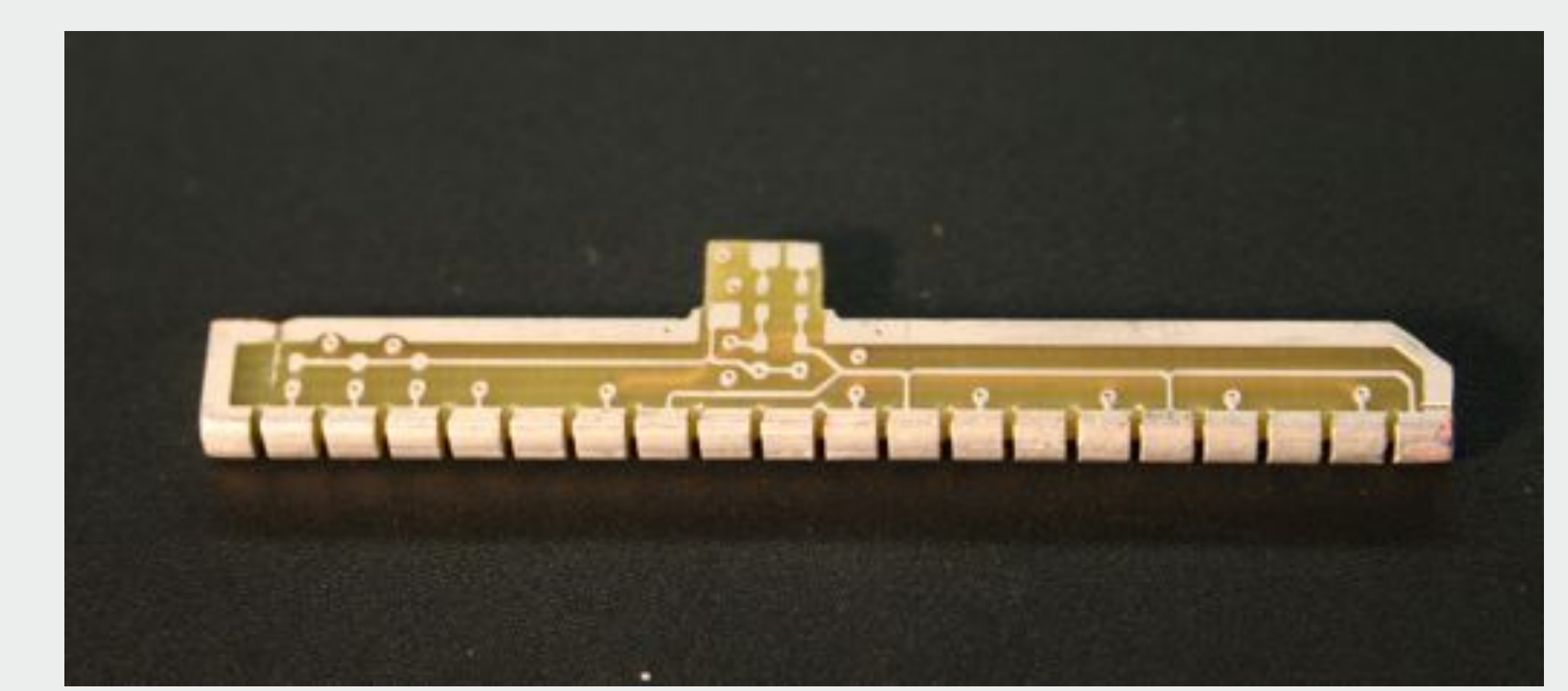


slice stack on carrier

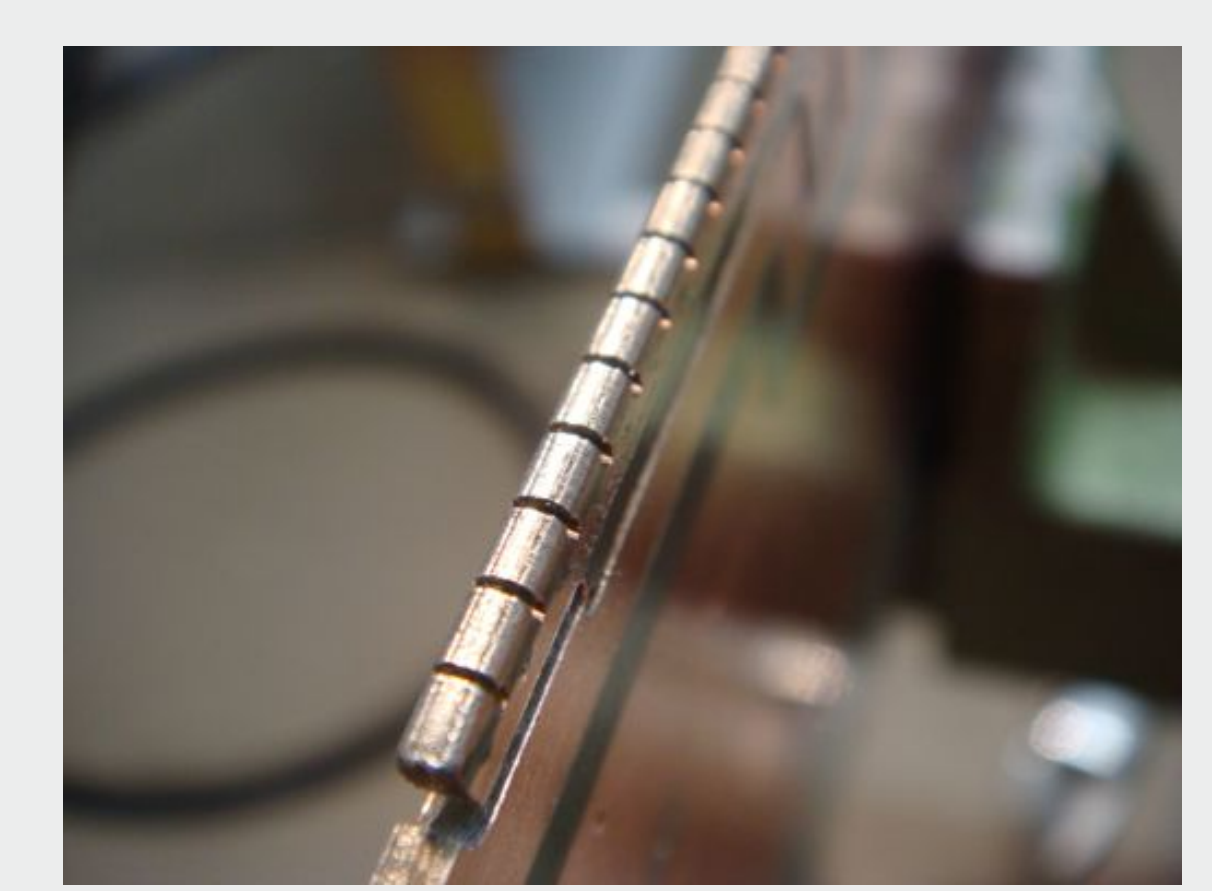


Complete WaveGuide

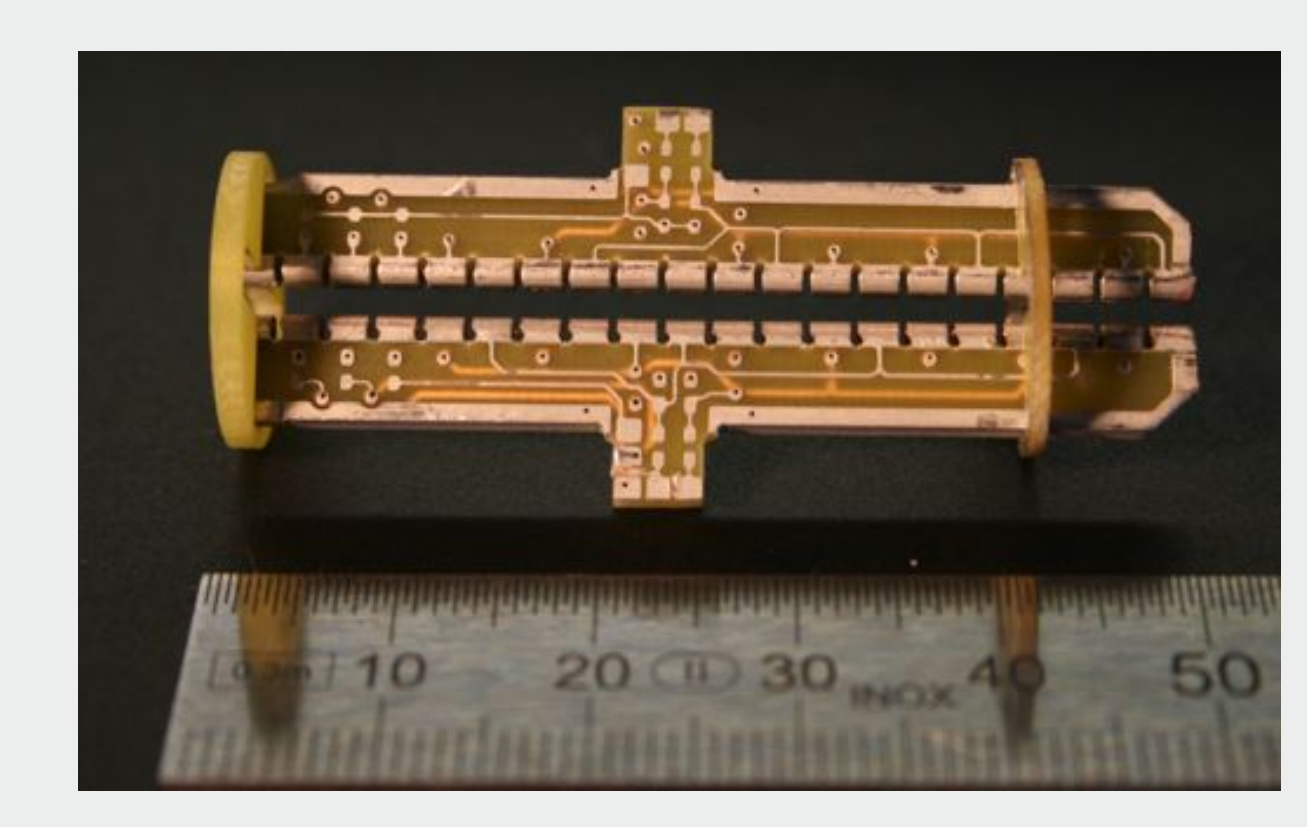
Miniature Quadrupole Ion WaveGuide



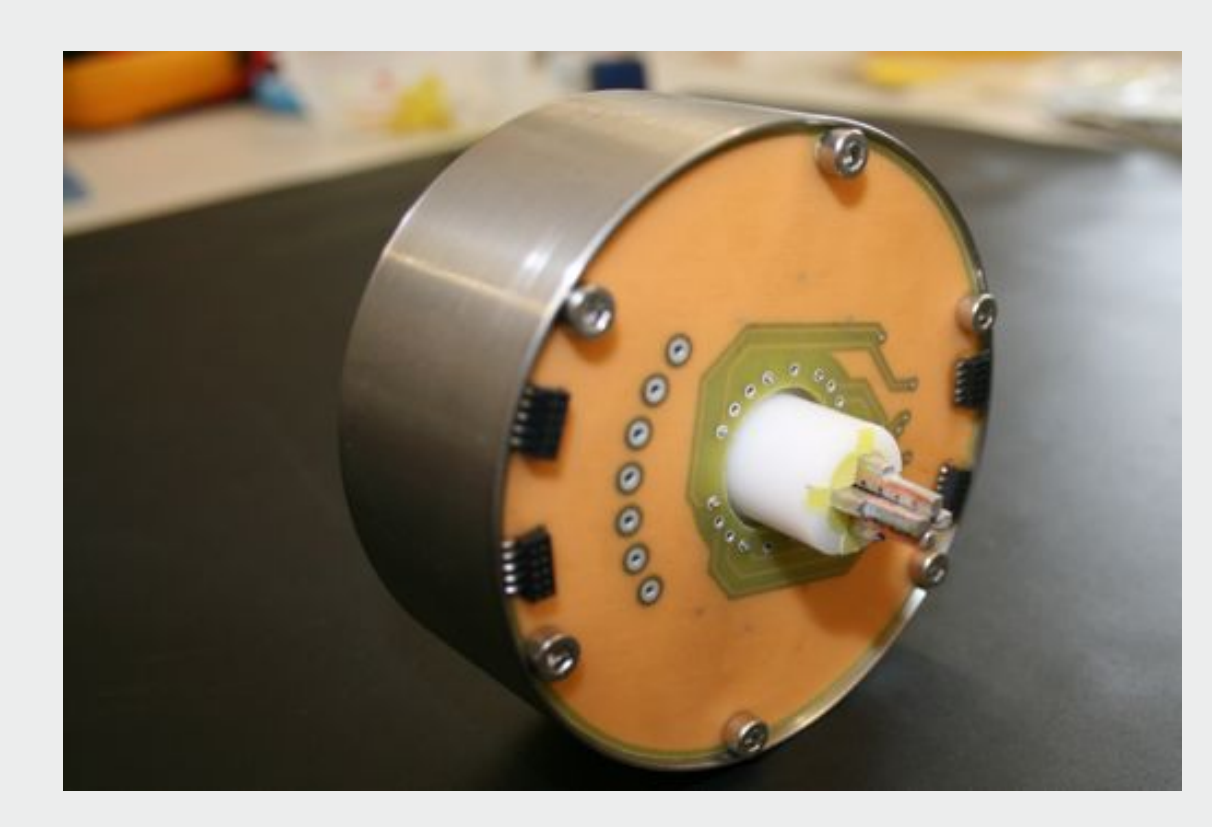
Single PCB with segmented electrodes



view onto shaped electrodes



assembled ion wave guide



complete system