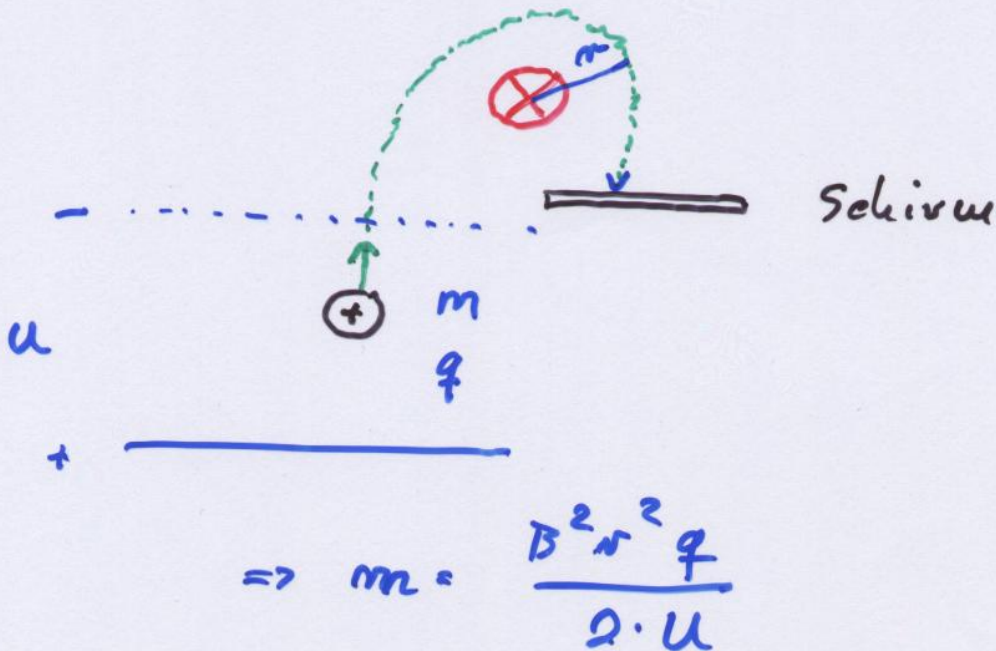


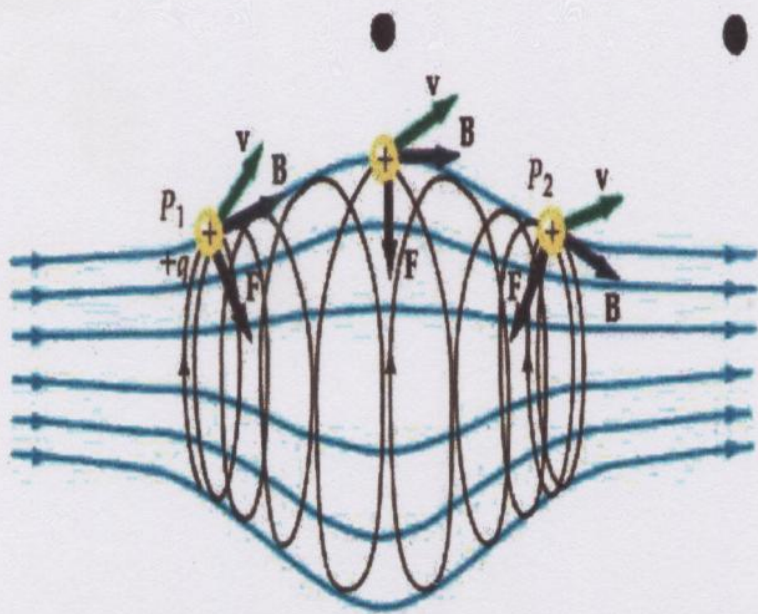
# Anwendungen

## a) Massenspektrometer

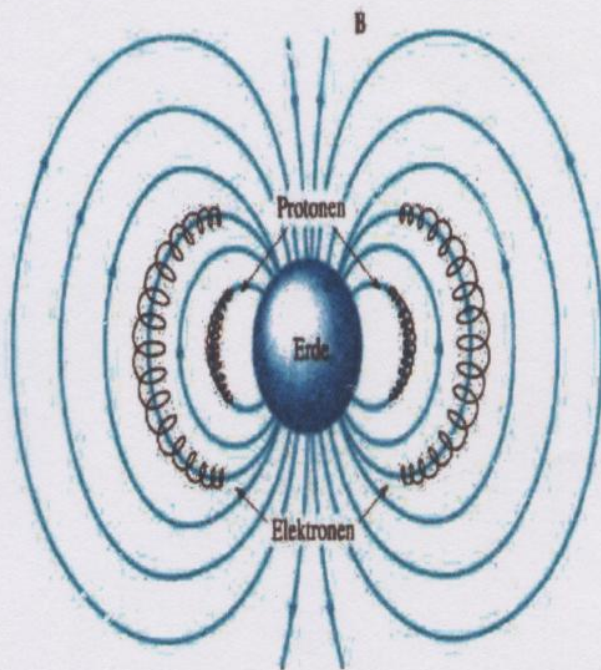


## b) Magnetische Flaschen, Fallon

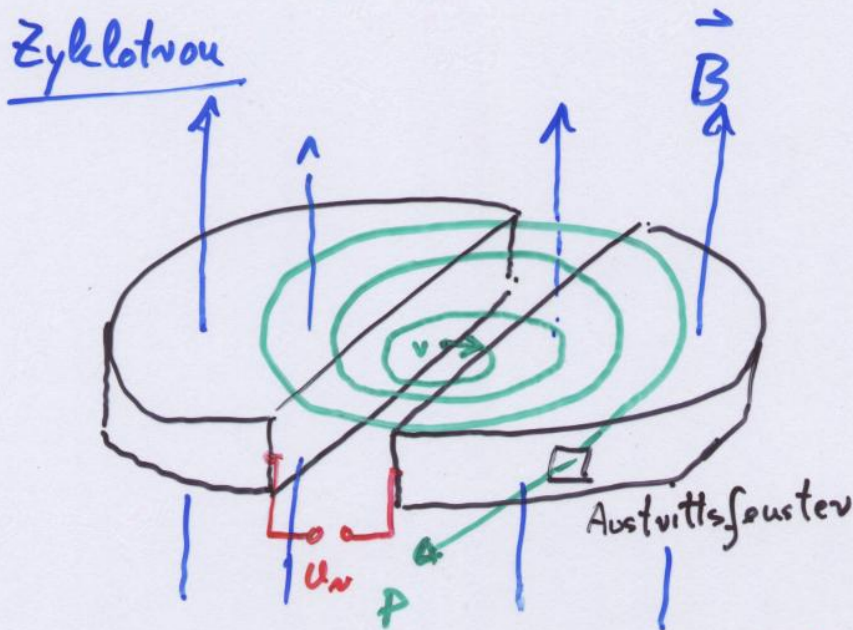
Objekte, die geladene Teilchen einschließen



Bewegung in  
 inhomogenen  
 Feldern:  
 magn. "Flaschen"  
 und "Fallen" möglich



### c) Teilchenbeschleuniger



$U_n$  erzeugt hochfrequentes Wechselfeld

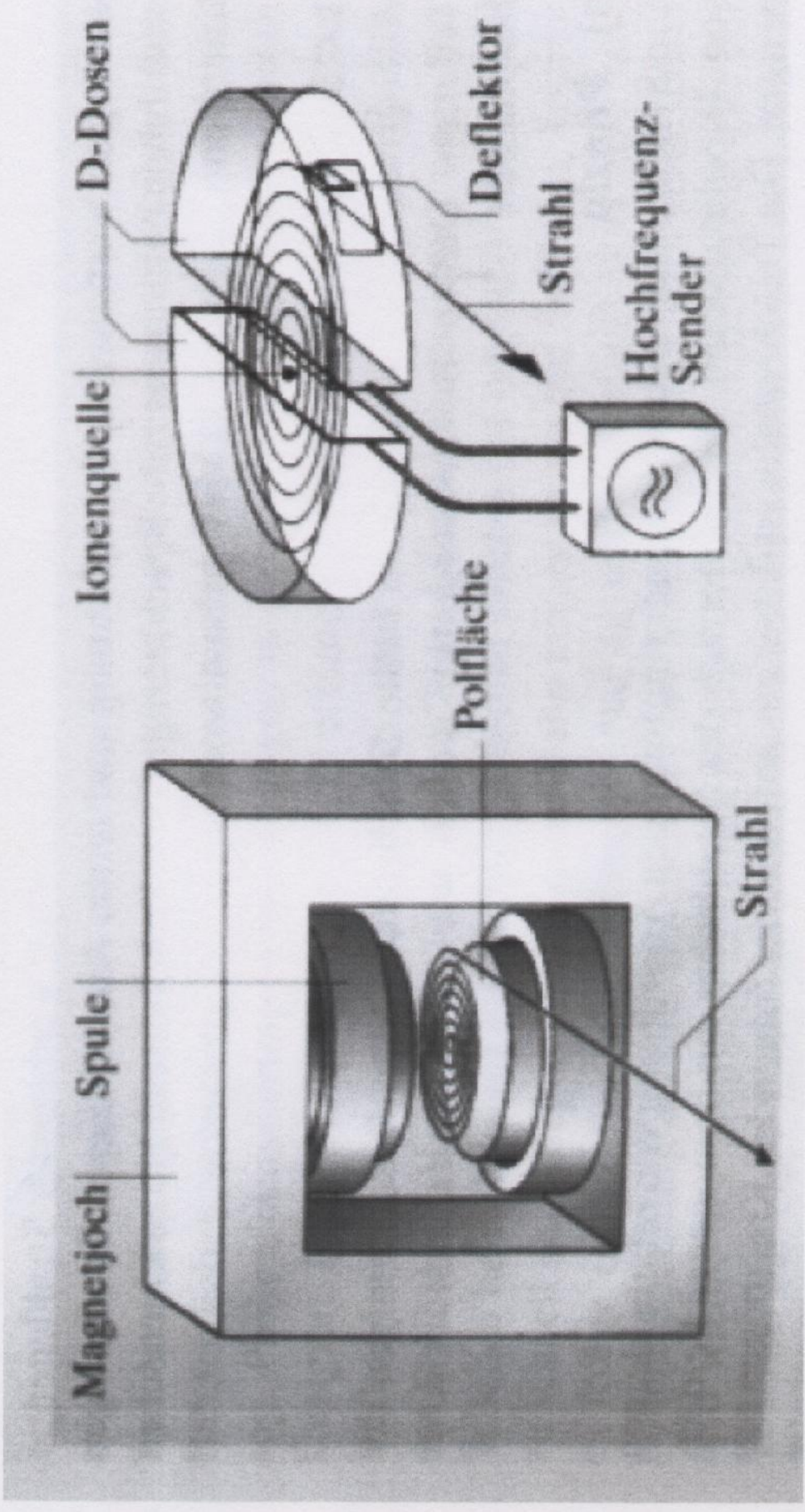
Umlauffrequenz

$$\nu = \frac{v}{2\pi r} = \frac{q \cdot B}{2\pi m} = \text{const}$$

Zyklotronfrequenz

Maximale Energien  $\sim 20 - 60 \text{ MeV}$

# Zyklotron

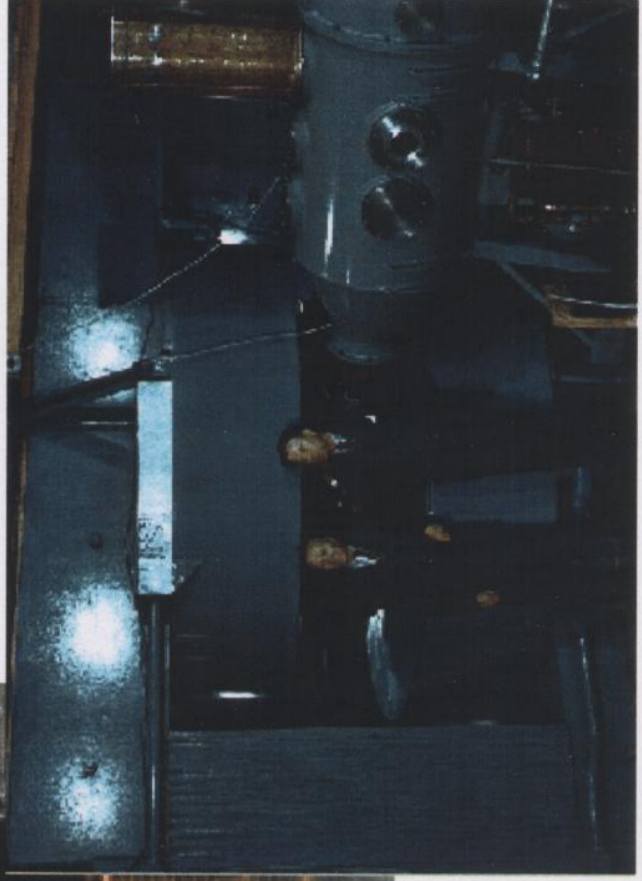


# Zyklotron

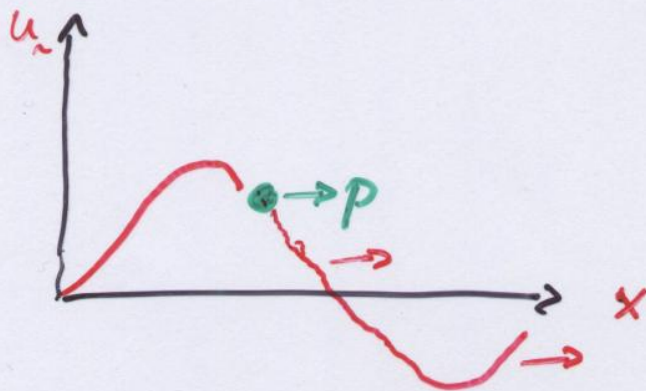
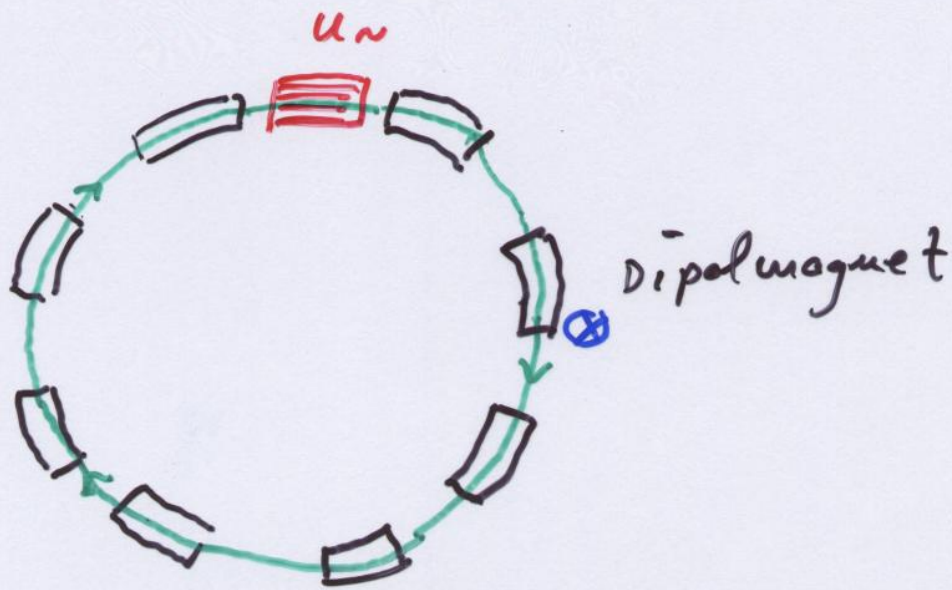
Forschungszentrum Karlsruhe



Uni Erlangen



# Synchrotron



Maximale Energie für  $e^-$ ,  $e^+$  :  
100 GeV

## a) Teilchendetektoren

$p : 4 \text{ TeV}$

Bestimmung des Impulses geladener Teilchen aus der Bohrkrümmung

# Synchrotron - groß

Forschungszentrum Karlsruhe  
in der Helmholtz-Gemeinschaft

Synchrotron Radiation

non - destructive  
materials testing  
and analysis  
microstructuring  
services for internal  
and external users

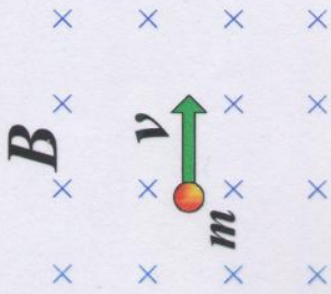


**ANKA**  
synchrotron radiation source





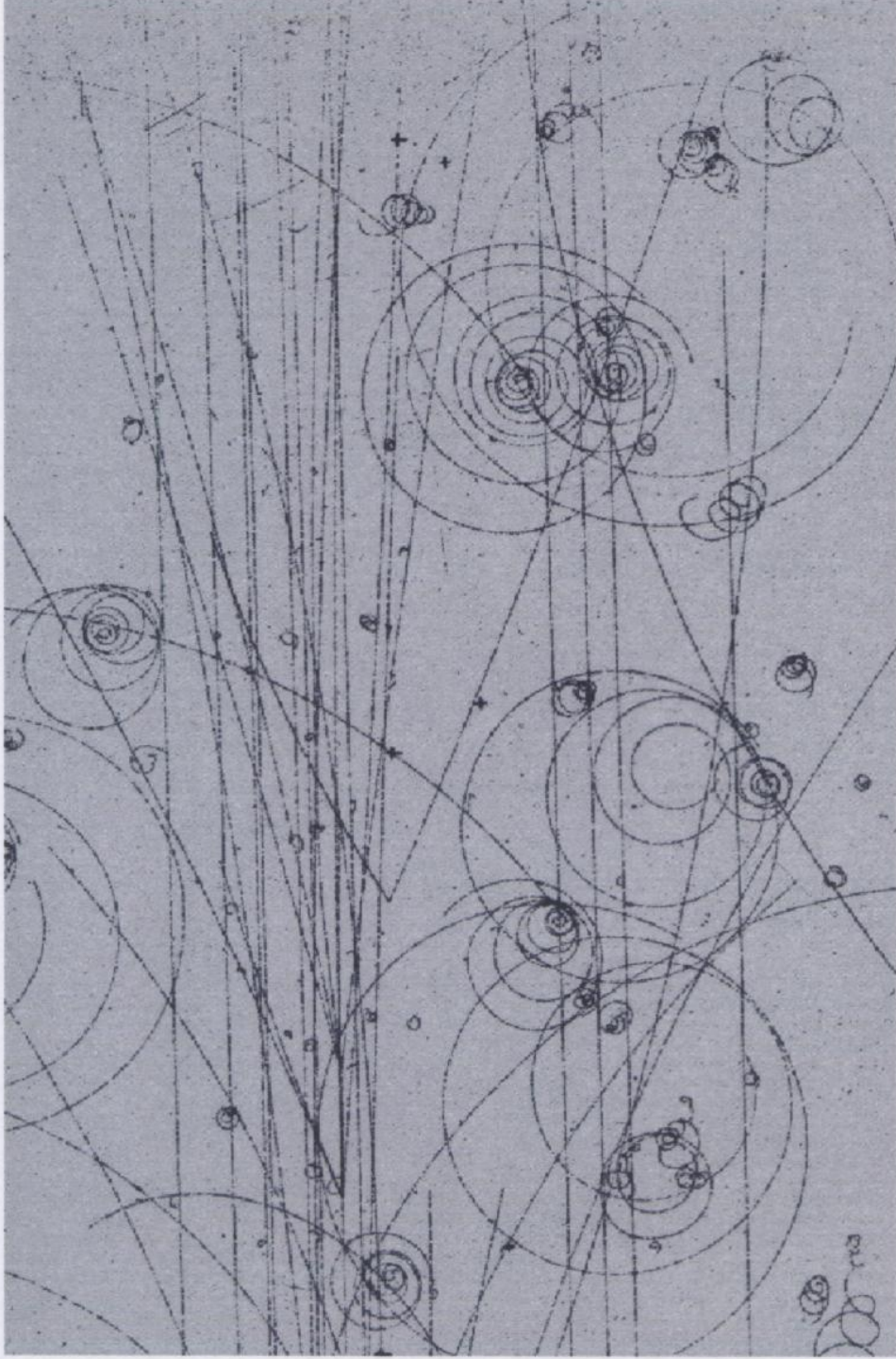
# Blasenammer



Flüssiger  
Wasserstoff

Drucksenkung  
Überheizung

Blasenbildung  
in der  
Flüssigkeit



# Impulsmessung Impulsunterdrückung



CMS Crystal Calorimeter (PbWO<sub>4</sub>)

CMS



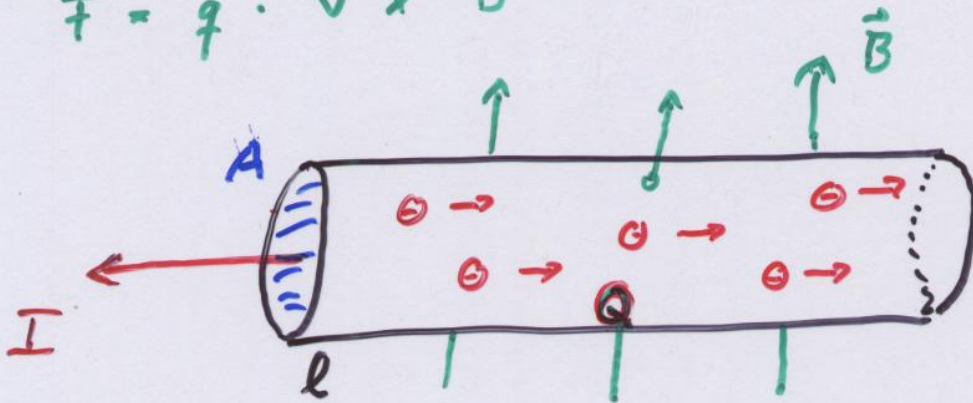
$H \rightarrow \gamma\gamma$

$m_H = 100 \text{ GeV}$

$\sigma_m = 0.5 \text{ GeV}$  at low luminosity

## 4.1.2 Kräfte auf Ströme im Magnetfeld

$$\vec{F} = q \cdot \vec{v} \times \vec{B}$$

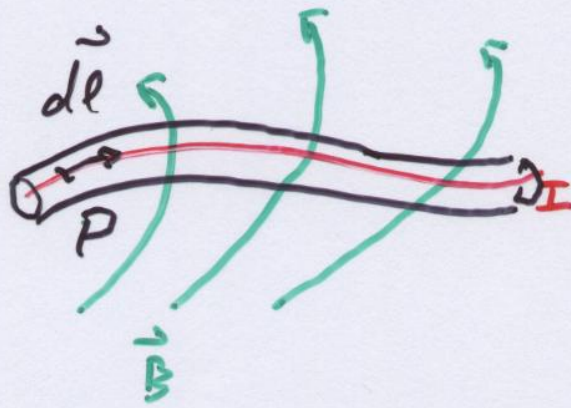


Jedes Elektron spürt Kraft:  $\vec{F}_i = -e \cdot \vec{v}_D \times \vec{B}$

$$\begin{aligned} I &= \int_A \vec{j} d\vec{A} = \rho \cdot \vec{v}_D \cdot A \\ &= \frac{Q}{V} \cdot v_D \cdot A \\ &= \frac{Q \cdot v_D}{l} \end{aligned}$$

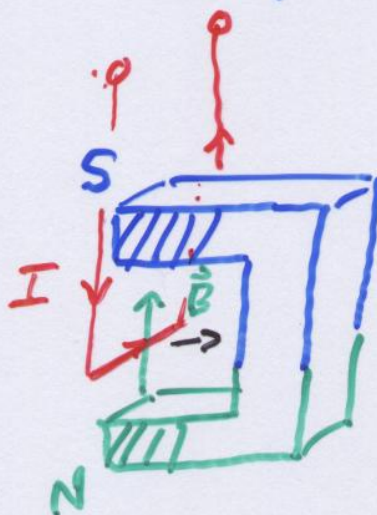
$$\begin{aligned} \vec{F} &= Q \cdot \vec{v}_D \times \vec{B} \\ &= I \cdot l \cdot \frac{\vec{v}_D}{|\vec{v}_D|} \times \vec{B} \\ &= I \cdot \vec{l} \times \vec{B} \end{aligned}$$

$$d\vec{F} = I \cdot d\vec{\ell} \times \vec{B}$$

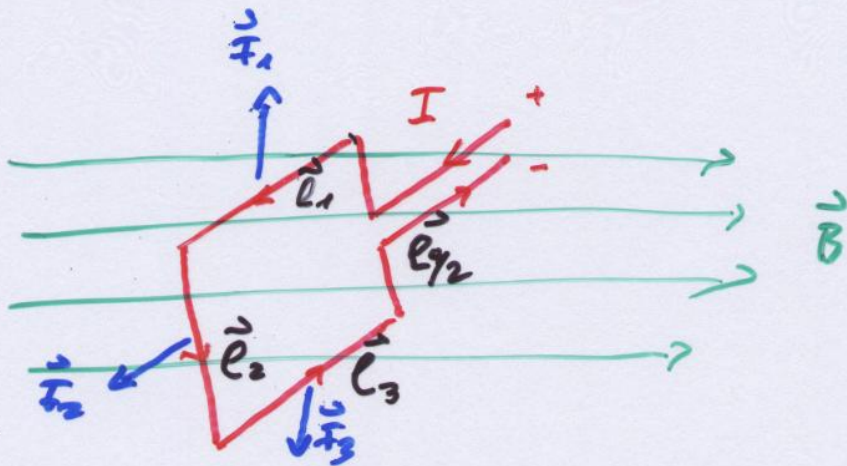


$$\vec{F} = I \cdot \int_P d\vec{\ell} \times \vec{B}$$

- Demo : Kraft auf Draht in Hufeisenmagneten



# Kraft auf Stromschleife



$$\vec{F}_1 = I \cdot \vec{l}_1 \times \vec{B}$$

$$\vec{F}_2 = I \cdot \vec{l}_2 \times \vec{B}$$

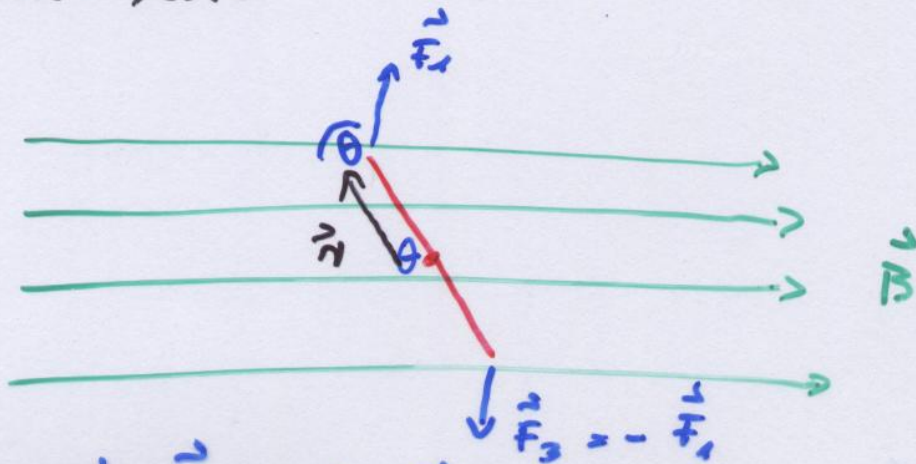
$$\vec{F}_3 = I \cdot \vec{l}_3 \times \vec{B}$$

$$\vec{F}_4 = I \cdot \vec{l}_4 \times \vec{B}$$

(Für  $l_1 = l_2 = l_3 = l_4$ ):

$$\sum \vec{F}_i = 0$$

Von der Seite:



Drehmoment:  $\vec{D} = 2 \vec{n} \times \vec{F}_1$

$$D = I \cdot l_x \cdot l_y \cdot B \cdot \sin \theta$$

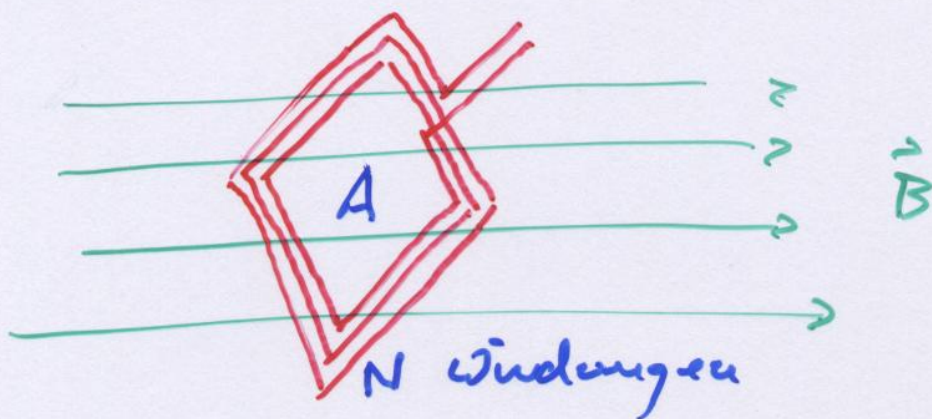
$$= I \cdot A \cdot B \cdot \sin \theta$$

$$\vec{D} = \underbrace{I \cdot \vec{A}} \times \vec{B}$$

$$= \vec{m} \times \vec{B}$$

Magnetisches Moment  $[A \cdot m^2]$

### • Spule im B-Feld



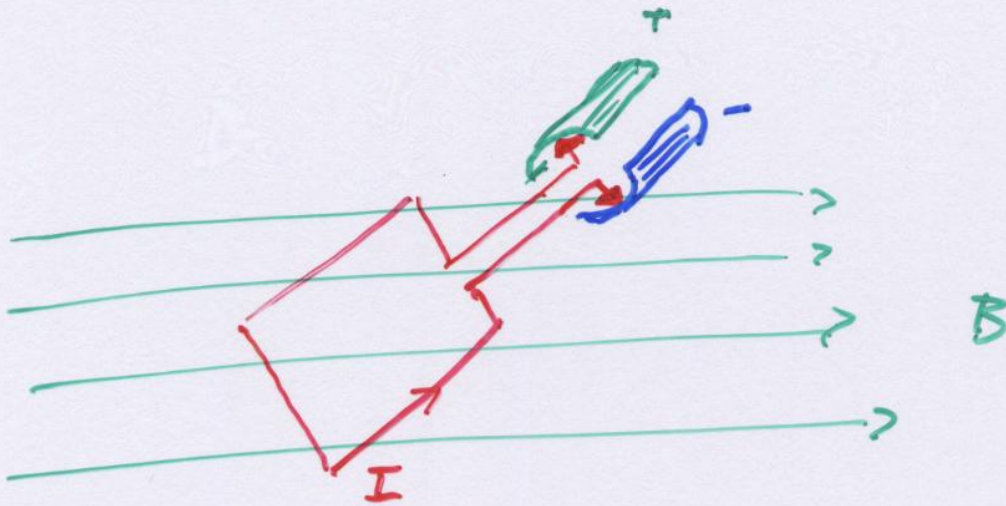
$$m = N \cdot I \cdot A$$

$$D = N \cdot I \cdot A \cdot B$$

Anwendungen:

a) Galvanometer:  $I \sim D$

## b) Elektromotor



Prinzip: Schleifkontakt so angeordnet,  
dass Strom nach  $\frac{1}{2}$  Drehung Richtung  
wechselt  $\Rightarrow$  Drehmoment wirkt immer  
in dieselbe Richtung