

# Designing a Time Projection Chamber for Schools



CLEOPATRA

Classroom Experiment On PArticle TRacking

DPG Spring Meeting Karlsruhe

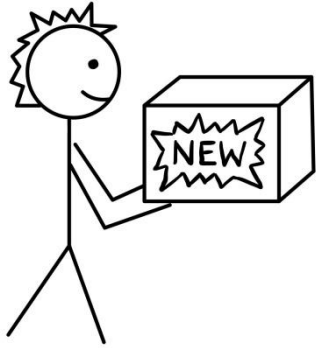
08.03.2024

Annika Hoverath



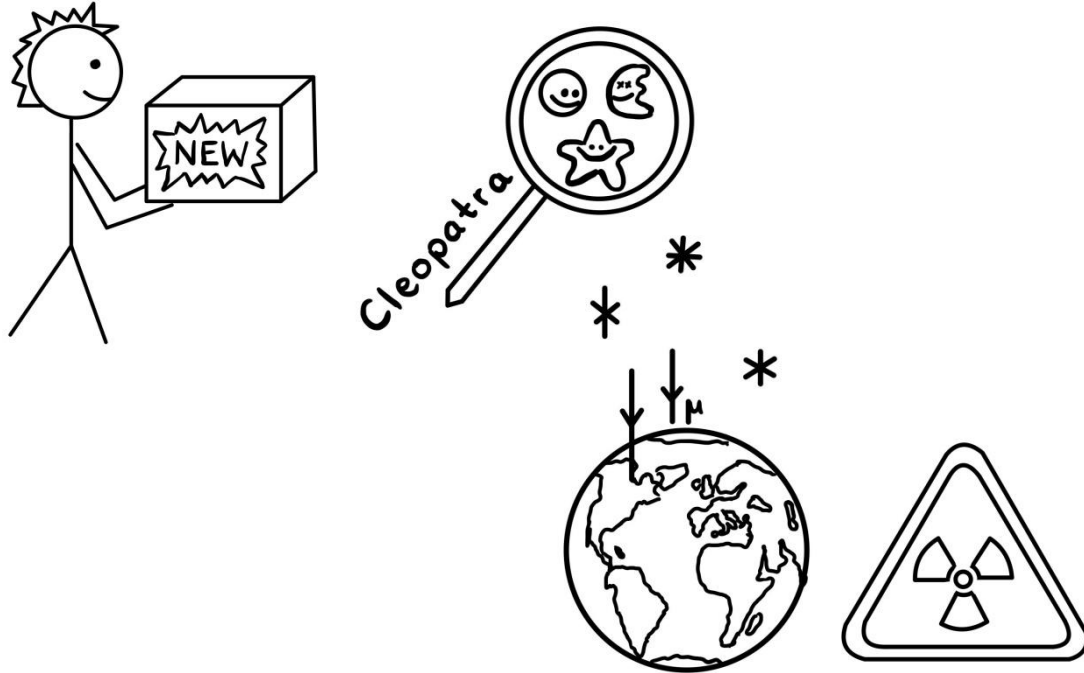
# CLEOPATRA - Goals

- Classroom Experiment On PArticle TRAcking



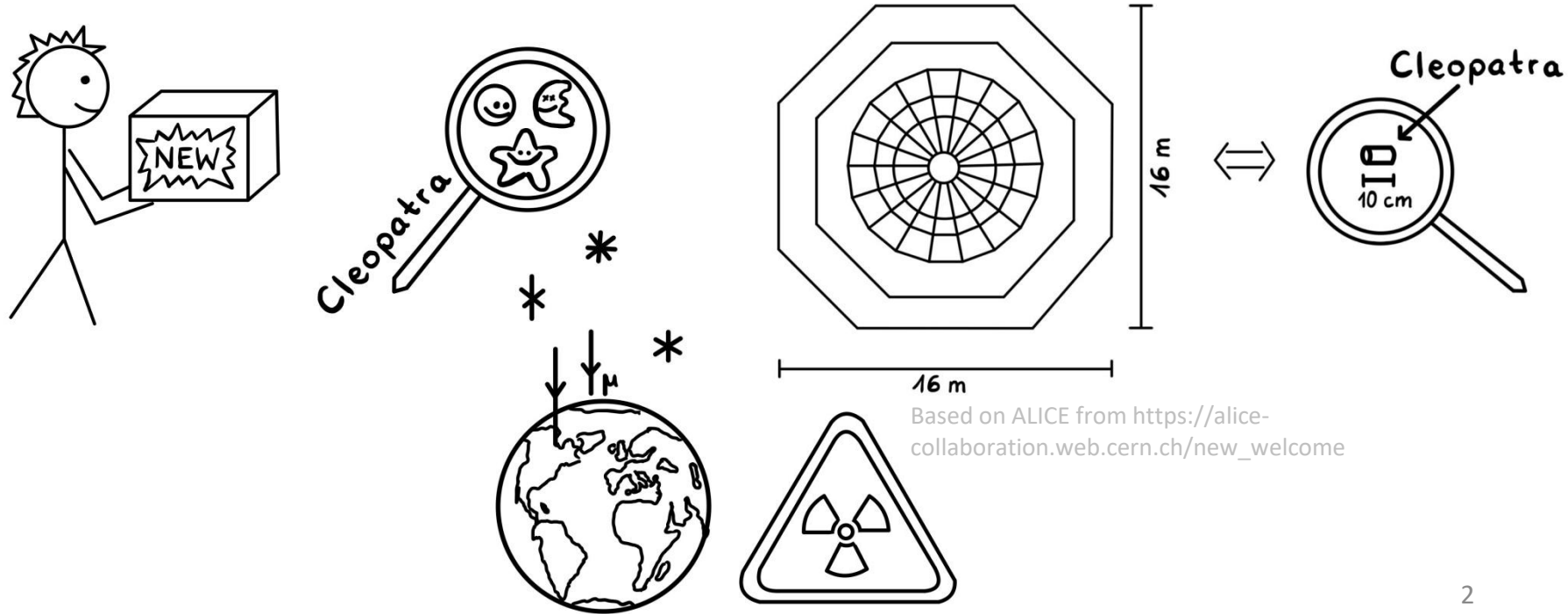
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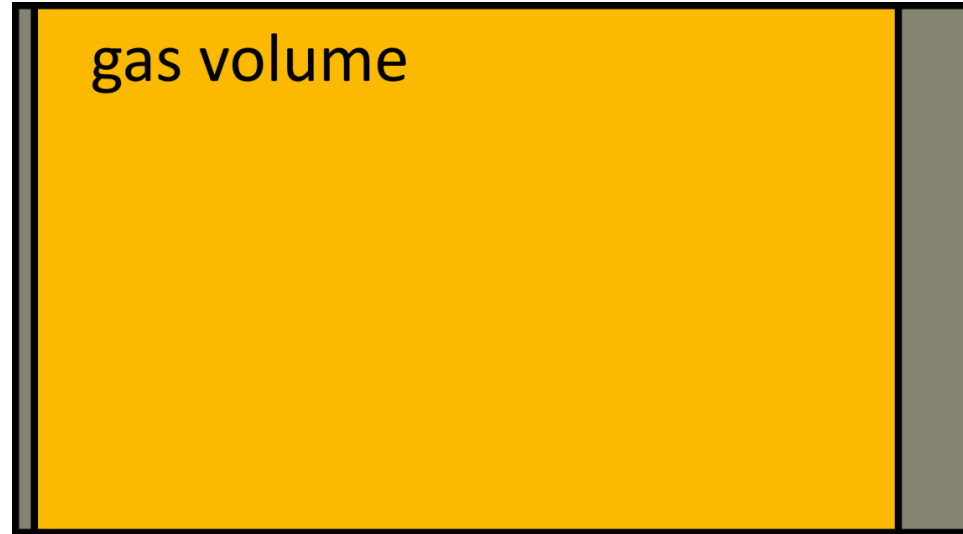


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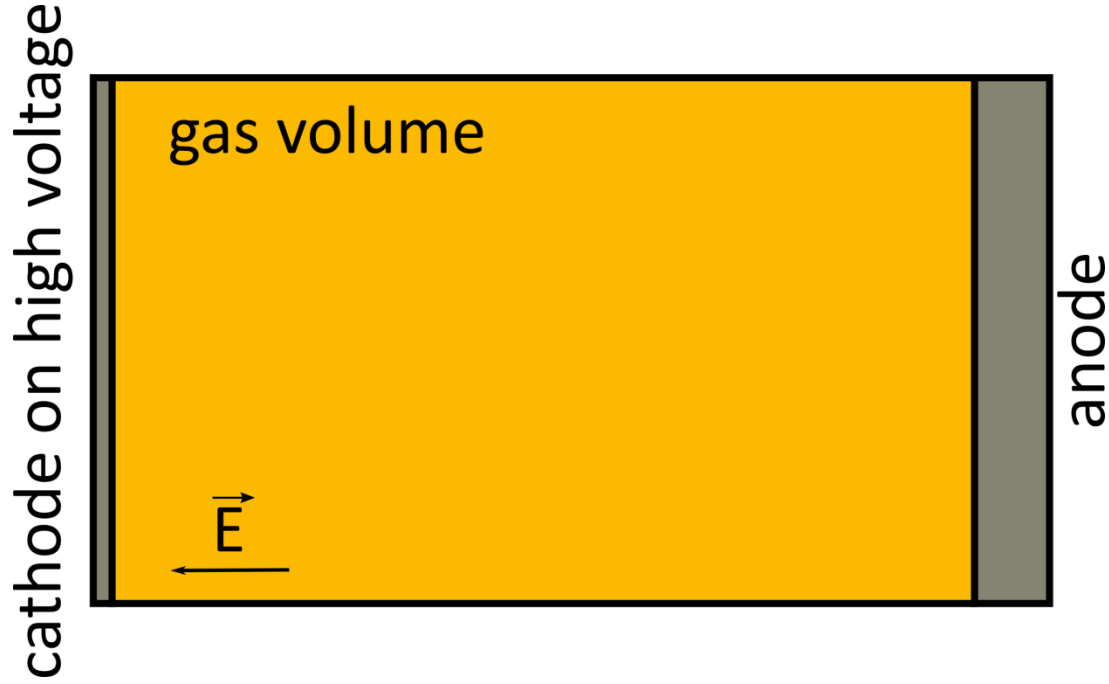
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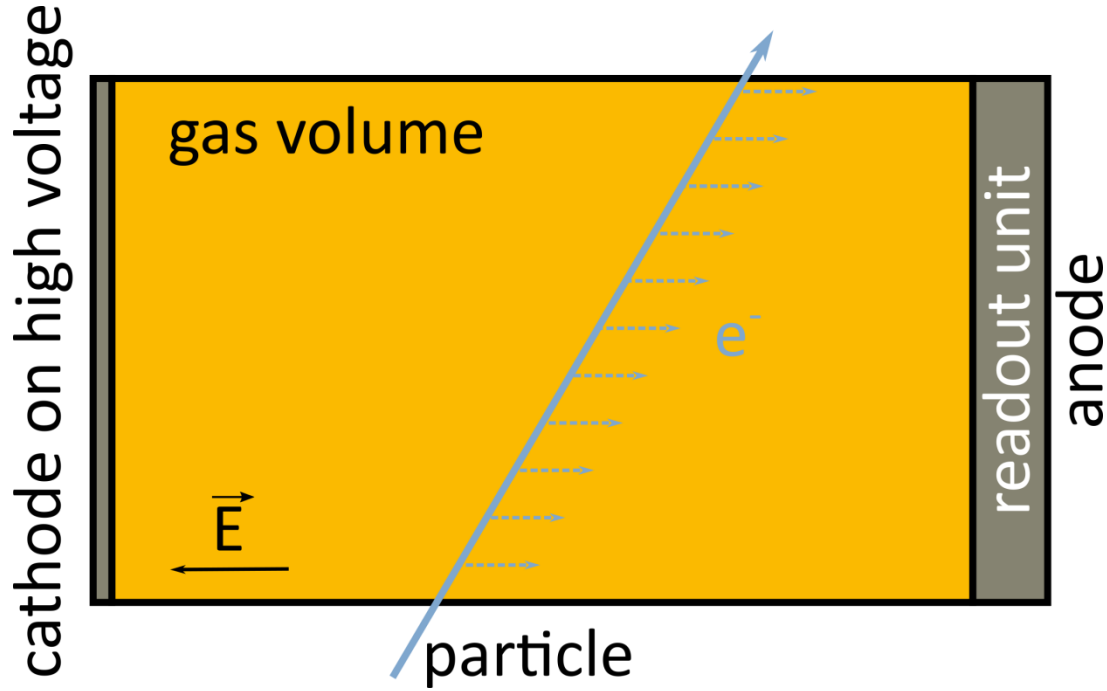
# Time Projection Chamber



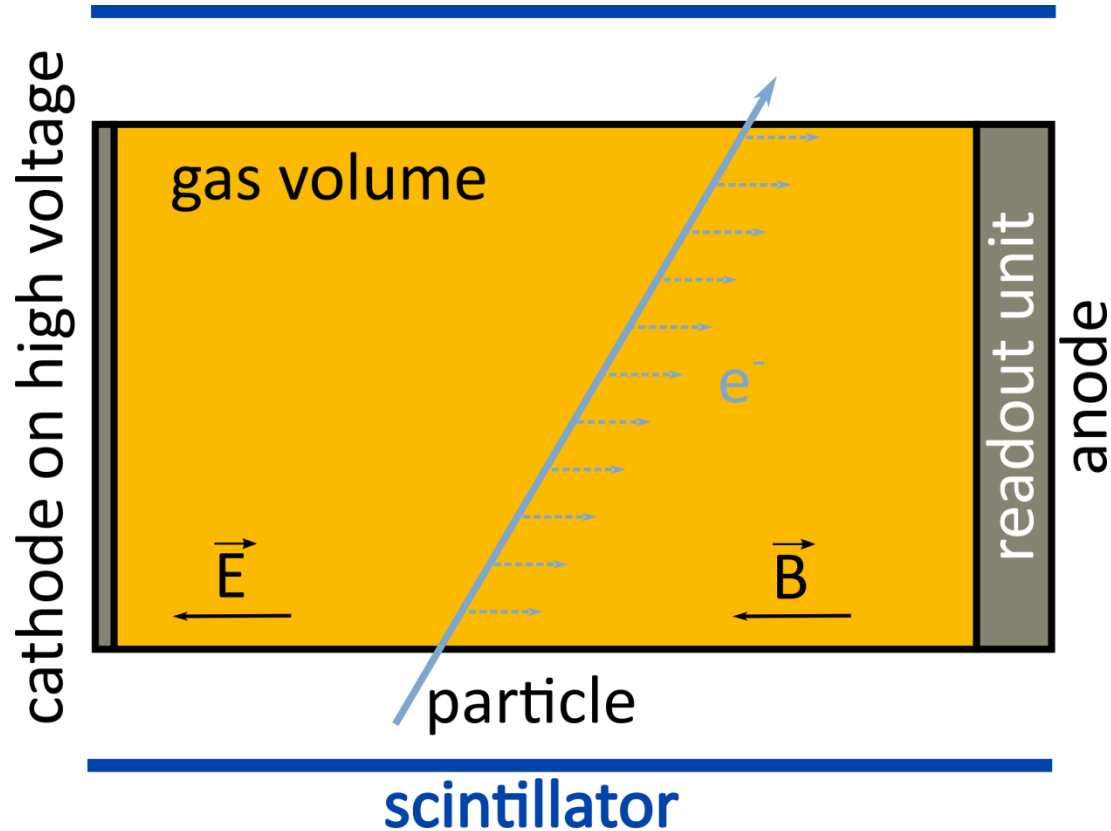
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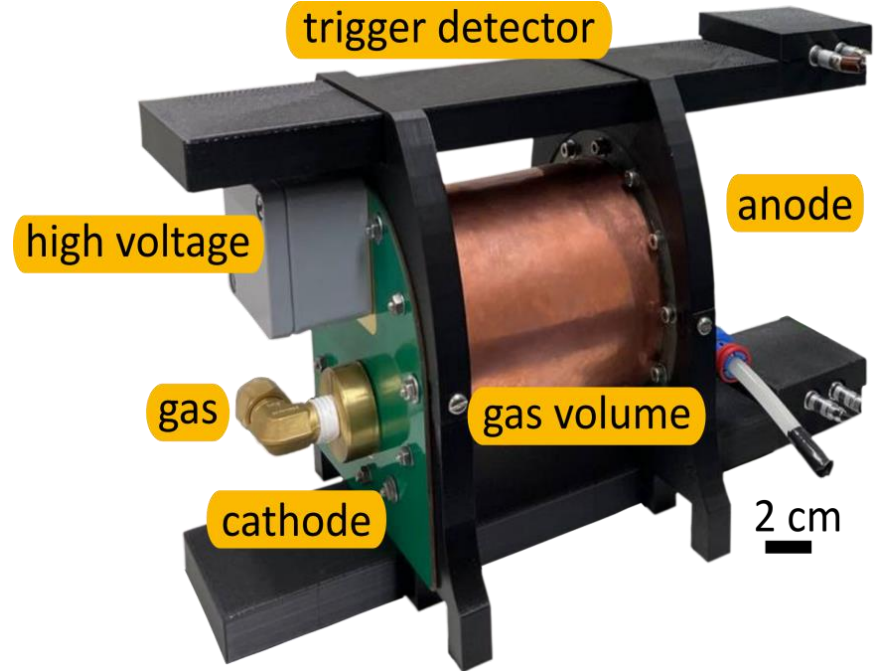
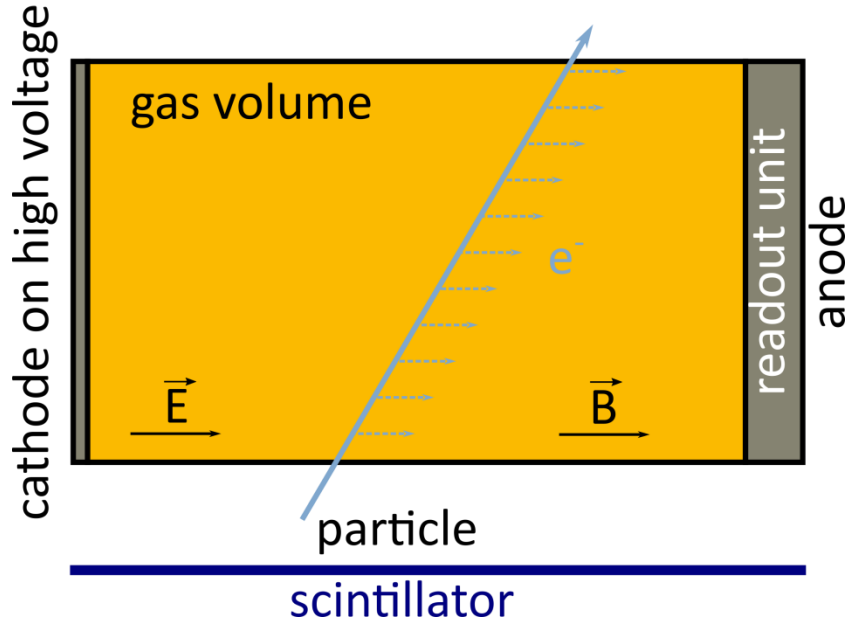


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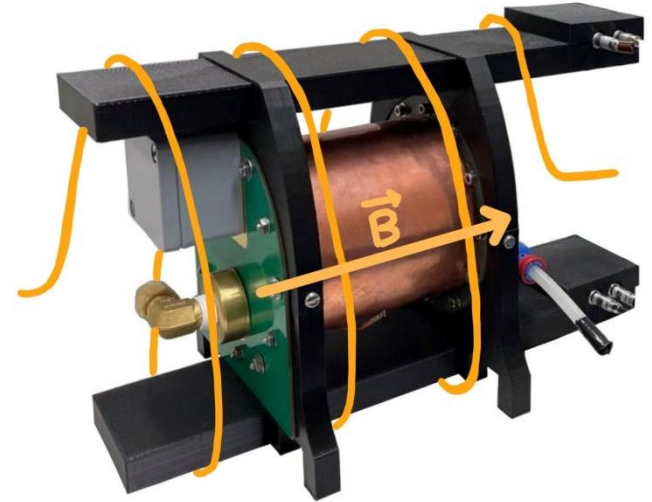


# CLEOPATRA - Setup



# Current Developments

- Magnetic field



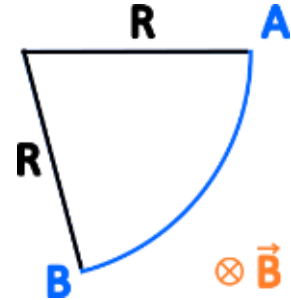
# Current Developments

- Magnetic field
- Scintillator



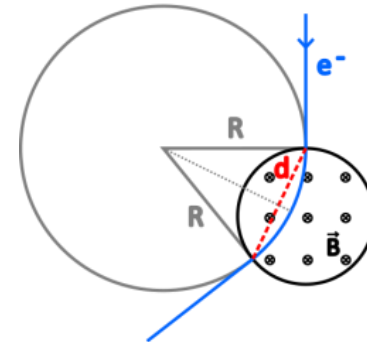
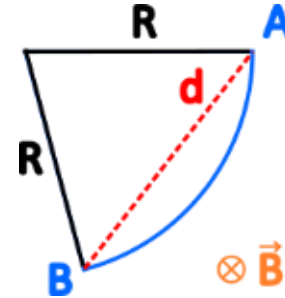
# Magnetic Field - Estimation

- Sagitta method
- $\overline{AB}$ : bent particle track



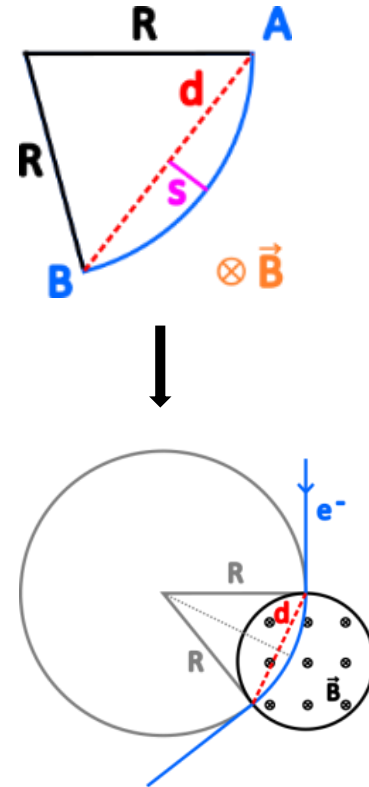
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- Sagitta method
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- $d$ : distance between A & B



# Magnetic Field - Estimation

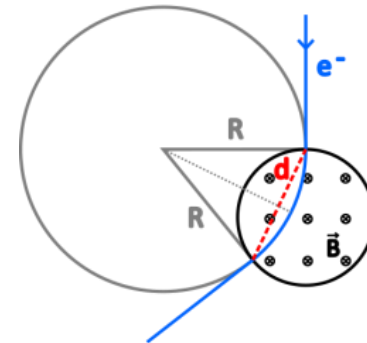
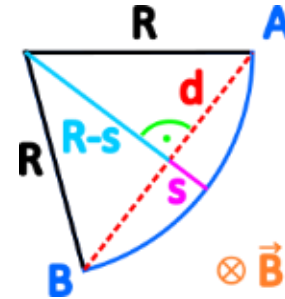
- Sagitta method
- $\overline{AB}$ : bent particle track
- $d$ : distance between A & B
- Goal: distinguish lines
- $s$ : minimal resolvable distance



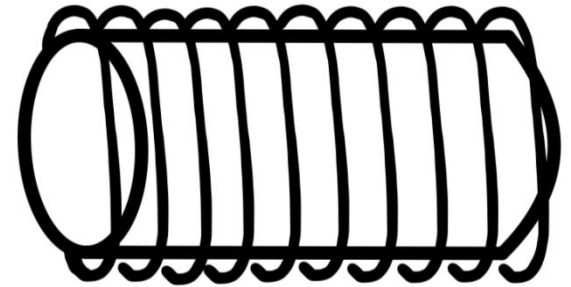
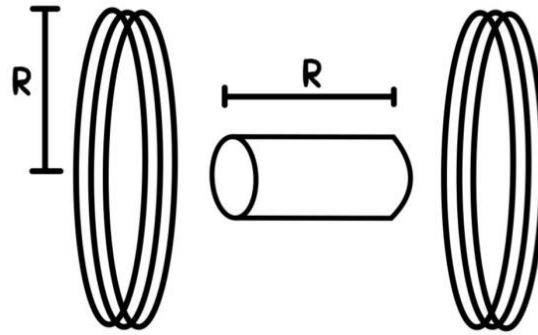
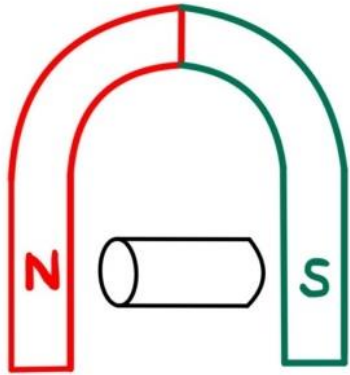
# Magnetic Field - Estimation

- Bent particles:  $^{90}\text{Sr}$
- Lorentz force
- + Pythagoras

$$\rightarrow B_{min} \approx 50 \text{ mT}$$

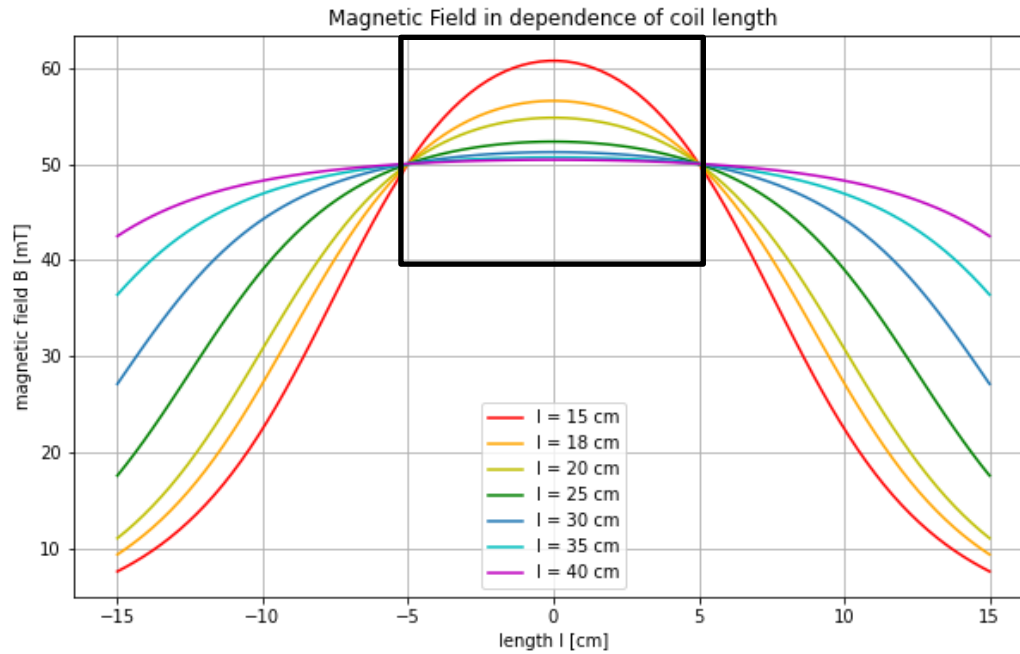


# Magnetic Field - Realization

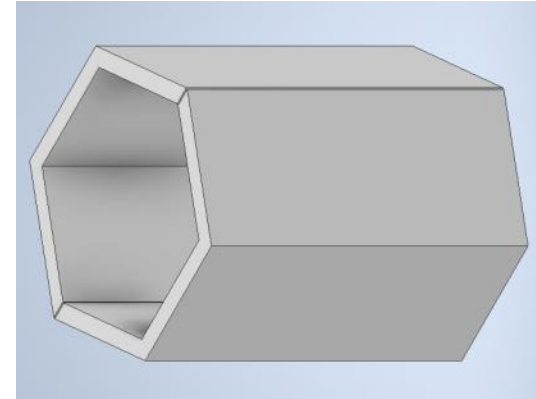
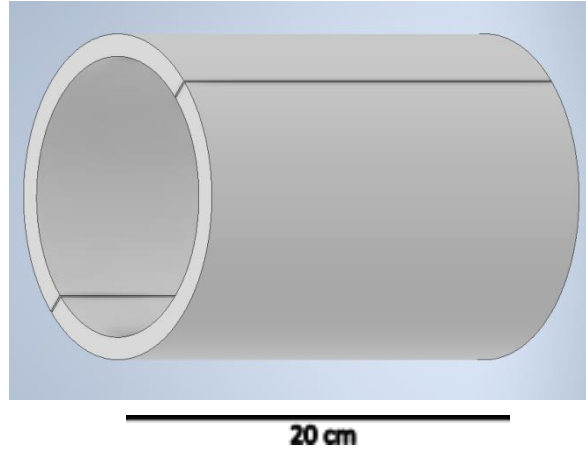
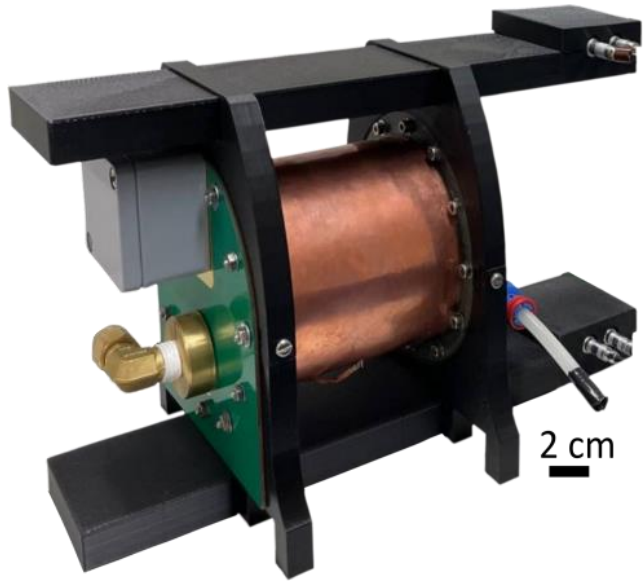




# Magnetic Field – Coil Length

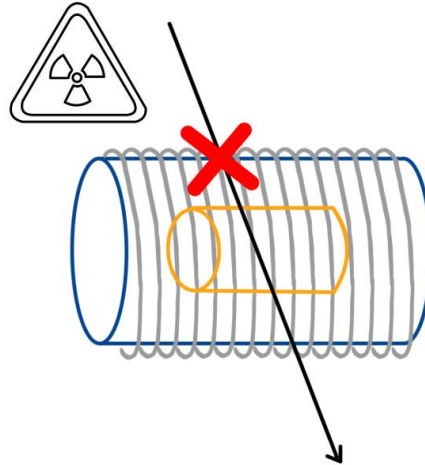


# Scintillators – Setup Ideas

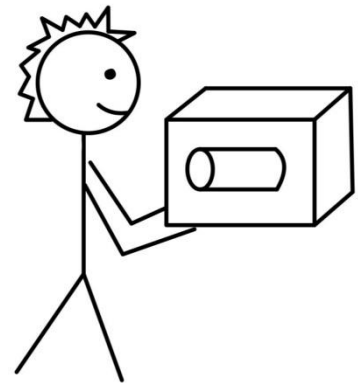


# Further Improvements

- Particles can't get through magnetic field AND scintillators  
→ separate setups

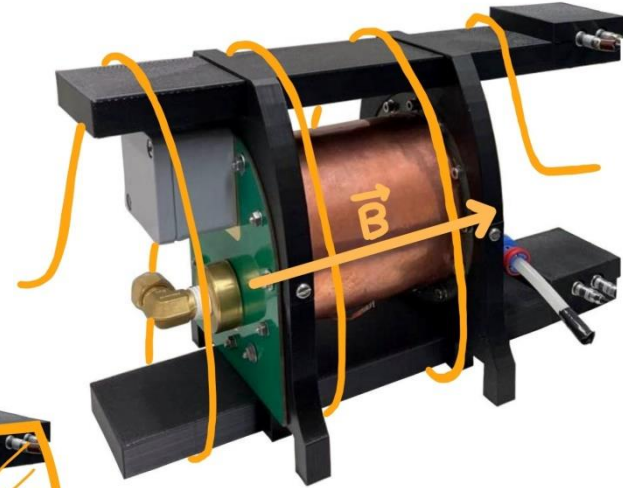


- Compact enough to send by post



# Current Developments

- Magnetic field
  - Particle identification

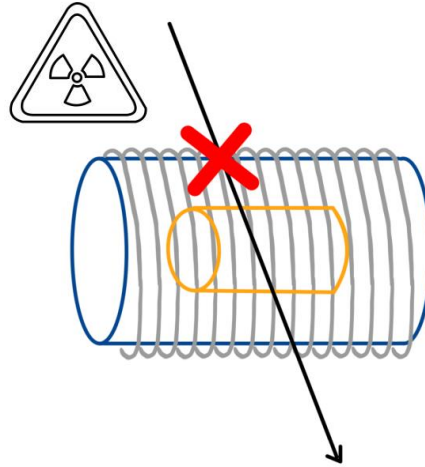


- Scintillator
  - Angle distribution

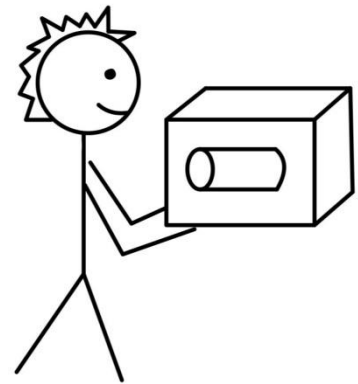


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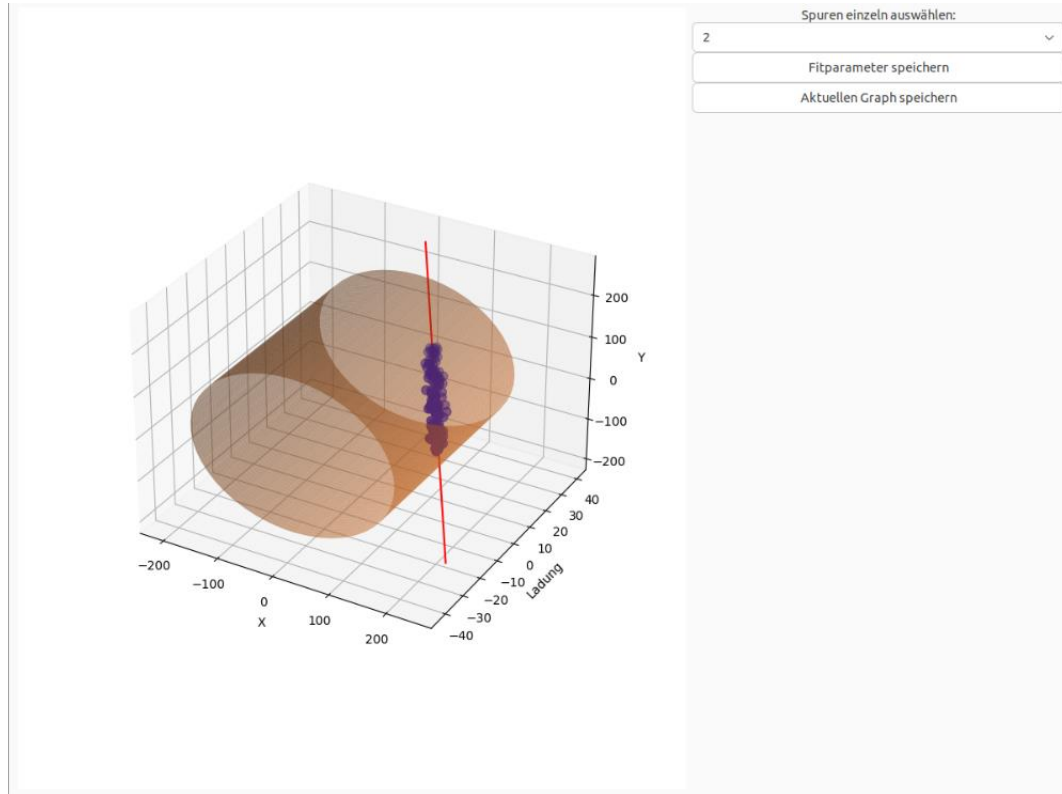
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# Backup

# Particle Tracks

Courant state of software



# Magnetic Field - Estimation

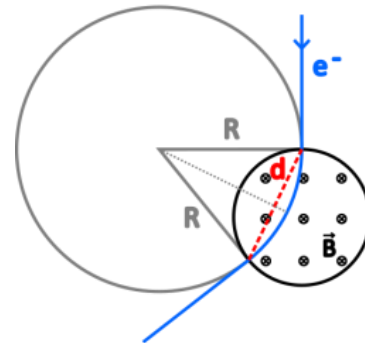
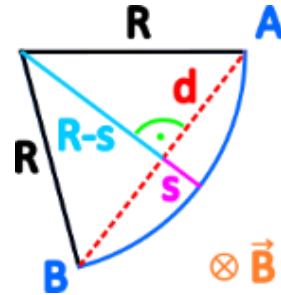
- Bent particles:  $^{90}\text{Sr}$

- $R(p) = \frac{p}{eB}$

- $R^2 = \frac{l^2}{2} + (R - s)^2$

with  $p_{max}$  of  $e^-$  of  $^{90}\text{Sr}$

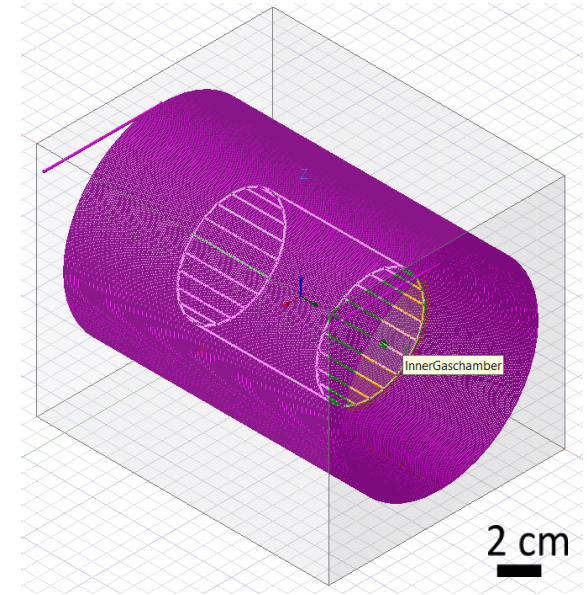
$$\rightarrow B_{min} = 50 \text{ mT}$$





# Magnetic Field – realization

Coil properties	Necessary values
Length	20 cm
Current	6.5 A
Windings	~ 1600
Wire diameter	1.5 mm
Resistance	~ 7 $\Omega$
Voltage	45 V
Power	~ 300 W



→ upper limit of possible realization