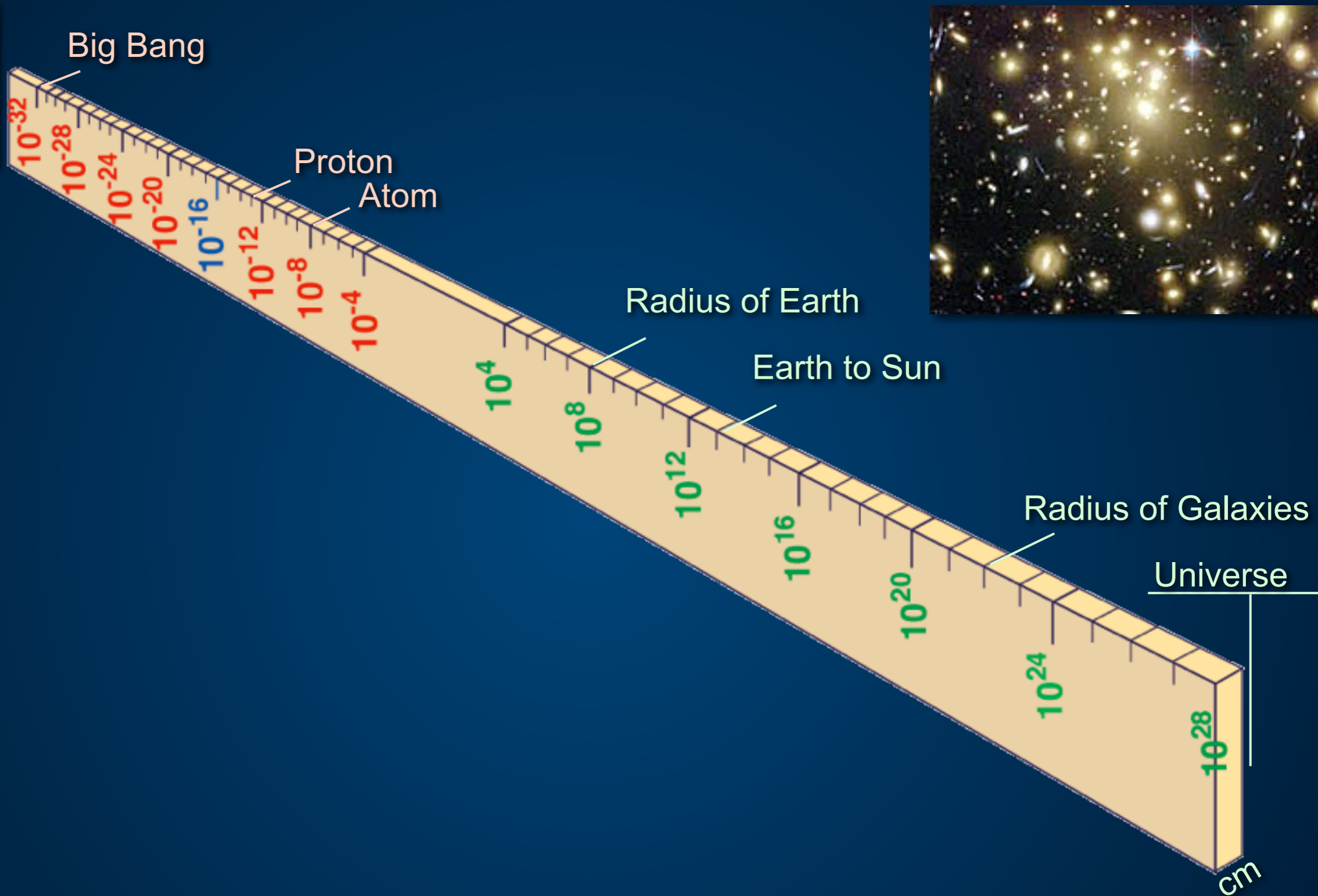


**Das Unsichtbare sichtbar,  
und das Unmögliche möglich machen**

***Die Forschung am***

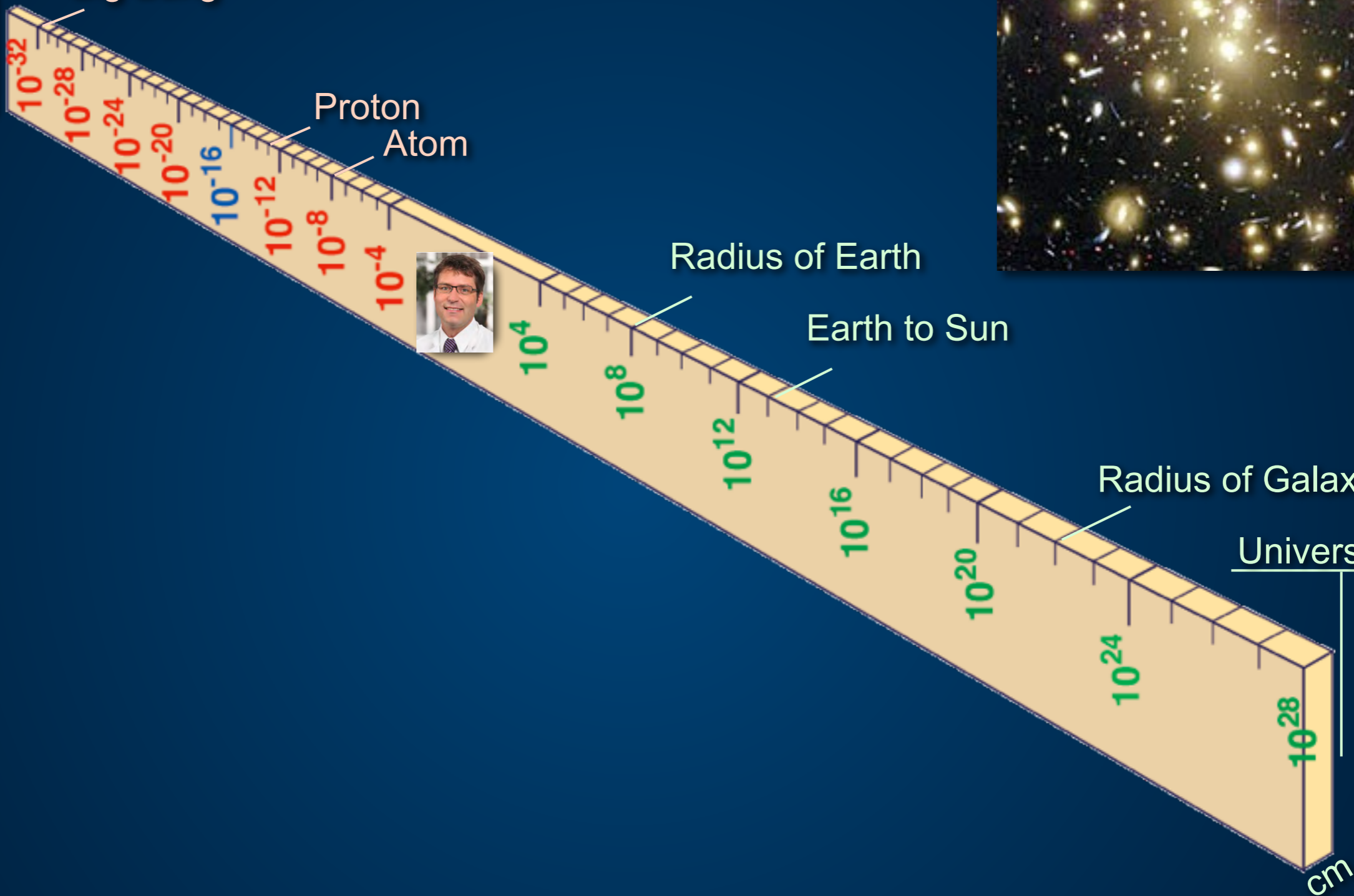


Prof. Günther Dissertori  
ETH Zürich



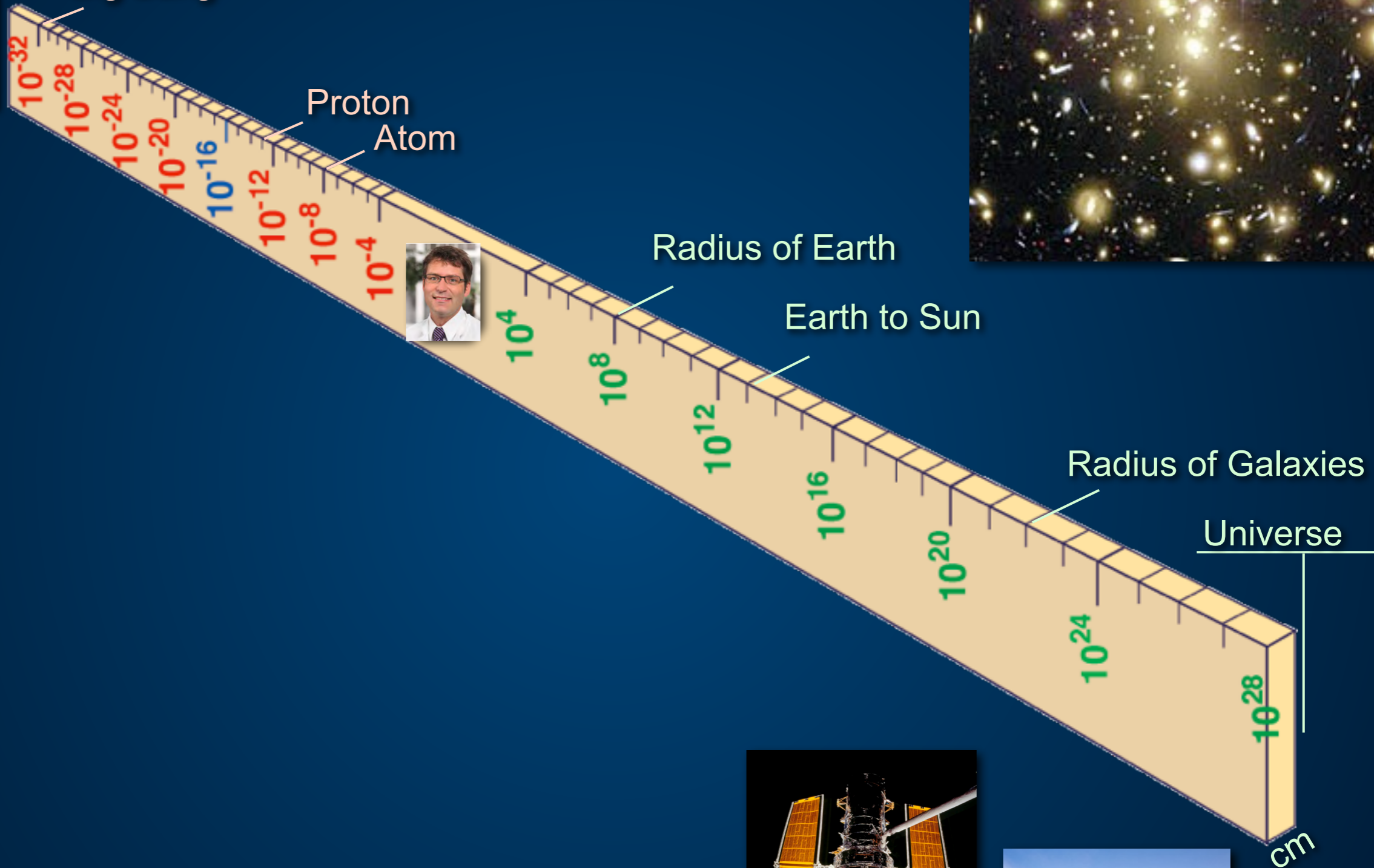


Big Bang



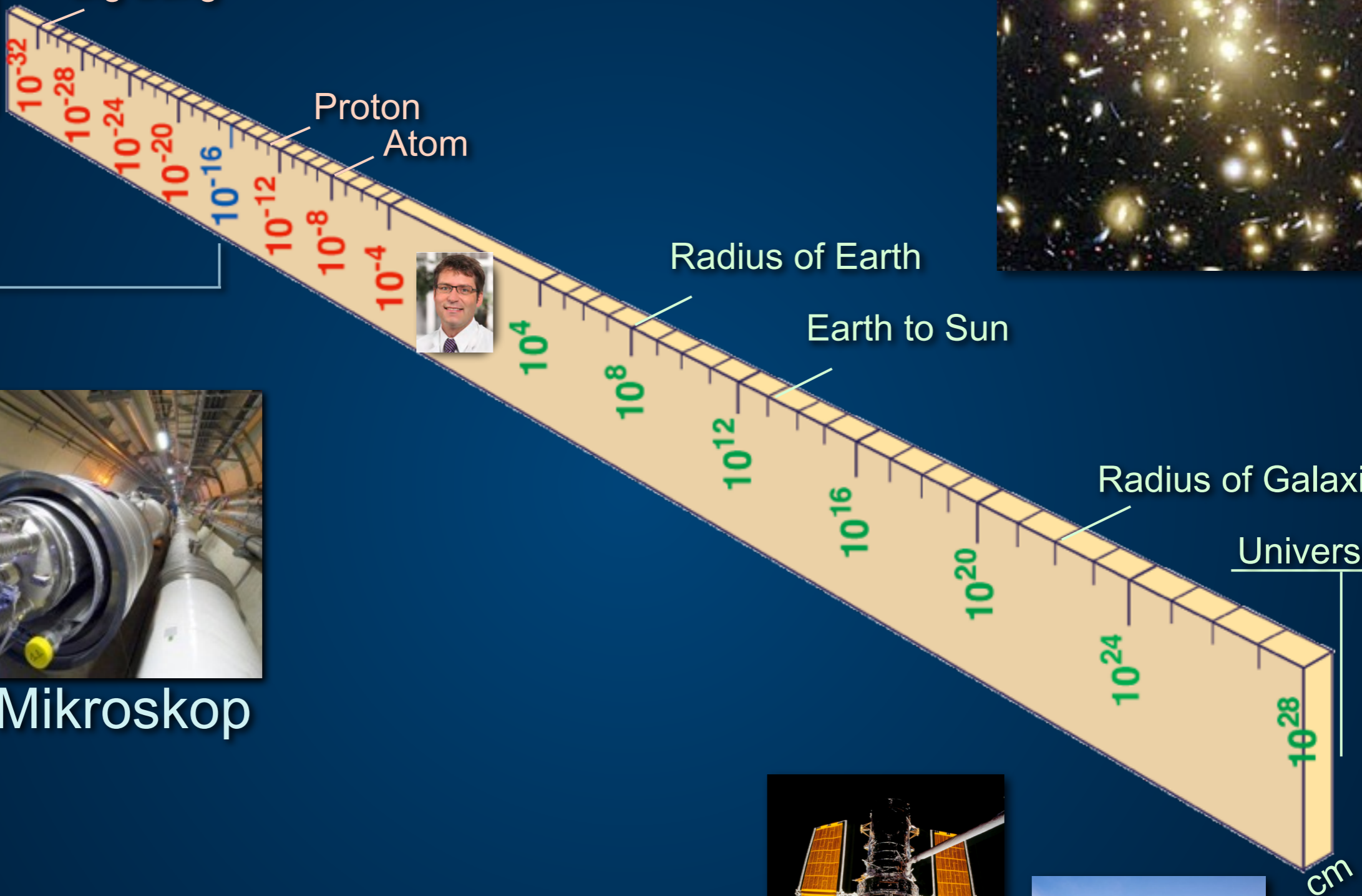


Big Bang



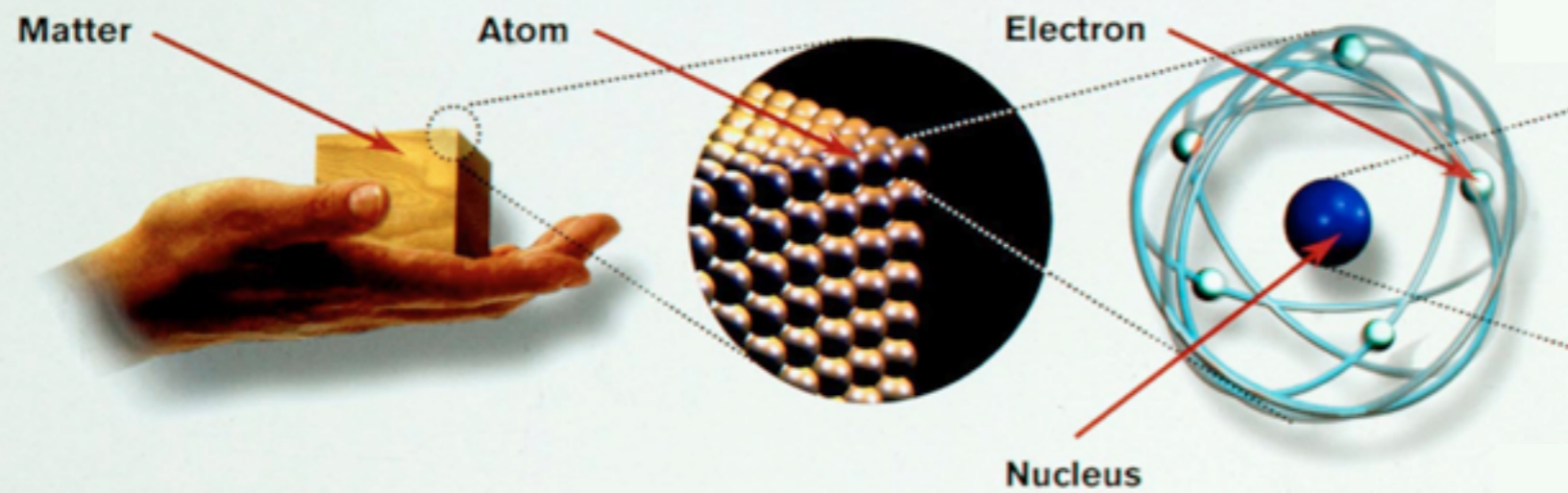


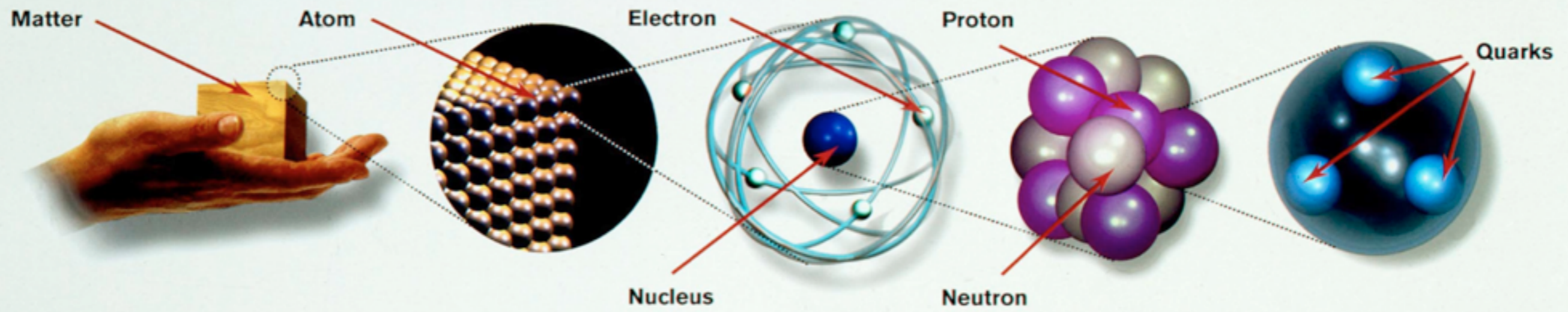
Big Bang



Super-Mikroskop

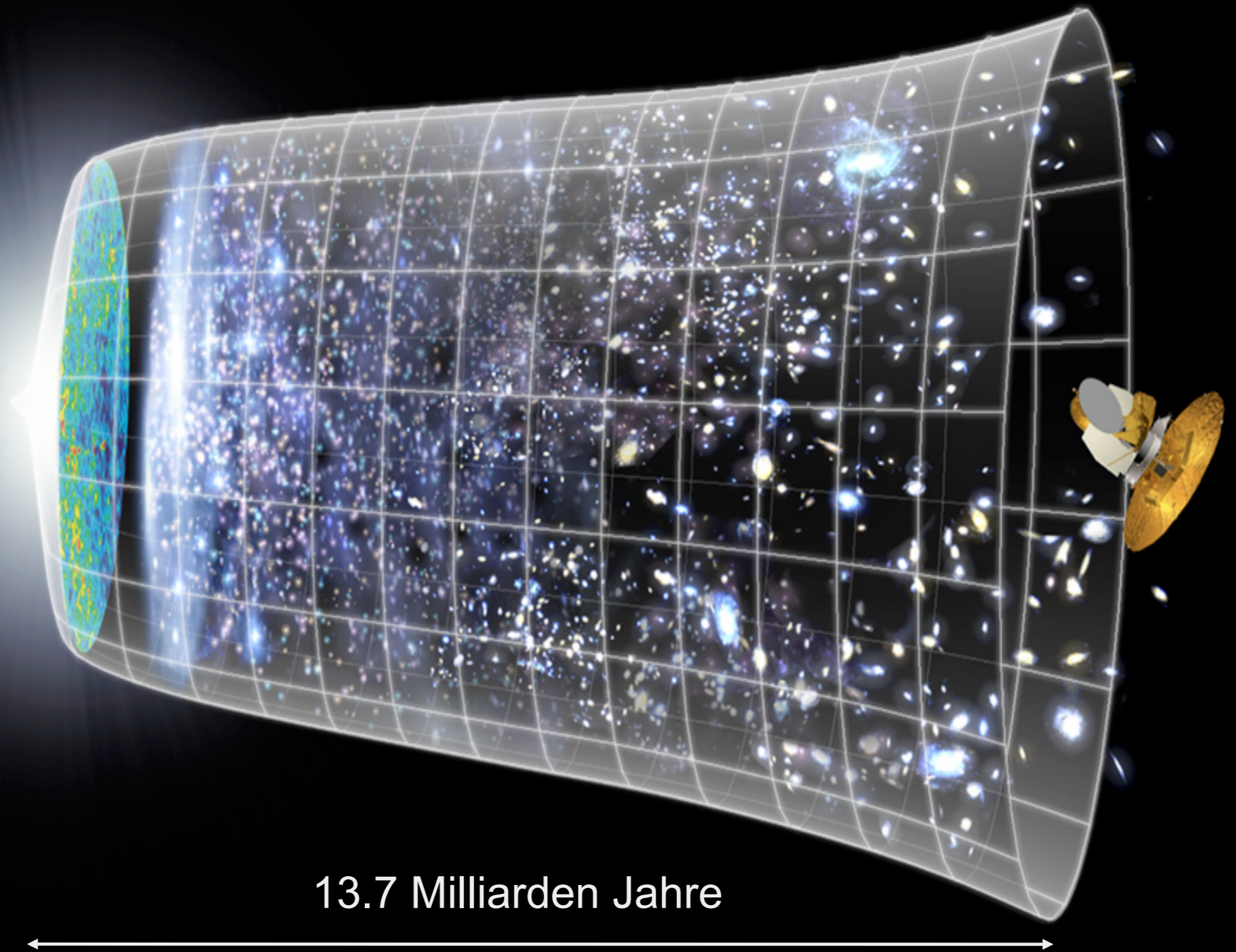






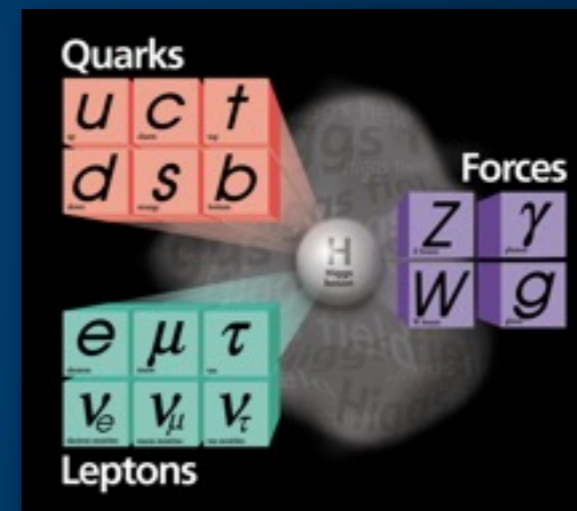
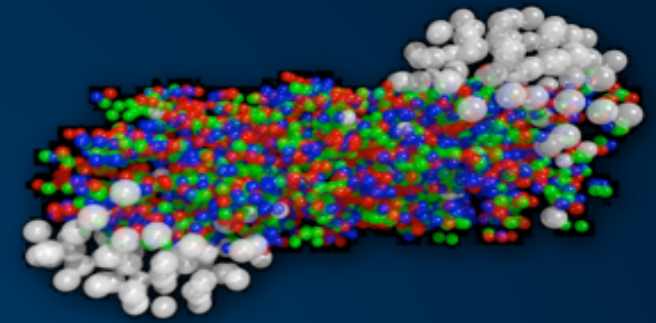






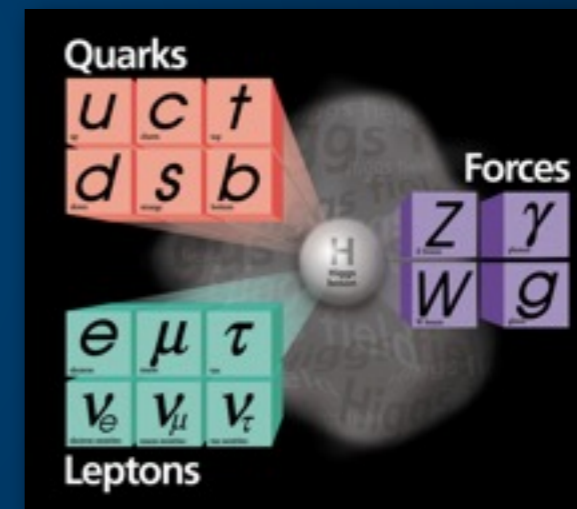
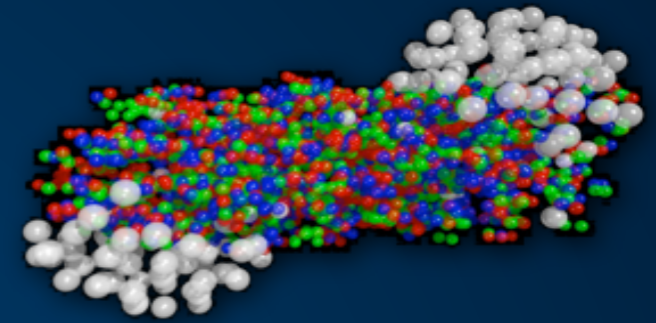
13.7 Milliarden Jahre

# Grosse offene Fragen



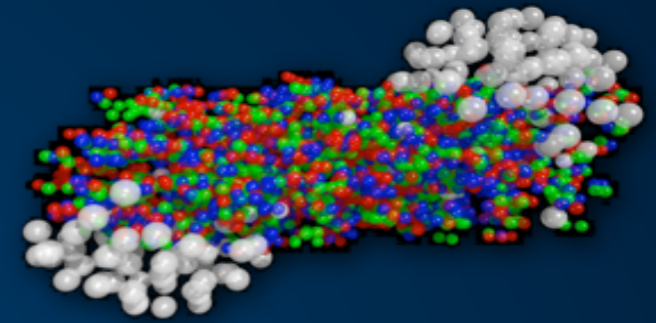
# Grosse offene Fragen

- Das Universum ganz kurz nach dem **Big Bang**

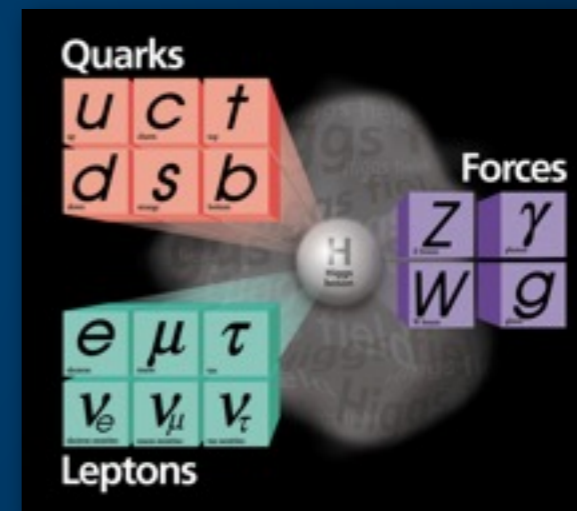


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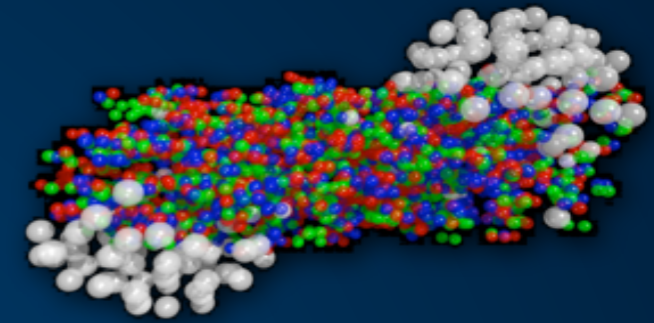


- Eigenschaften des neu entdeckten **Higgs Boson**, weitere neue Teilchen?

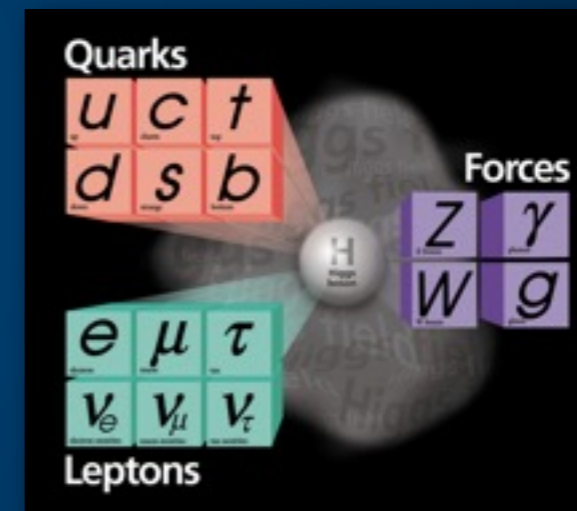


# Grosse offene Fragen

- Das Universum ganz kurz nach dem **Big Bang**



- Eigenschaften des neu entdeckten **Higgs Boson**, weitere neue Teilchen?



- was ist **Dunkle Materie** ?



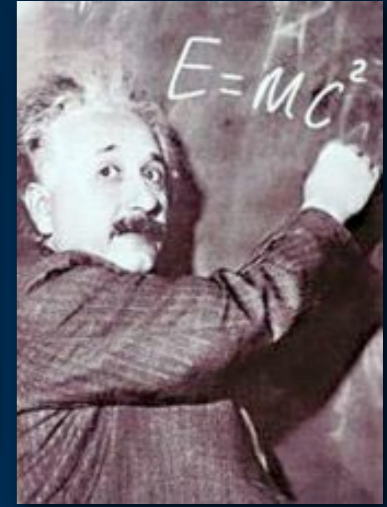


# CERN's Mission



# CERN's Mission

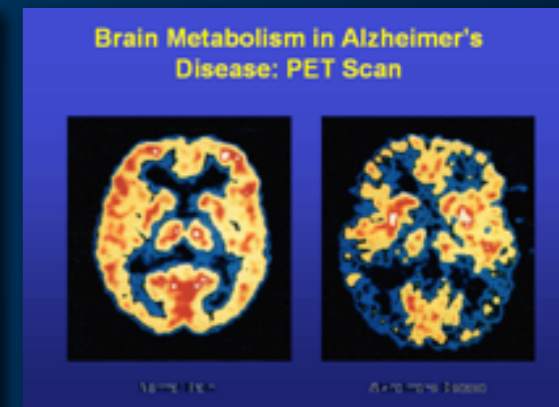
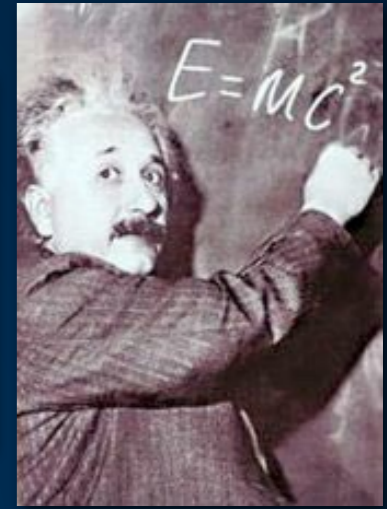
- Verschiebung der **Grenzen des Wissen**





# CERN's Mission

- Verschiebung der **Grenzen des Wissen**
- Entwicklung **neuer Technologien**

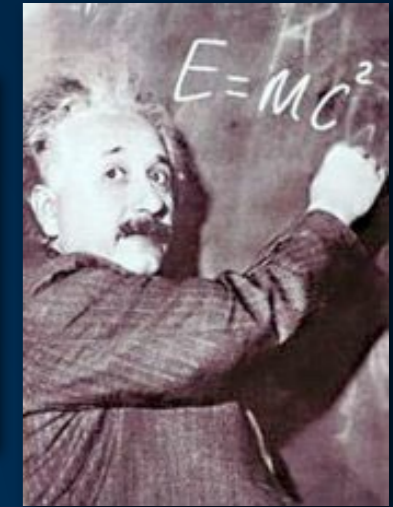




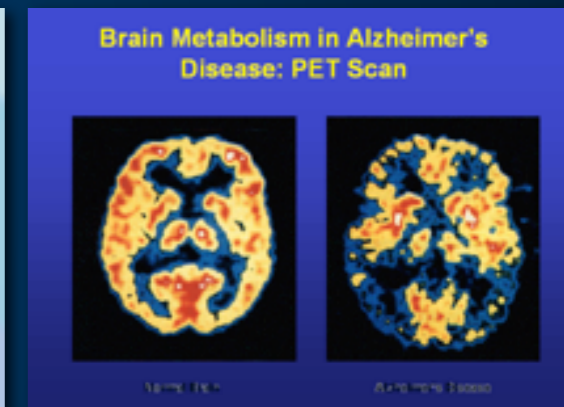


# CERN's Mission

- Verschiebung der **Grenzen des Wissen**



- Entwicklung **neuer Technologien**



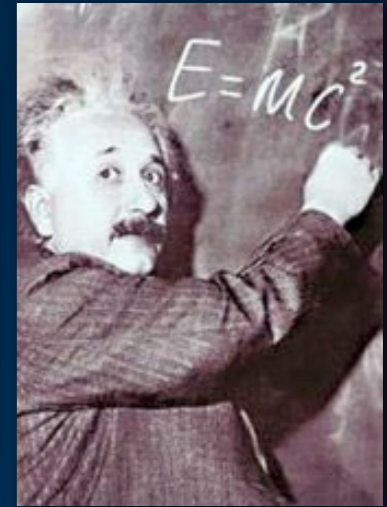
- Ausbildung der **Wissenschaftler und Ingenieure** von morgen



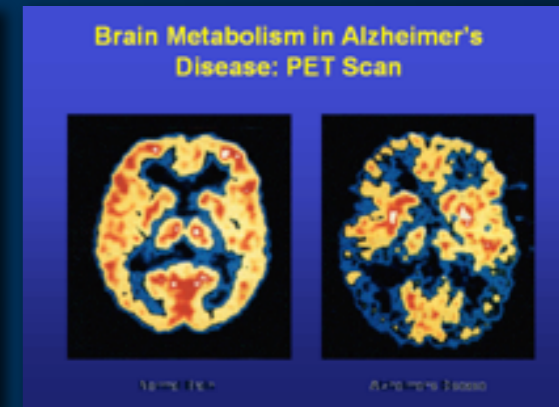


# CERN's Mission

● Verschiebung der **Grenzen des Wissen**



● Entwicklung **neuer Technologien**



● Ausbildung der **Wissenschaftler und Ingenieure** von morgen



● **Menschen** zusammenbringen



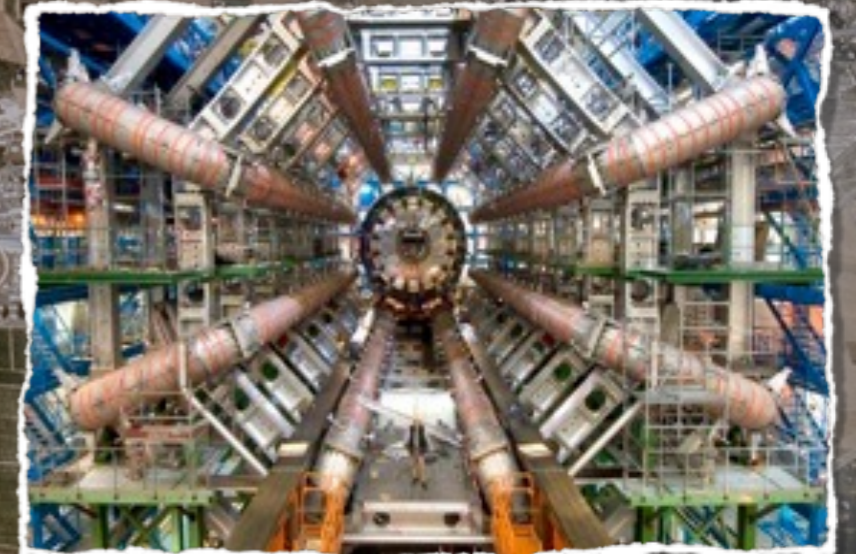
# Der Large Hadron Collider

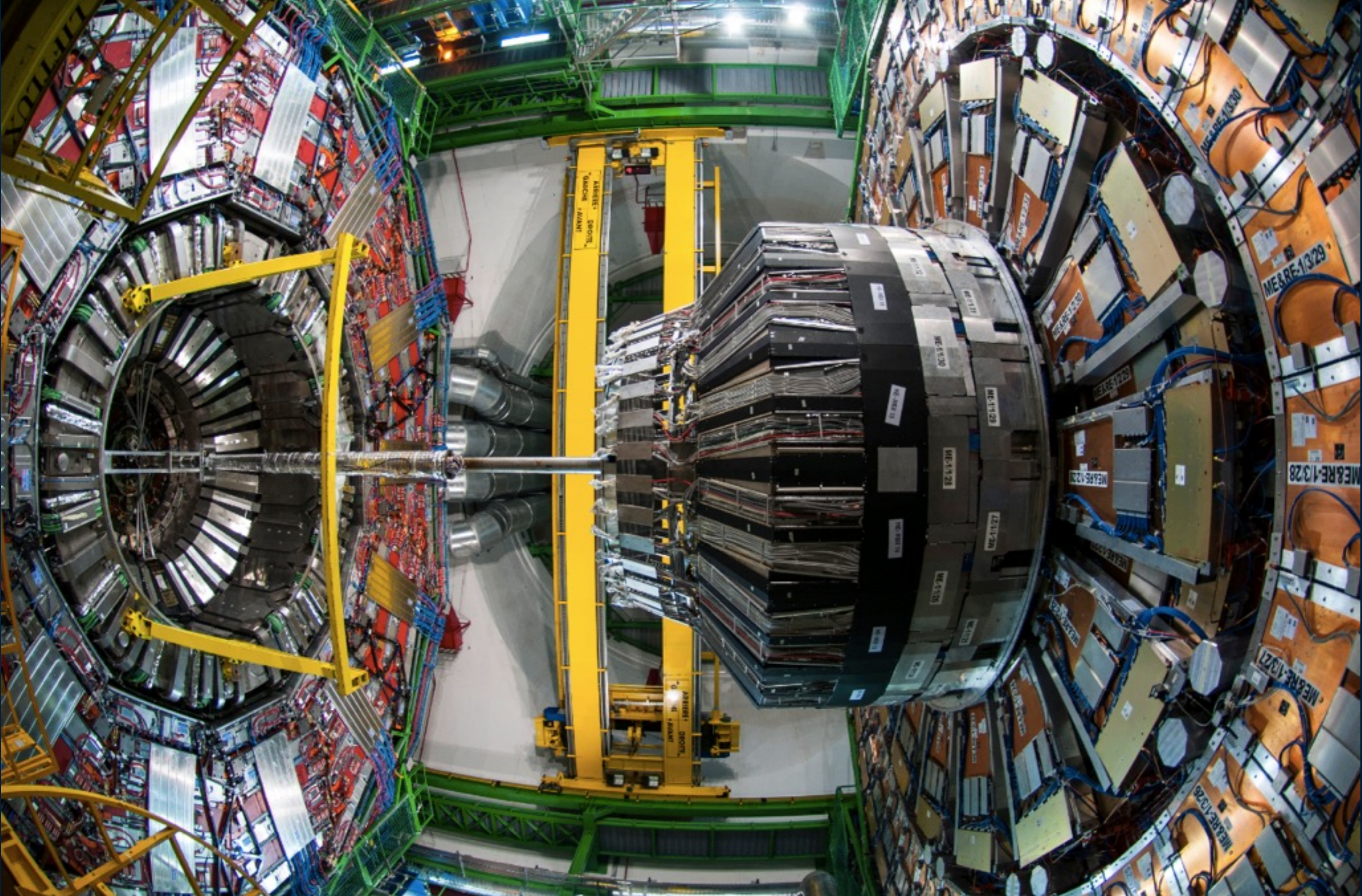
Eines der grössten, globalen wissenschaft. Projekte aller Zeiten



# Der Large Hadron Collider

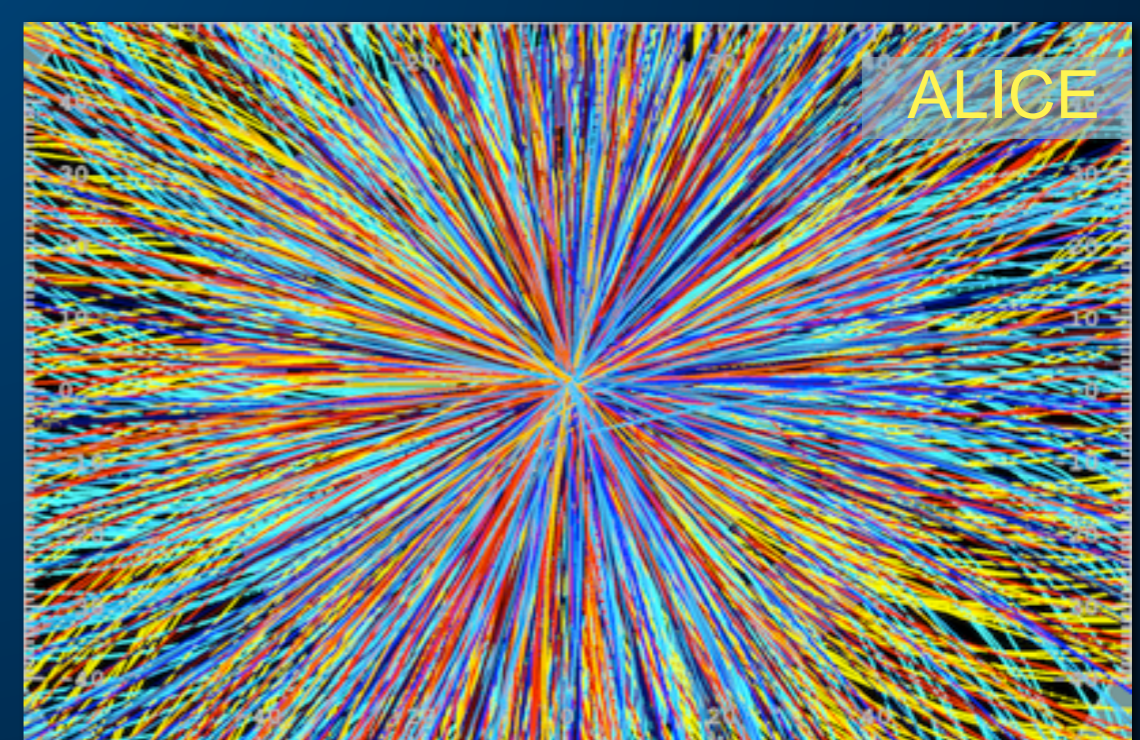
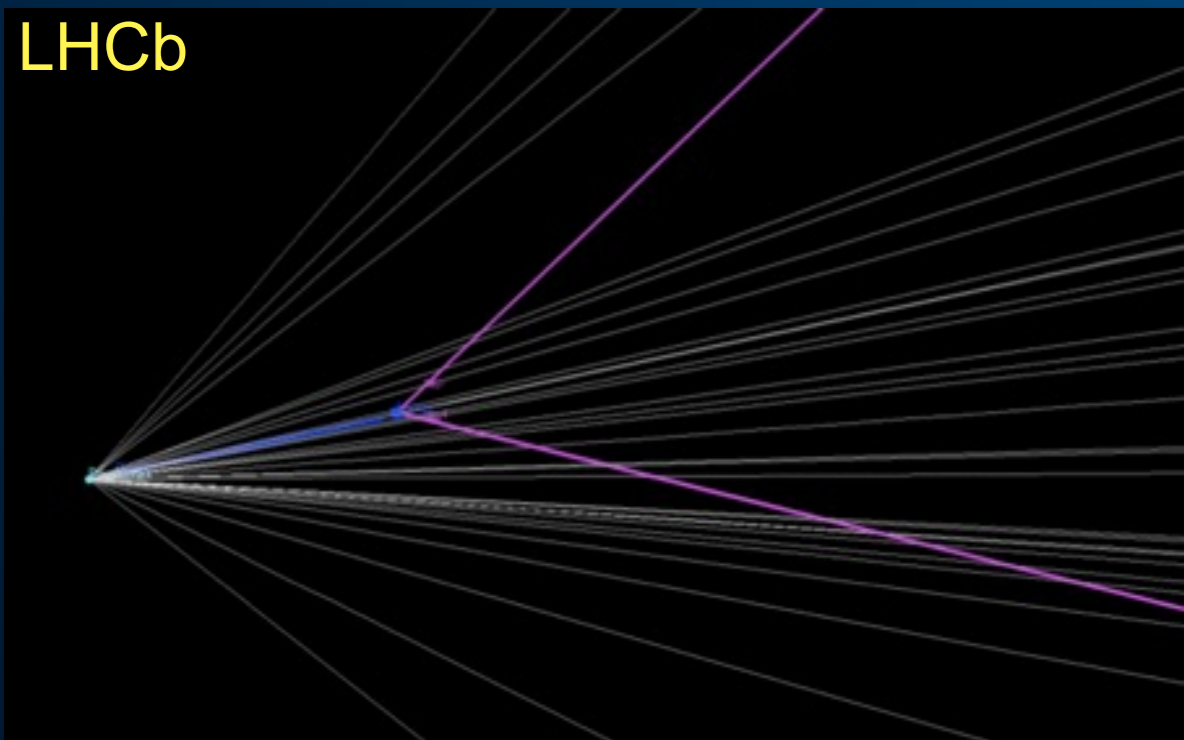
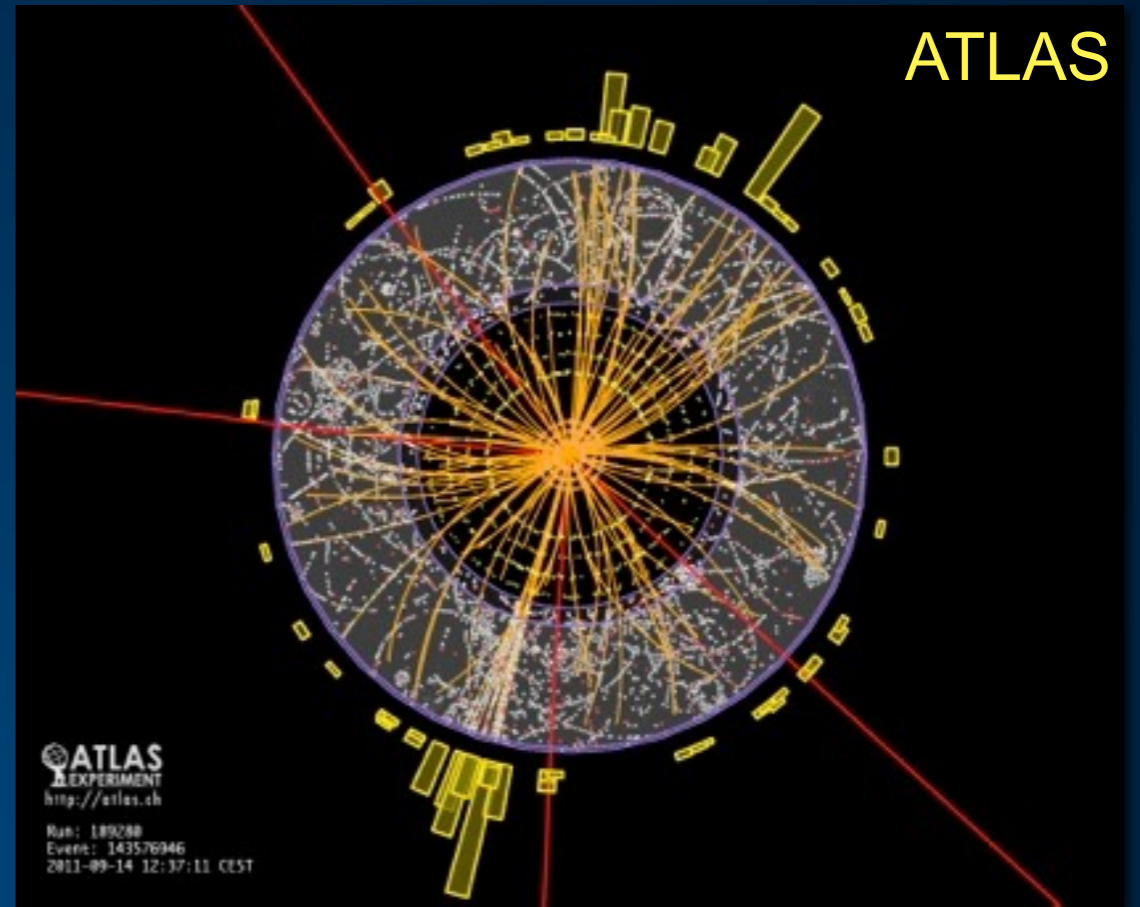
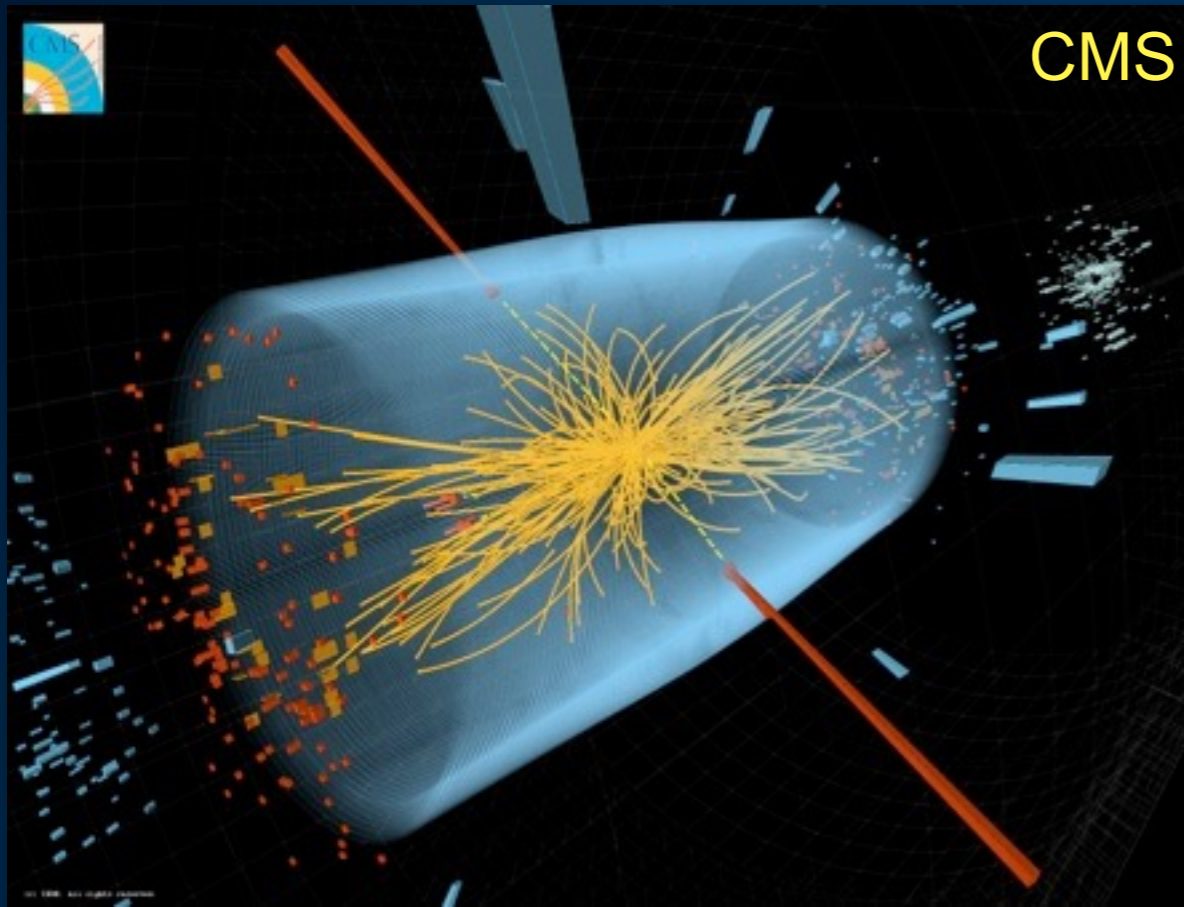
Eines der grössten, globalen wissenschaft. Projekte aller Zeiten



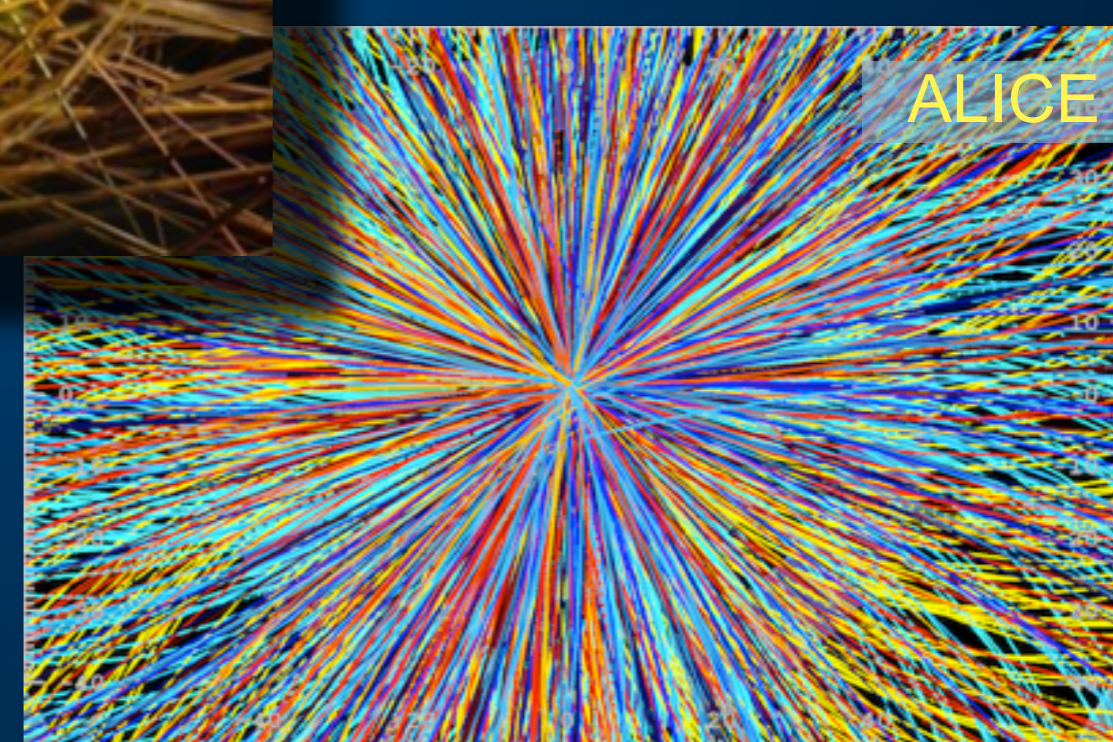
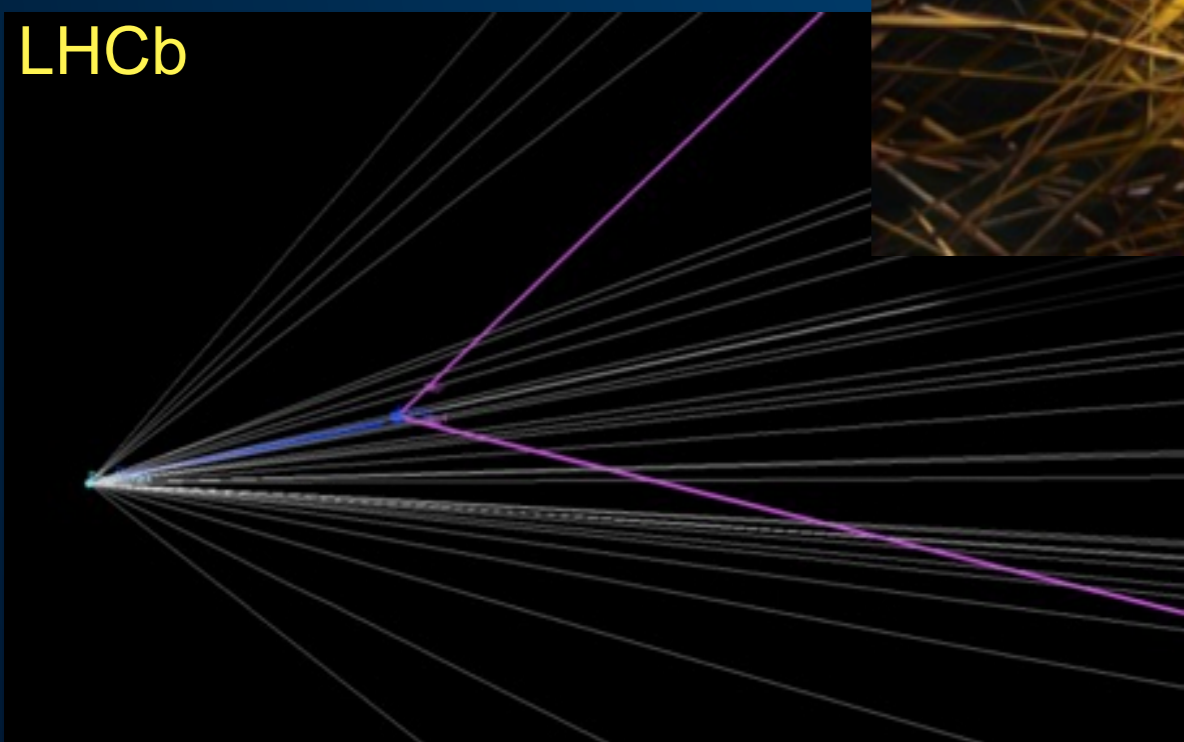
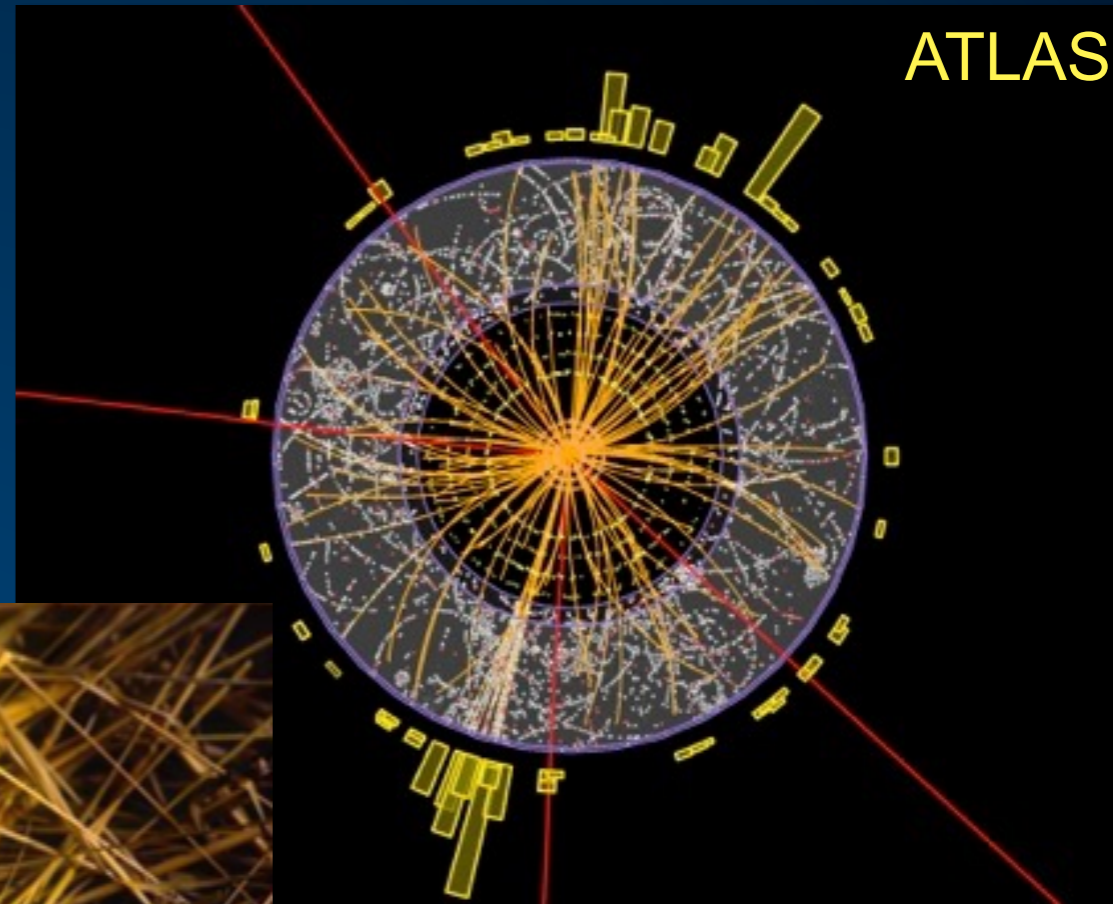
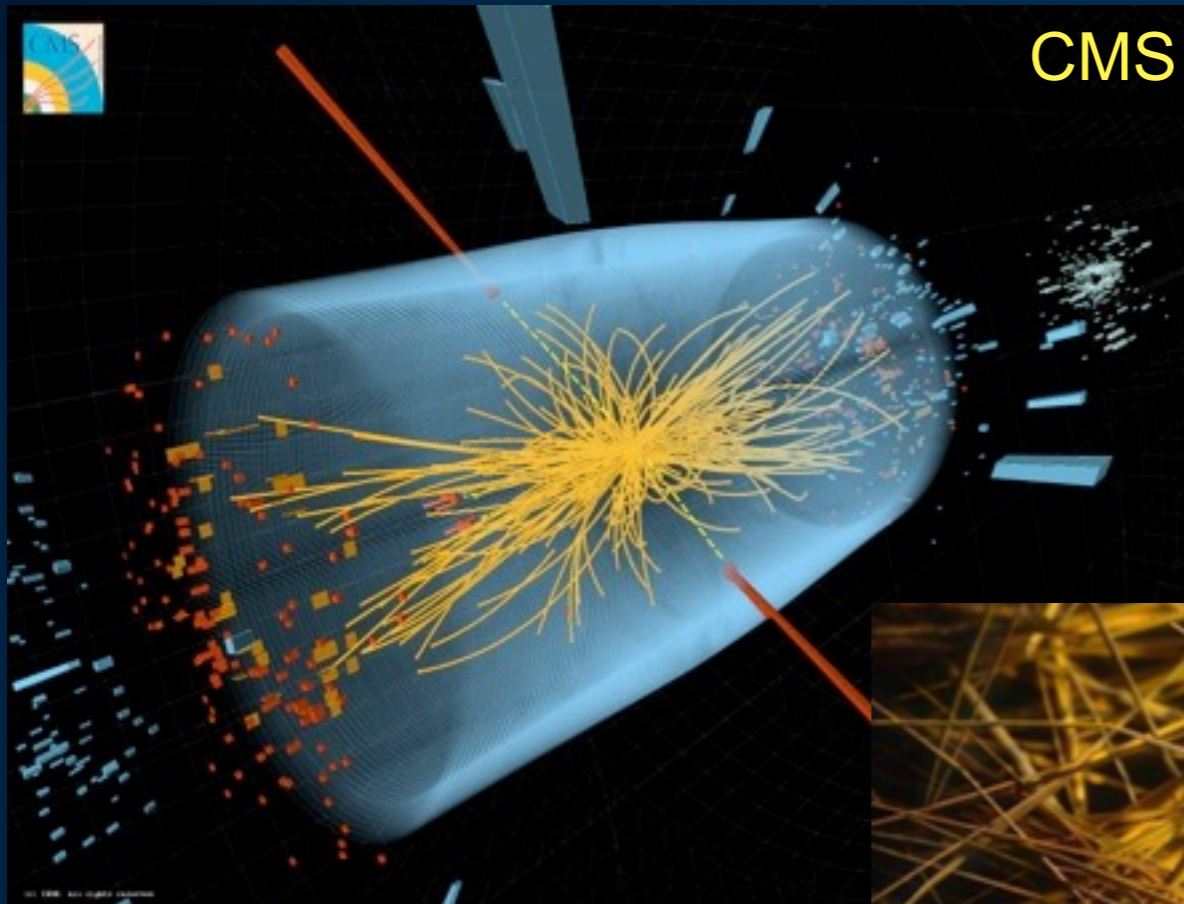




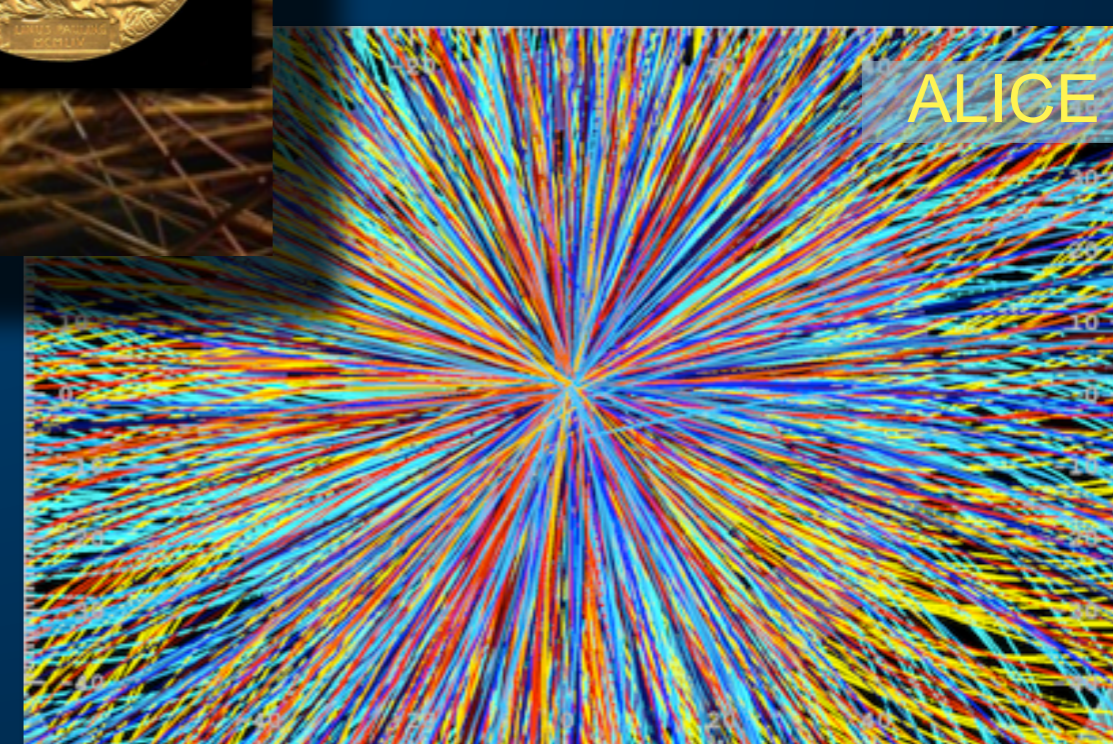
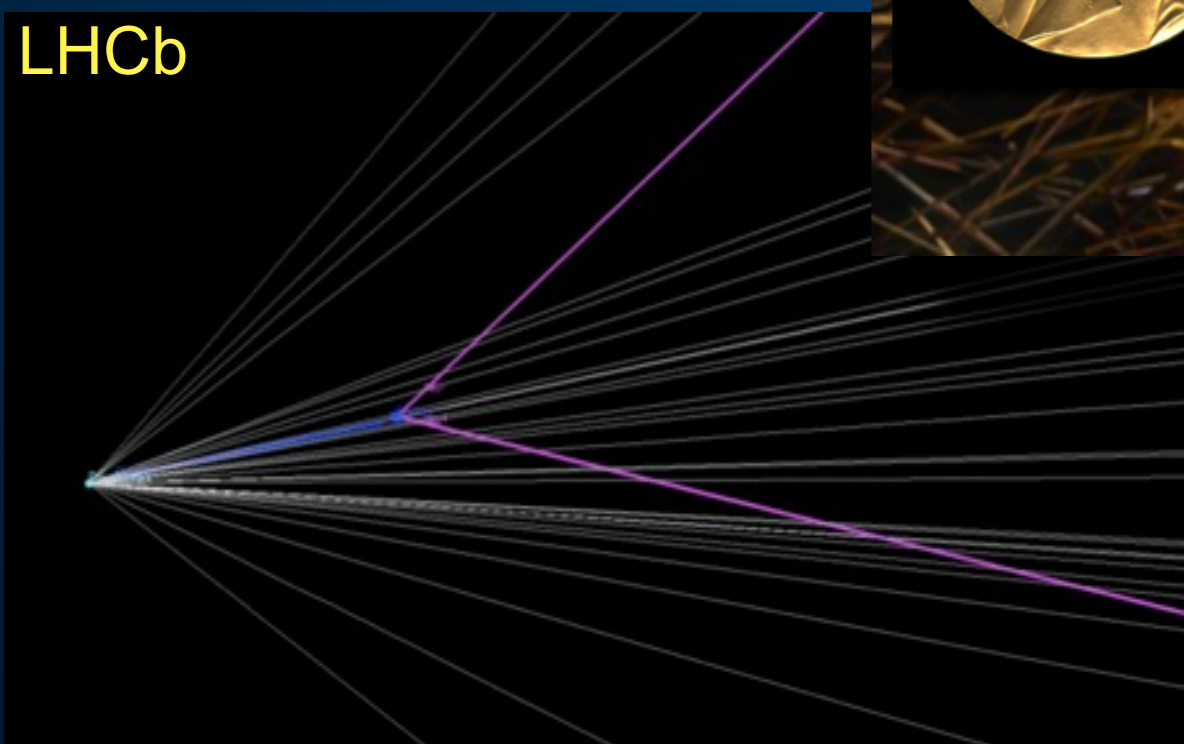
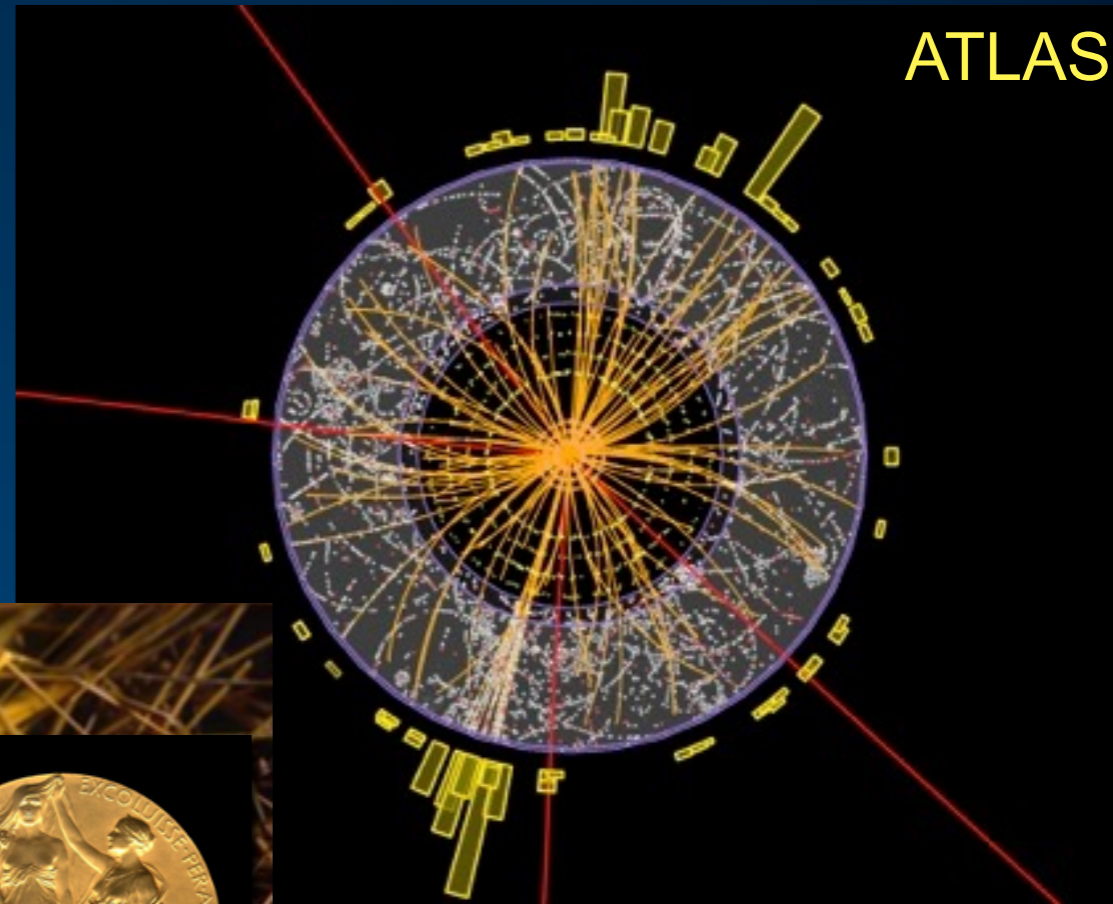
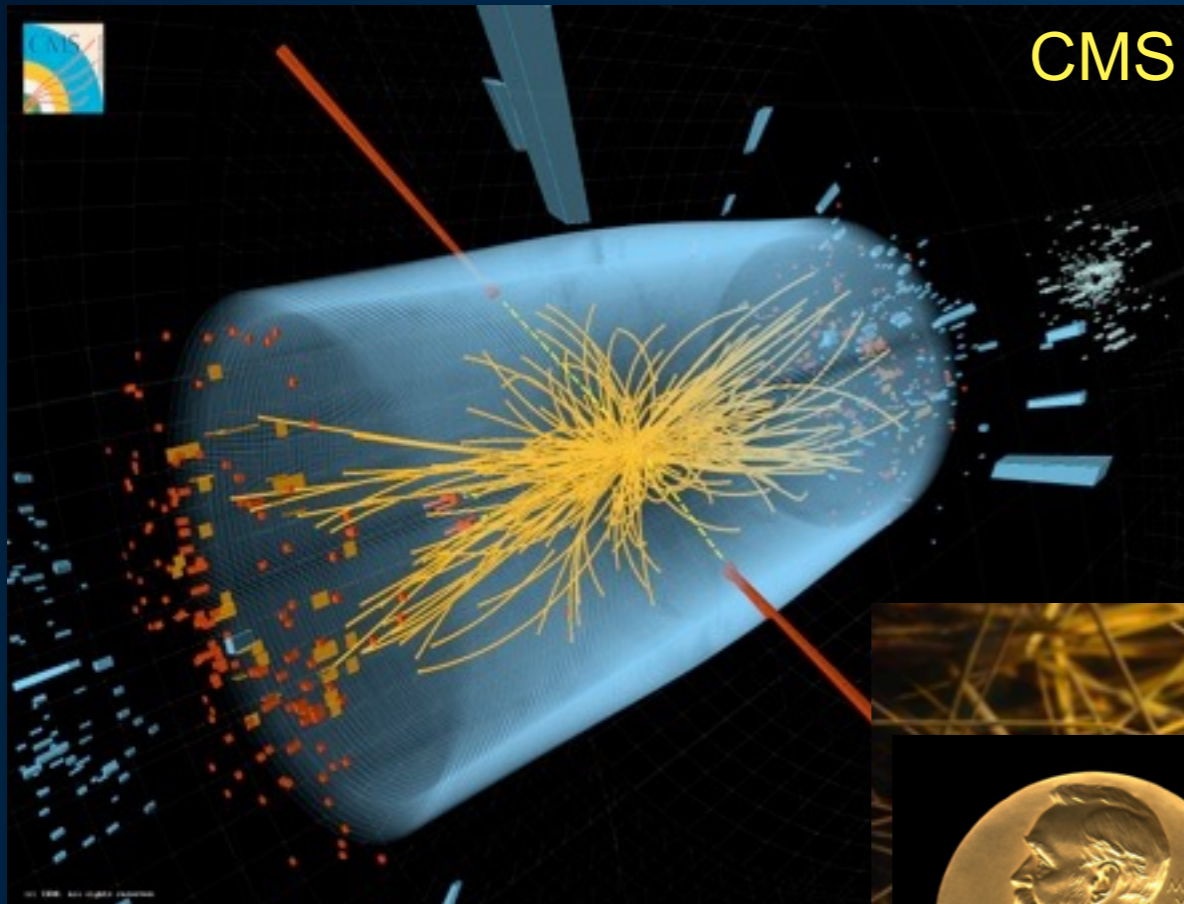








3 Gb/sec - Datenvolumen pro Jahr ~25 Petabytes



3 Gb/sec - Datenvolumen pro Jahr ~25 Petabytes

**Wozu ?**

# Beispiel: World Wide Web



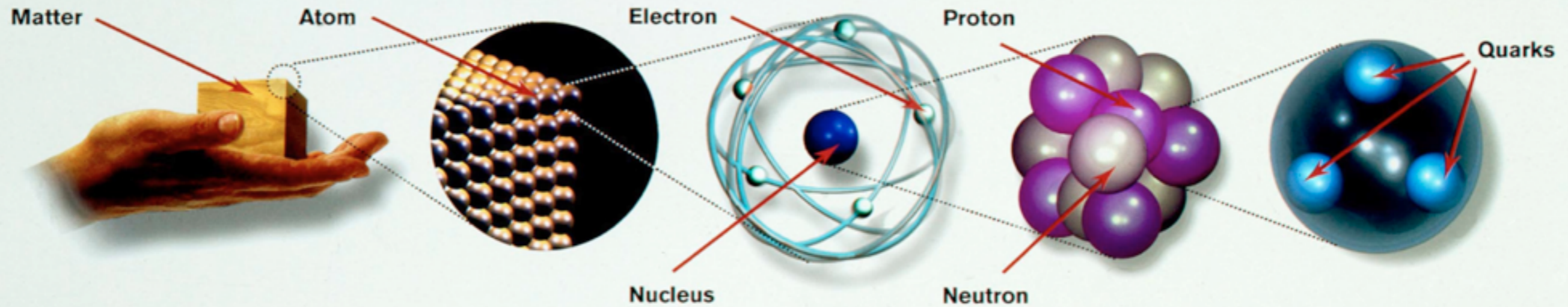
*interesting, but vague...*



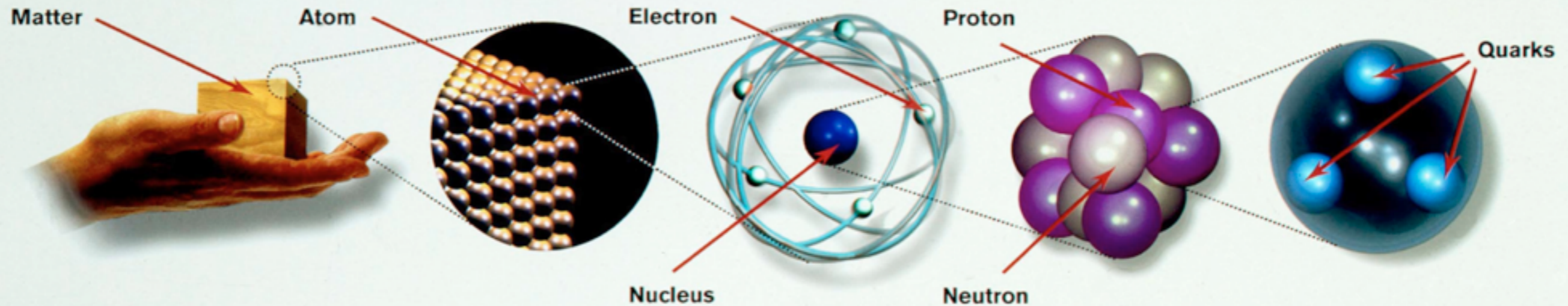
[www.cern.ch](http://www.cern.ch)

vor ~25 Jahren entwickelt:  
nicht vorhersehbar, dass es unsere moderne  
Kommunikationsgesellschaft revolutionieren würde

# Wir bestehen aus Teilchen



# Wir bestehen aus Teilchen

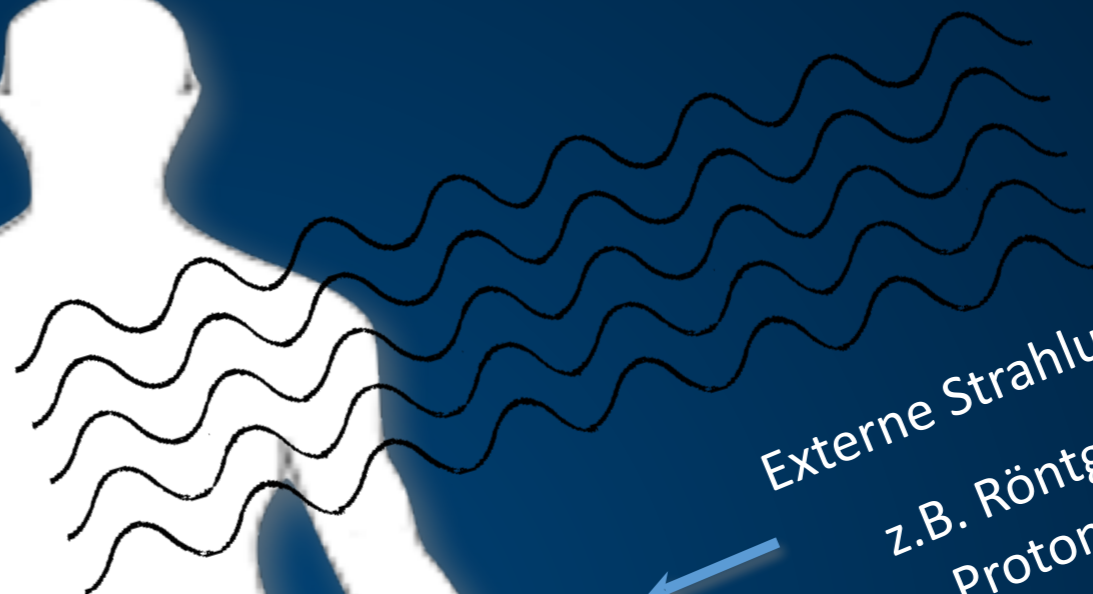
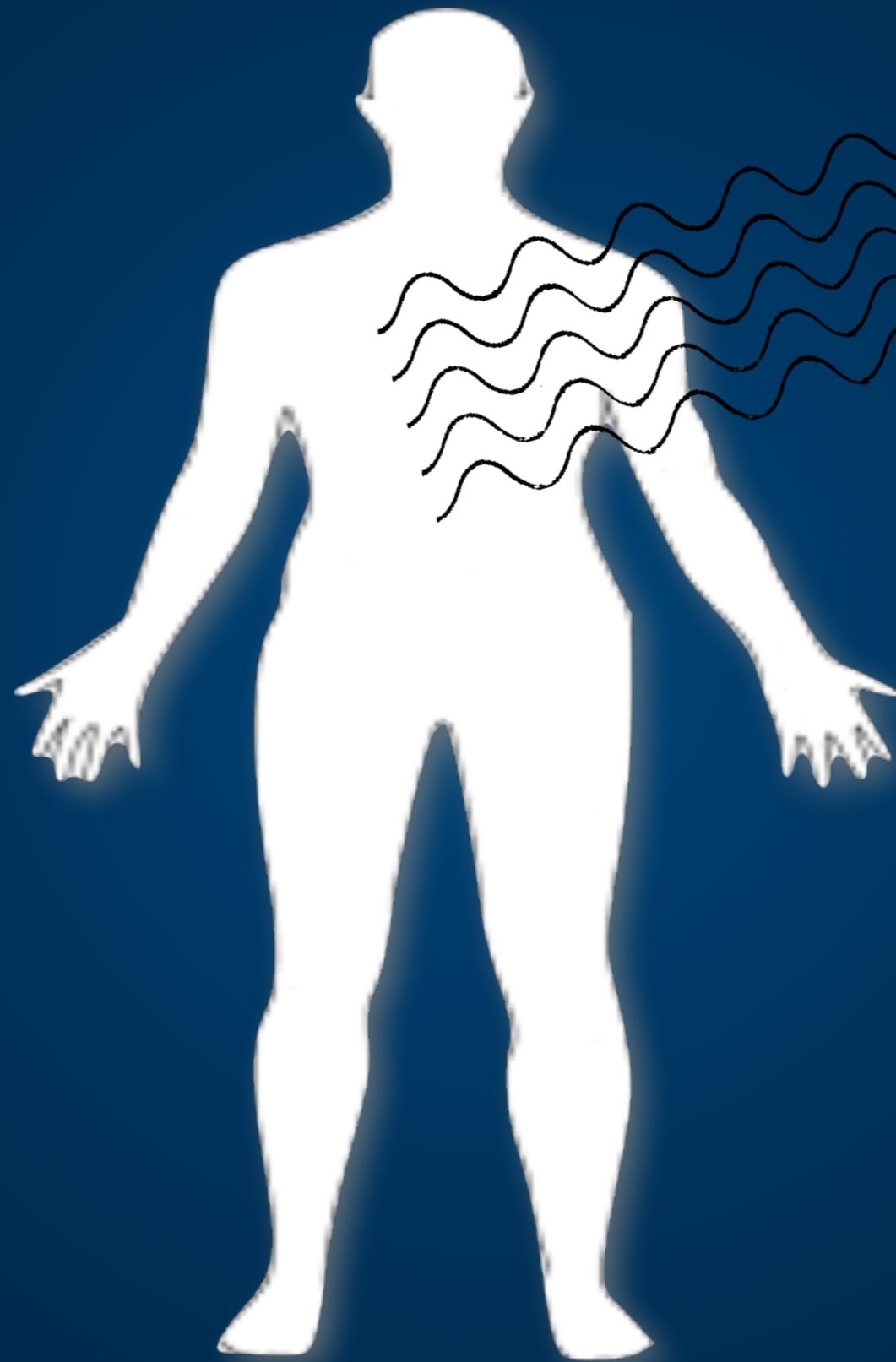


Teilchen interagieren mit anderen Teilchen

werden absorbiert, streuen, modifizieren die Materie

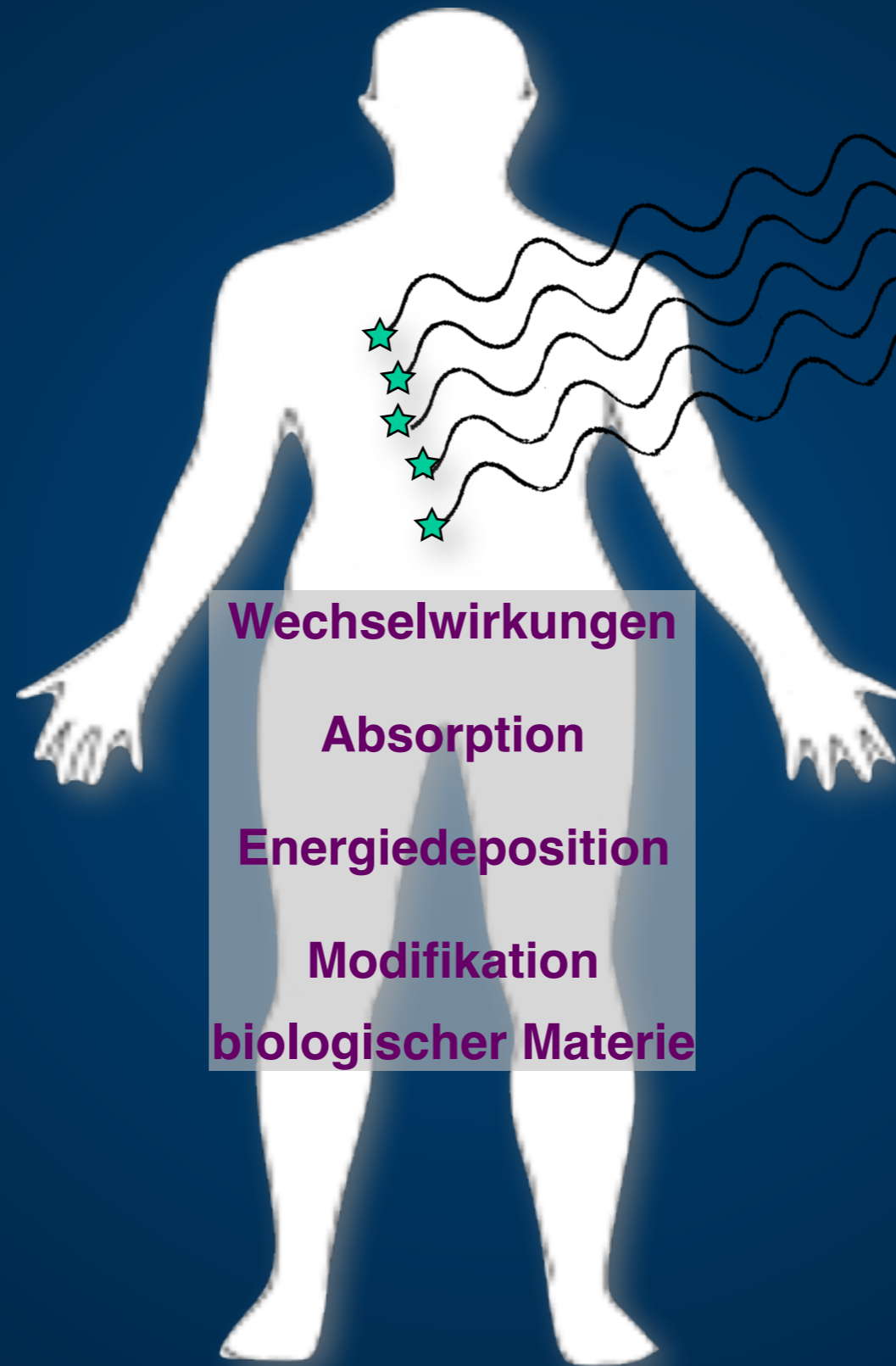
erzeugen messbare Signale





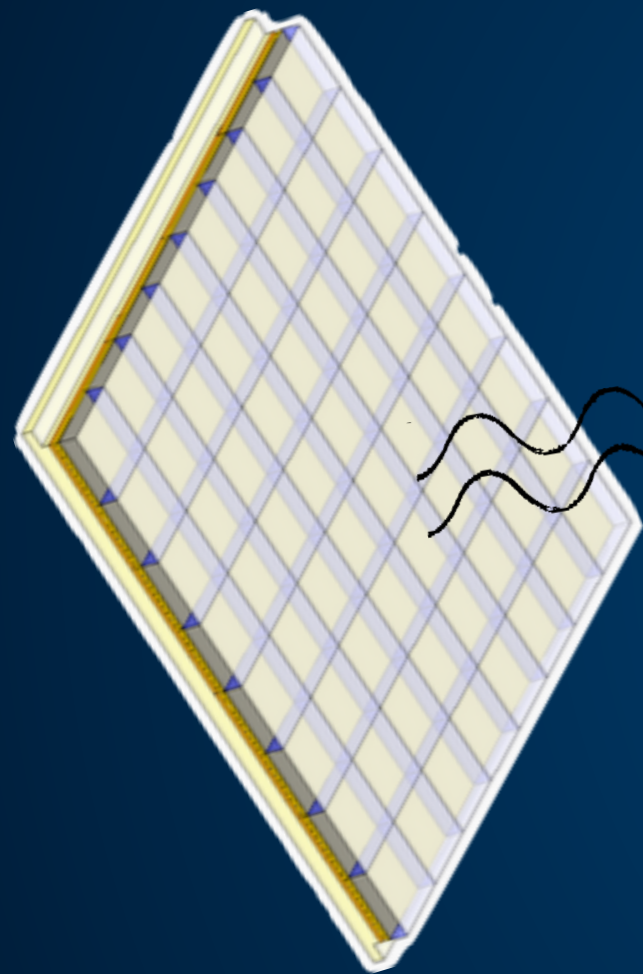
Externe Strahlung (Teilchen),  
z.B. Röntgenstrahlen,  
Protonenstrahlen



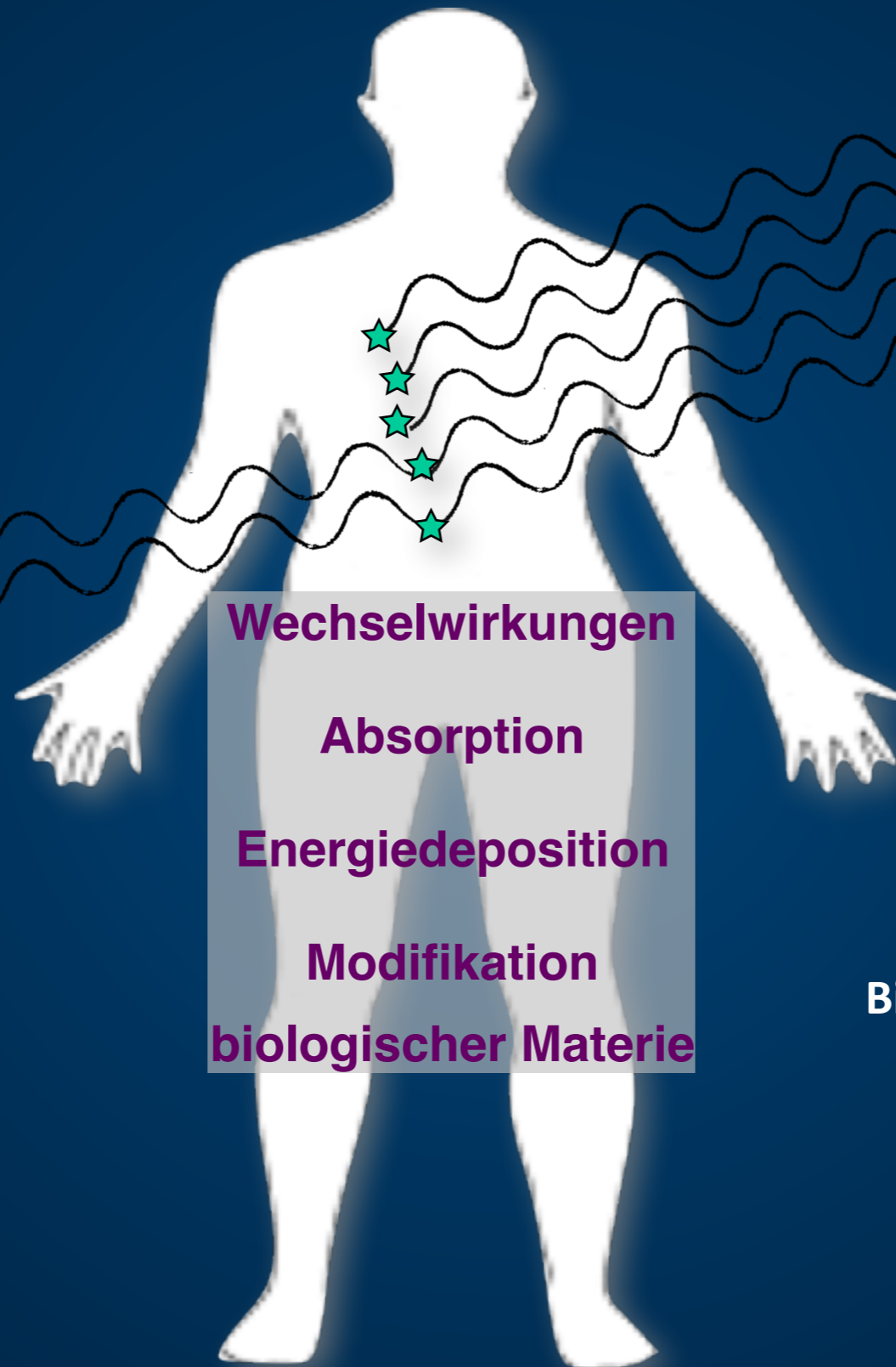


Externe Strahlung (Teilchen),  
z.B. Röntgenstrahlen,  
Protonenstrahlen

**Wechselwirkungen**  
**Absorption**  
**Energiedeposition**  
**Modifikation**  
**biologischer Materie**



externer Detektor



**Wechselwirkungen**  
**Absorption**  
**Energiedeposition**  
**Modifikation**  
**biologischer Materie**

Externe Strahlung (Teilchen),  
z.B. Röntgenstrahlen,  
Protonenstrahlen

**Bildgebung und Krebstherapie mit  
externer Strahlung**

Röntgen, CT,  
Protontherapie



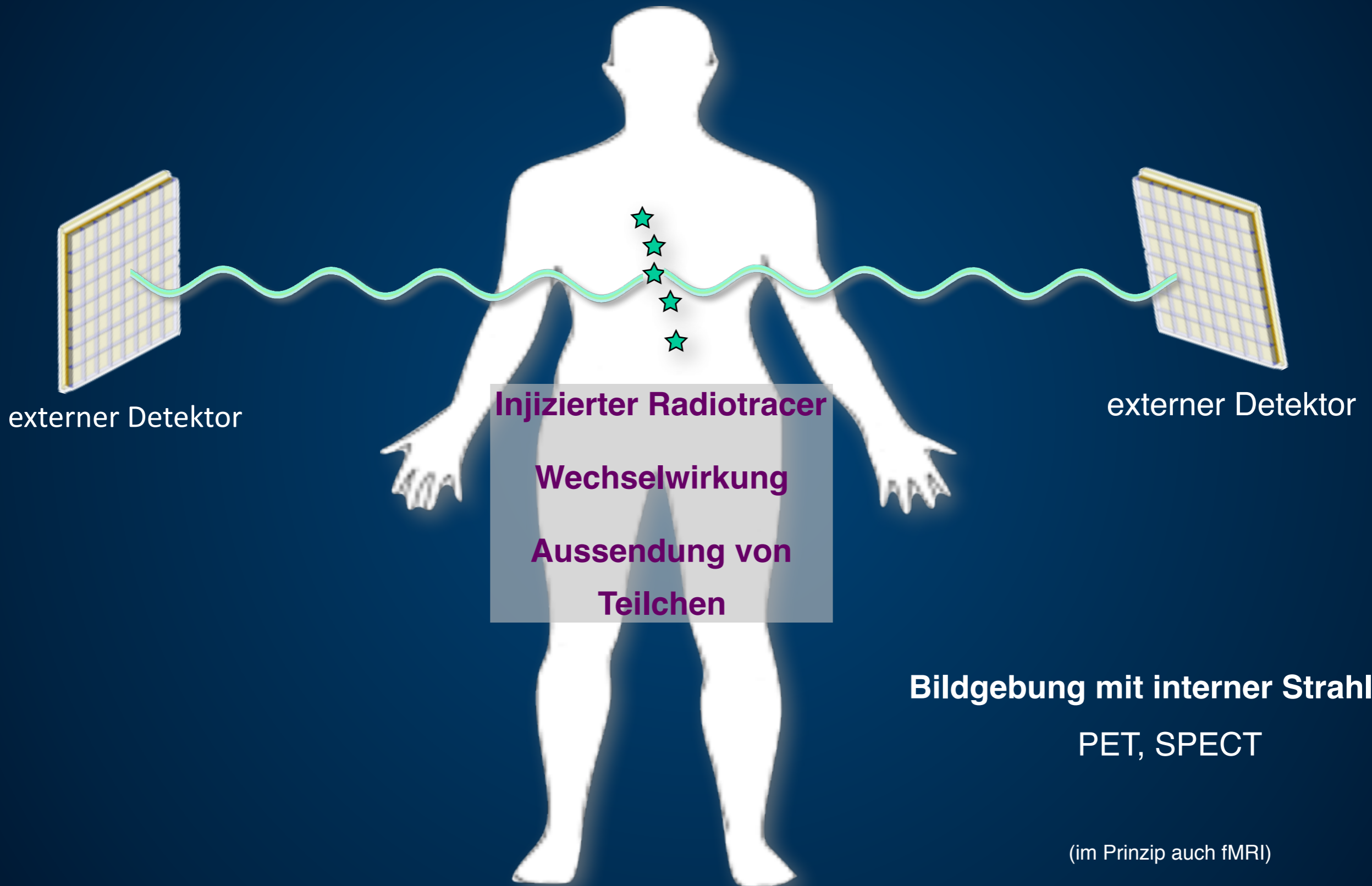


**Injizierter Radiotracer**

**Wechselwirkung**

**Aussendung von**

**Teilchen**



externer Detektor

**Injizierter Radiotracer**

**Wechselwirkung**

**Aussendung von**

**Teilchen**

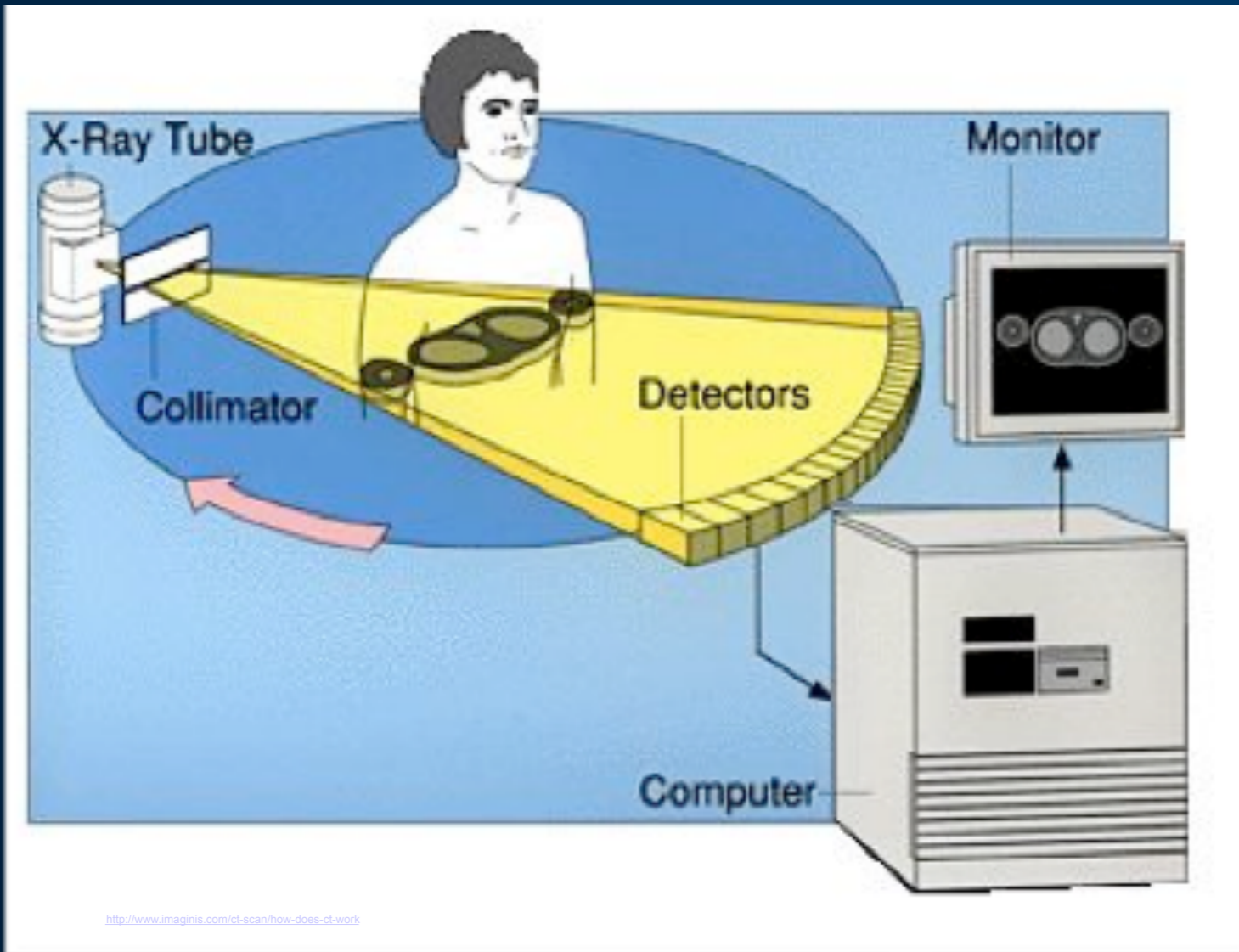
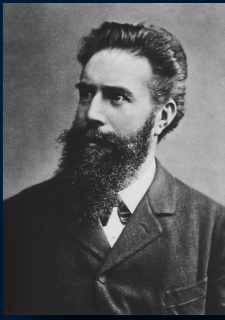
externer Detektor

**Bildgebung mit interner Strahlung**

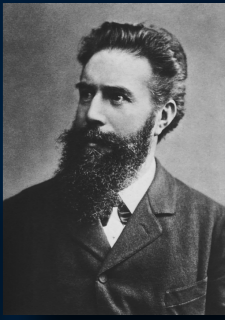
**PET, SPECT**

(im Prinzip auch fMRI)

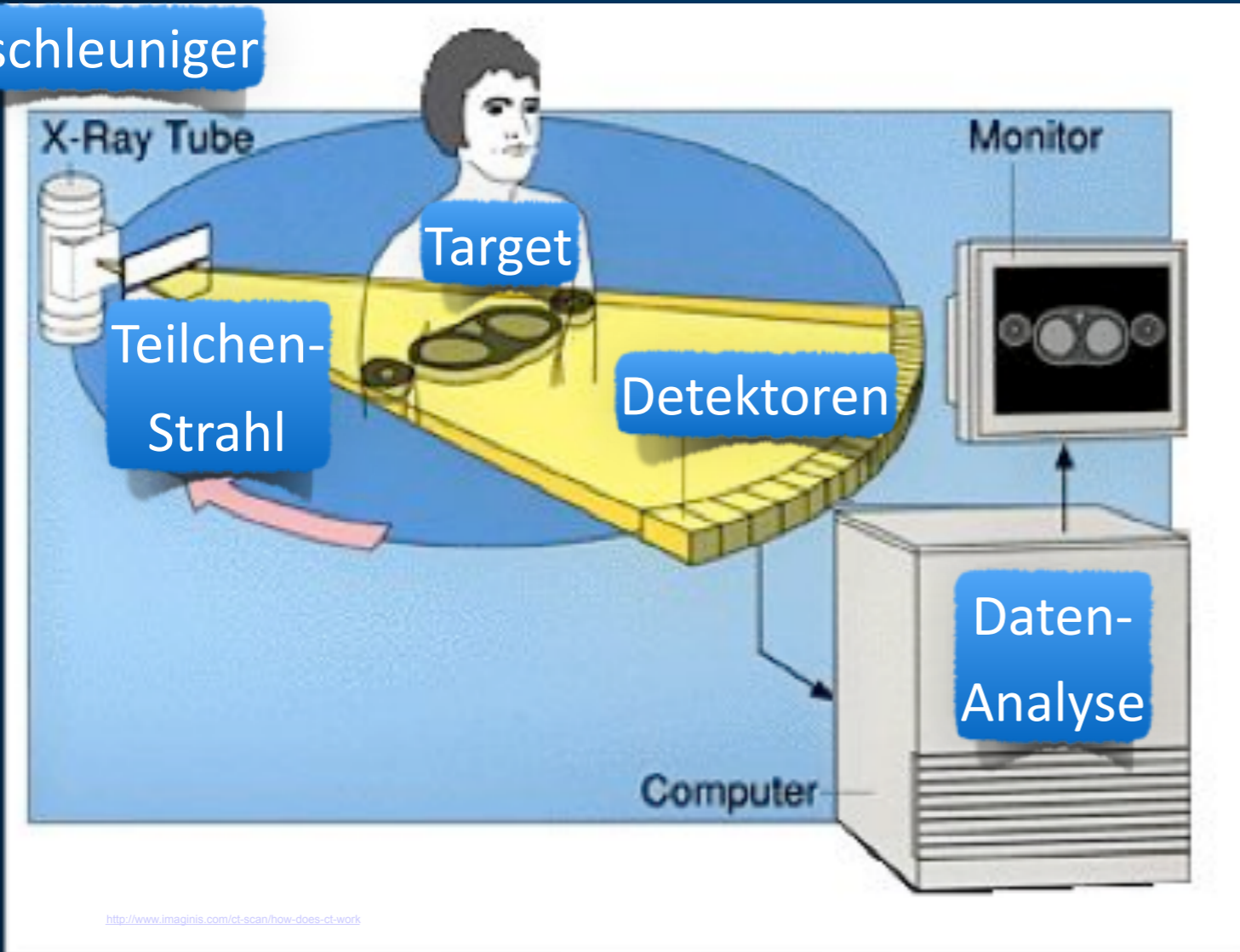
# D.h. Ihr nächster Röntgen-Termin ist ein Teilchenphysik-Experiment!



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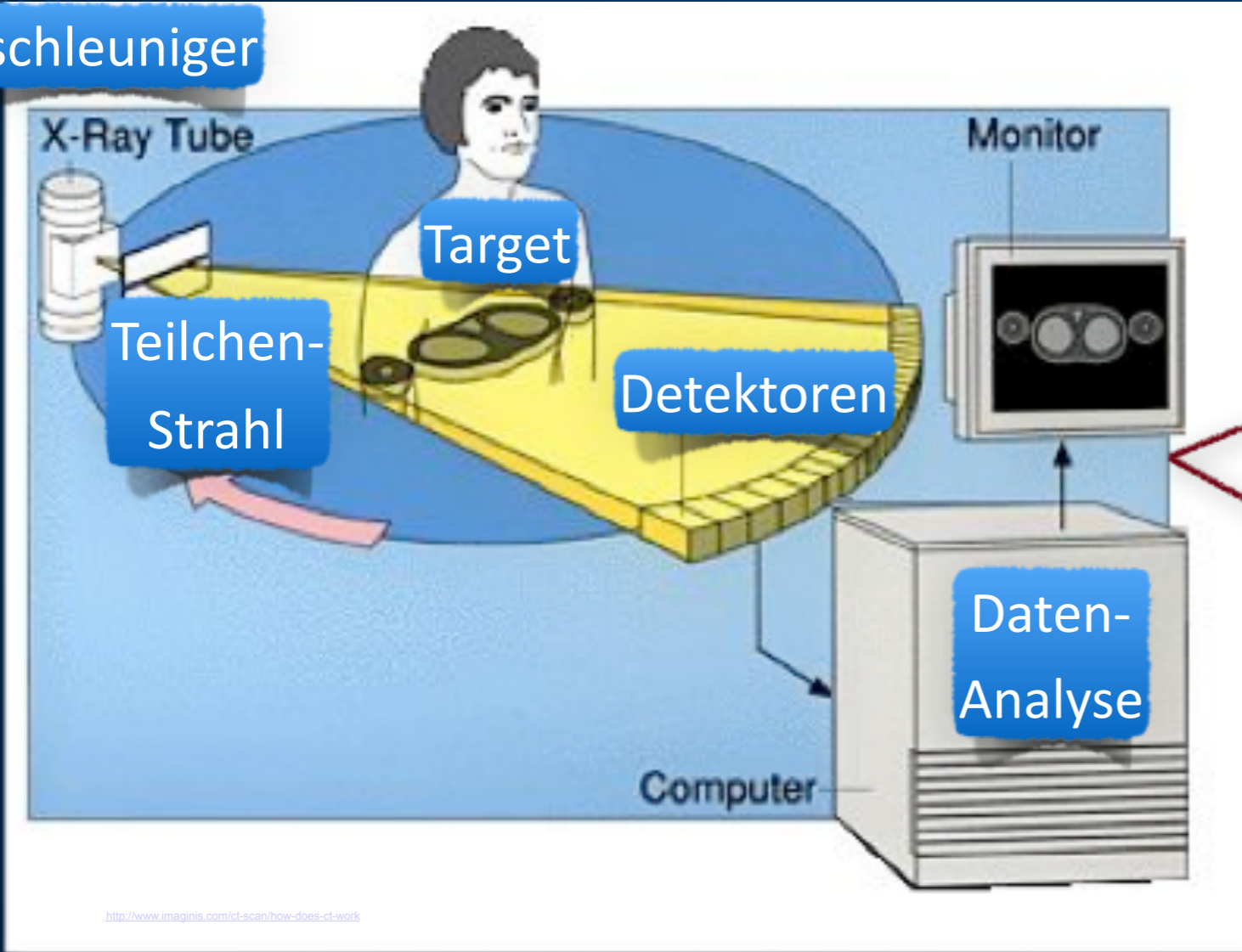
Beschleuniger



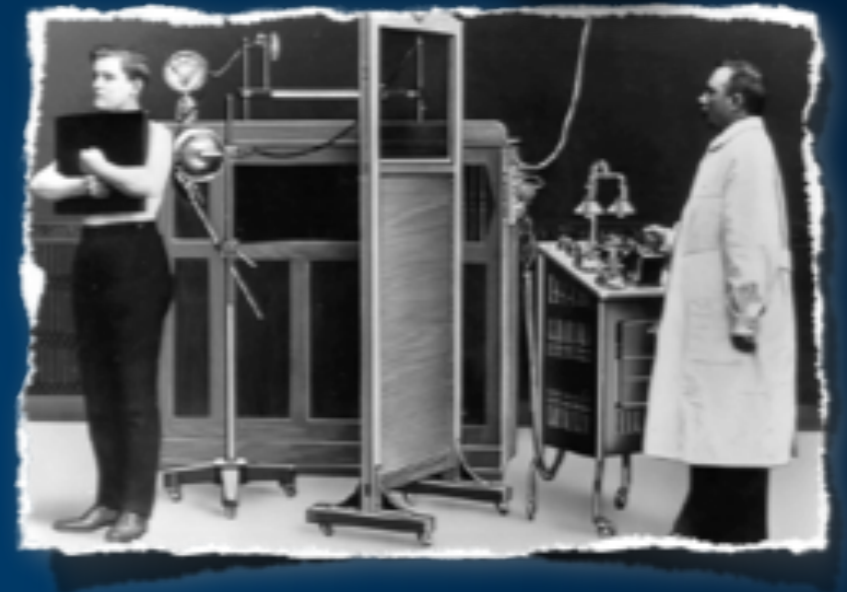
# D.h. Ihr nächster Röntgen-Termin ist ein Teilchenphysik-Experiment!



Beschleuniger

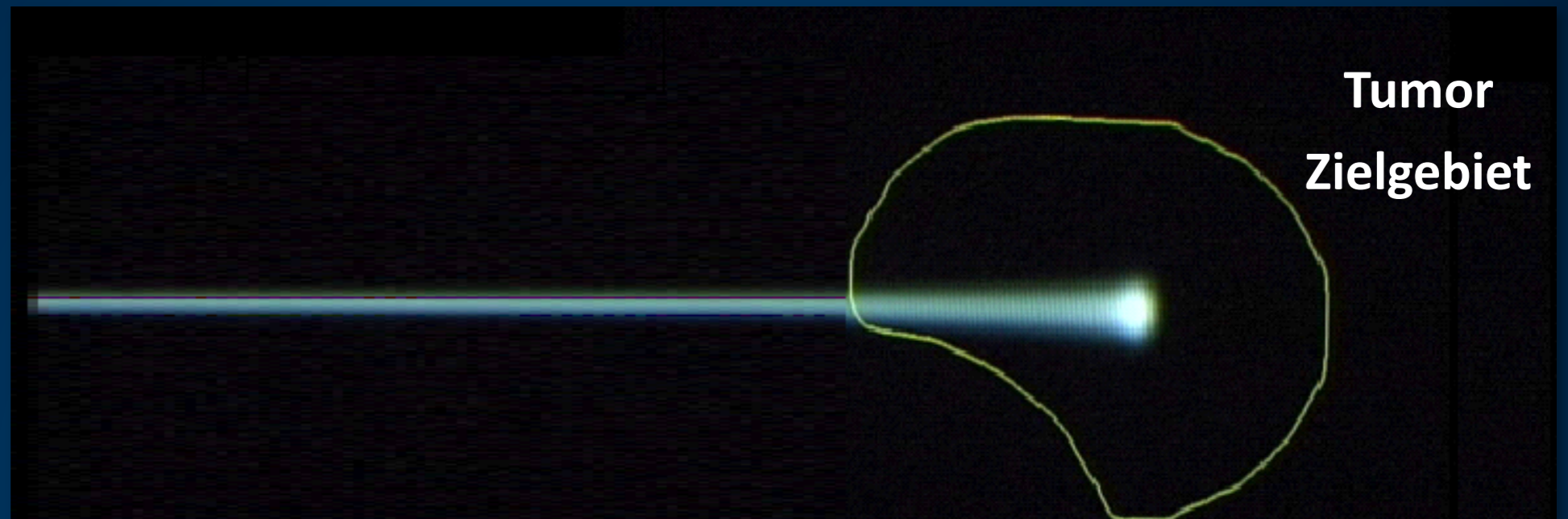


<http://www.imaginis.com/ct-scan/how-does-ct-work>



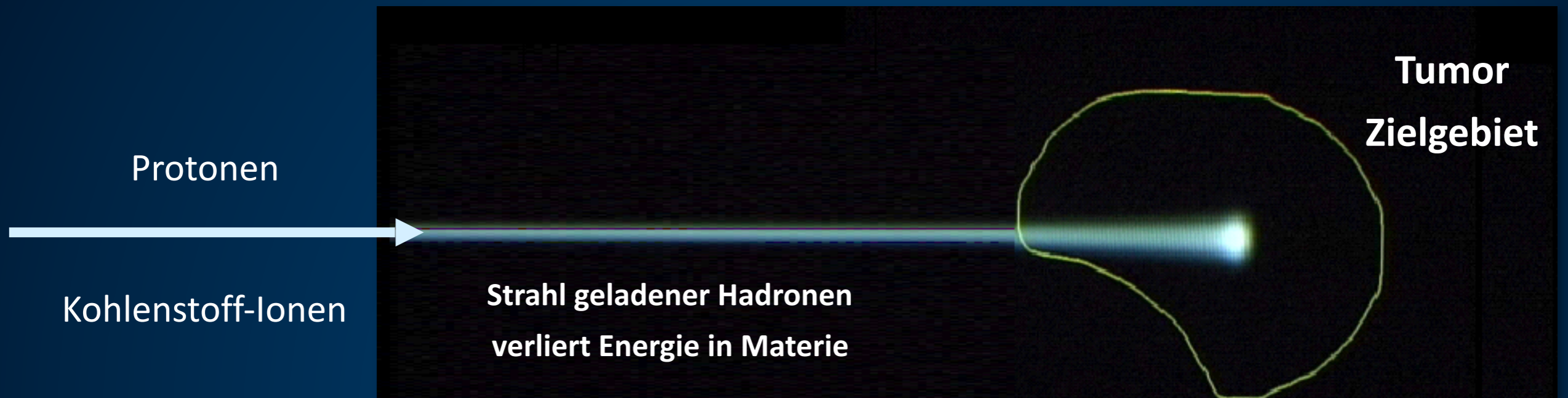


# Hadronen-Therapie



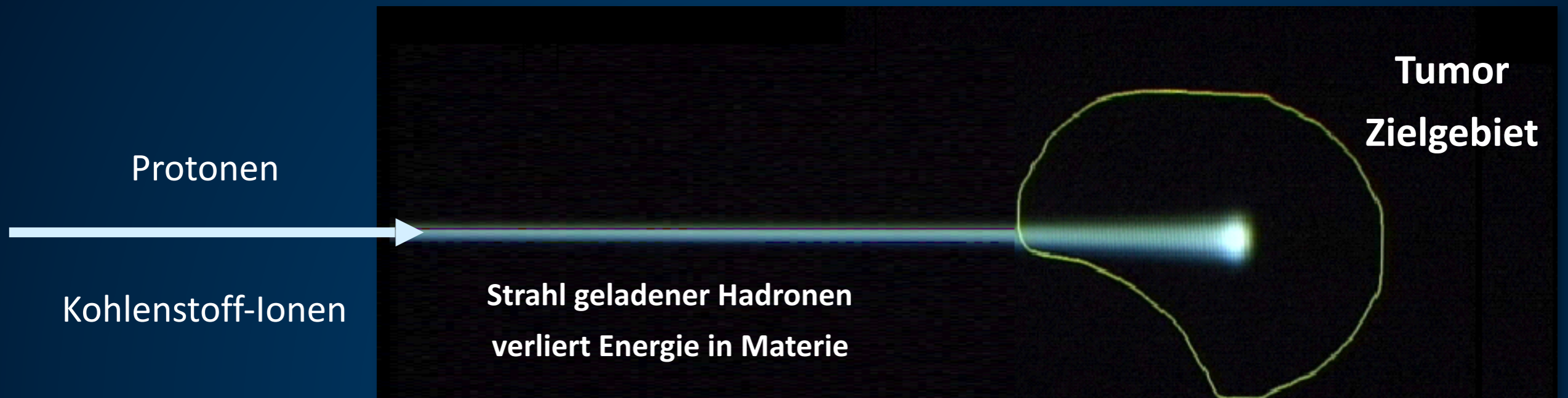
Parrinello, CERN

# Hadronen-Therapie

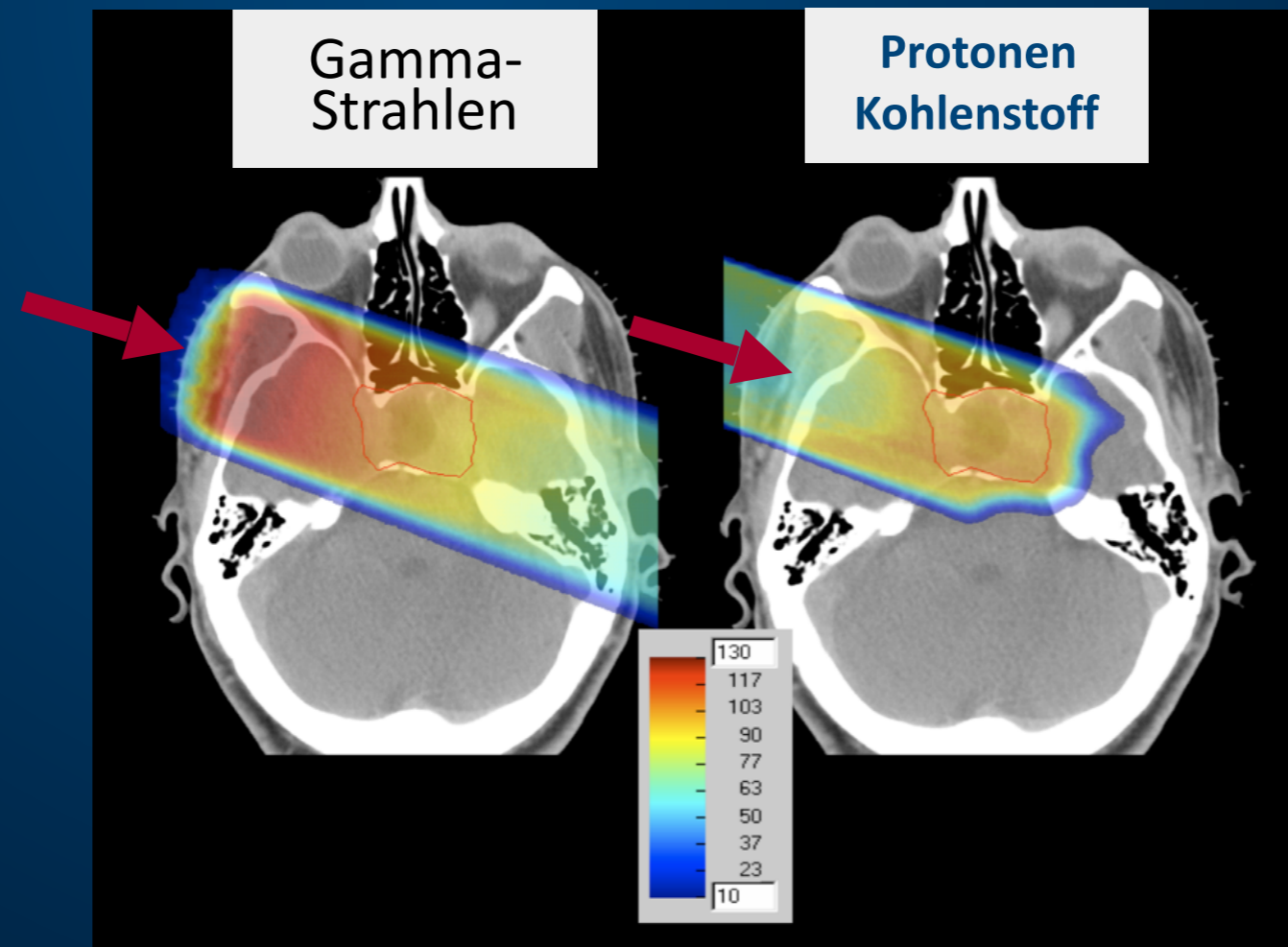


Parrinello, CERN

# Hadronen-Therapie

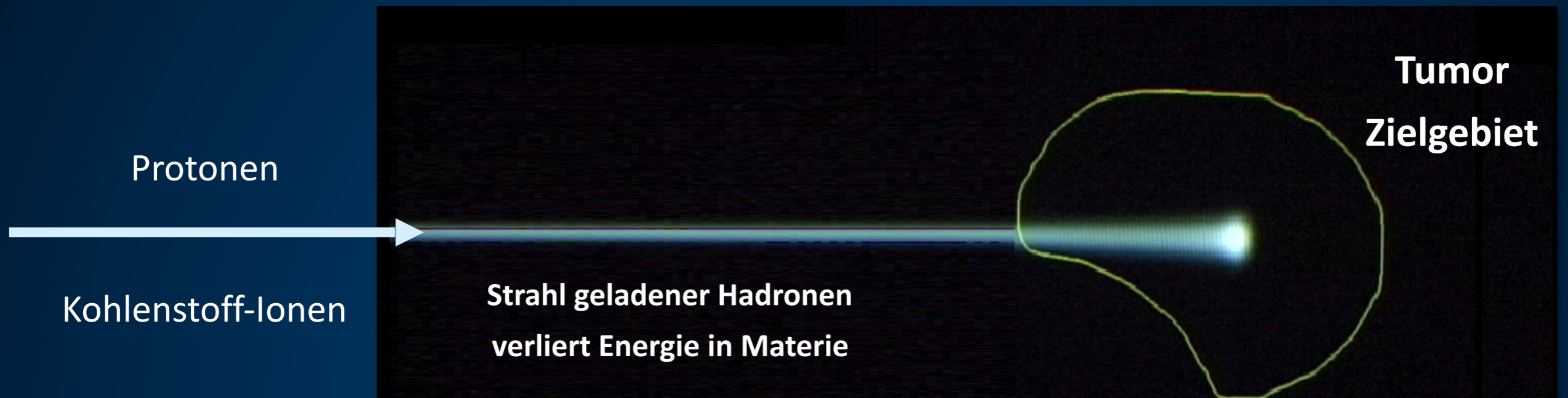


Parrinello, CERN



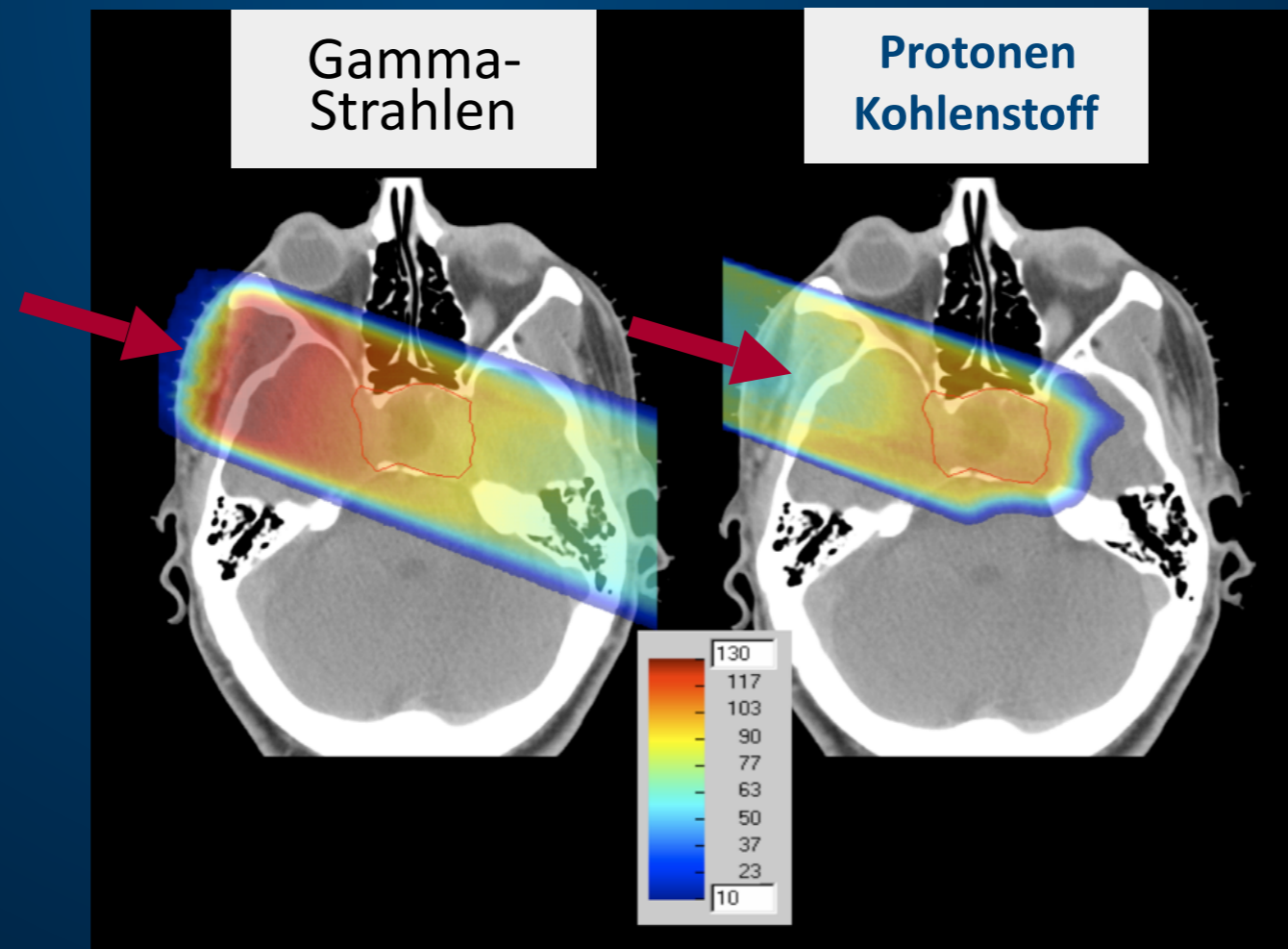
GSI

# Hadronen-Therapie



Parrinello, CERN

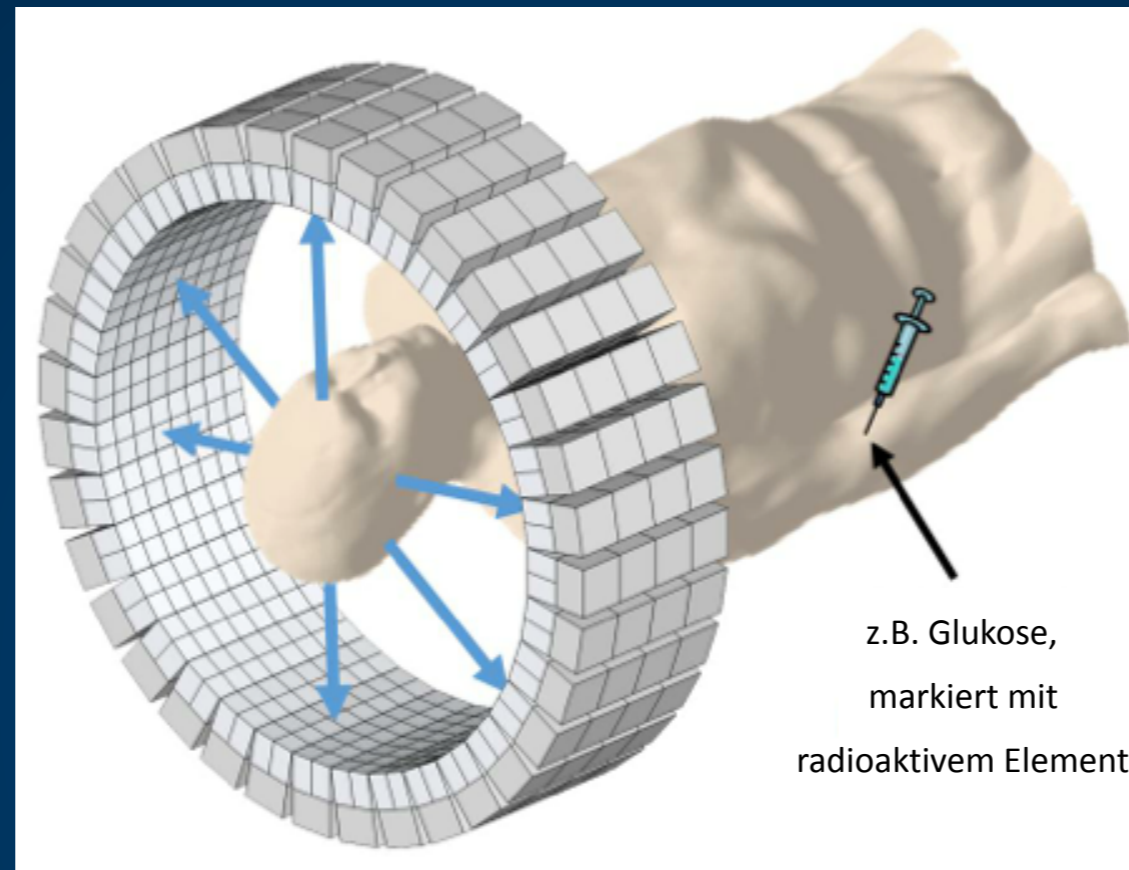
Erste Idee: Wilson, 1946



GSI

# Detektoren und Messprinzipien:

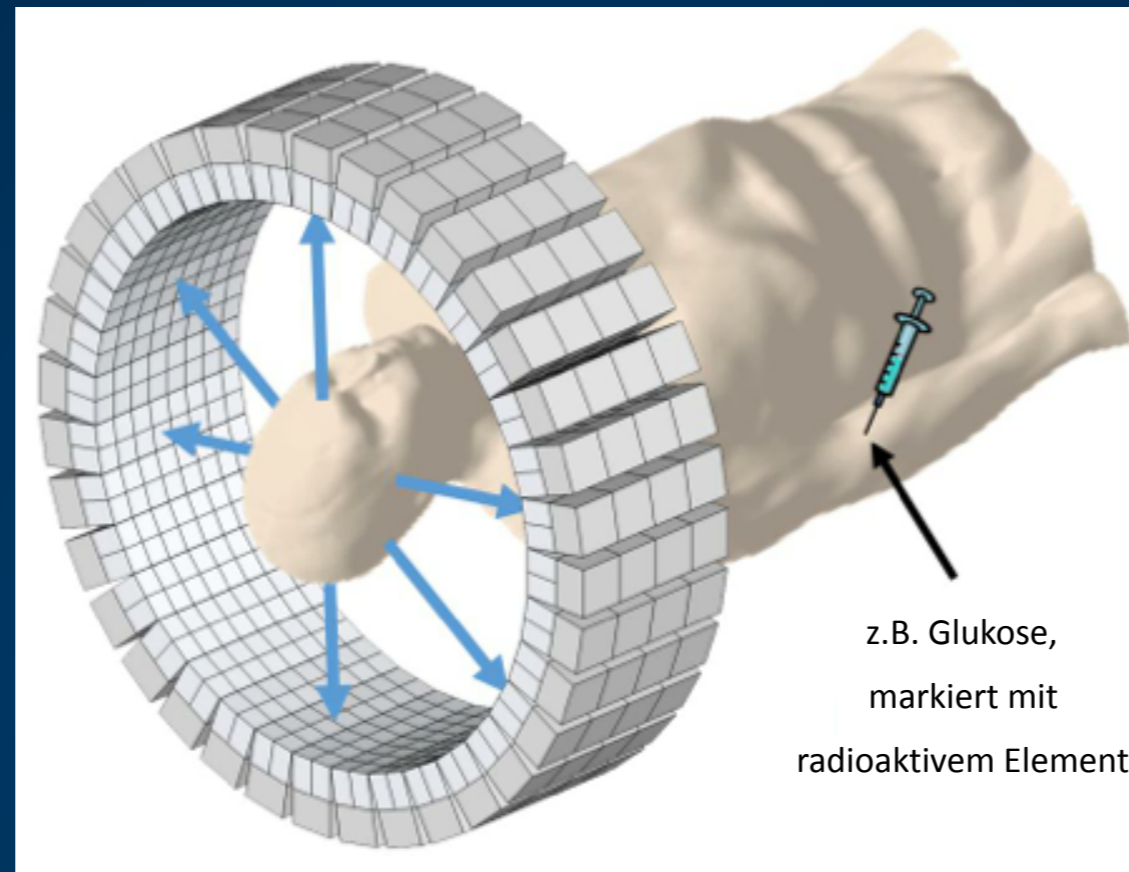
## Beispiel Positron-Emissions-Tomographie (PET)



# Detektoren und Messprinzipien:

## Beispiel Positron-Emissions-Tomographie (PET)

$$E = mc^2$$

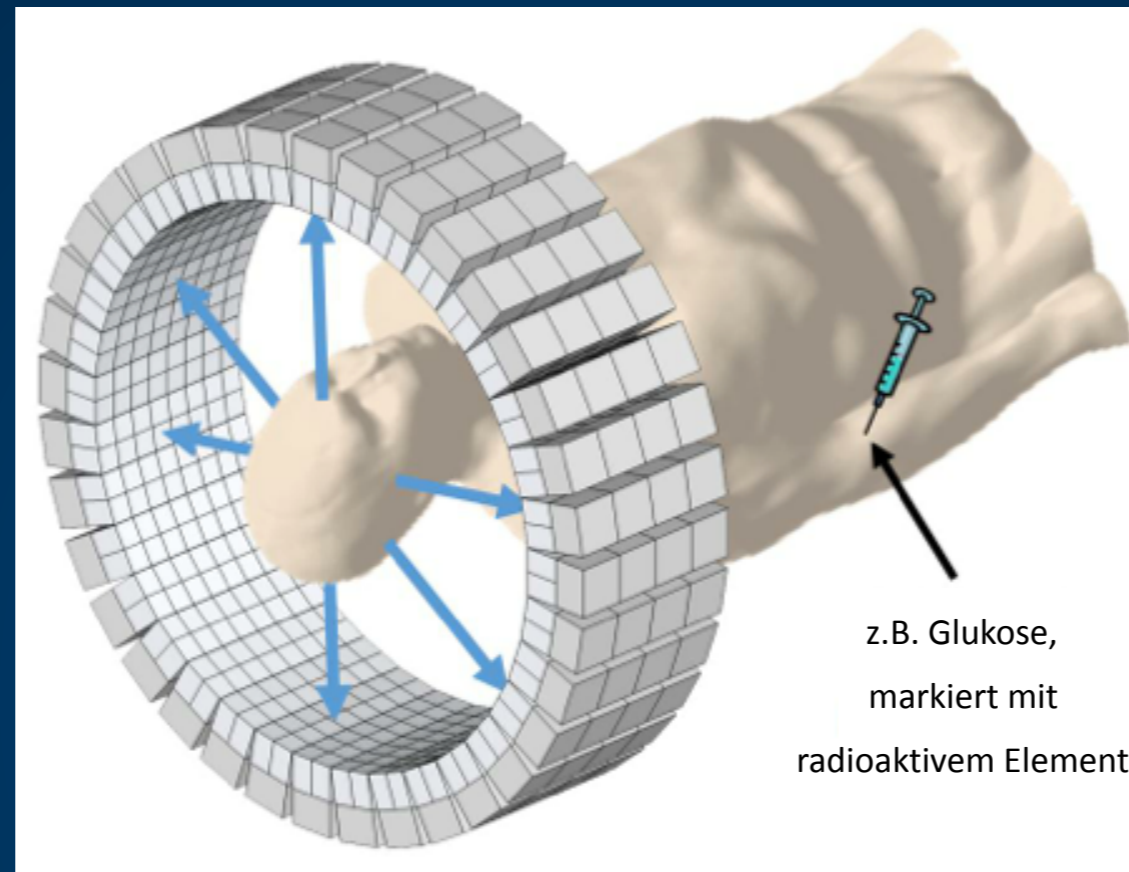


**Anti-  
Materie**

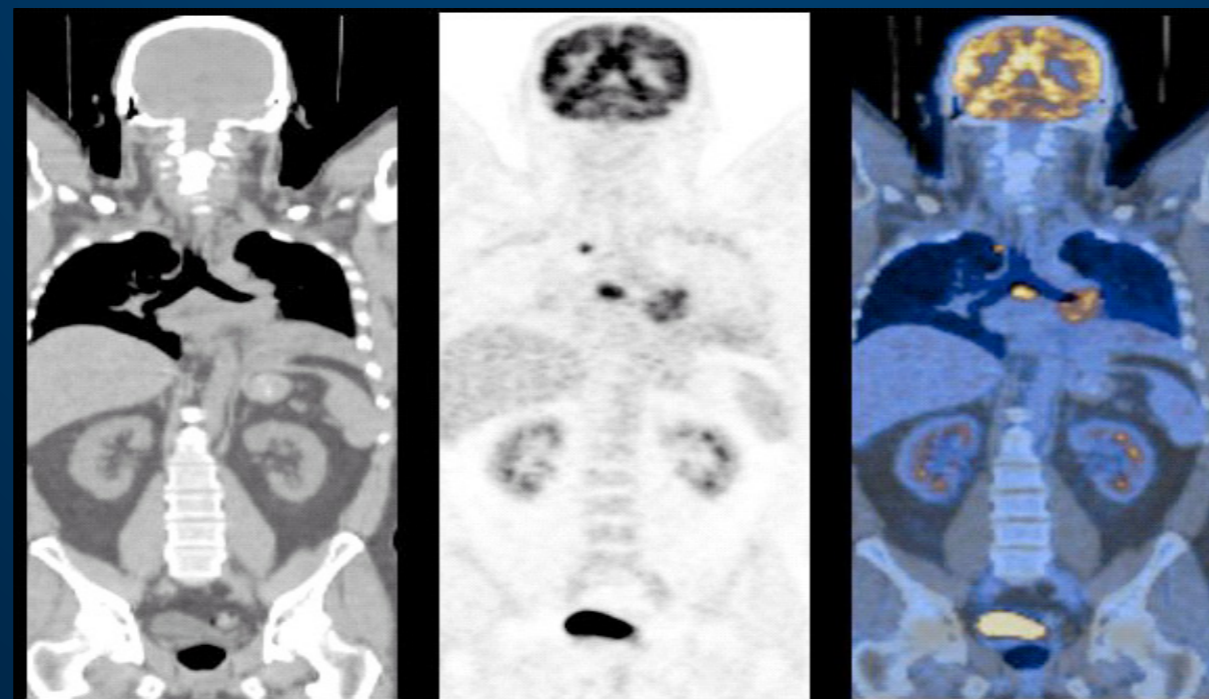
# Detektoren und Messprinzipien:

## Beispiel Positron-Emissions-Tomographie (PET)

$$E = mc^2$$

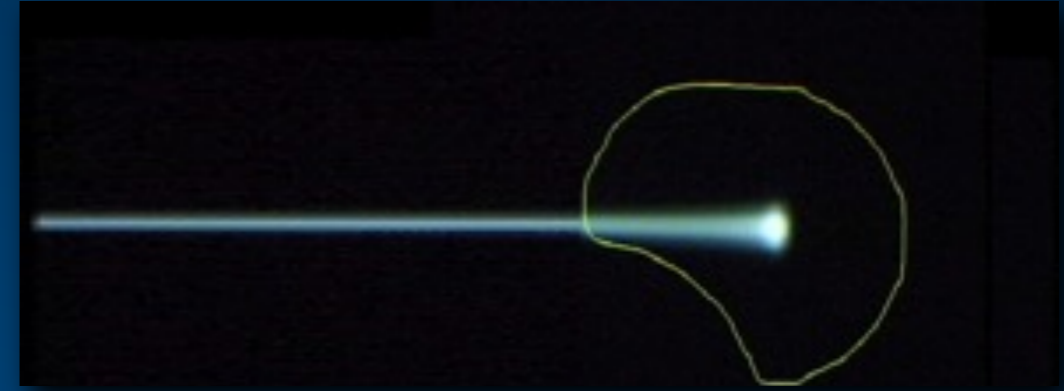


Anti-Materie



# Fazit

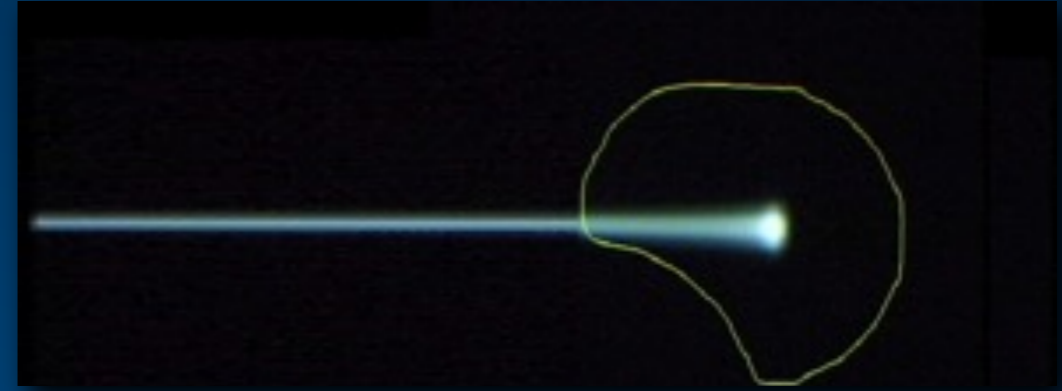
Teilchenstrahlen aus Beschleunigern zur Krebstherapie



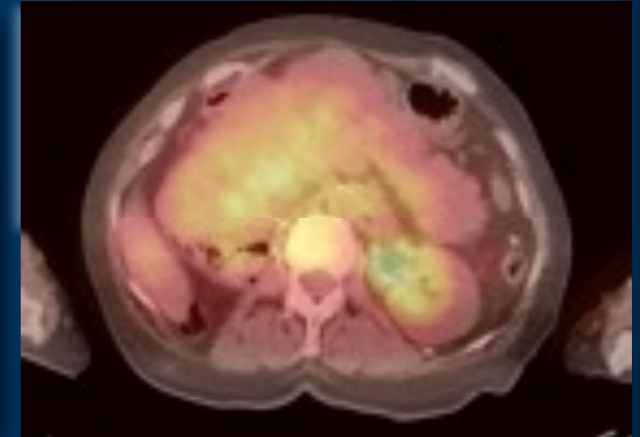
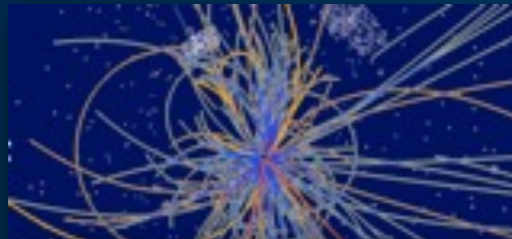


# Fazit

Teilchenstrahlen aus Beschleunigern zur Krebstherapie

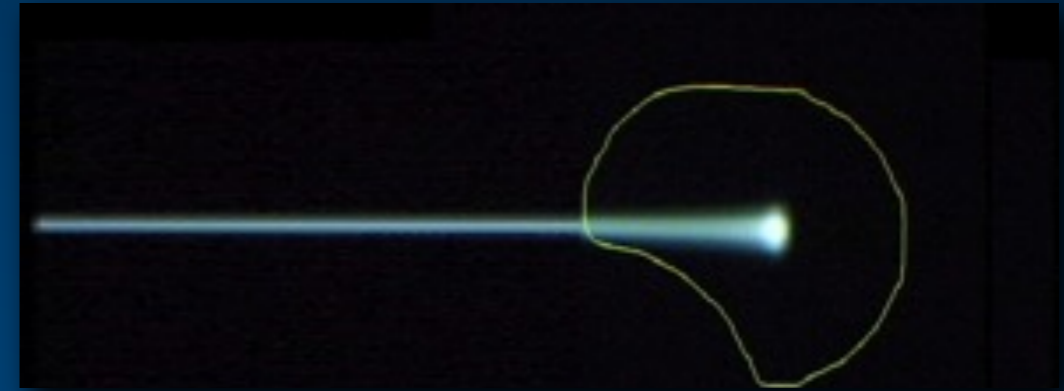


Teilchendetektor-Technologie für (bio-)medizinische Bildgebung

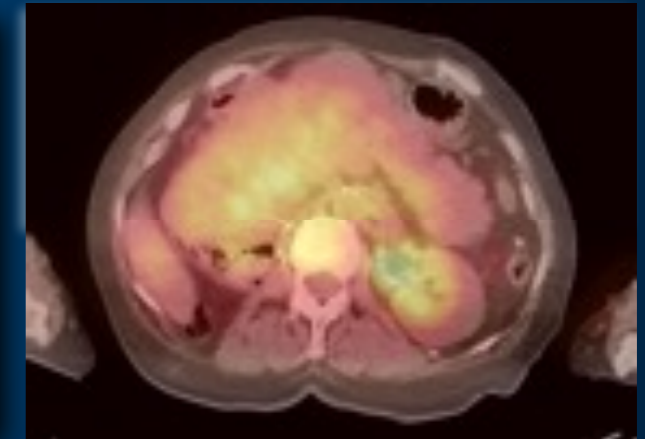
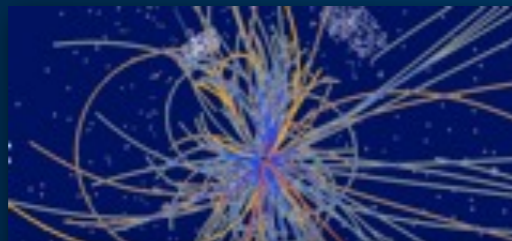


# Fazit

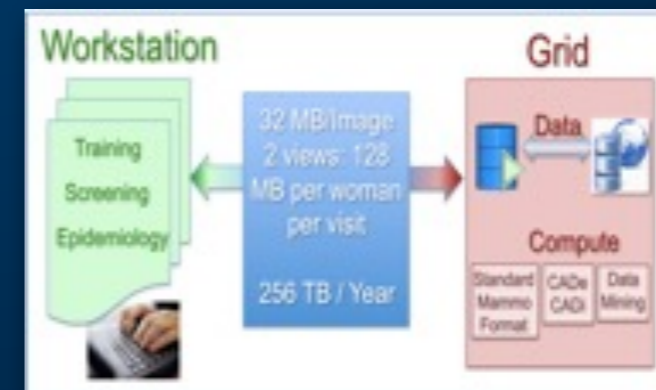
Teilchenstrahlen aus Beschleunigern zur Krebstherapie



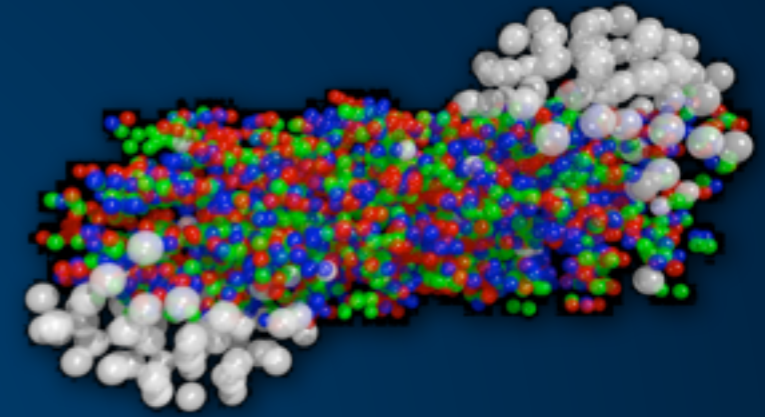
Teilchendetektor-Technologie für (bio-)medizinische Bildgebung



Grid Technologie für medizinische Datenverwaltung und Analyse

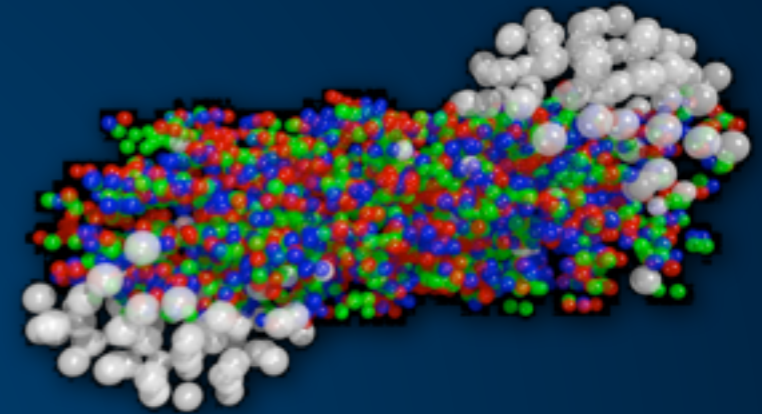


# Noch ein paar Gedanken



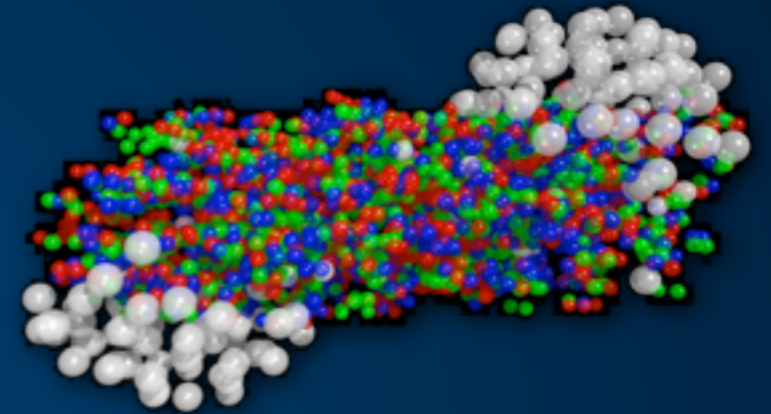
# Noch ein paar Gedanken

- mehr Atome in Ihrem kleinen Finger, als Sterne im gesamten Universum



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- wir bestehen aus 13 Milliarden Jahren alten Bausteinen



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- wir bestehen aus 13 Milliarden Jahren alten Bausteinen
- wir bestehen aus Sternenstaub

