

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

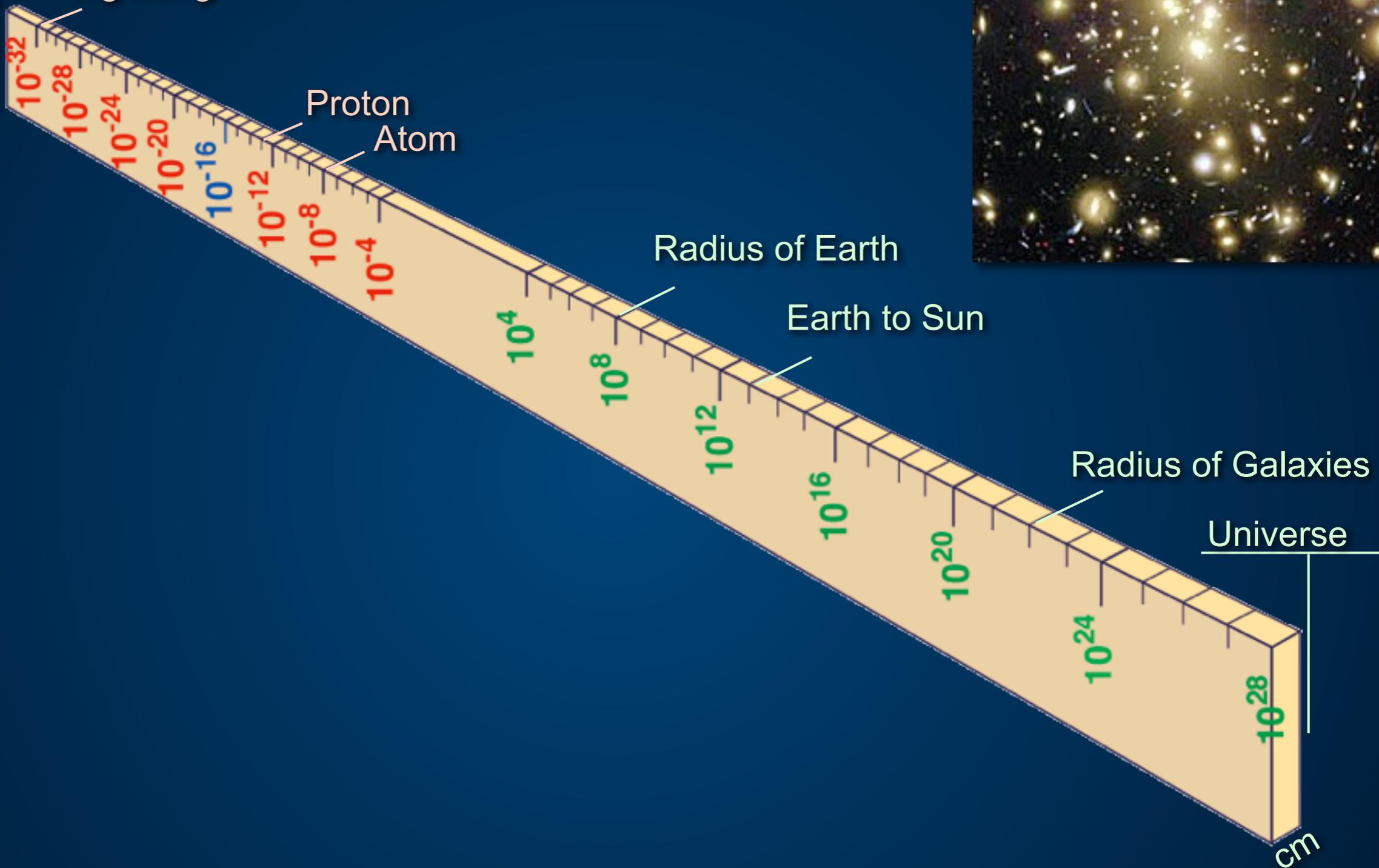
***Die Forschung am***



Prof. Günther Dissertori  
ETH Zürich

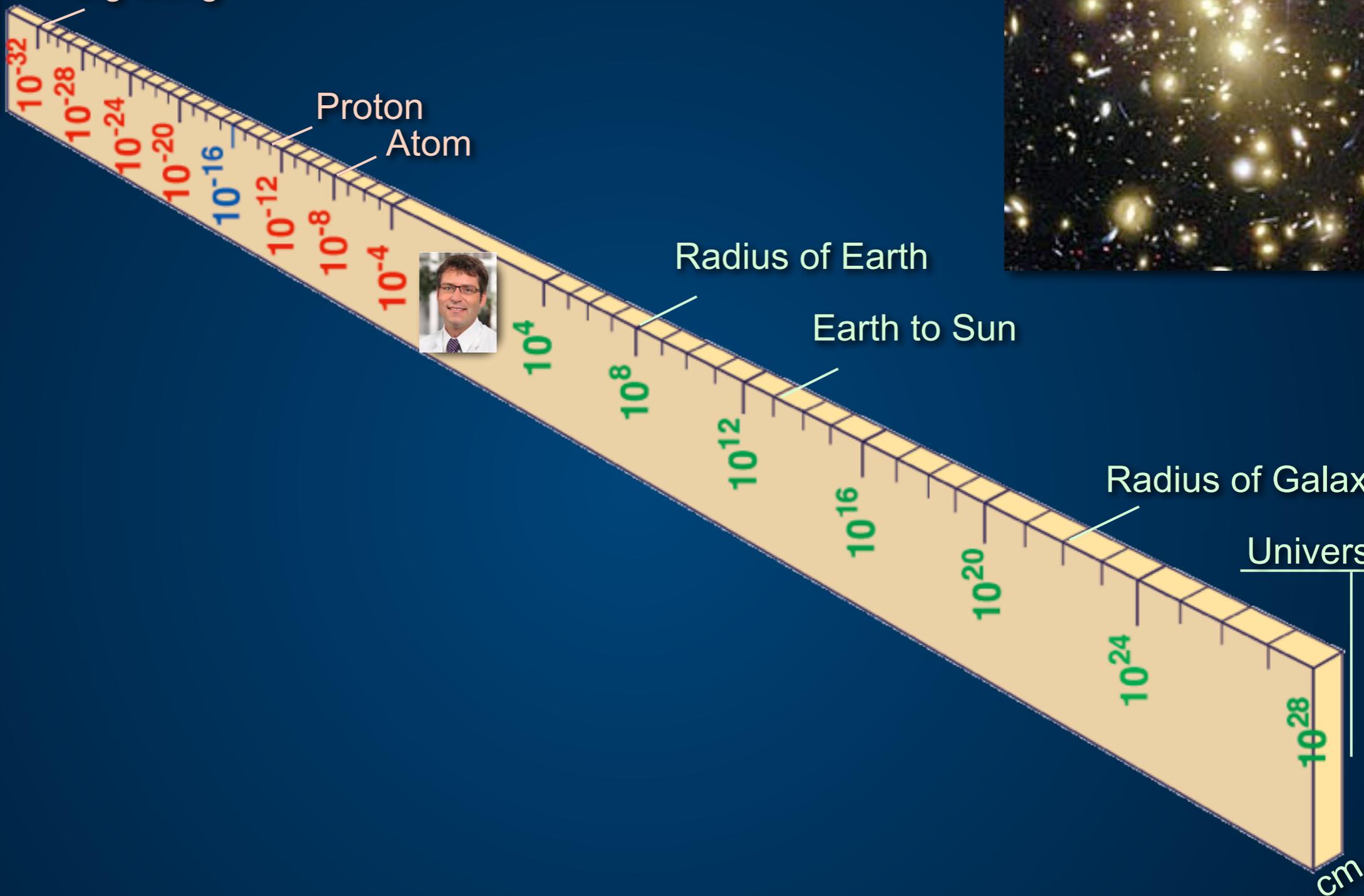


Big Bang



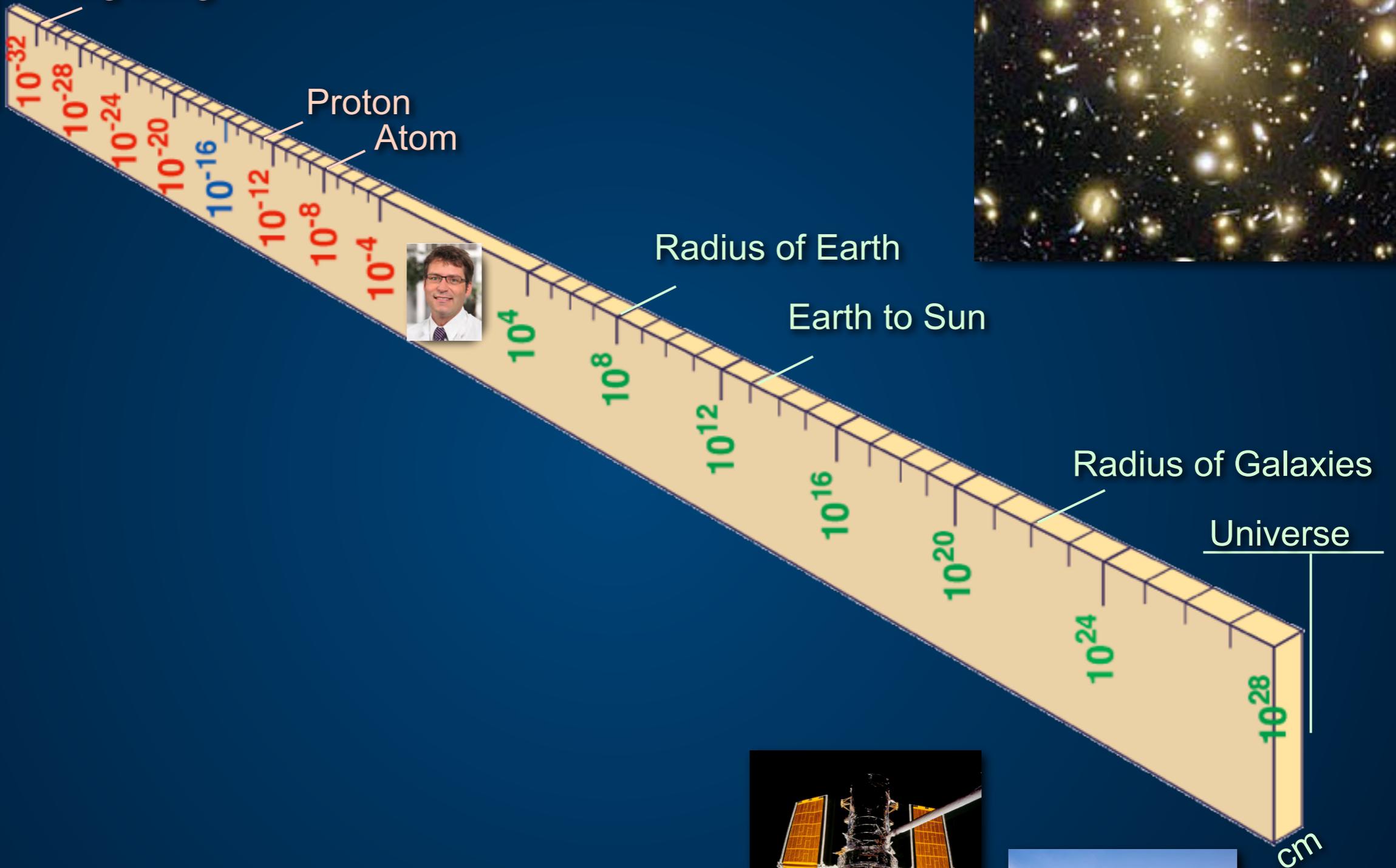


Big Bang





Big Bang





Big Bang



Proton  
Atom



Radius of Earth



Earth to Sun



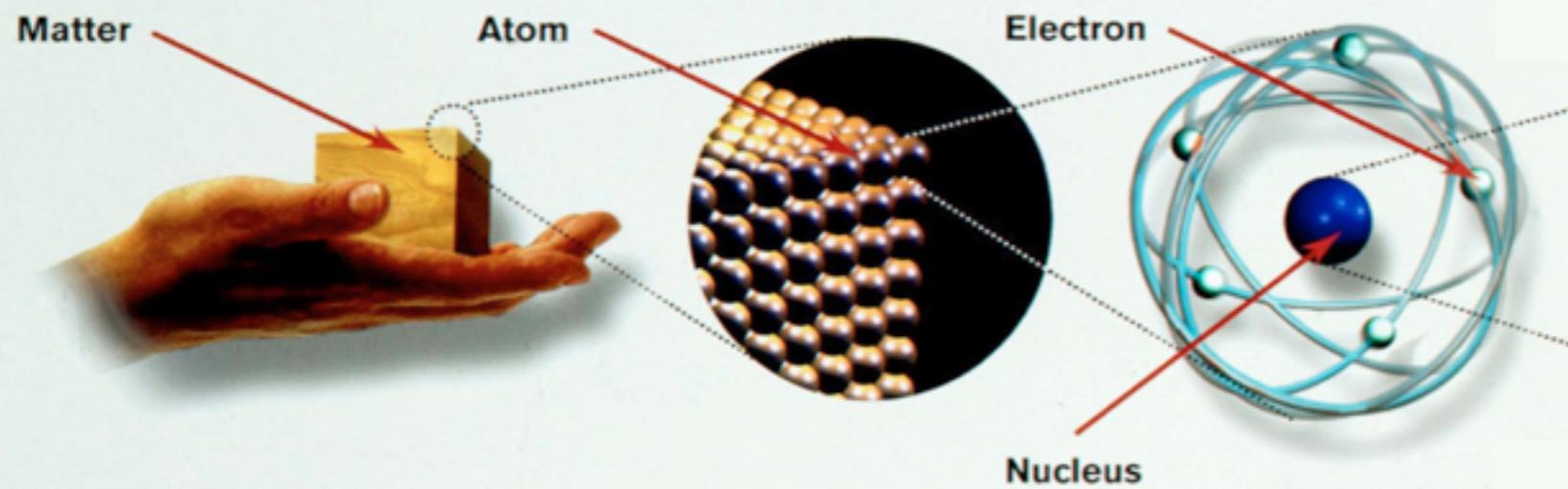
Super-Mikroskop

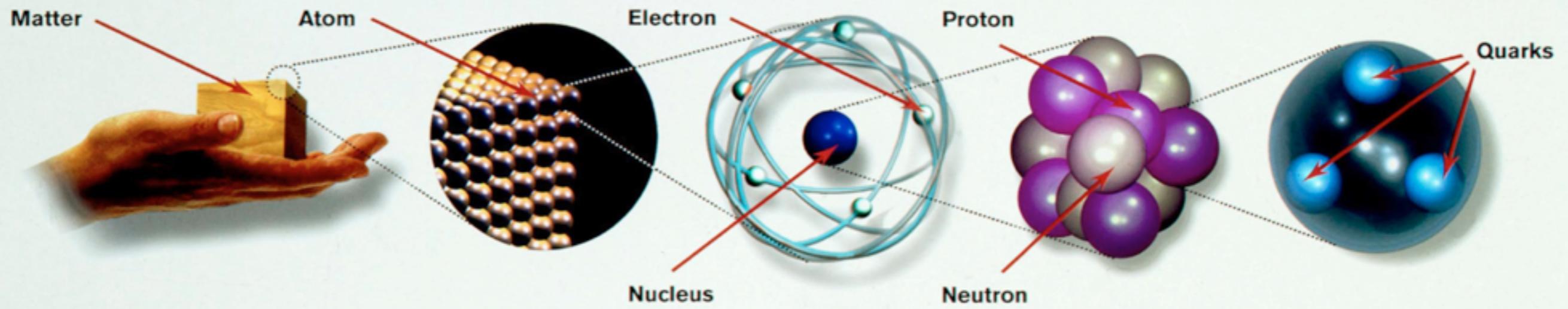
Radius of Galaxies

Universe

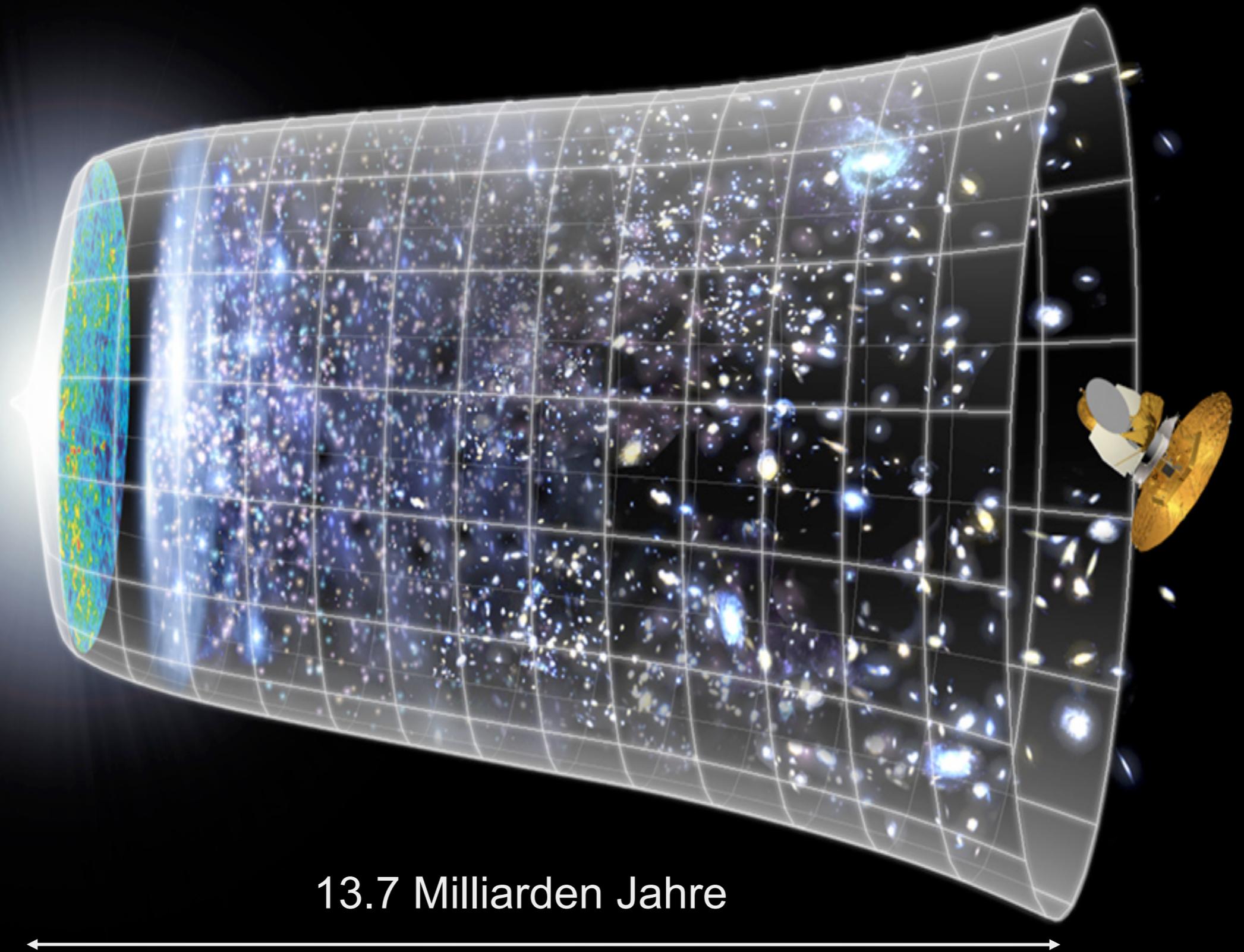
cm





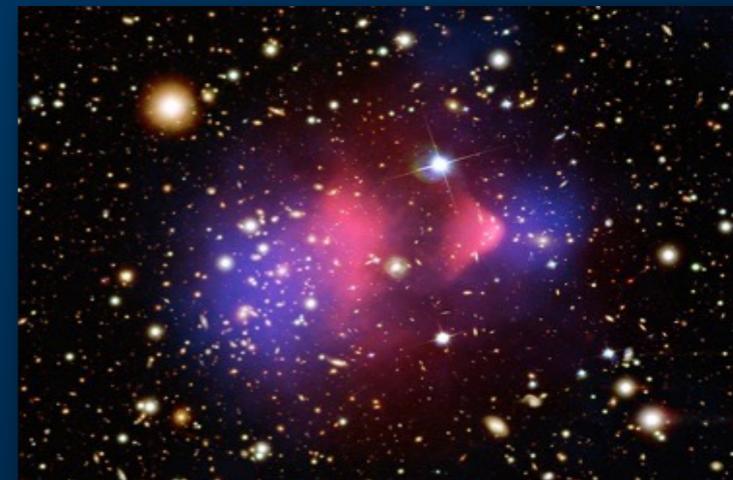
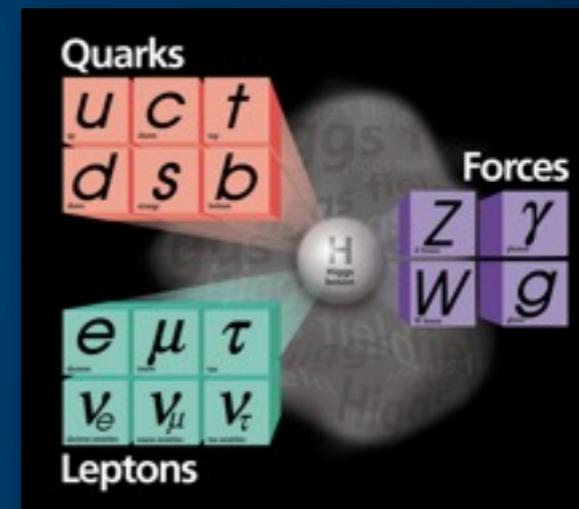
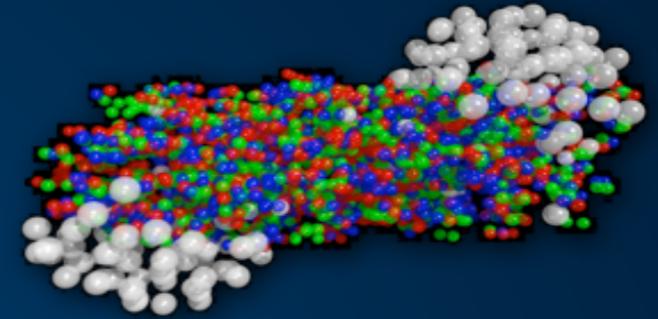






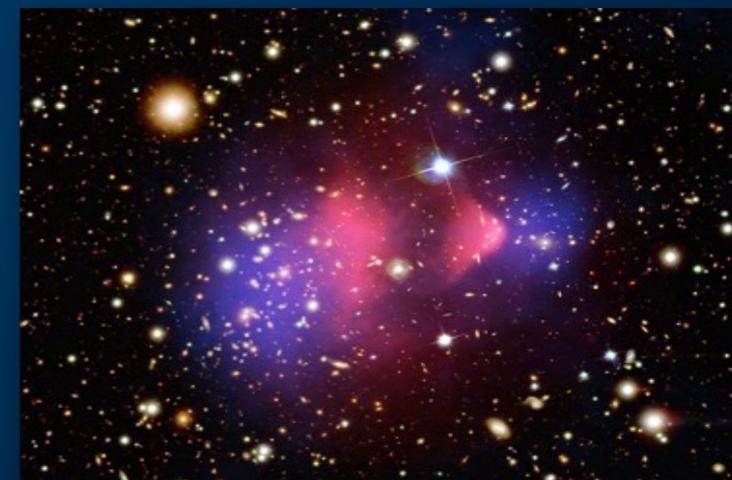
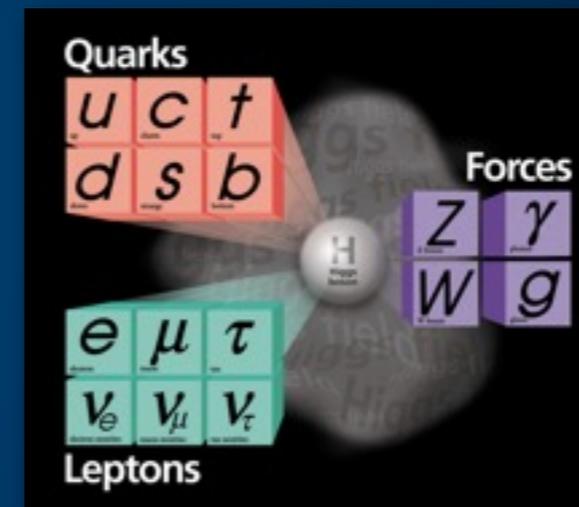
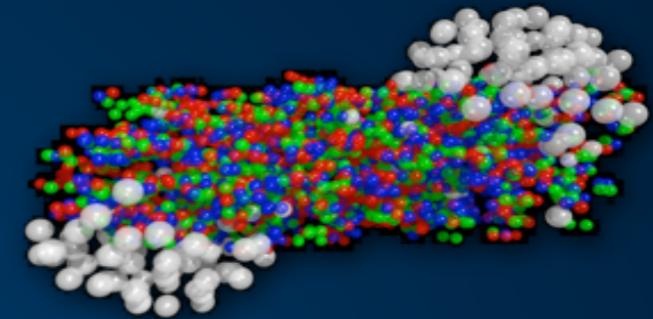
13.7 Milliarden Jahre

# Grosse offene Fragen



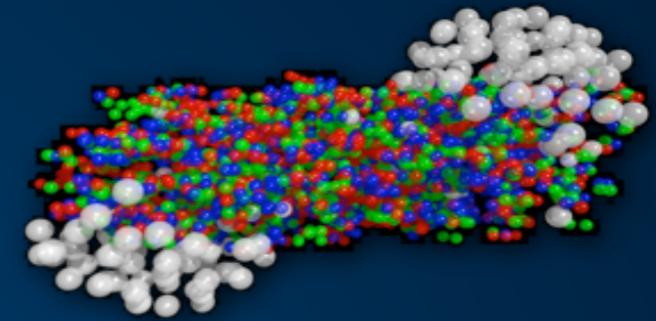
# Grosse offene Fragen

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

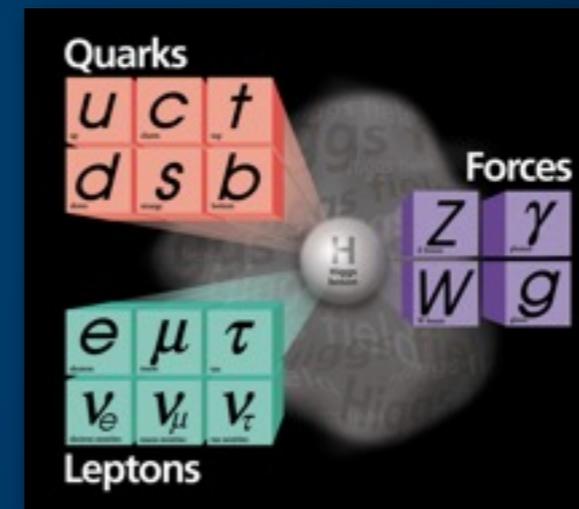


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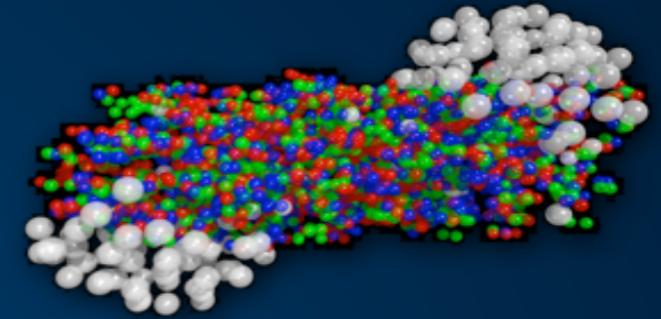


- Eigenschaften des neu entdeckten **Higgs Boson**, weitere neue Teilchen?

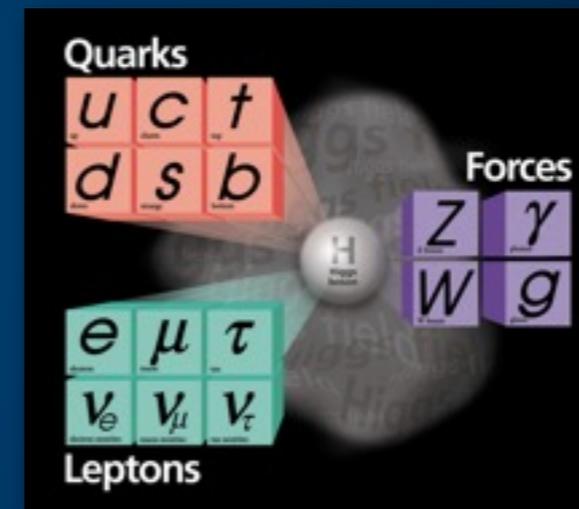


# Grosse offene Fragen

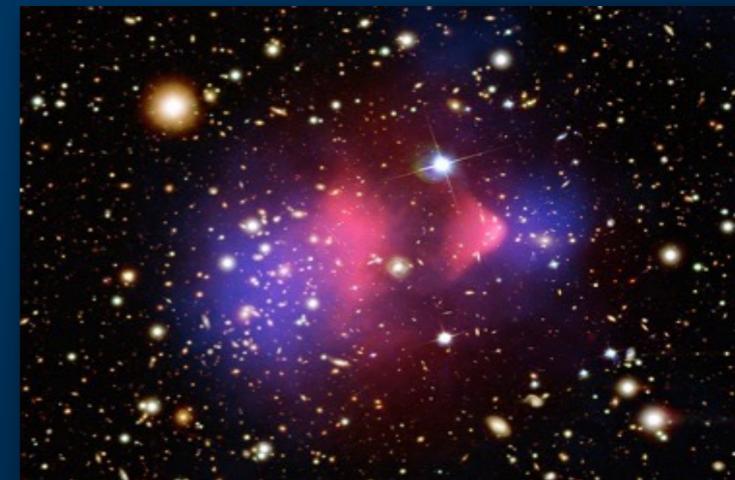
- Das Universum ganz kurz nach dem **Big Bang**



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



- was ist **Dunkle Materie** ?



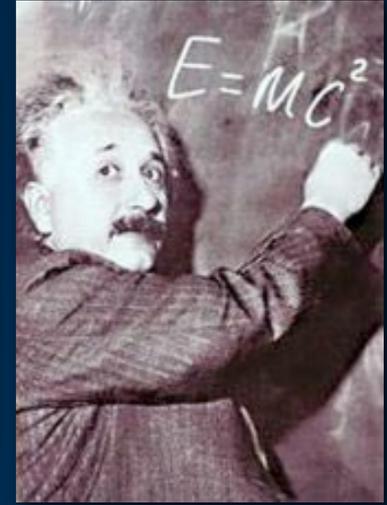
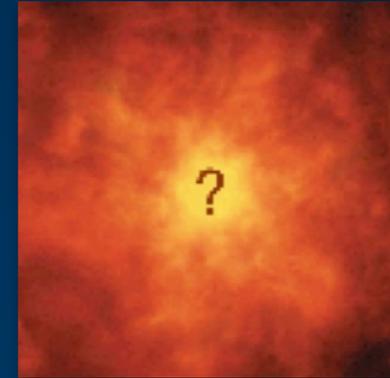


# CERN's Mission



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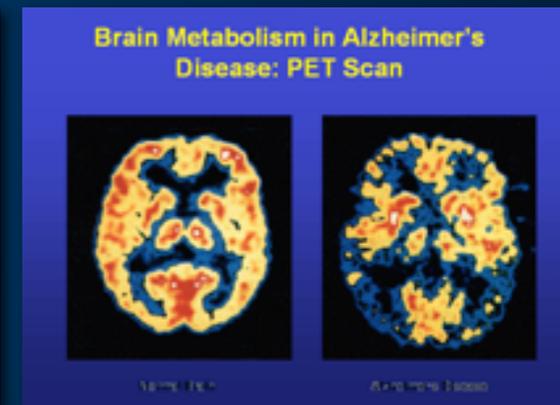
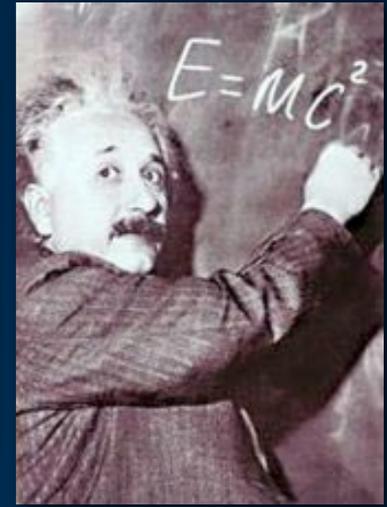
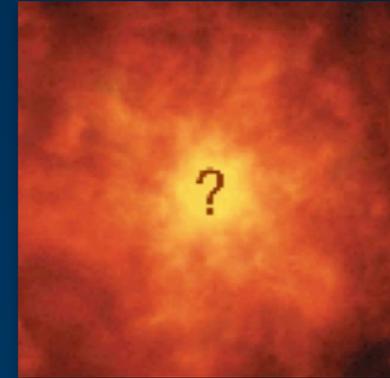
- Verschiebung der **Grenzen des Wissen**





# CERN's Mission

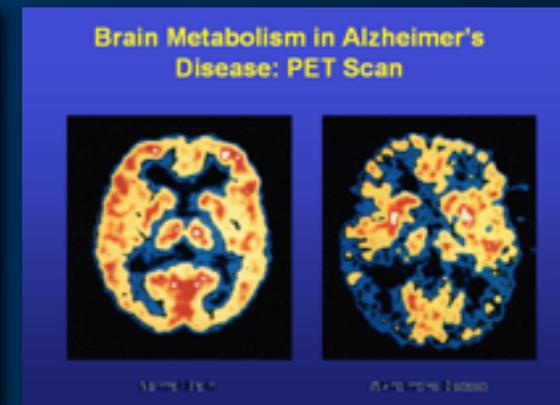
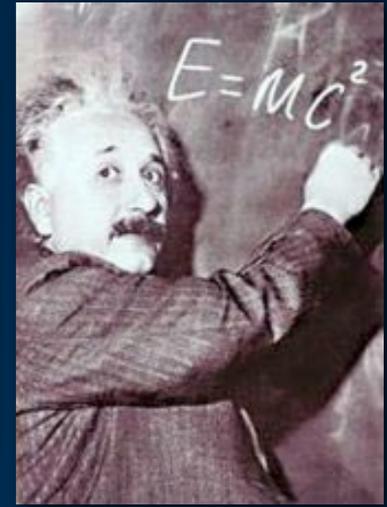
- Verschiebung der **Grenzen des Wissen**
- Entwicklung **neuer Technologien**





# CERN's Mission

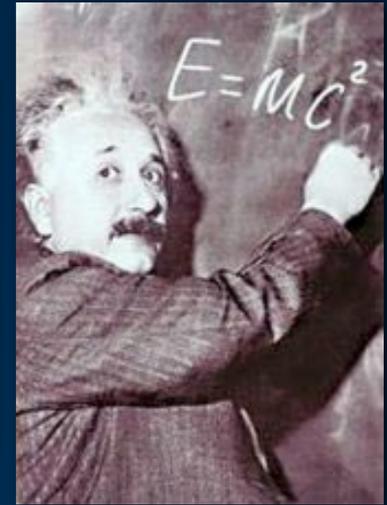
- Verschiebung der **Grenzen des Wissen**
- Entwicklung **neuer Technologien**
- Ausbildung der **Wissenschaftler und Ingenieure** von morgen





# CERN's Mission

- Verschiebung der **Grenzen des Wissen**



- Entwicklung **neuer Technologien**



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



- **Menschen** zusammenbringen



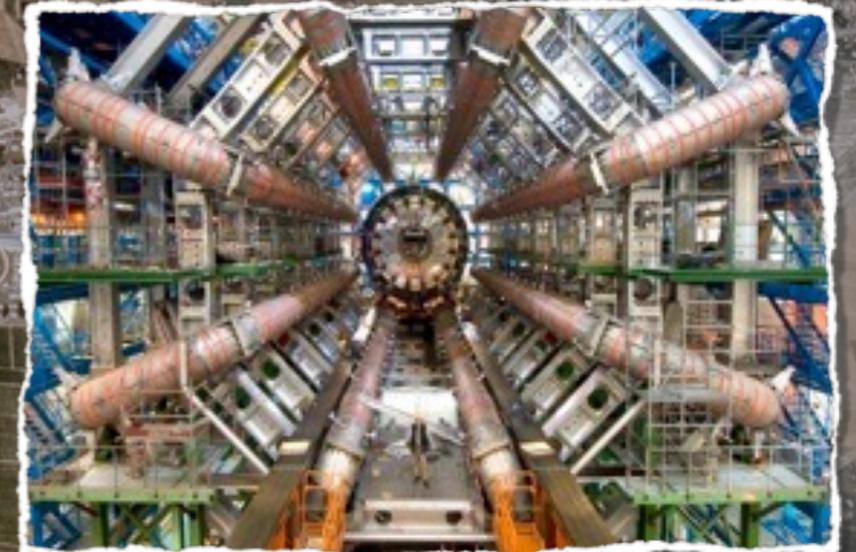
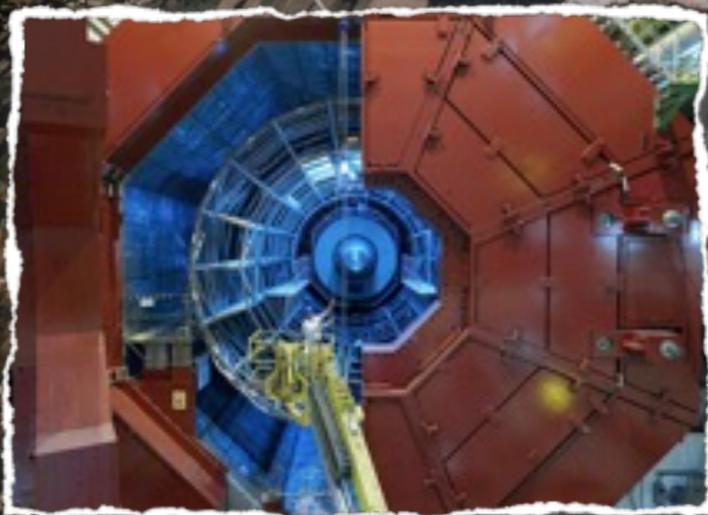
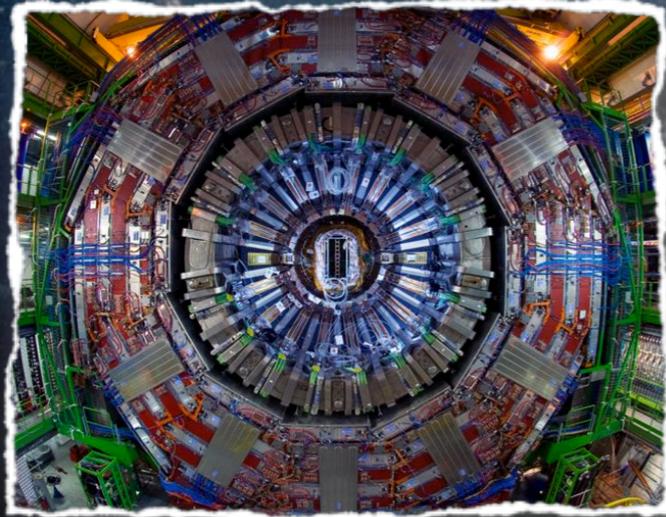
# Der Large Hadron Collider

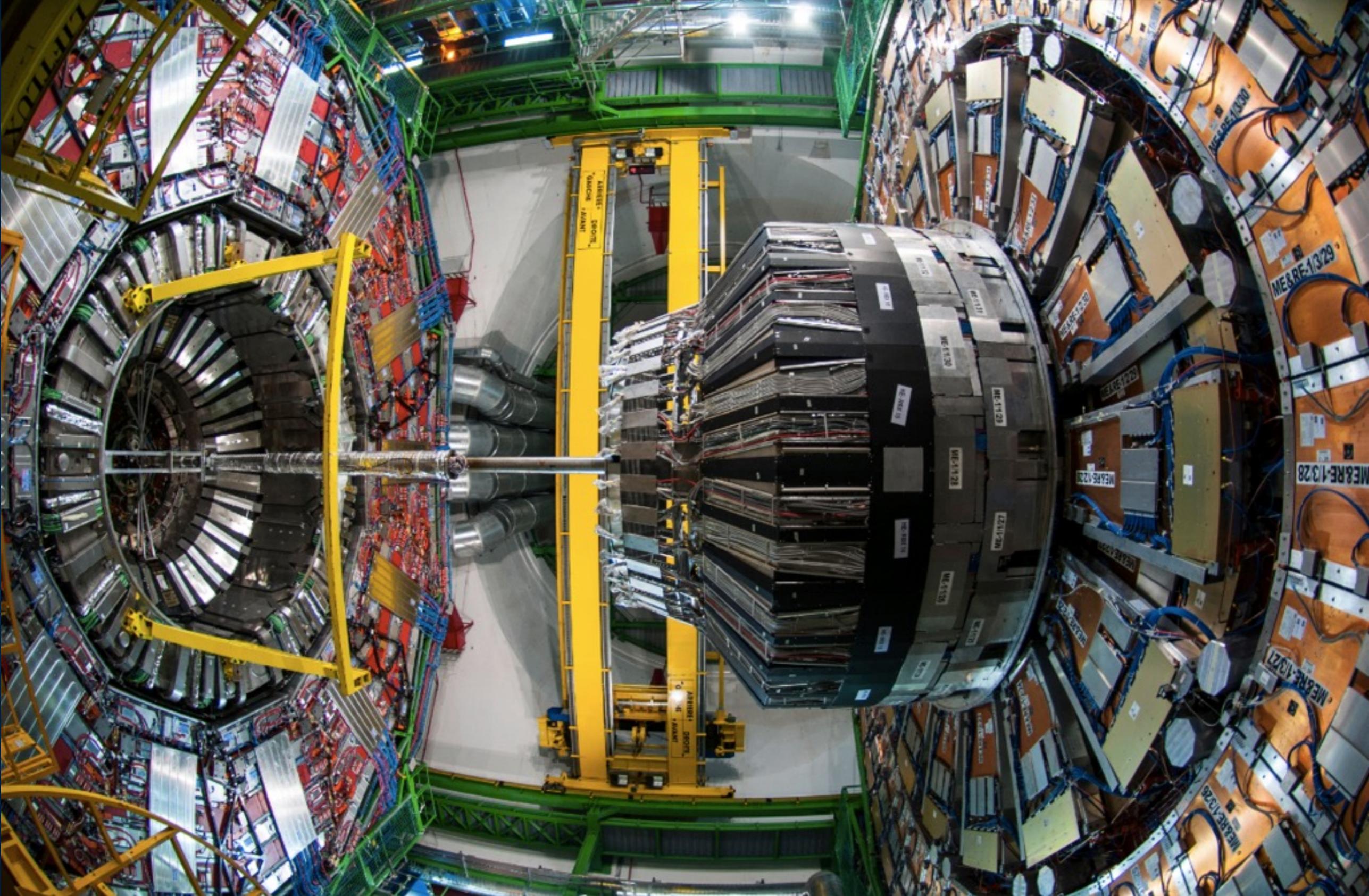
Eines der grössten, globalen wissenschaft. Projekte aller Zeiten



# Der Large Hadron Collider

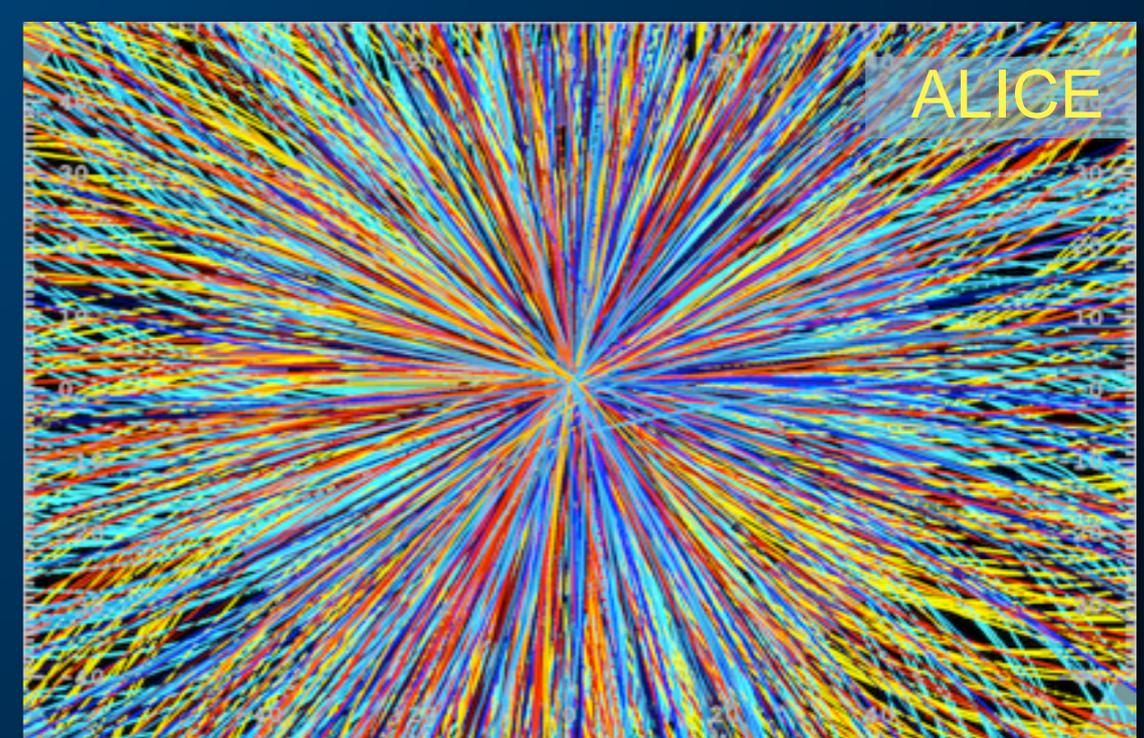
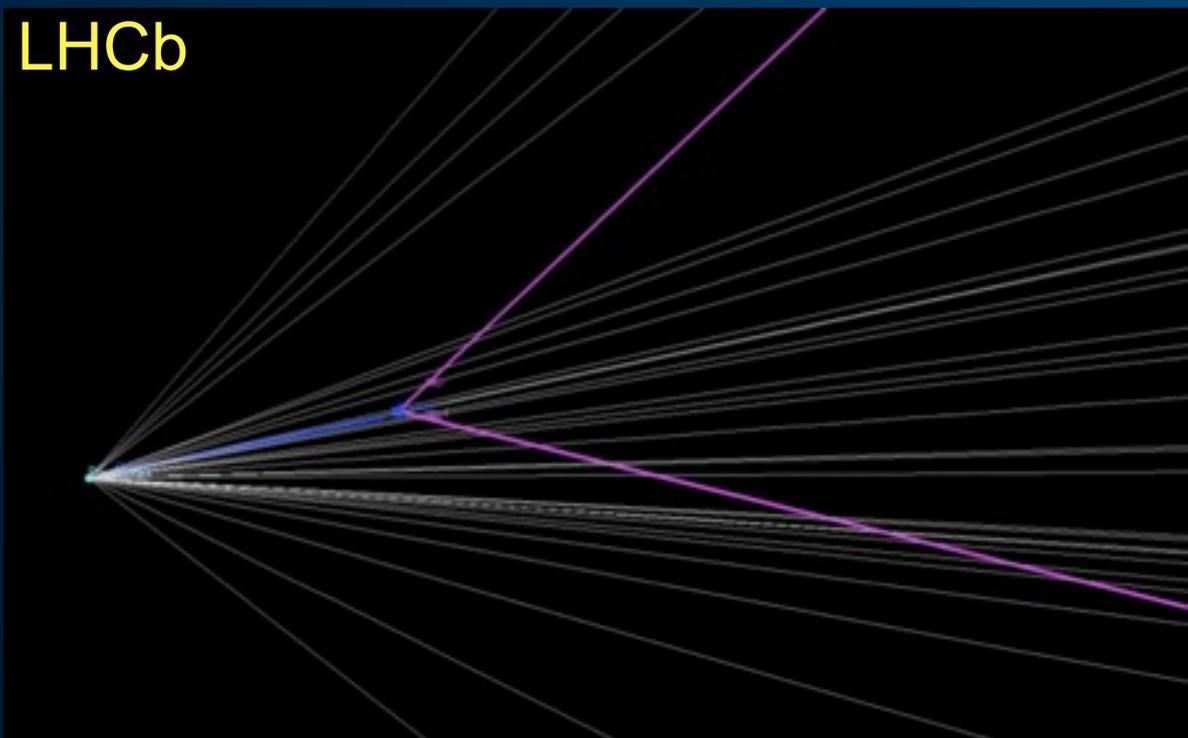
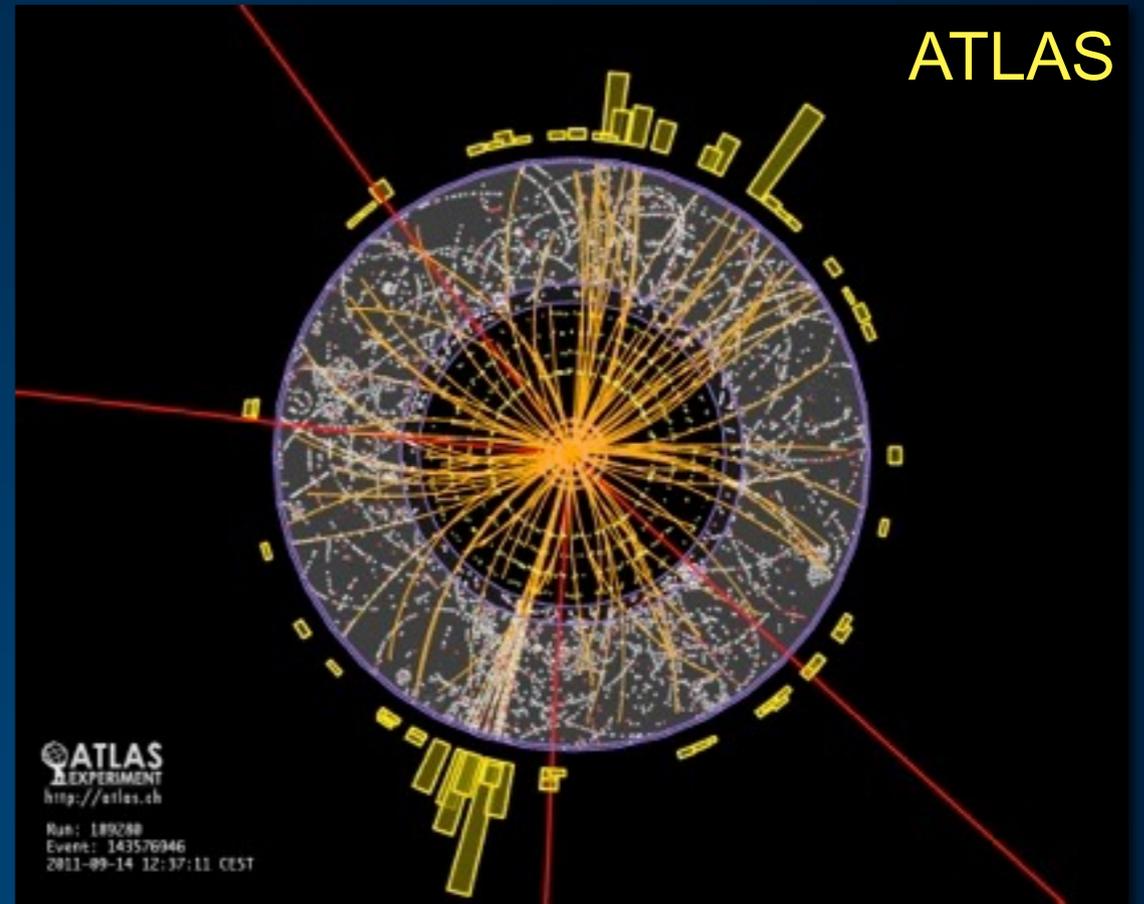
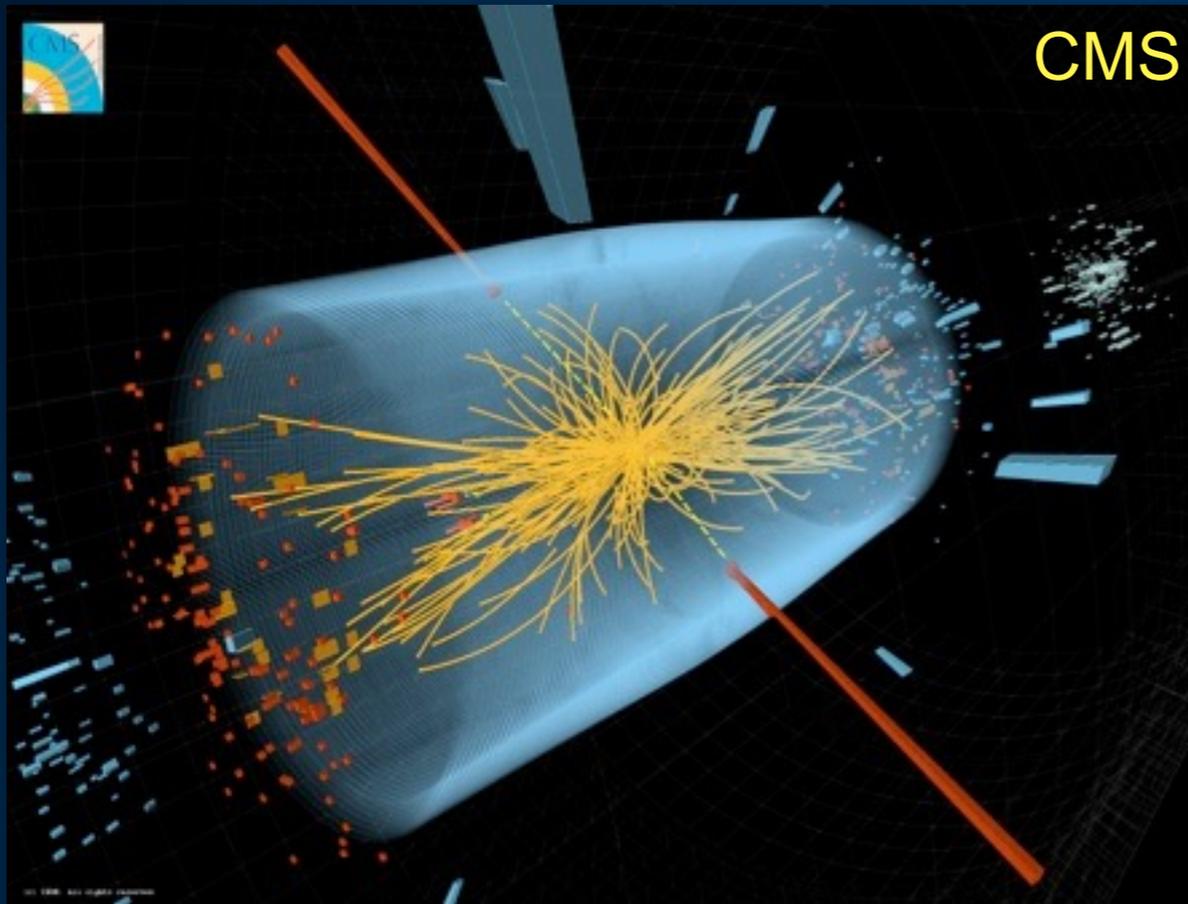
Eines der grössten, globalen wissenschaft. Projekte aller Zeiten

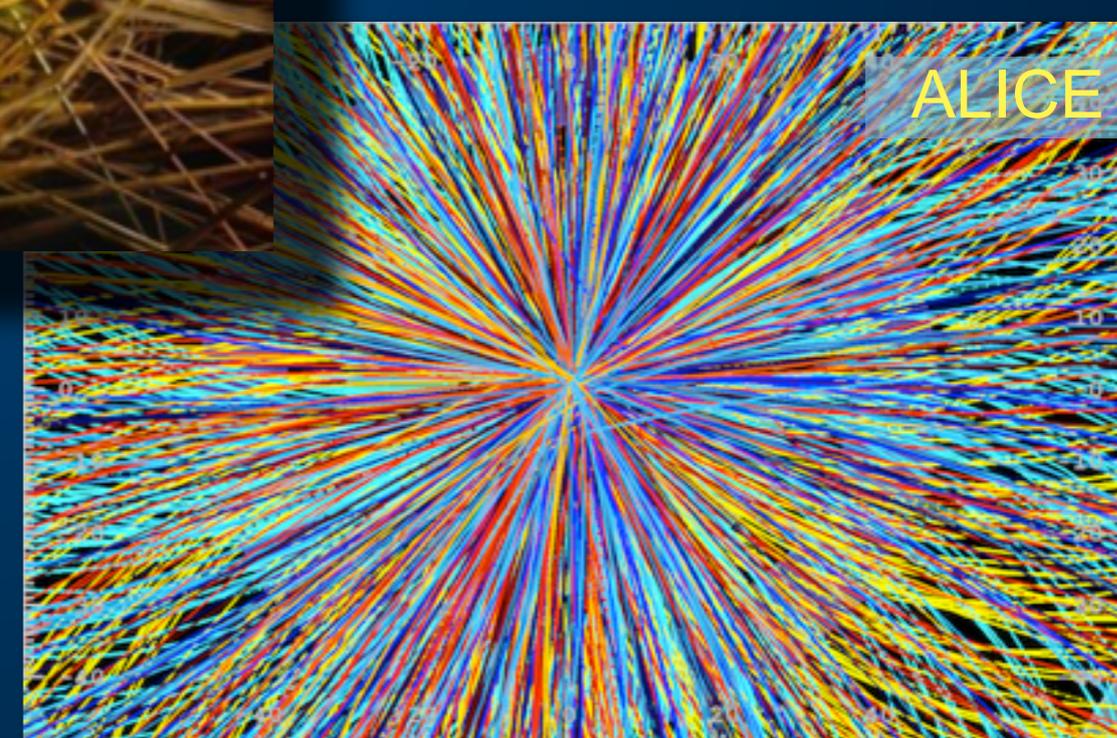
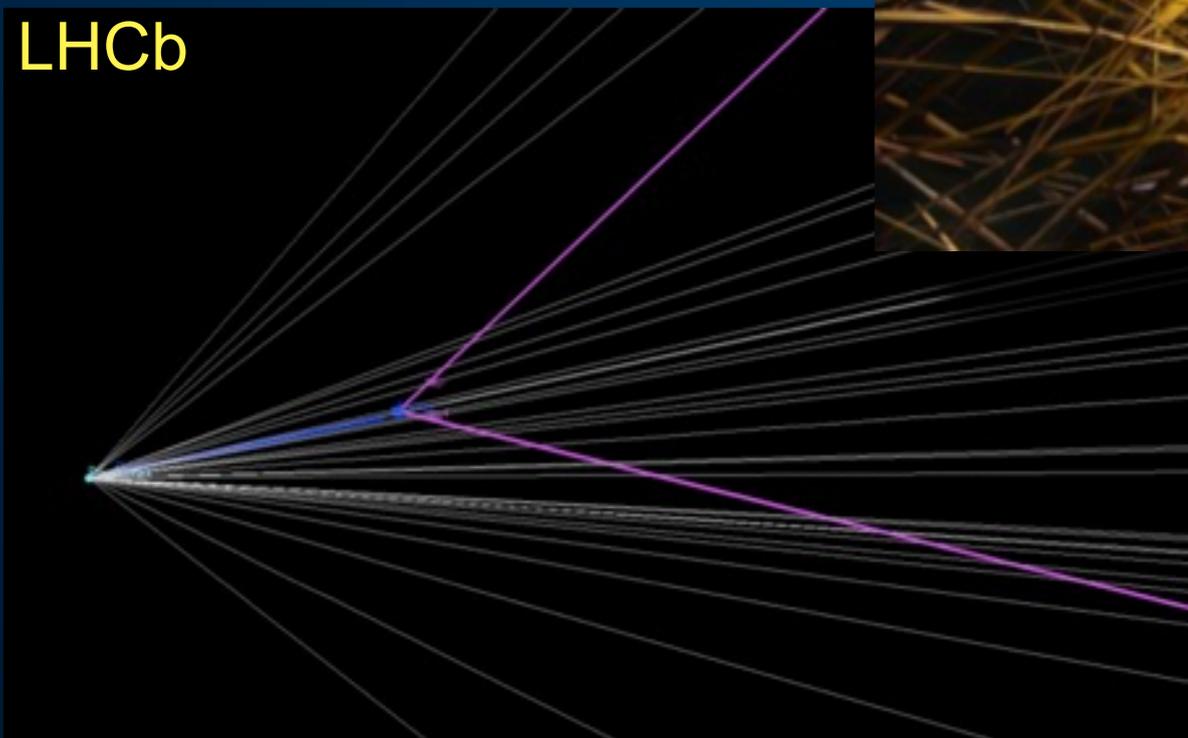
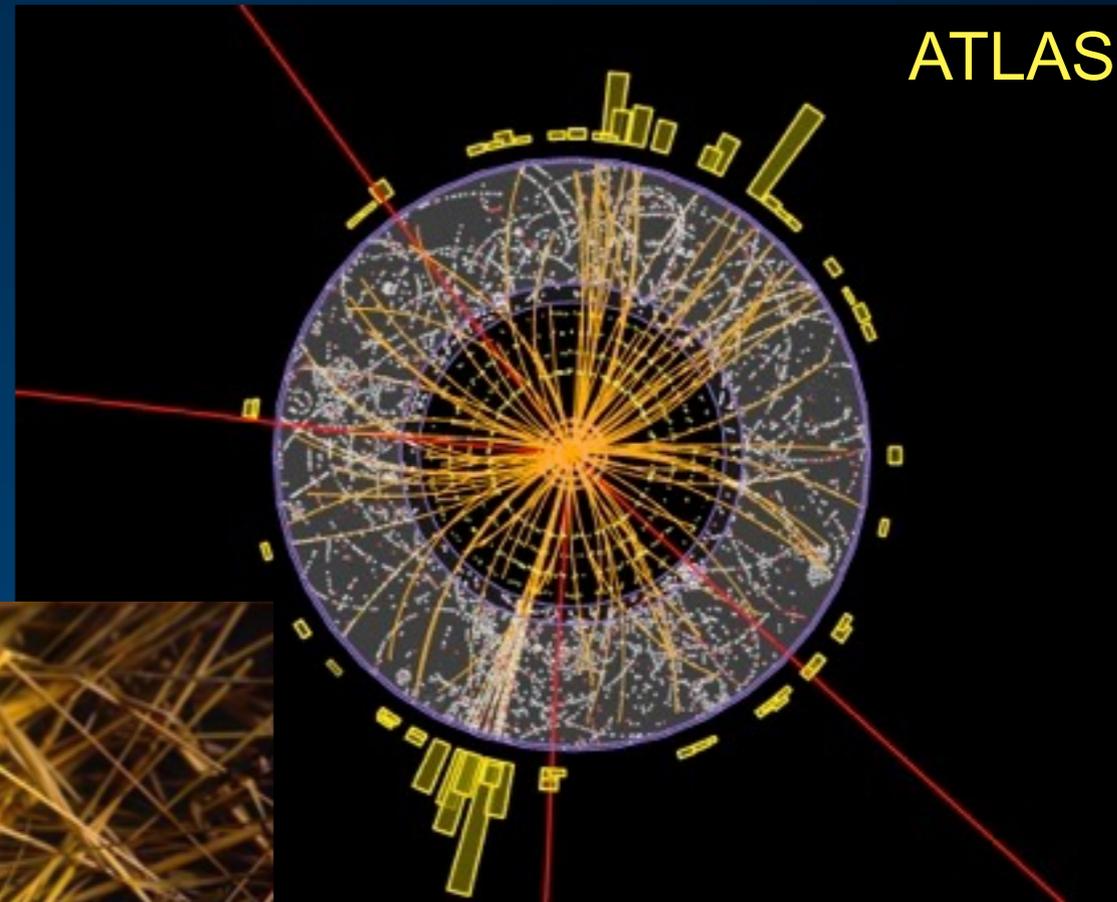
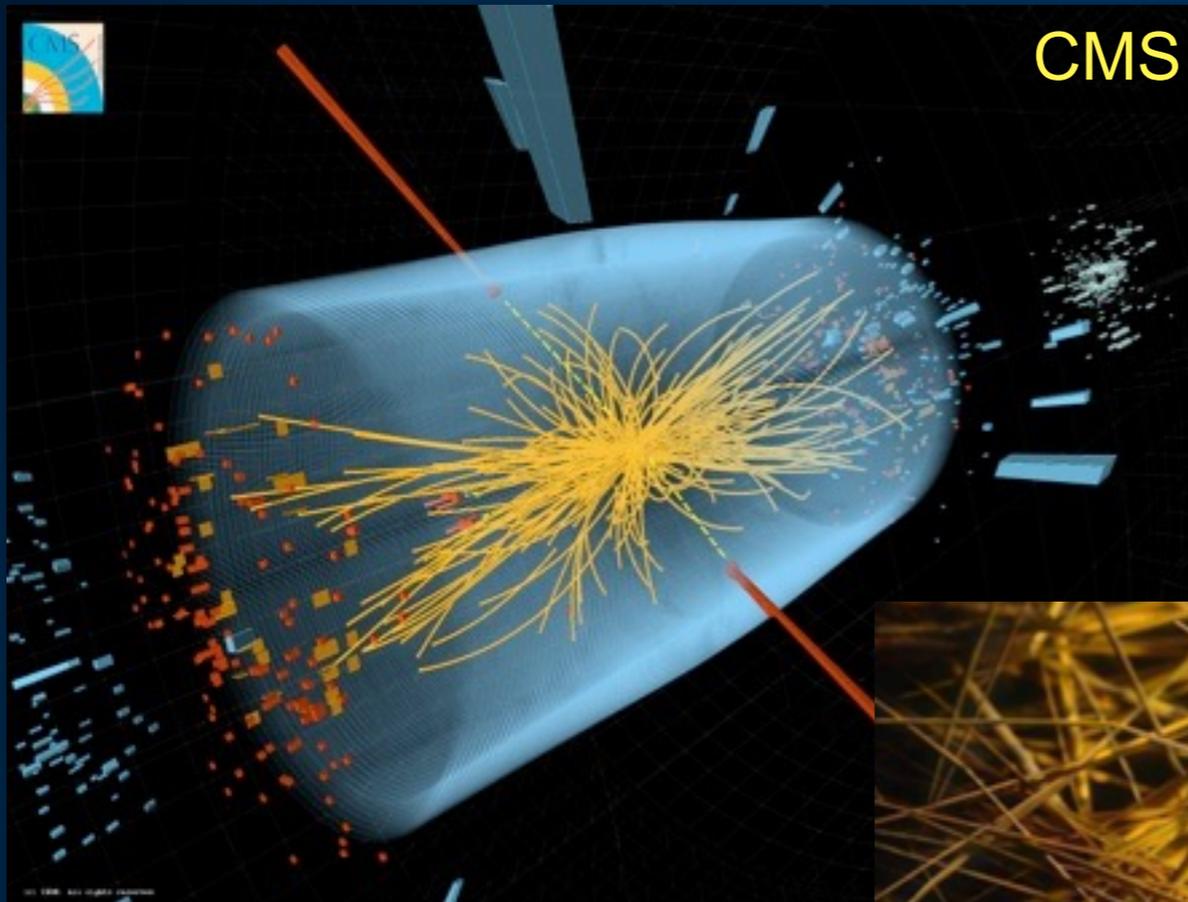




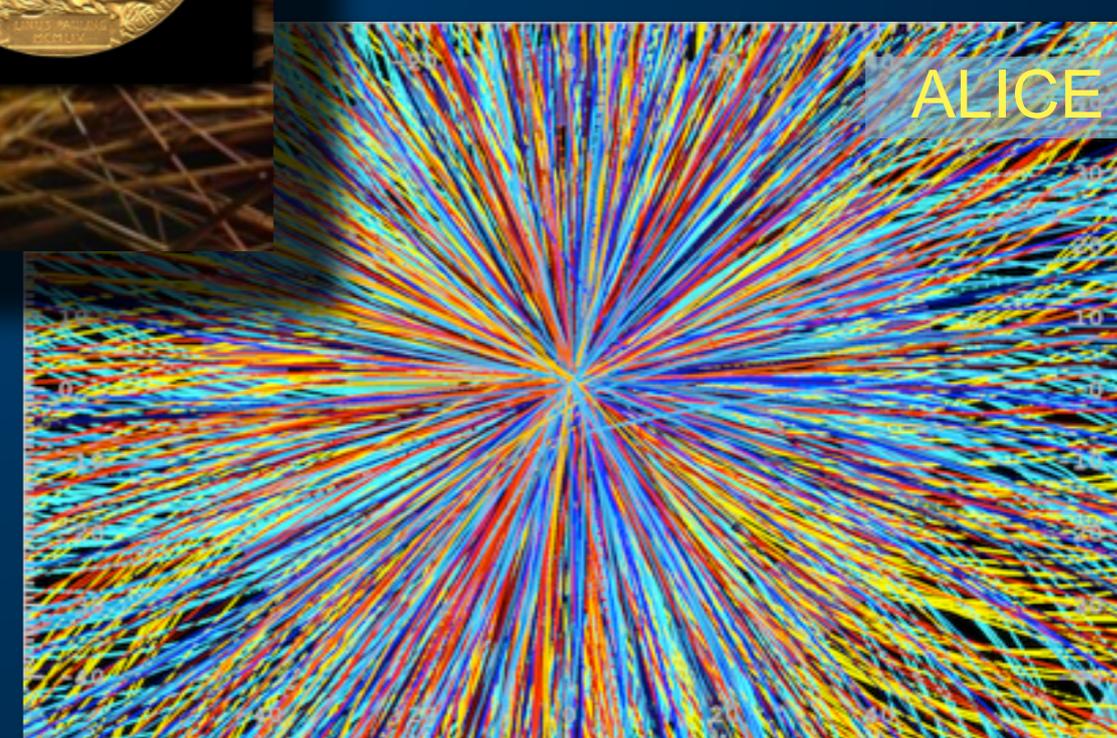
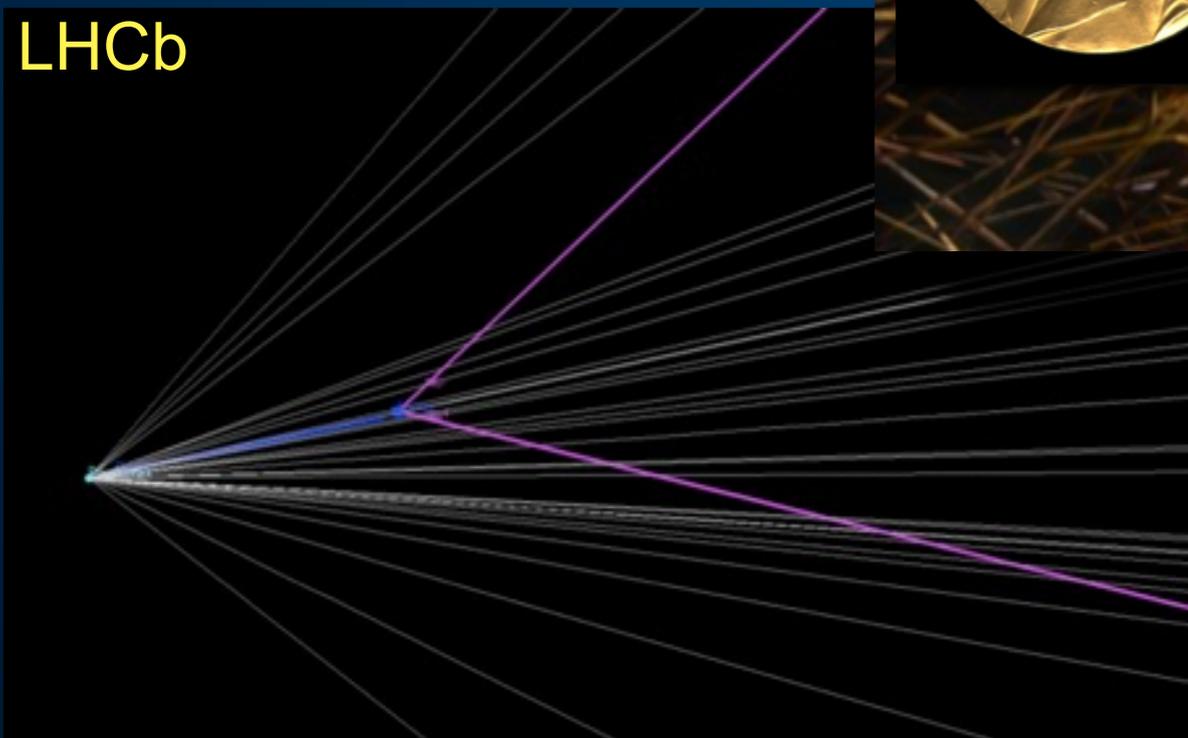
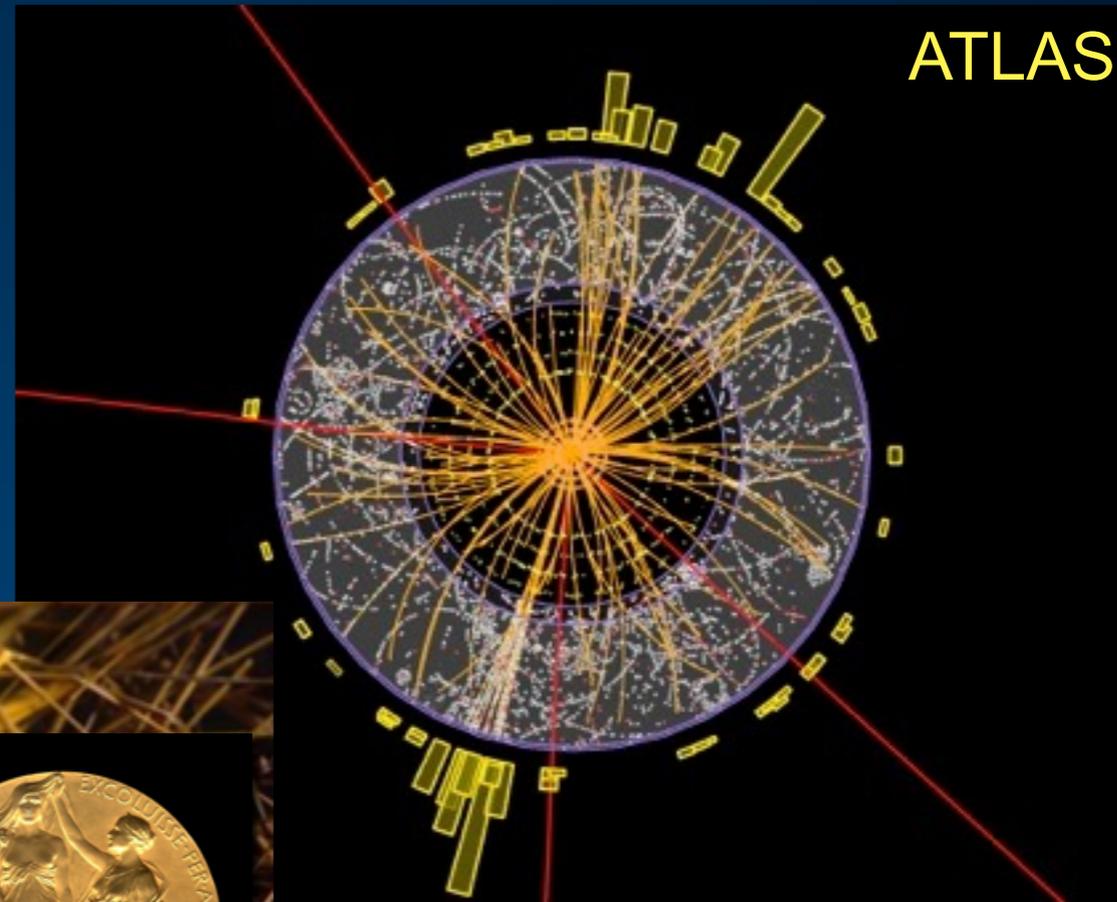
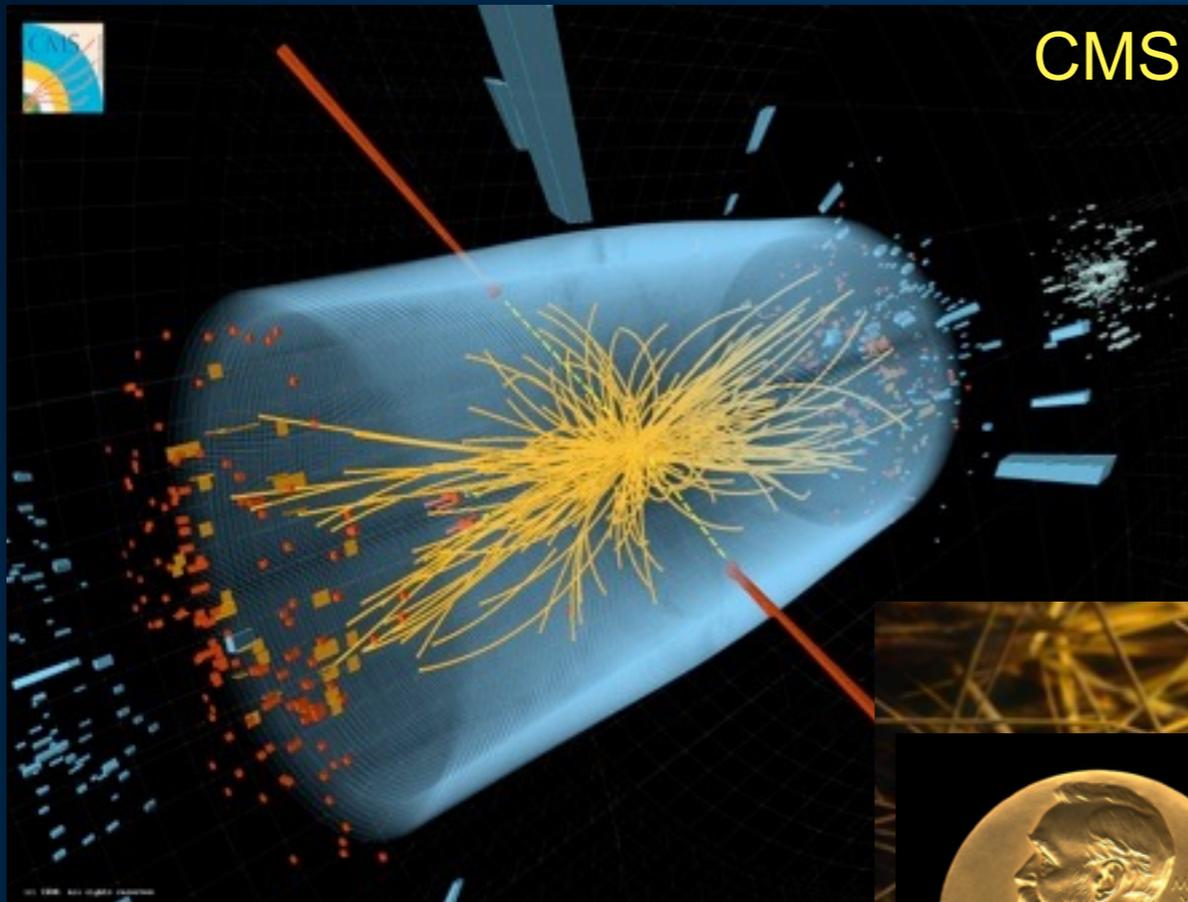








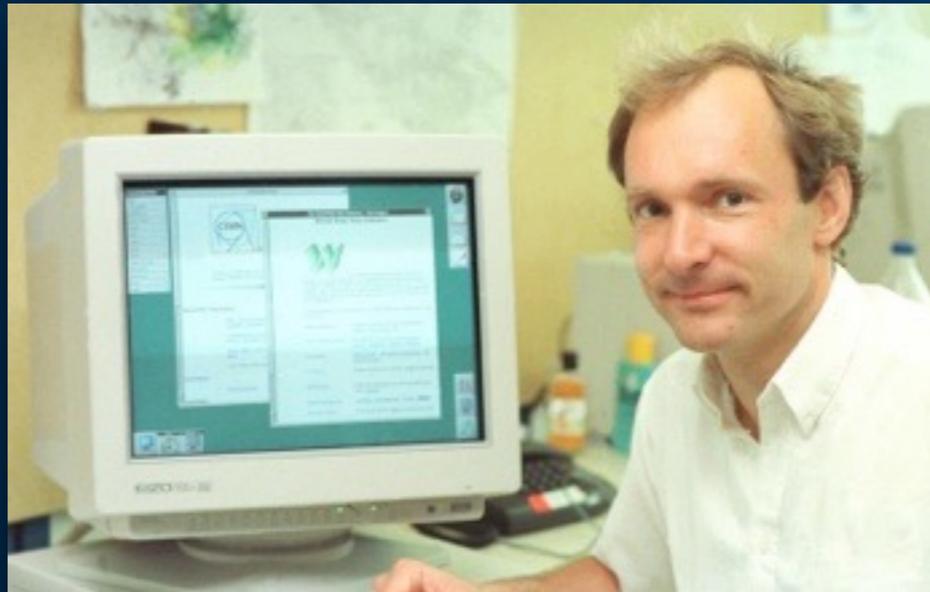
3 Gb/sec - Datenvolumen pro Jahr ~25 Petabytes



3 Gb/sec - Datenvolumen pro Jahr ~25 Petabytes

**Wozu ?**

# Beispiel: World Wide Web



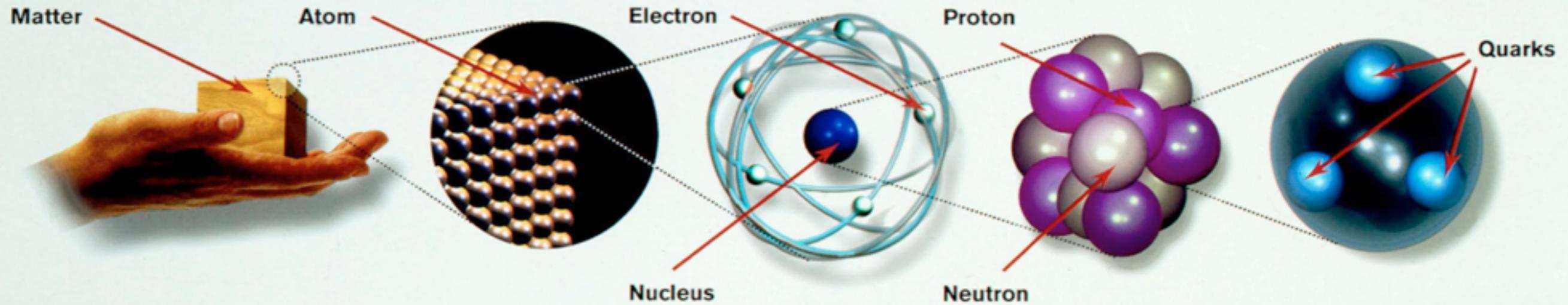
*interesting, but vague...*



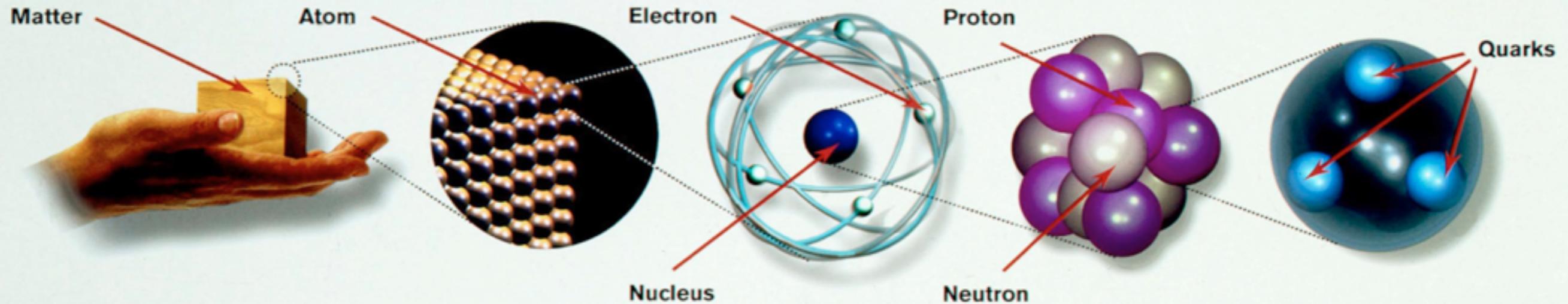
[www.cern.ch](http://www.cern.ch)

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

# Wir bestehen aus Teilchen



# Wir bestehen aus Teilchen

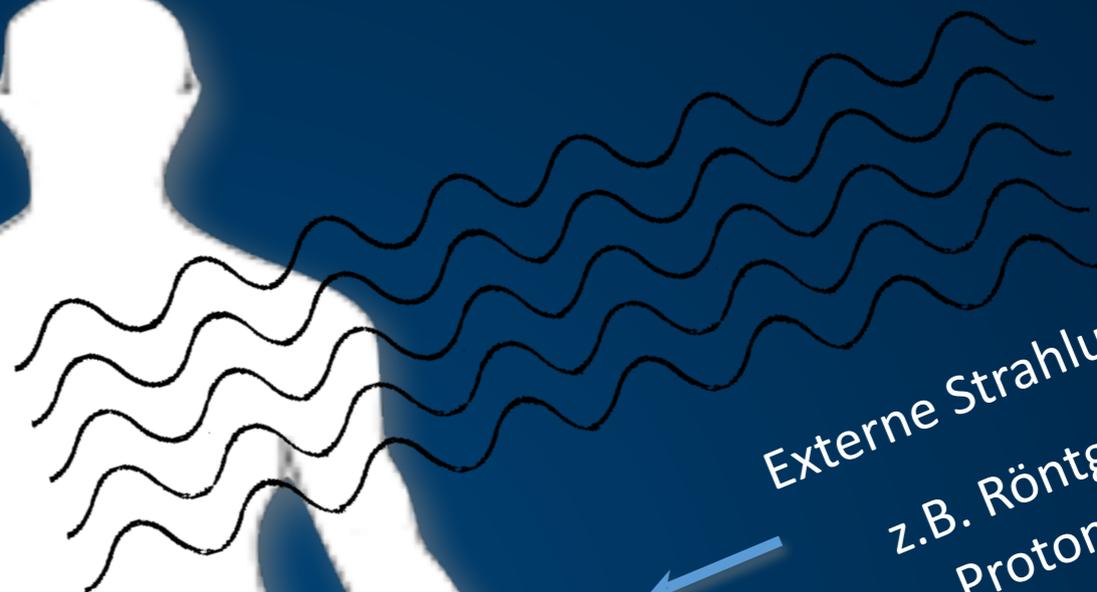
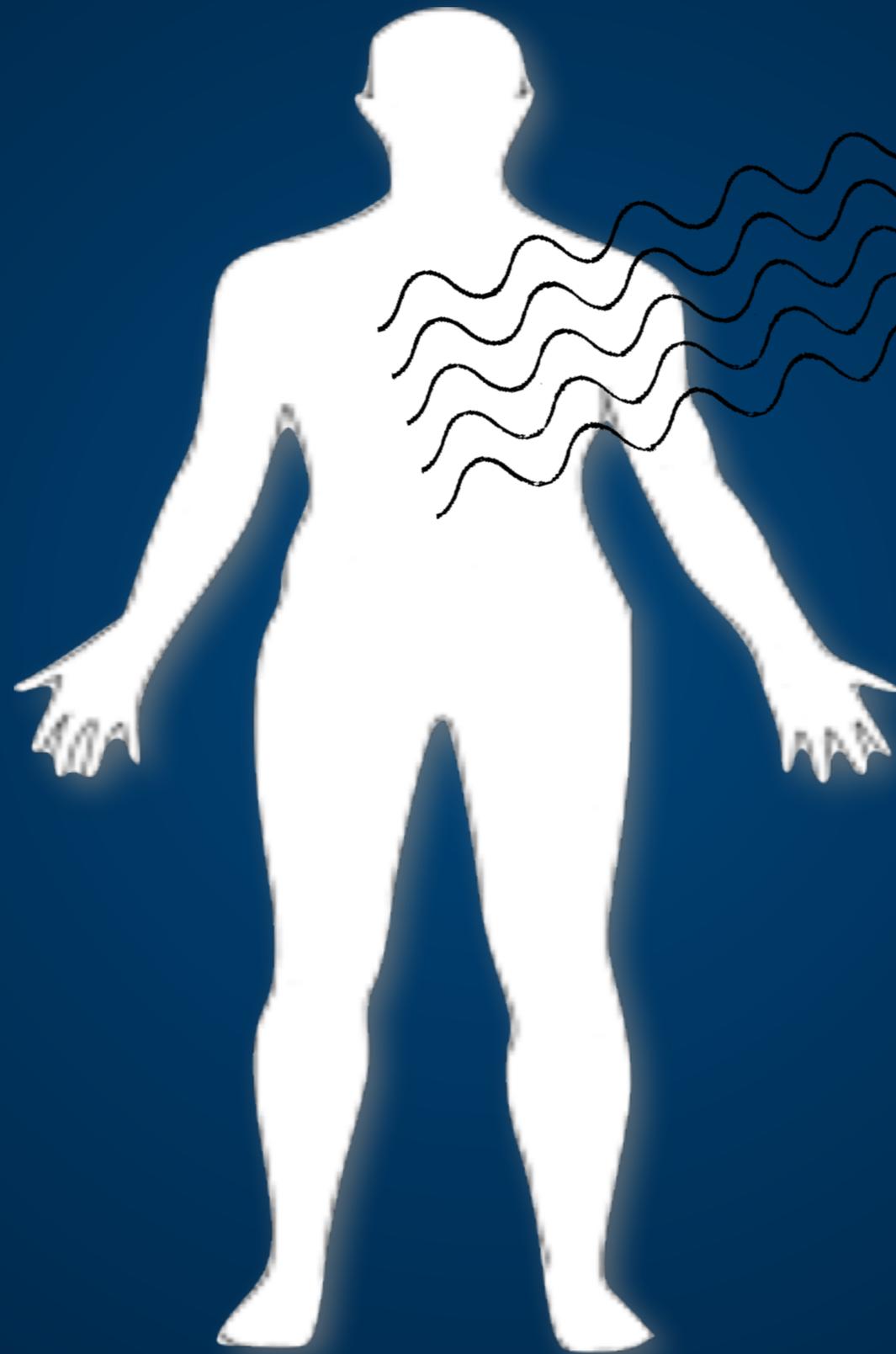


Teilchen interagieren mit anderen Teilchen

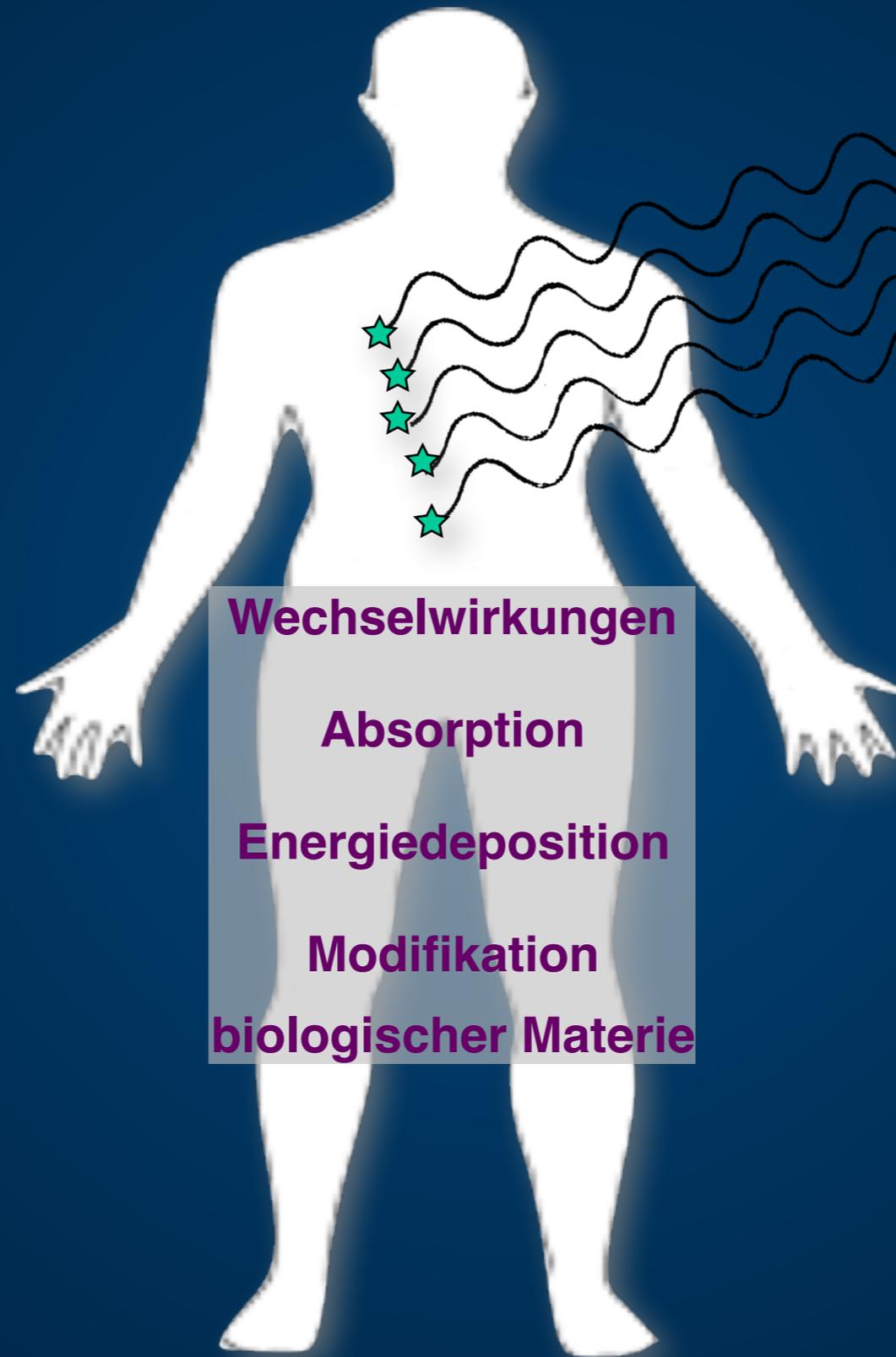
werden absorbiert, streuen, modifizieren die Materie

erzeugen messbare Signale



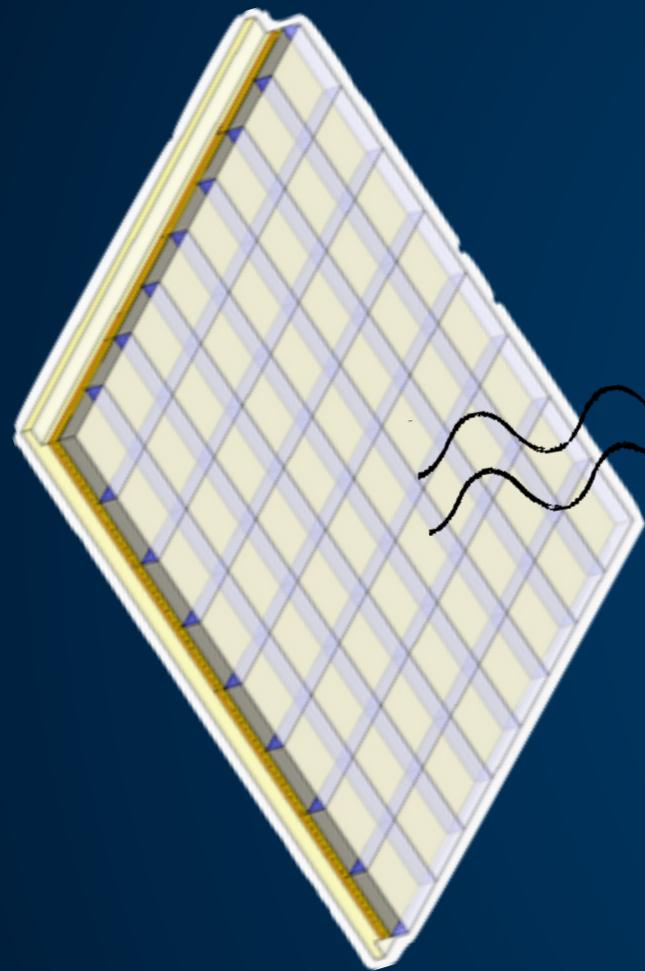


Externe Strahlung (Teilchen),  
z.B. Röntgenstrahlen,  
Protonenstrahlen

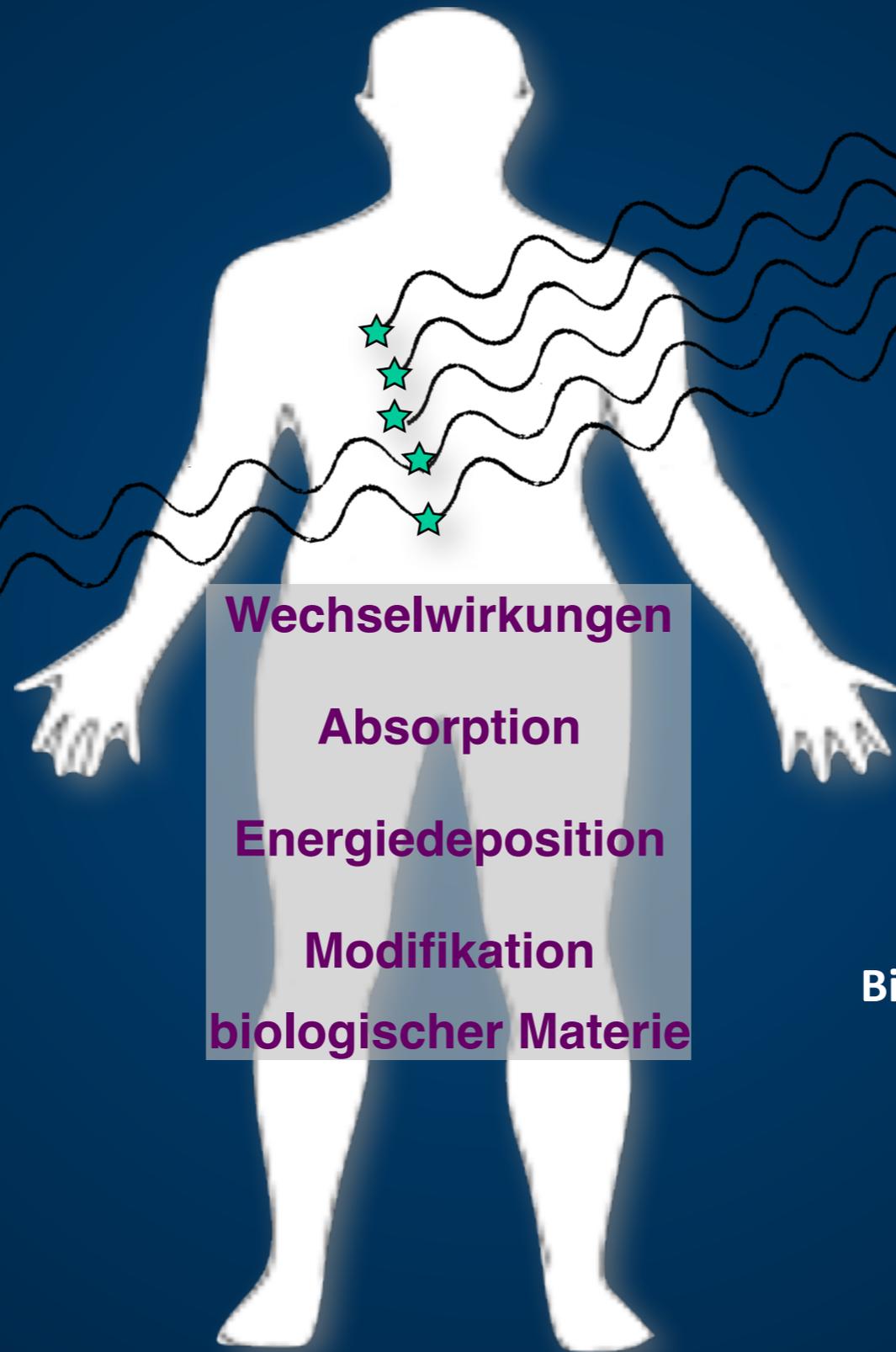


Externe Strahlung (Teilchen),  
z.B. Röntgenstrahlen,  
Protonenstrahlen

**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



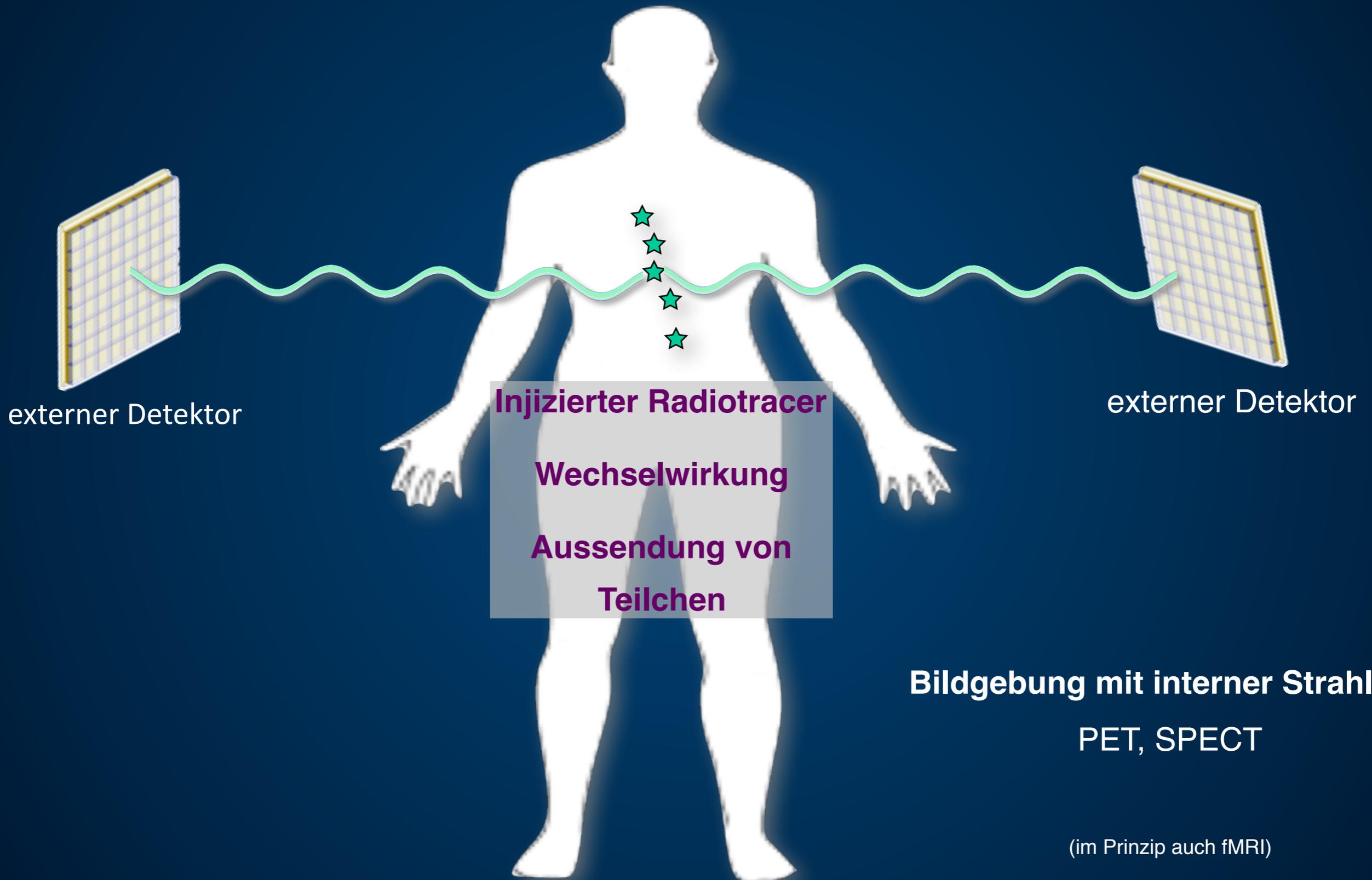


**Injizierter Radiotracer**

**Wechselwirkung**

**Aussendung von**

**Teilchen**



externer Detektor

**Injizierter Radiotracer**

**Wechselwirkung**

**Aussendung von**

**Teilchen**

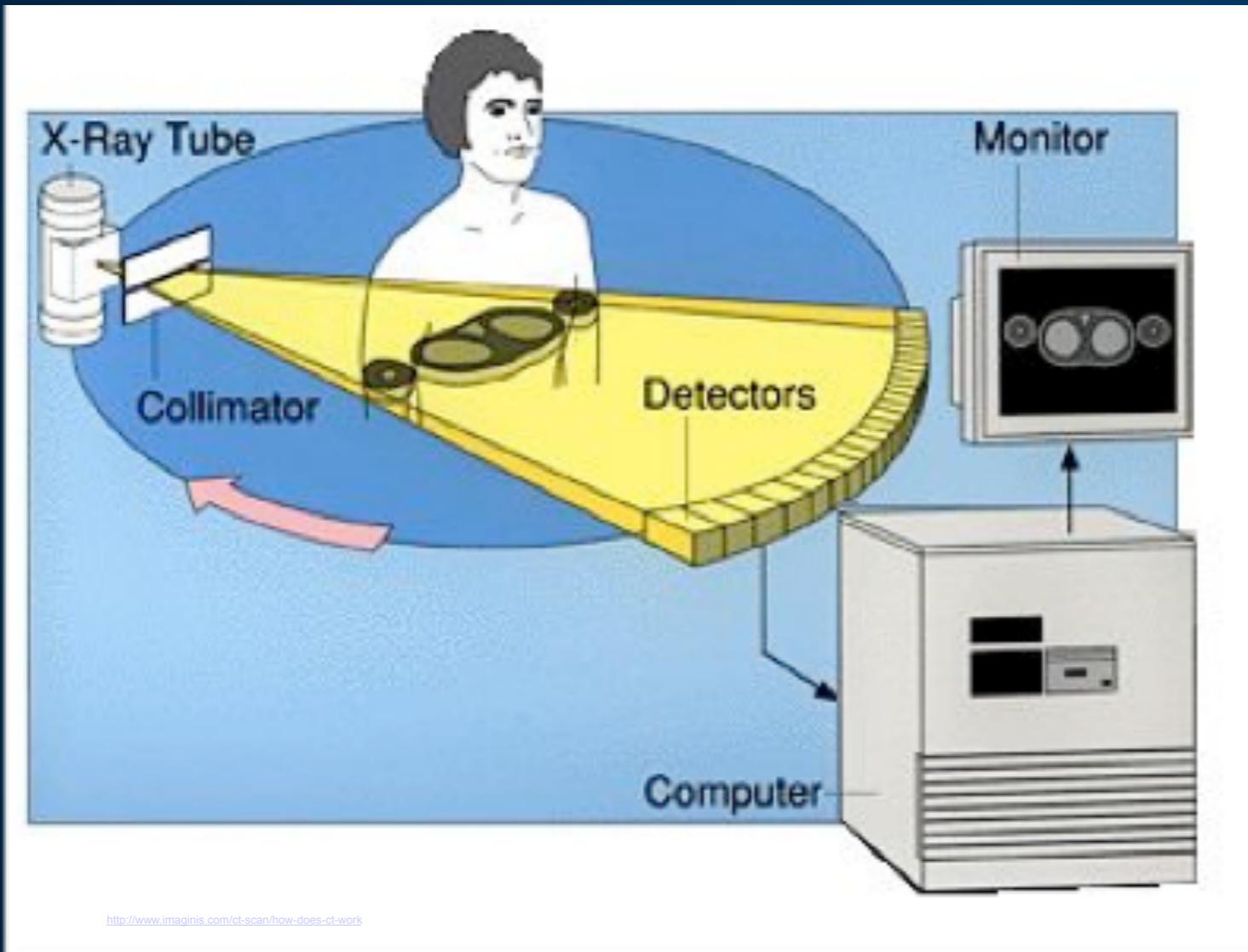
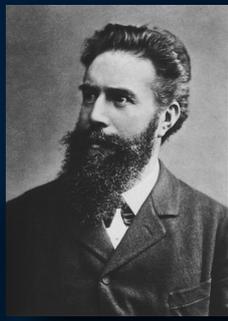
externer Detektor

**Bildgebung mit interner Strahlung**

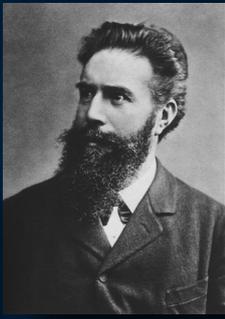
**PET, SPECT**

(im Prinzip auch fMRI)

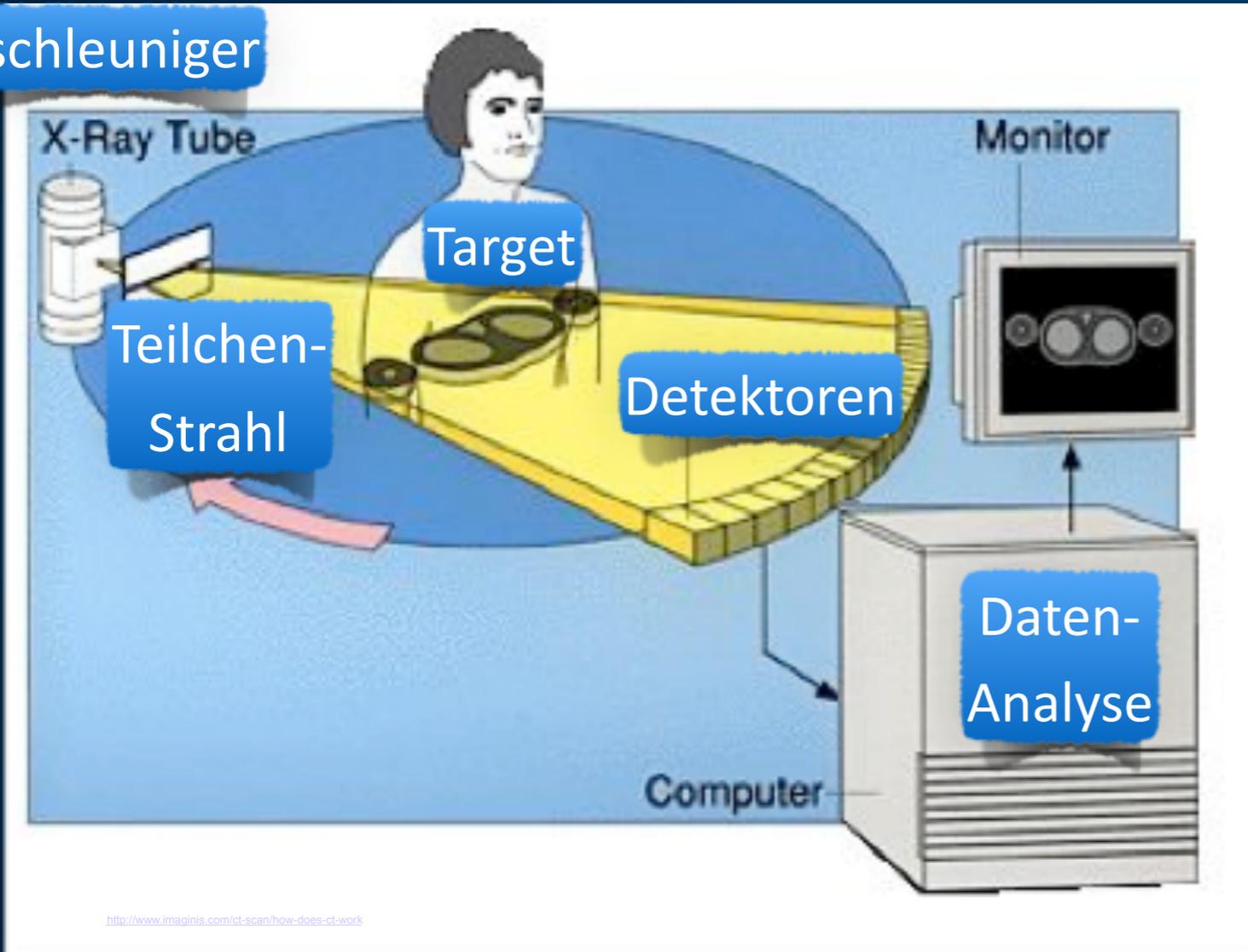
# D.h. Ihr nächster Röntgen-Termin ist ein Teilchenphysik-Experiment!



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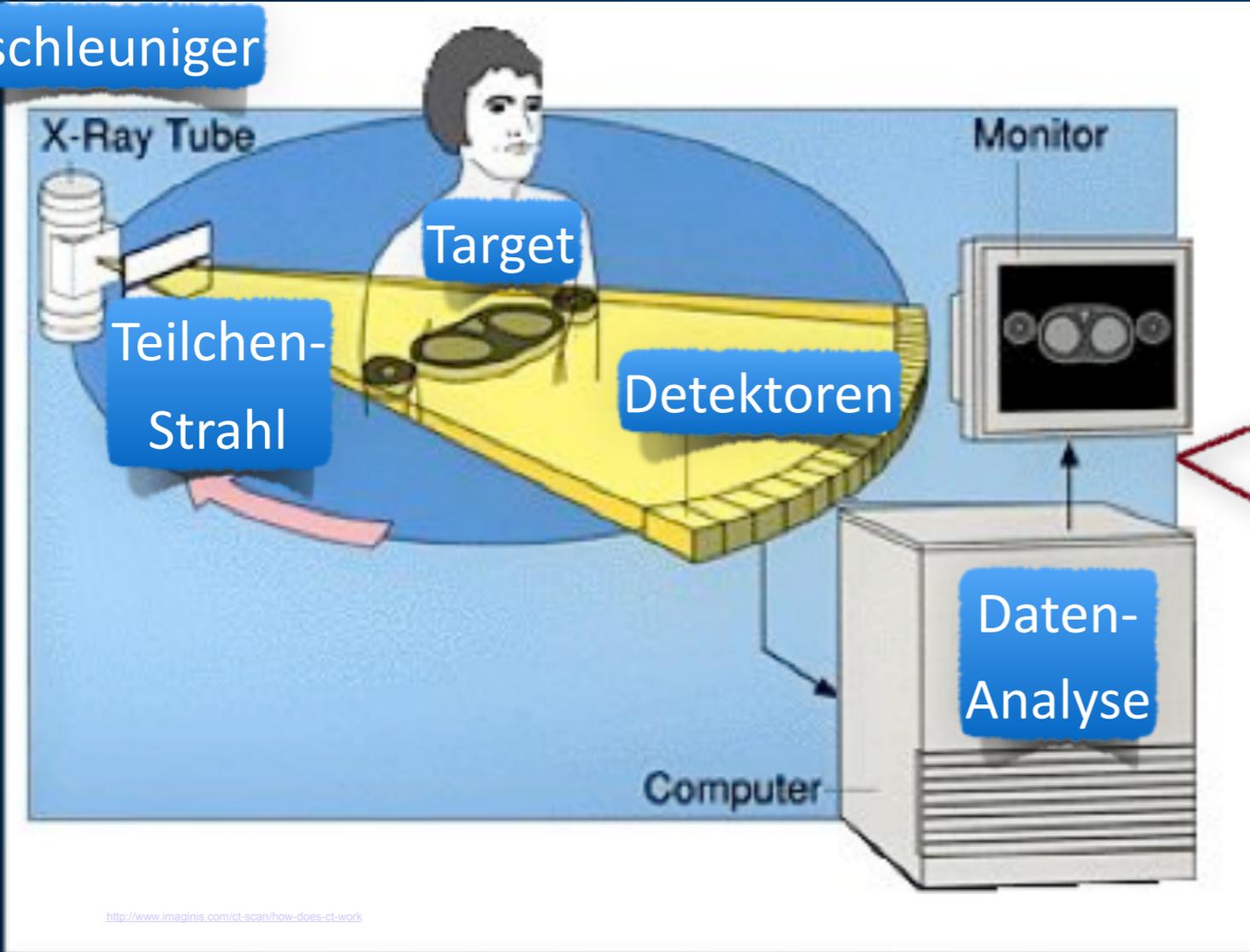
Beschleuniger



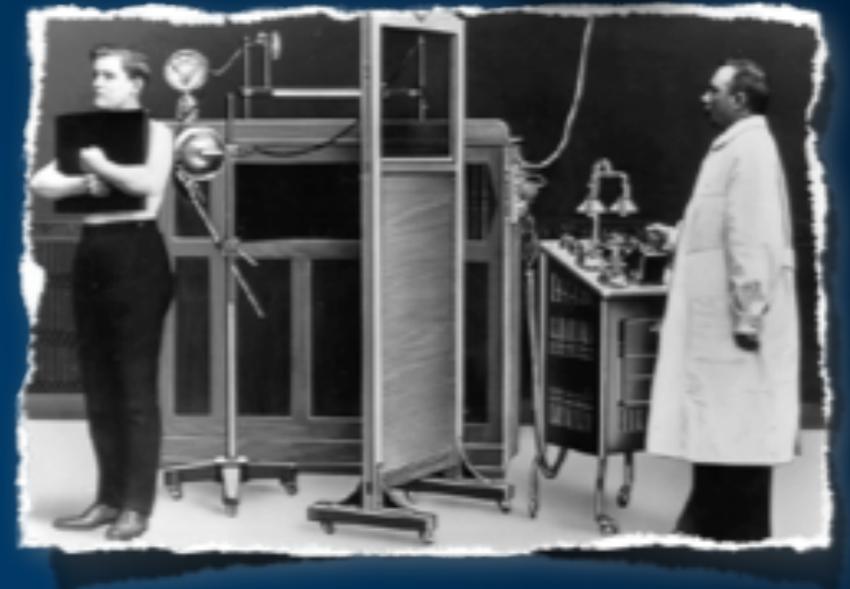
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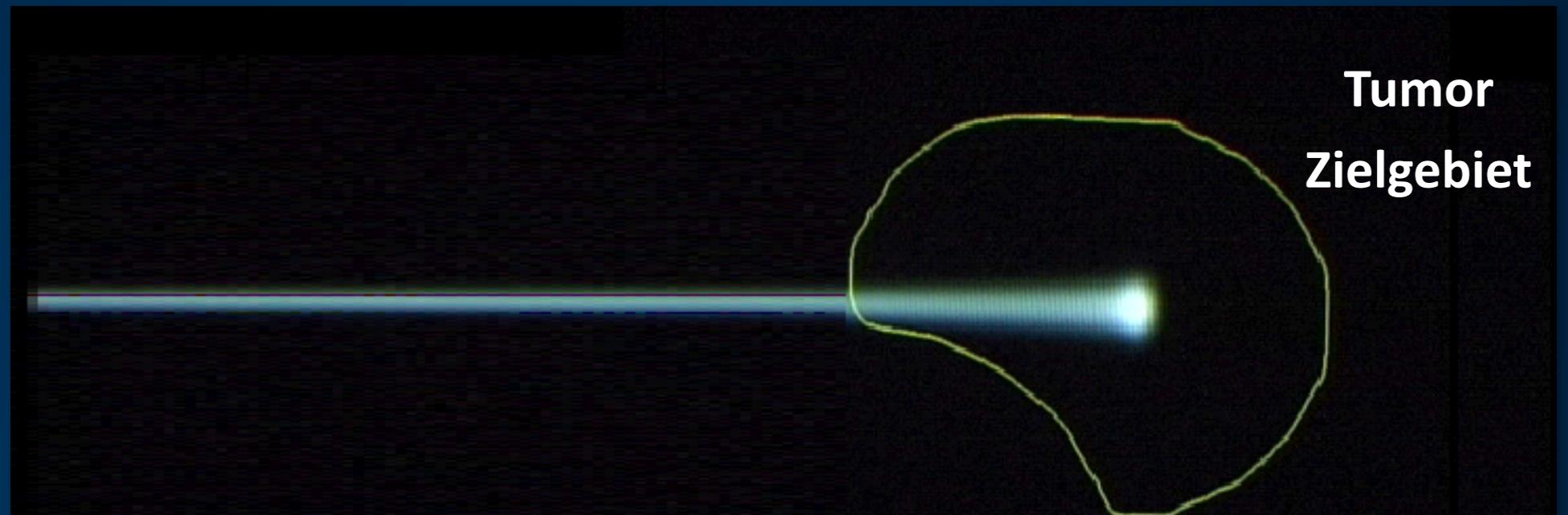
Beschleuniger



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

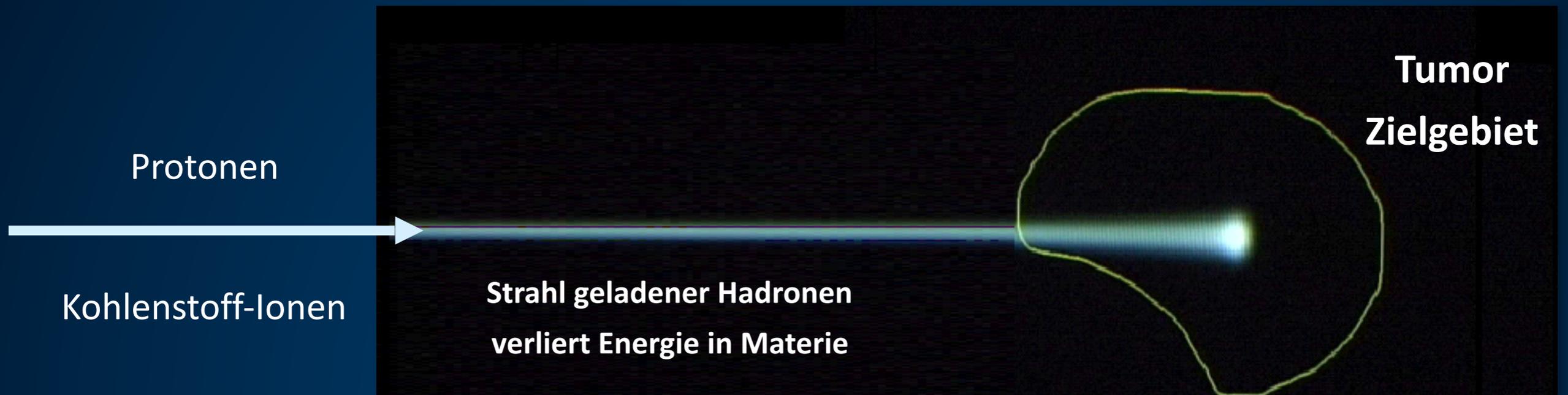


# Hadronen-Therapie



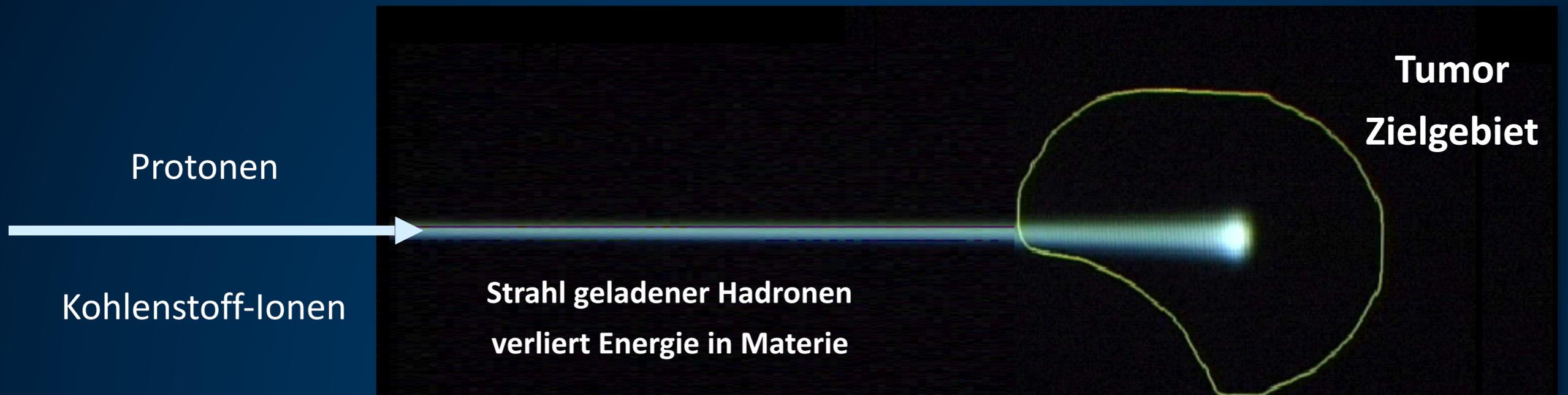
Parrinello, CERN

# Hadronen-Therapie

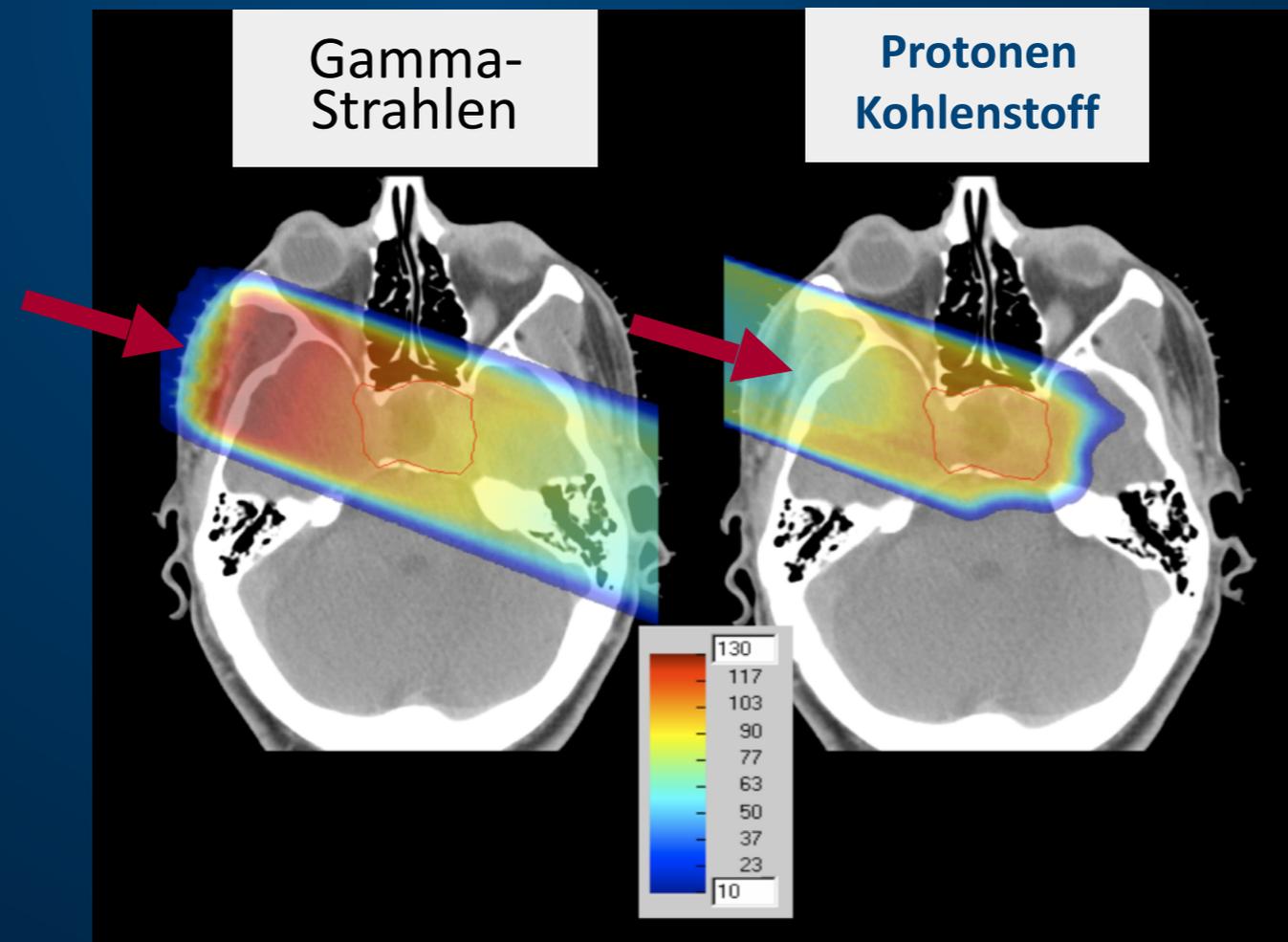


Parrinello, CERN

# Hadronen-Therapie

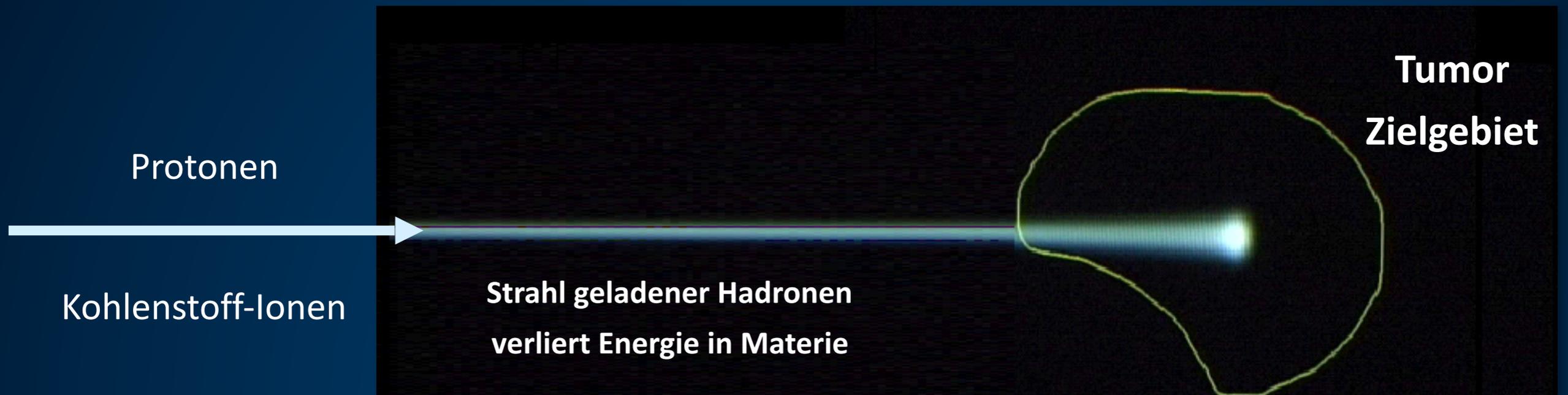


Parrinello, CERN



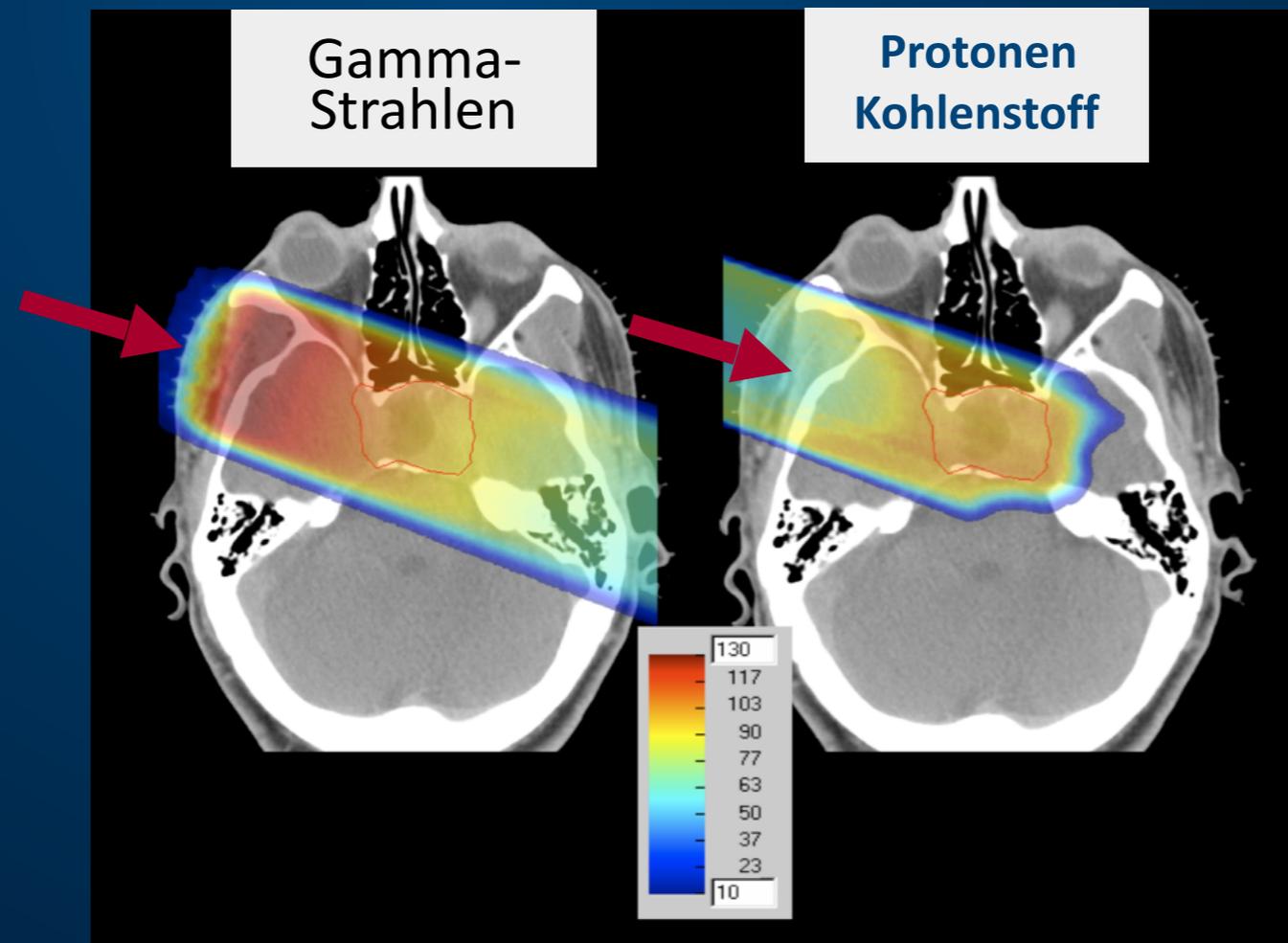
GSI

# Hadronen-Therapie



Parrinello, CERN

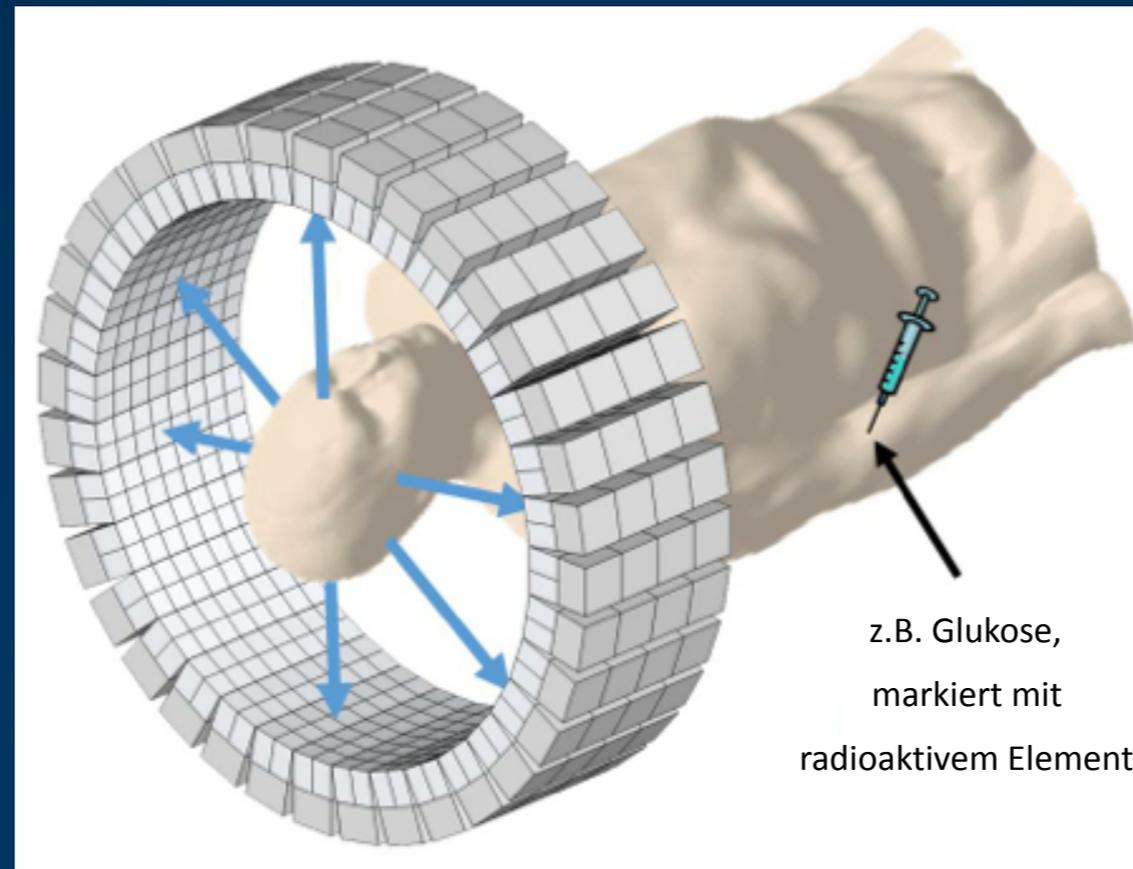
Erste Idee: Wilson, 1946



GSI

# Detektoren und Messprinzipien:

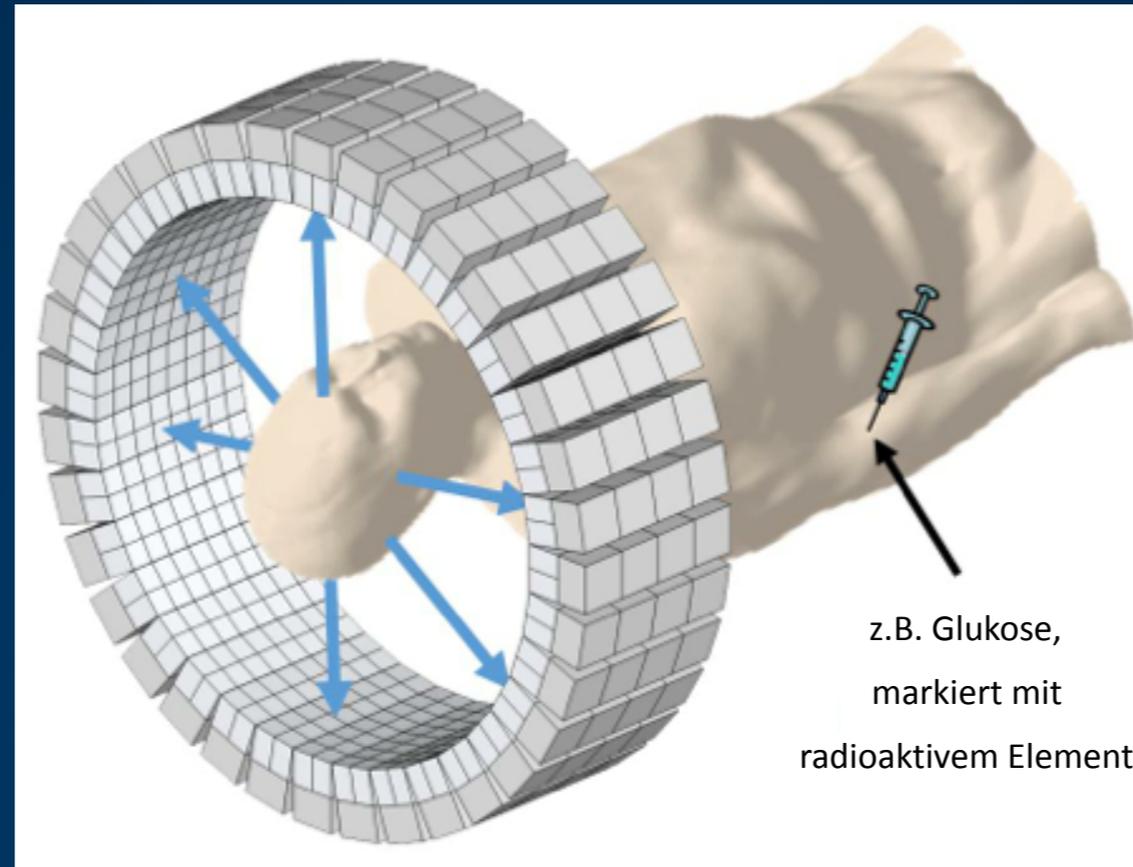
## Beispiel Positron-Emissions-Tomographie (PET)



# Detektoren und Messprinzipien:

## Beispiel Positron-Emissions-Tomographie (PET)

$$E = mc^2$$

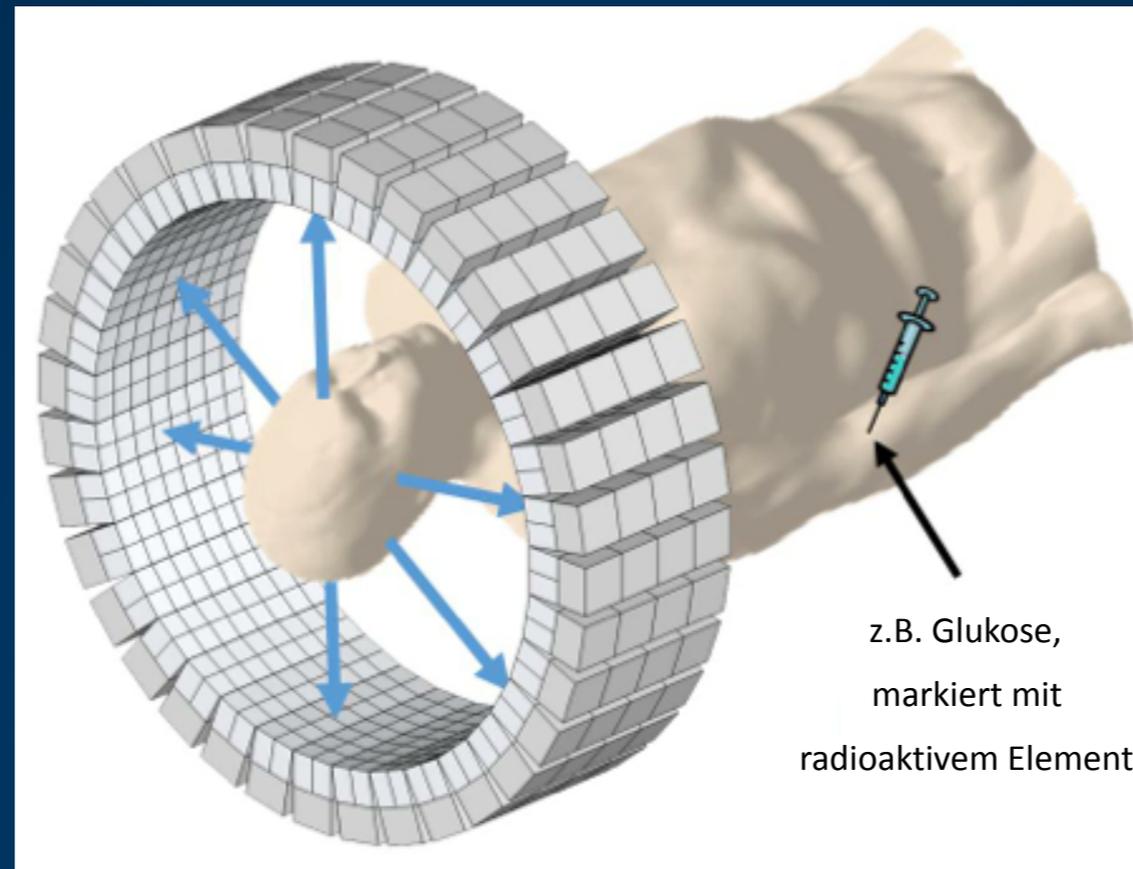


**Anti-  
Materie**

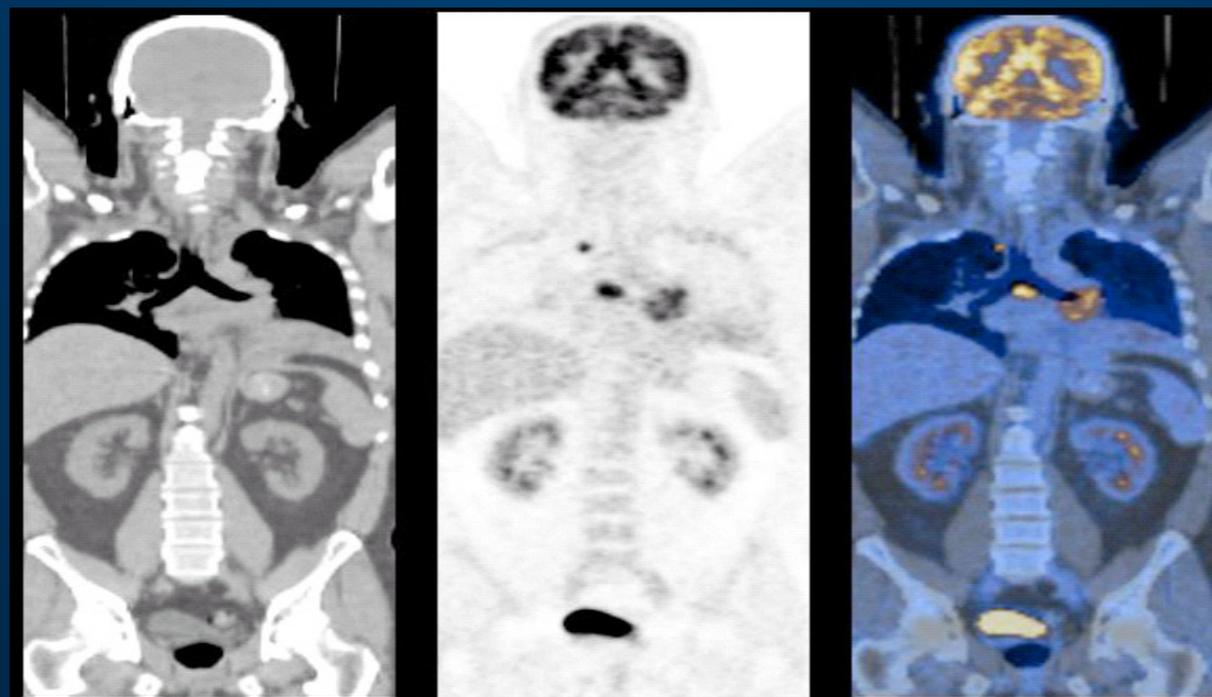
# Detektoren und Messprinzipien:

## Beispiel Positron-Emissions-Tomographie (PET)

$$E = mc^2$$



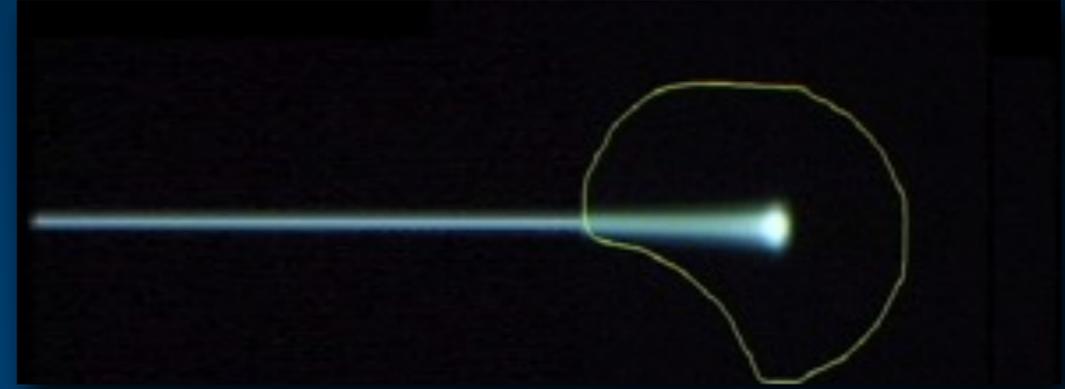
Anti-  
Materie



PET/MR: Kombination anatomischer und funktionaler/metabolischer Info

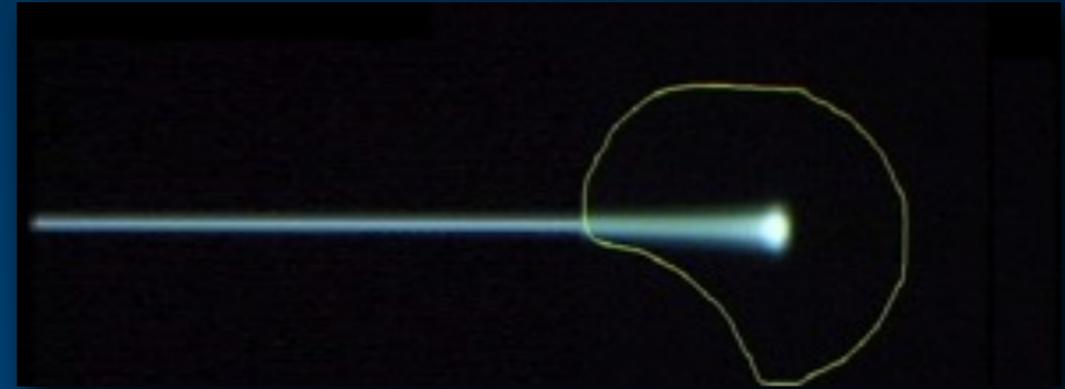
# Fazit

Teilchenstrahlen aus Beschleunigern zur Krebstherapie

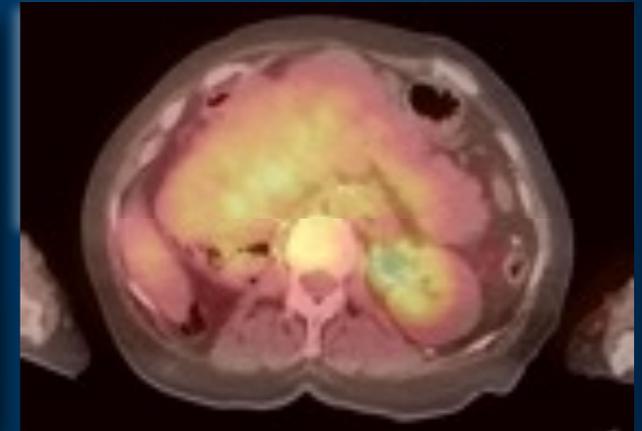
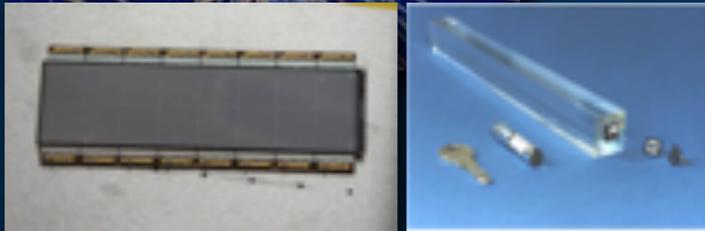
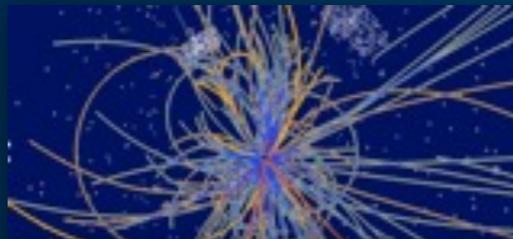


# Fazit

Teilchenstrahlen aus Beschleunigern zur Krebstherapie

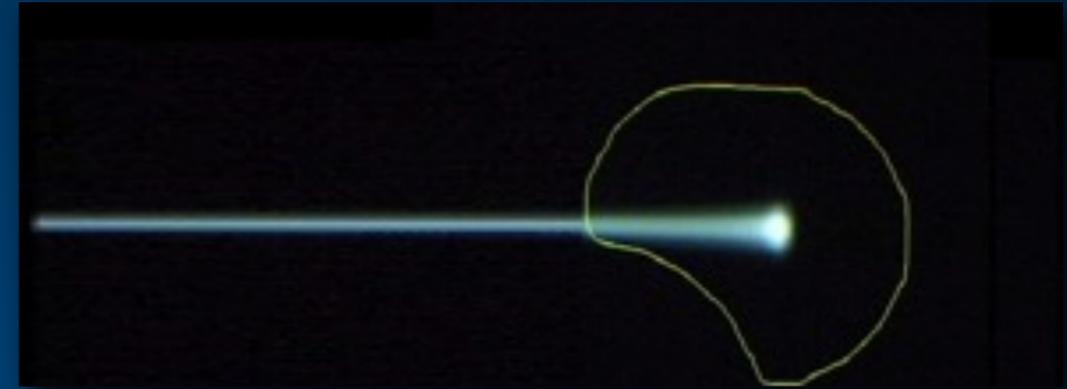


Teilchendetektor-Technologie für (bio-)medizinische Bildgebung

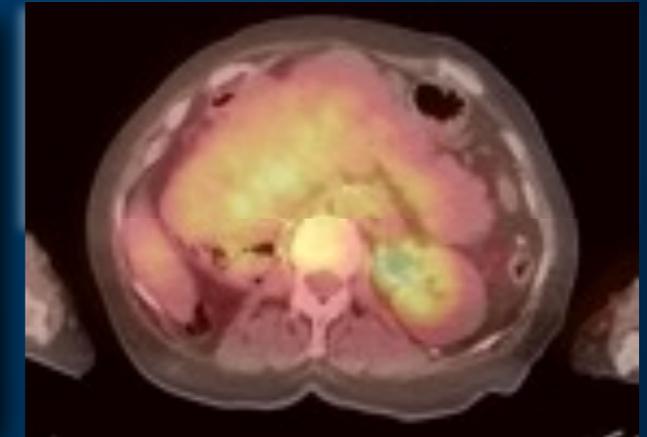
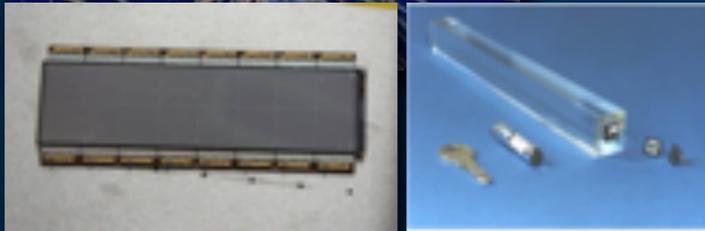
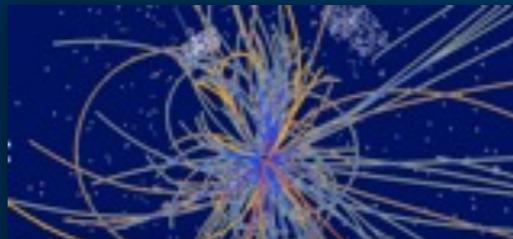


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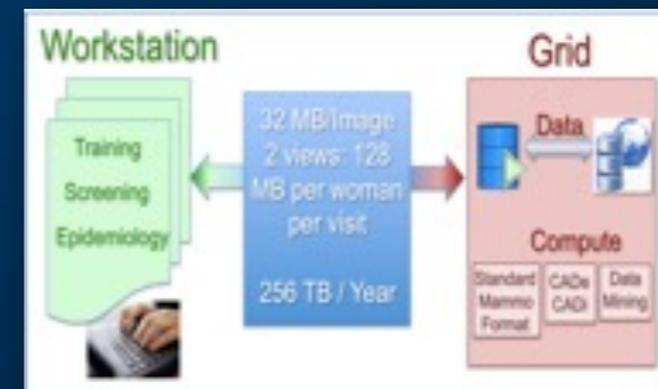
Teilchenstrahlen aus Beschleunigern zur Krebstherapie



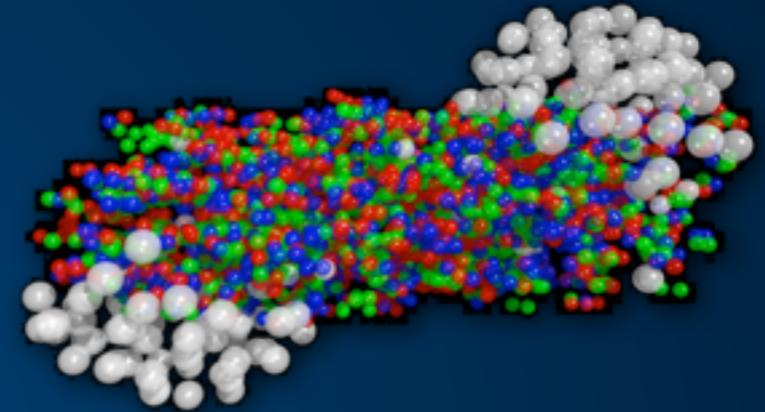
Teilchendetektor-Technologie für (bio-)medizinische Bildgebung



Grid Technologie für medizinische Datenverwaltung und Analyse

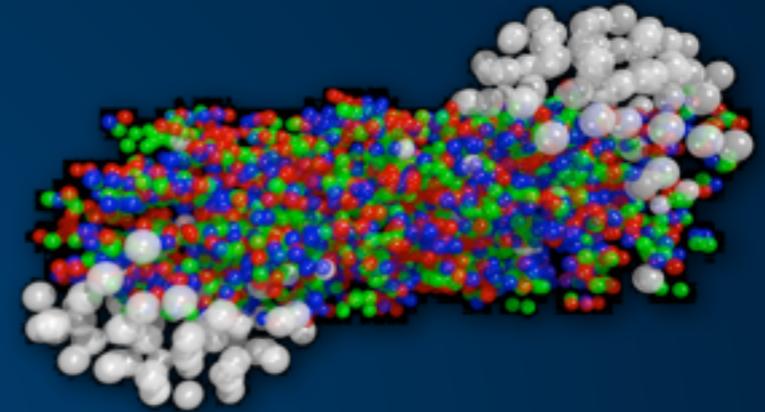


# Noch ein paar Gedanken



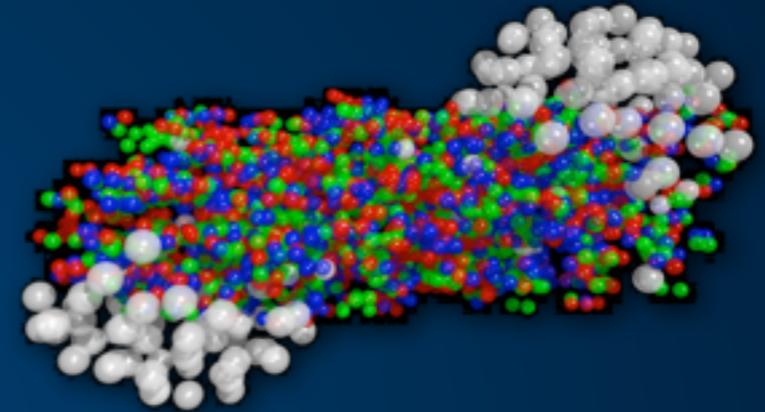
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