

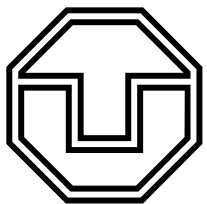
# Suche nach schweren Higgs-Bosonen am ATLAS-Detektor

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Disputationsvortrag

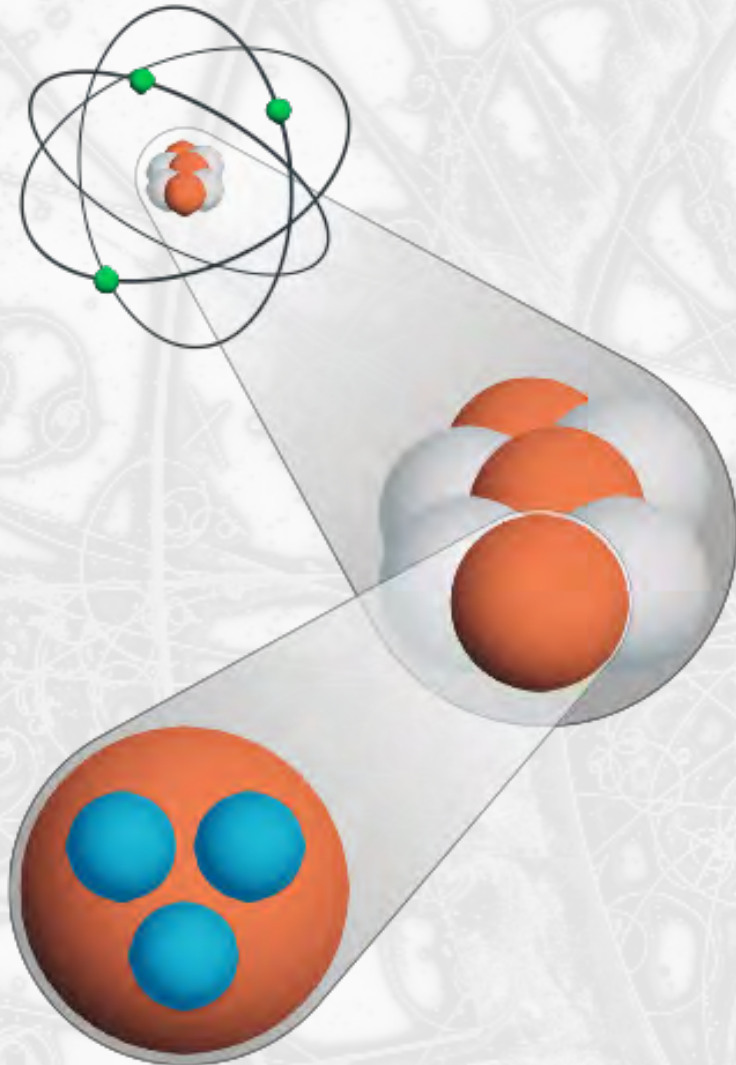
Sebastian Wahrmund

23.06.2017



**TECHNISCHE  
UNIVERSITÄT  
DRESDEN**

# Einleitung



- Fundamentale Bausteine der Materie
- Wechselwirkungen zwischen Elementarteilchen

## Fundamentale WW:

1. Gravitation
2. Elektromagnetismus
3. Schwache Kraft
4. Starke Kraft

# Standard Modell

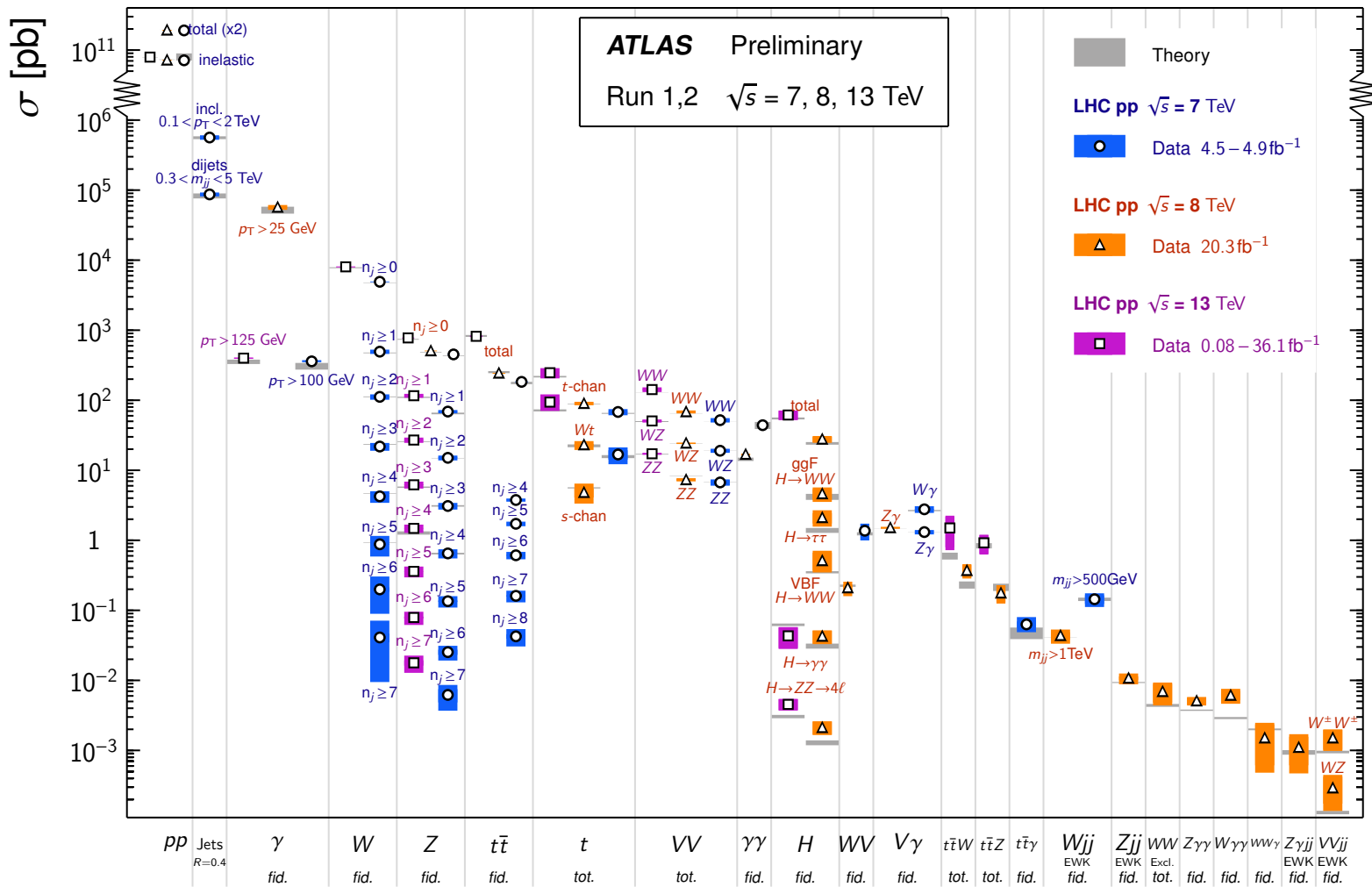


- 3 Generationen von Materieteilchen
- Eichbosonen (Wechselwirkungen)
- Higgsboson

# Messung des Standardmodells

Standard Model Production Cross Section Measurements

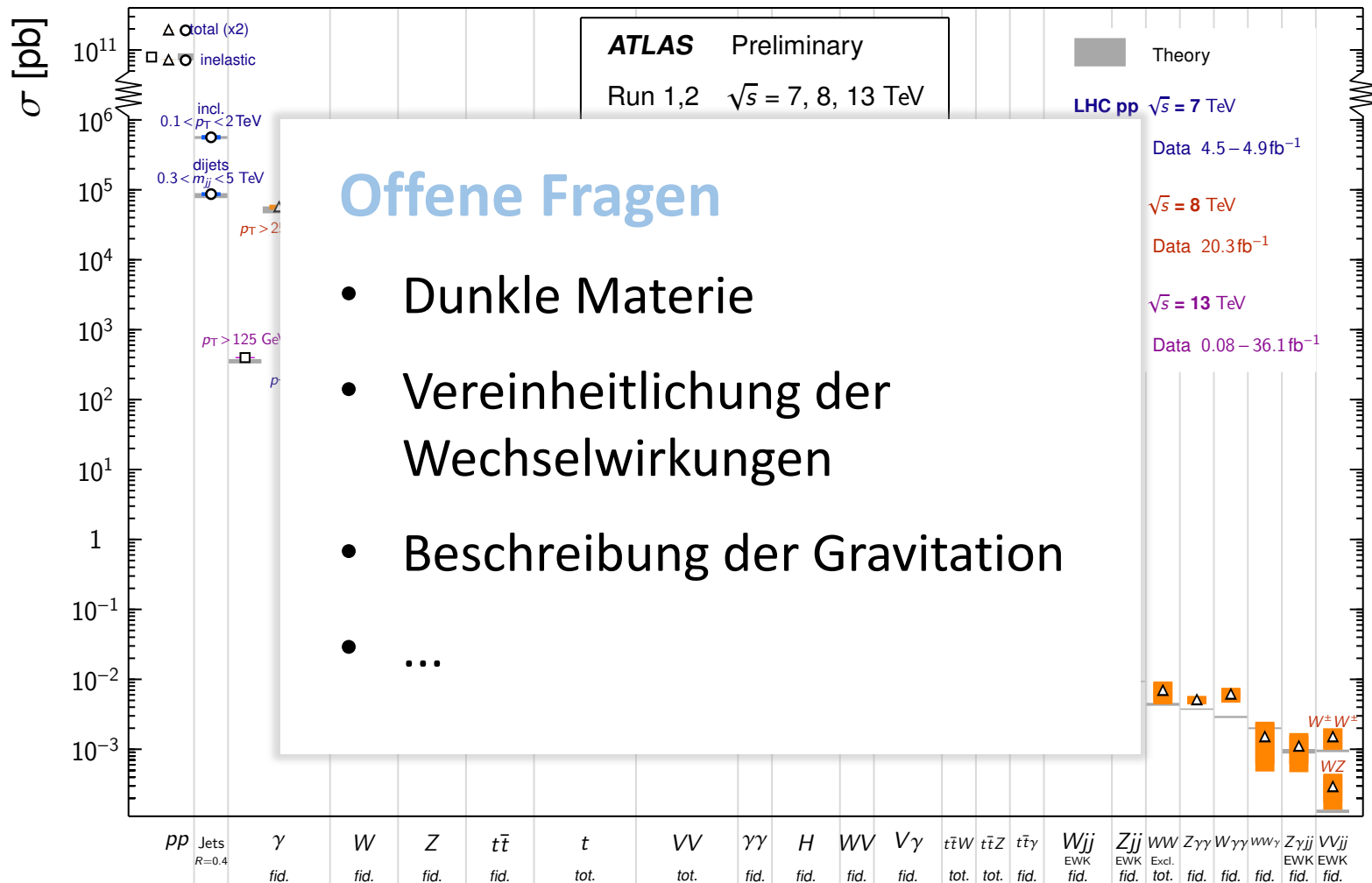
Status: May 2017



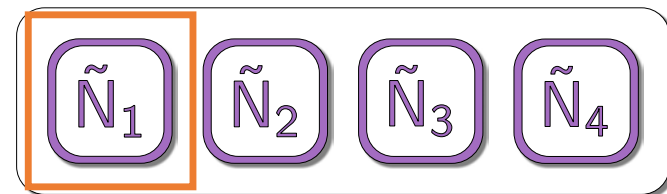
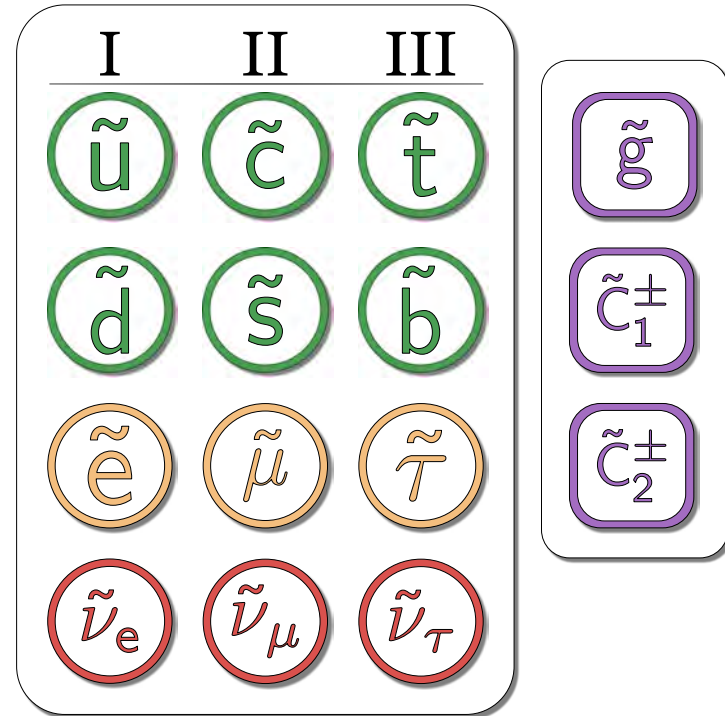
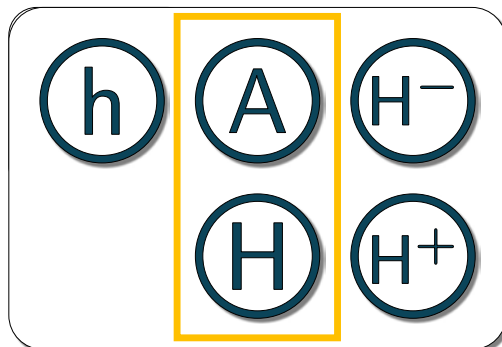
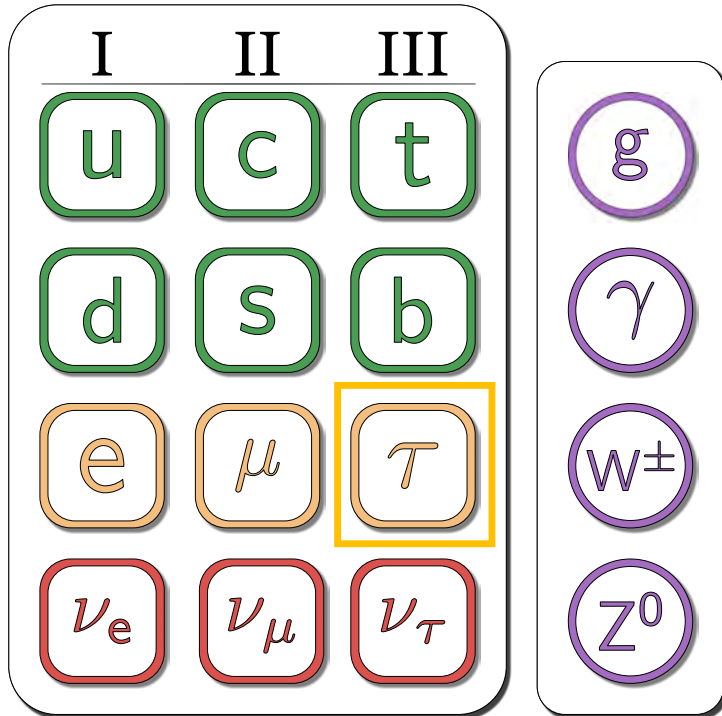
# Messung des Standardmodells

## Standard Model Production Cross Section Measurements

Status: May 2017

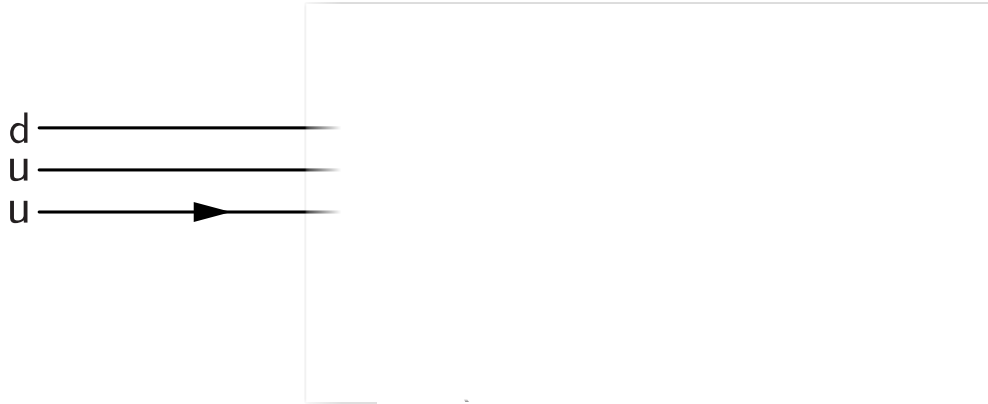


# MSSM

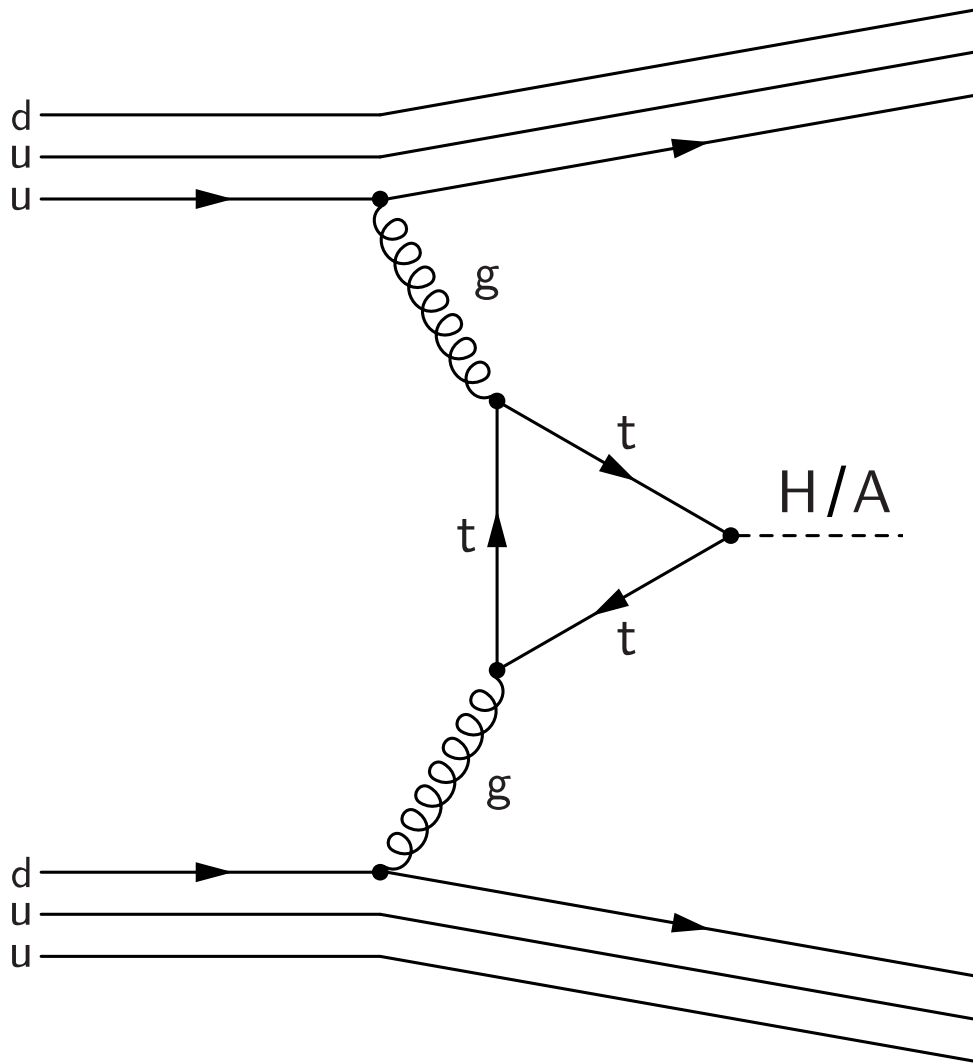


Dunkle Materie (?)

# Higgs Produktion

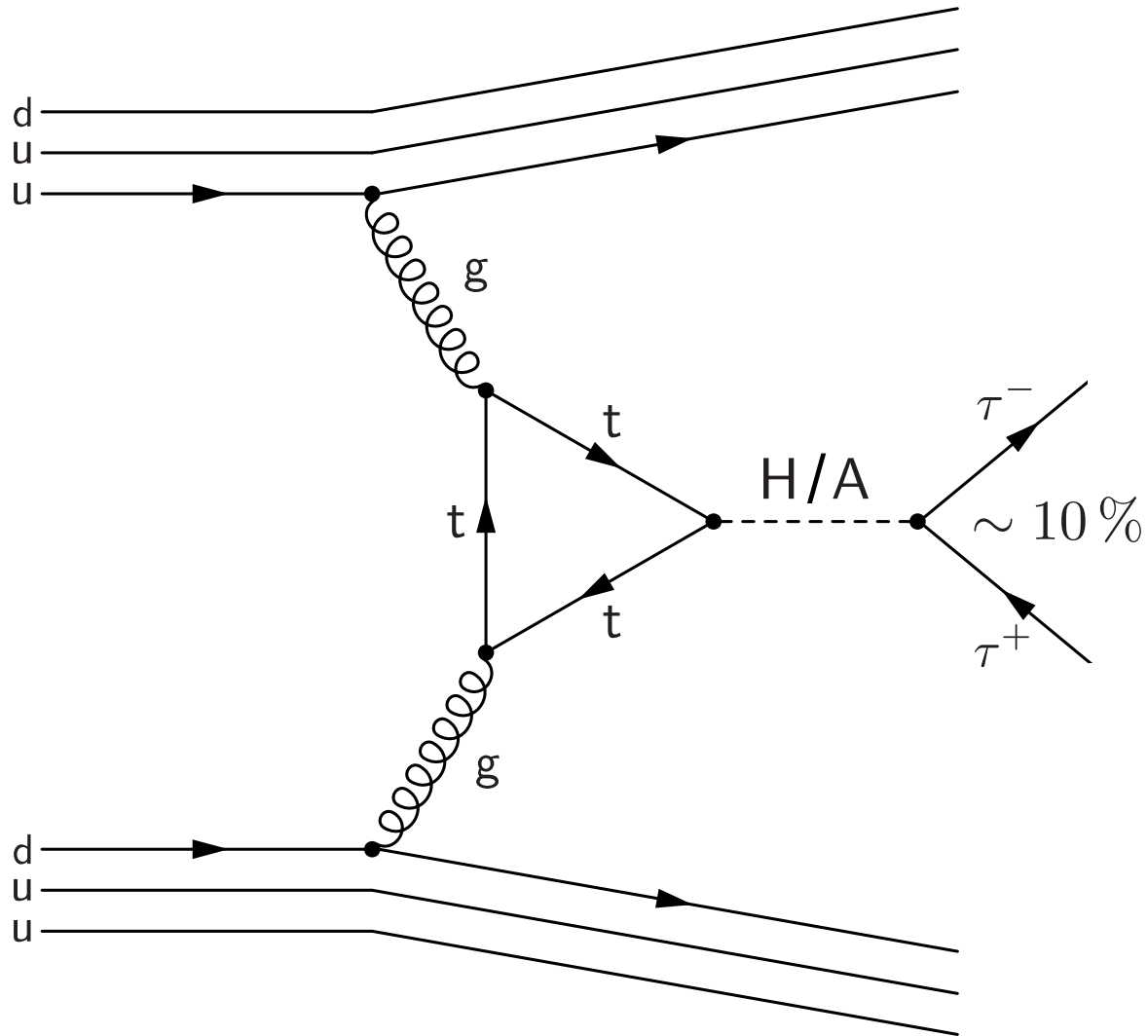


# Higgs Produktion

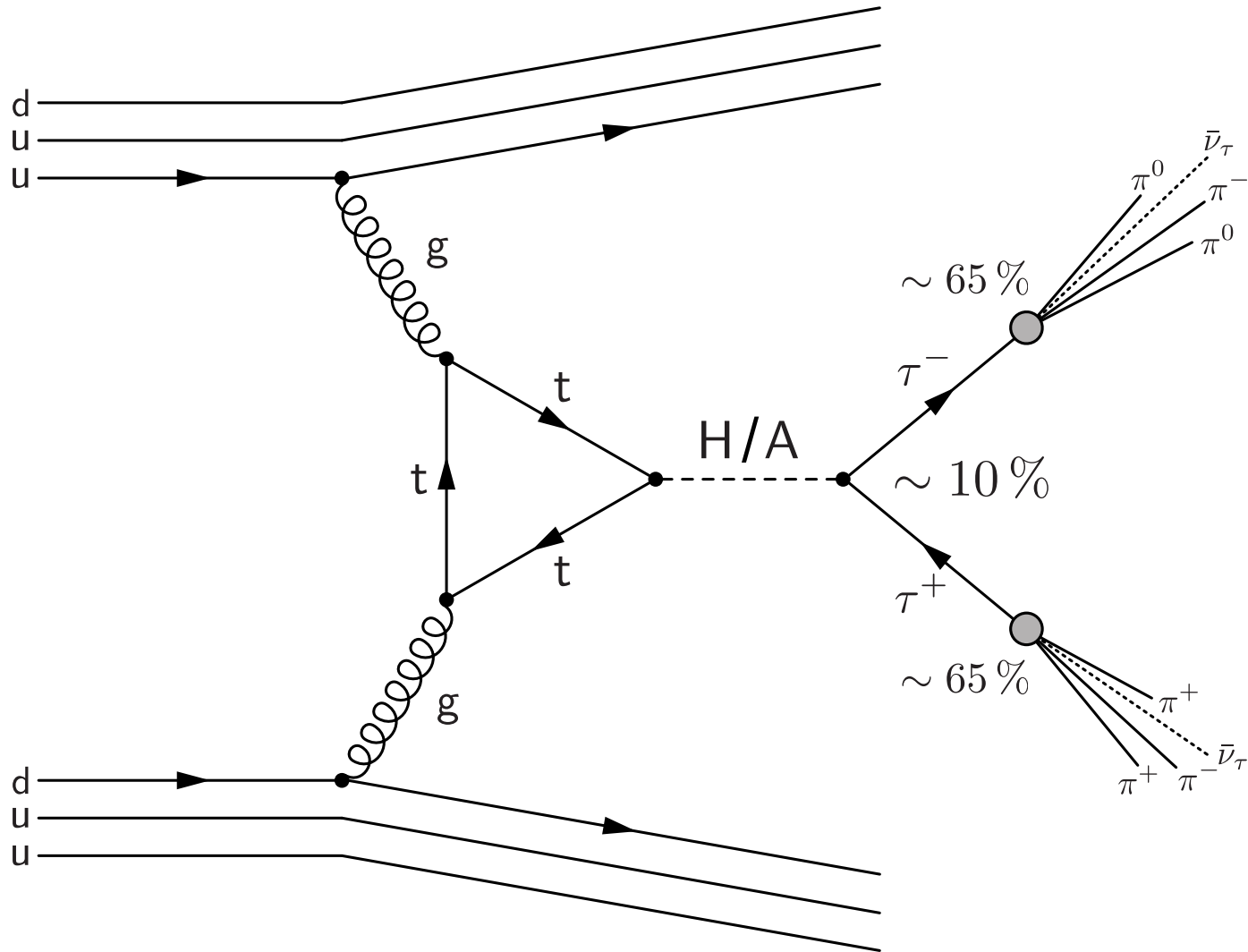




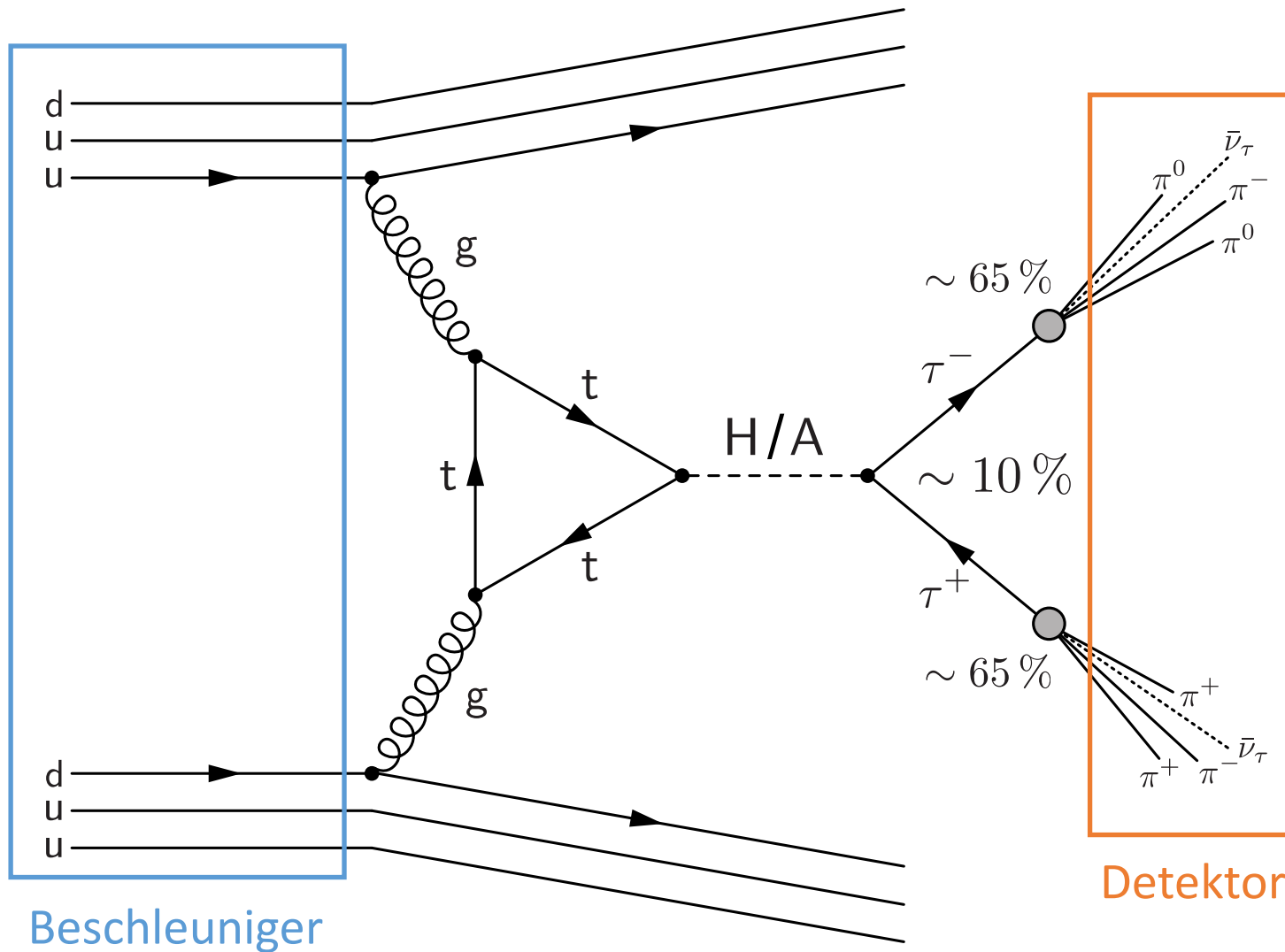
# Higgs Produktion



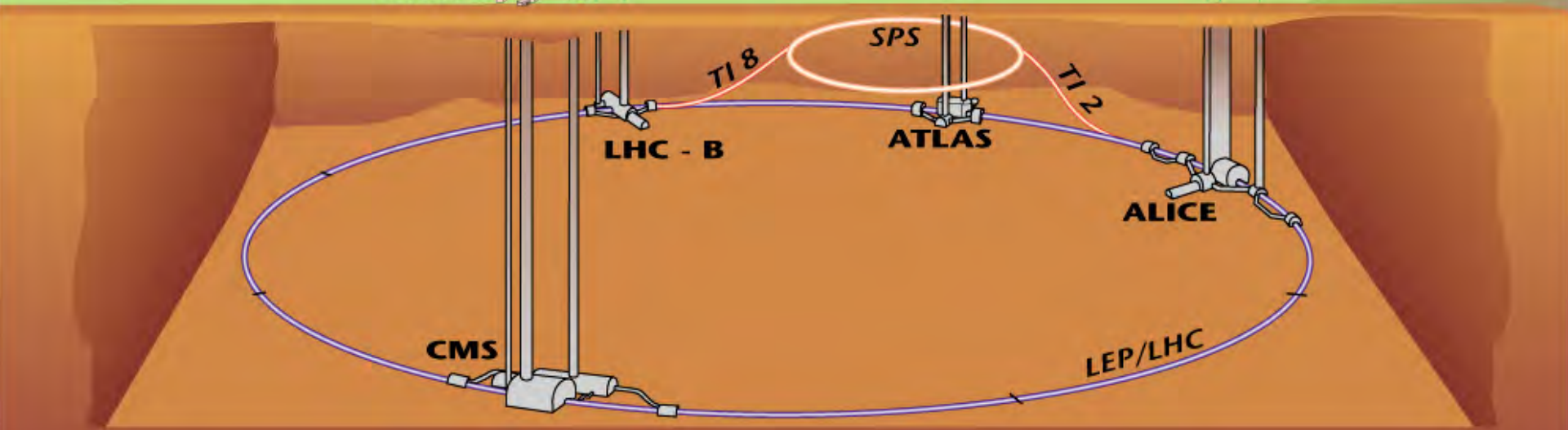
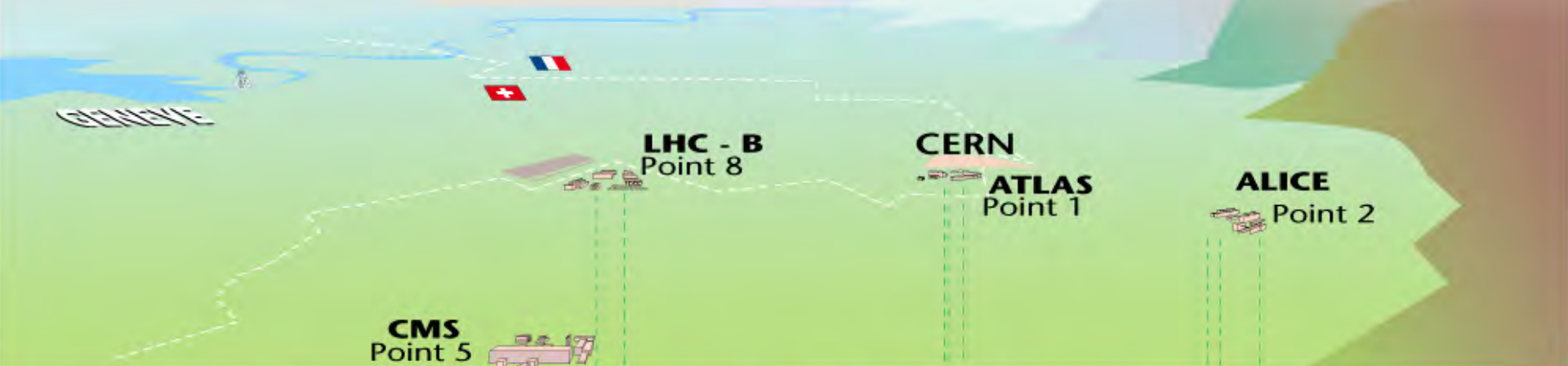
# Higgs Produktion



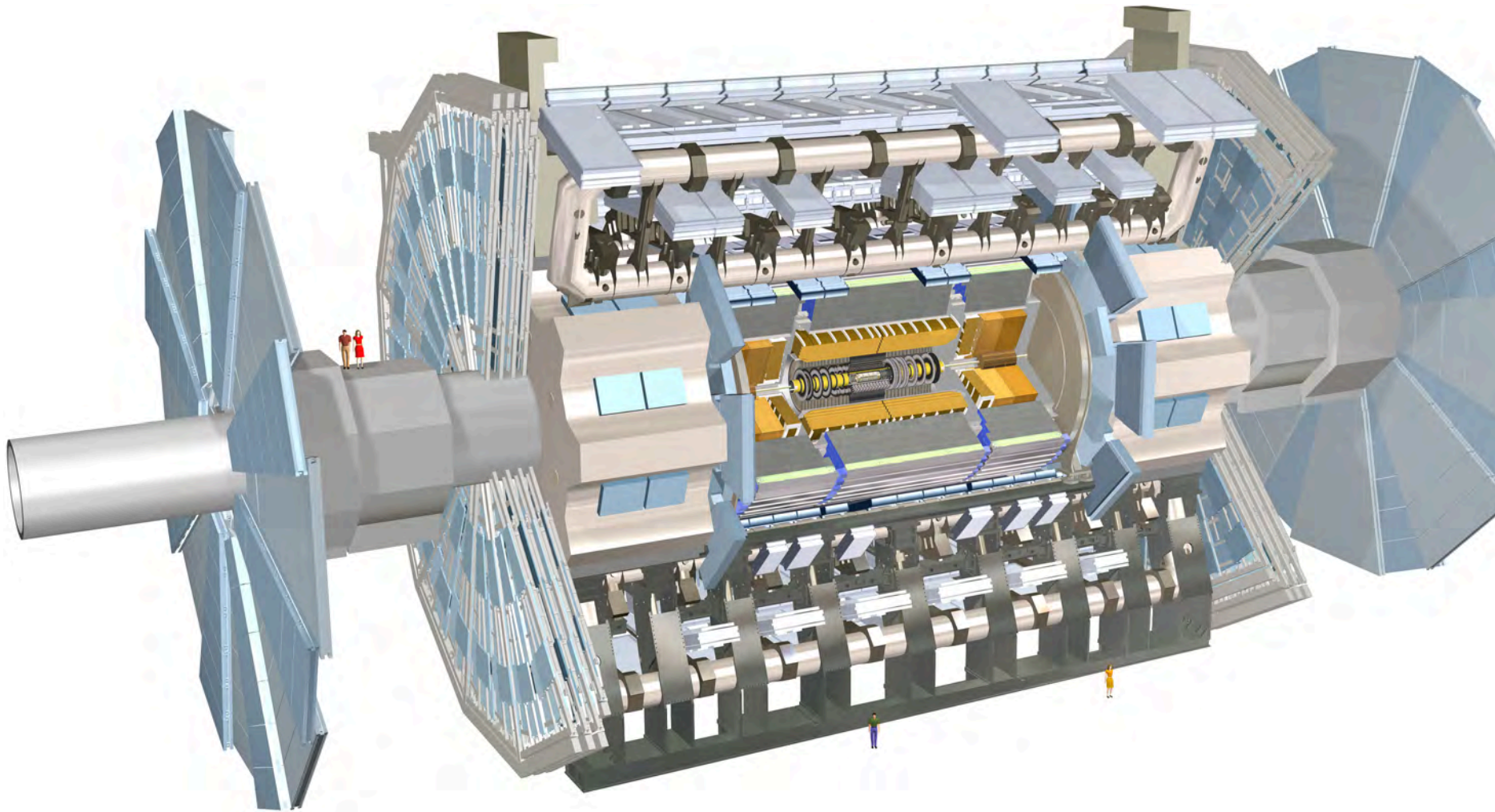
# Higgs Produktion



# CERN / LHC

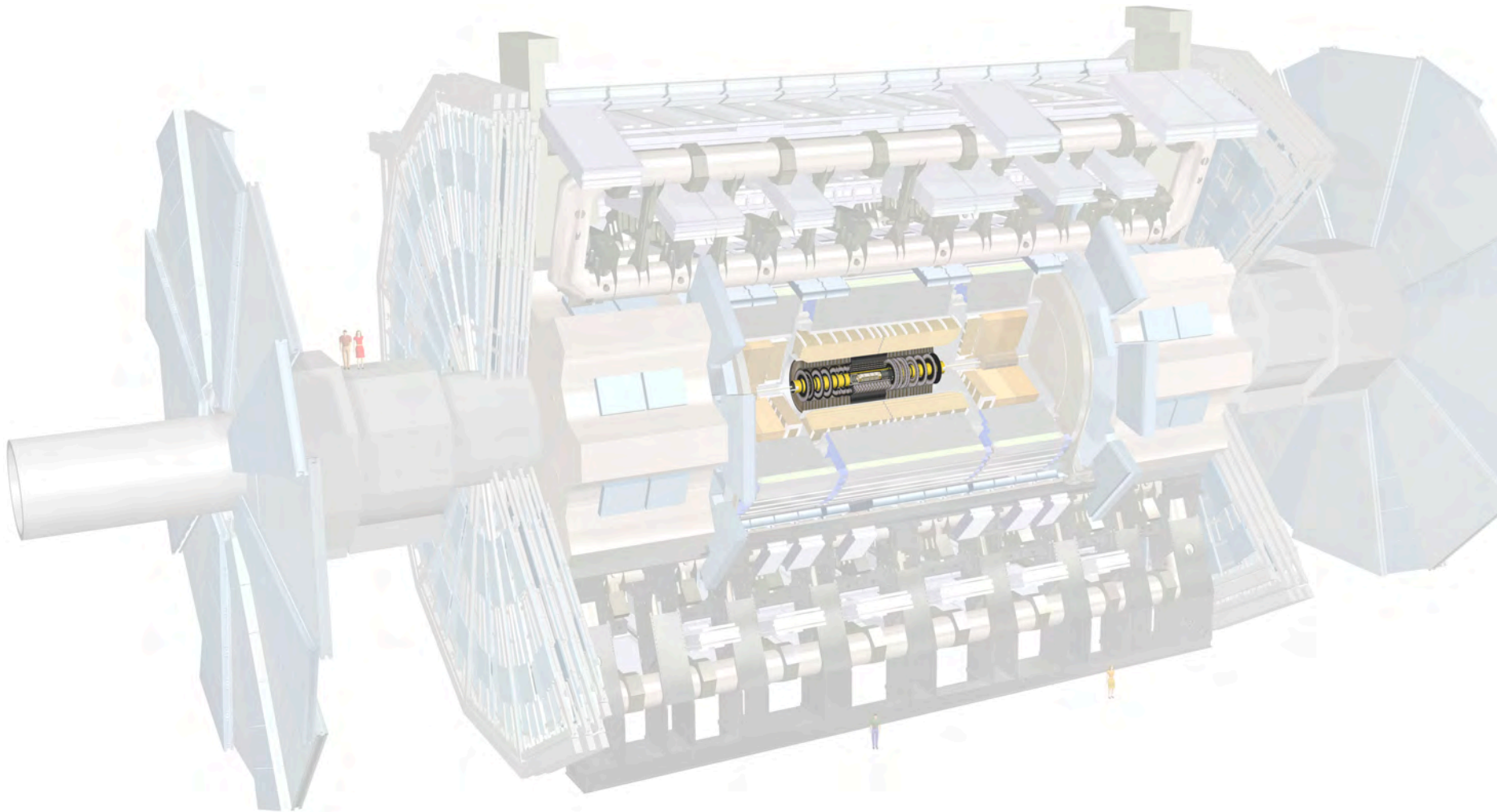


# ATLAS-Detektor



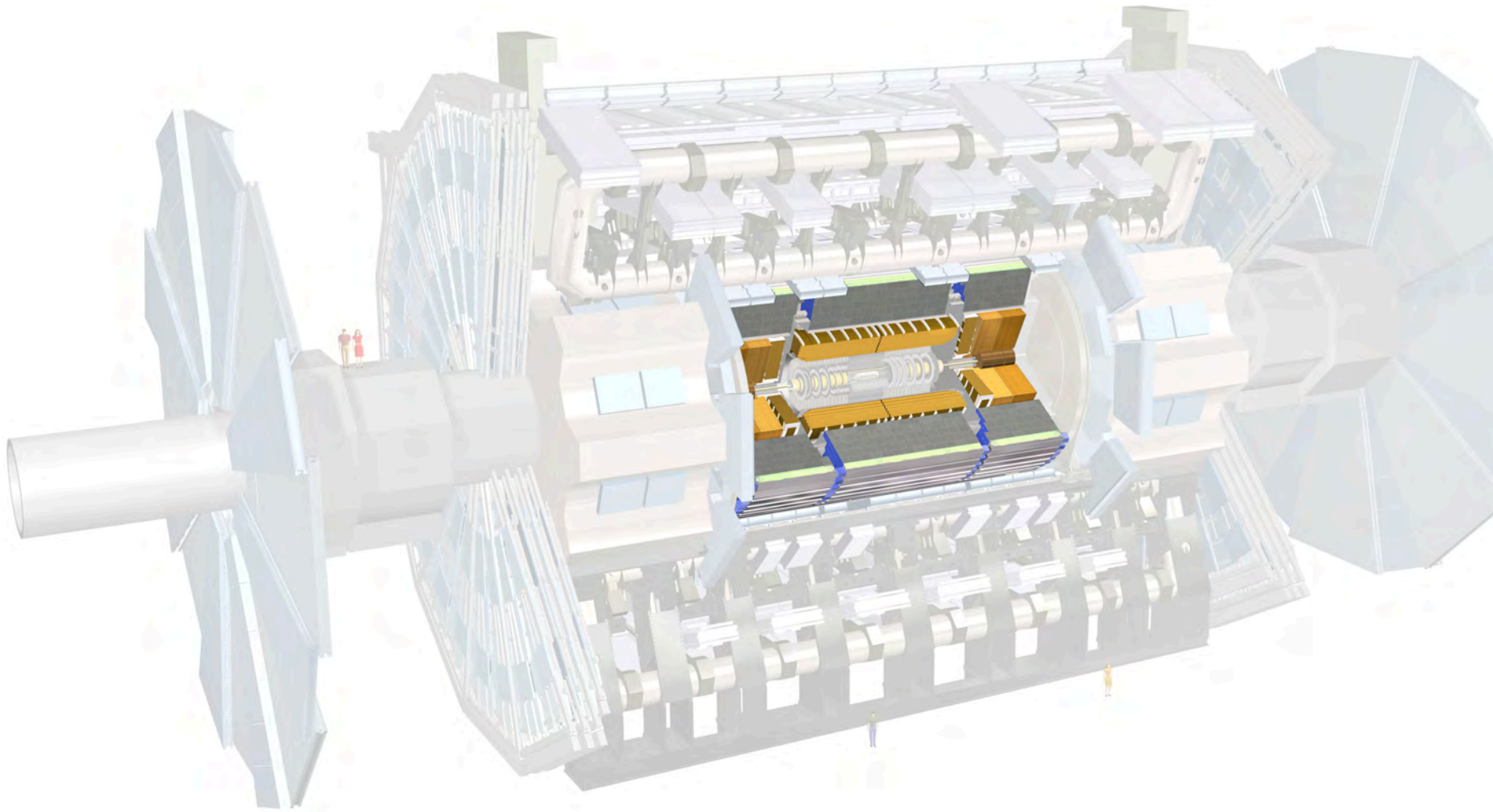
# ATLAS-Detektor

## Innerer Detektor



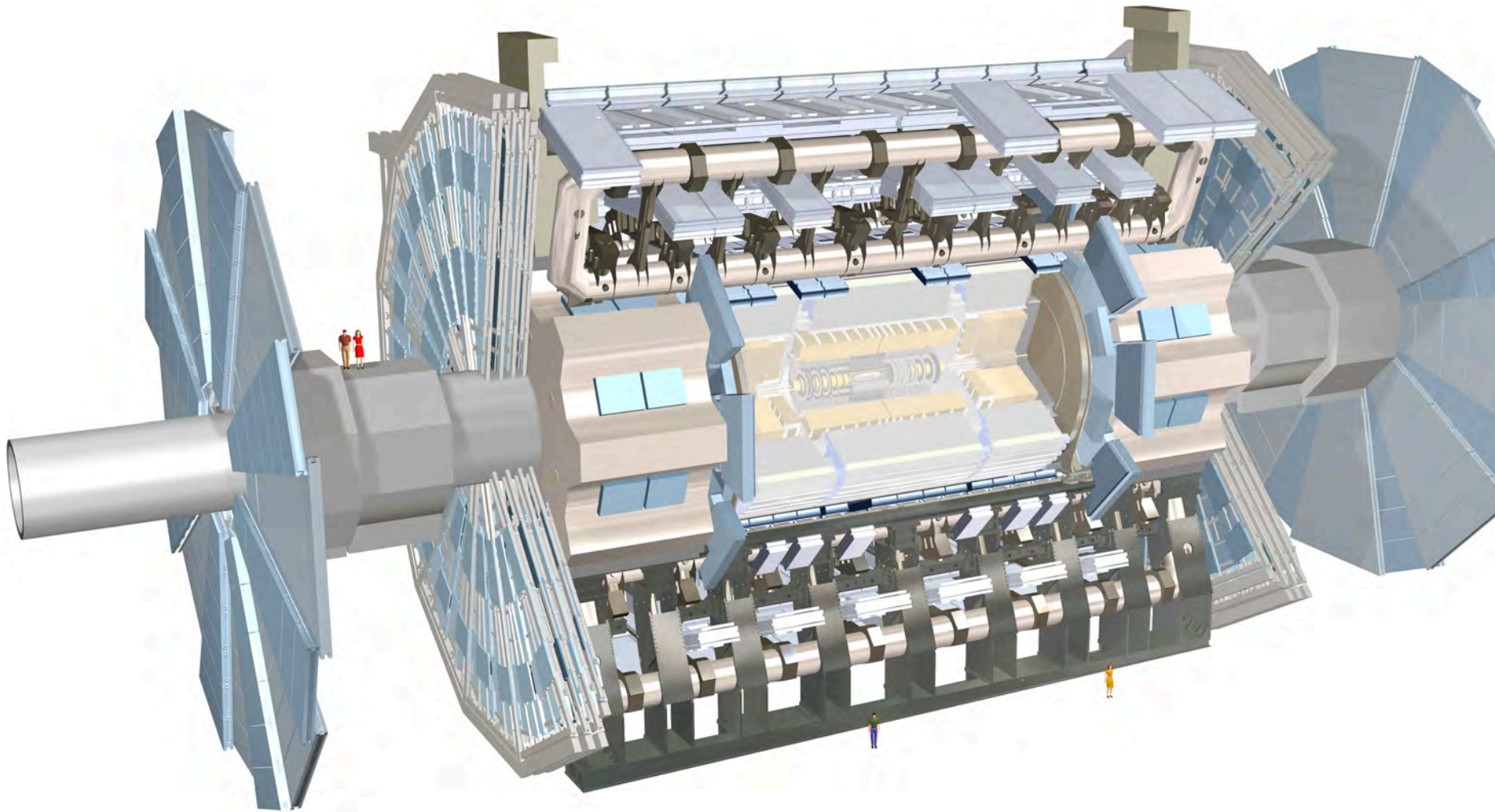
# ATLAS-Detektor

## Kalorimeter



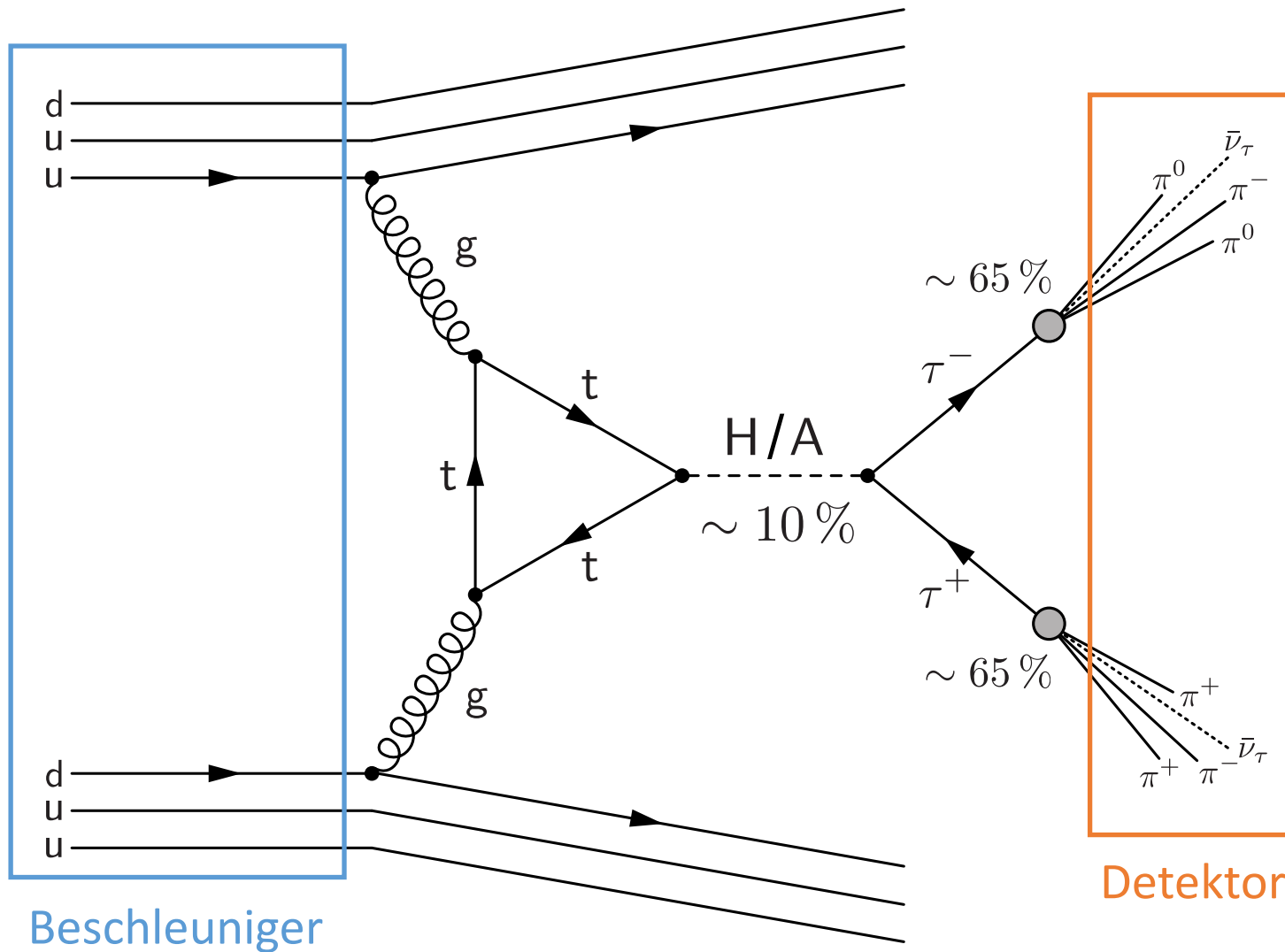
# ATLAS-Detektor

## Myon Spektrometer

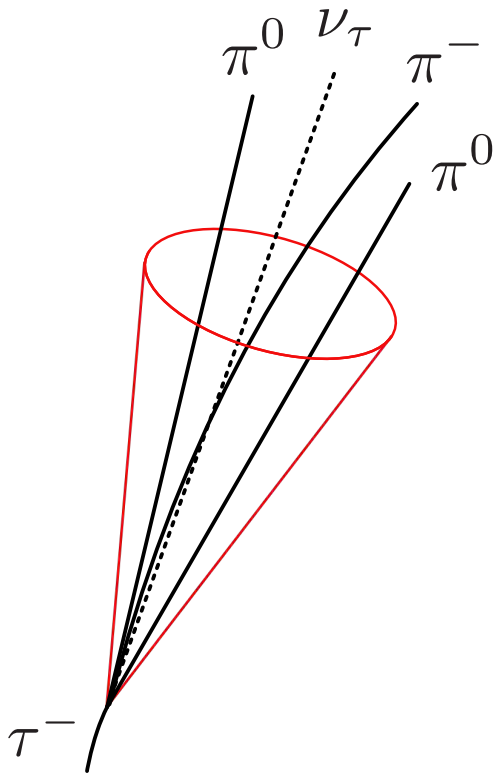




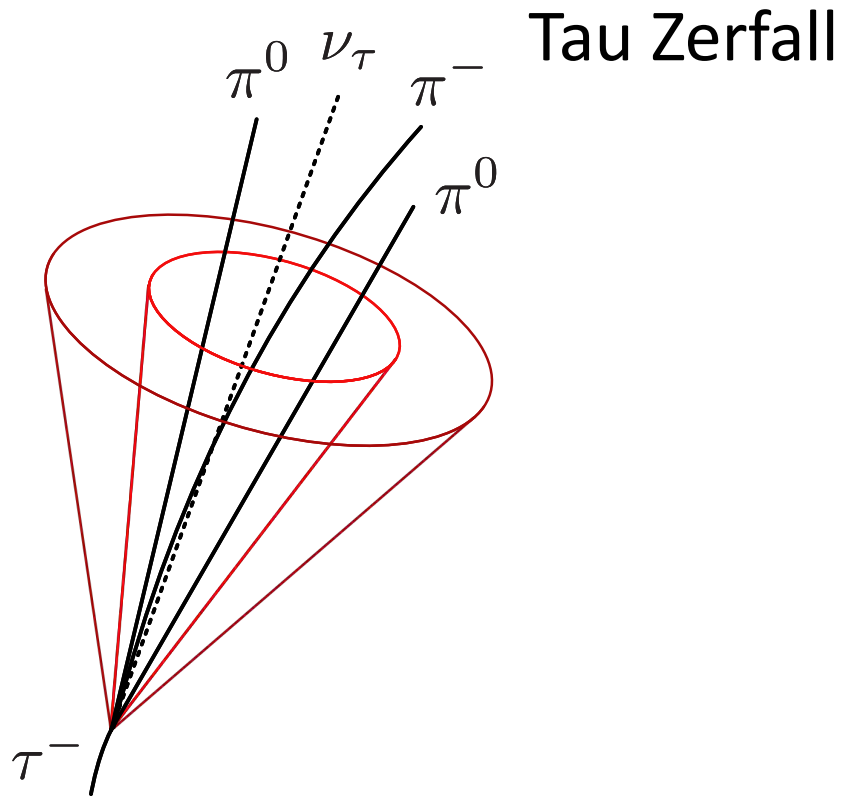
# Higgs Produktion



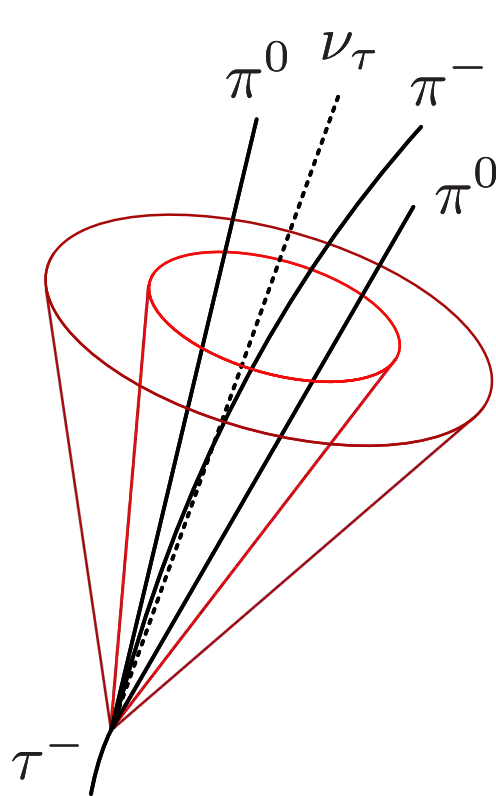
# Zerfall von Tau Leptonen



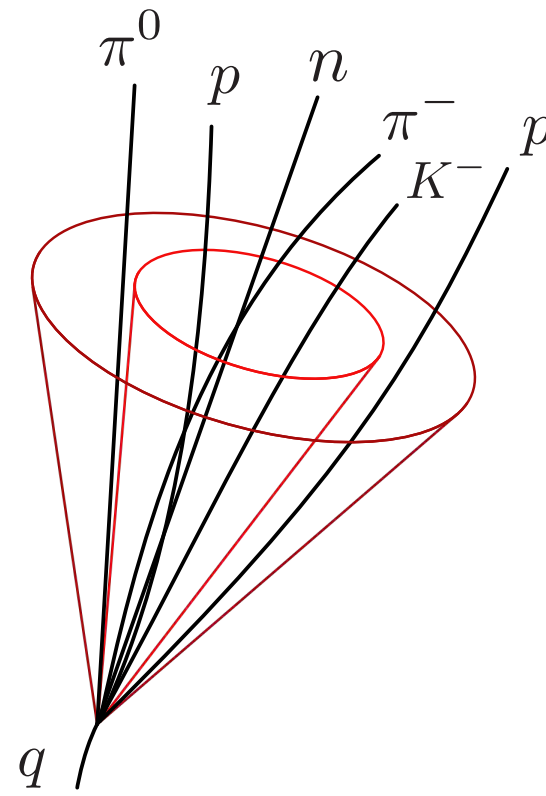
# Zerfall von Tau Leptonen



# Zerfall von Tau Leptonen

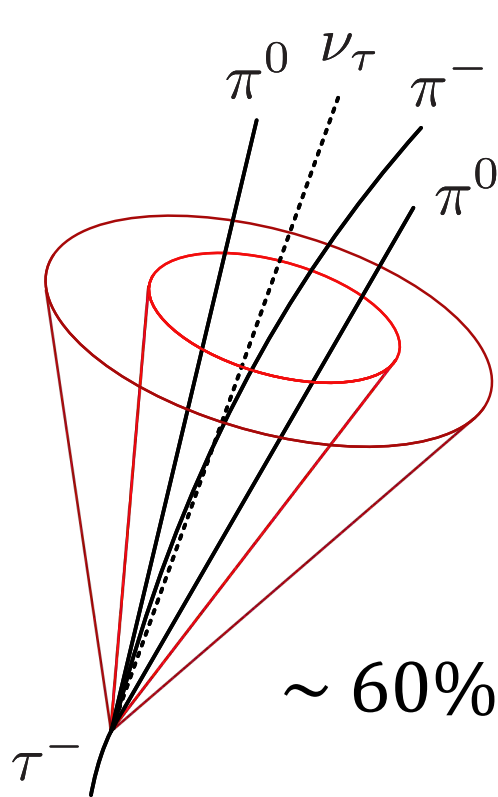


Tau Zerfall

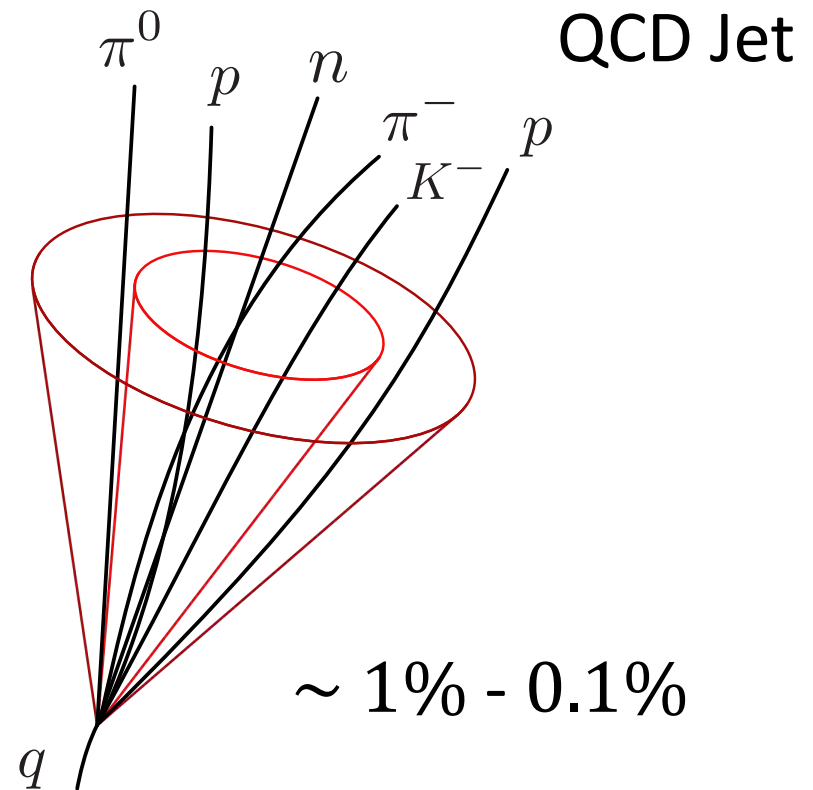


QCD Jet

# Zerfall von Tau Leptonen



Tau Zerfall

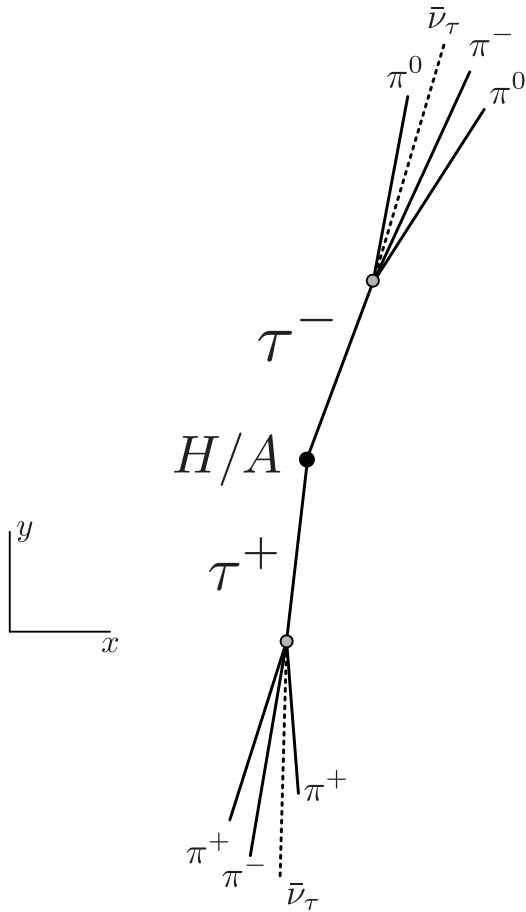


QCD Jet

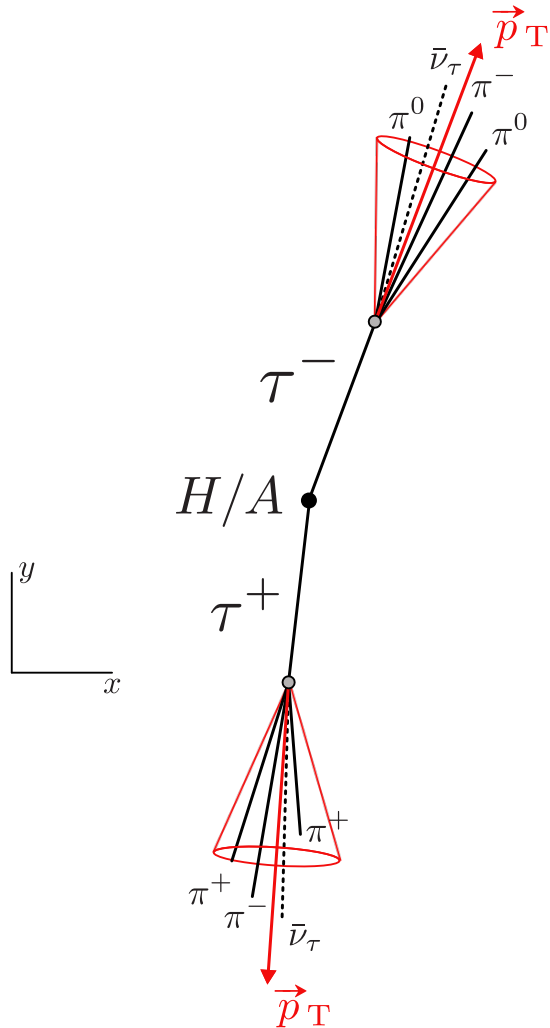
- Unterscheidung mit Hilfe von selbstlernenden Algorithmen

# Ereignis Selektion

- 2 Tau Leptonen mit gegensätzlicher elektrischer Ladung

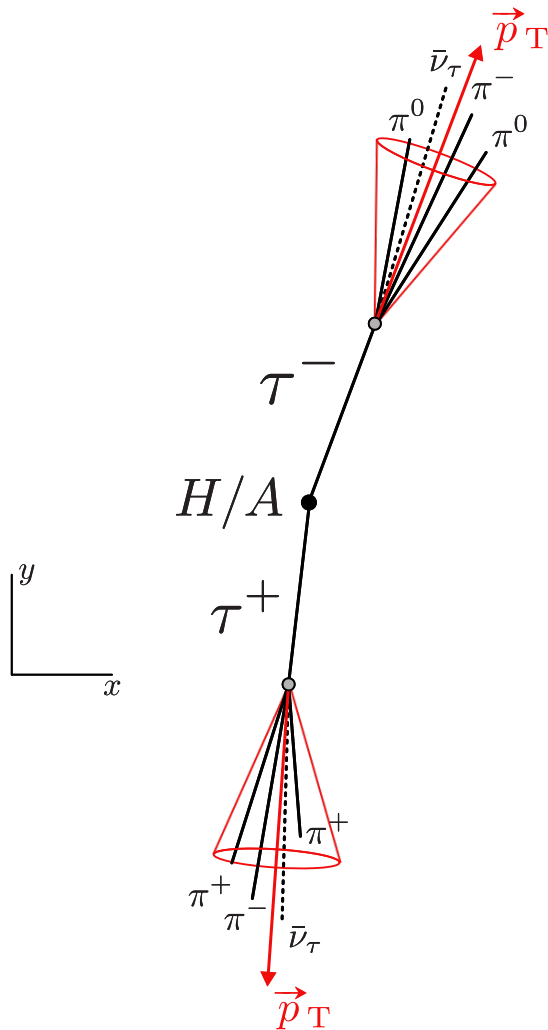


# Ereignis Selektion



- 2 Tau Leptonen mit gegensätzlicher elektrischer Ladung
- $p_T > 50 \text{ GeV}$

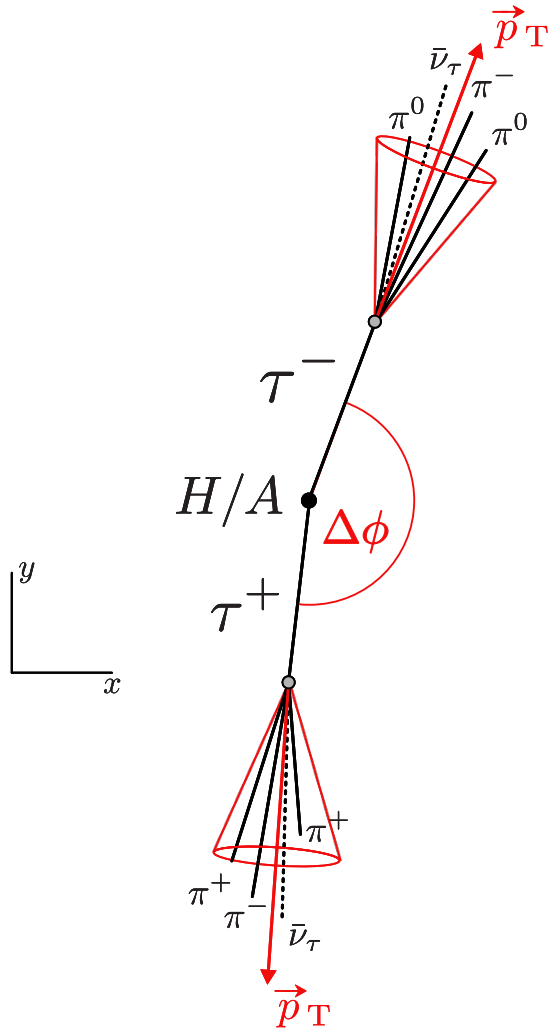
# Ereignis Selektion



- 2 Tau Leptonen mit gegensätzlicher elektrischer Ladung
- $p_T > 50$  GeV
- Keine leichten Leptonen ( $e^\pm, \mu^\pm$ )

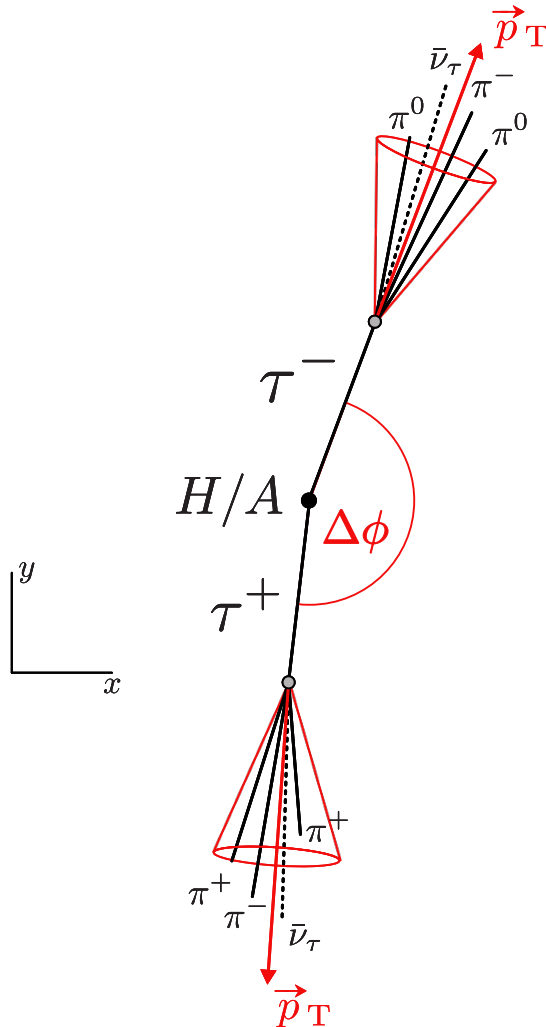


# Ereignis Selektion



- 2 Tau Leptonen mit gegensätzlicher elektrischer Ladung
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- $|\Delta\phi| > 2.7$

# Ereignis Selektion



- 2 Tau Leptonen mit gegensätzlicher elektrischer Ladung
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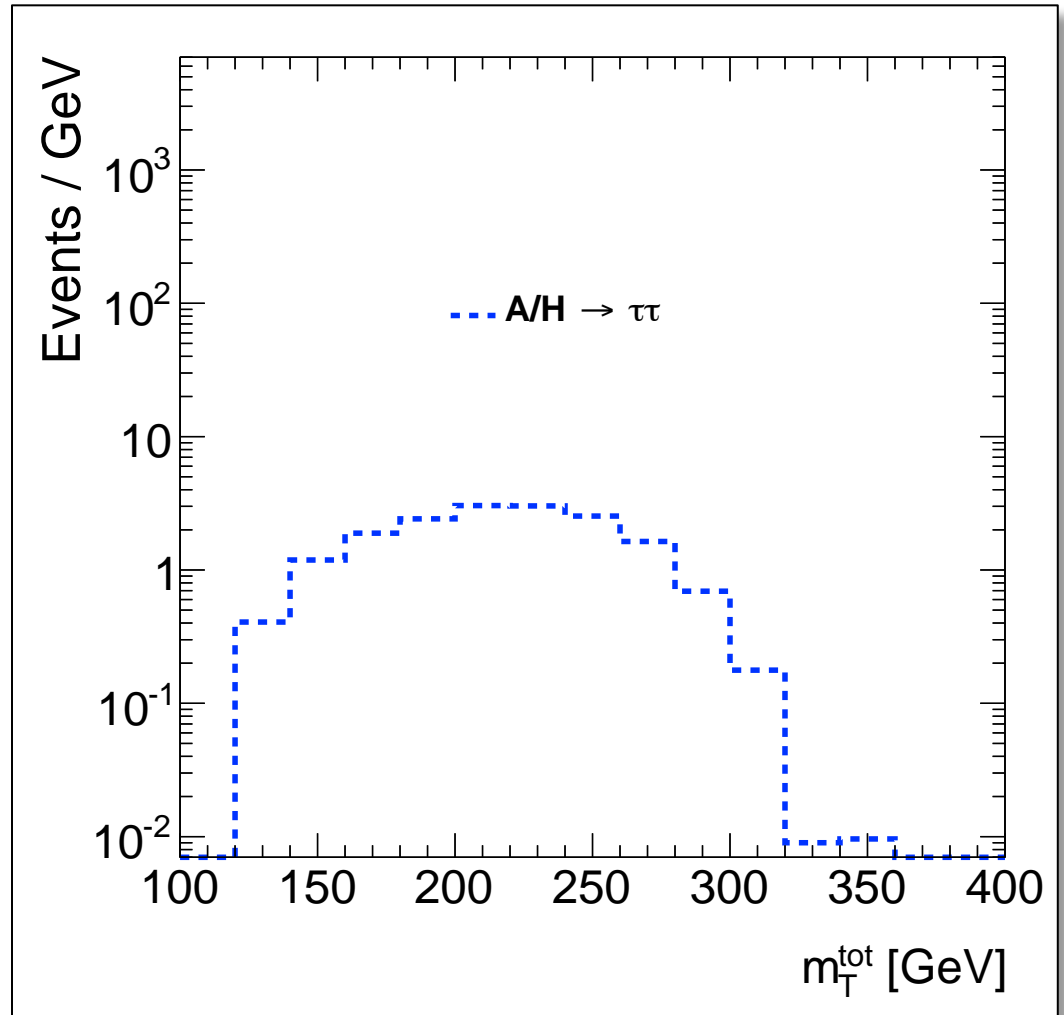
## „Di Tau Trigger“ (DTT)

- Trigger auf zwei Tau-Zerfall Signaturen ( $p_T > 29$  GeV und  $p_T > 20$  GeV)

## „Single Tau Trigger“ (STT)

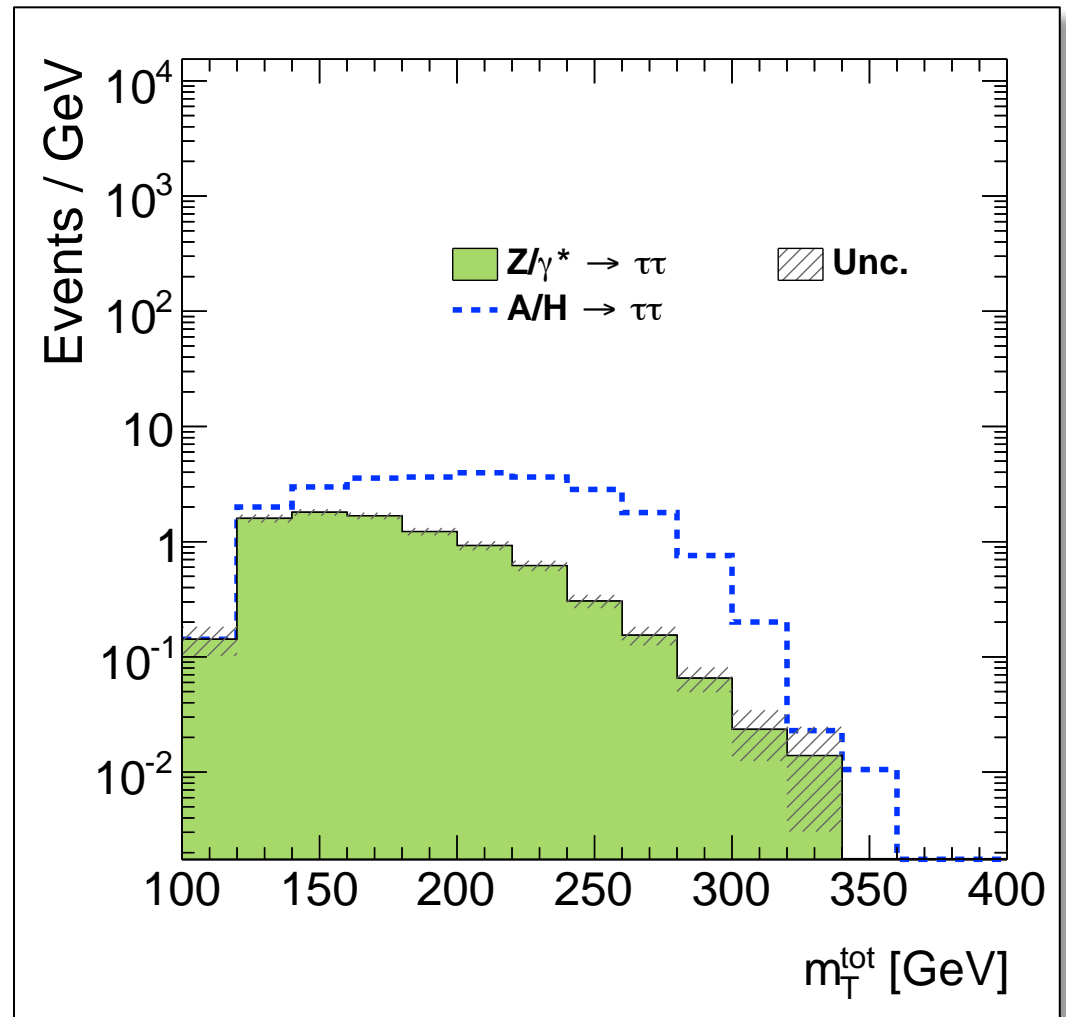
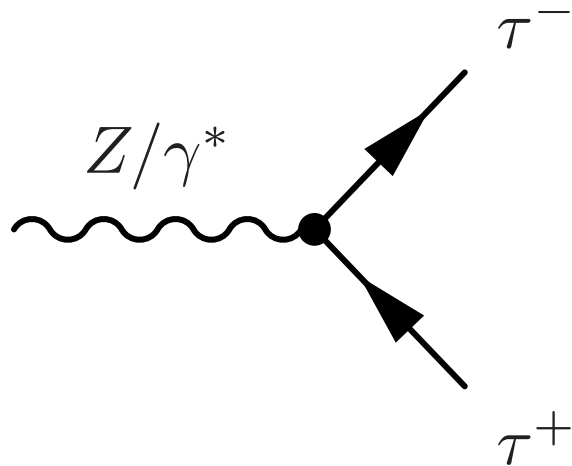
- Trigger auf eine einzelne Tau-Zerfall Signatur ( $p_T > 125$  GeV)

# Analyse



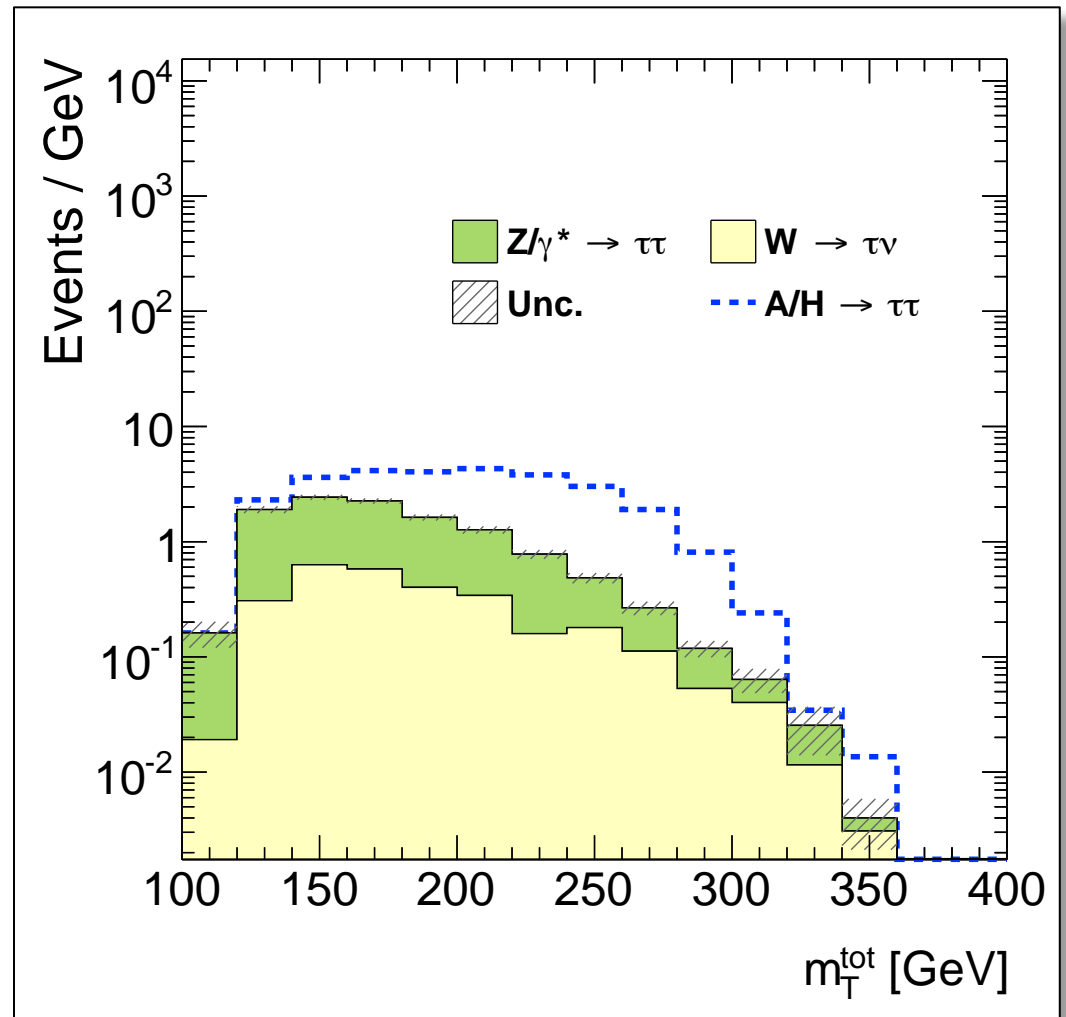
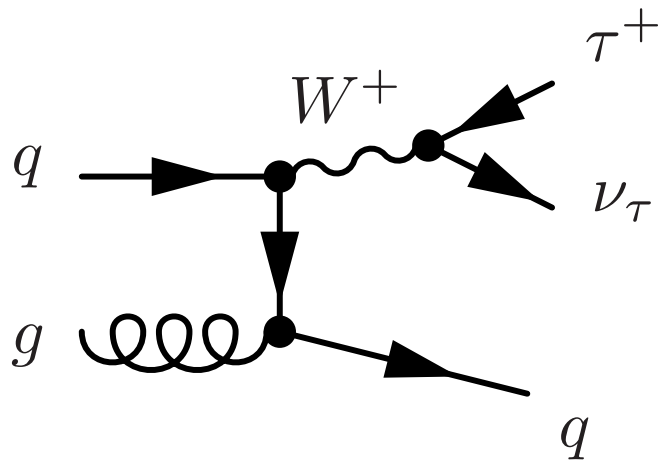
# Analyse

- $Z/\gamma^* \rightarrow \tau\tau$



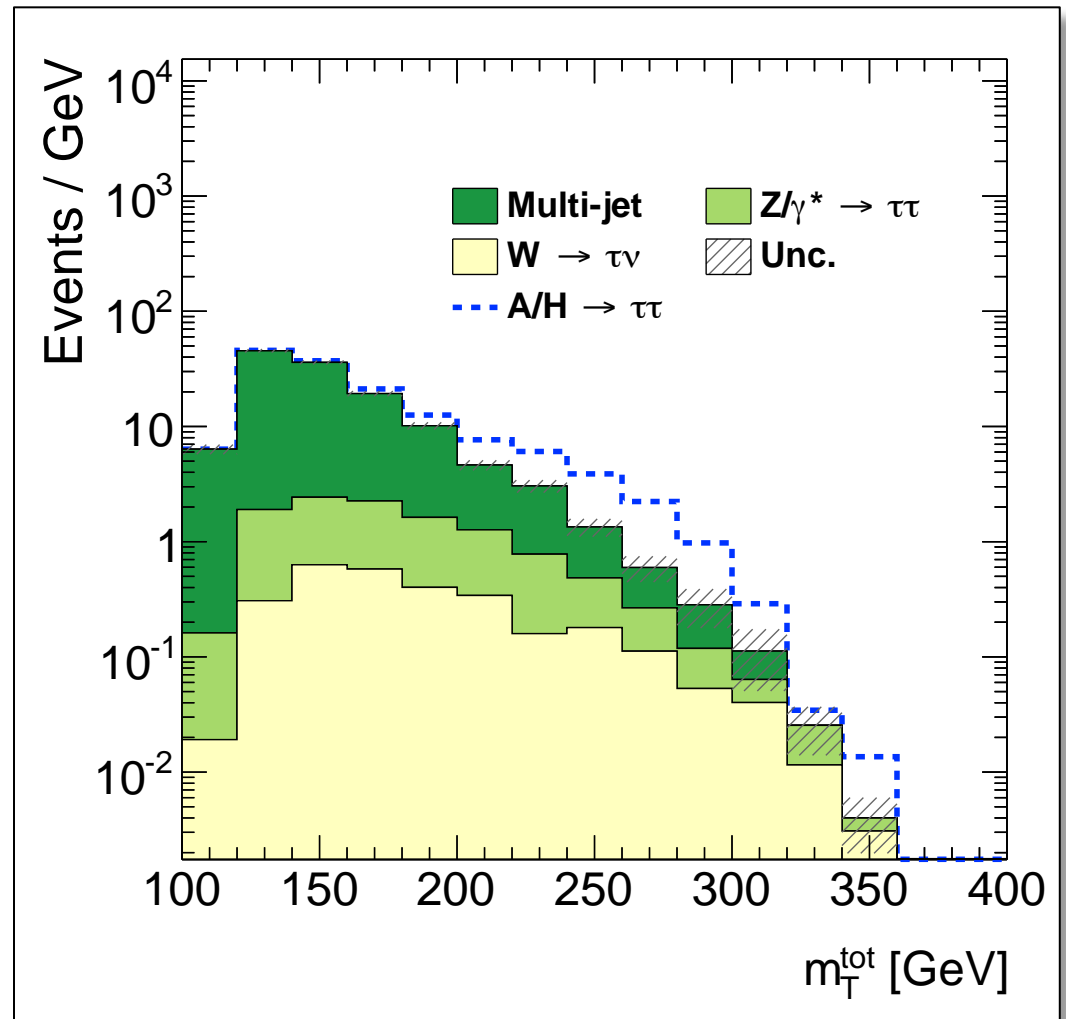
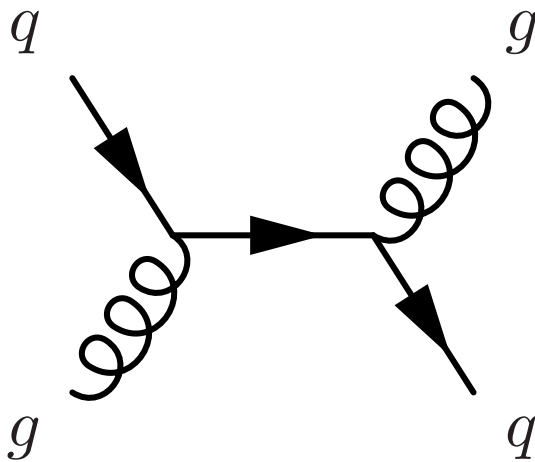
# Analyse

- $Z/\gamma^* \rightarrow \tau\tau$
- $W \rightarrow \tau\nu + \text{Jets}$



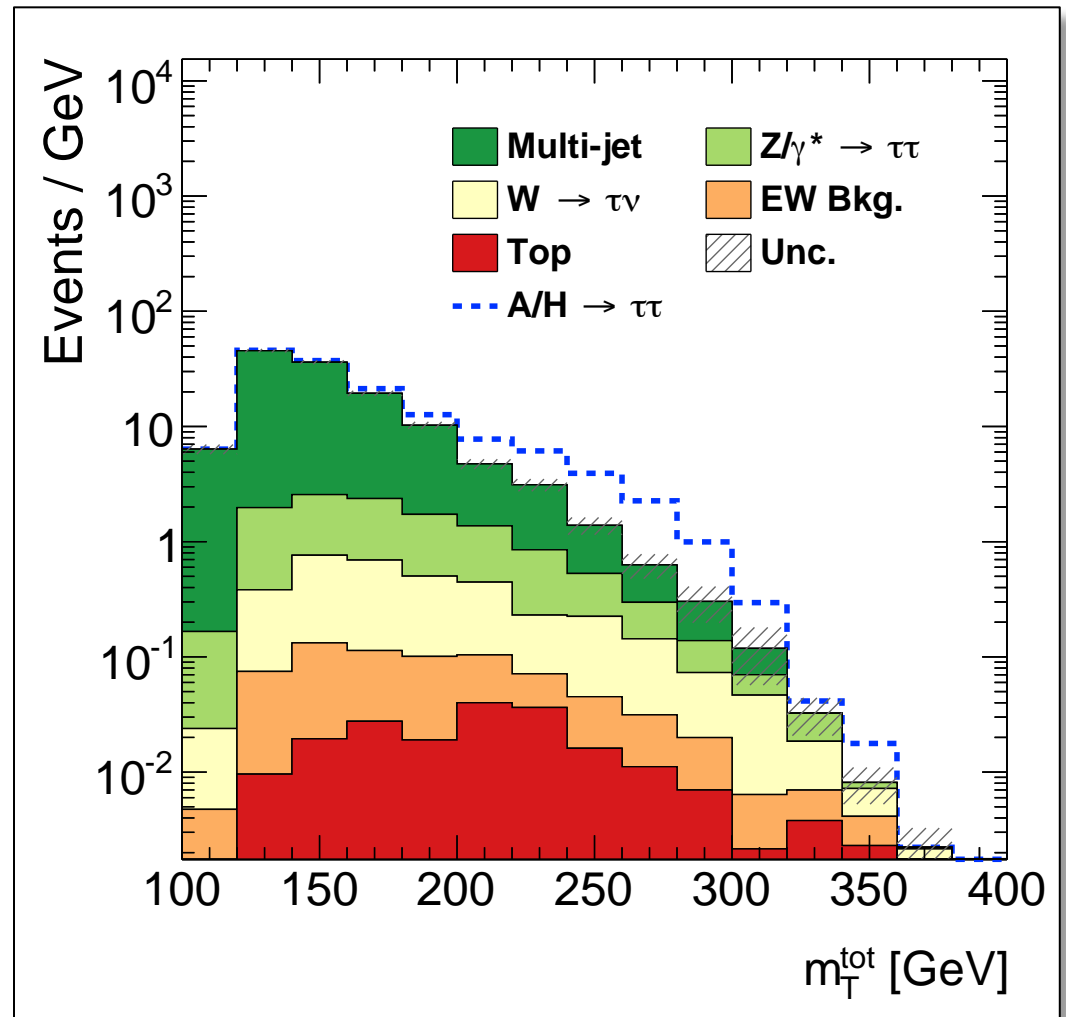
# Analyse

- $Z/\gamma^* \rightarrow \tau\tau$
- $W \rightarrow \tau\nu + \text{Jets}$
- QCD Multijet



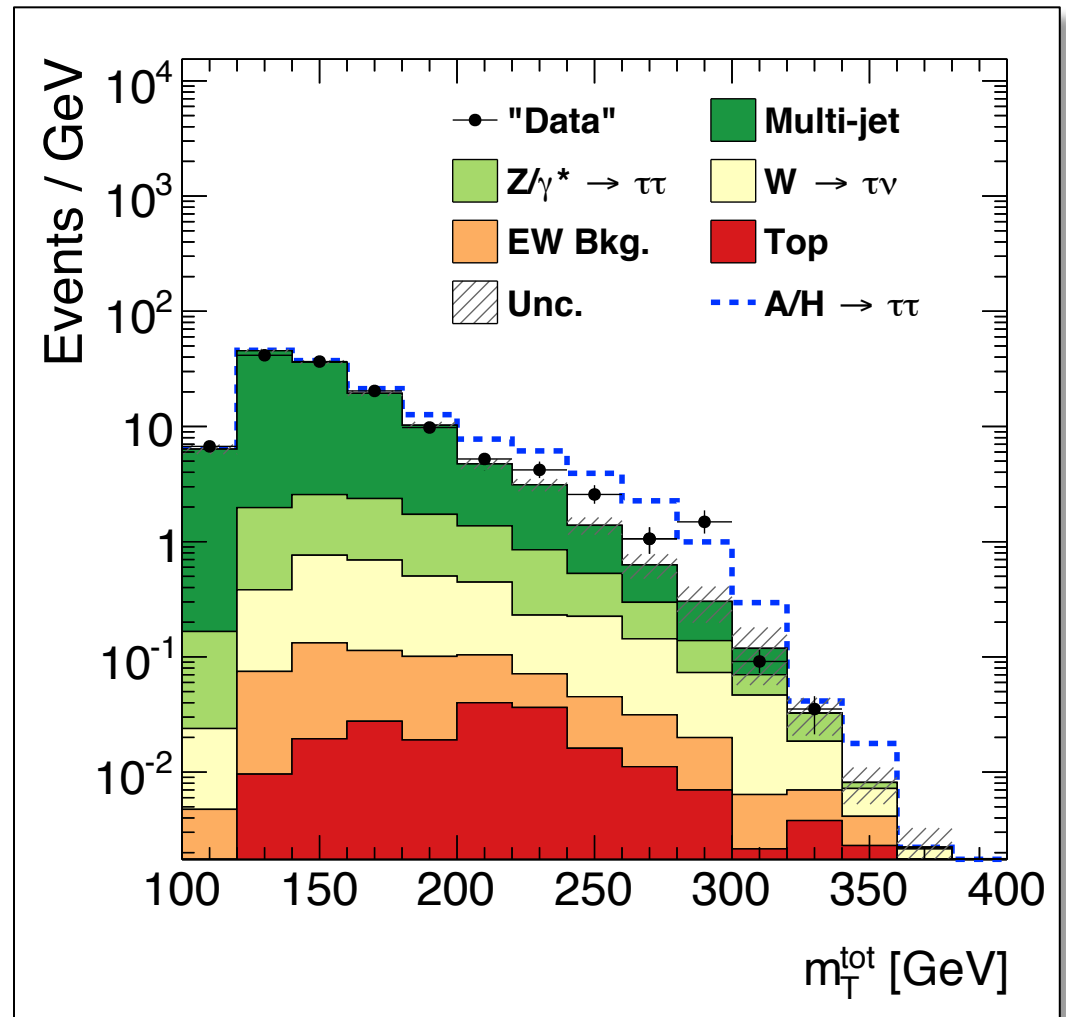
# Analyse

- $Z/\gamma^* \rightarrow \tau\tau$
- $W \rightarrow \tau\nu + \text{Jets}$
- QCD Multijet
- ...



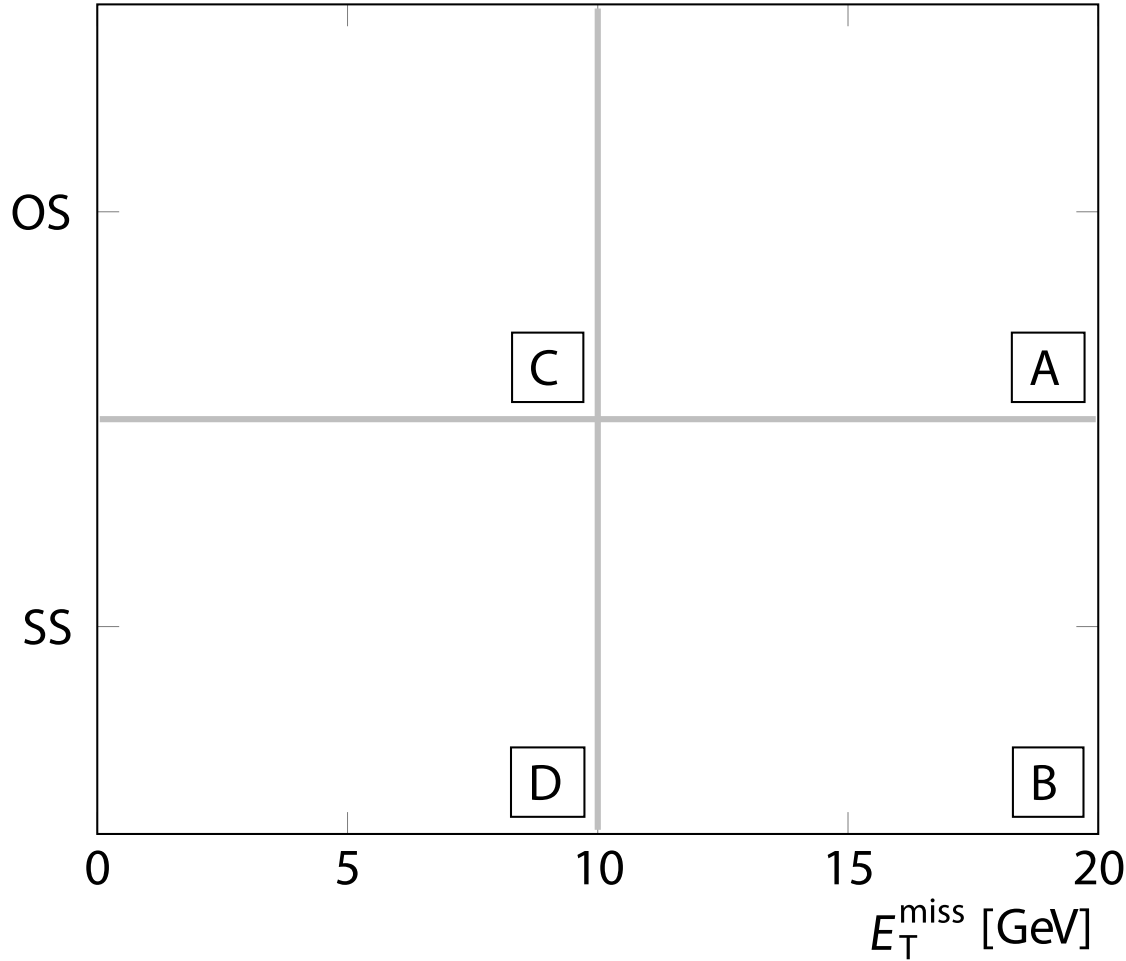
# Analyse

- $Z/\gamma^* \rightarrow \tau\tau$
- $W \rightarrow \tau\nu + \text{Jets}$
- QCD Multijet
- ...

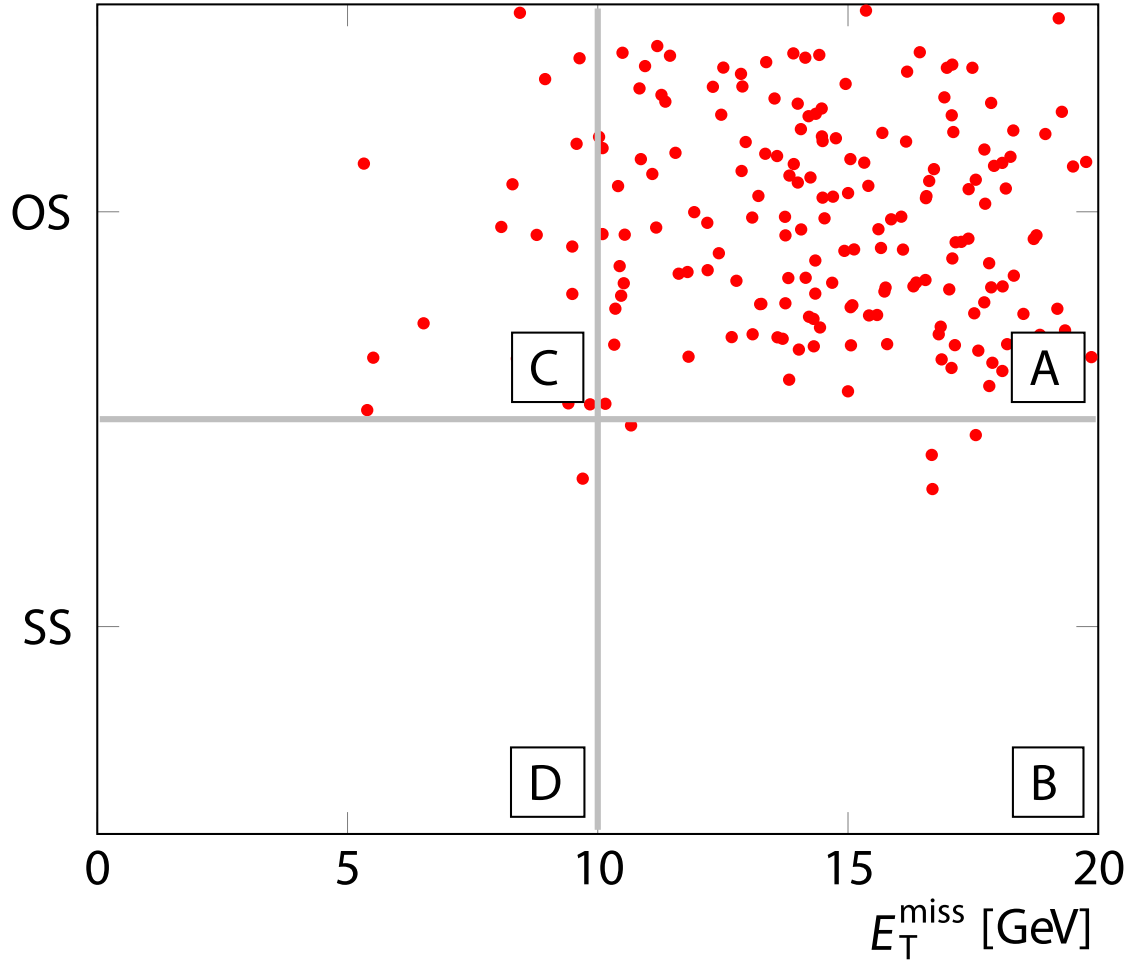




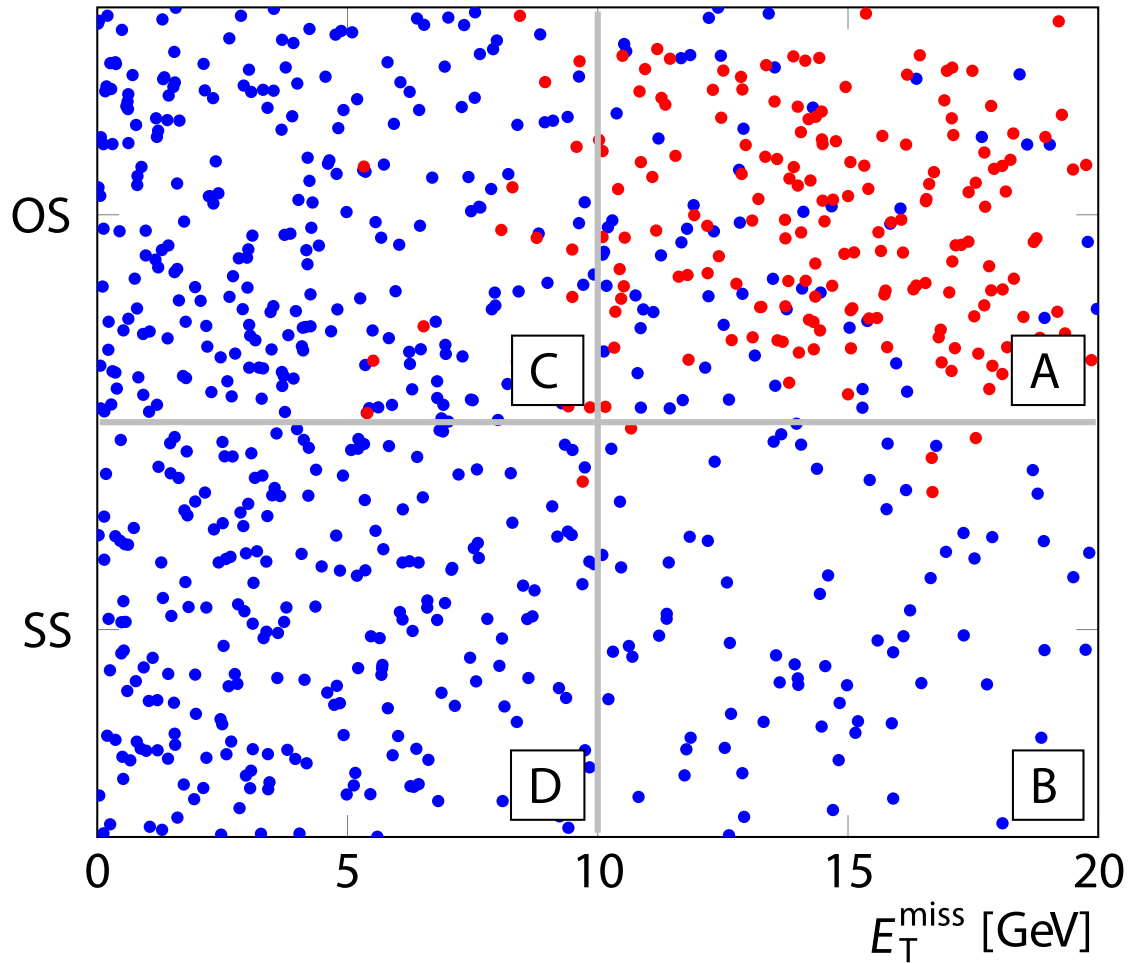
# QCD Multijet Abschätzung in DTT



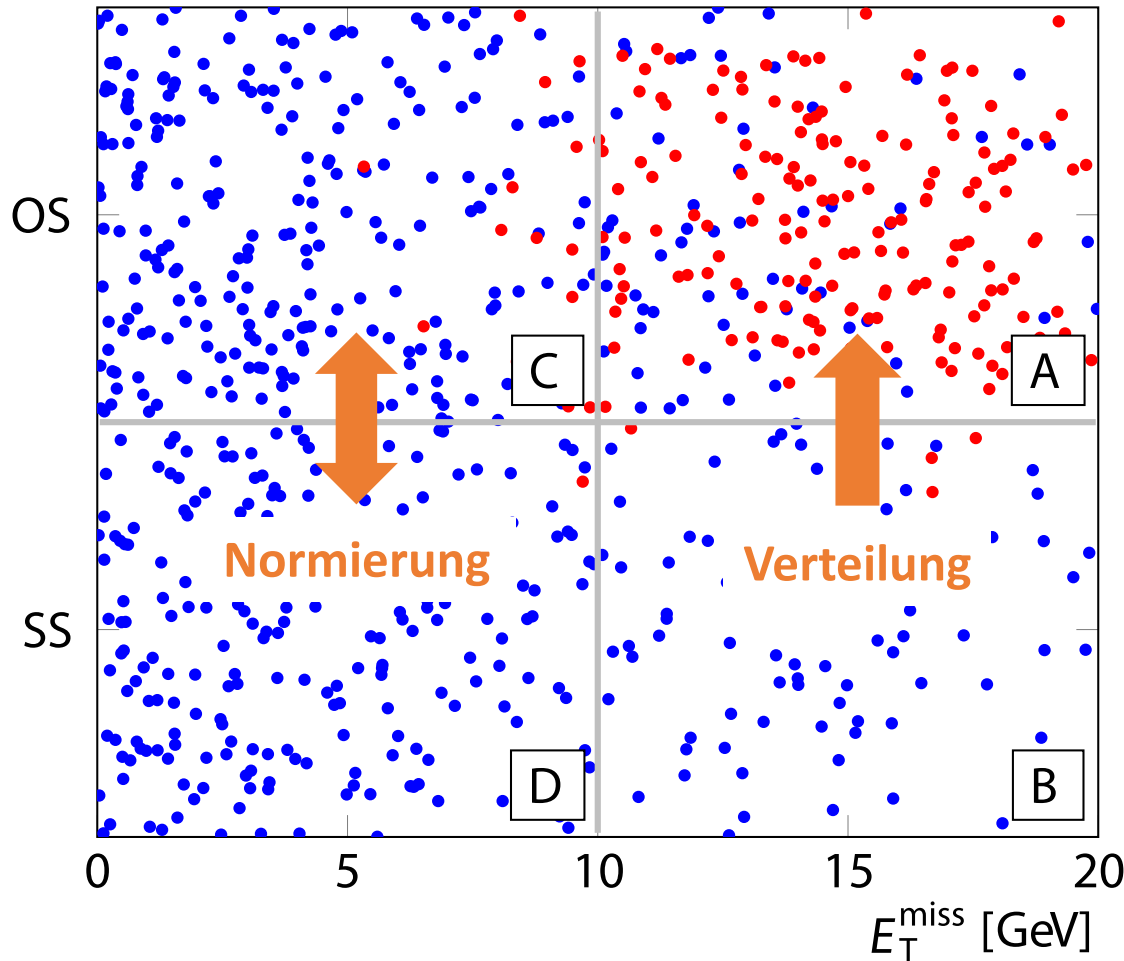
# QCD Multijet Abschätzung in DTT



# QCD Multijet Abschätzung in DTT



# QCD Multijet Abschätzung in DTT



- QCD Abschätzung:

$$\langle N_{\text{QCD},i}^{\text{A}} \rangle = N_{\text{data},i}^{\text{B}} \times R_{\text{OS/SS}}$$

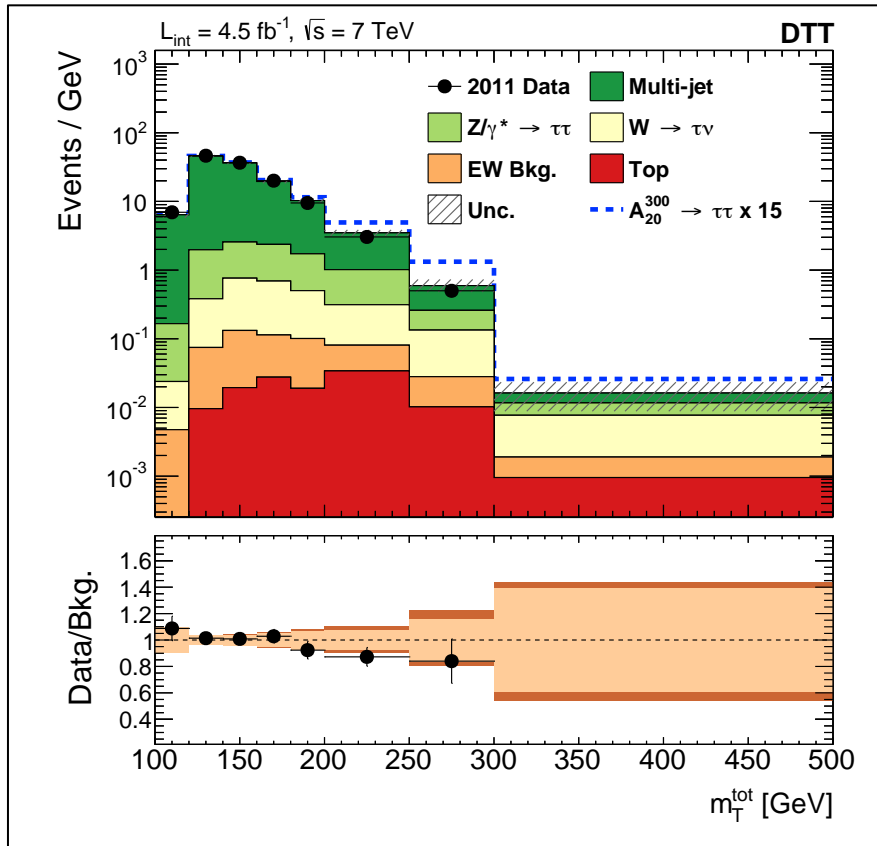
- Normierung:

$$R_{\text{OS/SS}} = \frac{\sum_i N_{\text{data},i}^{\text{C}}}{\sum_i N_{\text{data},i}^{\text{D}}}$$

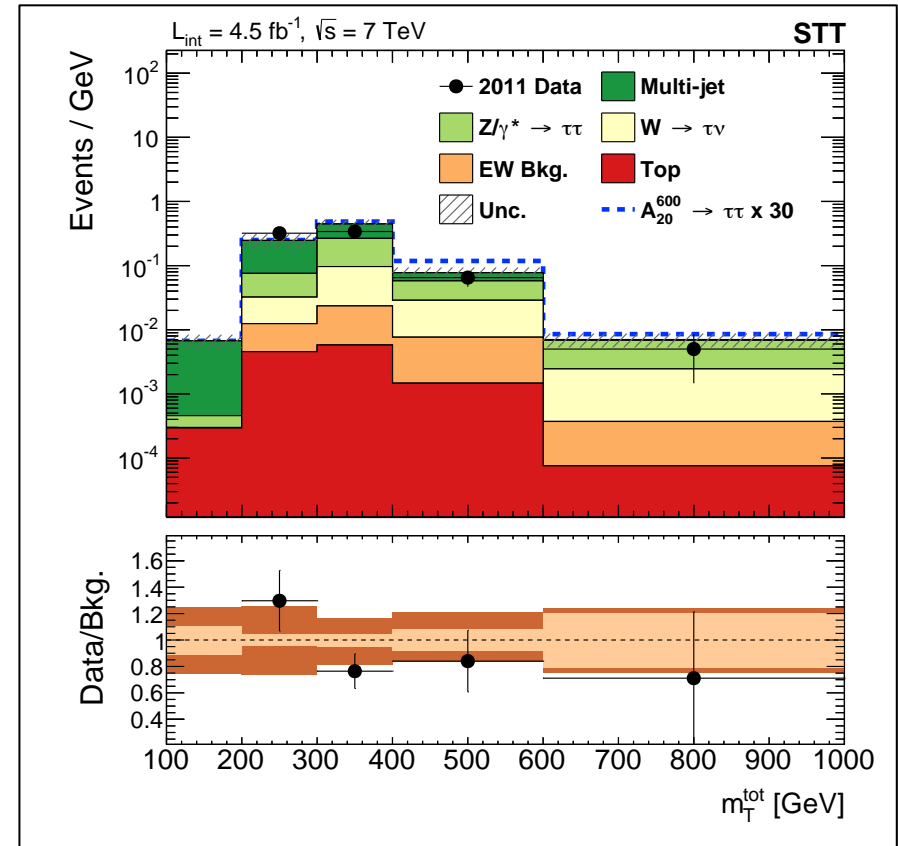
- Korrektur für nicht QCD Untergrund:

$$N_{\text{data},i}^{\text{B,C,D}} - \langle N_{\text{bkg},i}^{\text{B,C,D}} \rangle$$

# Finale Massenverteilungen

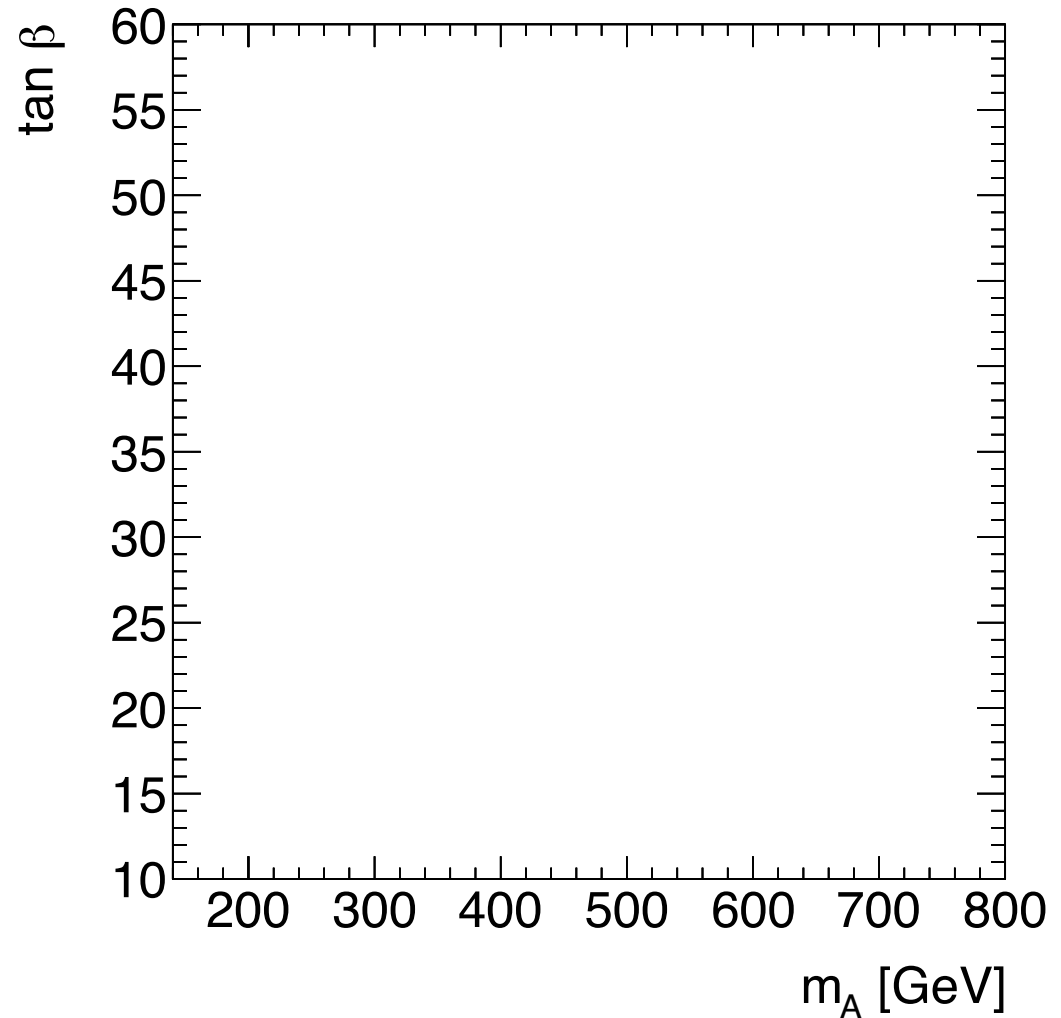


DTT



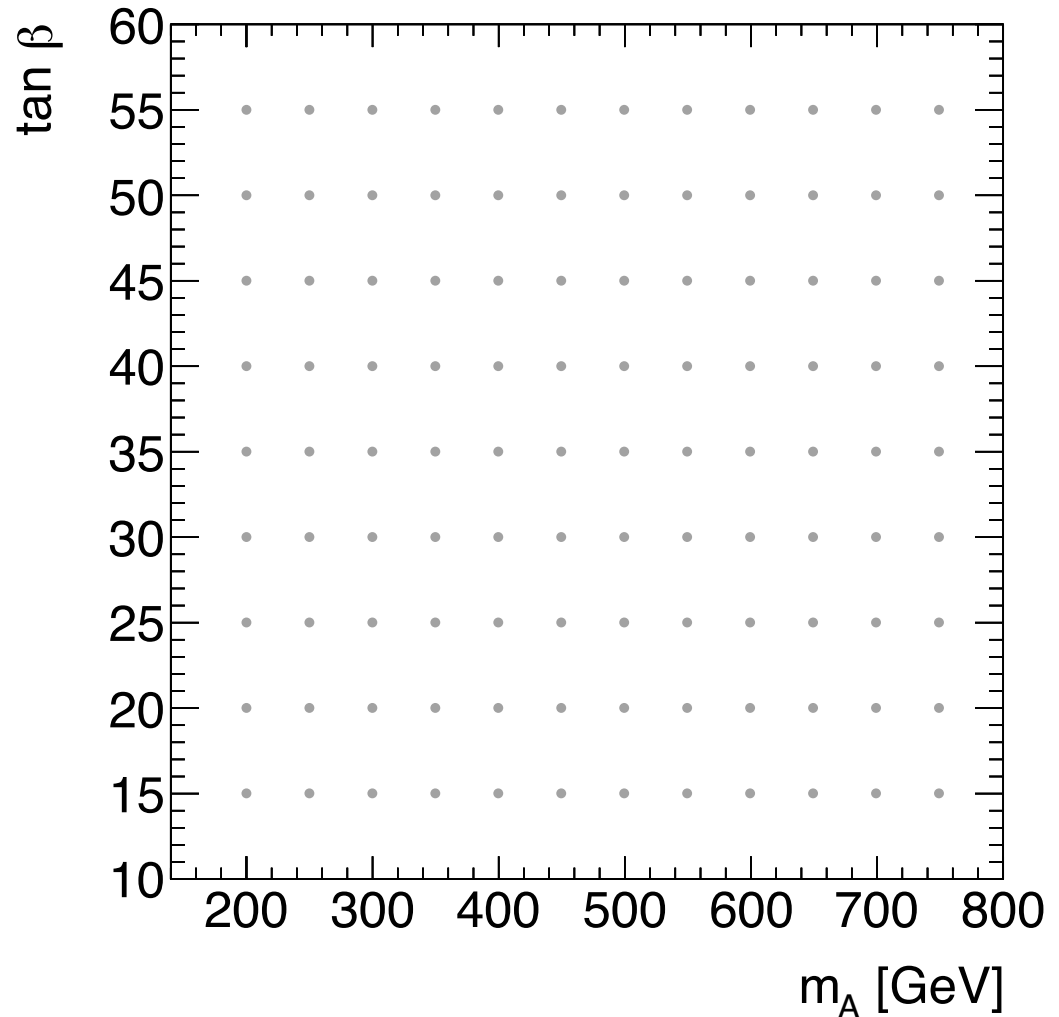
STT

# Ausschlusslimit



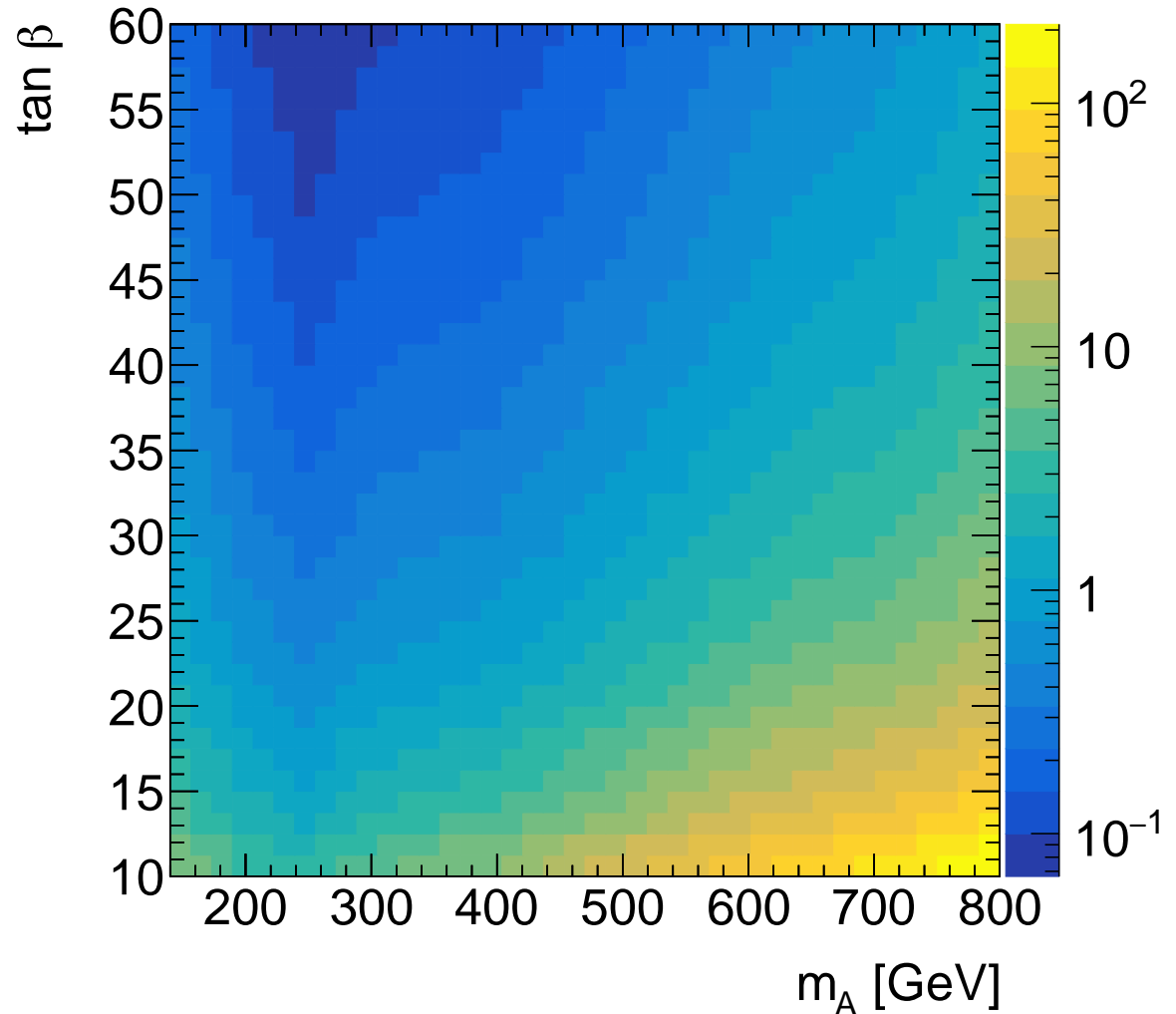
# Ausschlusslimit

- Raster in  $m_A / \tan \beta$



# Ausschlusslimit

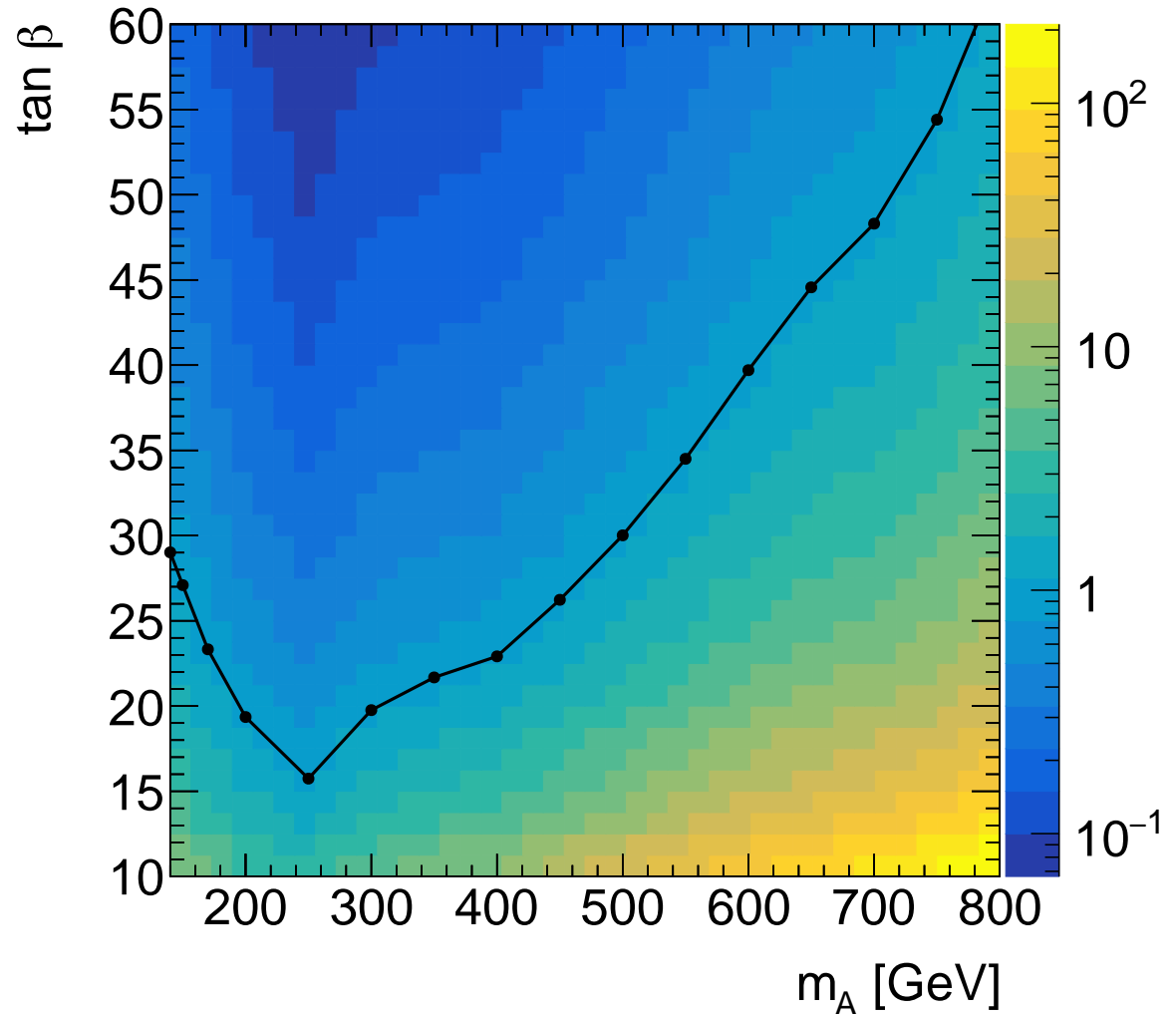
- Raster in  $m_A / \tan \beta$
- $\mu_{\text{up}}$  ( $\text{CL}_S = 95\%$ )





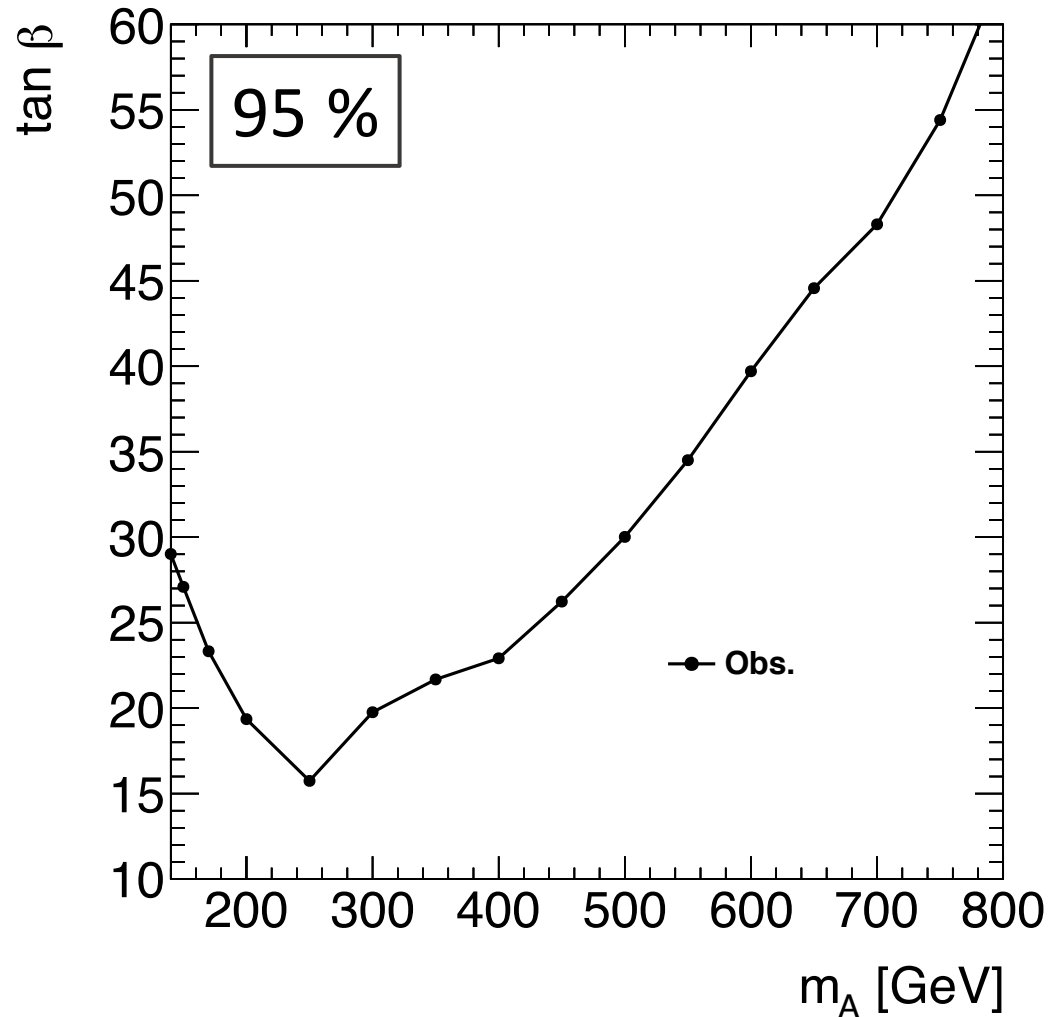
# Ausschlusslimit

- Raster in  $m_A / \tan \beta$
- $\mu_{\text{up}}$  ( $\text{CL}_S = 95\%$ )
- Ausschlusslimit für Nominalhypothese



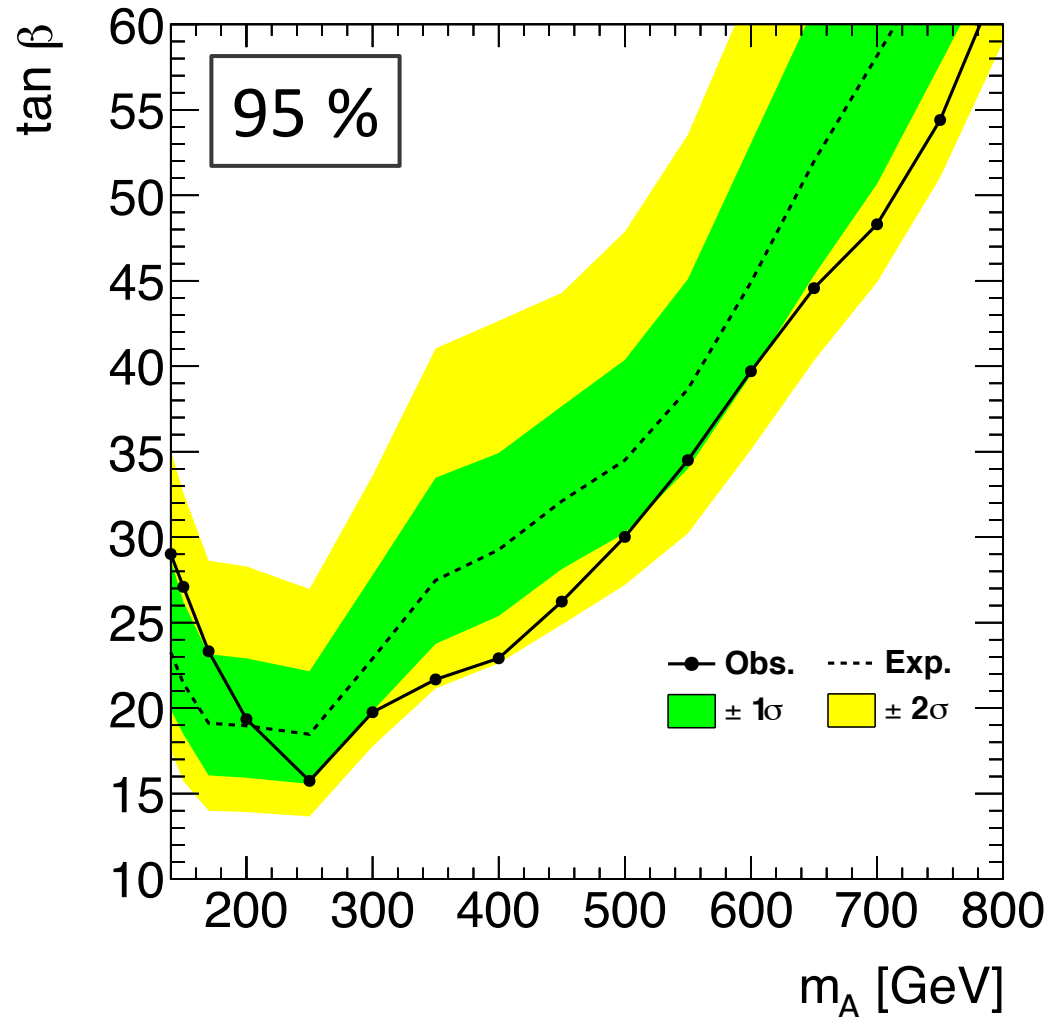
# Ausschlusslimit

- Raster in  $m_A / \tan \beta$
- $\mu_{\text{up}}$  ( $CL_S = 95\%$ )
- Ausschlusslimit für Nominalhypothese



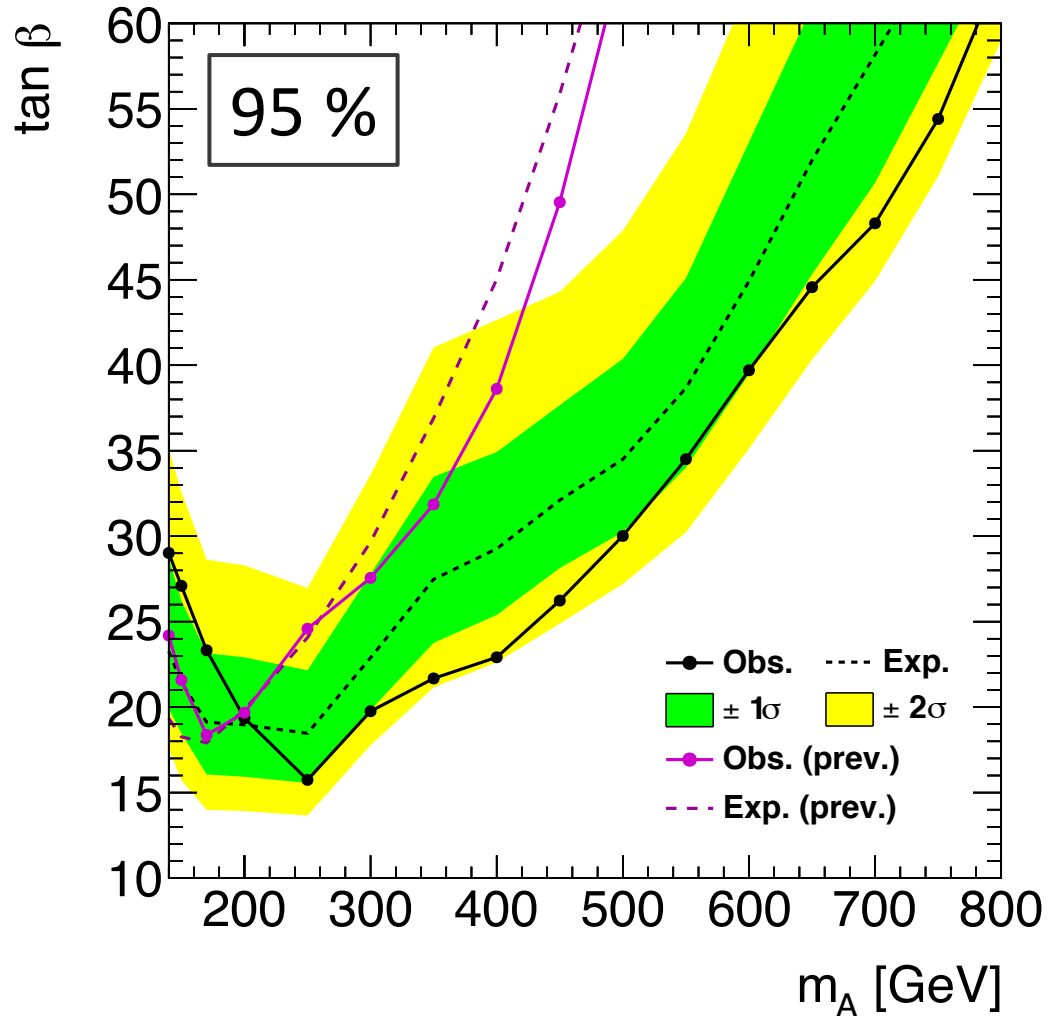
# Ausschlusslimit

- Raster in  $m_A / \tan \beta$
- $\mu_{\text{up}}$  ( $CL_S = 95\%$ )
- Ausschlusslimit für Nominalhypothese
- Erwartetes Ausschlusslimit



# Ausschlusslimit

- Raster in  $m_A / \tan \beta$
- $\mu_{\text{up}}$  ( $CL_S = 95\%$ )
- Ausschlusslimit für Nominalhypothese
- Erwartetes Ausschlusslimit
- Vergleich mit vorherigem Limit



# Zusammenfassung & Ausblick

- Suche nach schweren Higgs Bosonen im Kontext des MSSM
  - Analyse des 2011 Datensatz am ATLAS Detektor
  - Anwendung neuer Methoden zur Untergrundabschätzung
  - Deutliche Verbesserung des Ausschlusslimits
- Ebenfalls im Rahmen der Arbeit:
  - Optimierung von Tau Lepton Identifikationsalgorithmen
  - Vermessung von multiplen Parton-Parton Interaktionen („underlying event“)
  - Optimierung von Simulationsalgorithmen

# Zusammenfassung & Ausblick

