

*Jak si posvítit
na Higgsův Boson*

Jiří Kvita

PřF UP, RCPTM



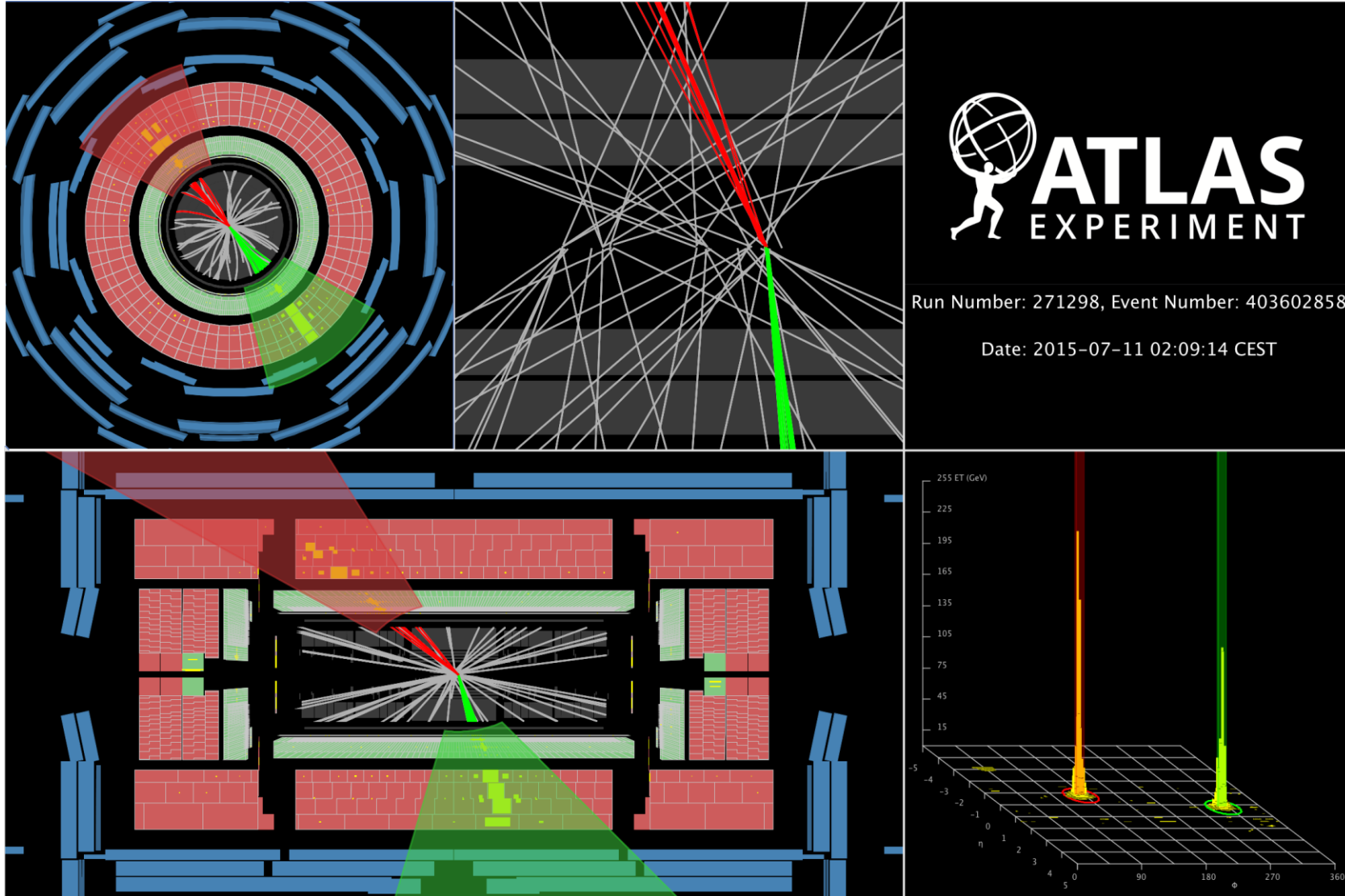
Částice

- Jak je vidíme? (sedmdesátá léta)



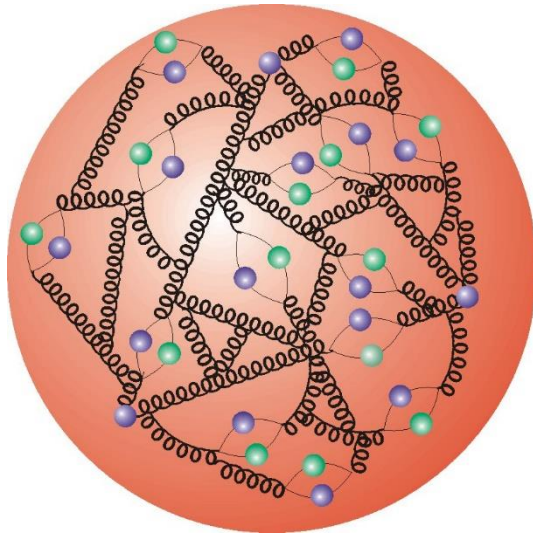
Částice

- Jak je vidíme? (současnost)



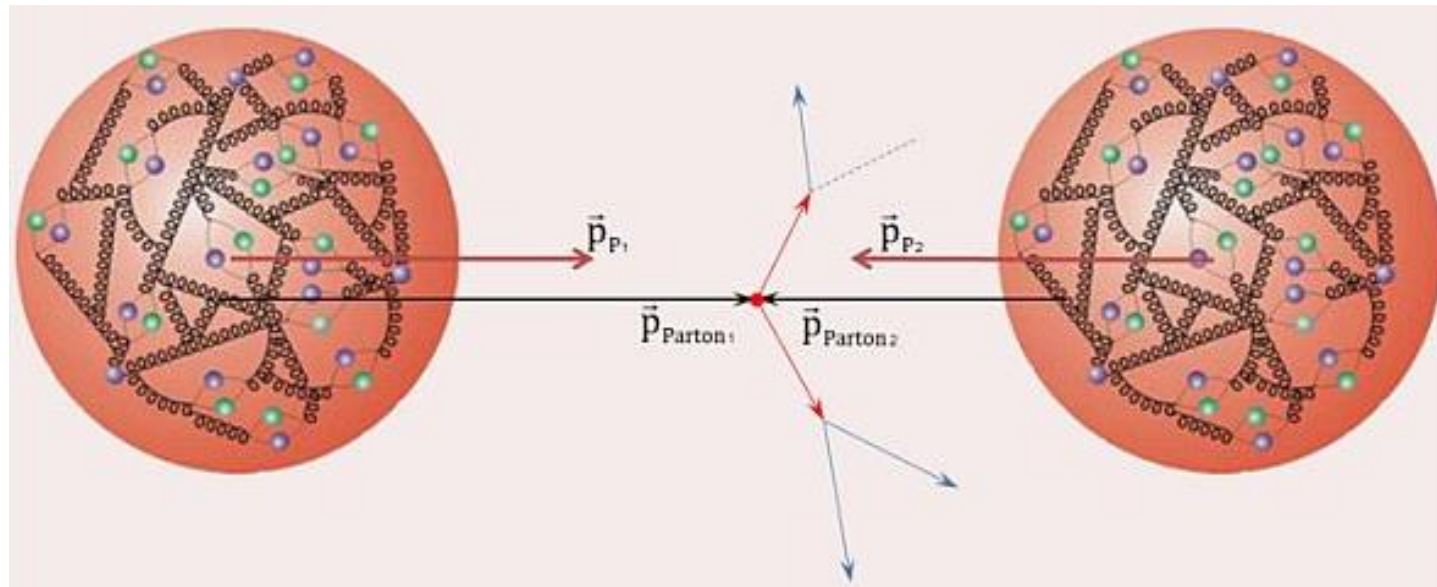
Srážky částic

- Chceme-li něco nového vytvořit, musíme nejprve něco rozbít 😊
- Proton:



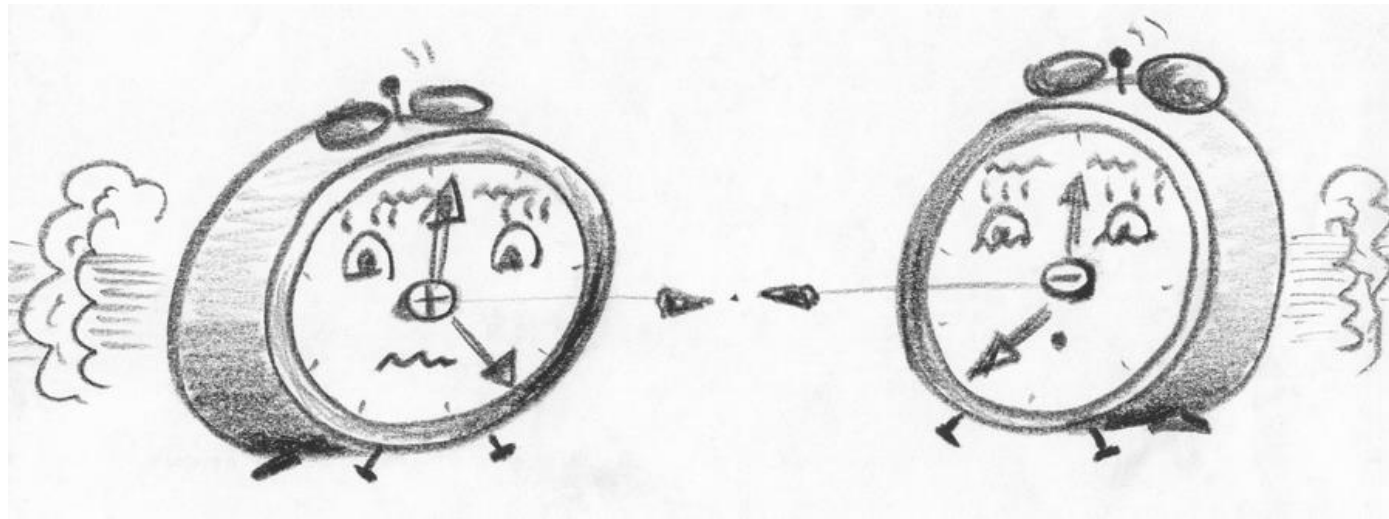
Srážky částic

- Chceme-li něco nového vytvořit, musíme nejprve něco rozbít ☺
- Srážka dvou protonů:



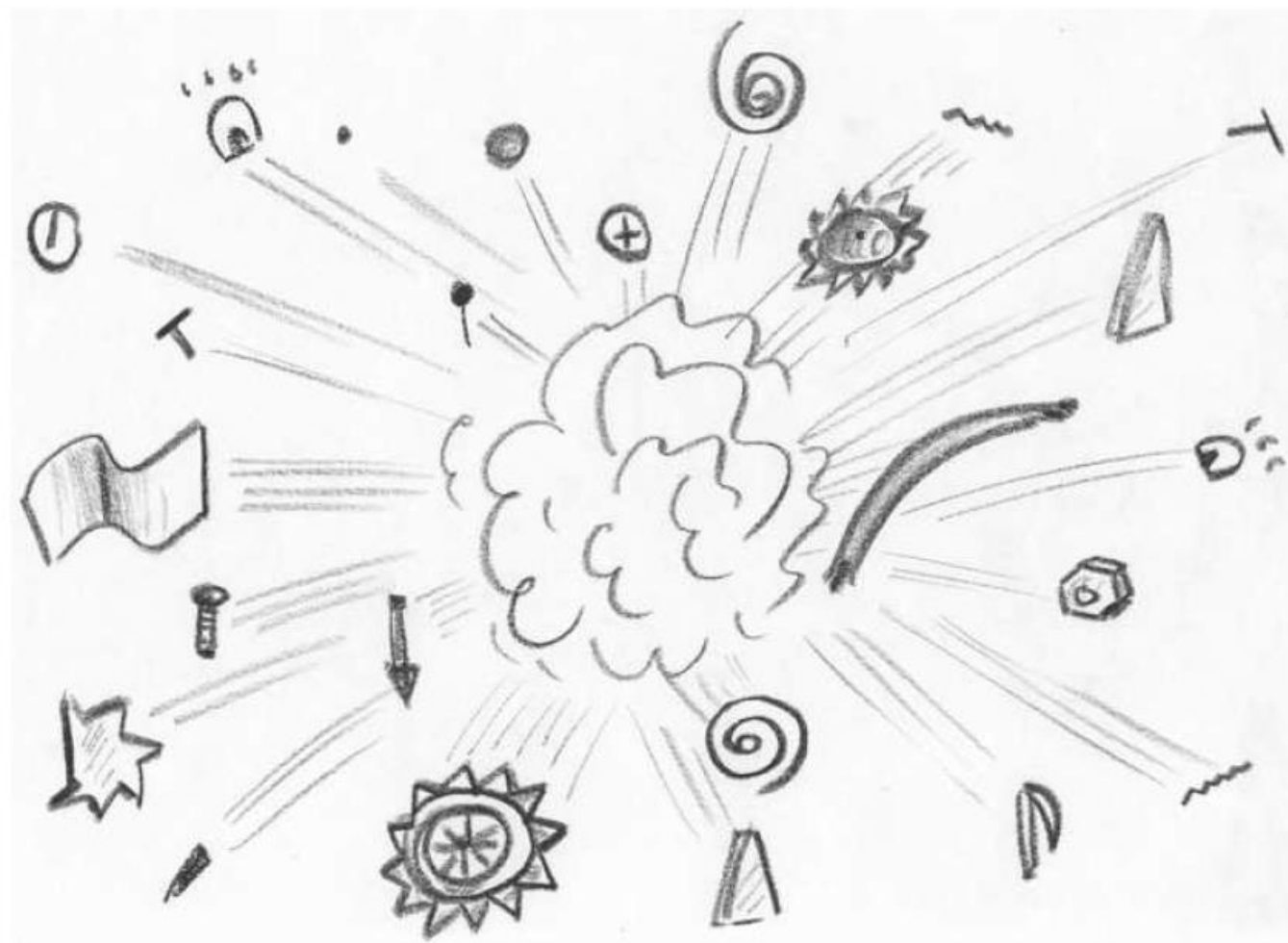
Srážky částic

- Chceme-li něco nového vytvořit, musíme nejprve něco rozbít 😊

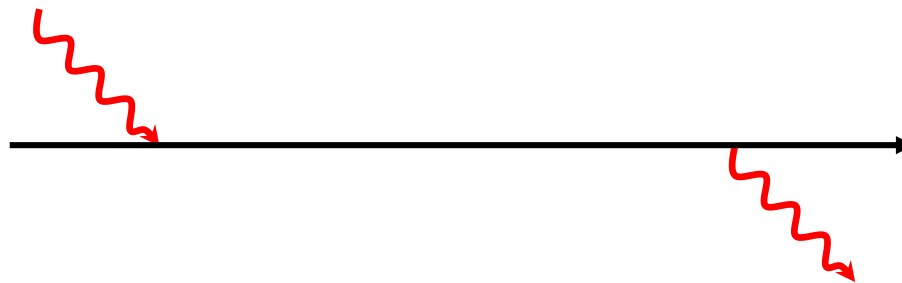
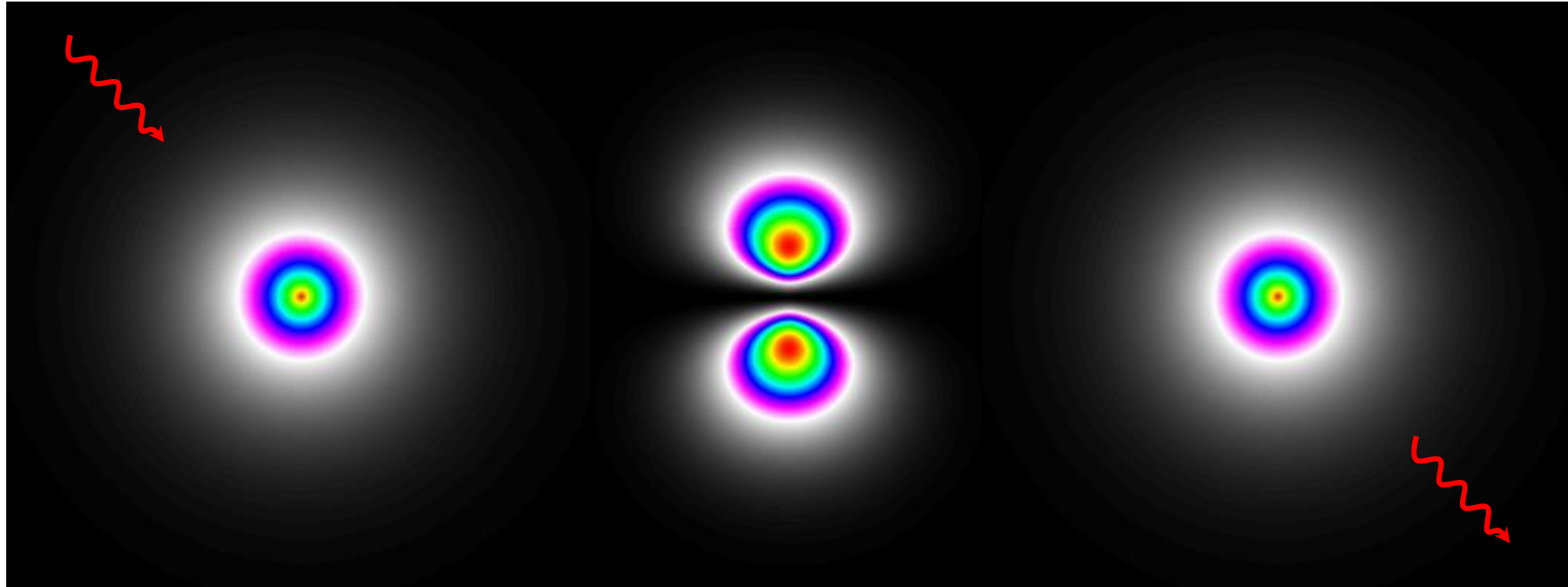


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- Chceme-li něco nového vytvořit, musíme nejprve něco rozbít 😊

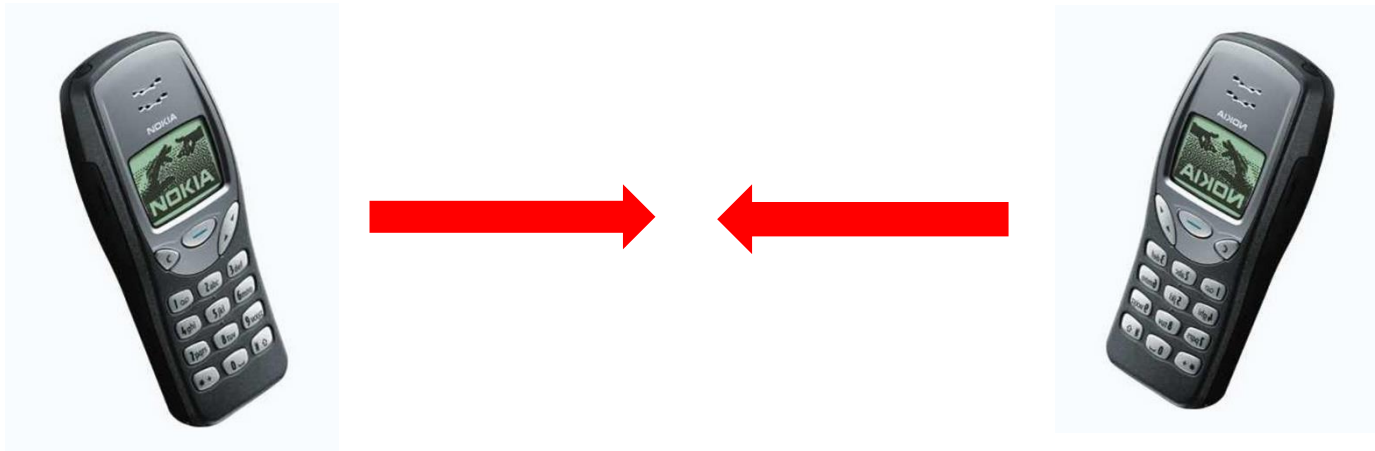


Posvitíme si na atom!



Srážky částic

- Chceme-li něco nového vytvořit, musíme nejprve něco rozbít 😊



Srážky částic

- Chceme-li něco nového vytvořit, musíme nejprve něco rozbít.
- Často se ale nestane skoro nic...



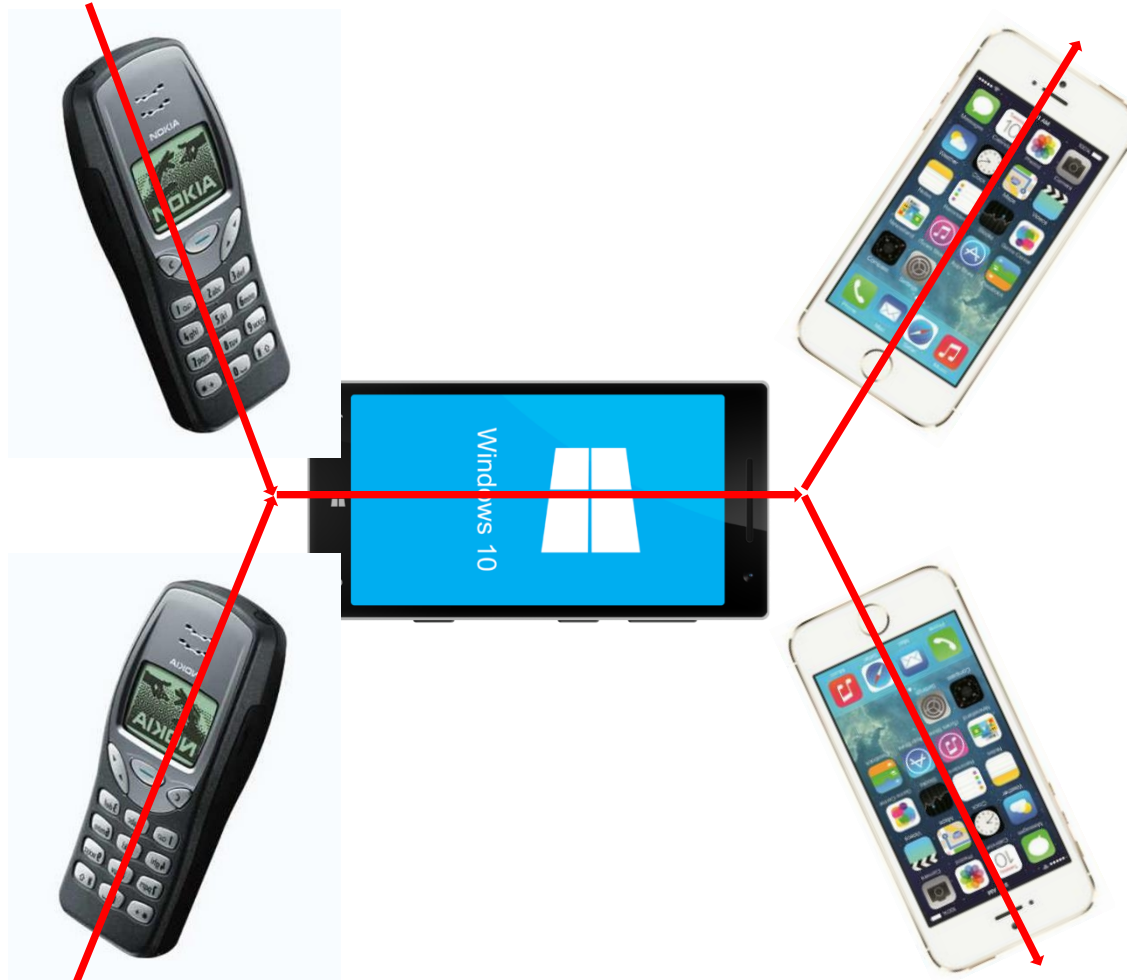
Srážky částic

- Chceme-li něco nového vytvořit, musíme nejprve něco rozbít.
- Ve srážkách ale mohou vznikat částice nové!
- $E = mc^2$



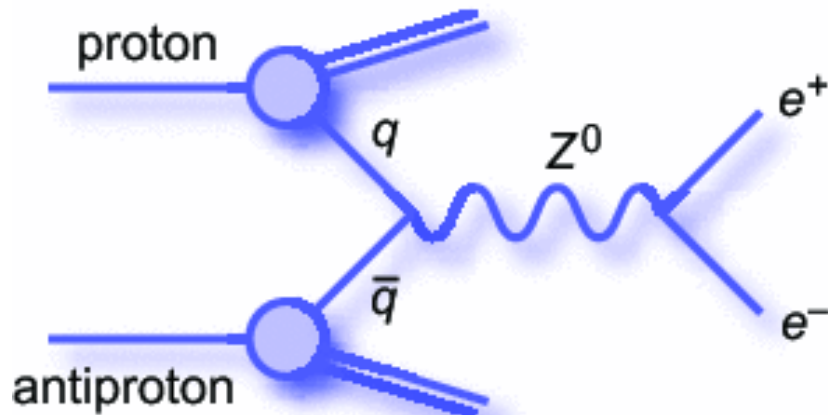
Srážky částic

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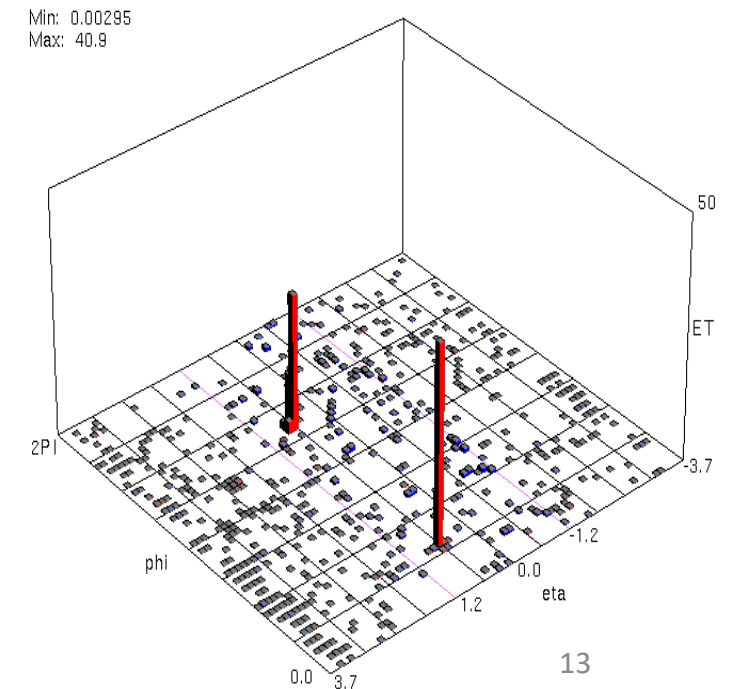
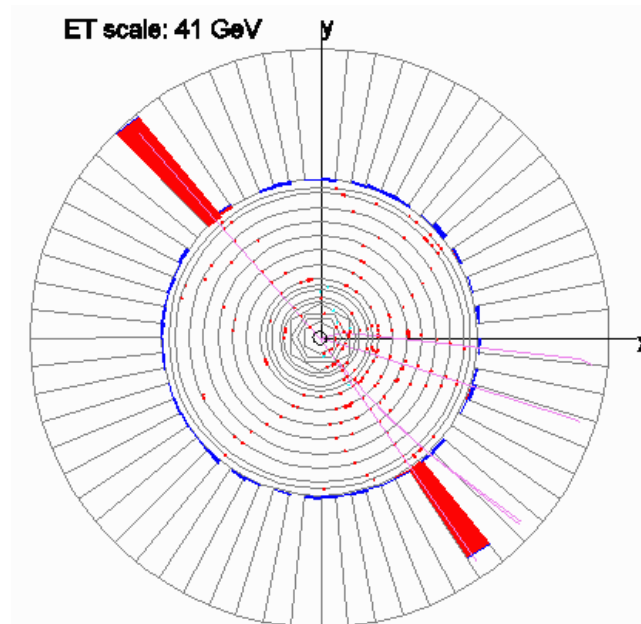


Interakce

- Energie se může přeměnit v hmotu nové těžké částice.
- Zde Z boson \sim těžký foton, nestabilní a rychle se rozpadá.
- $m^2c^4 = E^2 - p^2c^2$

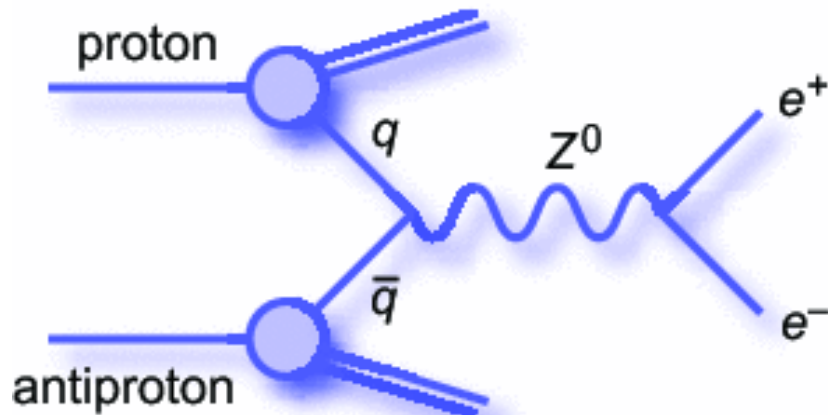


19. 10. 2016

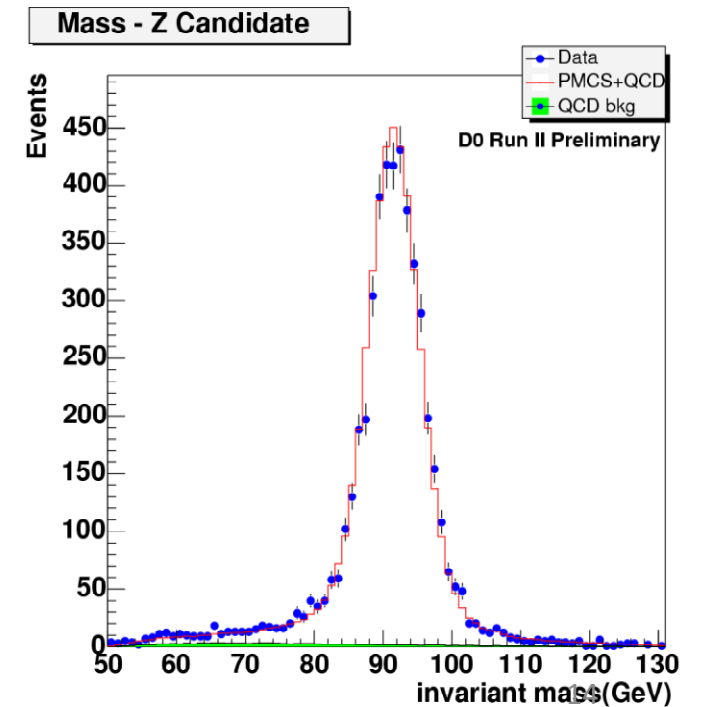
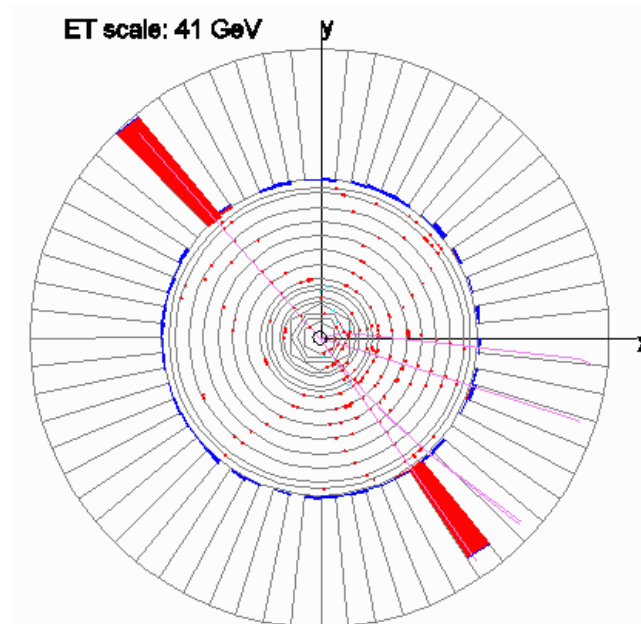


Interakce

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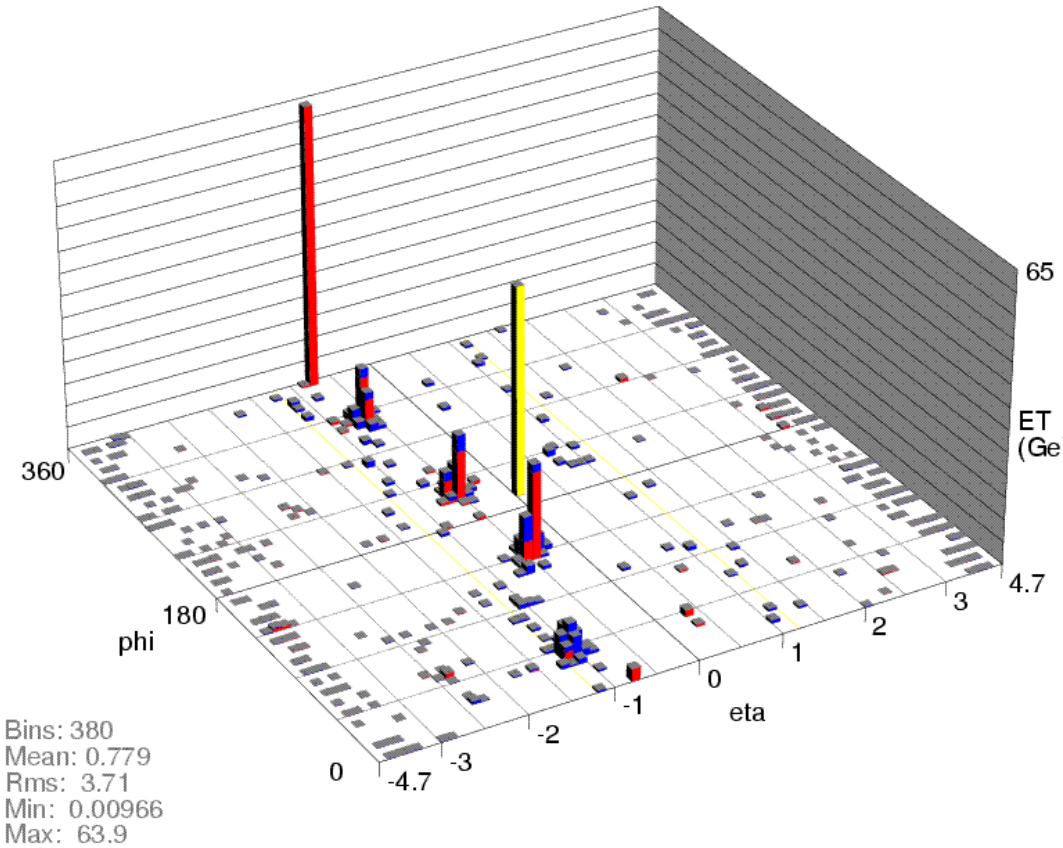
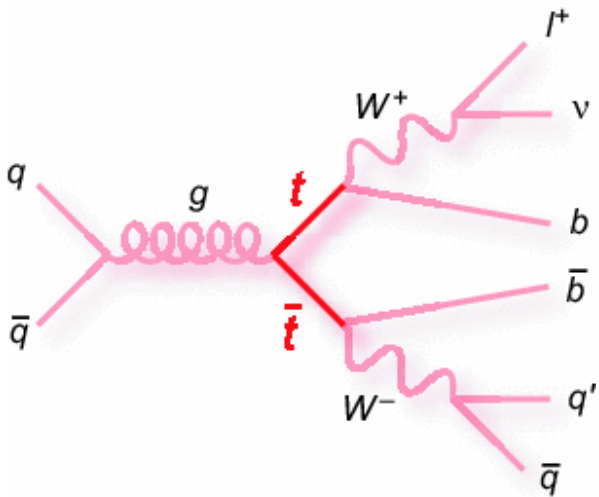


19. 10. 2016

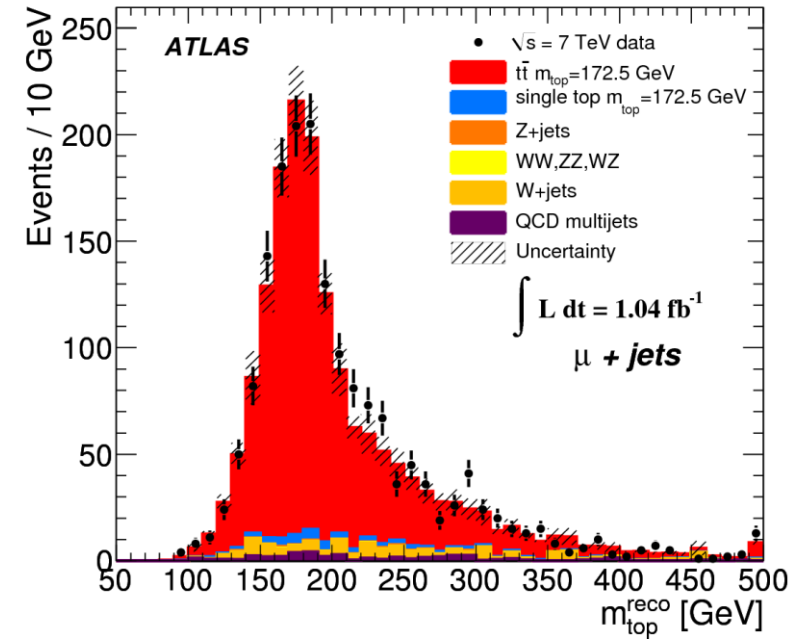


Interakce

- Složitější případ...

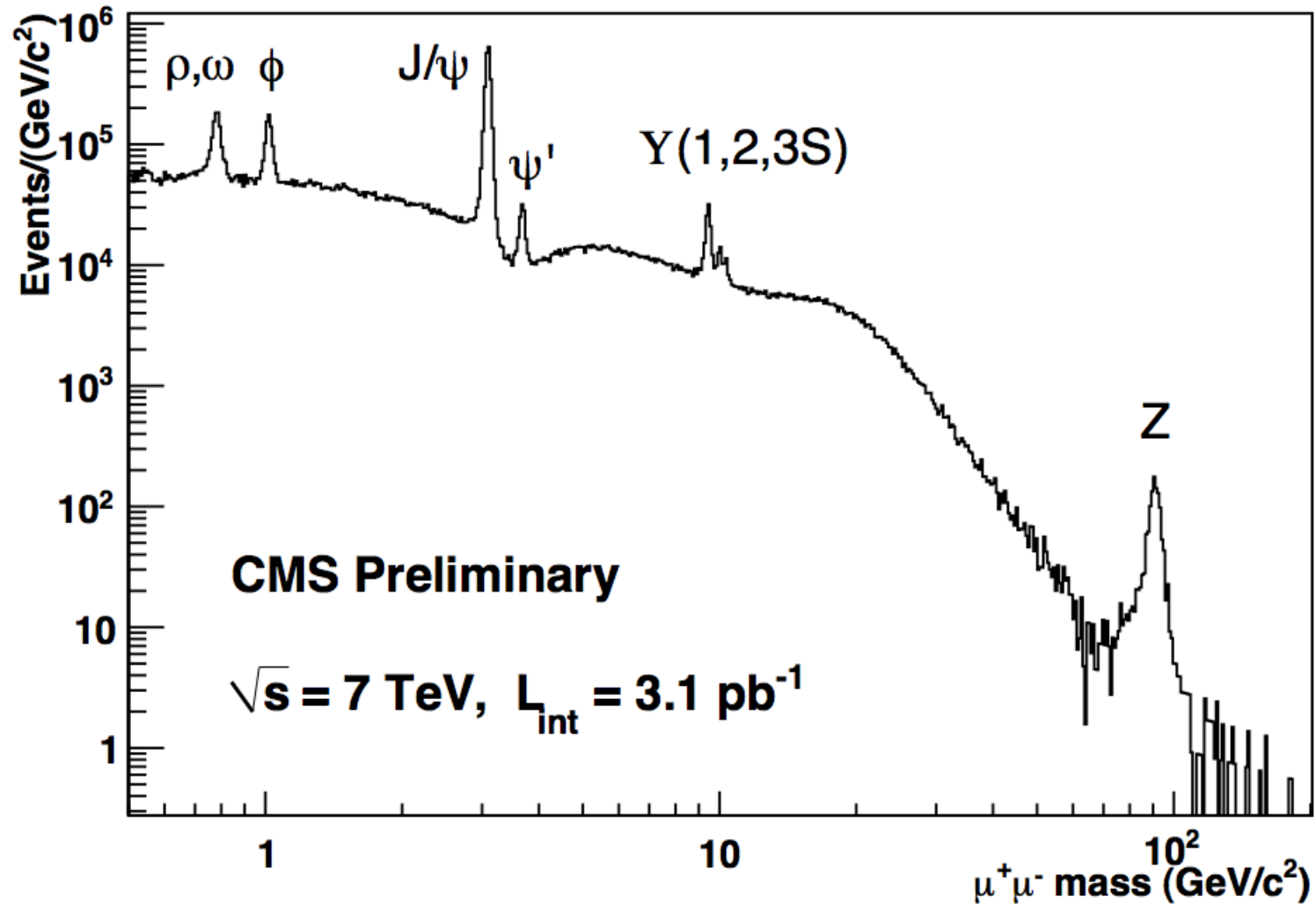


mE_t: 47.2
 phi_t: 195 deg



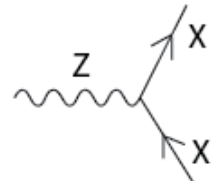
„Částice je kopeček!“

- ...když zkoumám, jak často se něco děje při různé energii.

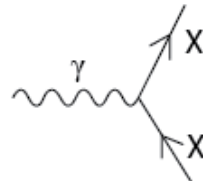


Všecky interakce světa [zatím...]

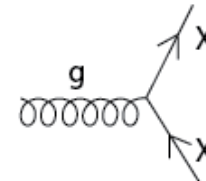
Standard Model Interactions (Forces Mediated by Gauge Bosons)



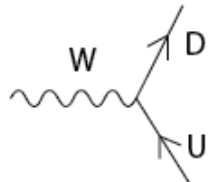
X is any fermion in the Standard Model.



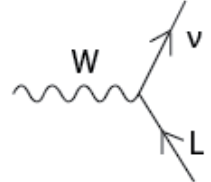
X is electrically charged.



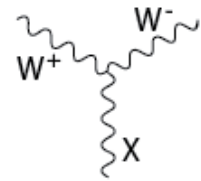
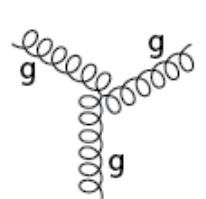
X is any quark.



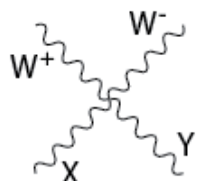
U is a up-type quark;
D is a down-type quark.



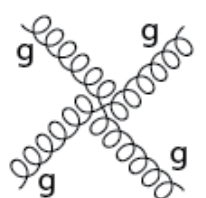
L is a lepton and ν is the corresponding neutrino.



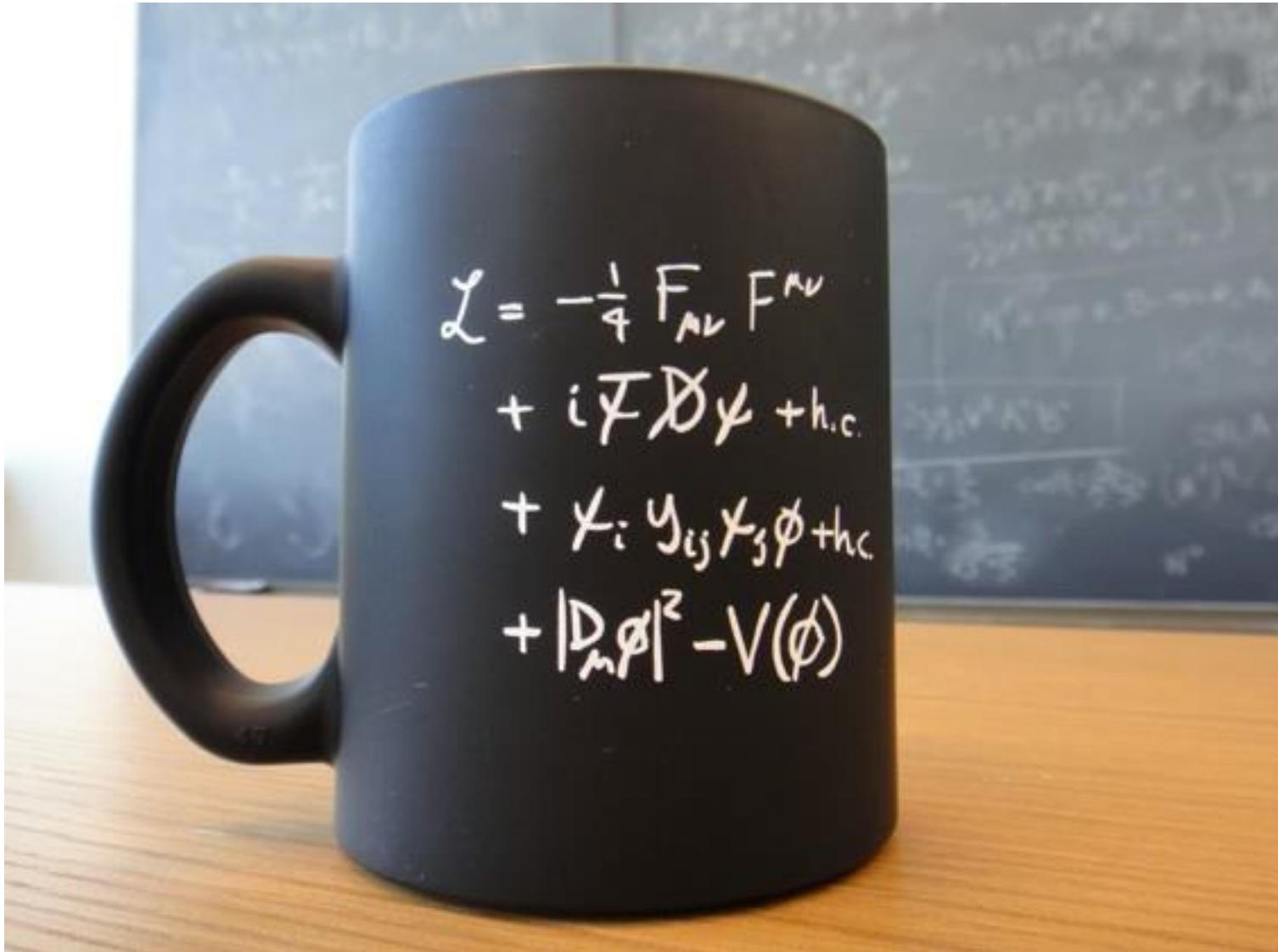
X is a photon or Z-boson.



X and Y are any two electroweak bosons such that charge is conserved.



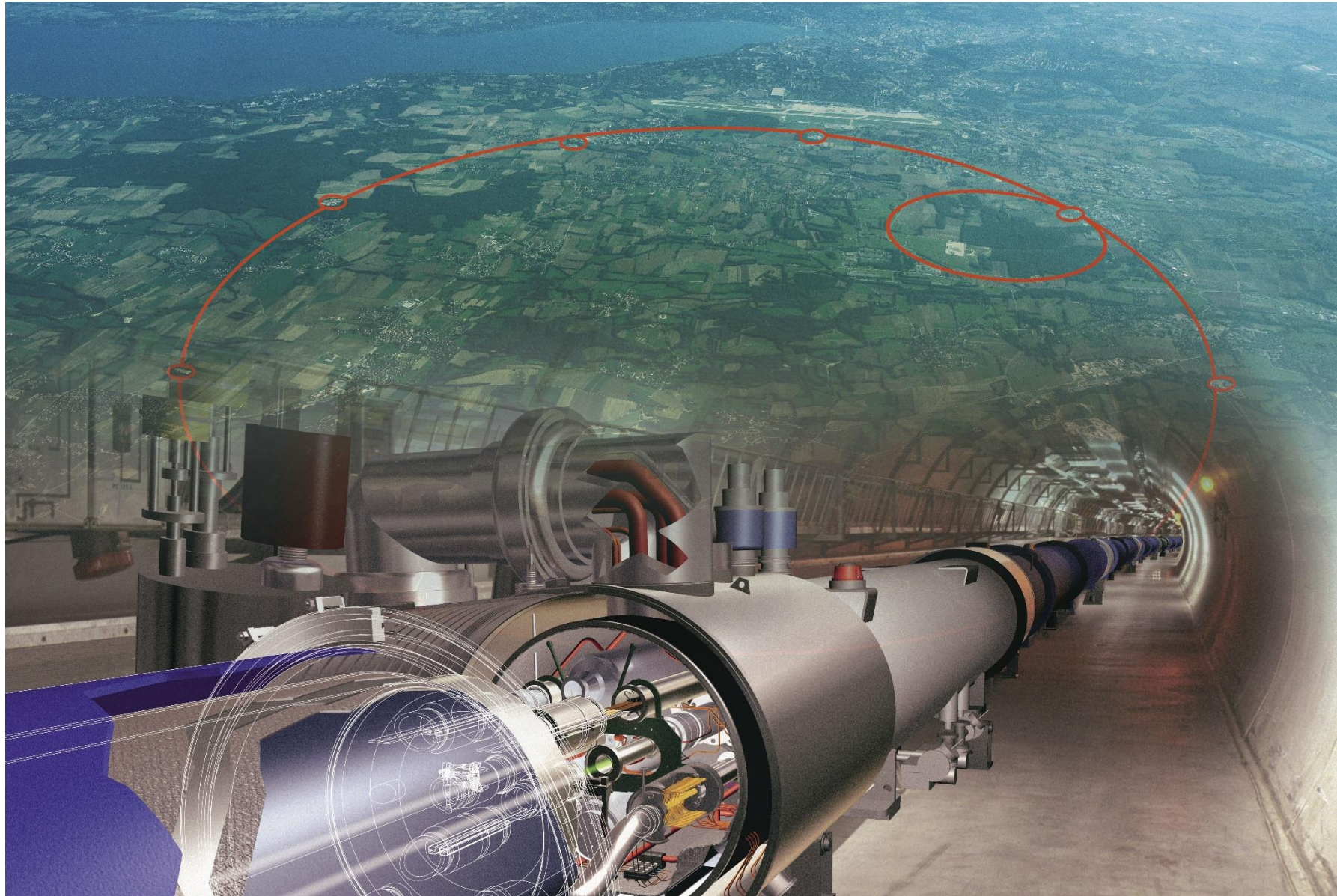
Všecky interakce světa [zatím...]



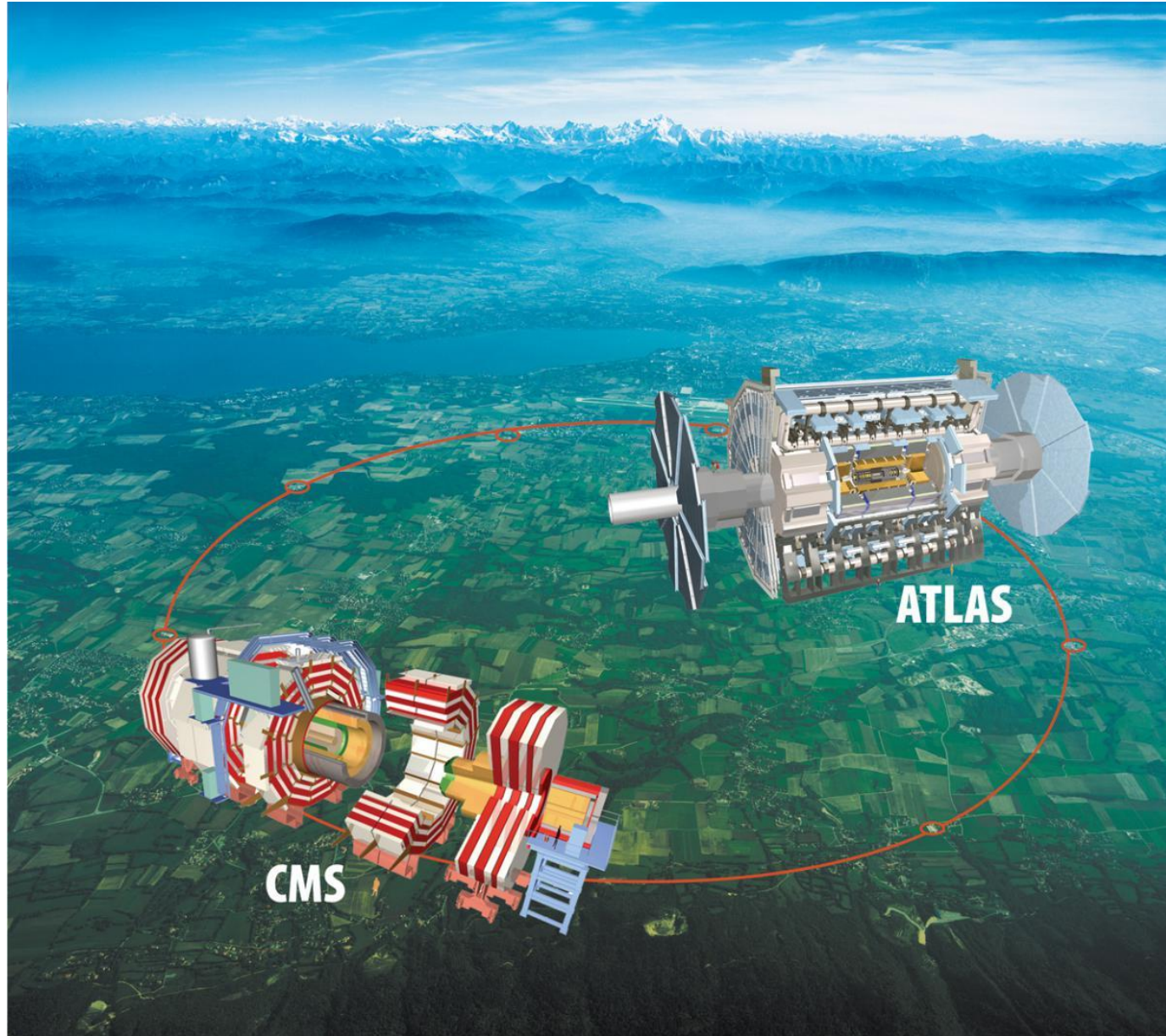
Všecky interakce světa [zatím ve skutečnosti...]

$$\begin{aligned}
 \mathcal{L}_{SM} = & -\frac{1}{2}\partial_\nu g_\mu^a \partial_\nu g_\mu^a - g_s f^{abc} \partial_\mu g_\nu^a g_\mu^b g_\nu^c - \frac{1}{4}g_s^2 f^{abc} f^{ade} g_\mu^b g_\nu^c g_\mu^d g_\nu^e - \partial_\nu W_\mu^+ \partial_\nu W_\mu^- - \\
 & M^2 W_\mu^+ W_\mu^- - \frac{1}{2}\partial_\nu Z_\mu^0 \partial_\nu Z_\mu^0 - \frac{1}{2c_w^2} M^2 Z_\mu^0 Z_\mu^0 - \frac{1}{2}\partial_\mu A_\nu \partial_\mu A_\nu - ig_{c_w} (\partial_\nu Z_\mu^0 (W_\mu^+ W_\mu^- - \\
 & W_\nu^+ W_\nu^-) - Z_\nu^0 (W_\mu^+ \partial_\nu W_\mu^- - W_\mu^- \partial_\nu W_\mu^+) + Z_\mu^0 (W_\nu^+ \partial_\nu W_\mu^- - W_\nu^- \partial_\nu W_\mu^+)) - \\
 & ig_{s_w} (\partial_\nu A_\mu (W_\mu^+ W_\nu^- - W_\nu^+ W_\mu^-) - A_\nu (W_\mu^+ \partial_\nu W_\mu^- - W_\mu^- \partial_\nu W_\mu^+) + A_\mu (W_\nu^+ \partial_\nu W_\mu^- - \\
 & W_\nu^- \partial_\nu W_\mu^+)) - \frac{1}{2}g^2 W_\mu^+ W_\nu^- W_\nu^+ W_\mu^- + \frac{1}{2}g^2 W_\mu^+ W_\nu^- W_\mu^- W_\nu^+ + g^2 c_w^2 (Z_\mu^0 W_\mu^+ Z_\nu^0 W_\nu^- - \\
 & Z_\mu^0 Z_\nu^0 W_\mu^+ W_\nu^-) + g^2 s_w^2 (A_\mu W_\mu^+ A_\nu W_\nu^- - A_\mu A_\nu W_\mu^+ W_\nu^-) + g^2 s_w c_w (A_\mu Z_\nu^0 (W_\mu^+ W_\nu^- - \\
 & W_\nu^+ W_\mu^-) - 2A_\mu Z_\mu^0 W_\nu^+ W_\nu^-) - \frac{1}{2}\partial_\mu H \partial_\mu H - 2M^2 \alpha_h H^2 - \partial_\mu \phi^+ \partial_\mu \phi^- - \frac{1}{2}\partial_\mu \phi^0 \partial_\mu \phi^0 - \\
 & \beta_h \left(\frac{2M^2}{g^2} + \frac{2M}{g} H + \frac{1}{2}(H^2 + \phi^0 \phi^0 + 2\phi^+ \phi^-) \right) + \frac{2M^4}{g^2} \alpha_h - \\
 & g\alpha_h M (H^3 + H\phi^0 \phi^0 + 2H\phi^+ \phi^-) - \\
 & \frac{1}{8}g^2 \alpha_h (H^4 + (\phi^0)^4 + 4(\phi^+ \phi^-)^2 + 4(\phi^0)^2 \phi^+ \phi^- + 4H^2 \phi^+ \phi^- + 2(\phi^0)^2 H^2) - \\
 & gM W_\mu^+ W_\mu^- H - \frac{1}{2}g \frac{M}{c_w^2} Z_\mu^0 Z_\mu^0 H - \\
 & \frac{1}{2}ig (W_\mu^+ (\phi^0 \partial_\mu \phi^- - \phi^- \partial_\mu \phi^0) - W_\mu^- (\phi^0 \partial_\mu \phi^+ - \phi^+ \partial_\mu \phi^0)) + \\
 & \frac{1}{2}g (W_\mu^+ (H \partial_\mu \phi^- - \phi^- \partial_\mu H) + W_\mu^- (H \partial_\mu \phi^+ - \phi^+ \partial_\mu H)) + \frac{1}{2}g \frac{1}{c_w} (Z_\mu^0 (H \partial_\mu \phi^0 - \phi^0 \partial_\mu H) + \\
 & M (\frac{1}{c_w} Z_\mu^0 \partial_\mu \phi^0 + W_\mu^+ \partial_\mu \phi^- + W_\mu^- \partial_\mu \phi^+)) - ig \frac{s_w^2}{c_w} M Z_\mu^0 (W_\mu^+ \phi^- - W_\mu^- \phi^+) + ig_{s_w} M A_\mu (W_\mu^+ \phi^- - \\
 & W_\mu^- \phi^+) - ig \frac{1-2c_w^2}{2c_w} Z_\mu^0 (\phi^+ \partial_\mu \phi^- - \phi^- \partial_\mu \phi^+) + ig_{s_w} A_\mu (\phi^+ \partial_\mu \phi^- - \phi^- \partial_\mu \phi^+) - \\
 & \frac{1}{4}g^2 W_\mu^+ W_\mu^- (H^2 + (\phi^0)^2 + 2\phi^+ \phi^-) - \frac{1}{8}g^2 \frac{1}{c_w^2} Z_\mu^0 Z_\mu^0 (H^2 + (\phi^0)^2 + 2(2s_w^2 - 1)^2 \phi^+ \phi^-) - \\
 & \frac{1}{2}g^2 \frac{s_w^2}{c_w} Z_\mu^0 \phi^0 (W_\mu^+ \phi^- + W_\mu^- \phi^+) - \frac{1}{2}ig^2 \frac{s_w^2}{c_w} Z_\mu^0 H (W_\mu^+ \phi^- - W_\mu^- \phi^+) + \frac{1}{2}g^2 s_w A_\mu \phi^0 (W_\mu^+ \phi^- + \\
 & W_\mu^- \phi^+) + \frac{1}{2}ig^2 s_w A_\mu H (W_\mu^+ \phi^- - W_\mu^- \phi^+) - g^2 \frac{s_w}{c_w} (2c_w^2 - 1) Z_\mu^0 A_\mu \phi^+ \phi^- - \\
 & g^2 s_w^2 A_\mu A_\nu \phi^+ \phi^- + \frac{1}{2}ig_s \lambda_{ij}^a (\bar{q}_i^\mu \gamma^\mu q_j^\mu) g_\mu^a - \bar{e}^\lambda (\gamma \partial + m_e^\lambda) e^\lambda - \bar{\nu}^\lambda (\gamma \partial + m_\nu^\lambda) \nu^\lambda - \bar{u}_j^\lambda (\gamma \partial + \\
 & m_u^\lambda) u_j^\lambda - \bar{d}_j^\lambda (\gamma \partial + m_d^\lambda) d_j^\lambda + ig_{s_w} A_\mu (-\bar{e}^\lambda \gamma^\mu e^\lambda) + \frac{2}{3}(\bar{u}_j^\lambda \gamma^\mu u_j^\lambda) - \frac{1}{3}(\bar{d}_j^\lambda \gamma^\mu d_j^\lambda) + \\
 & \frac{ig}{4c_w} Z_\mu^0 (\bar{\nu}^\lambda \gamma^\mu (1 + \gamma^5) \nu^\lambda) + (\bar{e}^\lambda \gamma^\mu (4s_w^2 - 1 - \gamma^5) e^\lambda) + (\bar{d}_j^\lambda \gamma^\mu (\frac{4}{3}s_w^2 - 1 - \gamma^5) d_j^\lambda) + \\
 & (\bar{u}_j^\lambda \gamma^\mu (1 - \frac{8}{3}s_w^2 + \gamma^5) u_j^\lambda) \} + \frac{ig}{2\sqrt{2}} W_\mu^+ ((\bar{\nu}^\lambda \gamma^\mu (1 + \gamma^5) U^{lep}{}_{\lambda\kappa} e^\kappa) + (\bar{u}_j^\lambda \gamma^\mu (1 + \gamma^5) C_{\lambda\kappa} d_j^\kappa)) + \\
 & \frac{ig}{2\sqrt{2}} W_\mu^- ((\bar{e}^\kappa U^{lep}{}_{\kappa\lambda}^\dagger \gamma^\mu (1 + \gamma^5) \nu^\lambda) + (\bar{d}_j^\kappa C_{\kappa\lambda}^\dagger \gamma^\mu (1 + \gamma^5) u_j^\lambda)) + \\
 & \frac{ig}{2M\sqrt{2}} \phi^+ (-m_e^\kappa (\bar{\nu}^\lambda U^{lep}{}_{\lambda\kappa} (1 - \gamma^5) e^\kappa) + m_\nu^\lambda (\bar{\nu}^\lambda U^{lep}{}_{\lambda\kappa} (1 + \gamma^5) e^\kappa) + \\
 & \frac{ig}{2M\sqrt{2}} \phi^- (m_e^\lambda (\bar{e}^\lambda U^{lep}{}_{\lambda\kappa}^\dagger (1 + \gamma^5) \nu^\kappa) - m_\nu^\kappa (\bar{e}^\lambda U^{lep}{}_{\lambda\kappa}^\dagger (1 - \gamma^5) \nu^\kappa) - \frac{g}{2} \frac{m_e^\lambda}{M} H (\bar{\nu}^\lambda \nu^\lambda) - \\
 & \frac{g}{2} \frac{m_c^\lambda}{M} H (\bar{e}^\lambda e^\lambda) + \frac{ig}{2} \frac{m_c^\lambda}{M} \phi^0 (\bar{\nu}^\lambda \gamma^5 \nu^\lambda) - \frac{ig}{2} \frac{m_c^\lambda}{M} \phi^0 (\bar{e}^\lambda \gamma^5 e^\lambda) - \frac{1}{4} \bar{\nu}_\lambda M_{\lambda\kappa}^R (1 - \gamma_5) \bar{\nu}_\kappa - \\
 & \frac{1}{4} \bar{\nu}_\lambda M_{\lambda\kappa}^R (1 - \gamma_5) \bar{\nu}_\kappa + \frac{ig}{2M\sqrt{2}} \phi^+ (-m_d^\kappa (\bar{u}_j^\lambda C_{\lambda\kappa} (1 - \gamma^5) d_j^\kappa) + m_u^\lambda (\bar{u}_j^\lambda C_{\lambda\kappa} (1 + \gamma^5) d_j^\kappa) + \\
 & \frac{ig}{2M\sqrt{2}} \phi^- (m_d^\lambda (\bar{d}_j^\lambda C_{\lambda\kappa}^\dagger (1 + \gamma^5) u_j^\kappa) - m_u^\kappa (\bar{d}_j^\lambda C_{\lambda\kappa}^\dagger (1 - \gamma^5) u_j^\kappa) - \frac{g}{2} \frac{m_\lambda^\lambda}{M} H (\bar{u}_j^\lambda u_j^\lambda) - \\
 & \frac{g}{2} \frac{m_\lambda^\lambda}{M} H (\bar{d}_j^\lambda d_j^\lambda) + \frac{ig}{2} \frac{m_\lambda^\lambda}{M} \phi^0 (\bar{u}_j^\lambda \gamma^5 u_j^\lambda) - \frac{ig}{2} \frac{m_\lambda^\lambda}{M} \phi^0 (\bar{d}_j^\lambda \gamma^5 d_j^\lambda) + \bar{G}^a \partial^2 G^a + g_s f^{abc} \partial_\mu \bar{G}^a G^b g_\mu^c + \\
 & \bar{X}^+ (\partial^2 - M^2) X^+ + \bar{X}^- (\partial^2 - M^2) X^- + \bar{X}^0 (\partial^2 - \frac{M^2}{c_w^2}) X^0 + \bar{Y} \partial^2 Y + ig_{c_w} W_\mu^+ (\partial_\mu \bar{X}^0 X^- - \\
 & \partial_\mu \bar{X}^+ X^0) + ig_{s_w} W_\mu^+ (\partial_\mu \bar{Y} X^- - \partial_\mu \bar{X}^+ Y) + ig_{c_w} W_\mu^- (\partial_\mu \bar{X}^- X^0 - \\
 & \partial_\mu \bar{X}^0 X^+) + ig_{s_w} W_\mu^- (\partial_\mu \bar{X}^- Y - \partial_\mu \bar{Y} X^+) + ig_{c_w} Z_\mu^0 (\partial_\mu \bar{X}^+ X^+ - \\
 & \partial_\mu \bar{X}^- X^-) + ig_{s_w} A_\mu (\partial_\mu \bar{X}^+ X^+ - \\
 & \partial_\mu \bar{X}^- X^-) - \frac{1}{2}gM (\bar{X}^+ X^+ H + \bar{X}^- X^- H + \frac{1}{c_w} \bar{X}^0 X^0 H) + \frac{1-2c_w^2}{2c_w} igM (\bar{X}^+ X^0 \phi^+ - \bar{X}^- X^0 \phi^-) + \\
 & \frac{1}{2c_w} igM (\bar{X}^0 X^- \phi^+ - \bar{X}^0 X^+ \phi^-) + igM s_w (\bar{X}^0 X^- \phi^+ - \bar{X}^0 X^+ \phi^-) + \\
 & \frac{1}{2}igM (\bar{X}^+ X^+ \phi^0 - \bar{X}^- X^- \phi^0) .
 \end{aligned}$$


CERN: laboratoř „ $E = mc^2$ “



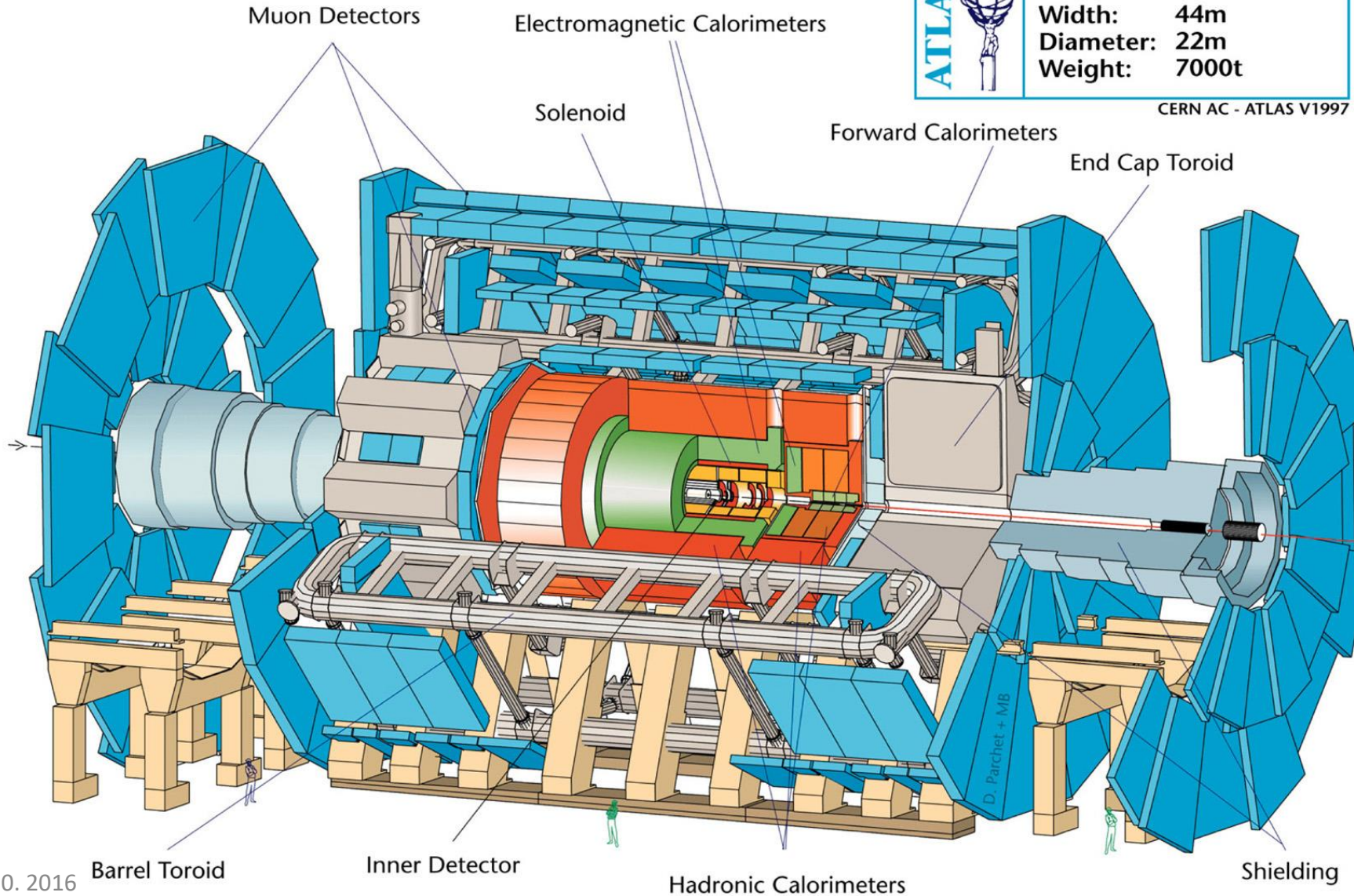
CERN – Evropské centrum (sub)jaderného výzkumu




Experiment ATLAS

ATLAS 	Detector characteristics	
	Width:	44m
	Diameter:	22m
	Weight:	7000t

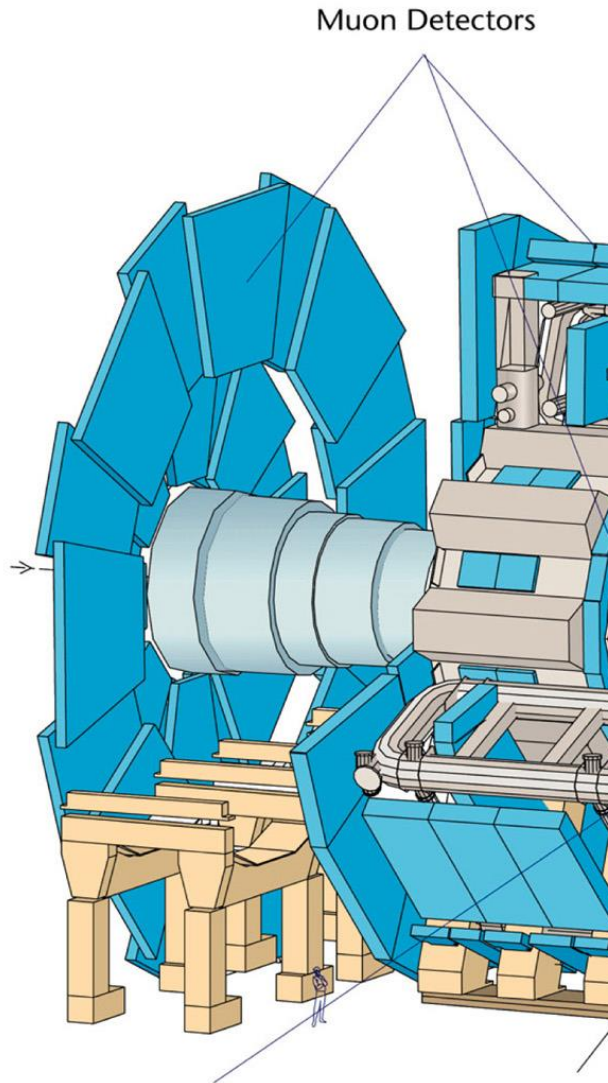
CERN AC - ATLAS V1997



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CERN AC - ATLAS V1997

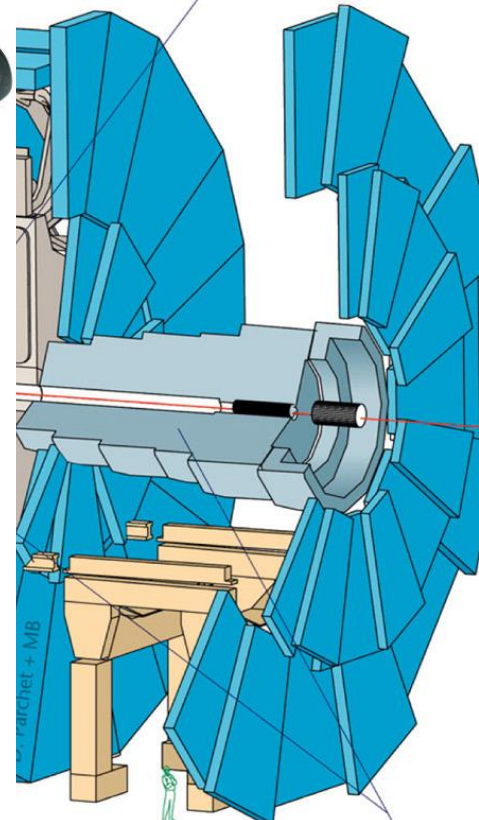


Electromagnetic Calorimeters


Solenoid

Forward Calorimeters

End Cap Toroid



Experiment ATLAS

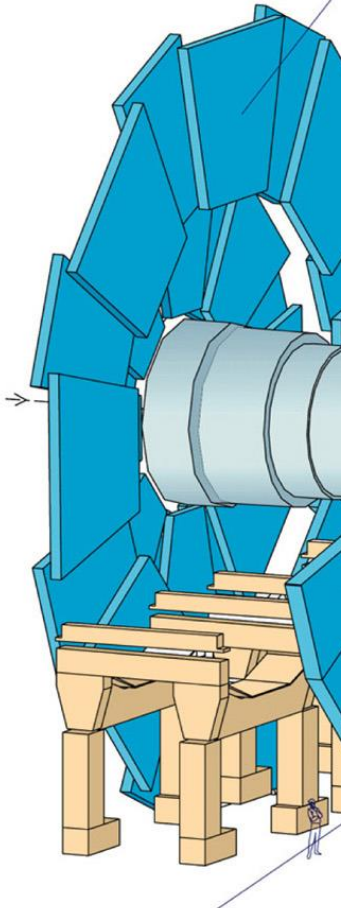
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CERN AC - ATLAS V1997

Muon Detectors

Electromagnetic Calorimeters

Solenoid

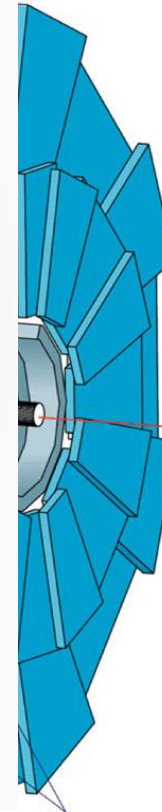


Barrel Toroid



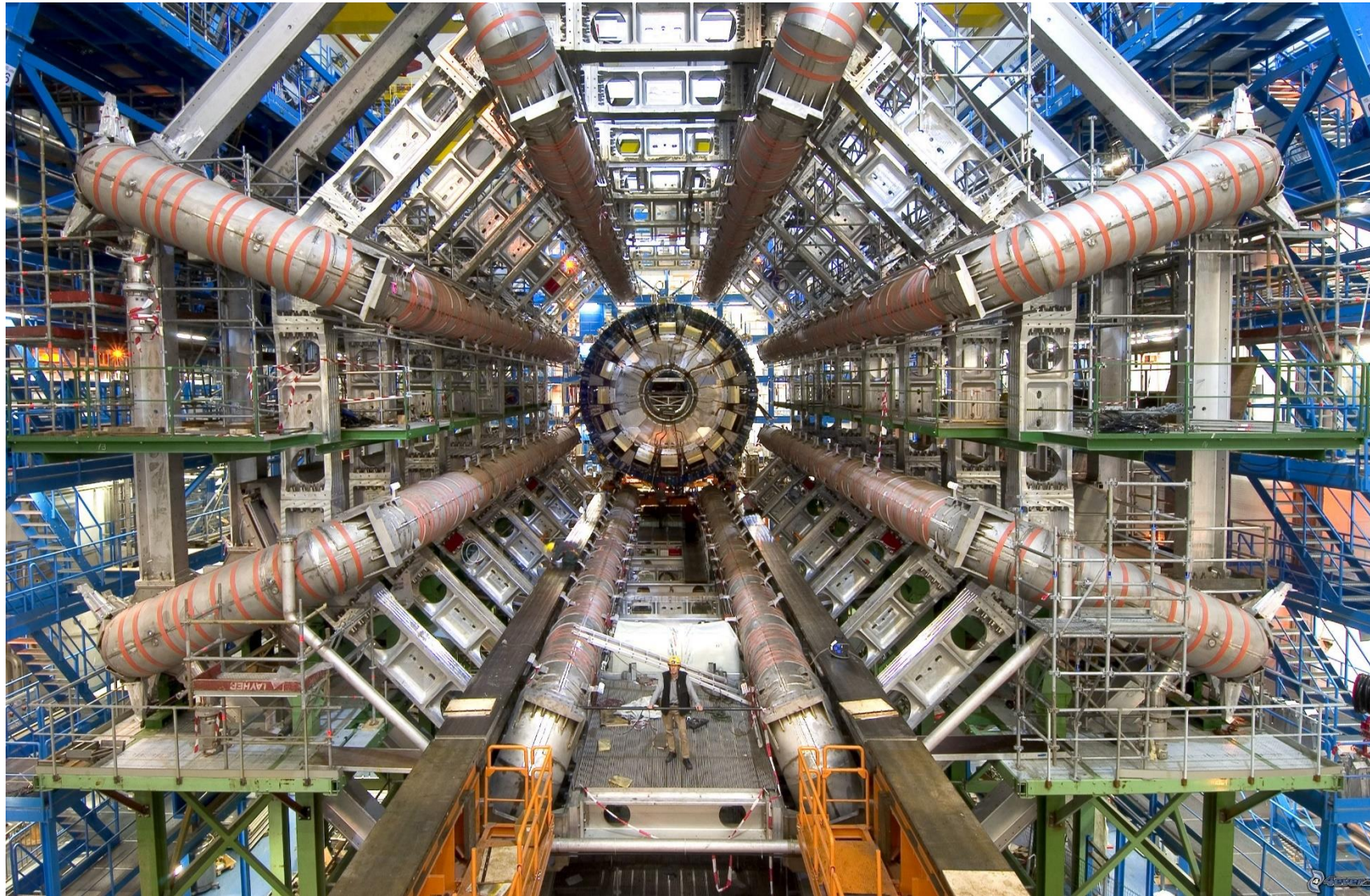
Inner Detector

Hadronic Calorimeters

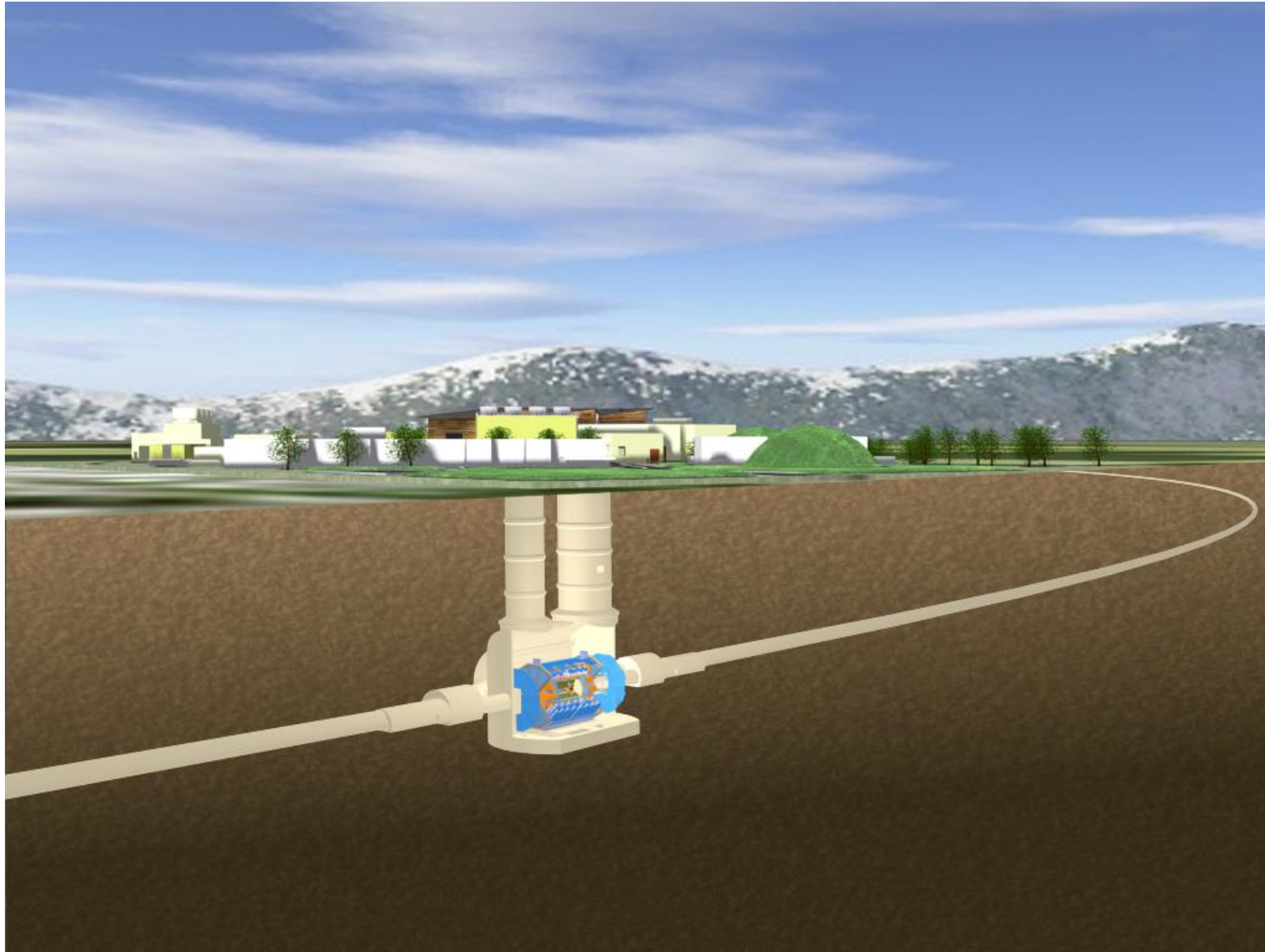


Shielding

Experiment ATLAS



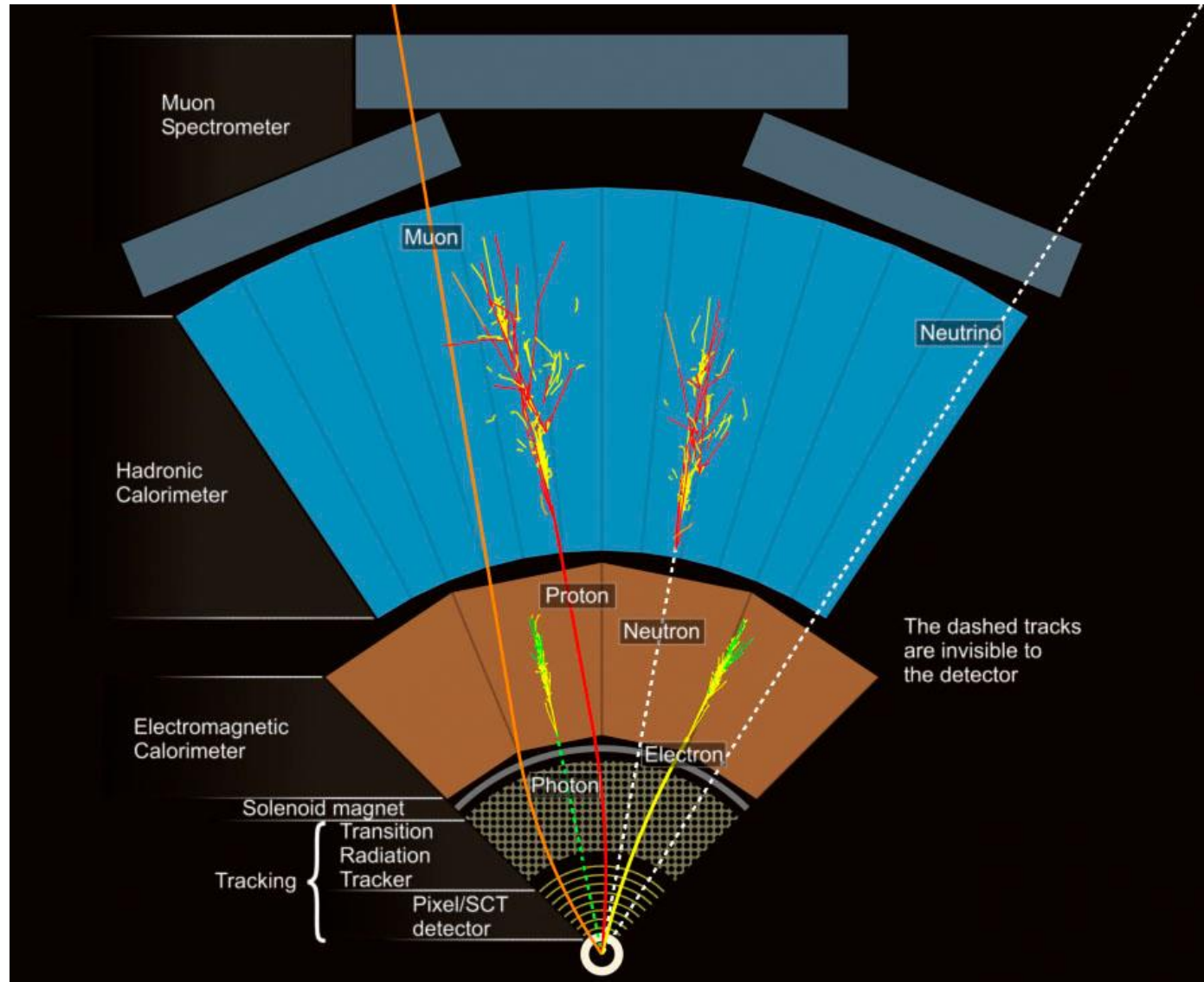
Experiment ATLAS



Experiment ATLAS



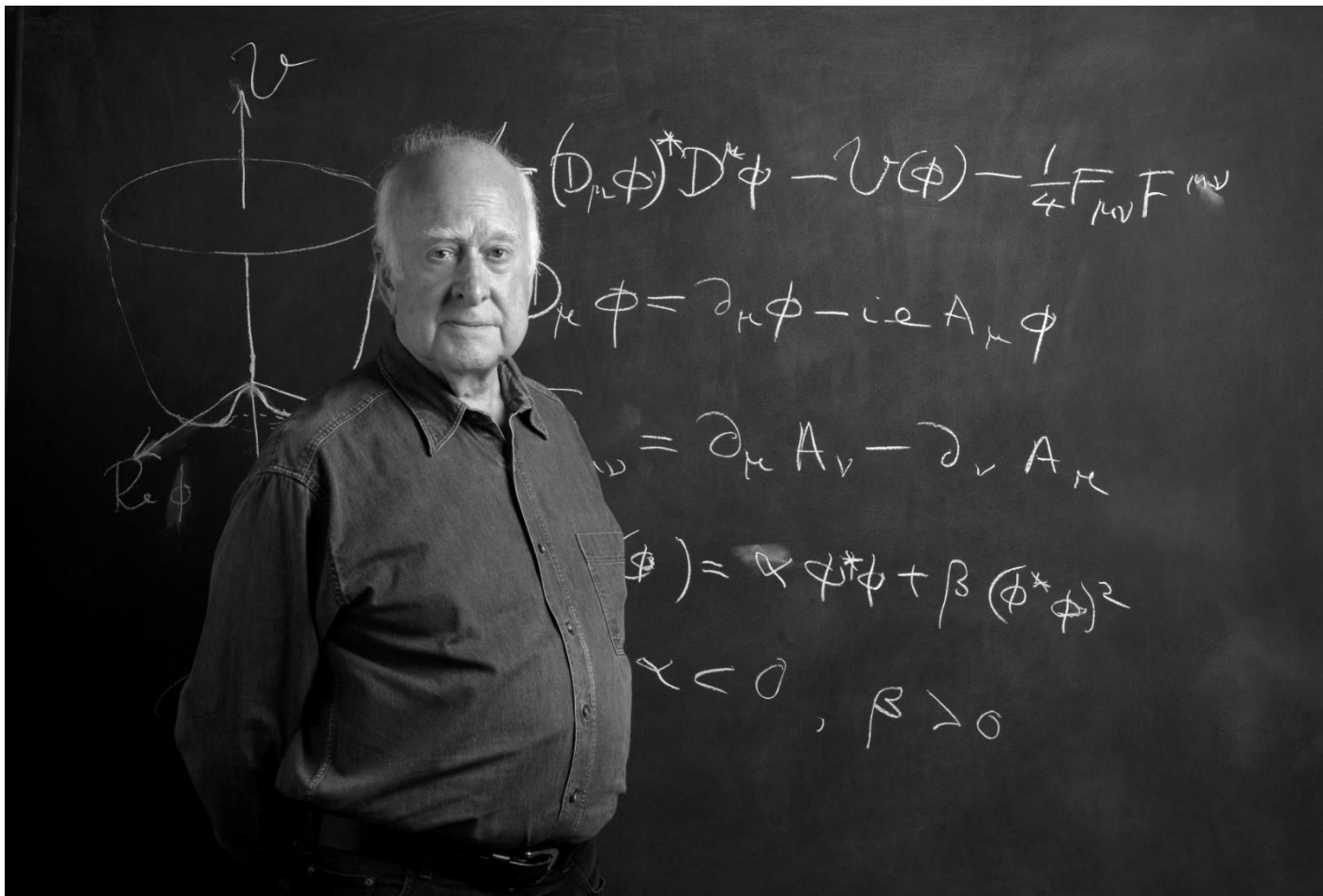
Jak ATLAS vidí částice



Higgs :: Peter Higgs

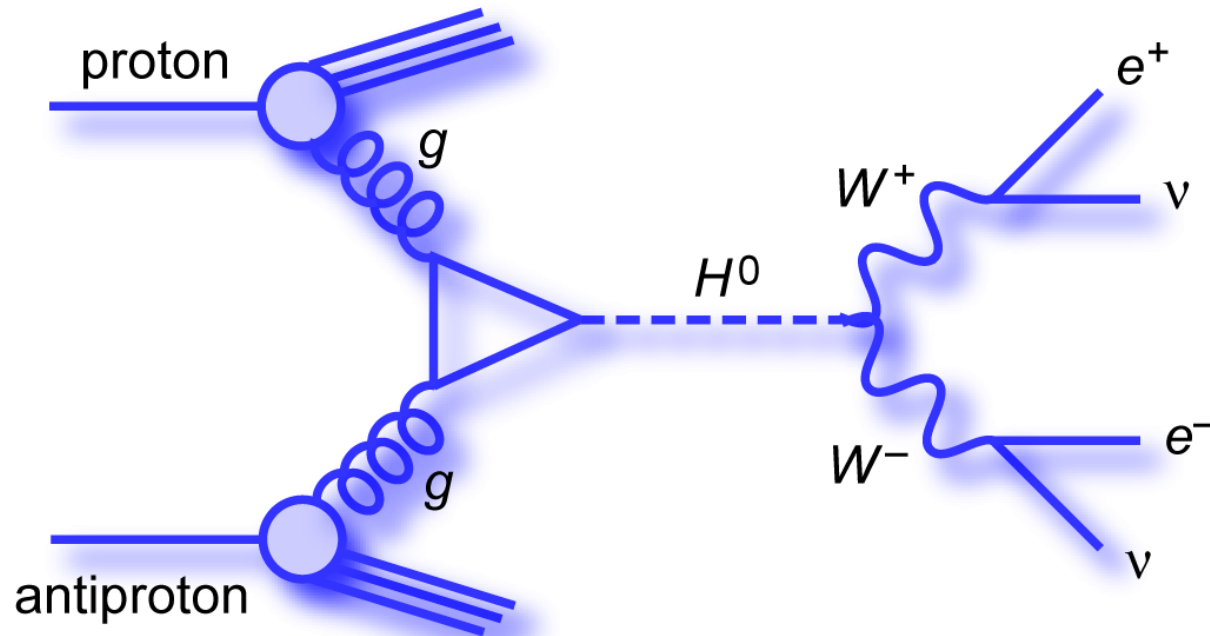
- Teorie „z hrnečku“ funguje pro nehmotné částice...
- Jak částicím v teorii dodat hmotnost?

$$\mathcal{L} = -\frac{1}{4} F_{\mu\nu} F^{\mu\nu} + i\bar{\psi}\not{D}\psi + \text{h.c.}$$

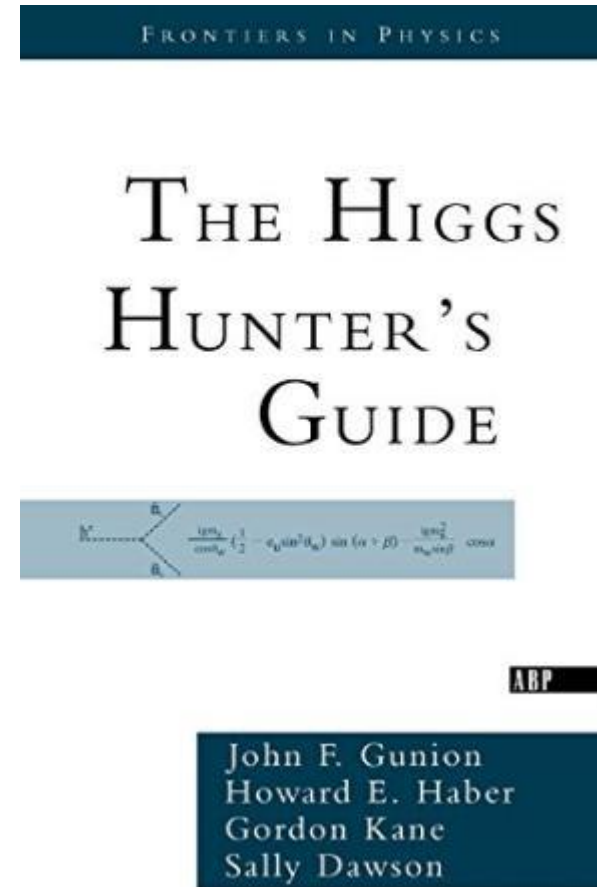
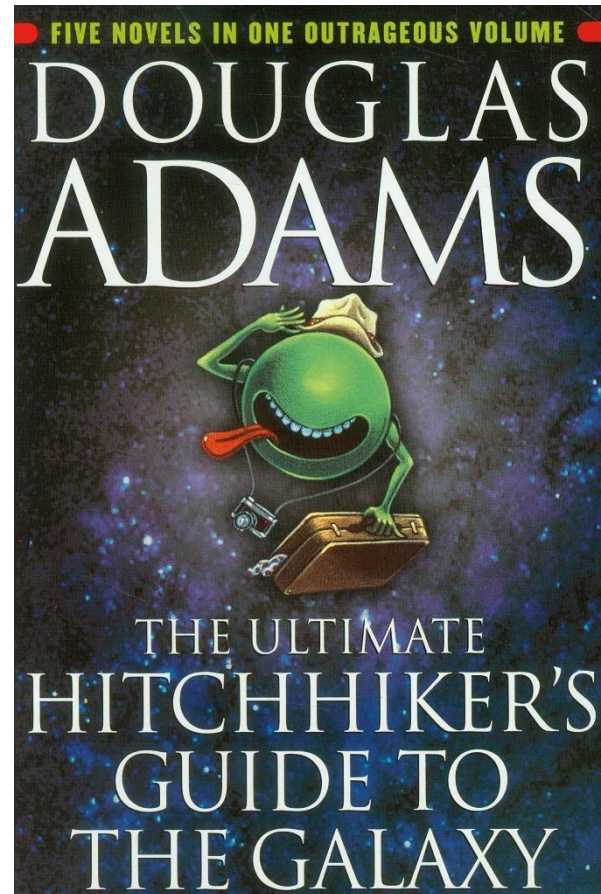


Higgsův boson

- Interakcí s Higgsovým polem získávají částice hmotnost (r. 1964).
- Bonus: Teorie předpovídá novou částici (Higgs), ale neříká, jak těžkou.
- Čekajme tedy někde kopeček, ale hledějme, jestli vůbec, a kde.

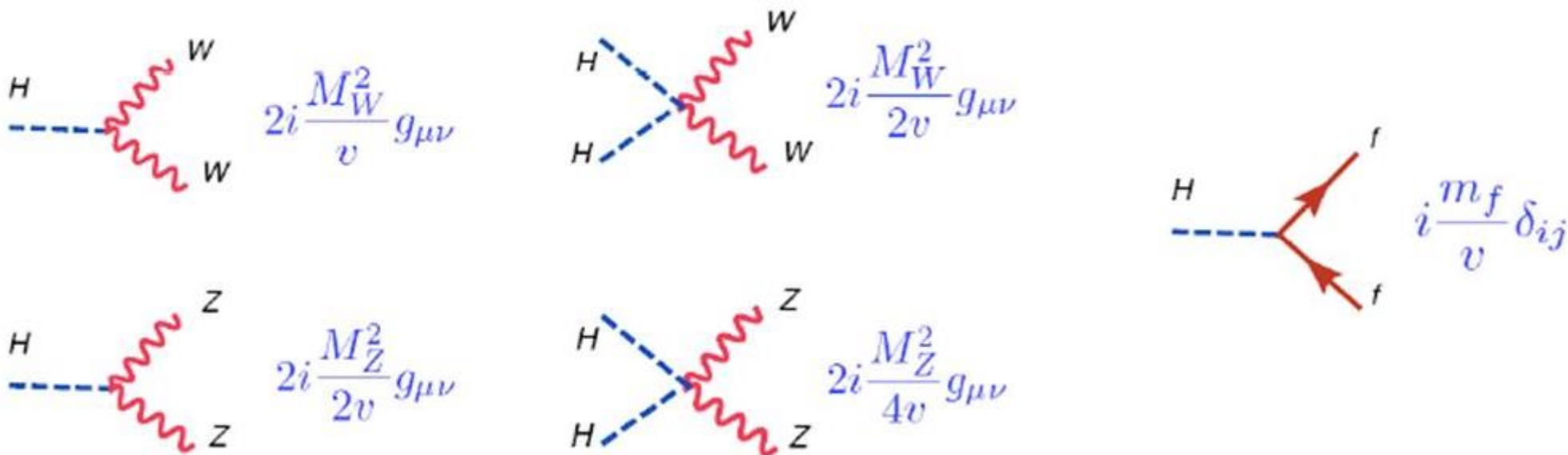


Hon na Higgsův boson



Higgsův boson

- BEH boson (Brout, Englert, Higgs).
- Do r. 2012: Neutrální a zřejmě těžká (dosud nepozorovaná) částice.
- Interakce BEH bosonu s danou částicí je tím větší, čím je částice těžší.
- A zkoumejme zároveň více možností, na co se Higgs může rozpadat:



Higgsův boson

- BEH boson (Brout, Englert, Higgs).
(a také Gerald Guralnik, C. R. Hagen, and Tom Kibble)



The Nobel Prize in Physics 2013
François Englert, Peter Higgs

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The Nobel Prize in Physics 2013



Photo: A. Mahmoud
François Englert
Prize share: 1/2



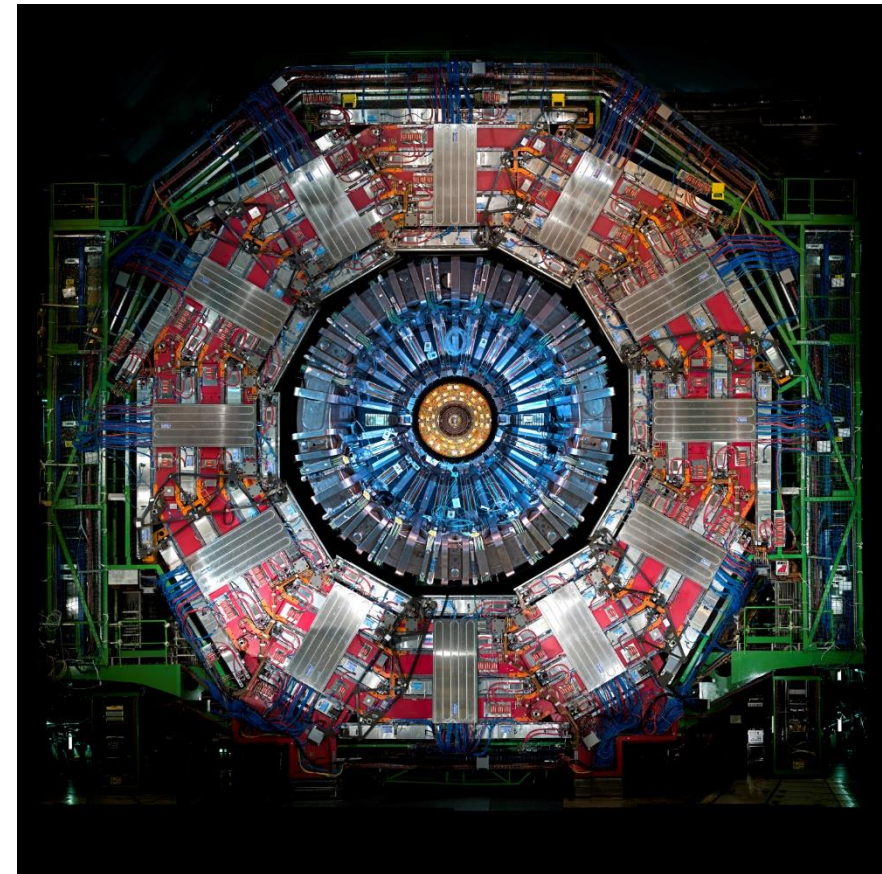
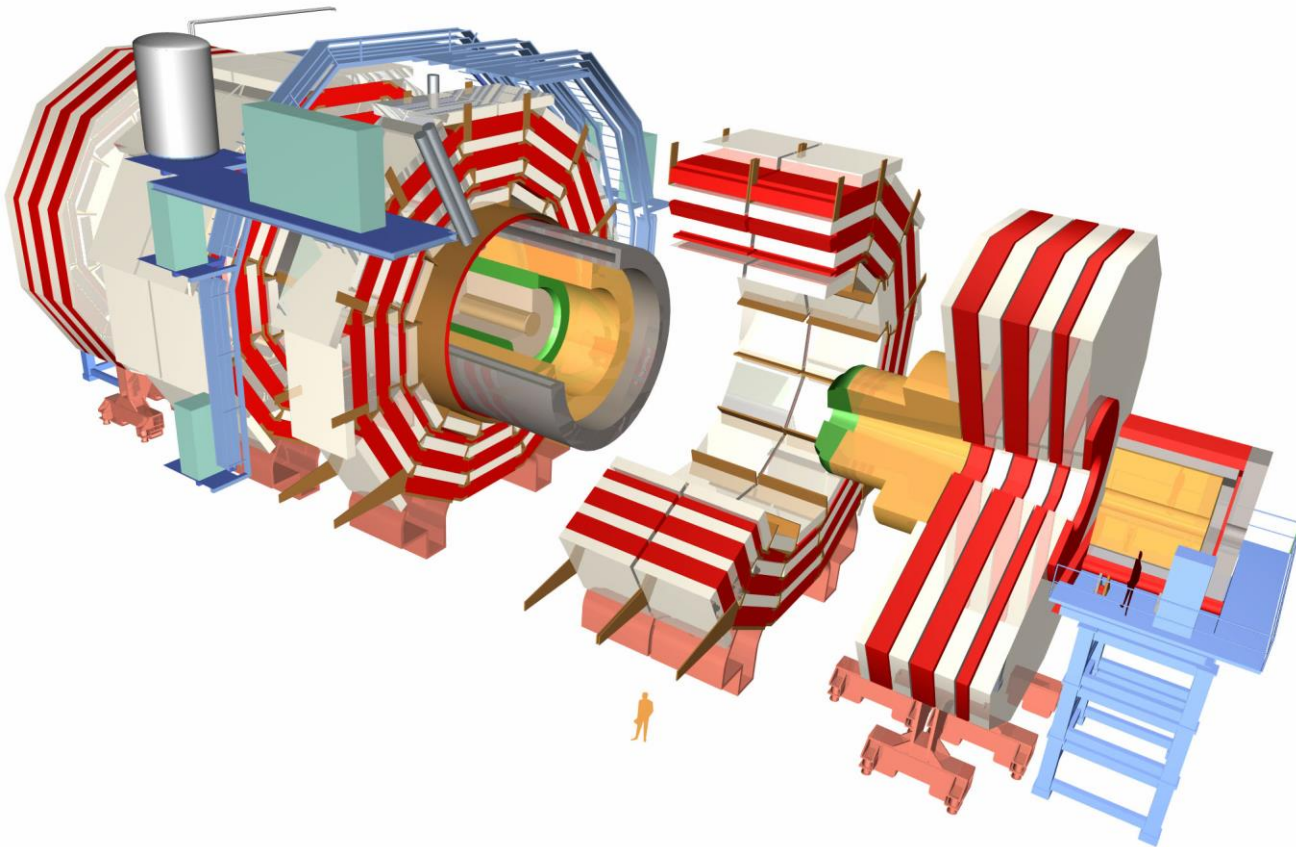
Photo: A. Mahmoud
Peter W. Higgs
Prize share: 1/2



Robert Brout (1928 -- 2011)

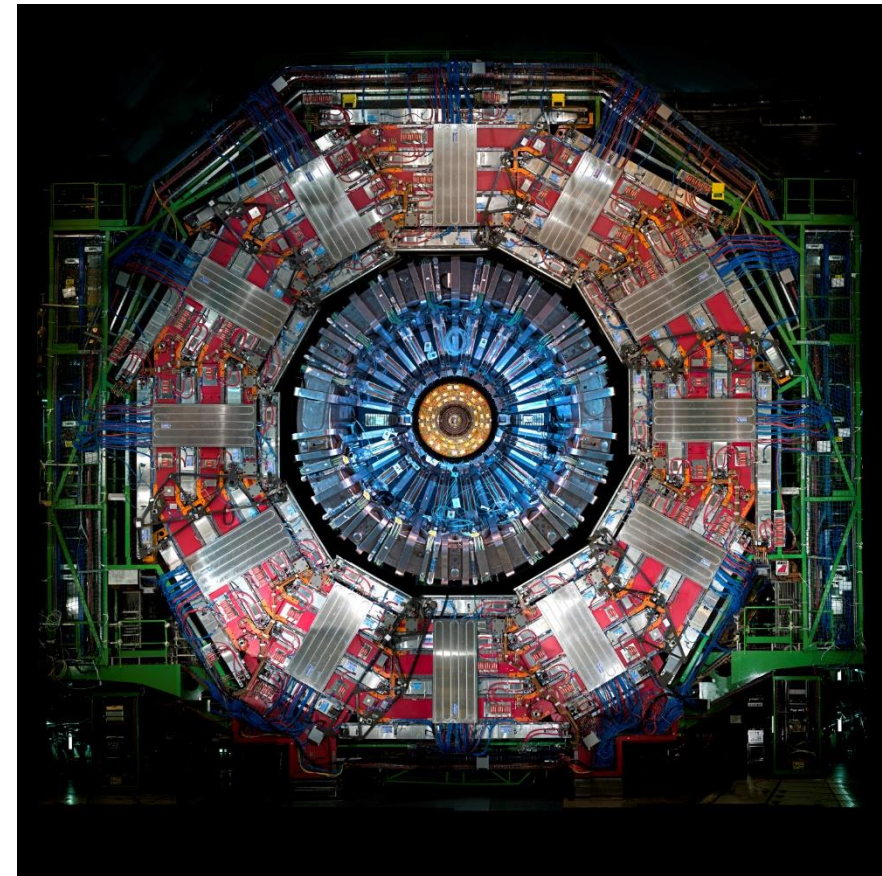
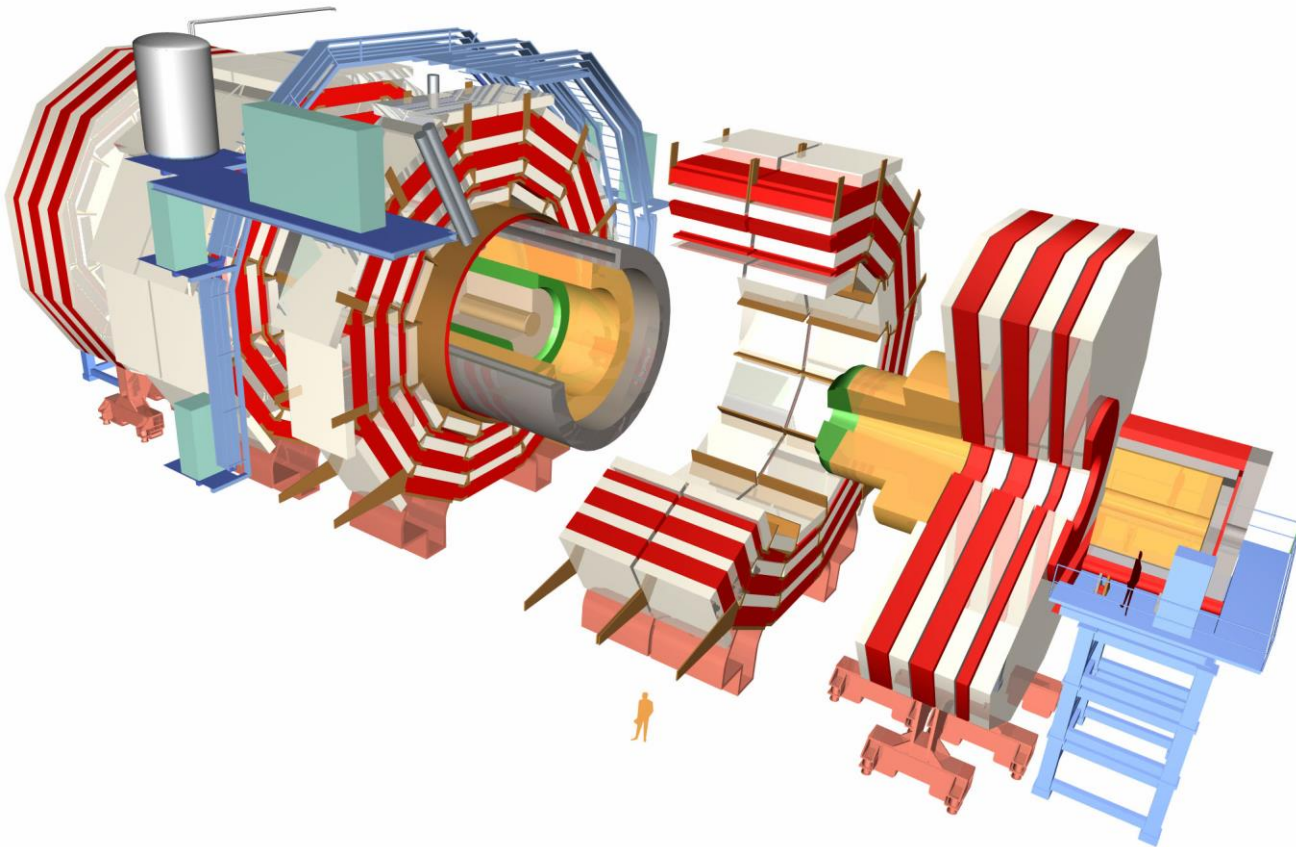
Mezitím u konkurence ... Experiment CMS...

- ...byl navržen tak, aby nejlépe viděl rozpad Higgsova bosonu na dva fotony.



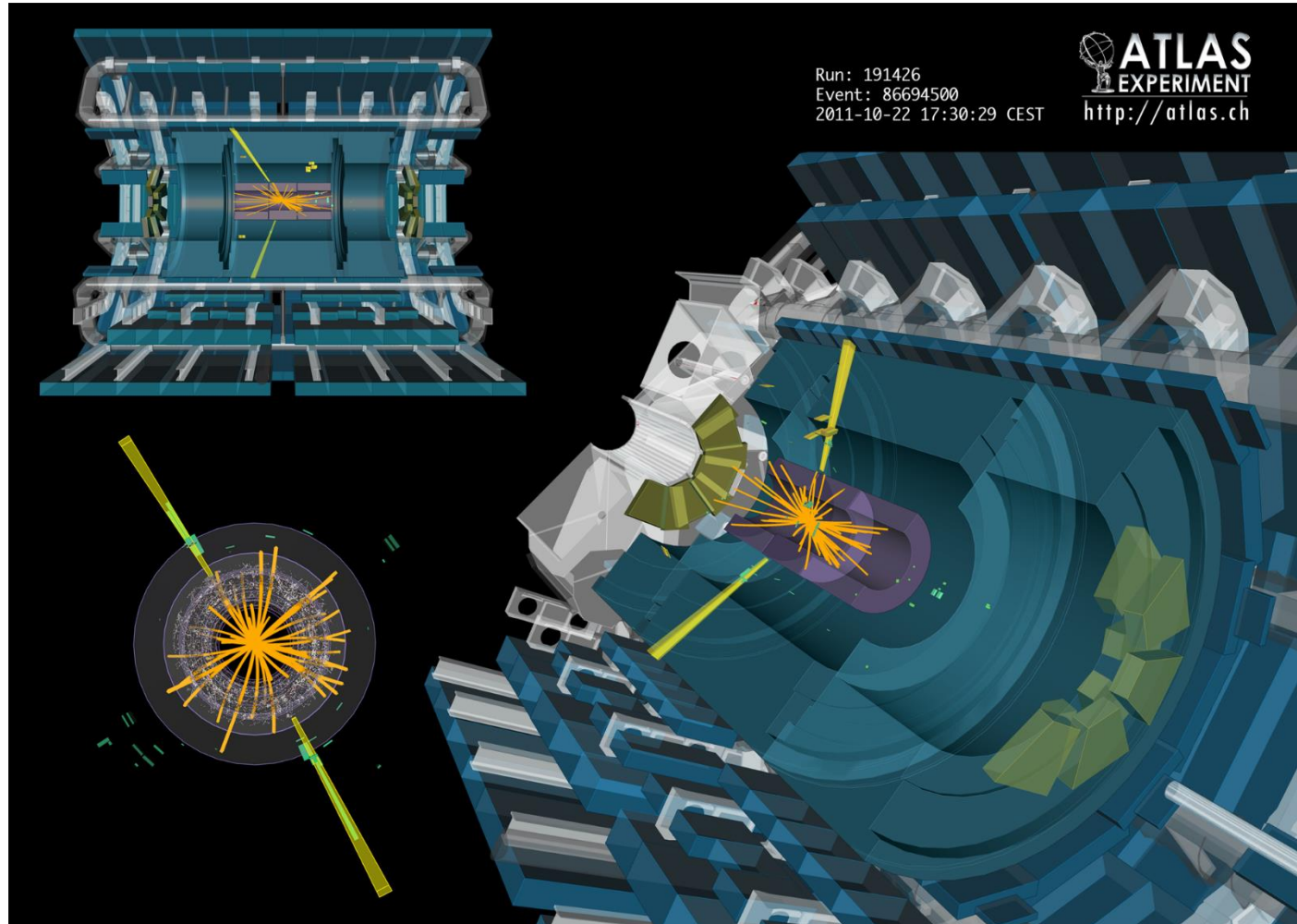
Mezitím u konkurence ... Experiment CMS...

- ...byl navržen tak, aby nejlépe viděl rozpad Higgsova bosonu na dva fotony.
- Rozpad Higgsova bosonu na dva fotony??



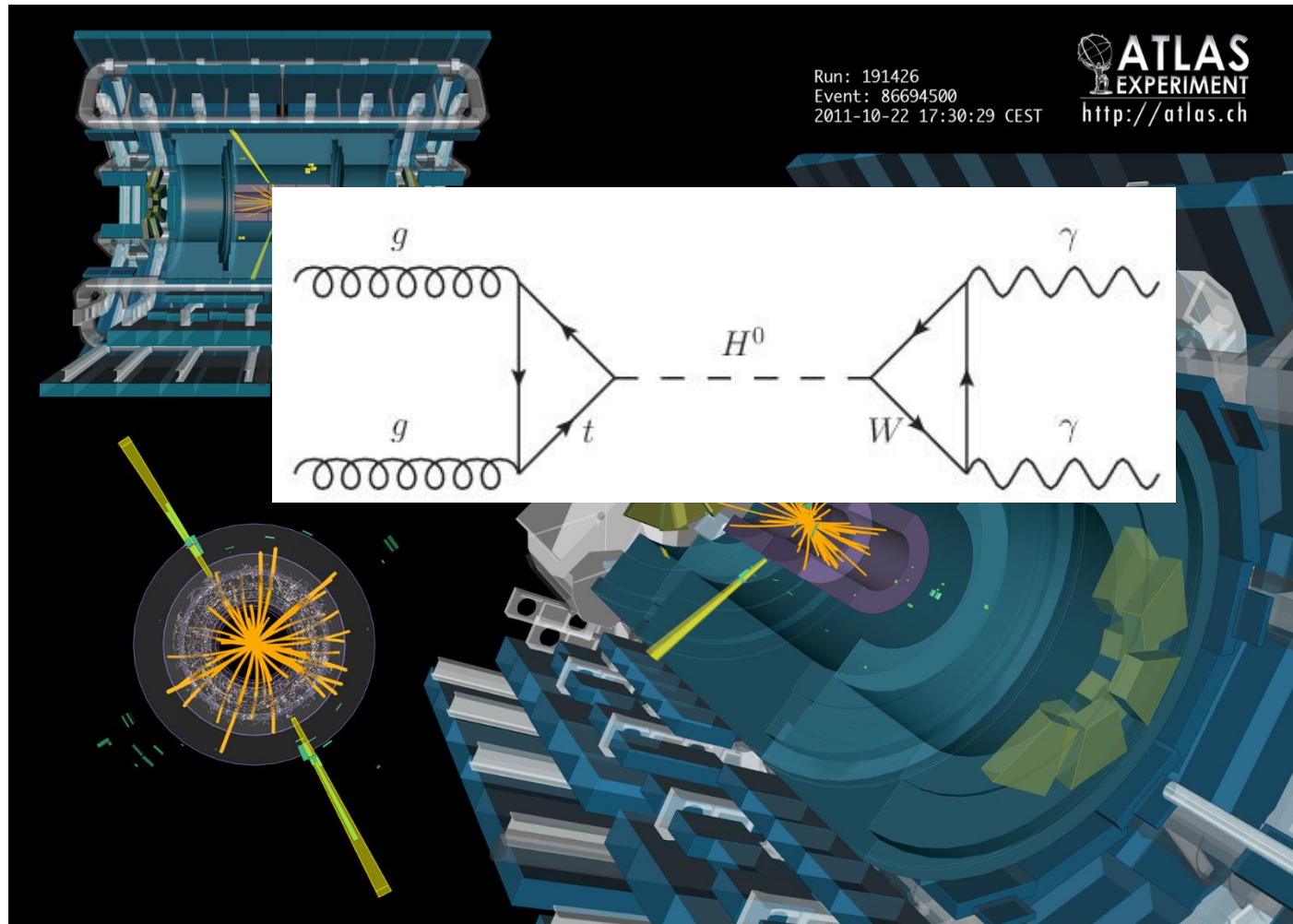
Higgsův boson

- Rozpad Higgsova bosonu na dva fotony??



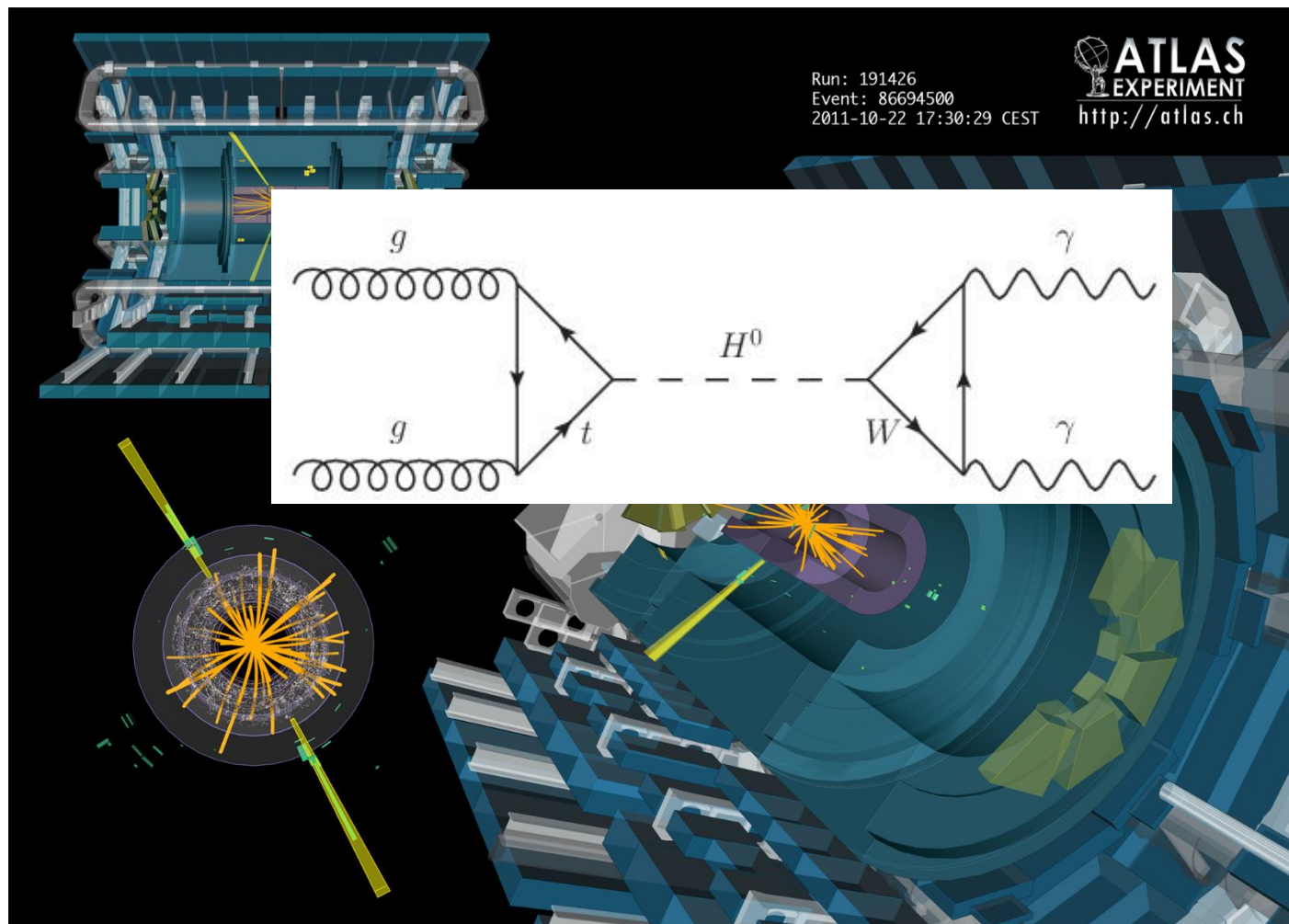
Higgsův boson

- Rozpad Higgsova bosonu na dva fotony?? – Ano!!



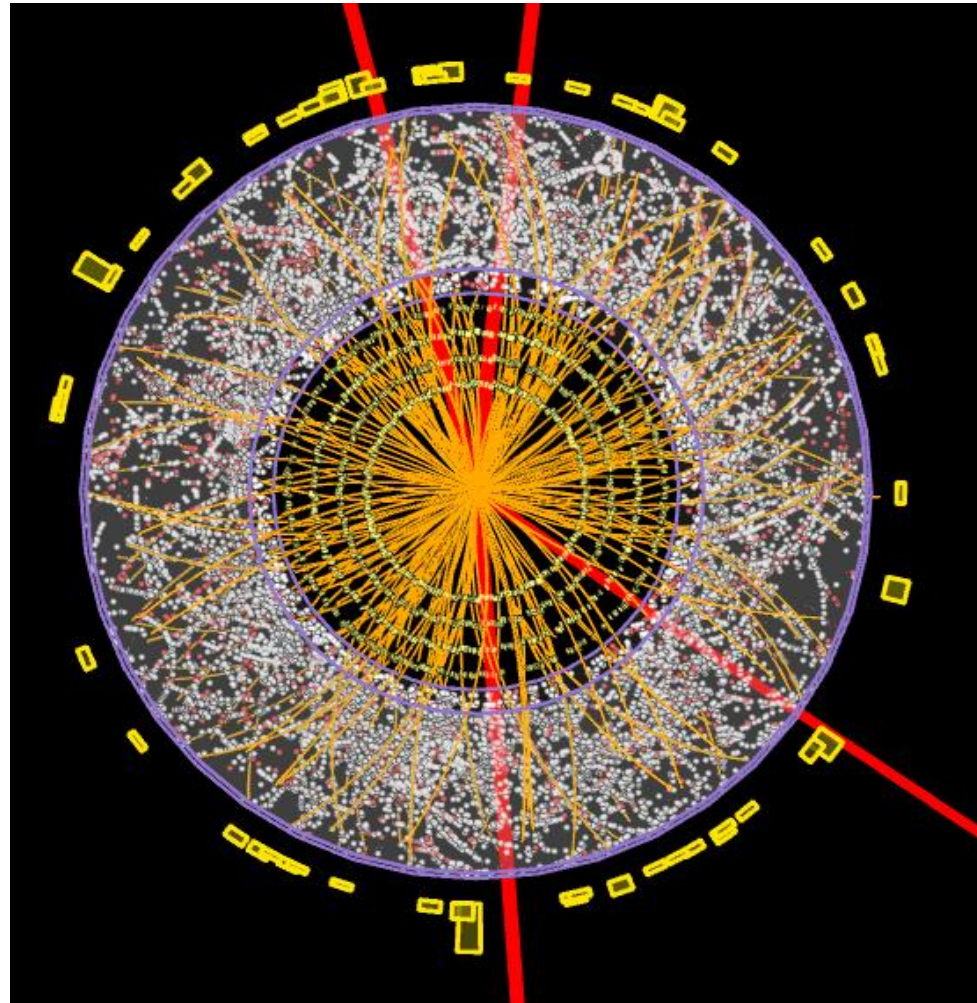
Higgsův boson

- Rozpad Higgsova bosonu na dva fotony?? – Ano!!
- Higgs si vlastně posvítí na nás 😊



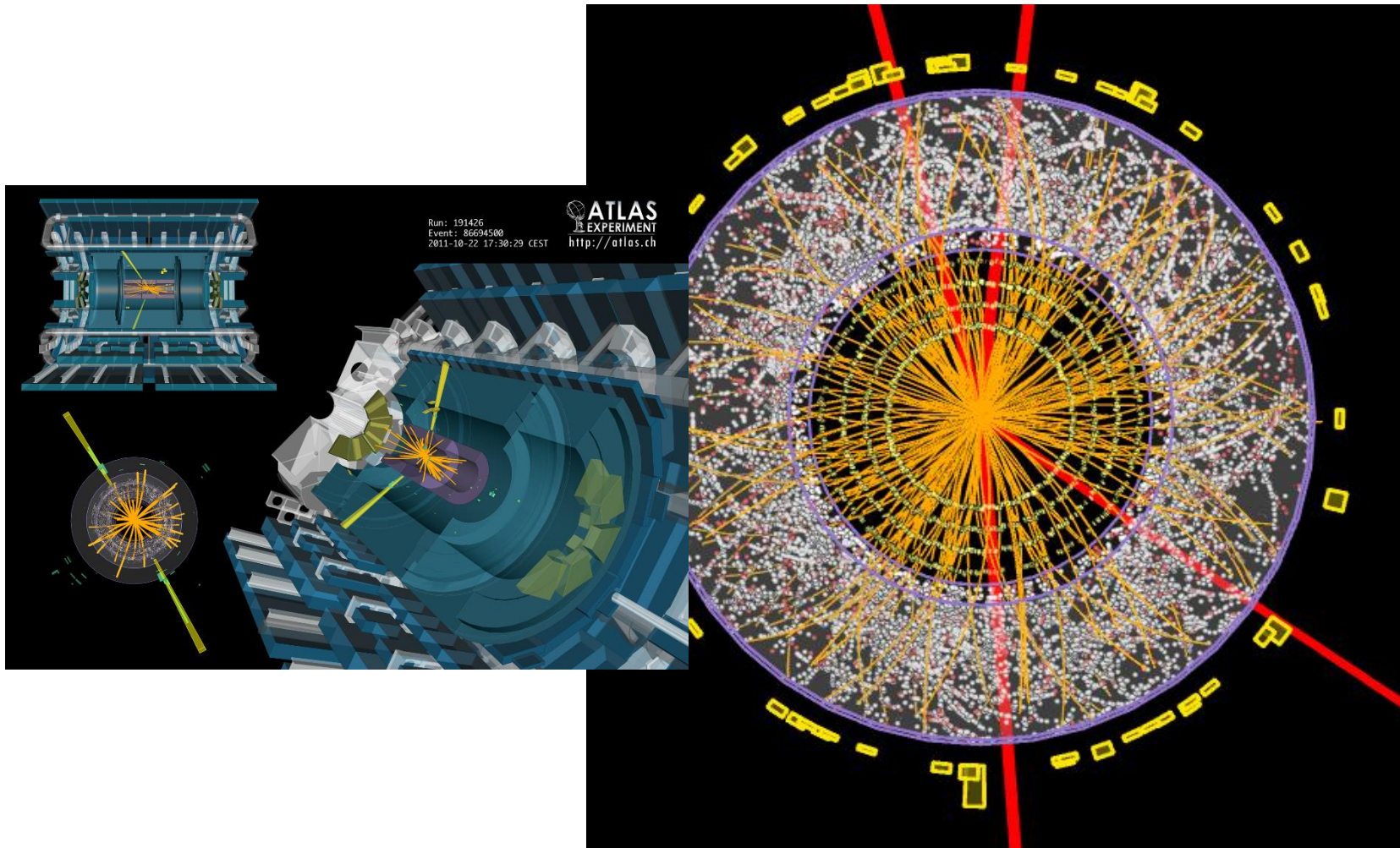
Higgsův boson

- Jak vypadá? Aneb: jedna vlaštovka jaro nedělá...



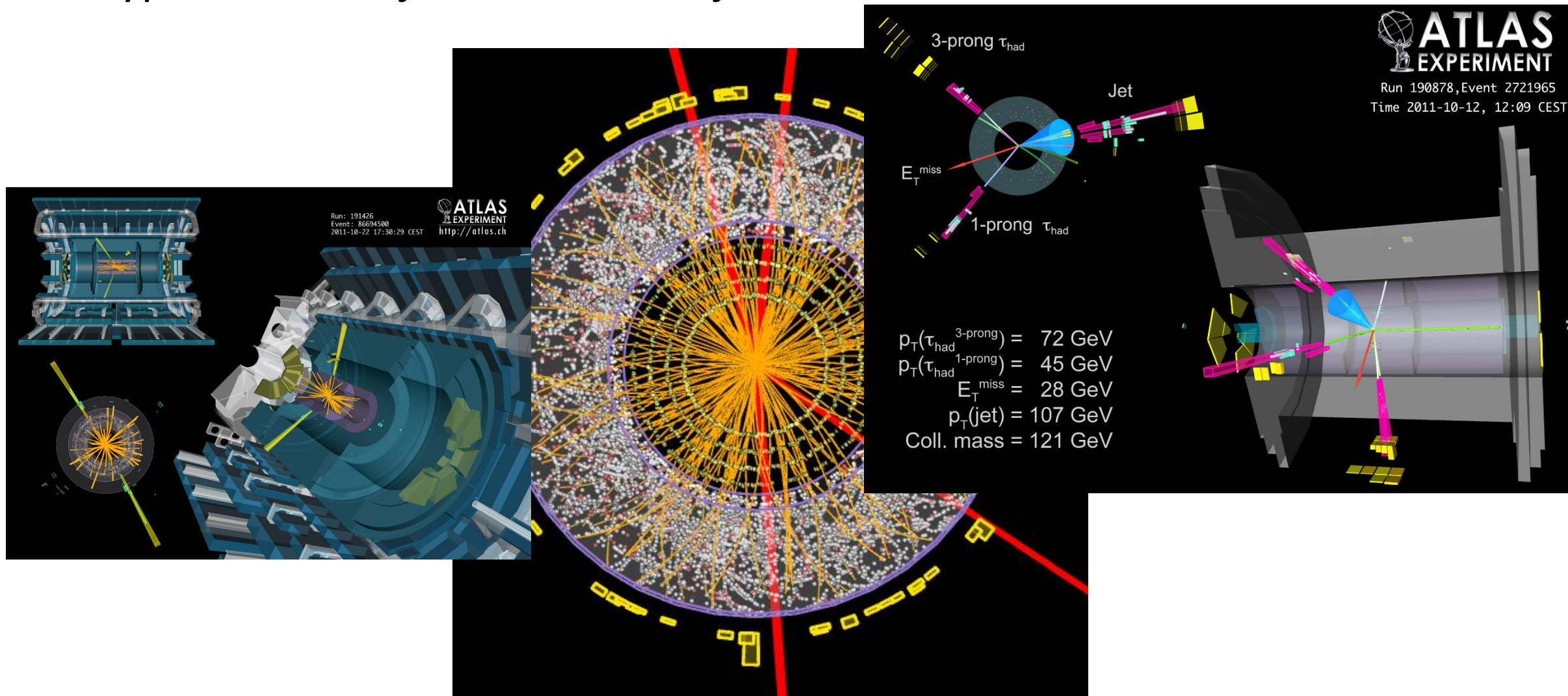
Higgsův boson

- Jak vypadá? Aneb: jedna vlašťovka jaro nedělá...



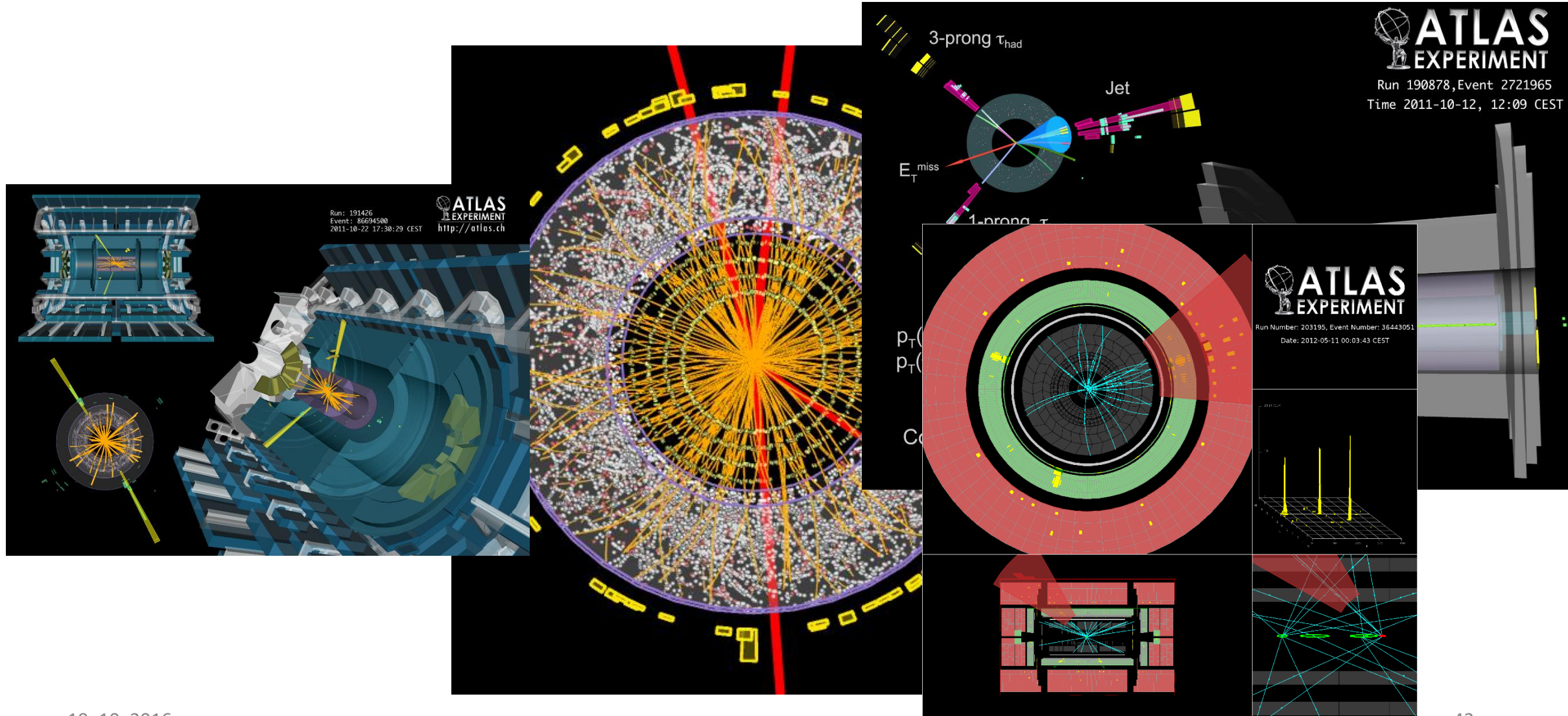
Higgsův boson

- Jak vypadá? Aneb: jedna vlašťovka jaro nedělá...



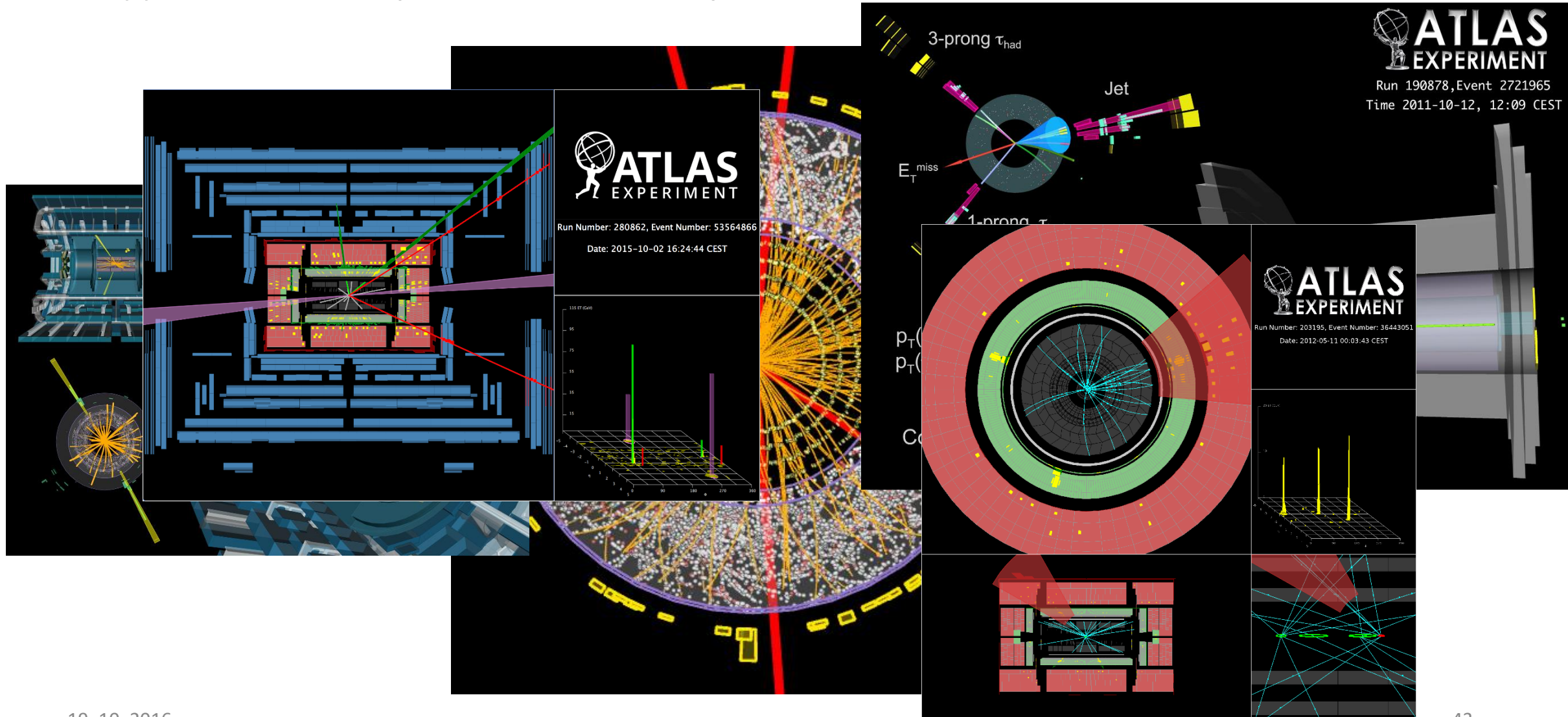
Higgsův boson

- Jak vypadá? Aneb: jedna vlašťovka jaro nedělá...



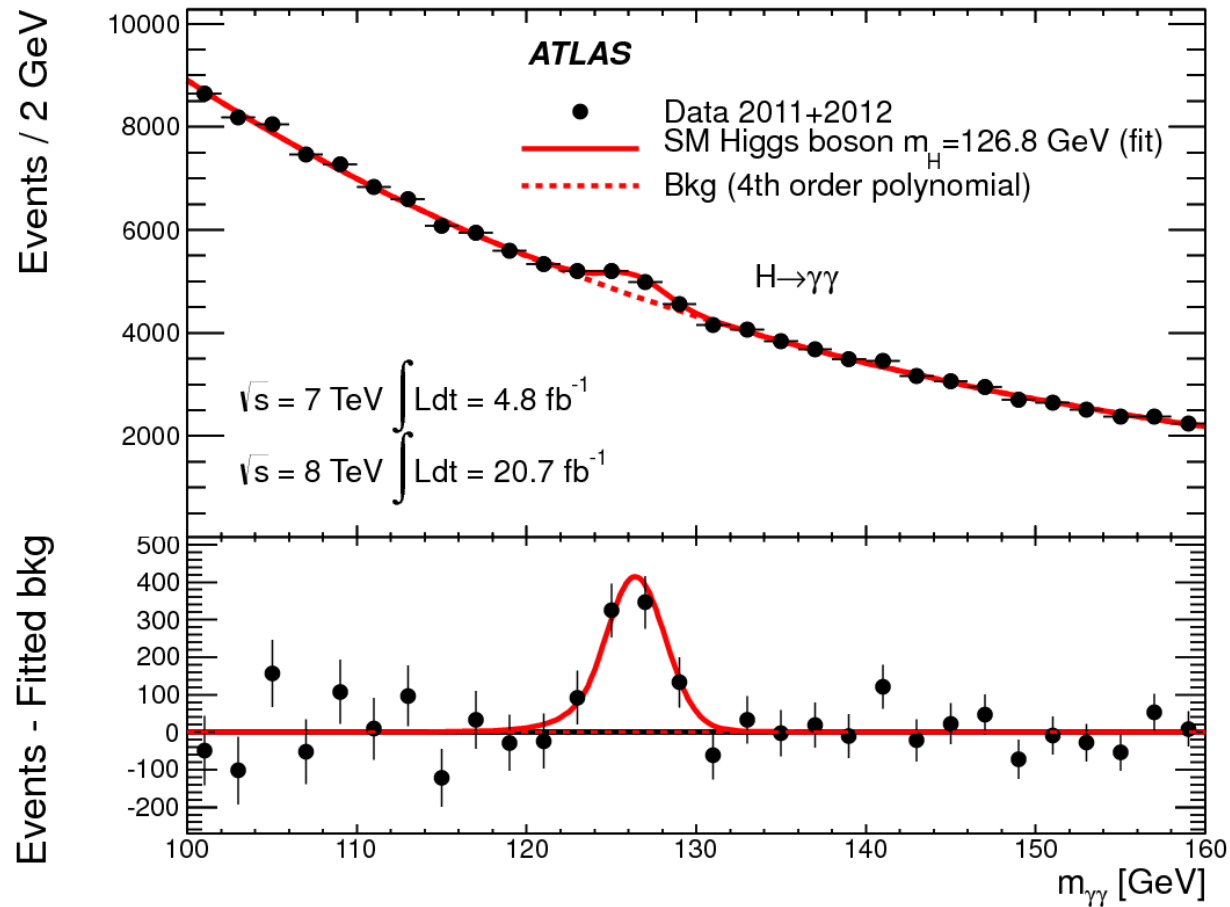
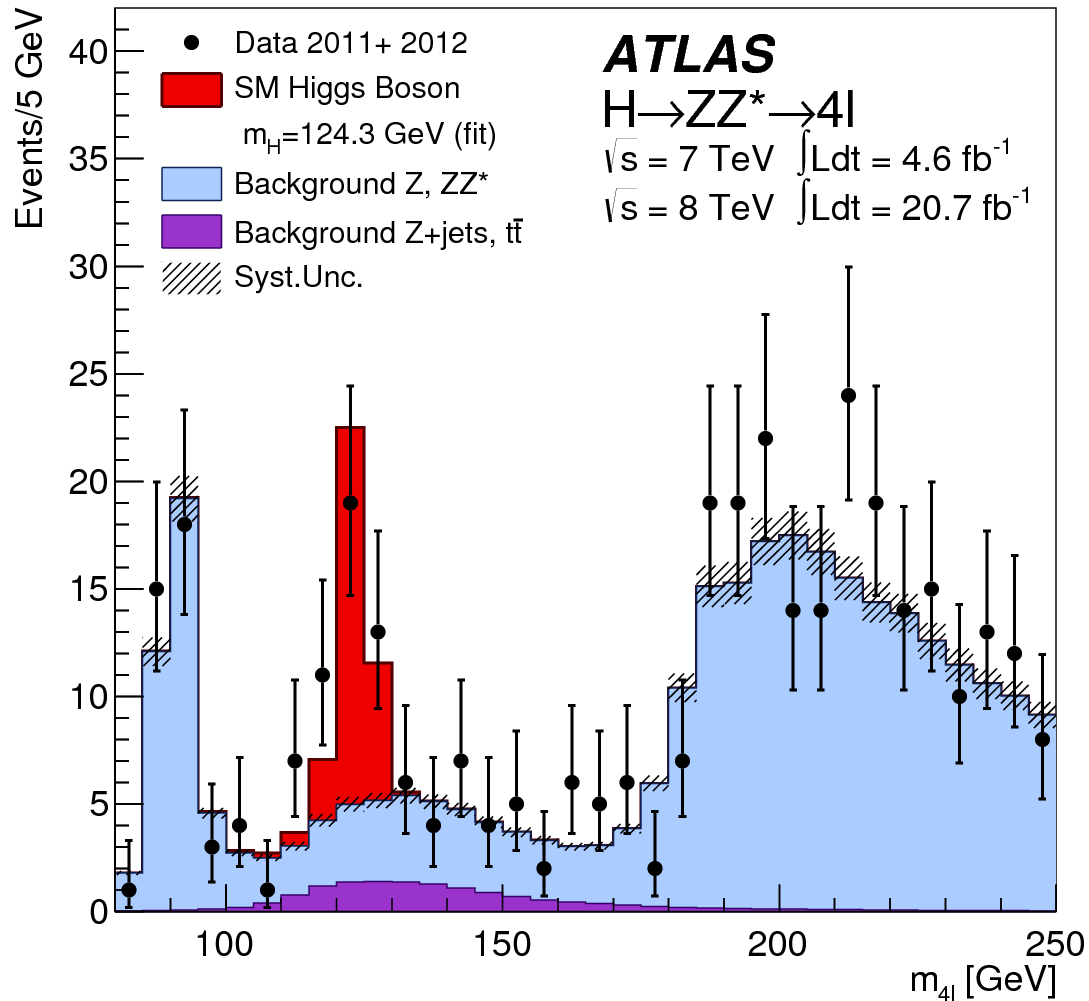
Higgsův boson

- Jak vypadá? Aneb: jedna vlaštovka jaro nedělá...



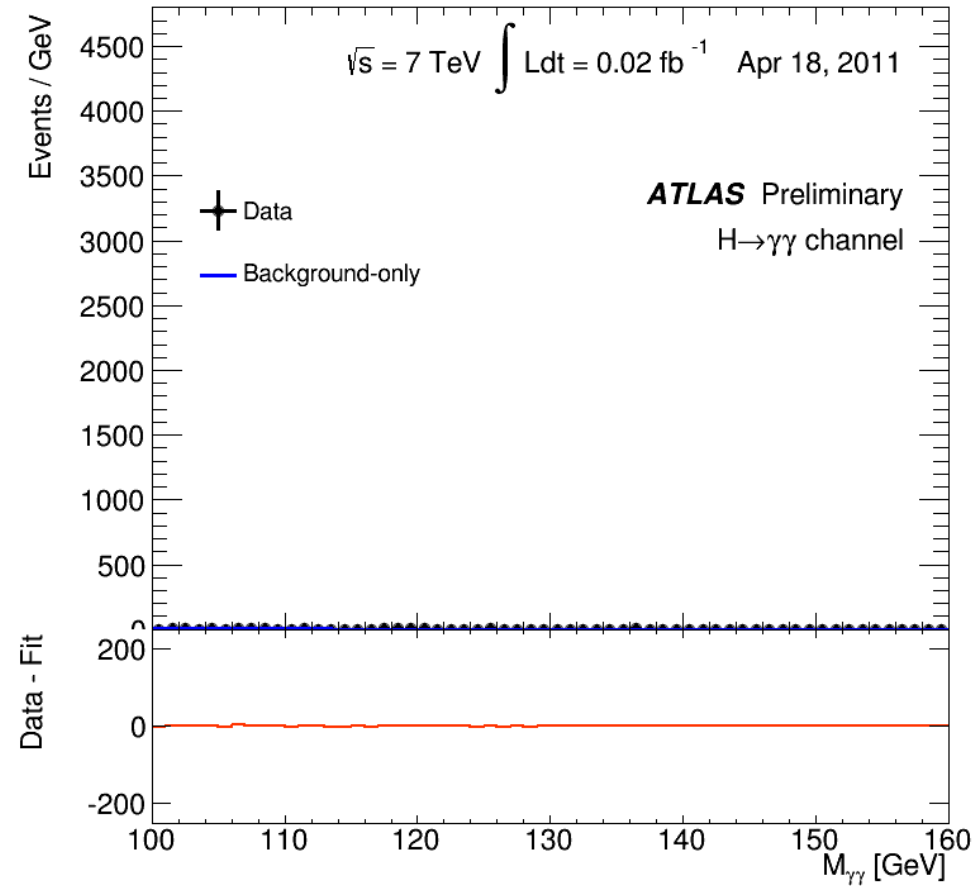
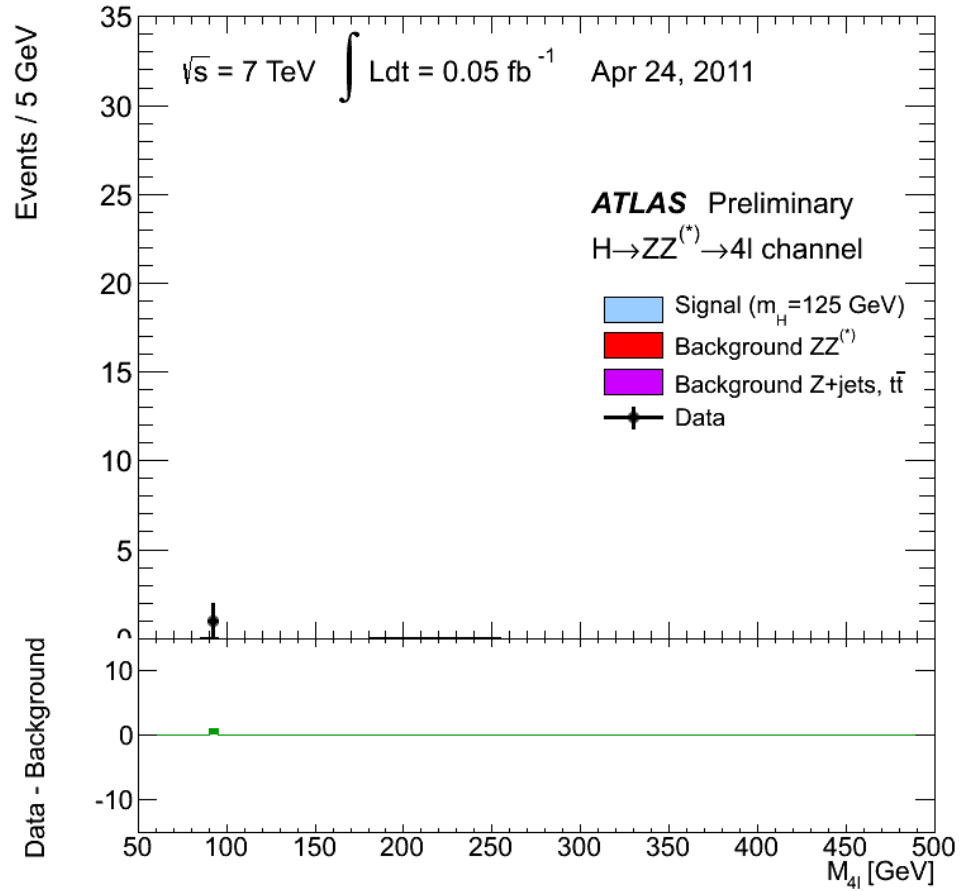
Higgsův boson

- Mnoho událostí, měsíce běhu urychlovače a provozu detektoru:



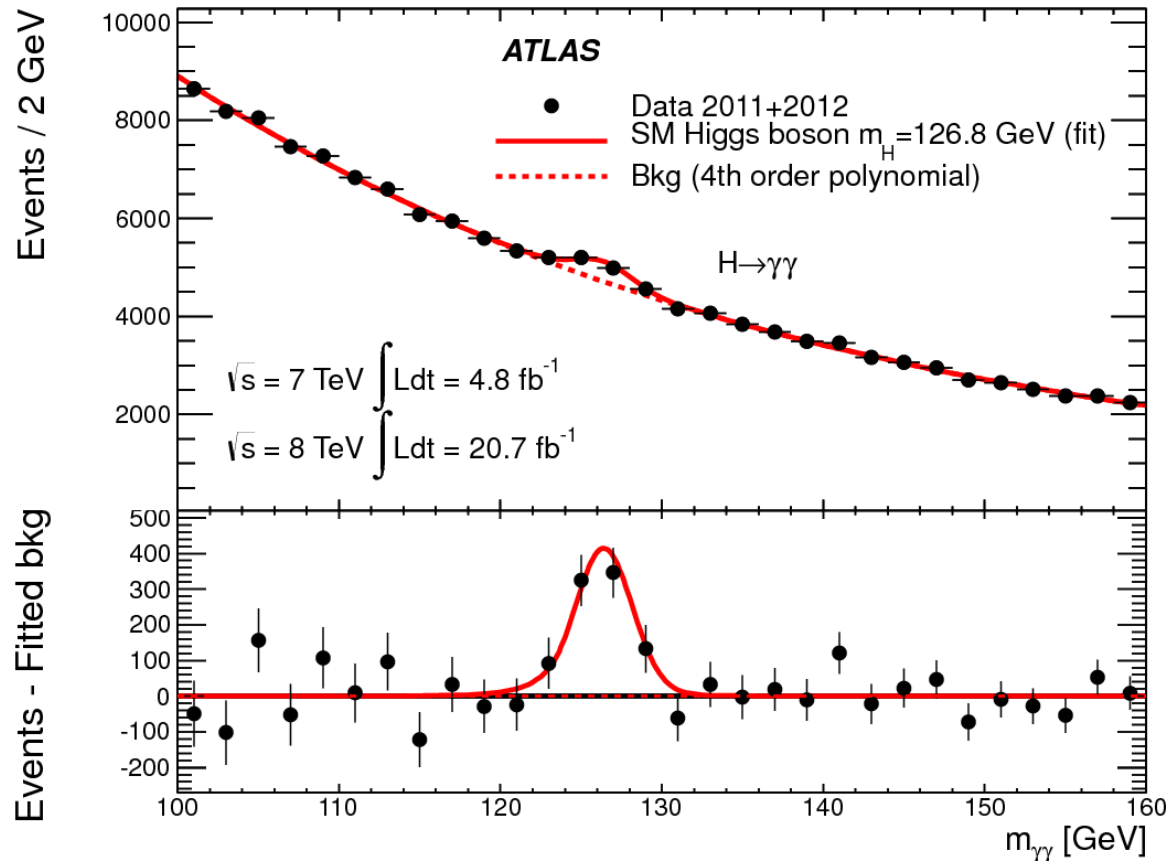
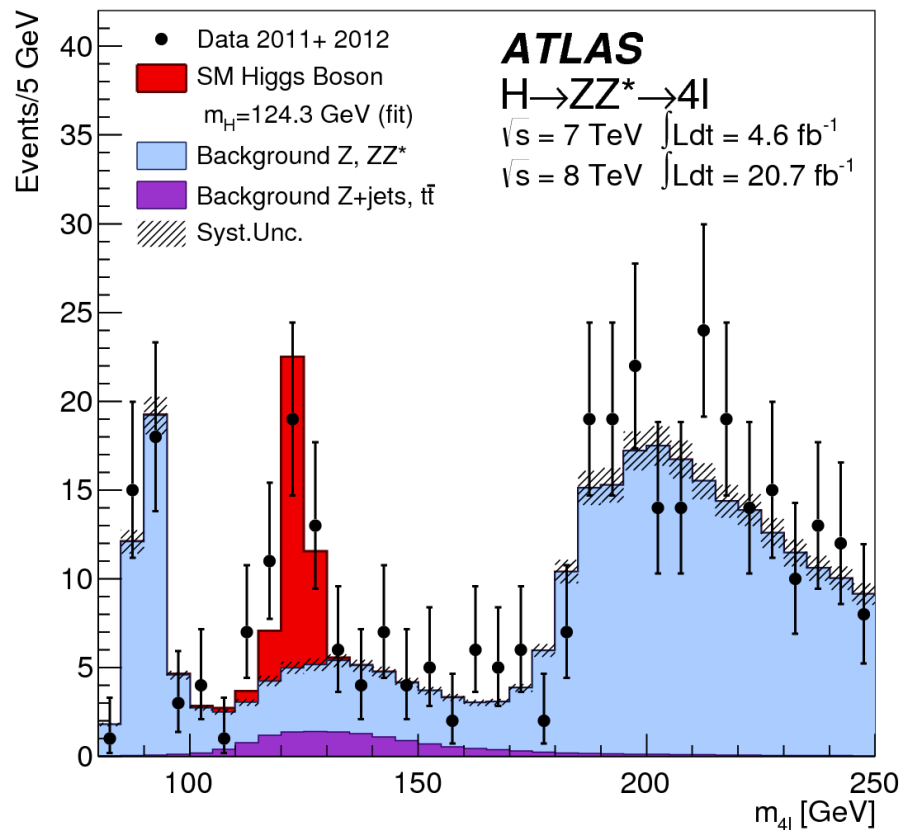
Higgsův boson

- Čekání na Higgse.



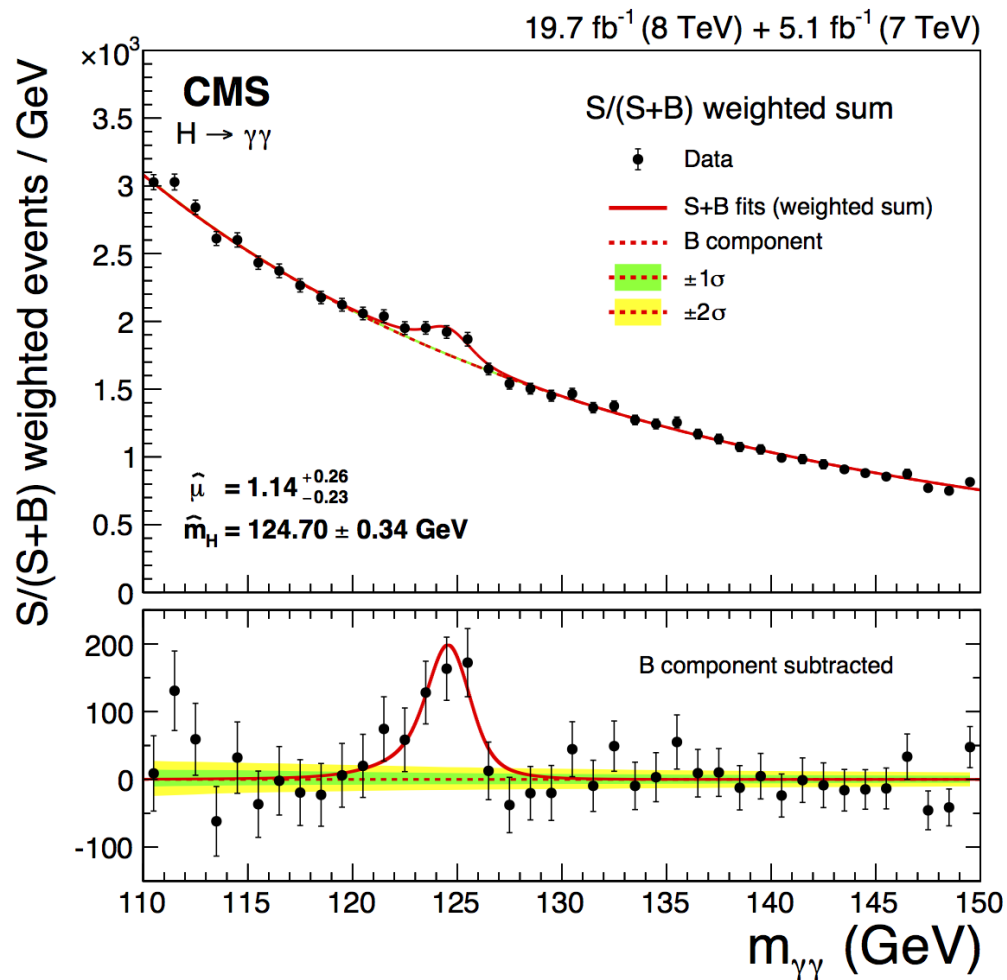
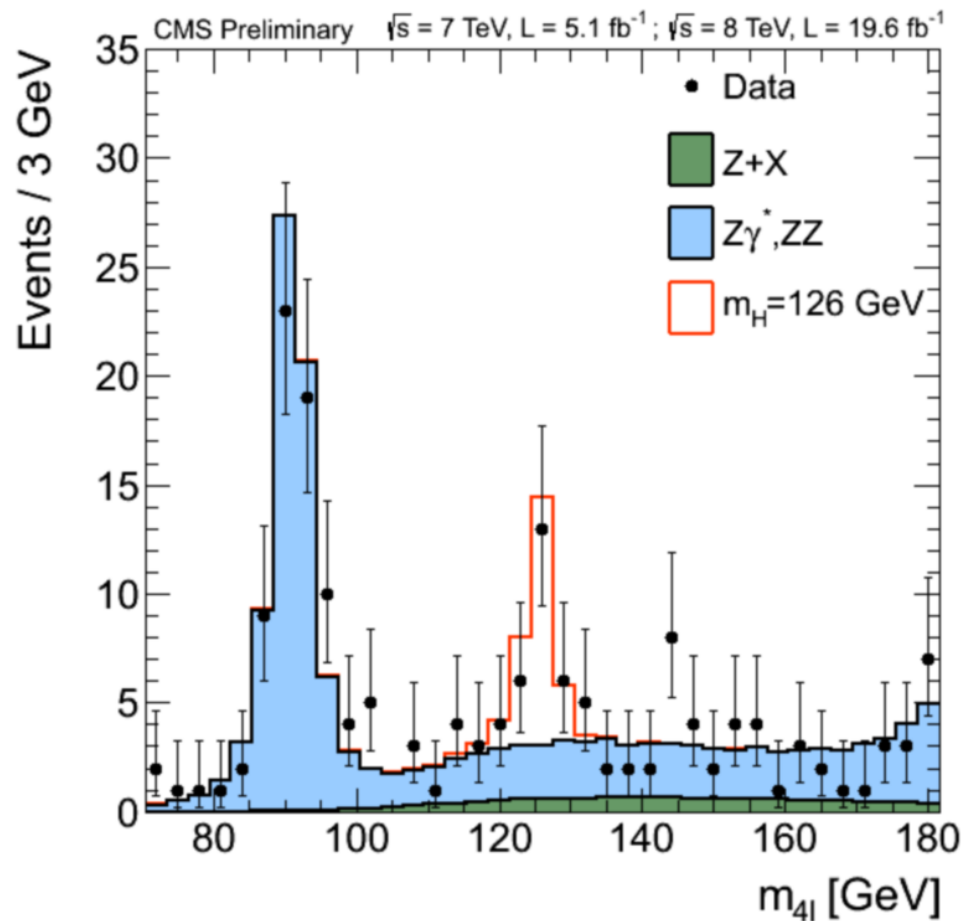
Higgsův boson

- Viděno experimentem ATLAS:

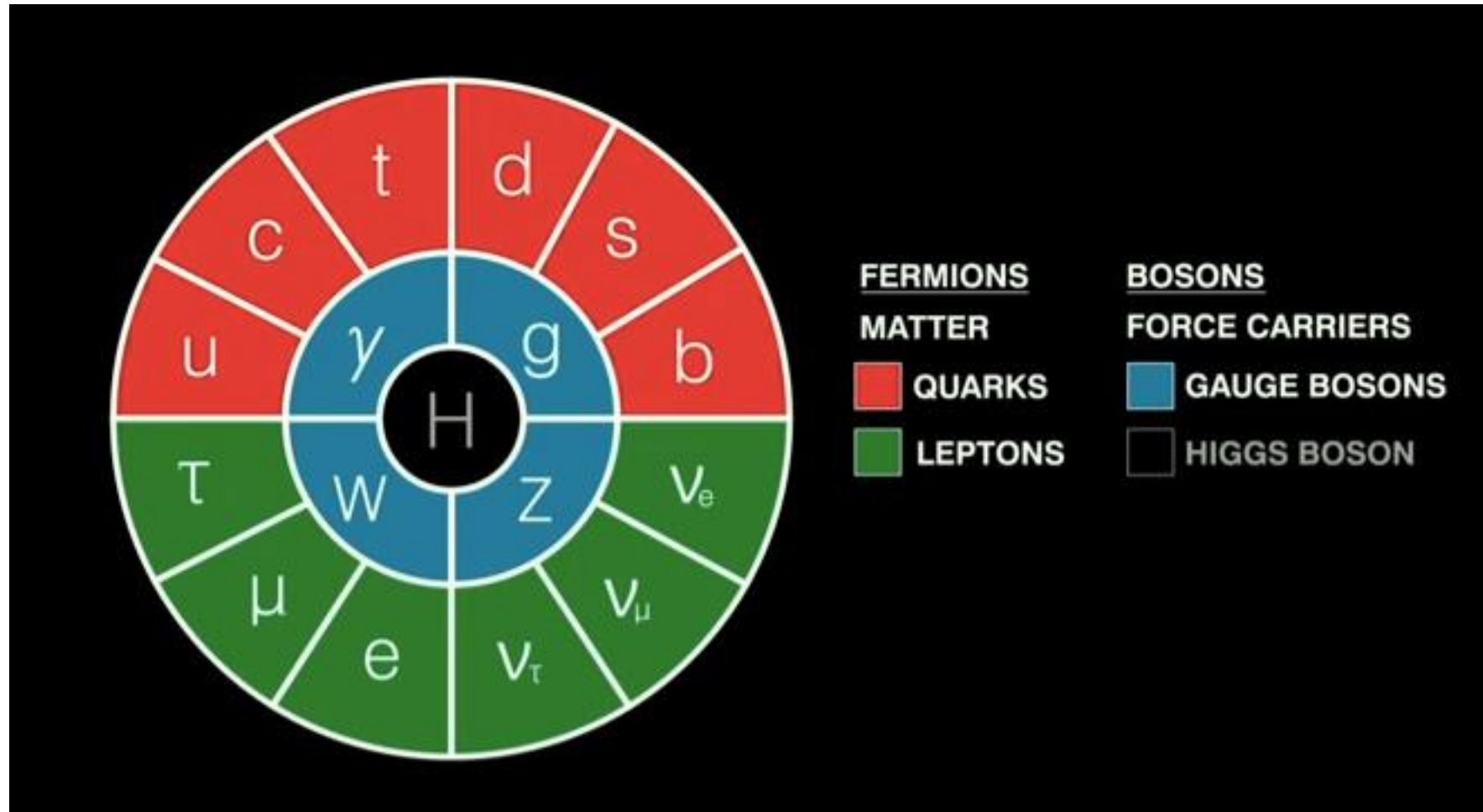


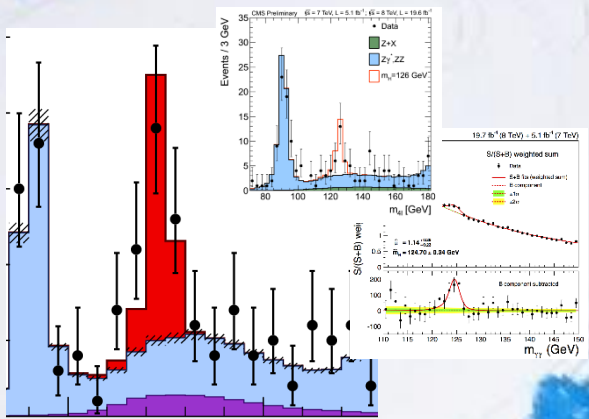
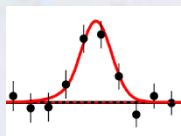
Higgsův boson

- ...mezitím u konkurence (experiment CMS):



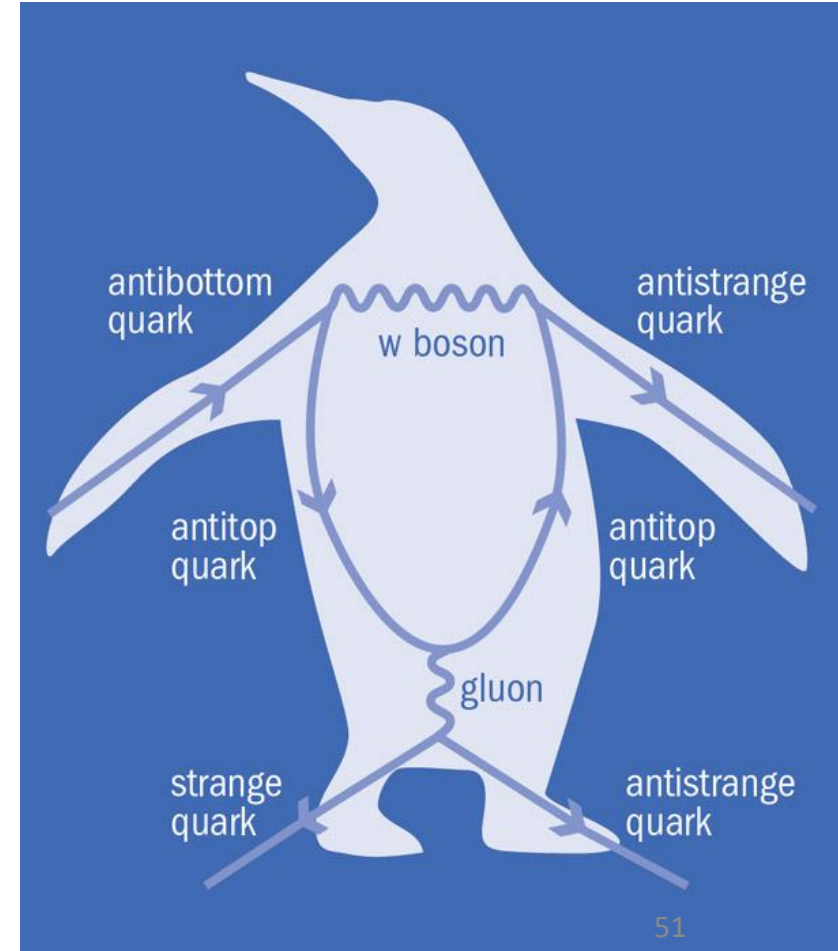
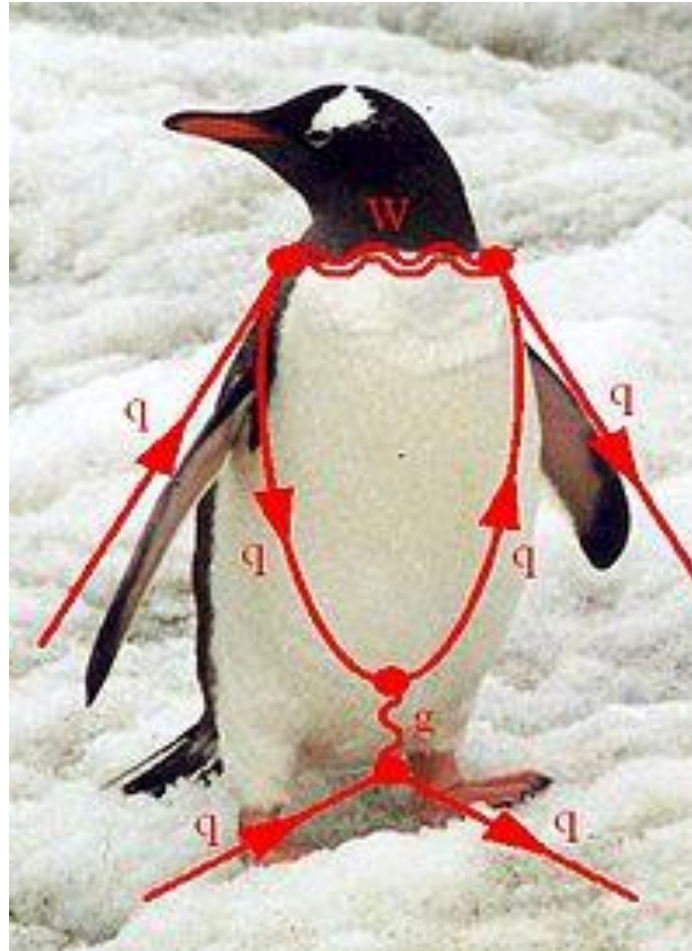
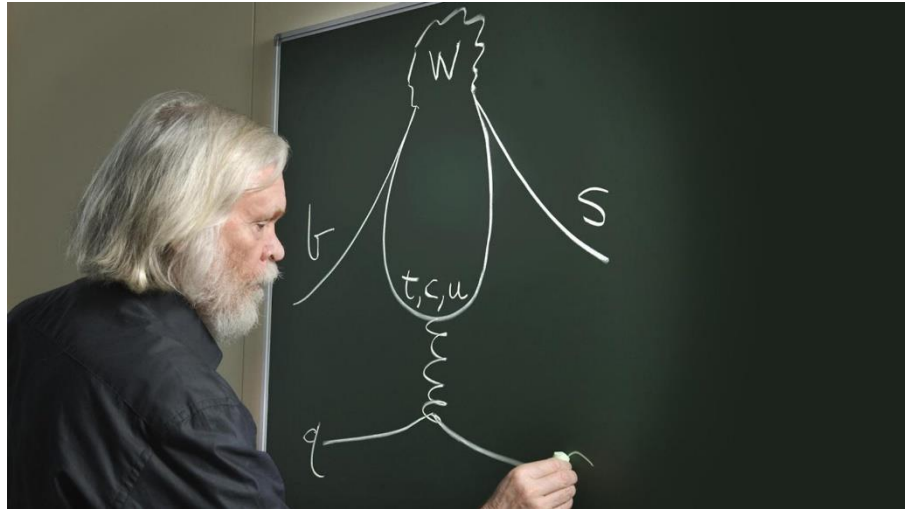
Elementárni, Watson!







Tučňák

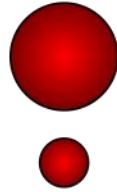


Elementární

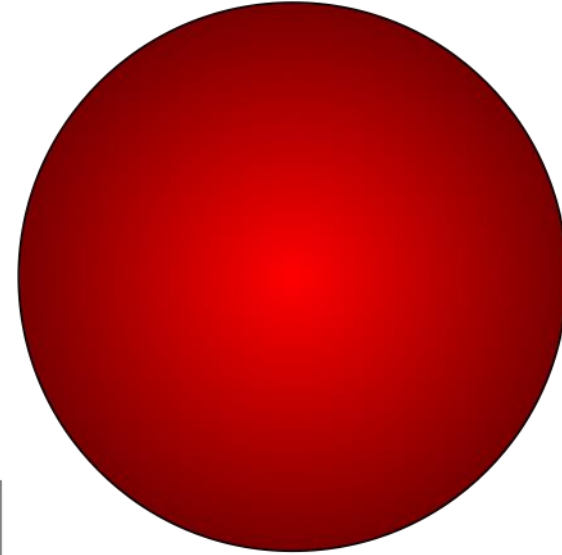
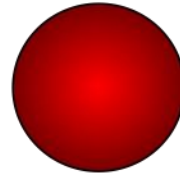
Up Quark
~ 0.002 GeV



Charm Quark
1.25 GeV



Top Quark
175 GeV



Down Quark
~ 0.005 GeV

Strange Quark
~ 0.095 GeV

Bottom Quark
4.2 GeV

These are relative masses not size – they have no measurable size

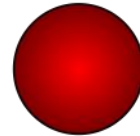
Electron
0.0005 GeV



Muon
0.105 GeV



Tau
1.78 GeV



For reference:



Proton
0.938 GeV

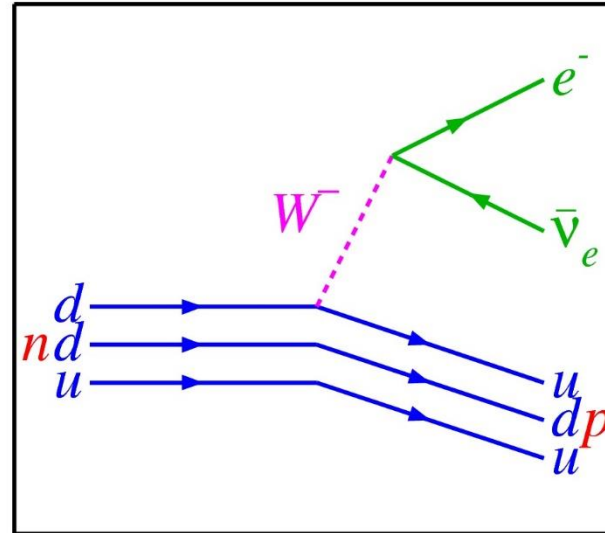
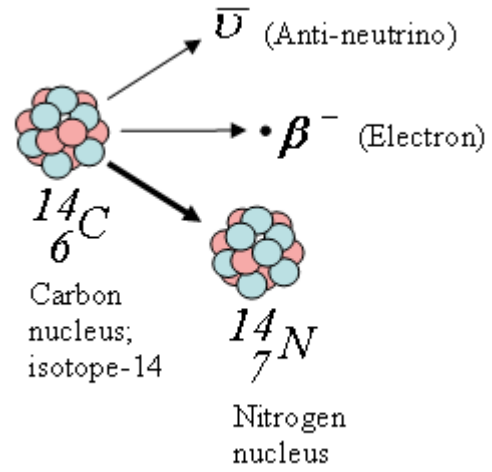
Electron Neutrino
~ 0

Muon Neutrino
~ 0

Tau Neutrino
~ 0

← Originally thought to be massless but now not

Beta rozpad



Realita

Activities gv Tue Jan 6, 14:57

```
emacs@kvita-HP
File Edit Options Buffers Tools C++ Help
MMlepton rc_lepton;
rc_lepton.pt = ed->leptons.pt.at(0) / GeV;
rc_lepton.eta = ( rc_channel == FakesWeights::EJETS ) ? ed->electrons.property["el_cl_eta"].at(0) : ed->muons.property["mu_cl_eta"].at(0);
rc_lepton.eta = fabs( rc_lepton.eta );

double hthad = 0.;
double dR_lj_min = 1e10; // distance between the electron and the closest jet
double pTDR_lj_min = 0.; //pT/dR (lepton-closest jet)
for( size_t j = 0; j < ed->jets.n; ++j ) {
    const double jet_pT = ed->jets.pt.at(j) / GeV;

    hthad += jet_pT;

    double dR_lj = PhysicsHelperFunctions::DeltaR( ed->leptons, 0, ed->jets, j );

    //cout << "Nj = " << ed->jets.n << " j_ind = " << j << " dR_lj = " << dR_lj << endl;

    if( dR_lj < dR_lj_min ) {
        dR_lj_min = dR_lj;
        pTDR_lj_min = jet_pT / dR_lj;
    }
}
rc_event.hthad = hthad;
rc_lepton.dR = dR_lj_min;
rc_lepton.dRpt = pTDR_lj_min;

const double lep_phi = ed->leptons.phi.at(0);
const double met_phi = ed->MET.phi;
double dPhi = PhysicsHelperFunctions::Phi_mphi_phi( lep_phi - met_phi );
rc_lepton.dPhi = fabs( dPhi );

int trigger = ed->leptons.property["trigMatch"].at(0); // which trigger the lepton is associated with
// (use lep_trigMatch in MiniSL)
rc_lepton.trigger = trigger; // 1,2 or 3, or even adding the info on the prescale

bool tight = ( rc_channel == FakesWeights::EJETS ) ? ed->electrons.property["tight"].at(0) : ed->muons.property["tight"].at(0);

// Finally..
qcd_weight = m_noma->GetFakesWeight( rc_channel, rc_event, rc_lepton, tight );
// qcd_weight = m_noma->GetFakesWeight( rc_channel, tight, rc_lepton.pt, rc_lepton.eta, rc_lepton.dRpt, rc_event.jetpt, rc_event.njets, rc_event.ntag, rc_lepton.trigger );

// cout << "ch: " << rc_channel << " tight = " << tight << " pT = " << rc_lepton.pt << " dR_lj_min = " << rc_lepton.dR << " dPhi_l_MET = " << rc_lepton.dPhi << " trigger = " << rc_lepton.trigger << endl;
-:--- CutFlowTbarResolved.cxx 51% L613 (C++/l Abbrev)

-rw-r--r-- 1 qitek zp 63 Jan 6 13:56 histograms_data_mu.root
-rw-r--r-- 1 qitek zp 1.7M Jan 6 13:56 histograms_data_el.root
drwxr-xr-x 5 qitek zp 6.0K Jan 6 13:56 .
[lxplus0142] /afs/cern.ch/user/q/qitek/qitek/TopResolved_8TeV_MAMbo/MAMbo/run/
```

```
emacs@kvita-HP
File Edit Options Buffers Tools Python Help
#!/usr/bin/python
import os, sys
from ROOT import *
from array import array

from MAMboPlottingToolkit import *
_cans = []
_files = []
_corrs = []
```

gv: img/eps/el_reco_4j2b_topH_m.eps: Data/Prediction

ATLAS Internal
 $L_{dt} = 20.3 \text{ fb}^{-1}$ $\sqrt{s} = 8 \text{ TeV}$

Events / GeV

Reconstructed hadronic pseudo-top mass [GeV]

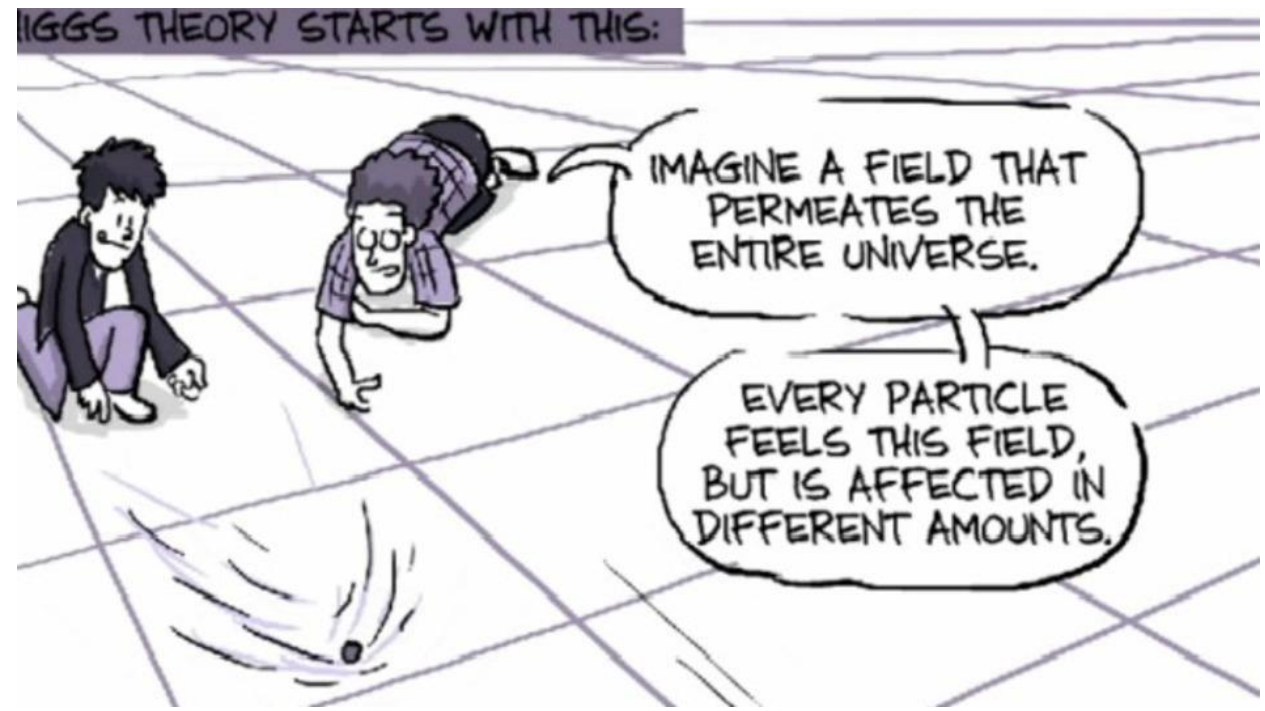
Data/Prediction

Legend:

- Data e+jets
- $t\bar{t}$ (non full-had)
- Single top
- W+jets
- Z+jets
- WW/ZZ/WZ
- Fake lept.
- Stat. uncert.

19. 10. 2016

Higgs



Srážky protonů

Srážky protonů