

MICHIEL VEEN

MIJN PHD: LEVENSDUUR VAN HET HIGGS BOSON

Dutch Teacher Programme 28-09-2018

Gebaseerd op "Higgs boson width measurements with different methods at LHC", Roberto Di Nardo



Geboren: Vlissingen



Wonen in Almere



Wonen in Saint-Genis



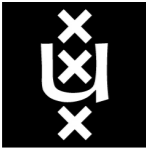
rijksuniversiteit
groningen



EERSTE LUC EXPERIENCE: MASTERPROJECT

- ▶ "A fast tool to predict peaking and semi-peaking backgrounds in two body decay processes"





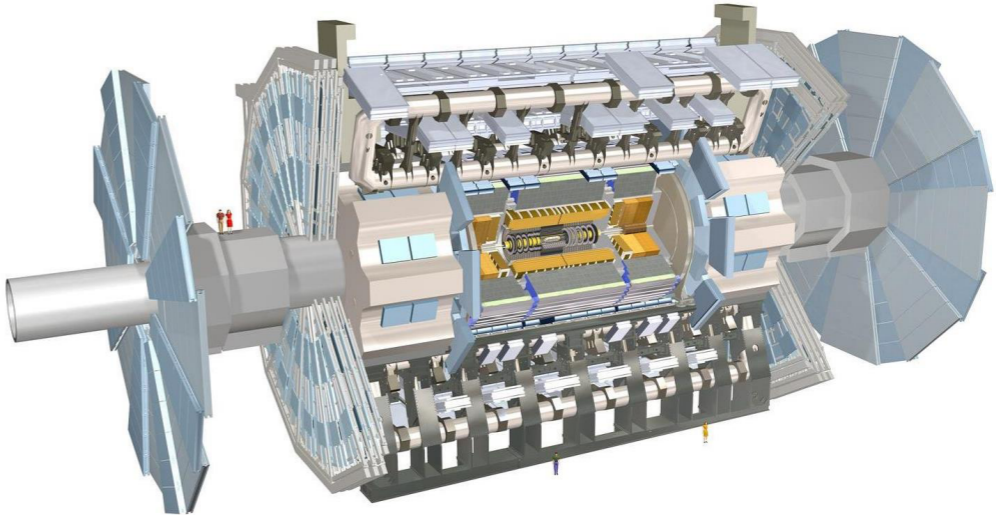
UNIVERSITEIT
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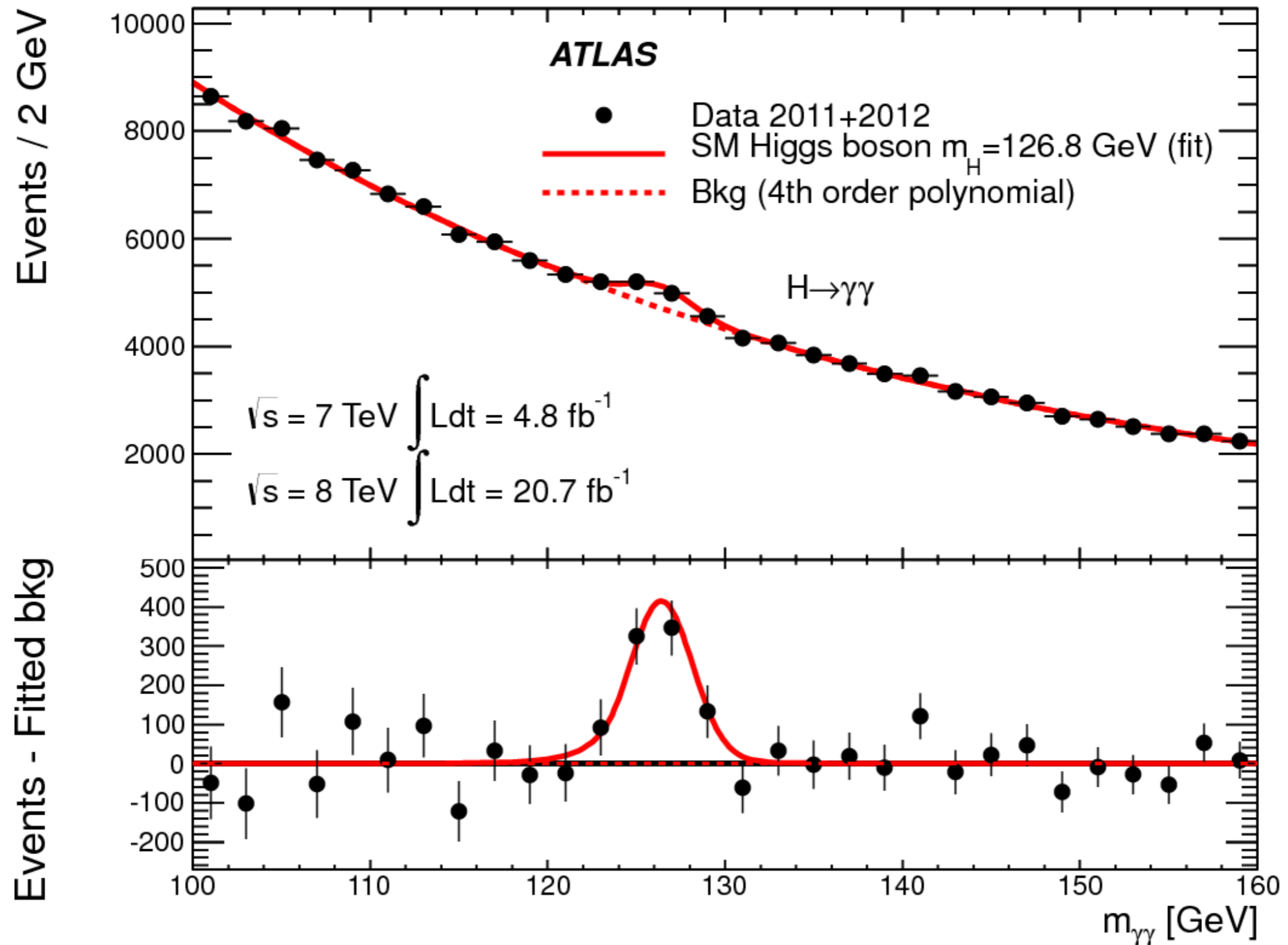
Nikhef



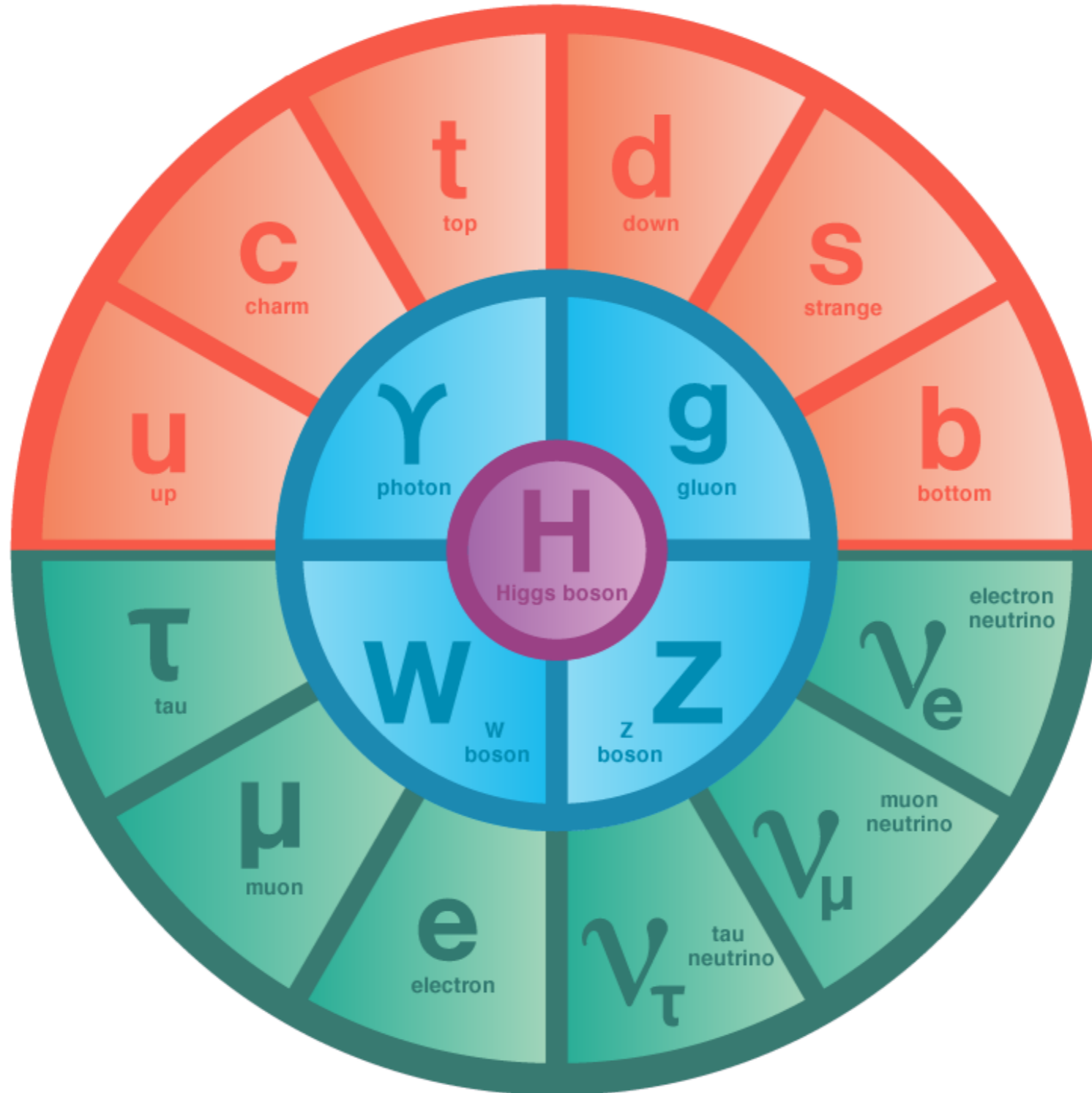
ATLAS
EXPERIMENT



GROOTSTE ATLAS SUCCES: HIGGS ONTDEKKING



LAATSTE STUKJE STANDARD MODEL



ONTDEKKING HALVE EEUW NA THEORETISCHE VOORSPELLING!

IS DE HIGGS DE STANDARD MODEL HIGGS?

- ▶ Is het ontdekte Higgs boson ook echt het **standard model Higgs boson**?
- ▶ Tot nu toe **alle tests doorstaan!** (massa, singaalsterkte, koppelingen, spin, pariteit)
- ▶ Hoe zit het met de **levensduur van het Higgs boson**?
- ▶ Veel modellen die nieuwe deeltjes introduceren voorspellen een andere levensduur voor het Higgs boson!
- ▶ **Hoe kunnen we deze levensduur meten?**

LEVENSDUUR BEPALEN: VLEGAFSTAND

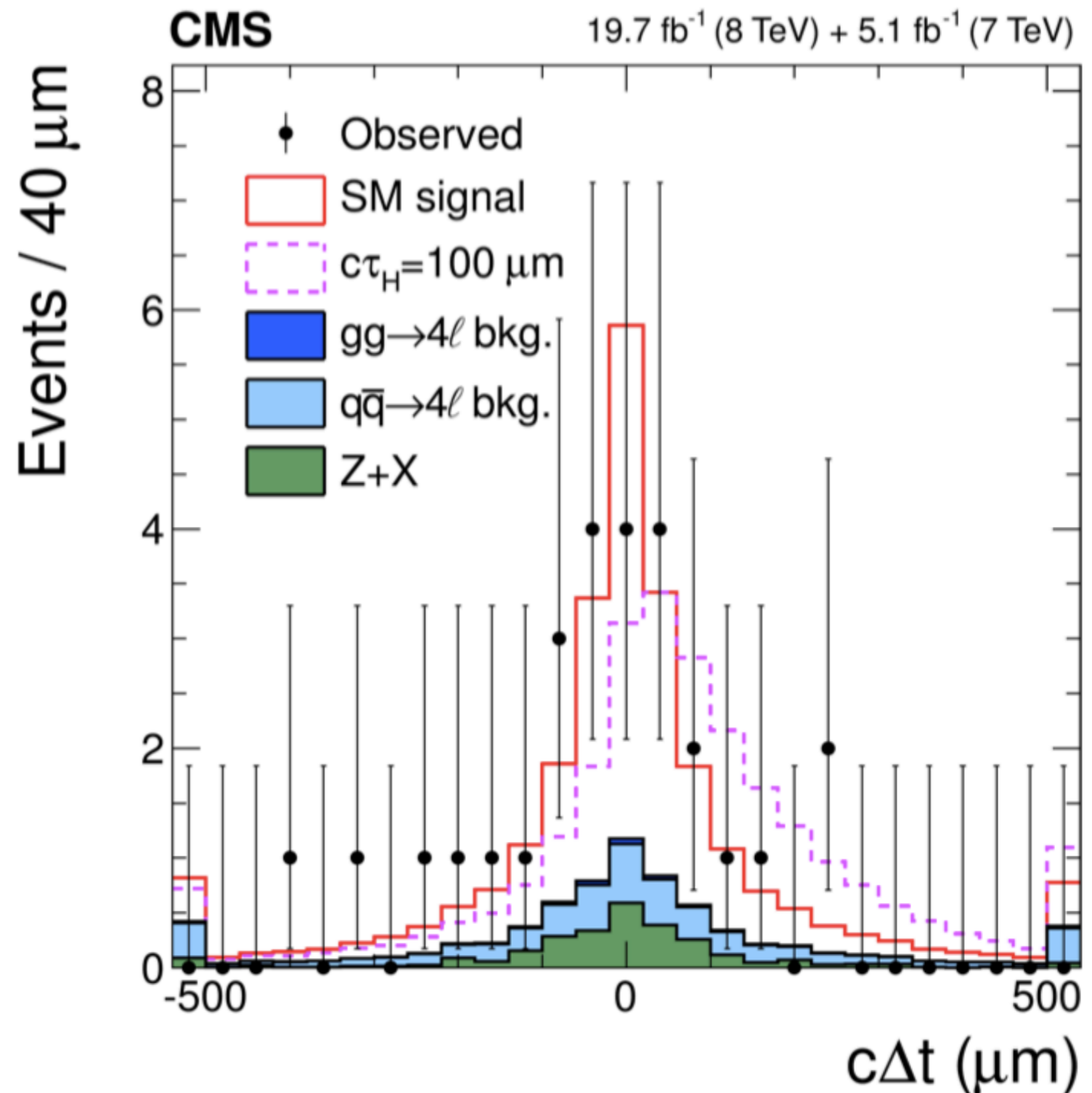
- ▶ De levensduur bepaald hoe ver het Higgs boson vliegt voordat het vervalt

- ▶ Voorspelling:

$$c\tau_H \sim 4.8 \cdot 10^{-8} \mu\text{m}$$

- ▶ Meting

$$c\tau_H < 57 \mu\text{m}$$



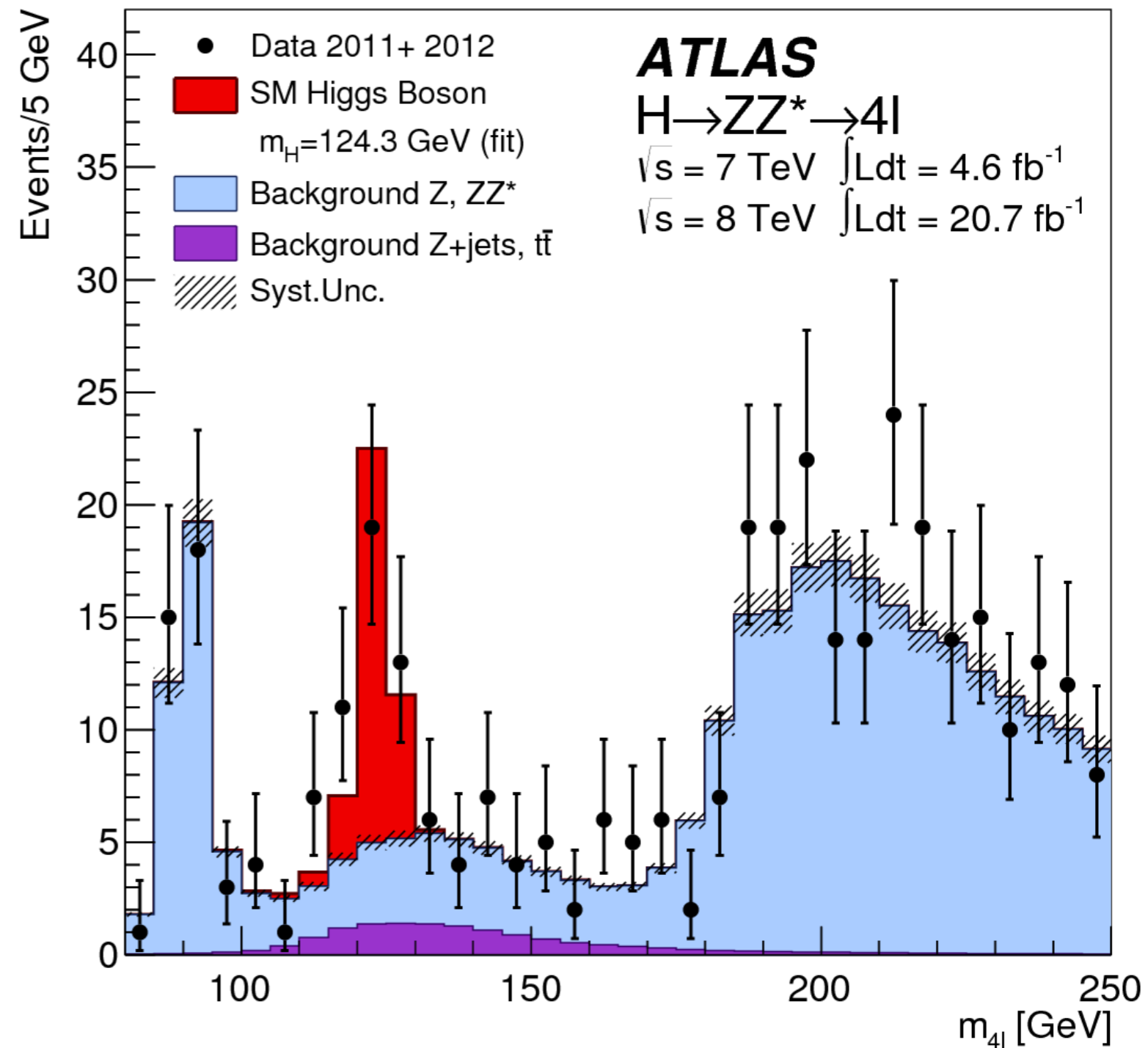
- ▶ De breedte van de Higgs piek in het massaspectrum wordt bepaald door de levensduur

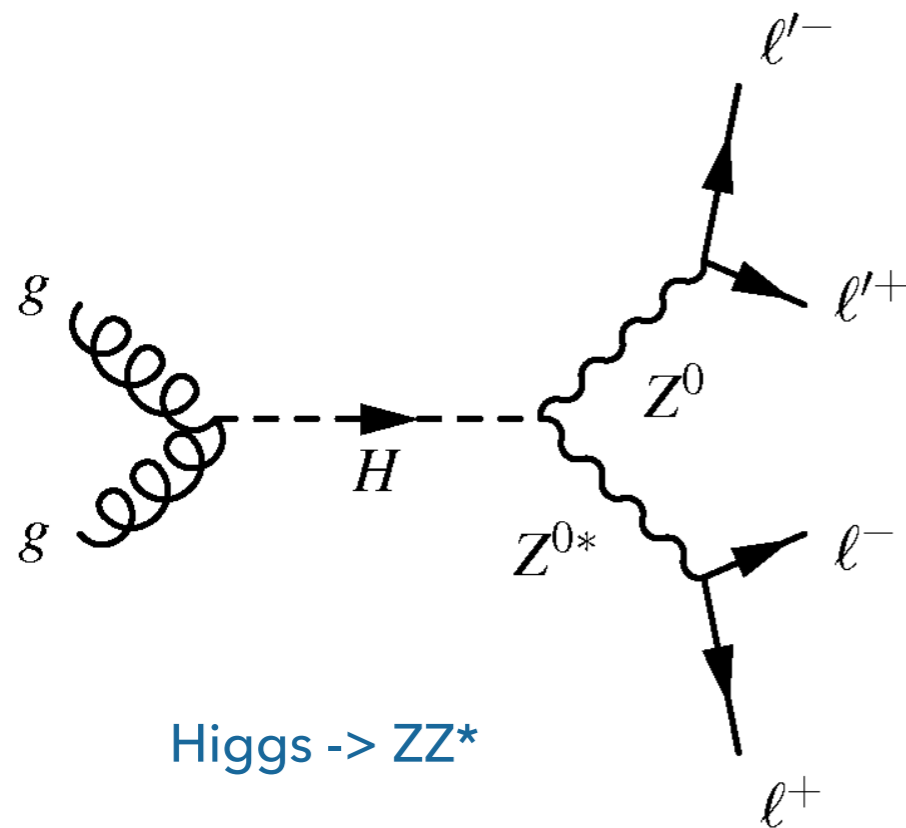
- ▶ Voorspelling

$$\Gamma_H \sim 4.1 \text{ MeV}$$

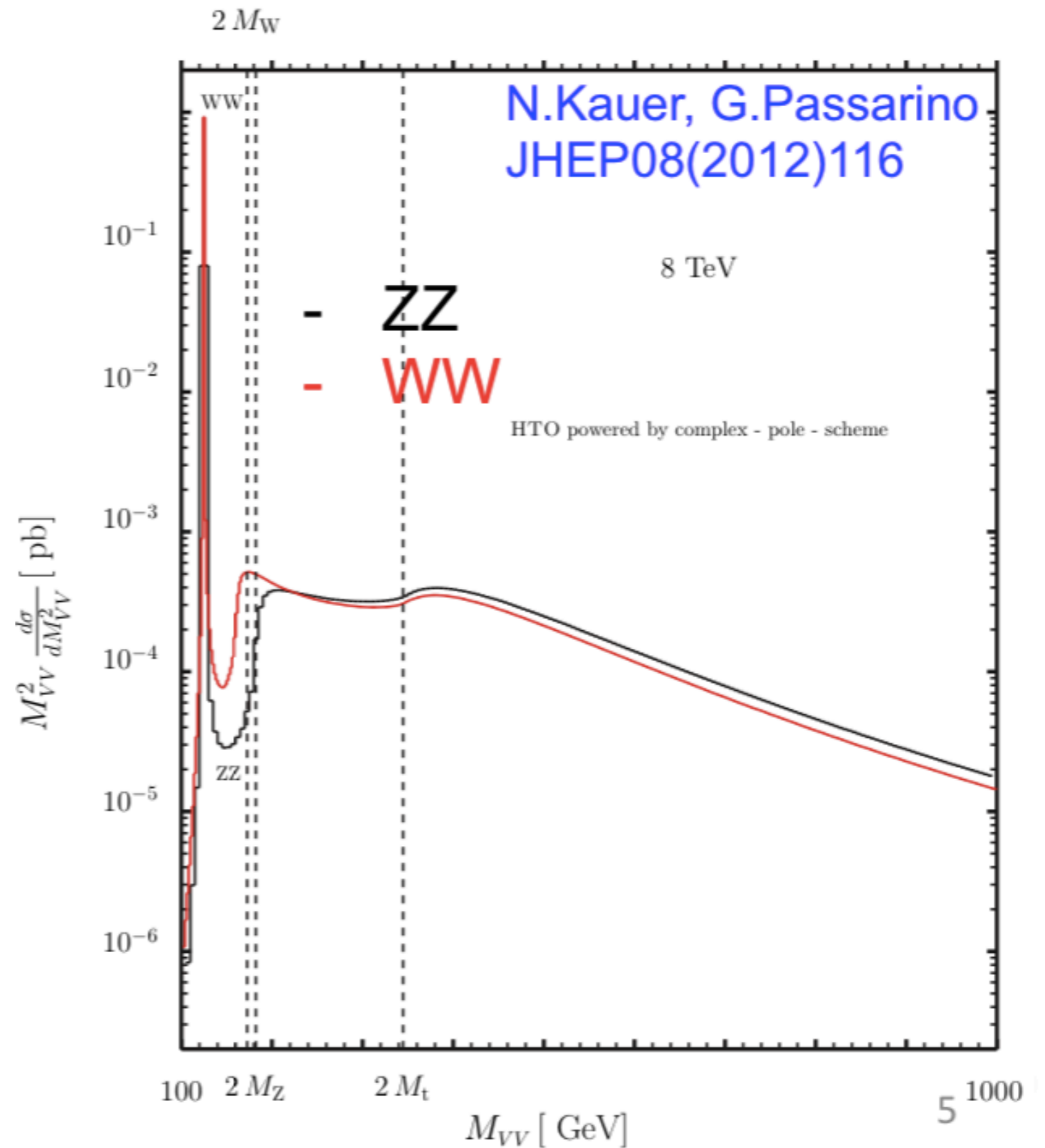
- ▶ ATLAS Meting

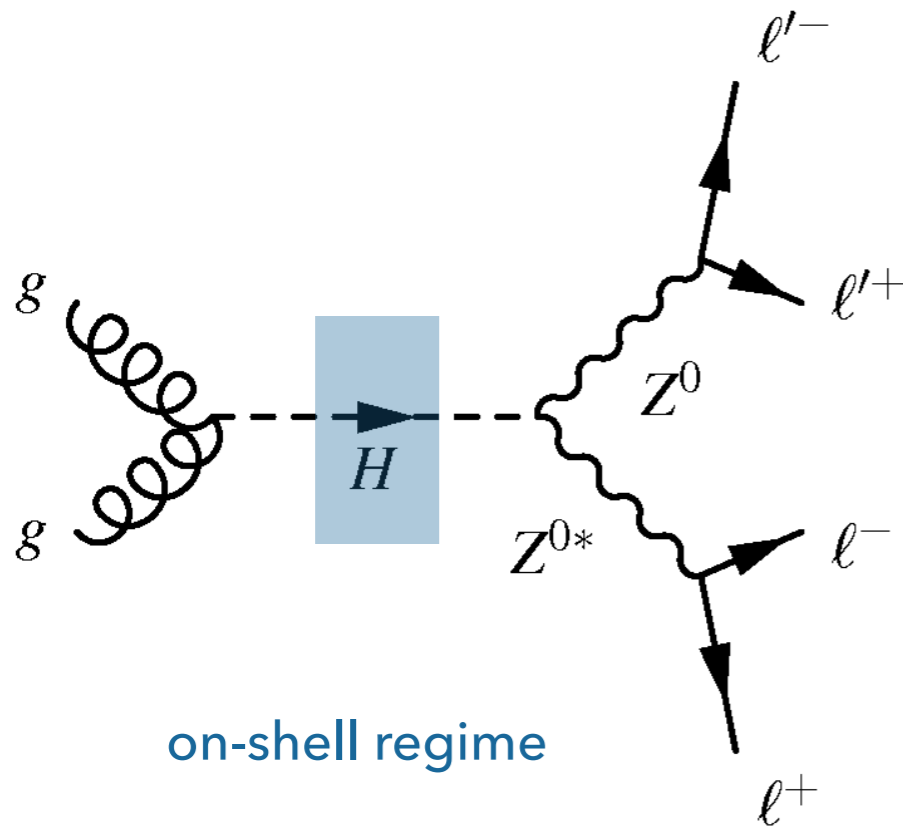
$$\Gamma_H < 2.6 \text{ GeV}$$





Higgs \rightarrow ZZ^*

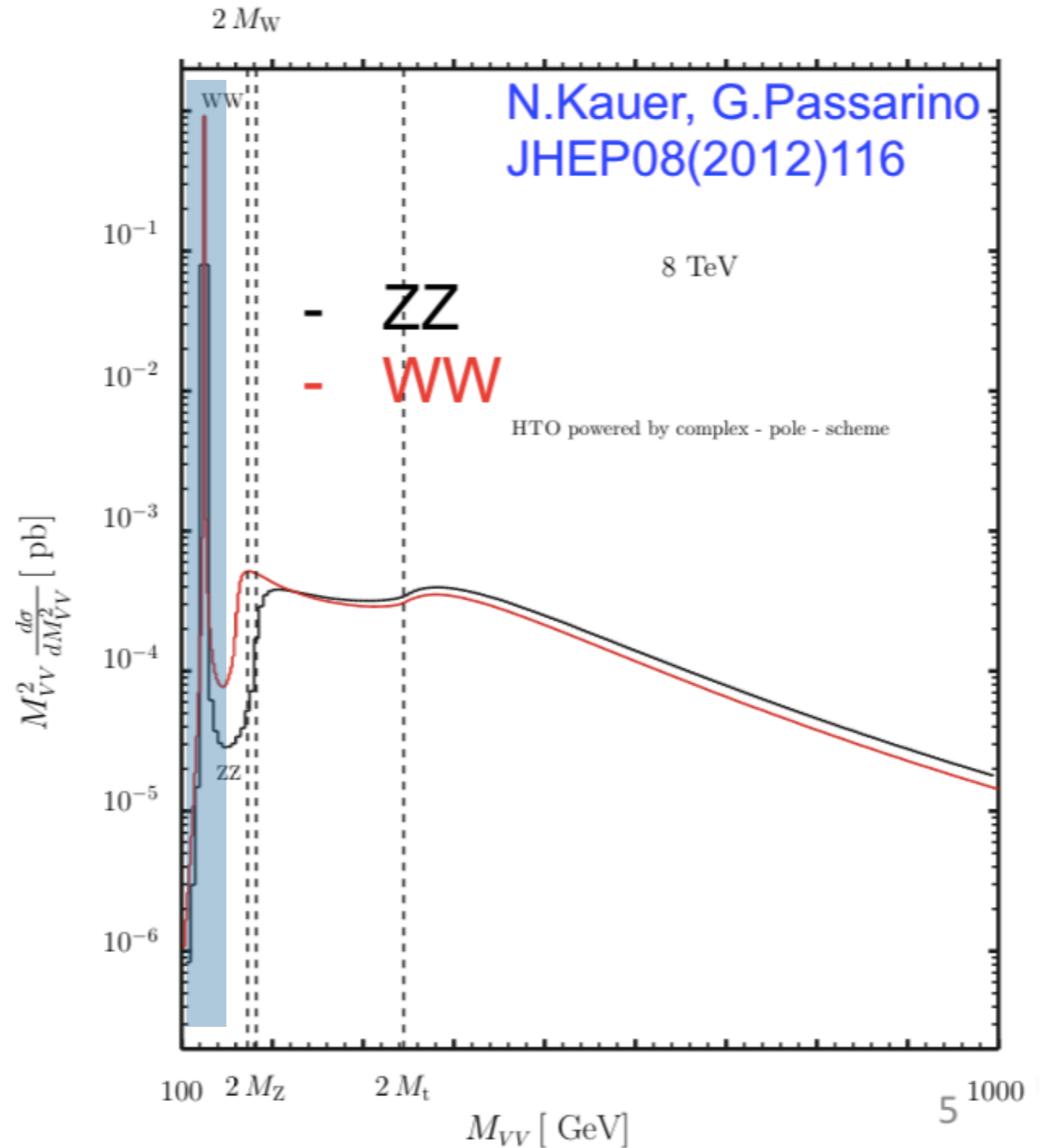


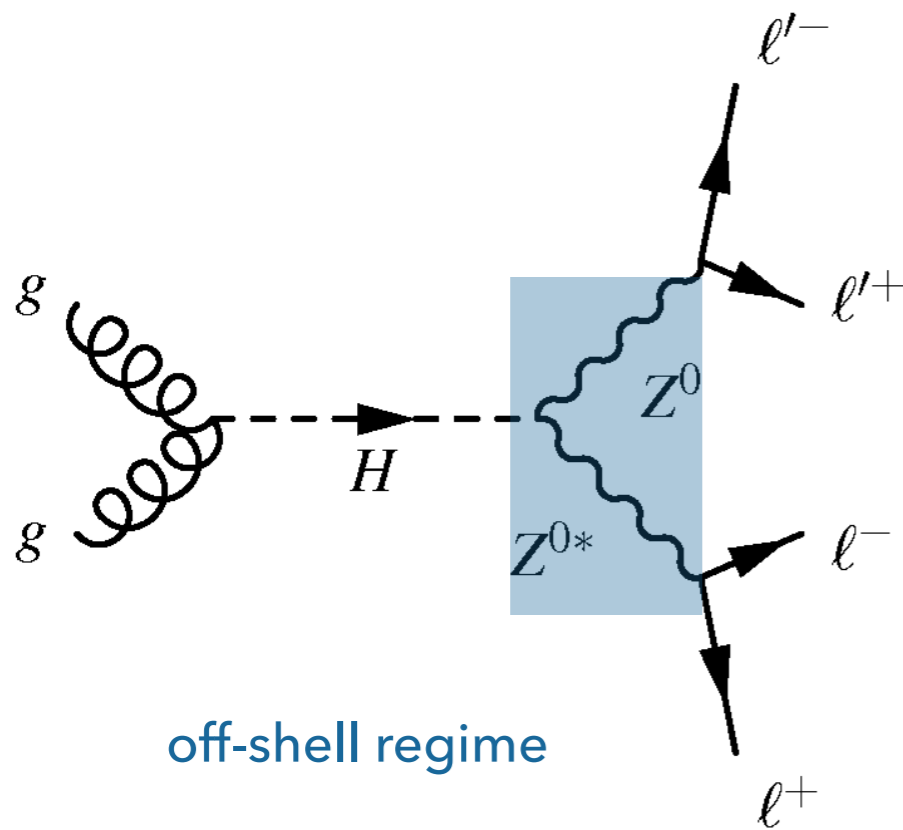


on-shell regime

Higgs massa

$\sim 125\text{GeV}$

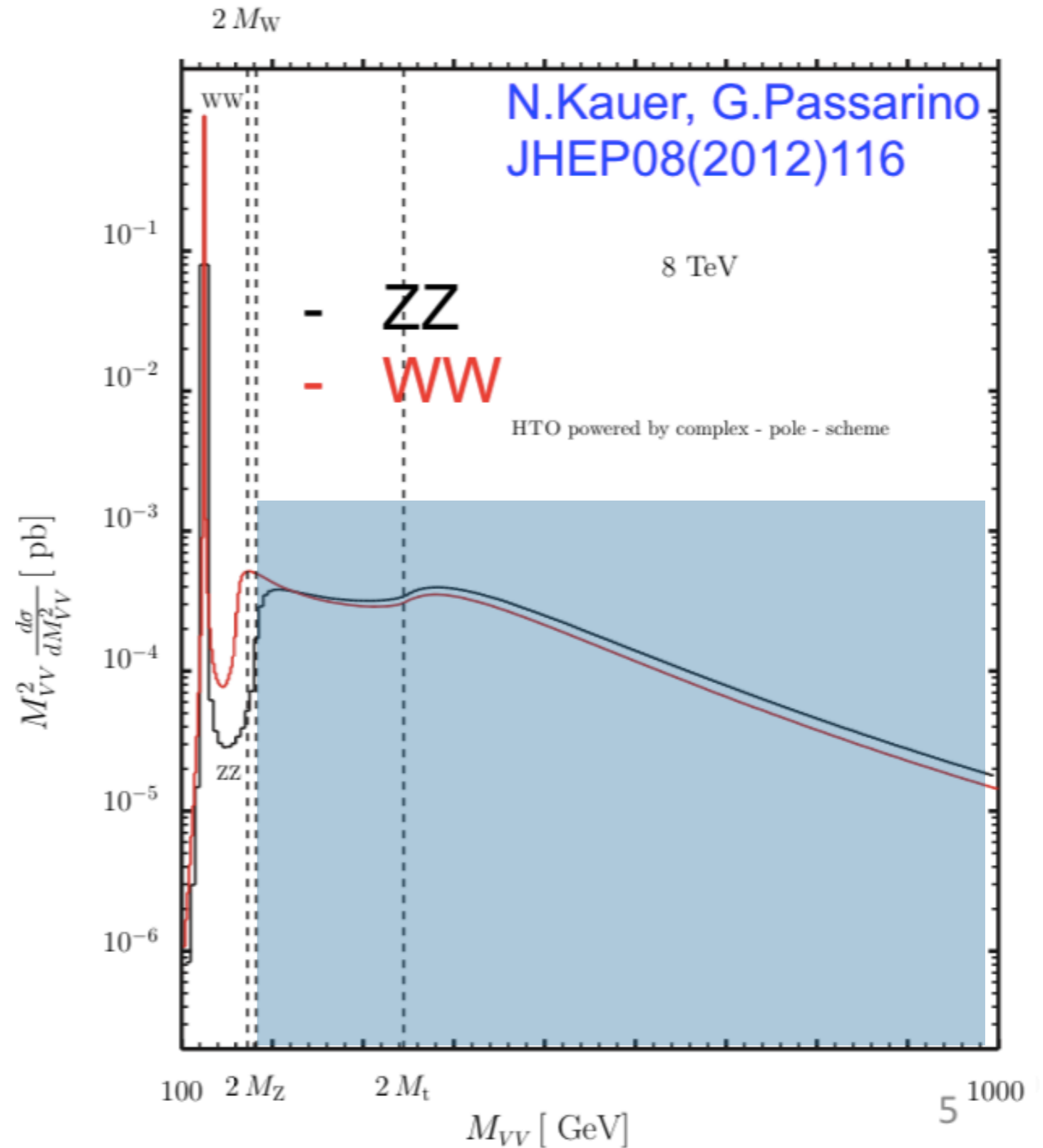




off-shell regime

> 2x Z massa

~200GeV+



- ▶ On-shell Higgs productie hangt af van de koppeling en de levensduur

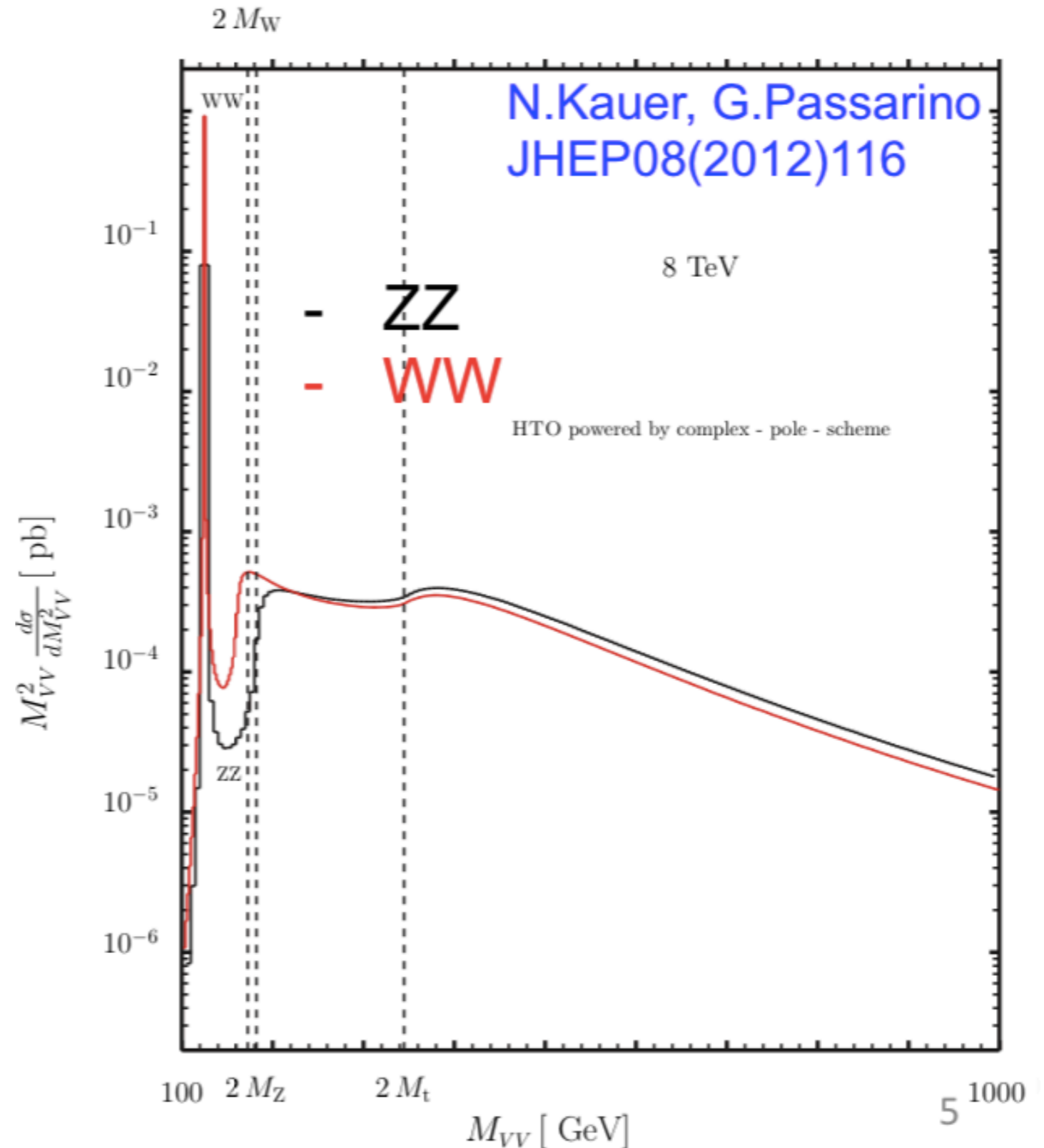
$$\frac{\sigma_{\text{on-shell}}^{gg \rightarrow H \rightarrow ZZ}}{\sigma_{\text{on-shell, SM}}^{gg \rightarrow H \rightarrow ZZ}} = \frac{\kappa_{g,\text{on-shell}}^2 \cdot \kappa_{V,\text{on-shell}}^2}{\Gamma_H / \Gamma_H^{\text{SM}}}$$

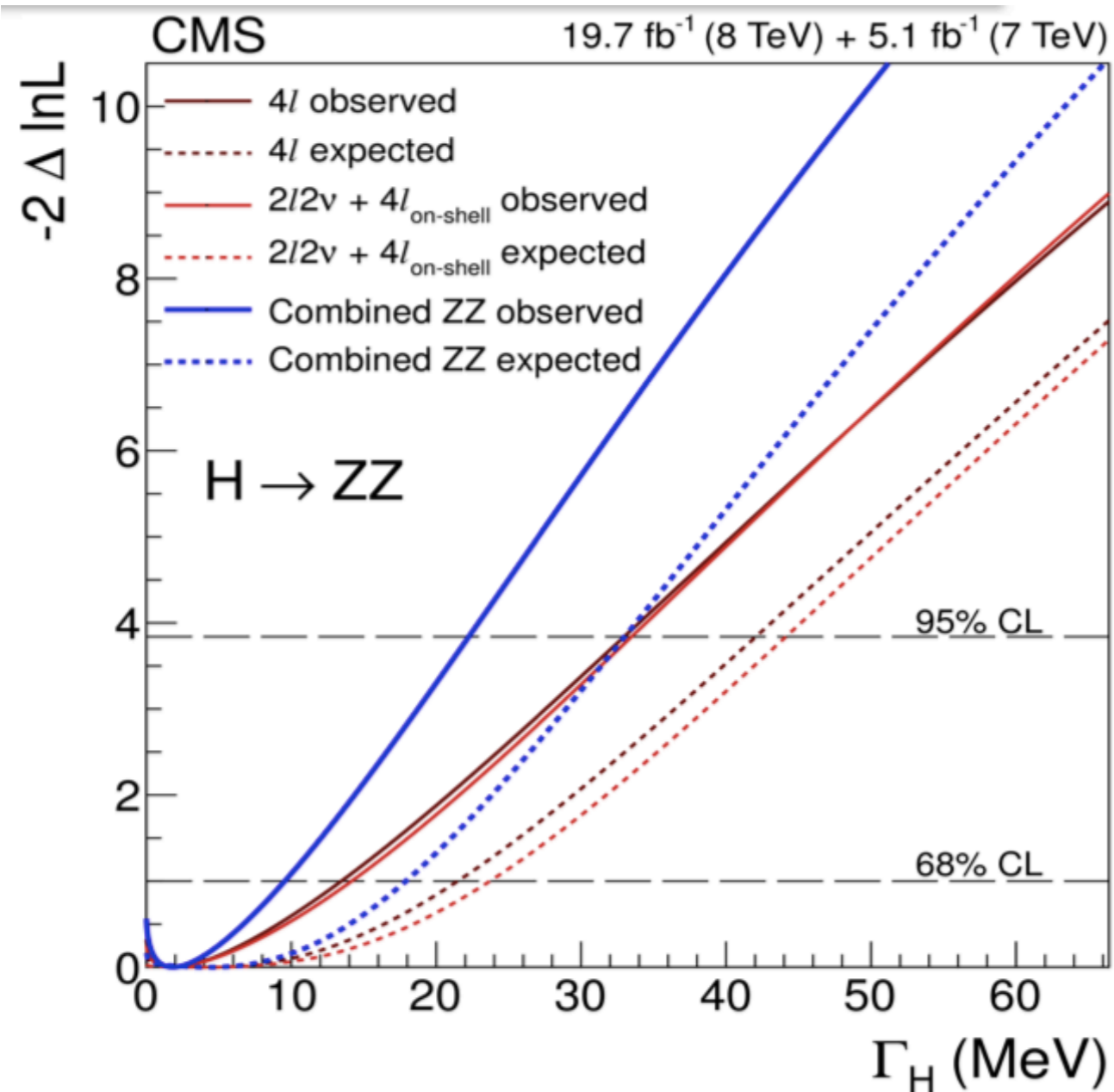
- ▶ Off-shell Higgs hangt alleen af van de koppeling

$$\frac{\sigma_{\text{off-shell}}^{gg \rightarrow H^* \rightarrow ZZ}}{\sigma_{\text{off-shell, SM}}^{gg \rightarrow H^* \rightarrow ZZ}} = \kappa_{g,\text{off-shell}}^2 \cdot \kappa_{V,\text{off-shell}}^2$$

- ▶ De ratio geeft de levensduur!

$$\frac{\sigma_{\text{off-shell}}^{gg \rightarrow H \rightarrow ZZ}}{\sigma_{\text{on-shell}}^{gg \rightarrow H \rightarrow ZZ}} \sim \Gamma_H$$





▶ Limiet van CMS:

$$\Gamma_H < 22 \text{ MeV}$$

▶ Limiet van ATLAS

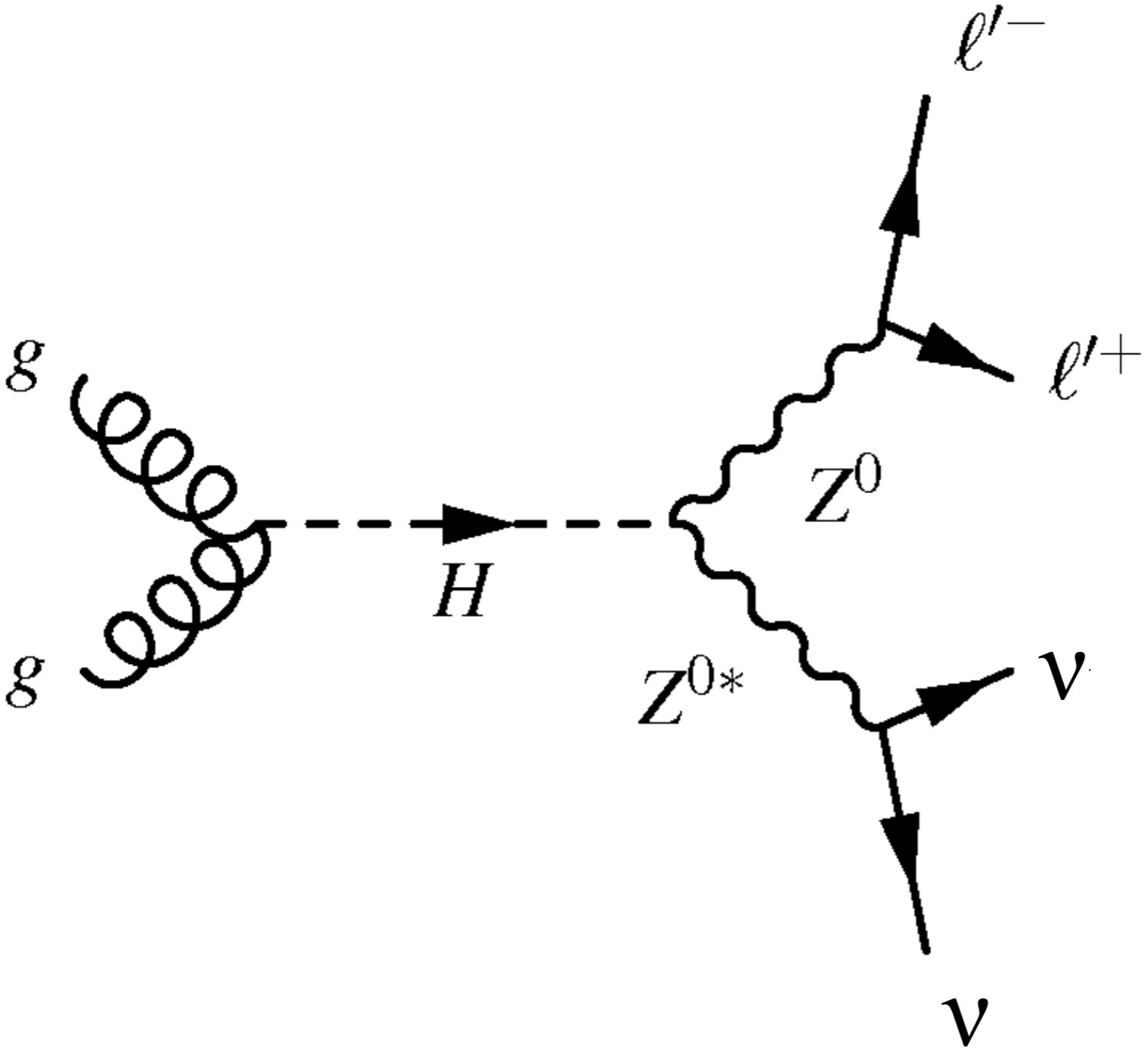
$$\Gamma_H < 22.7 \text{ MeV}$$

▶ Voorspelling

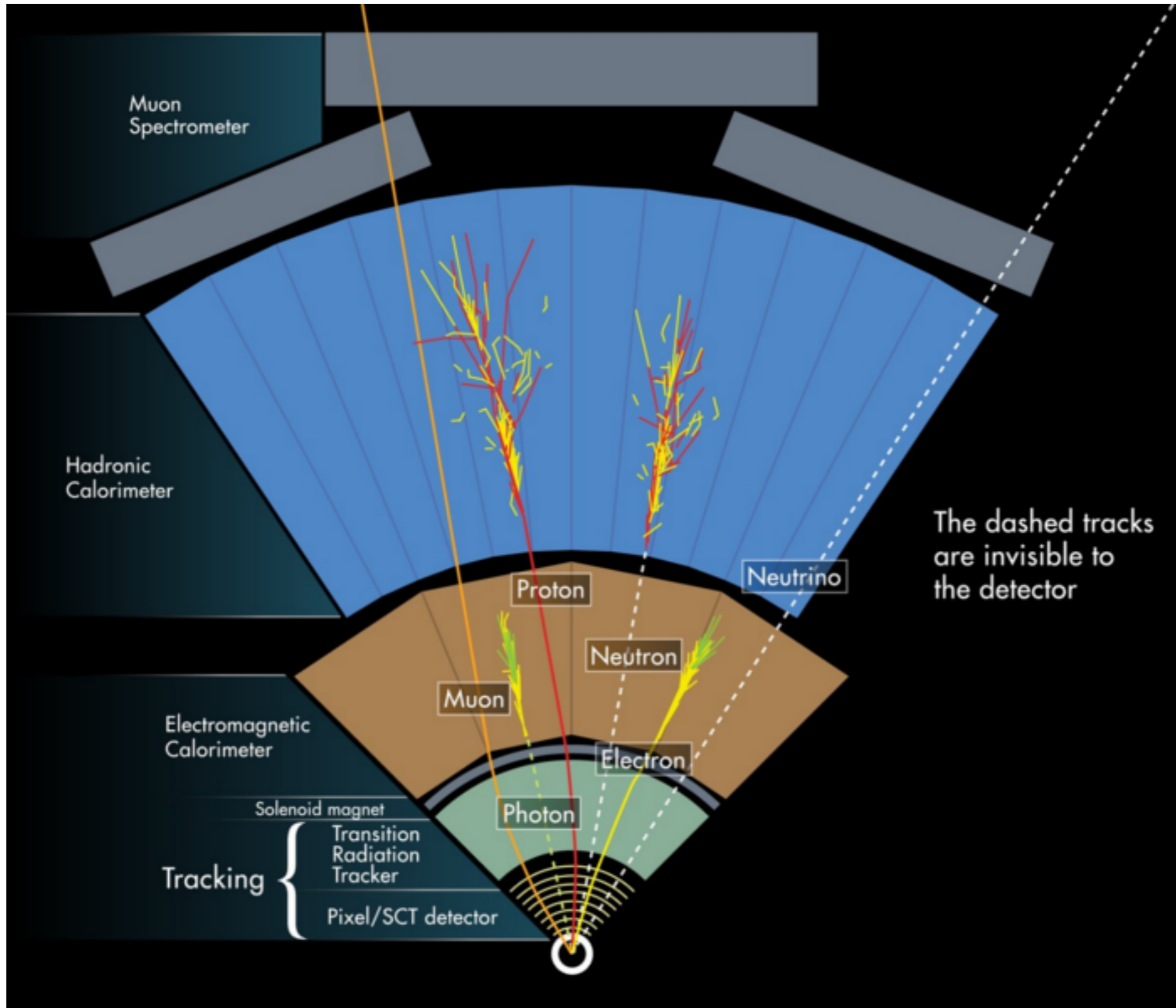
$$\Gamma_H \sim 4.1 \text{ MeV}$$

BACKUPS

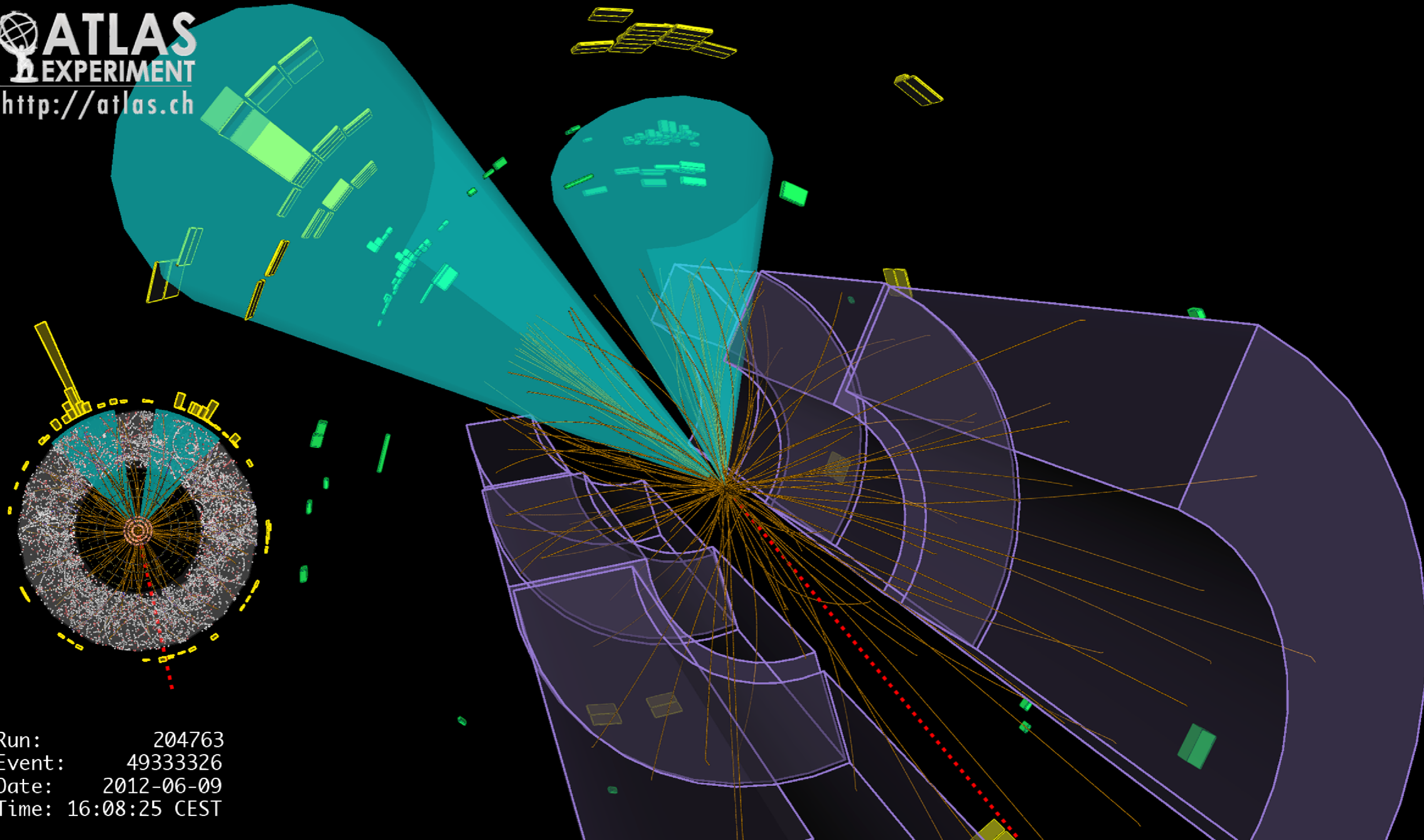
HIGGS BOSON: WAT DOE IK?



HOE DETECTEER JE DEELTJES?



 **ATLAS**
EXPERIMENT
<http://atlas.ch>



Run: 204763
Event: 49333326
Date: 2012-06-09
Time: 16:08:25 CEST