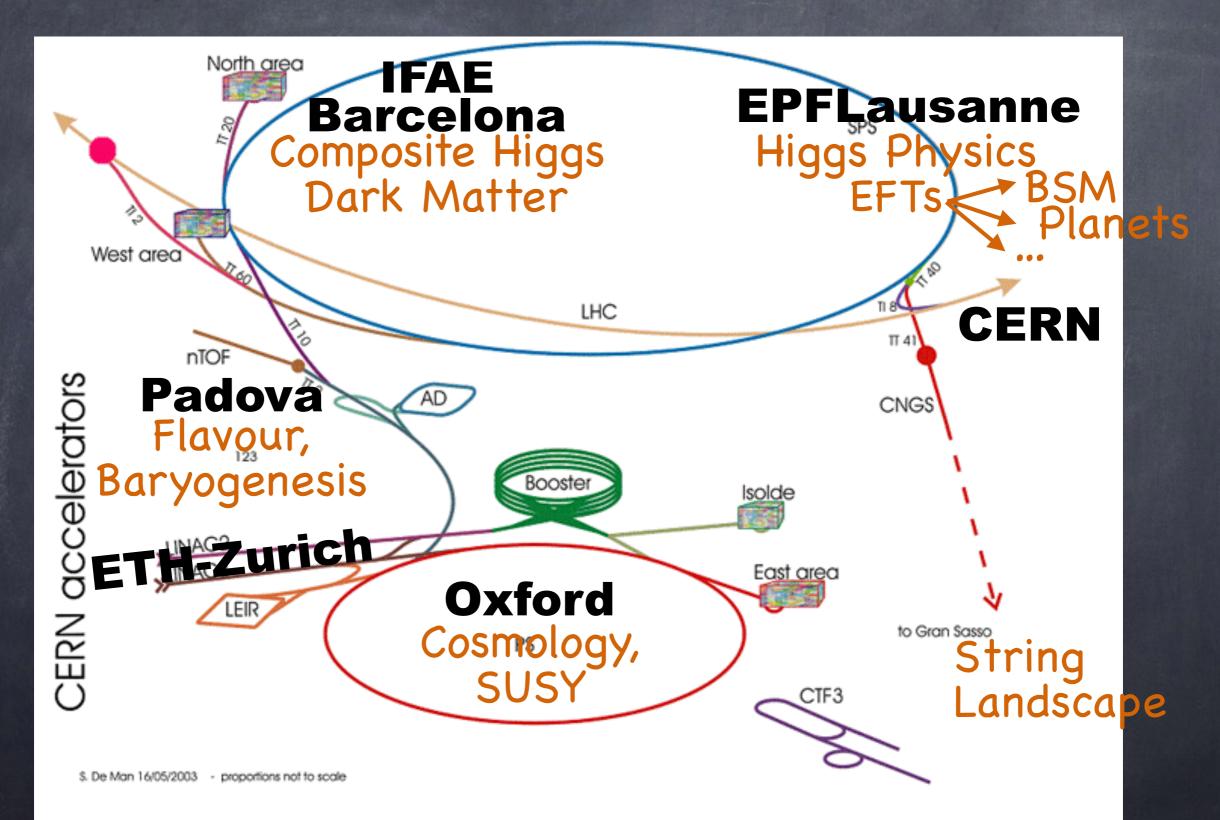
#### Francesco Riva



#### Francesco Riva

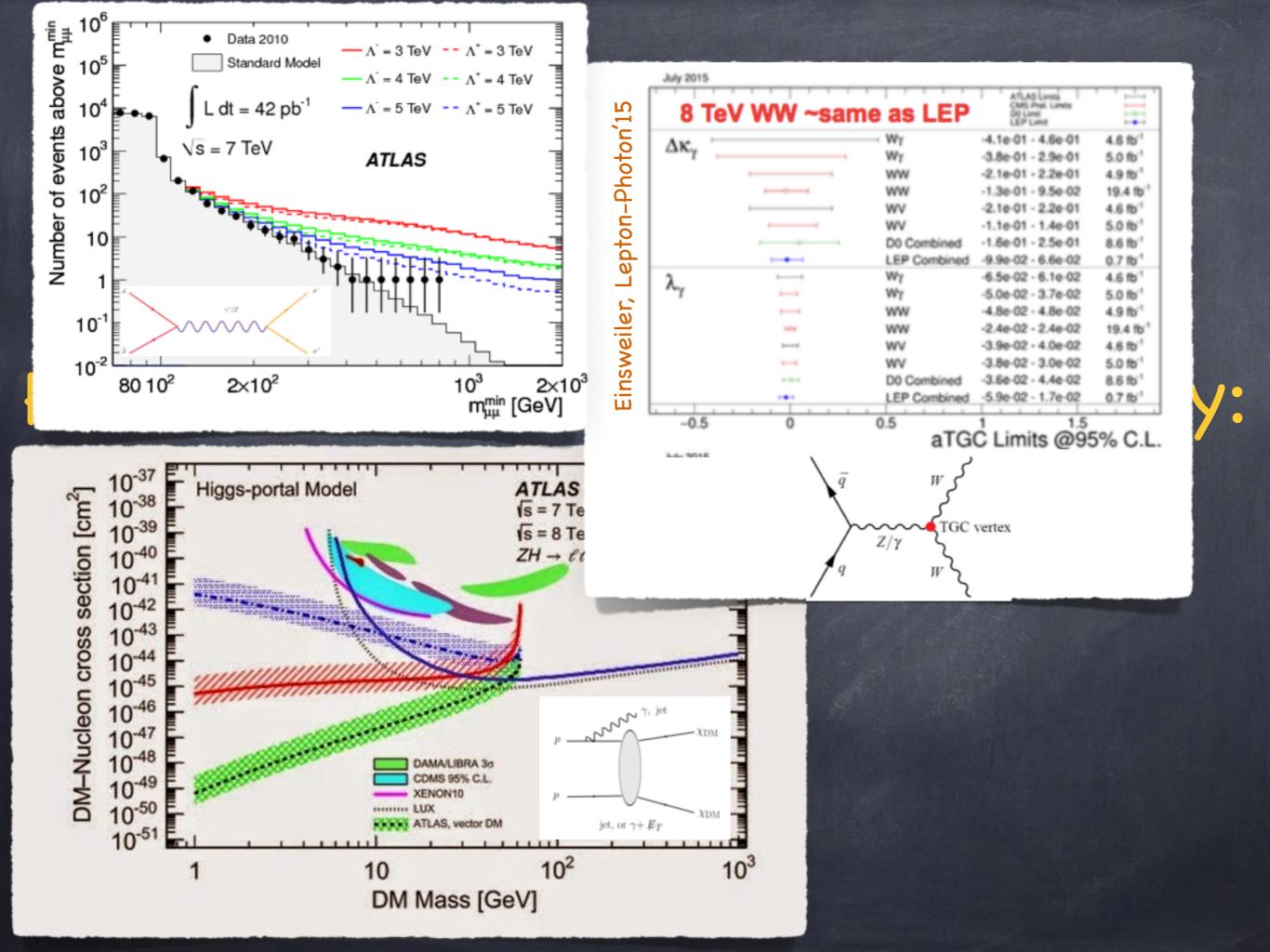
## Precision Searches at High-Energy: What is being searched for?

#### Francesco Riva

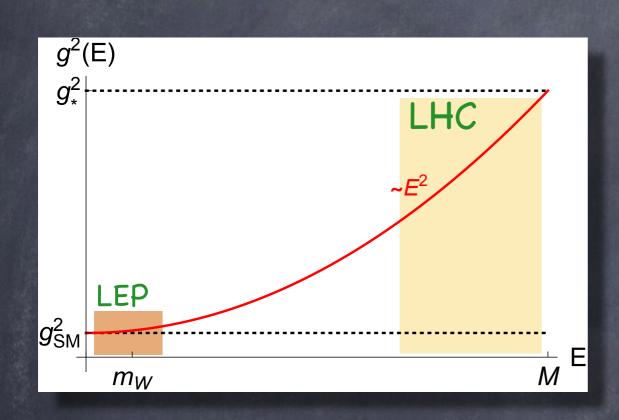
# Precision Searches at High-Energy: What is being searched for?

Motivated/Structured by BSM EFT.

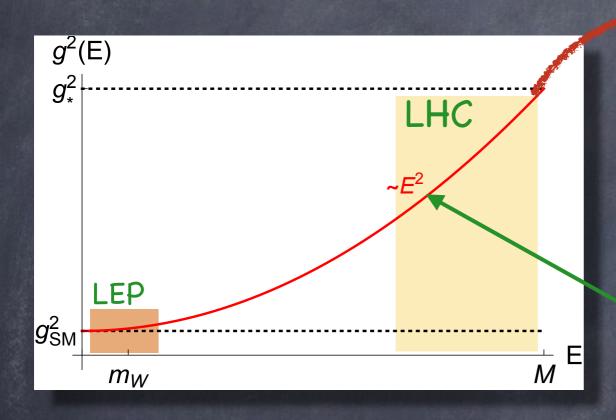
Compared to other searches through BSM EFT.



small sensitivity LHC better than LEP? High sensitivity High Energy
High Energy

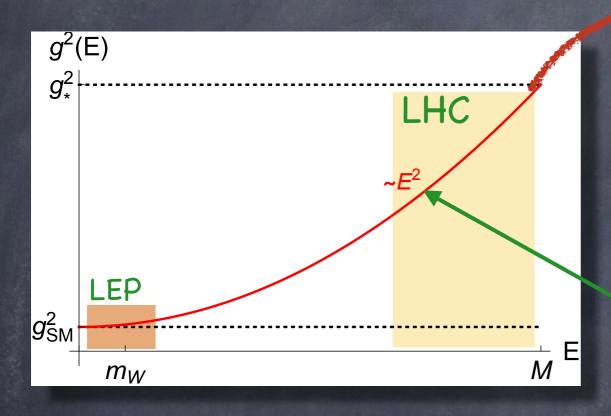


small sensitivity HC better than LEP? High sensitivity High Energy
High Energy



EFT: motivates of this this in terms of this

small sensitivity HC better than LEP? High sensitivity High Energy



EFT: motivates of this this in terms of this

$$\mathcal{A}=g^2(E)=g_{SM}^2\left(1+\frac{g_*^2}{g_{SM}^2}\frac{E^2}{M^2}\right) \qquad \begin{array}{c} M=\text{BSM scale}\\ g_*=\text{BSM coupling} \end{array}$$

Small Sensitivity at High energy requires strong coupling

Higgs as a (pseudo)  $H \rightarrow H + c$  Goldstone boson:

$$g_*D_\mu H$$



Higgs as a (pseudo)  $H \to H + c$   $g_* D_\mu H$   $\epsilon H$  K Goldstone hoson:

Goldstone boson:  $\frac{g_*^2}{M^2}(H^\dagger D_\mu H)^2 \quad \text{big} \qquad \blacktriangleright \ \lambda (H^\dagger H)^2 \quad \text{small}$ 

Large effects in WLWL scattering (which is why the LHC was built)

Higgs as a (pseudo)  $H \to H + c$   $g_* D_\mu H$   $\epsilon H$  X Goldstone boson:  $\frac{g_*^2}{M^2}(H^\dagger D_\mu H)^2 \quad \text{big} \qquad \blacktriangleright \ \lambda (H^\dagger H)^2 \quad \text{small}$ 

- Large effects in WLWL scattering (which is why the LHC was built)

Dipole-strong transverse qauge bosons?

$$g_*W_{\mu\nu}$$

$$D_{\mu} = \partial_{\mu} + igW_{\mu}$$

Higgs as a (pseudo)  $H \rightarrow H + c$  $g_*D_\mu H$ Goldstone boson:

$$g_*D_\mu H$$

$$\epsilon H \times$$

on: 
$$\frac{g_*^2}{M^2}(H^\dagger D_\mu H)^2 \quad \text{big} \qquad \blacktriangleright \ \lambda (H^\dagger H)^2 \quad \text{small}$$

$$ightarrow \lambda (H^\dagger H)^2$$
 small

Large effects in WLWL scattering (which is why the LHC was built)

Dipole-strong transverse qauge bosons?

 $g_*W_{\mu\nu}$ 

$$D_{\mu} = \partial_{\mu} + igW_{\mu}$$

Structurally consistent:

Inonu-Wigner Contraction ('53) (Like Poincaré->Galilei)

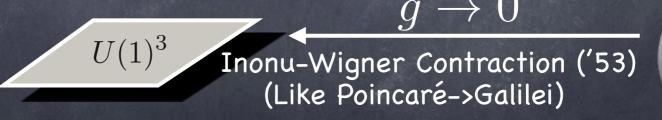
SU(2)

- Higgs as a (pseudo)  $H \rightarrow H + c$  $g_*\overline{D_\mu H}$ Goldstone boson:
  - $\epsilon H \times$
  - on:  $\frac{g_*^2}{M^2}(H^\dagger D_\mu H)^2 \quad \text{big} \qquad \qquad \lambda (H^\dagger H)^2$
  - Large effects in WLWL scattering (which is why the LHC was built)

- Dipole-strong transverse qauge bosons?
- $g_*W_{\mu\nu}$

 $D_{\mu} = \partial_{\mu} + igW_{\mu}$ 

Structurally consistent:



- Only irrelevant interactions are strong!
- Large effects at high-E:  $g_* \epsilon_{abc} W_\mu^{a \ \nu} W_{\nu \rho}^{b \ W^{c \ \rho \mu}}$

SU(2)

lacktriangle Higgs as a (pseudo) H 
ightarrow H + c

 $g_*D_\mu H$ 

 $\epsilon H \times$ 

Goldstone bo

-4.1e-01 - 4.6e-01 4.6 fb<sup>-1</sup> Δĸ., -3.8e-01 - 2.9e-01 5.0 fb<sup>-1</sup> -2.1e-01 - 2.2e-01 4.9 fb<sup>-1</sup> -1.3e-01 - 9.5e-02 19.4 fb -2.1e-01 - 2.2e-01 4.6 fb" -1.1e-01 - 1.4e-01 5.0 fb<sup>-1</sup> -1.6e-01 - 2.5e-01 8.6 fb<sup>-1</sup> LEP Combined -9.9e-02 - 6.6e-02 0.7 fb<sup>-1</sup> -6.5e-02 - 6.1e-02 4.6 fb" -5.0e-02 - 3.7e-02 5.0 fb<sup>-1</sup> -4.8e-02 - 4.8e-02 4.9 fb<sup>-1</sup> -2.4e-02 - 2.4e-02 19.4 fb -3.9e-02 - 4.0e-02 4.6 fb<sup>-1</sup> -3.8e-02 - 3.0e-02 5.0 fb<sup>-1</sup> -3.6e-02 - 4.4e-02 8.6 fb<sup>-1</sup> aTGC Limits @95% C.L.

gauge bosons
Structure

Only irreleva

> Dipole-strong

q  $Z/\gamma$ TGC vertex

These searches are valuable for this type of models (only)

 $I)^2$  small

he LHC was built)

$$= \partial_{\mu} + igW_{\mu}$$

 $W_T \sim gg_* rac{E^2}{M^2}$ 

Large effects at high-E:

 $\frac{g_* \epsilon_{abc} W_{\mu}^{a\nu} W_{\nu\rho}^{o} W^{c\rho\mu}}{M^2}$ 

## Strong Coupling for Vectors?

Side effects

de effects 
$$\frac{g_*\epsilon_{abc}W_\mu^{a\,\nu}W_{\nu\rho}^bW^{c\,\rho\mu}}{\frac{g_*^2}{M^2}} \frac{g_*^2}{M^4}(W_{\mu\nu})^4$$
 
$$\sim gg_*\frac{E^2}{M^2}$$
 
$$g_*^2\frac{E^4}{M^4}$$

In the cross-section, for  $E^2/M^2 > g/g_*$ :

 $SM^2$ <<dim-6 x SM << dim-6² = dim-8 x SM << dim-8² dominate

(but EFT expansion ok: after that, series converges...)

#### Conclusions

Precision tests at the LHC



BSM perspective

EFT motivation/structure

