Vector Boson Scattering Measurements to Probe New Physics

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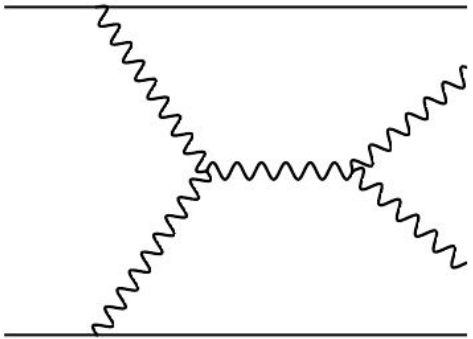
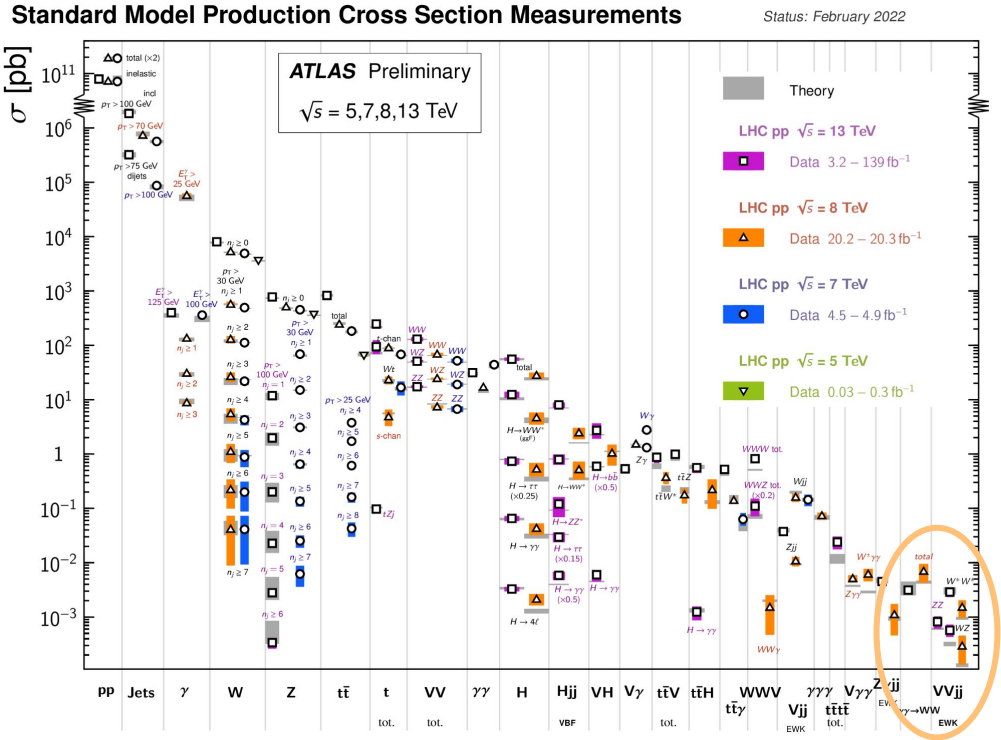
Vector Boson Scattering

Very rare processes in the SM

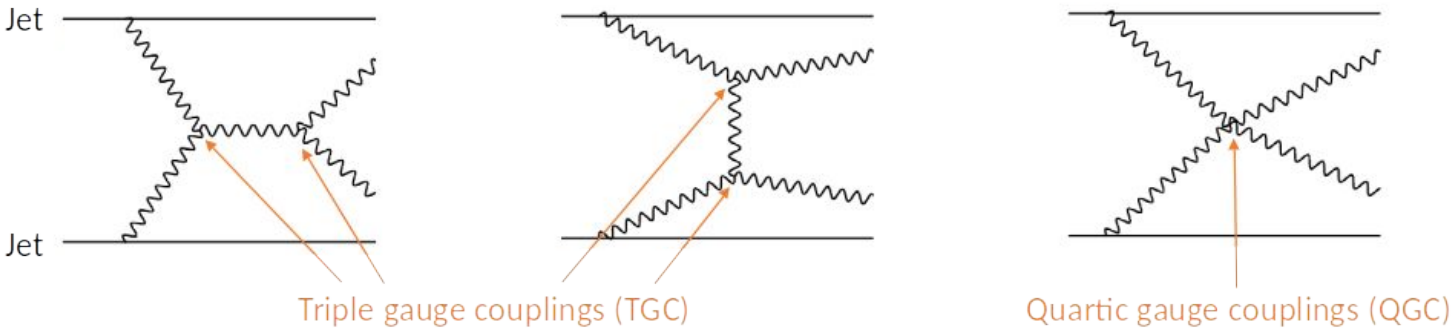
Electroweak production of vector bosons associated with jets: scattering («collision») of vector bosons



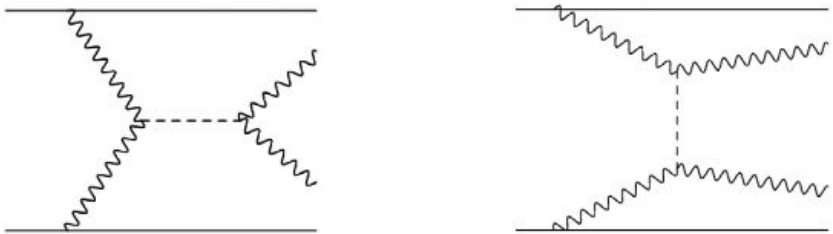


VBS: a Unique Probe to EW Interactions

Lots of different gauge couplings can be involved



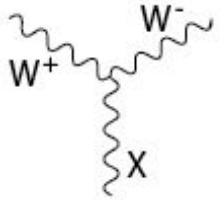
Even couplings with the Higgs boson

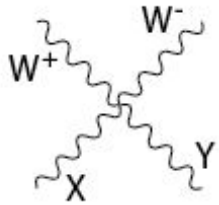


These graphs are necessary to allow VBS in the SM !

New Physics in EW Interactions

- Not all EW couplings are allowed in the SM

aTGC 

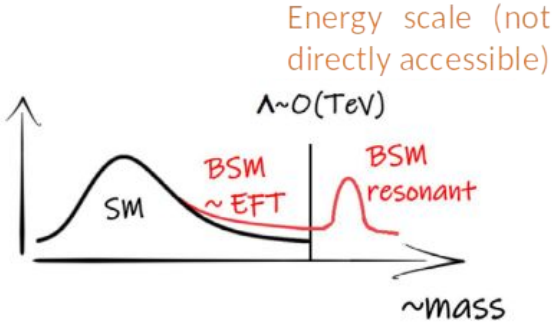
aQGC 

- Parameterization of New Physics effects in VBS: EFT approach

$$\mathcal{L}_{EFT} = \mathcal{L}_{SM} + \frac{1}{\Lambda}\mathcal{L}_5 + \frac{1}{\Lambda^2}\mathcal{L}_6 + \frac{1}{\Lambda^3}\mathcal{L}_7 + \frac{1}{\Lambda^4}\mathcal{L}_8 + \ldots$$

  - VBS: sensitivity to dimension 8 operators
  - Basis: Eboli model

	SM				Not SM				
Operators	WWWW	WWZZ	WWγγ	WWγZ	ZZZZ	ZZZγ	ZZγγ	Zγγγ	γγγγ
FS0, FS1	✓	✓			✓				
FM0, FM1, FM7	✓	✓	✓	✓	✓	✓	✓		
FM2, FM3, FM4, FM5		✓	✓	✓	✓	✓	✓		
FT0, FT1, FT2	✓	✓	✓	✓	✓	✓	✓	✓	✓
FT5, FT6, FT7		✓	✓	✓	✓	✓	✓	✓	✓
FT8, FT9					✓	✓	✓	✓	✓

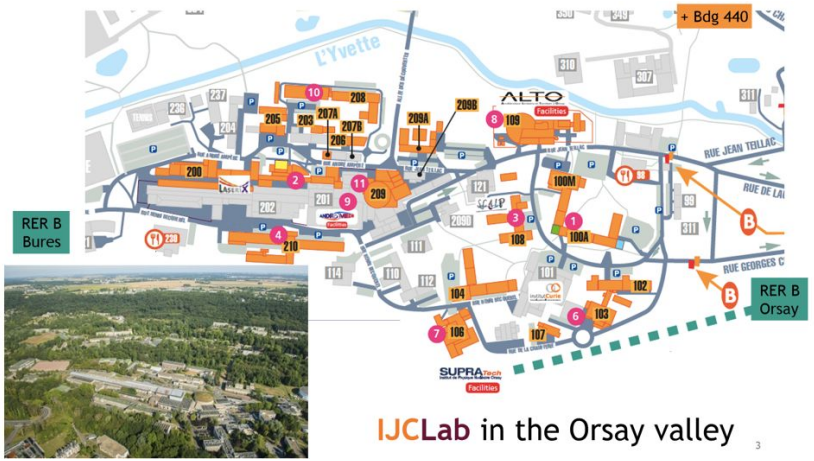


Context

- The lab: IJCLab (Laboratoire de physique des deux infinis Irène Joliot-Curie)
  - Largest particle physics lab in France
  - Located in Orsay (Paris area)

- The ATLAS group
  - ~30 physicists (staff + post-doc + PhD)
  - Higgs physics, VBS physics
  - Strong commitments to Phase 2 upgrades: ITK, HGTD, LAr

- The VBS Team
  - 3 staff physicists, 1 post-doc, 4 PhD students



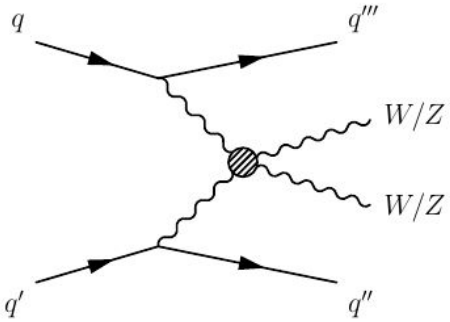
IJCLab in the Orsay valley

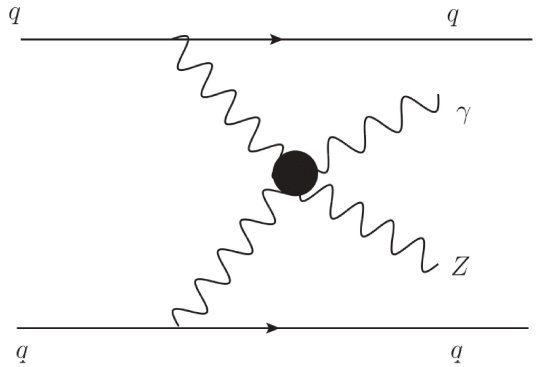
- Collaborators
  - The position is funded by ANR grant “EFT@LHC”
  - Collaboration with other French ATLAS groups and theorists specialized in EFTs

Scientific Project I

Develop Run-3 VBS analyses to maximise sensitivity to EFT effects

- Channels with strongest EFT sensitivity:
  - Semi-leptonic VBS: WW/WZ/ZZ with $V_1 \rightarrow$ leptons and $V_2 \rightarrow$ hadrons
  - Zγ with $Z \rightarrow \nu\nu$





- Largest sensitivity at high energies
  - Work on boosted topologies
  - High-pT objects
  - Large potential for significant improvements wrt Run-2 analyses

Scientific Project II

(Re)use of EFT constraints

- Global EFT constraints
  - Mapping VBS EFT constraints to SMEFT
  - Understand relations with other processes

- Simplified likelihoods
  - Full EFT likelihoods usually too complex to be easily re-used by theorists
  - Several approaches exist to simplify them
  - Towards publication of accurate simplified likelihoods

The position

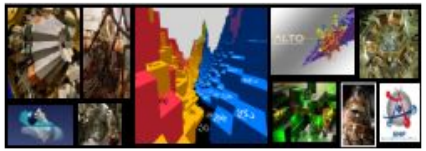
- 2 years fixed term post-doc contract
- Will be opened in a few weeks
- Start date in Spring, negociable

Backup

IJCLab

7 Scientific Poles

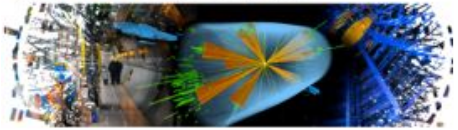
PHYSIQUE NUCLÉAIRE
NUCLEAR PHYSICS ~ 70



A2C Astroparticles, Astrophysics & Cosmology ~ 60

Accelerator Physics

PHE Physique des Hautes Energies
High Energy Physics ~ 100



Theory ~ 80

Energy and Environment

Health Physics ~ 25

~ 110 PhD