Sensitivity to anomalous WWγ couplings at the LHC

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- Effective lagrangian
- Observables sensitive to anomalous coupling
- Outlook

WWγ Triple Gauge Boson Vertex

Potential scenario:

- New physics modify the self-interaction of gauge bosons
- It occurs at an energy scale well above that probed experimentally
- Can be integrated out $\rightarrow$ result expressed as set of anomalous vertices

Most general effective Lagrangian (conserving C and P separately):

$$\mathcal{L}/g_{WW\gamma} = i(W^{\dagger}_{\mu\nu}W^{\mu}A^{\nu} - W_{\mu\nu}W^{\dagger\mu}A^{\nu}) + i\kappa^{\gamma}W^{\dagger}_{\mu}W_{\nu}A^{\mu\nu} + i\frac{\lambda^{\gamma}}{M_W^2}W^{\dagger}_{\rho\mu}W^{\mu}{}_{\nu}A^{\nu\rho}$$

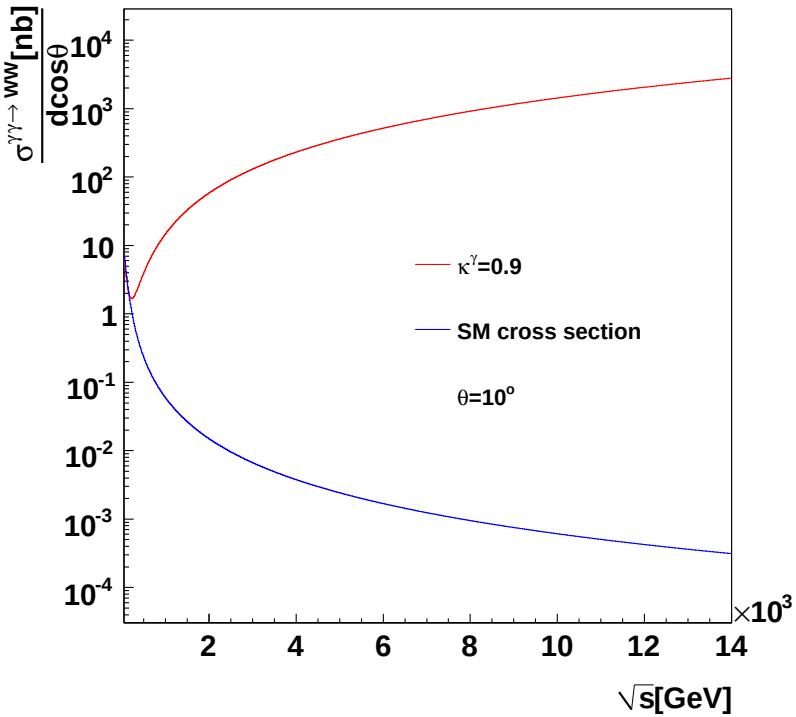
$$\begin{aligned} W_{\mu\nu} &\equiv \partial_{\mu}W_{\nu} - \partial_{\nu}W_{\mu} \\ g_{WW\gamma} &= -e \end{aligned}$$

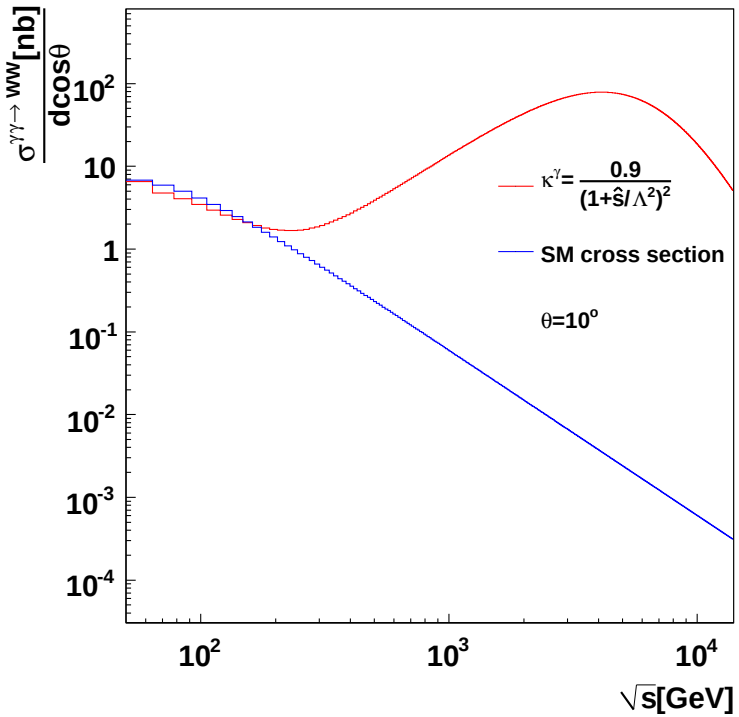
Recovering SM:

- $\kappa^{\gamma} \rightarrow 1$
- $\lambda^{\gamma} \rightarrow 0$

Unitarity breaking

- Small modification of $\kappa^\gamma, \lambda^\gamma$ leads to a violation of unitarity



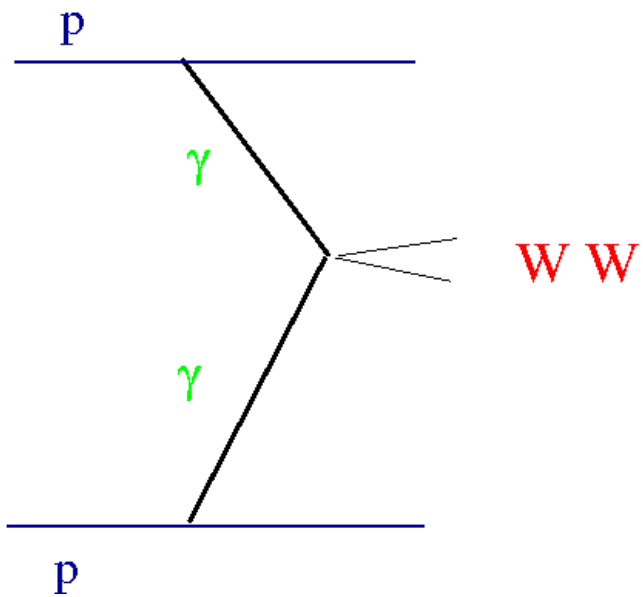


- To avoid that, the deviation from SM $\kappa^\gamma, \lambda^\gamma$ supplemented with form factors
- Precise form not known - a conventional form:

$$\kappa^\gamma \to \frac{\kappa^\gamma}{(1+\hat{s}/\Lambda^2)^2}, \quad \lambda^\gamma \to \frac{\lambda^\gamma}{(1+\hat{s}/\Lambda^2)^2}$$

QED WW production at the LHC

In the process $p + p \to p\gamma\gamma p \to pW^+W^-p$



- Moving charged particle is accompanied by the photon field, photons interact
- $\gamma\gamma \to W^+W^-$ - three diagrams in SM

- Using roman pots to detect the protons
- Event topology:
  - lepton + jet
  - lepton + lepton
  - jet+jet - rejected because it has large QCD background
- $\to$ trigger on leptons from the W decays

Monte Carlo implementation

- The photon spectrum is calculated in WWA (Weizsäcker-Williams approximation)
- The photon flux implemented in the DPEMC Monte Carlo
- DPEMC interfaced with O'Mega
  - Generic code that allows to generate LO matrix elements for a given process
  - User can implement any model by defining Feynman rules
  - SM, SM with anomalous WWV, SUSY, QCD...

Aim of the study:

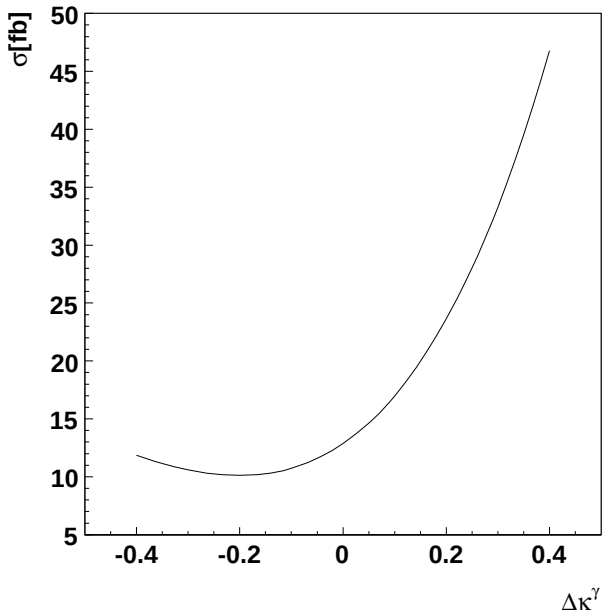
- To find observables that are sensitive to the anomalous couplings

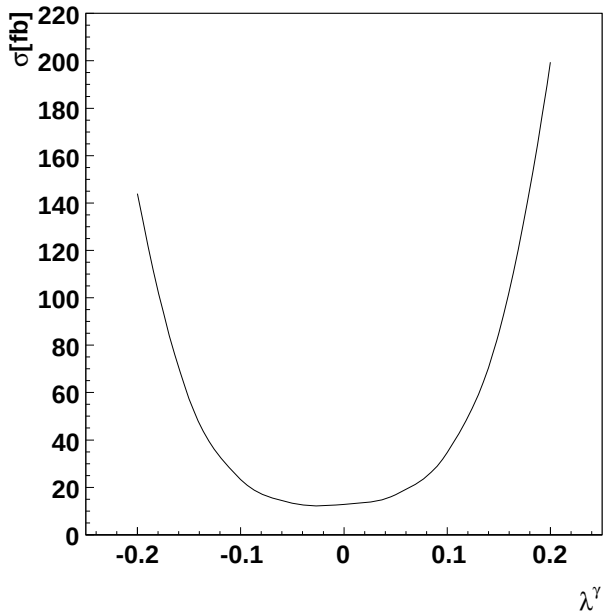
Total cross section $pp \to pWWp$

- $\sigma^{pp\to pWWp} = 12.8\,\text{fb}$ (SM: κ^γ=1, $\lambda^\gamma = 0$)
- Reminder: luminosity at the LHC $\mathcal{L} = 5 \ldots 500\text{fb}^{-1}$

Introducing new notation:

- $\Delta\kappa^\gamma$ deviation from the standard model $\to \kappa^\gamma = 1 + \Delta\kappa^\gamma$



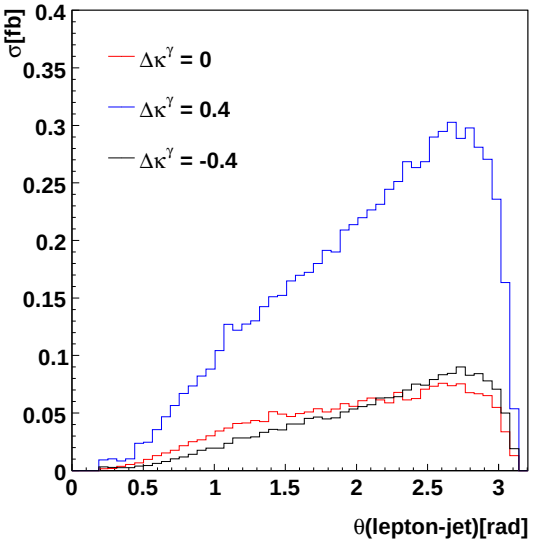


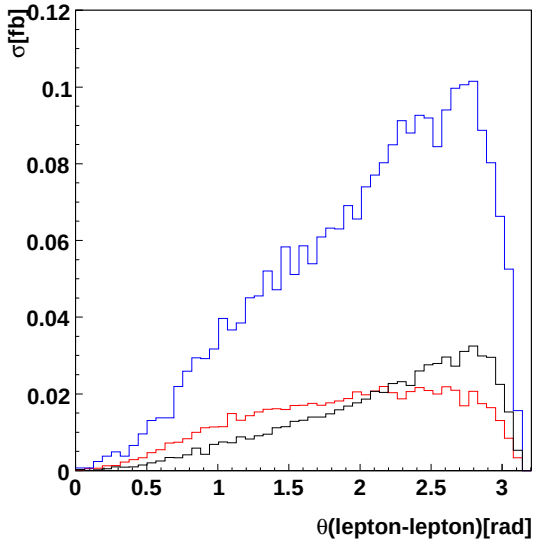
Current limits:

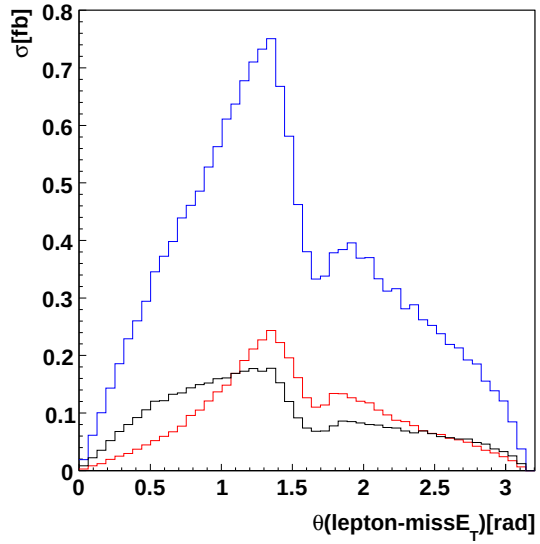
CDF(2007)	-0.46 $< \Delta\kappa^\gamma <$0.39	-0.18 $< \lambda^\gamma <$ 0.17
DELPHI	-0.19 $< \Delta\kappa^\gamma <$0.84	-0.36 $< \lambda^\gamma <$ 0.31

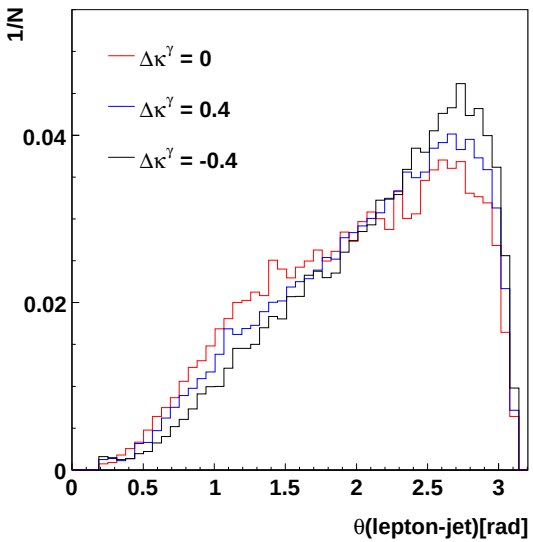
- Enhancement of the cross section, except for some values of $\Delta\kappa^\gamma$

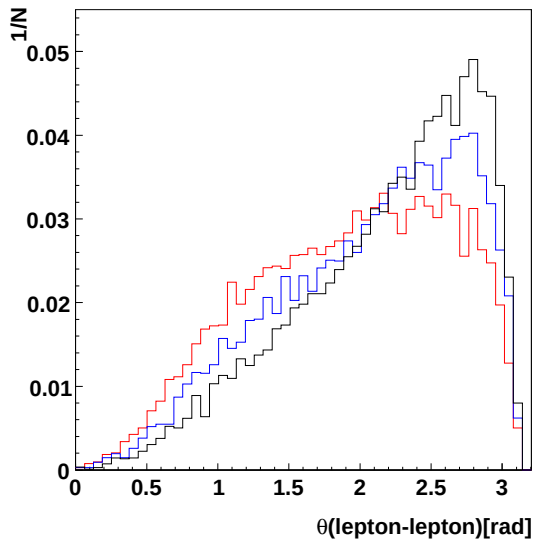
Angular distributions - $\Delta\kappa^{\gamma}$

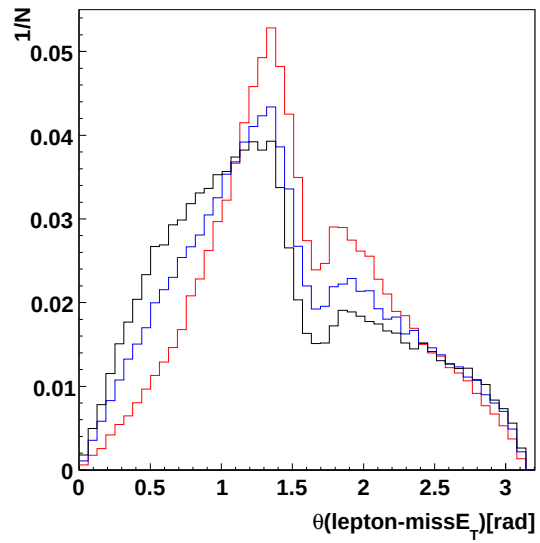






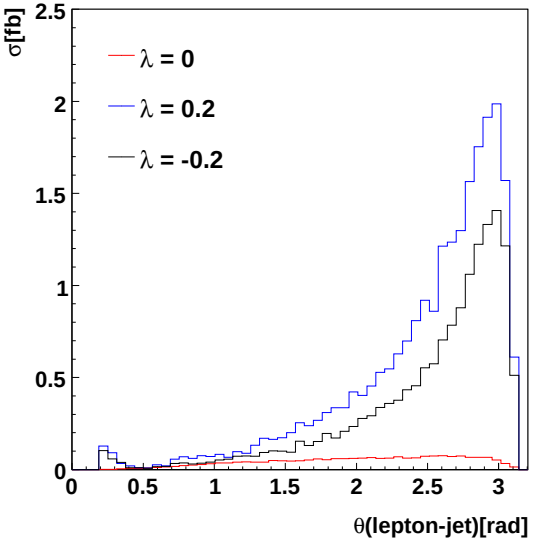


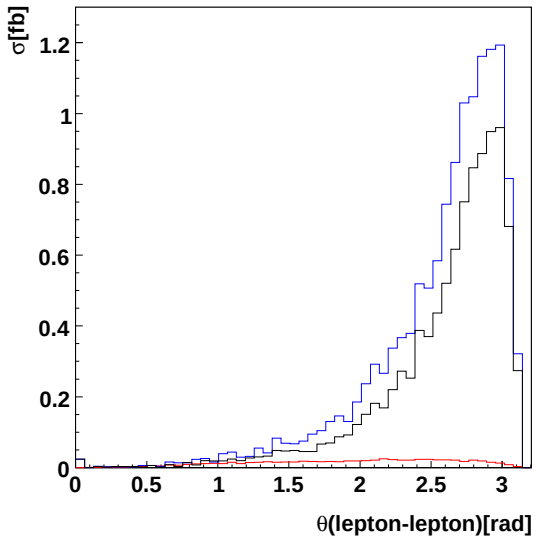


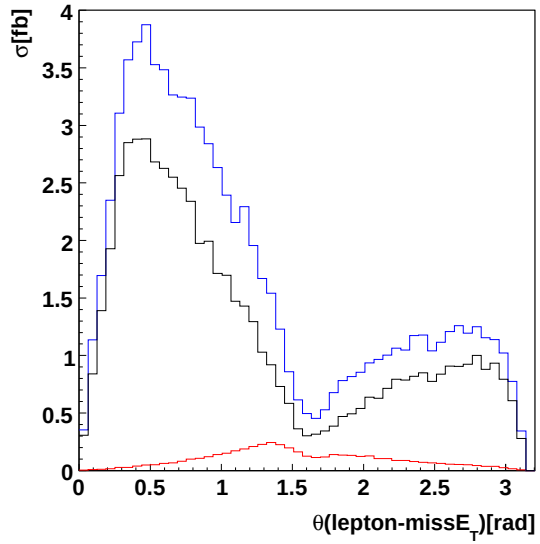


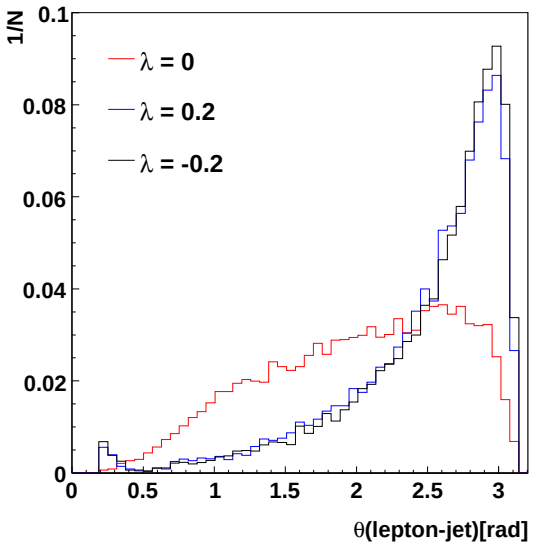
- Shape of angular distributions is not greatly sensitive to $\Delta\kappa^{\gamma}$

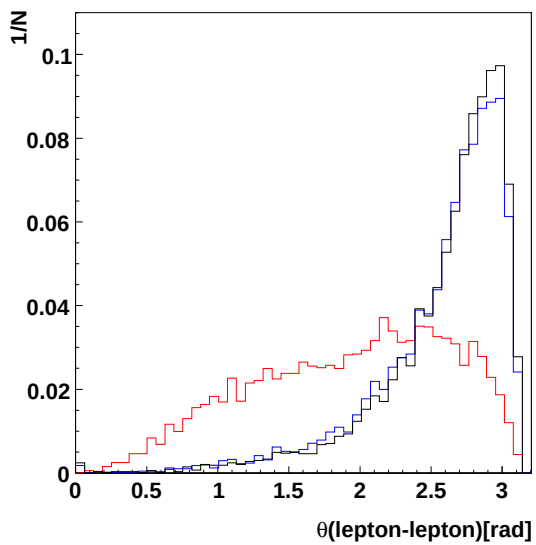
Angular distributions - λ^{γ}

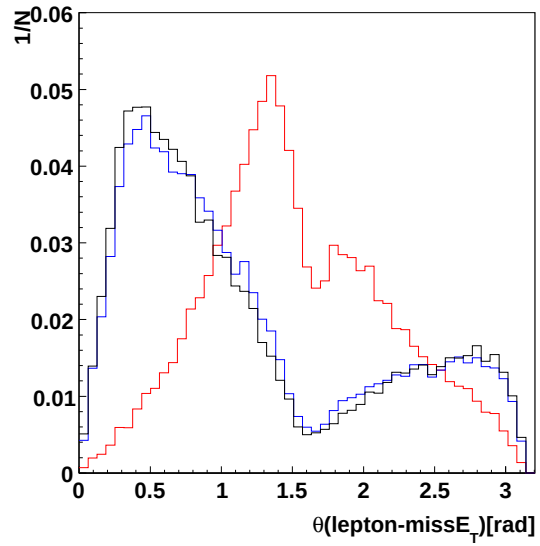












- Shape of angular distributions is sensitive to λ^{γ}

Conclusion of the first study

- SM cross section $\sigma^{pp\to pWWp} = 12.8\,\text{fb}$ moderate (e.g. exclusive Higgs production $\sigma \sim 1\,\text{fb}$)
- Total cross section sensitive to both the TGCs $\kappa^\gamma, \lambda^\gamma$
- Shape of the angular distribution between leading jet, lepton and missing E_T sensitive to λ^γ

Further studies:

- Must take the acceptance of the roman pots into account ($\sim 30\%$)
- Background study - mainly WW produced in double pomeron exchange (100 higher cross section)

BACKUP SLIDES

Relations:

- Magnetic moment of W: $\mu_W = \frac{e}{2m_W}(1 + \kappa^\gamma + \lambda^\gamma)$
- Electric quadratic moment of W: $\mu_W = \frac{e}{m_W^2}(\kappa^\gamma - \lambda^\gamma)$