

# High precision QCD amplitudes (towards higher-loop revolution)

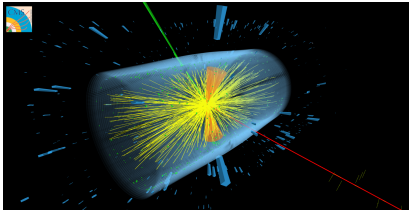
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NExT 2021

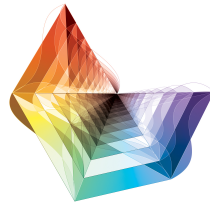


# Why amplitudes?

experiment: recent **LHC** measurements  
 → high precision predictions  
 to test SM



theory: progress in understanding  
 $\mathcal{N}=4$  SYM **gauge** theory  
 → what about QCD?



let's focus on 3-loops

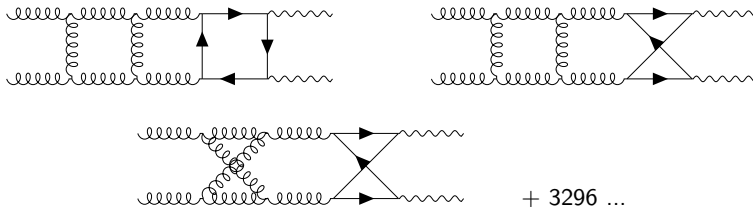
# 3-loops amplitudes

## milestones



- 🕒 1→1 QCD [[Tarasov et al., PRLB, 1980](#)]
- 🕒 2→1 QCD [[Vermaseren et al., arXiv:0508055](#)]
- 🕒 2→2 SYM [[Henn et al., arXiv:1608.00850](#)]
- 🕒 2→2 QCD [[Tancredi et al., arXiv:2011.13946](#)]

## upcoming $gg \rightarrow \gamma\gamma$ process [[arXiv:21xx.xxxxx](#)]



# Amplitude structure

general amplitude structure

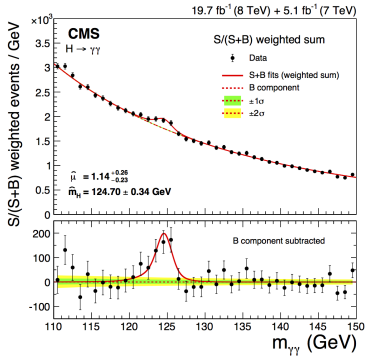
$\mathcal{A} =$	kinematics	$\otimes$ color	$\otimes$ spin	$\otimes$ integral
e.g.	$\frac{10093sd^3+12t}{1561d}$	$\frac{1}{N_c^2} \text{tr}(T^{a_1} T^{a_2})$	$\frac{[4 3\rangle\langle 1 2\rangle}{[2 1\rangle\langle 3 4\rangle}$	$Li_2\left(\frac{-t-i\epsilon}{s+i\epsilon}\right)$
<i>a priori</i> ?	<b>X</b>	✓	✓	✓

but **factorial** growth of intermediate complexity

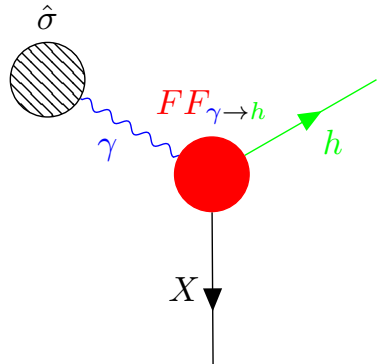
approximate	1L	2L	3L
#Feynman diagrams	$1 \cdot 10^1$	$1 \cdot 10^2$	$3 \cdot 10^3$
size before IBP [MB]	$3 \cdot 10^{-1}$	$5 \cdot 10^1$	$2 \cdot 10^4$
size in terms of GPLs [kB]	$2 \cdot 10^1$	$6 \cdot 10^2$	$4 \cdot 10^3$

# Outlook

## interference with Higgs



## photon fragmentation functions



Thank you !