



Status on MadGraph5_aMC@NLO

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on behalf of the team



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main message

- Moving forward on many direction
 - **capabilities** of the code

Development status

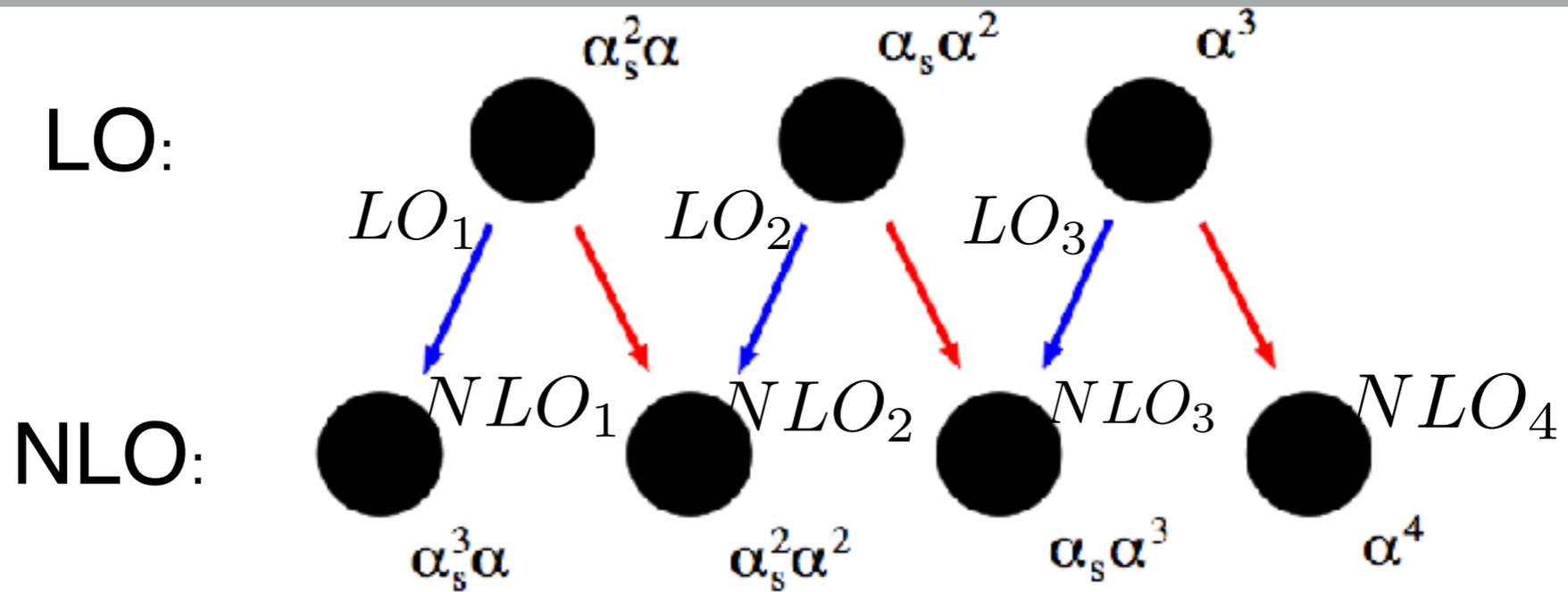
- Electroweak NLO
- Dark Matter -> Maddm
- Beam Dump Experiment -> MadDump

Development status

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- Dark Matter -> Maddm
- Beam Experiment -> MadDump

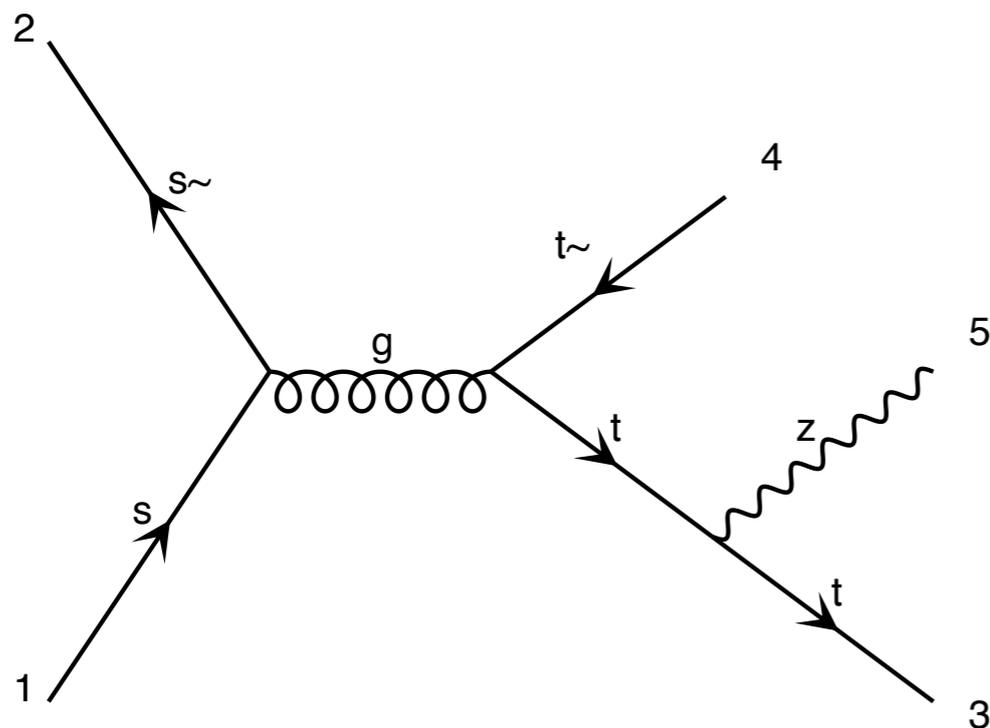
R. Frederix,^a S. Frixione,^b V. Hirschi,^c D. Pagani,^a H.-S. Shao,^d M. Zaro^e

To appear this month

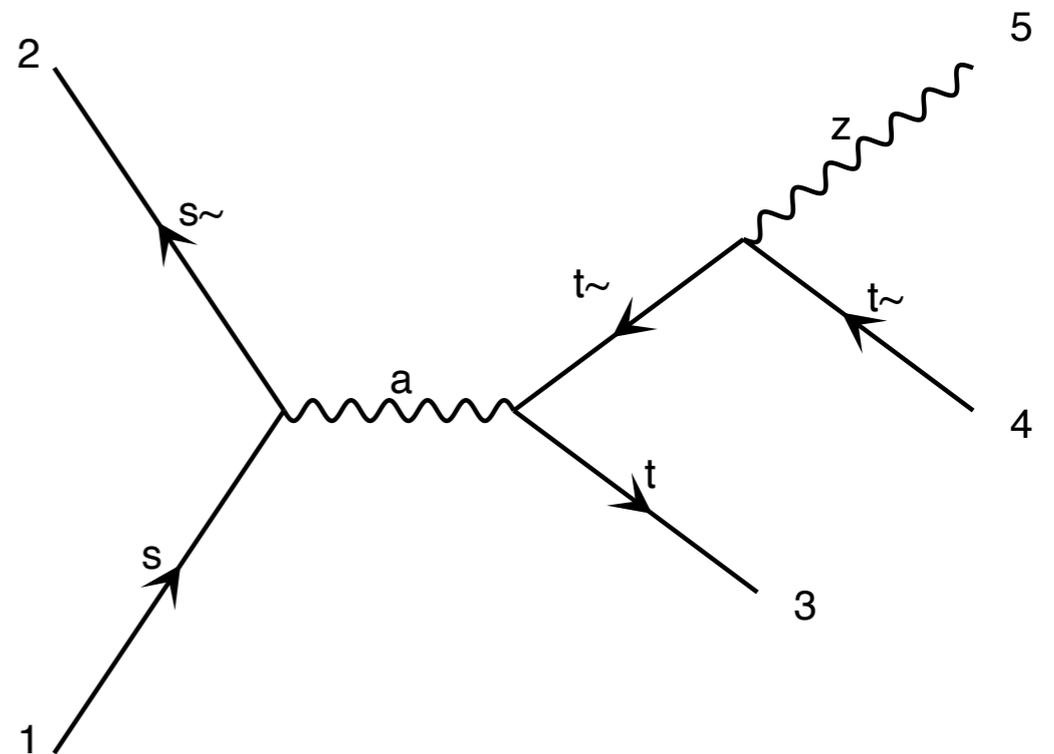


$t\bar{t}Z$ Production

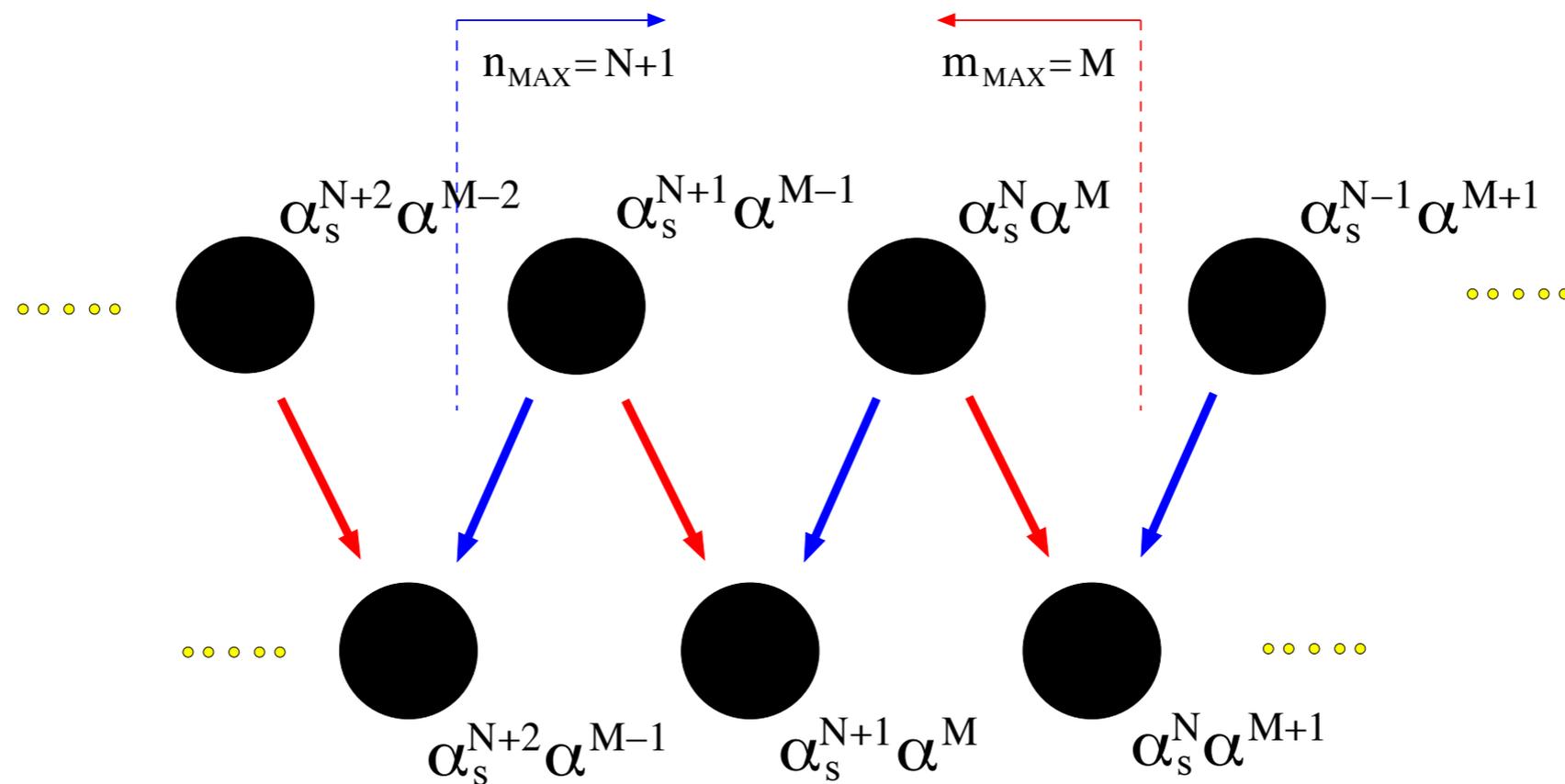
$LO_1 : \alpha_s^2 \alpha$



$LO_3 : \alpha^3$

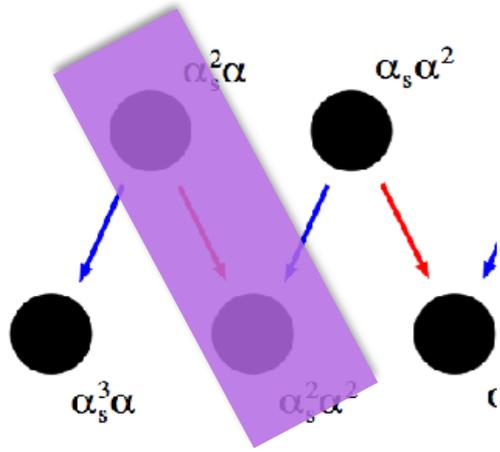


MG5_aMC> generate p₁ p₂ > p₃ p₄ p₅ p₆ QCD=n_{max} QED=m_{max} [QCD QED]



Previous results

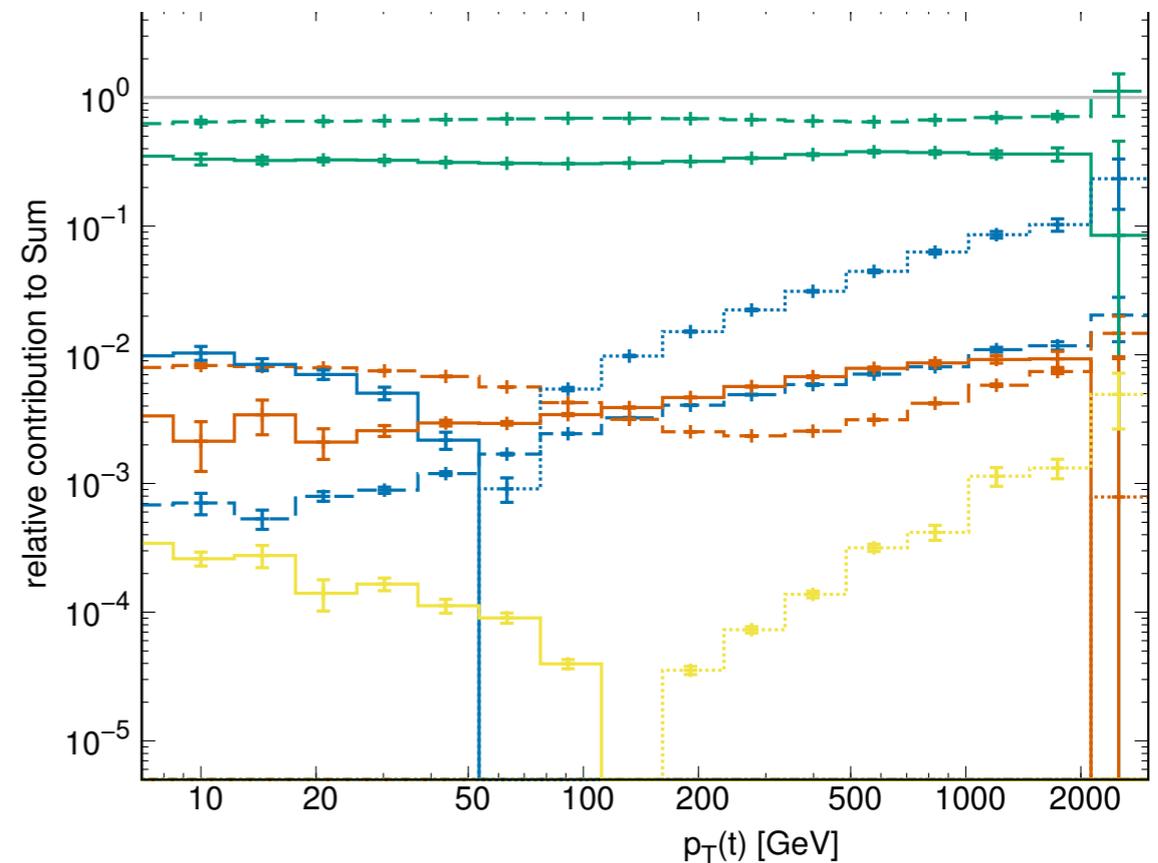
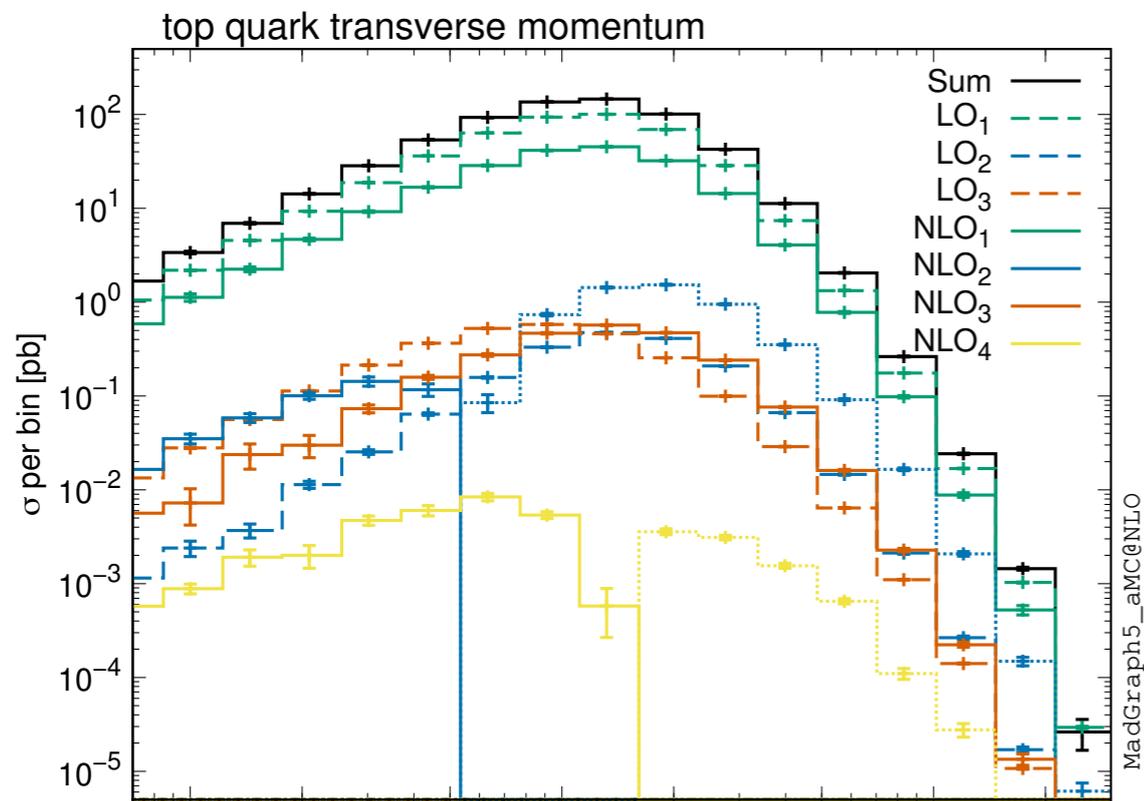
- 1407.0823: top pair
- 1504.03446: top pair plus heavy boson
- 1612.06548: dijet



Process	Syntax	Cross section (in pb)		Correction (in %)
		LO	NLO	
$pp \rightarrow e^+ \nu_e$	p p > e+ ve QCD=0 QED=2 [QED]	$5.2498 \pm 0.0005 \cdot 10^3$	$5.2113 \pm 0.0006 \cdot 10^3$	-0.73 ± 0.01
$pp \rightarrow e^+ \nu_e j$	p p > e+ ve j QCD=1 QED=2 [QED]	$9.1468 \pm 0.0012 \cdot 10^2$	$9.0449 \pm 0.0014 \cdot 10^2$	-1.11 ± 0.02
$pp \rightarrow e^+ \nu_e j j$	p p > e+ ve j j QCD=2 QED=2 [QED]	$3.1562 \pm 0.0003 \cdot 10^2$	$3.0985 \pm 0.0005 \cdot 10^2$	-1.83 ± 0.02
$pp \rightarrow e^+ e^-$	p p > e+ e- QCD=0 QED=2 [QED]	$7.5367 \pm 0.0008 \cdot 10^2$	$7.4997 \pm 0.0010 \cdot 10^2$	-0.49 ± 0.02
$pp \rightarrow e^+ e^- j$	p p > e+ e- j QCD=1 QED=2 [QED]	$1.5059 \pm 0.0001 \cdot 10^2$	$1.4909 \pm 0.0002 \cdot 10^2$	-1.00 ± 0.02
$pp \rightarrow e^+ e^- j j$	p p > e+ e- j j QCD=2 QED=2 [QED]	$5.1424 \pm 0.0004 \cdot 10^1$	$5.0410 \pm 0.0007 \cdot 10^1$	-1.97 ± 0.02
$pp \rightarrow e^+ e^- \mu^+ \mu^-$	p p > e+ e- mu+ mu- QCD=0 QED=4 [QED]	$1.2750 \pm 0.0000 \cdot 10^{-2}$	$1.2083 \pm 0.0001 \cdot 10^{-2}$	-5.23 ± 0.01
$pp \rightarrow e^+ \nu_e \mu^- \bar{\nu}_\mu$	p p > e+ ve mu- vm~ QCD=0 QED=4 [QED]	$5.1144 \pm 0.0007 \cdot 10^{-1}$	$5.3019 \pm 0.0009 \cdot 10^{-1}$	$+3.67 \pm 0.02$
$pp \rightarrow H e^+ \nu_e$	p p > h e+ ve QCD=0 QED=3 [QED]	$6.7643 \pm 0.0001 \cdot 10^{-2}$	$6.4914 \pm 0.0012 \cdot 10^{-2}$	-4.03 ± 0.02
$pp \rightarrow H e^+ e^-$	p p > h e+ e- QCD=0 QED=3 [QED]	$1.4554 \pm 0.0001 \cdot 10^{-2}$	$1.3700 \pm 0.0002 \cdot 10^{-2}$	-5.87 ± 0.02
$pp \rightarrow H j j$	p p > h j j QCD=0 QED=3 [QED]	$2.8268 \pm 0.0002 \cdot 10^0$	$2.7075 \pm 0.0003 \cdot 10^0$	-4.22 ± 0.01
$pp \rightarrow W^+ W^- W^+$	p p > w+ w- w+ QCD=0 QED=3 [QED]	$8.2874 \pm 0.0004 \cdot 10^{-2}$	$8.8017 \pm 0.0012 \cdot 10^{-2}$	$+6.21 \pm 0.02$
$pp \rightarrow Z Z W^+$	p p > z z w+ QCD=0 QED=3 [QED]	$1.9874 \pm 0.0001 \cdot 10^{-2}$	$2.0189 \pm 0.0003 \cdot 10^{-2}$	$+1.58 \pm 0.02$
$pp \rightarrow Z Z Z$	p p > z z z QCD=0 QED=3 [QED]	$1.0761 \pm 0.0001 \cdot 10^{-2}$	$0.9741 \pm 0.0001 \cdot 10^{-2}$	-9.47 ± 0.02
$pp \rightarrow H Z Z$	p p > h z z QCD=0 QED=3 [QED]	$2.1005 \pm 0.0003 \cdot 10^{-3}$	$1.9155 \pm 0.0003 \cdot 10^{-3}$	-8.81 ± 0.02
$pp \rightarrow H Z W^+$	p p > h z w+ QCD=0 QED=3 [QED]	$2.4408 \pm 0.0000 \cdot 10^{-3}$	$2.4809 \pm 0.0005 \cdot 10^{-3}$	$+1.64 \pm 0.02$
$pp \rightarrow H H W^+$	p p > h h w+ QCD=0 QED=3 [QED]	$2.7827 \pm 0.0001 \cdot 10^{-4}$	$2.4259 \pm 0.0027 \cdot 10^{-4}$	-12.82 ± 0.10
$pp \rightarrow H H Z$	p p > h h z QCD=0 QED=3 [QED]	$2.6914 \pm 0.0003 \cdot 10^{-4}$	$2.3926 \pm 0.0003 \cdot 10^{-4}$	-11.10 ± 0.02
$pp \rightarrow t \bar{t} W^+$	p p > t t~ w+ QCD=2 QED=1 [QED]	$2.4119 \pm 0.0003 \cdot 10^{-1}$	$2.3025 \pm 0.0003 \cdot 10^{-1}$	-4.54 ± 0.02
$pp \rightarrow t \bar{t} Z$	p p > t t~ z QCD=2 QED=1 [QED]	$5.0456 \pm 0.0006 \cdot 10^{-1}$	$5.0033 \pm 0.0007 \cdot 10^{-1}$	-0.84 ± 0.02
$pp \rightarrow t \bar{t} H$	p p > t t~ h QCD=2 QED=1 [QED]	$3.4480 \pm 0.0004 \cdot 10^{-1}$	$3.5102 \pm 0.0005 \cdot 10^{-1}$	$+1.81 \pm 0.02$
$pp \rightarrow t \bar{t} j$	p p > t t~ j QCD=3 QED=0 [QED]	$3.0277 \pm 0.0003 \cdot 10^2$	$2.9683 \pm 0.0004 \cdot 10^2$	-1.96 ± 0.02
$pp \rightarrow j j j$	p p > j j j QCD=3 QED=0 [QED]	$7.9639 \pm 0.0010 \cdot 10^6$	$7.9472 \pm 0.0011 \cdot 10^6$	-0.21 ± 0.02
$pp \rightarrow t j$	p p > t j QCD=0 QED=2 [QED]	$1.0613 \pm 0.0001 \cdot 10^2$	$1.0539 \pm 0.0001 \cdot 10^2$	-0.70 ± 0.02

Table 2: Processes considered in sect. 6.2. The second column reports the MG5_AMC syntax used to generate them. The third and fourth columns display the fully-inclusive results for the quantities defined in eq. (6.12). The fifth column shows the results for the fractional correction defined in eq. (6.14). All uncertainties are due to MC integration errors.

	$pp \rightarrow t\bar{t}$	$pp \rightarrow t\bar{t}Z$	$pp \rightarrow t\bar{t}W^+$	$pp \rightarrow t\bar{t}H$	$pp \rightarrow t\bar{t}j$
LO ₁	$4.3803 \pm 0.0005 \cdot 10^2$ pb	$5.0463 \pm 0.0003 \cdot 10^{-1}$ pb	$2.4116 \pm 0.0001 \cdot 10^{-1}$ pb	$3.4483 \pm 0.0003 \cdot 10^{-1}$ pb	$3.0278 \pm 0.0003 \cdot 10^2$ pb
LO ₂	$+0.405 \pm 0.001$ %	-0.691 ± 0.001 %	$+0.000 \pm 0.000$ %	$+0.406 \pm 0.001$ %	$+0.525 \pm 0.001$ %
LO ₃	$+0.630 \pm 0.001$ %	$+2.259 \pm 0.001$ %	$+0.962 \pm 0.000$ %	$+0.702 \pm 0.001$ %	$+1.208 \pm 0.001$ %
LO ₄					$+0.006 \pm 0.000$ %
NLO ₁	$+46.164 \pm 0.022$ %	$+44.809 \pm 0.028$ %	$+49.504 \pm 0.015$ %	$+28.847 \pm 0.020$ %	$+26.571 \pm 0.063$ %
NLO ₂	-1.075 ± 0.003 %	-0.846 ± 0.004 %	-4.541 ± 0.003 %	$+1.794 \pm 0.005$ %	-1.971 ± 0.022 %
NLO ₃	$+0.552 \pm 0.002$ %	$+0.845 \pm 0.003$ %	$+12.242 \pm 0.014$ %	$+0.483 \pm 0.008$ %	$+0.292 \pm 0.007$ %
NLO ₄	$+0.005 \pm 0.000$ %	-0.082 ± 0.000 %	$+0.017 \pm 0.003$ %	$+0.044 \pm 0.000$ %	$+0.009 \pm 0.000$ %
NLO ₅					$+0.005 \pm 0.000$ %



1804.XXXXX

Development status

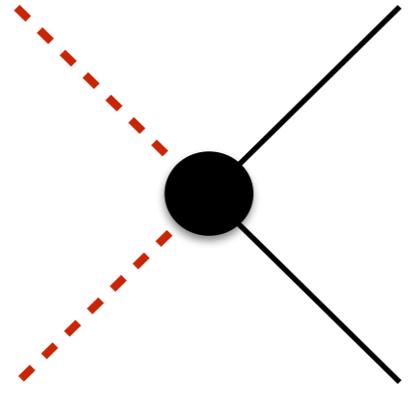
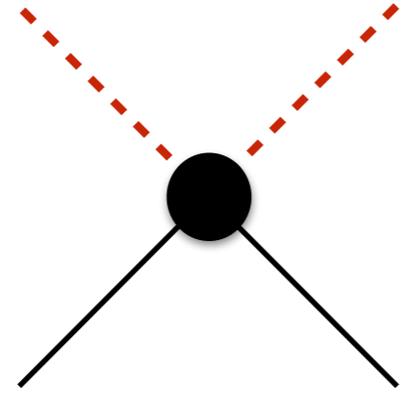
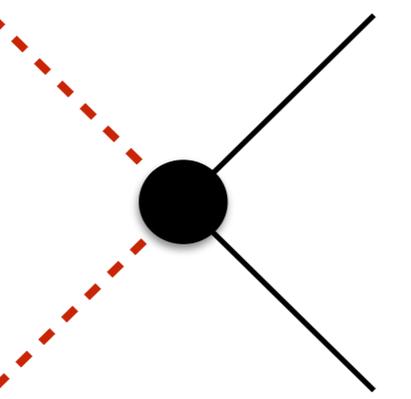
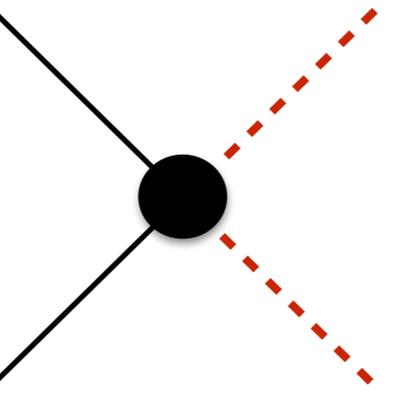
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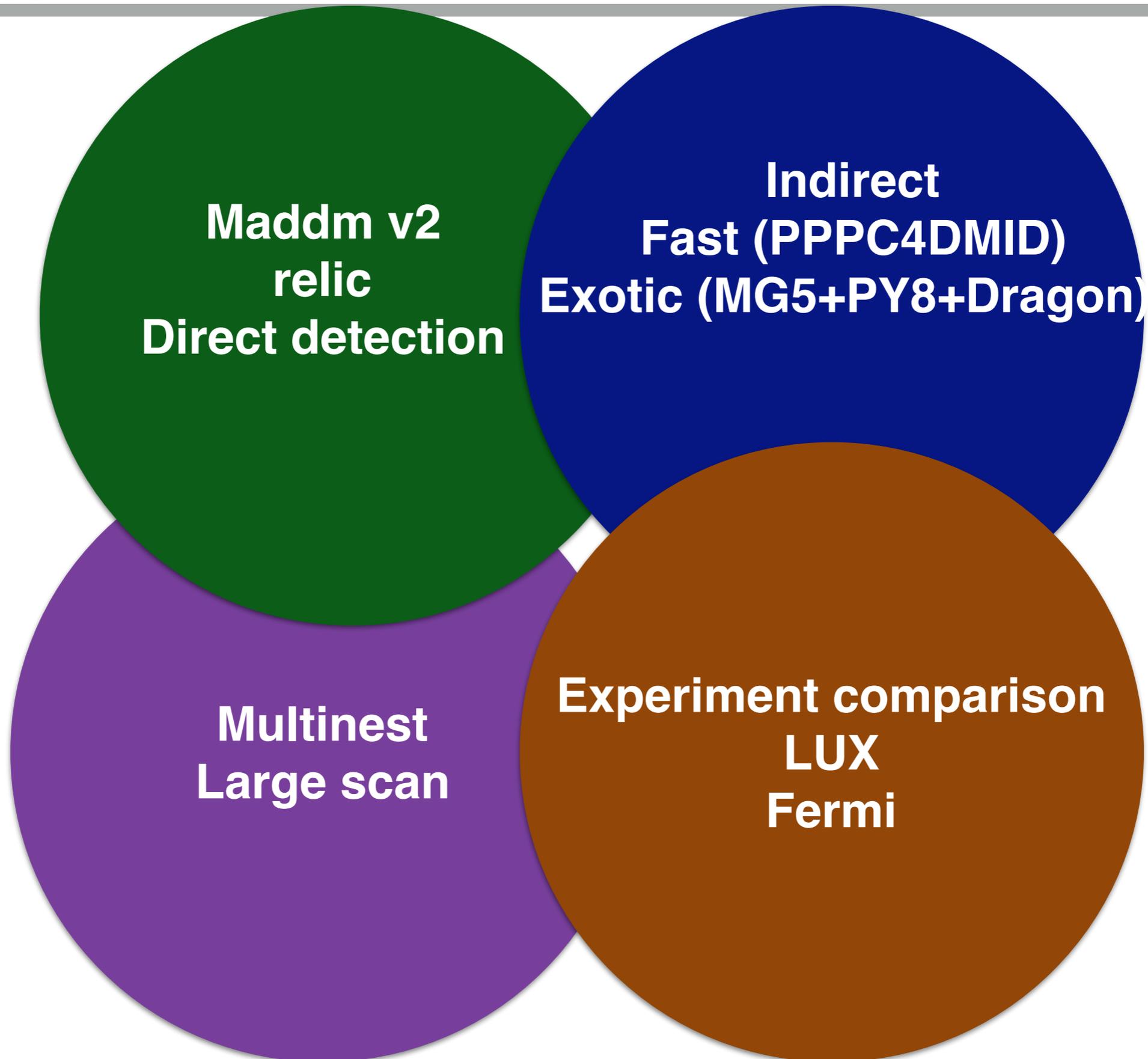
Federico Ambrogio^a, Chiara Arina^a, Mihailo Backović^{a,b}, Jan Heisig^c, Fabio Maltoni^a, Luca Mantani^a,
Olivier Mattelaer^a, Gopolang Mohlabeng^{d,e}

^b B12, *Chemin du Cyclotron 6, B-1348 Louvain-la-Neuve, Belgium*

Publish last week: [1804.00044](#)

-> See Federico talk tomorrow morning for more details

<p>Relic density</p>		<ul style="list-style-type: none"> • Is the model produce enough DM • Present in Maddm v1.0
<p>Direct detection</p>		<ul style="list-style-type: none"> • Scattering of DM within normal matter (earth detector) • Present in Maddm v2.0
<p>Indirect detection</p>		<ul style="list-style-type: none"> • Remnant of DM annihilation (telescope) • New in Maddm v3.0
<p>Collider</p>		<ul style="list-style-type: none"> • Production of DM at collider (LHC) • MG5_aMC@NLO



- MadDM is a **PLUGIN** of MG5aMC
 - ➔ **User contrib/ UserHook**
 - ➔ **Visibility to external contributor**

Example of Plugin

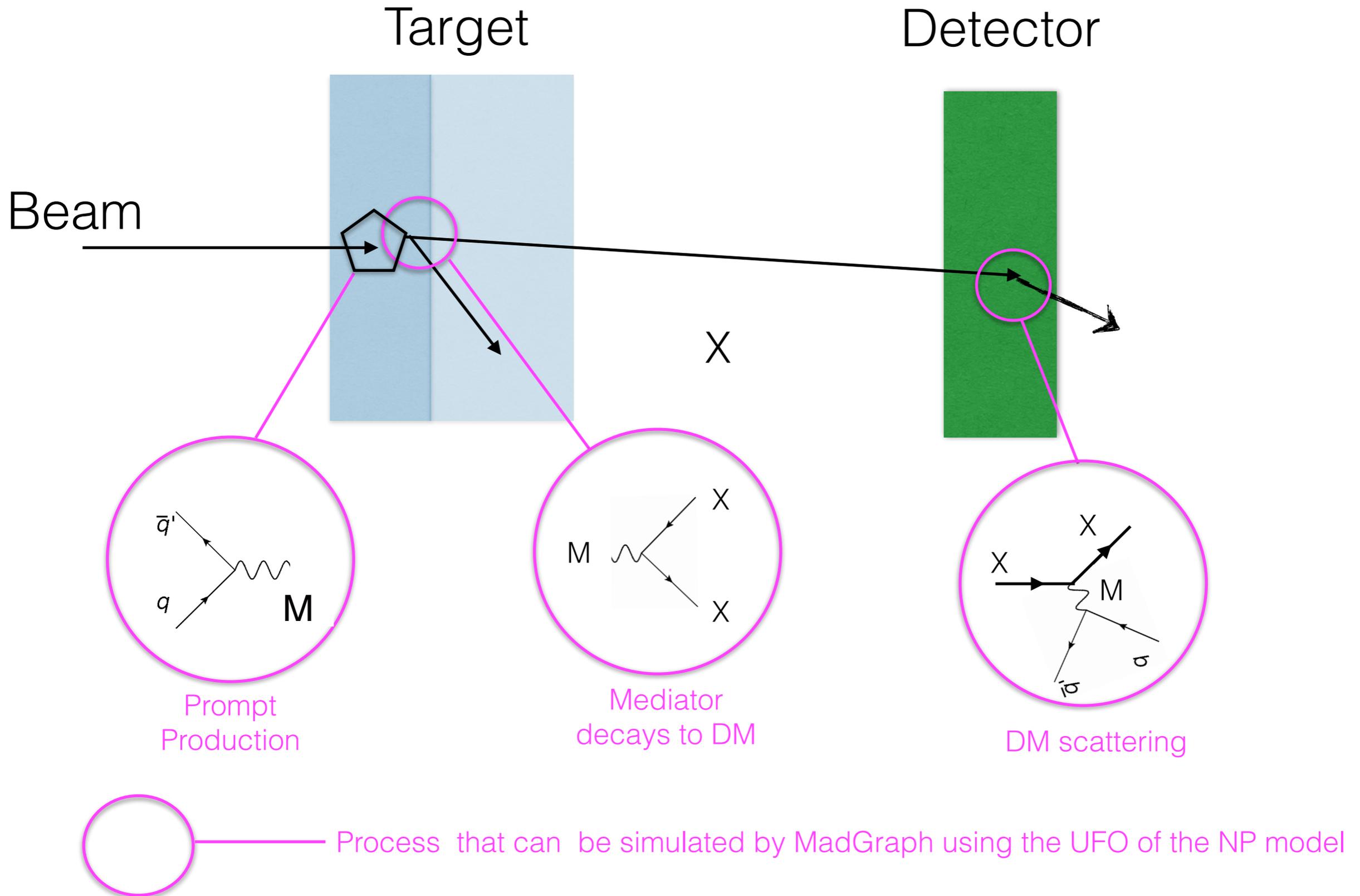
- Momenta (a C++ version of Madweight)
- New Cluster implementation
- Generation of gridpack on HPC machine (MPI)
- Mass reshuffling of events
- Madee (ILC accelerator) **(See Ulrike talk)**

Development status

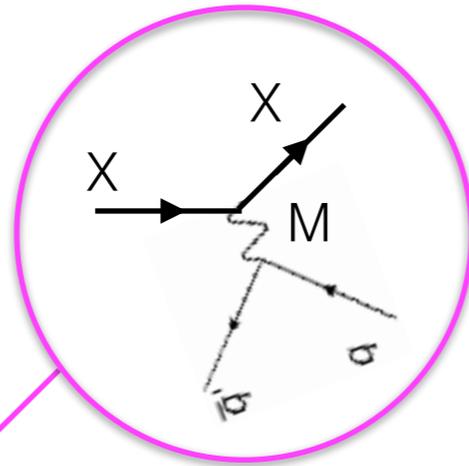
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Luca Buonocore, Francesco Tramontano, Claudia Frugiuele
With help of Fabio Maltoni, OM

Work in progress



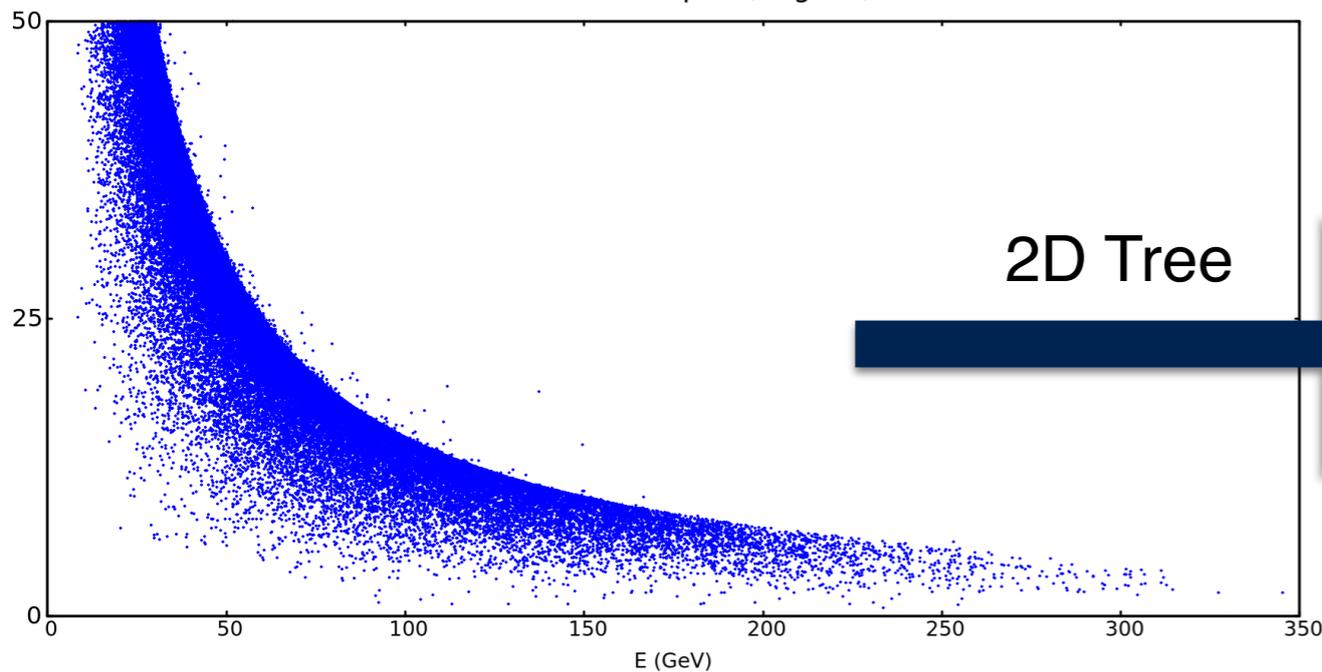
Detector



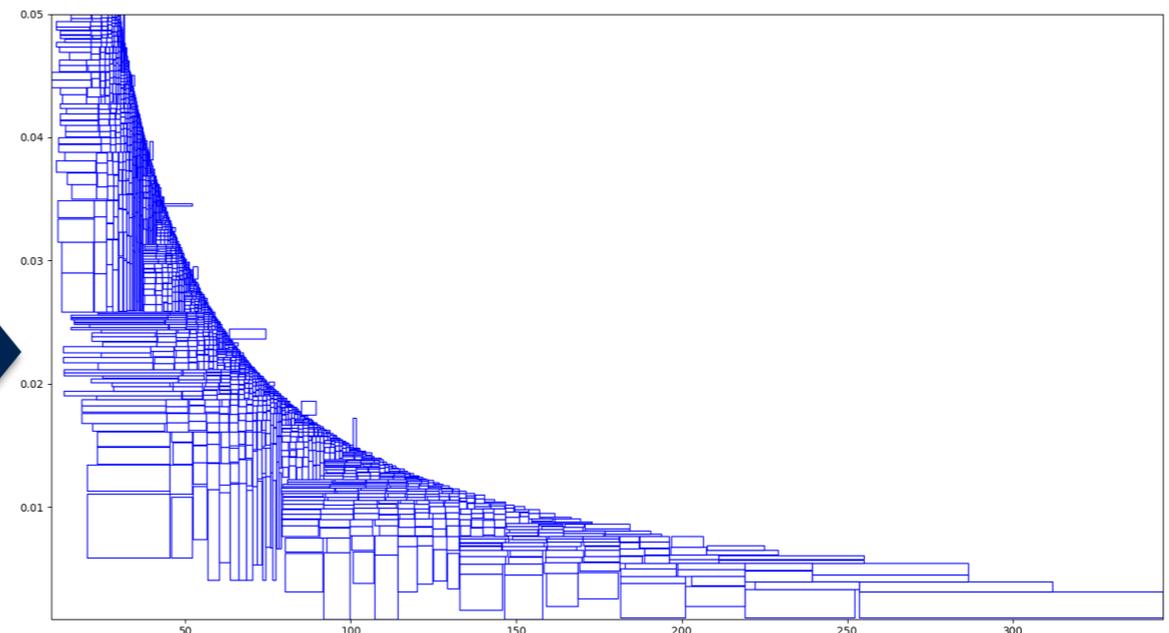
Long-Lived
Mediator
Scattering

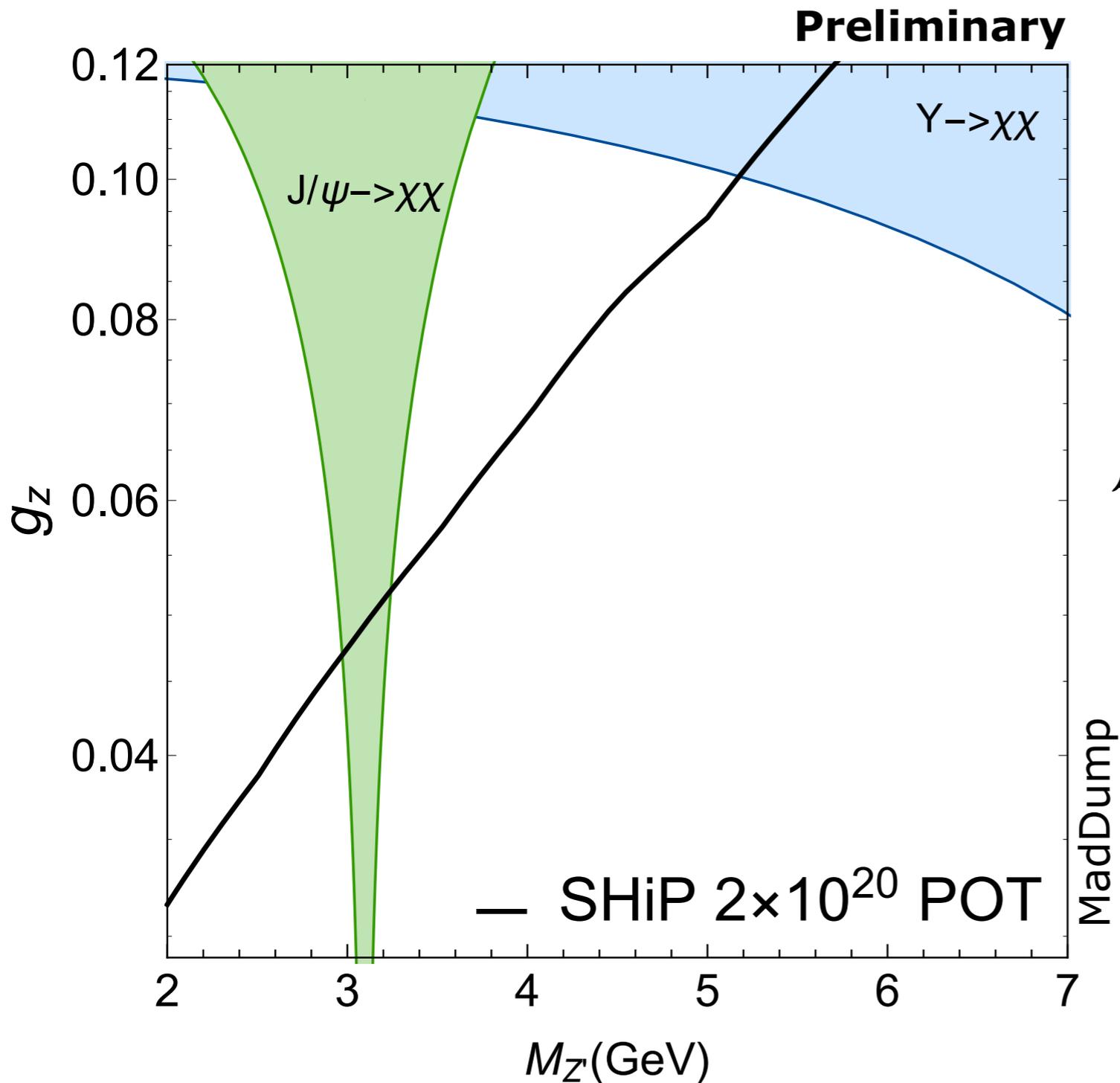
- Need “special” PDF for the incoming beam (in Energy/angle)
- Using a 2D Tree

2d DM scatter plot (original)



2D Tree



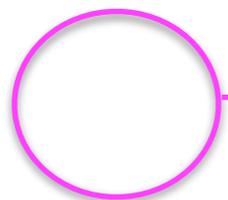


$$\mathcal{L}_{Z'} = \frac{g_z}{2} Z'_\mu \left(\frac{1}{3} \bar{Q}_L \gamma^\mu Q_L + \frac{1}{3} \bar{u}_R \gamma^\mu u_R + \frac{1}{3} \bar{d}_R \gamma^\mu d_R \right)$$

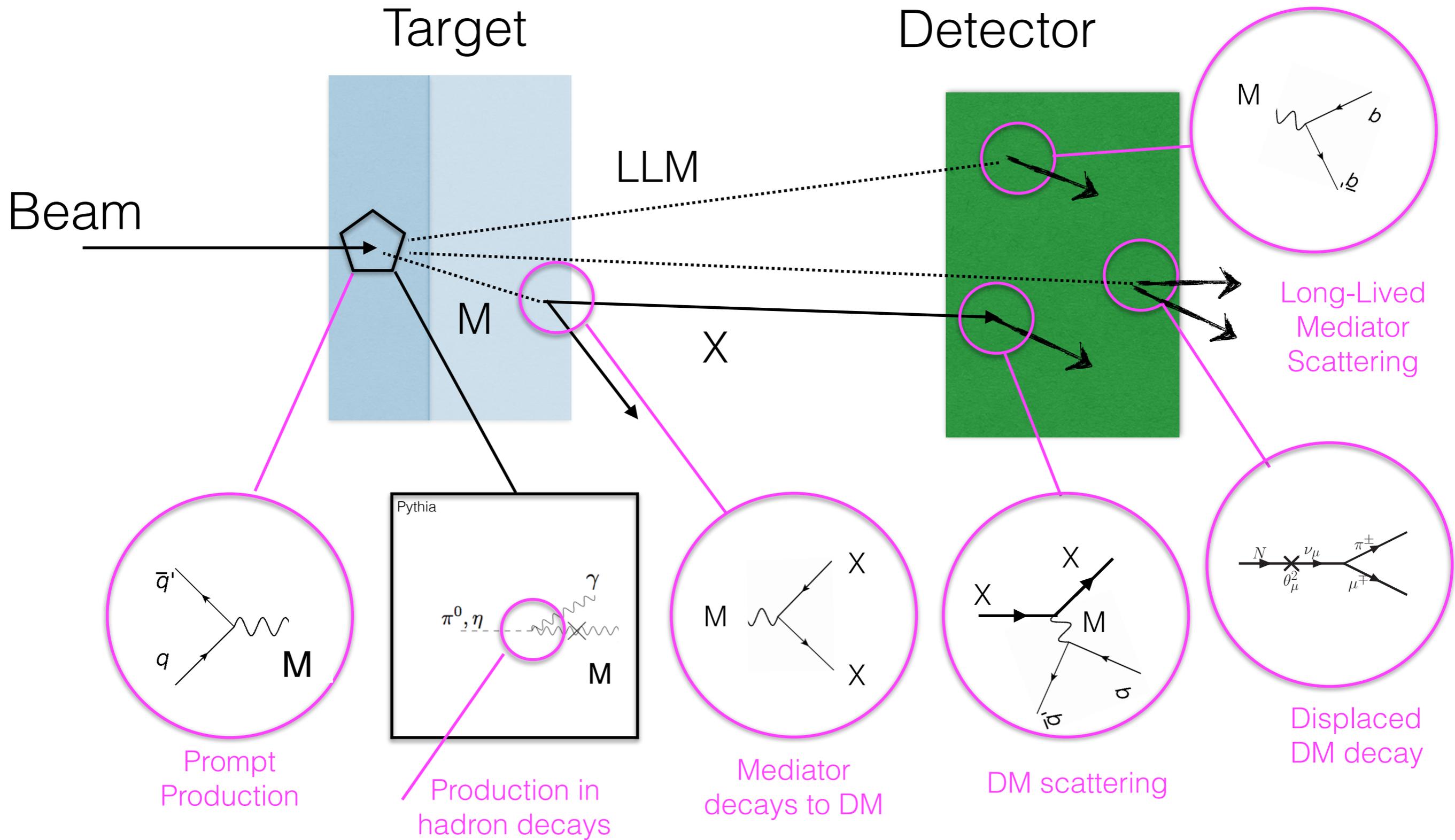
$$\mathcal{L}_\chi \supset \frac{g_z}{2} Z'_\mu \left[(\partial_\mu \chi^\dagger) \chi - \chi^\dagger \partial_\mu \chi \right]$$

- indeed, indirect limits and UV completion might provides stronger constraints than J/Ψ and Y decays

[Dobrescu Frugiuele 2015]
[Pospelov et al 2017]



Process that can be simulated by MadGraph using the UFO of the NP model



main message

- Moving forward on many direction

Conclusion

- Core development
 - LO/NLO QCD/ NLO EW
- PLUGIN extension
 - Maddm v3 / MadDump /...
- Extension of the capabilities
 - Lead-Lead/fix target/...