In [1]:
```
%cd ../..
```

```
/home/jan/FMF/masters
```

In [2]:
```
saved = "ml_hep_sim/analysis/results/ul/"
```

Get hists pipeline

In [3]:
```
from ml_hep_sim.analysis.hists_pipeline import get_hists_pipeline
```

In [4]:
```
use_class = False

hists_pipeline = get_hists_pipeline(use_classifier=use_class)
hists_pipeline.pipes = hists_pipeline.pipes[:-1] # this one only makes 1 hist
```

```
WARNING:root:available variables: {'lepton pT': 0, 'lepton eta': 1, 'missing energy': 2, 'jet1 pT': 3, 'jet1 eta
': 4, 'jet2 pT': 5, 'jet2 eta': 6, 'jet3 pT': 7, 'jet3 eta': 8, 'jet4 pT': 9, 'jet4 eta': 10, 'm jj': 11, 'm jjj
': 12, 'm lv': 13, 'm jlv': 14, 'm bb': 15, 'm wbb': 16, 'm wwbb': 17}
```

In [5]:
```
if use_class:
    saved += "class_"
else:
    saved += "mbb_"
```

In [6]:
```
saved
```

Out[6]:
```
'ml_hep_sim/analysis/results/ul/mbb_'
```

Make many hists

In [7]:
```
from ml_hep_sim.analysis.hists_pipeline import MakeHistsFromSamplesLumi
from ml_hep_sim.analysis.ul_pipeline import UpperLimitScannerBlock
import numpy as np
```

In [8]:
```
lumi_start, lumi_end, lumi_step = 10, 300, 24
lumi = [lumi_start, lumi_end, lumi_step]

sig_frac = 0.1
xsec = 10
```

Lumi table

In [9]:
```
_sig, _bkg = [], []

for l in np.linspace(*lumi):
    _sig.append(l * xsec * sig_frac)
    _bkg.append(l * xsec)
    print(f"lumi: {l} sig: {_sig[-1]}, bkg: {_bkg[-1]}")
```

```
lumi: 10.0 sig: 10.0, bkg: 100.0
lumi: 22.608695652173914 sig: 22.608695652173914, bkg: 226.08695652173913
lumi: 35.21739130434783 sig: 35.21739130434783, bkg: 352.17391304347825
lumi: 47.826086956521735 sig: 47.82608695652174, bkg: 478.2608695652174
lumi: 60.43478260869565 sig: 60.434782608695656, bkg: 604.3478260869565
lumi: 73.04347826086956 sig: 73.04347826086956, bkg: 730.4347826086956
lumi: 85.65217391304347 sig: 85.65217391304348, bkg: 856.5217391304348
lumi: 98.26086956521739 sig: 98.26086956521739, bkg: 982.6086956521739
lumi: 110.8695652173913 sig: 110.86956521739131, bkg: 1108.695652173913
lumi: 123.4782608695652 sig: 123.4782608695652, bkg: 1234.782608695652
lumi: 136.08695652173913 sig: 136.08695652173913, bkg: 1360.8695652173913
lumi: 148.69565217391303 sig: 148.69565217391303, bkg: 1486.9565217391303
lumi: 161.30434782608694 sig: 161.30434782608697, bkg: 1613.0434782608695
lumi: 173.91304347826085 sig: 173.91304347826087, bkg: 1739.1304347826085
lumi: 186.52173913043478 sig: 186.52173913043478, bkg: 1865.2173913043478
lumi: 199.1304347826087 sig: 199.13043478260872, bkg: 1991.304347826087
lumi: 211.7391304347826 sig: 211.73913043478262, bkg: 2117.391304347826
lumi: 224.3478260869565 sig: 224.3478260869565, bkg: 2243.478260869565
lumi: 236.9565217391304 sig: 236.9565217391304, bkg: 2369.565217391304
lumi: 249.56521739130434 sig: 249.56521739130437, bkg: 2495.6521739130435
lumi: 262.17391304347825 sig: 262.17391304347825, bkg: 2621.7391304347825
lumi: 274.78260869565213 sig: 274.78260869565213, bkg: 2747.826086956521
lumi: 287.39130434782606 sig: 287.39130434782606, bkg: 2873.9130434782605
lumi: 300.0 sig: 300.0, bkg: 3000.0
```

UL setup

In [10]:
```
b_sig_bkg = hists_pipeline.pipes[-1]
```

In [11]:
```
sig_fracs = np.linspace(0.01, 0.1, 6) # do different signal fraction (injections)
```

In [12]:
```
sig_fracs
```

Out[12]:
```
array([0.01 , 0.028, 0.046, 0.064, 0.082, 0.1  ])
```

In [13]:
```
# set mu and gamma (mc correction) bounds
poi_bound = (0.0, 100.0)
gamma_bound = (1e-10, 100.0)

N_gen = 10**6
bkg_err = 0.1 # sys error
bins = 22
bounds = []

for b in range(bins+1):
    if b == 0:
        bounds.append(poi_bound)
    else:
        bounds.append(gamma_bound)
```

In [14]:
```
if use_class:
    bin_range = (0.5, 1.1)
else:
    bin_range = (0.01, 3.0)

hists_ul_blocks = []

for sf in sig_fracs:
    hists_block = MakeHistsFromSamplesLumi(bin_range=bin_range, N_gen=N_gen,
                                           bins=bins, alpha=sf, lumi=lumi, xsec=xsec)(b_sig_bkg)

    ul_block = UpperLimitScannerBlock(bkg_err=bkg_err, workers=24, par_bounds=bounds, mc_test=False)(hists_bloc

    hists_ul_blocks.append(hists_block)
    hists_ul_blocks.append(ul_block)

for sf in sig_fracs:
    hists_block = MakeHistsFromSamplesLumi(bin_range=bin_range, N_gen=N_gen,
                                           bins=bins, alpha=sf, lumi=lumi, xsec=xsec)(b_sig_bkg)
    "ml_hep_sim/analysis/results/ul/""ml_hep_sim/analysis/results/ul/"
    ul_block = UpperLimitScannerBlock(bkg_err=bkg_err, workers=24, par_bounds=bounds, mc_test=True)(hists_block

    hists_ul_blocks.append(hists_block)
    hists_ul_blocks.append(ul_block)
```

Build pipeline

In [15]:
```
from ml_hep_sim.pipeline.pipes import Pipeline

pipe = Pipeline()
pipe.compose(hists_pipeline, hists_ul_blocks)
pipe.fit()
```

```
100%|██████████| 10/10 [00:05<00:00,  1.73it/s]
100%|██████████| 10/10 [00:05<00:00,  1.73it/s]
100%|██████████| 10/10 [00:00<00:00, 5739.33it/s]
100%|██████████| 10/10 [00:00<00:00, 4065.82it/s]
100%|██████████| 10/10 [00:00<00:00, 329.05it/s]
100%|██████████| 10/10 [00:00<00:00, 348.12it/s]
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca802ccb20> with N=10.0 in loop
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca802ccb20> with N=22.6086956521
73914 in loop
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d71d5b0> with N=60.4347826086
```

```
9565 in loop
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d71d5b0> with N=47.8260869565
21735 in loop
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca802ccb20> with N=35.2173913043
4783 in loop
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d71d5b0> with N=85.6521739130
4347 in loop
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d71d5b0> with N=73.0434782608
6956 in loop
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d71d5b0> with N=123.478260869
5652 in loop
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d71d5b0> with N=98.2608695652
1739 in loop
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d71d5b0> with N=110.869565217
3913 in loop
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d71d5b0> with N=136.086956521
73913 in loop
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d71d5b0> with N=148.695652173
91303 in loop
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d71d5b0> with N=173.913043478
26085 in loop
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d71d5b0> with N=161.304347826
08694 in loop
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d71d5b0> with N=186.521739130
43478 in loop
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d71d5b0> with N=211.739130434
7826 in loop
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d71d5b0> with N=199.130434782
6087 in loop
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d71d5b0> with N=236.956521739
1304 in loop
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d71d5b0> with N=224.347826086
9565 in loop
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d71d5b0> with N=274.782608695
65213 in loop
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d71d5b0> with N=287.391304347
82606 in loop
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d71d5b0> with N=300.0 in loop
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d71d5b0> with N=249.565217391
30434 in loop
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d71d5b0> with N=262.173913043
47825 in loop
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca802ccb20> with N=10.0 done
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca802ccb20> with N=22.6086956521
73914 done
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca802ccb20> with N=35.2173913043
4783 done
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d71d5b0> with N=47.8260869565
21735 done
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d71d5b0> with N=60.4347826086
9565 done
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d71d5b0> with N=73.0434782608
6956 done
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d71d5b0> with N=85.6521739130
4347 done
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d71d5b0> with N=110.869565217
3913 done
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d71d5b0> with N=186.521739130
43478 done
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d71d5b0> with N=98.2608695652
1739 done
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d71d5b0> with N=123.478260869
5652 done
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d71d5b0> with N=173.913043478
26085 done
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d71d5b0> with N=161.304347826
08694 done
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d71d5b0> with N=199.130434782
6087 done
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d71d5b0> with N=224.347826086
9565 done
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d71d5b0> with N=136.086956521
73913 done
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d71d5b0> with N=262.173913043
47825 done
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d71d5b0> with N=148.695652173
91303 done
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d71d5b0> with N=211.739130434
7826 done
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d71d5b0> with N=236.956521739
1304 done
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d71d5b0> with N=249.565217391
30434 done
```

```
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d71d5b0> with N=274.782608695
65213 done
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d71d5b0> with N=300.0 done
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d71d5b0> with N=287.391304347
82606 done
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d72f610> with N=10.0 in loop
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d72f610> with N=22.6086956521
73914 in loop
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d72f610> with N=73.0434782608
6956 in loop
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d72f610> with N=85.6521739130
4347 in loop
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d72f610> with N=35.2173913043
4783 in loop
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9565 in loop
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d72f610> with N=47.8260869565
21735 in loop
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3913 in loop
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1739 in loop
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5652 in loop
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08694 in loop
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6087 in loop
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d72f610> with N=173.913043478
26085 in loop
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d72f610> with N=186.521739130
43478 in loop
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d72f610> with N=211.739130434
7826 in loop
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d72f610> with N=236.956521739
1304 in loop
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d72f610> with N=300.0 in loop
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d72f610> with N=287.391304347
82606 in loop
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d72f610> with N=224.347826086
9565 in loop
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d72f610> with N=274.782608695
65213 in loop
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d72f610> with N=249.565217391
30434 in loop
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d72f610> with N=262.173913043
47825 in loop
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d72f610> with N=10.0 done
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d72f610> with N=22.6086956521
73914 done
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d72f610> with N=35.2173913043
4783 done
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d72f610> with N=47.8260869565
21735 done
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d72f610> with N=85.6521739130
4347 done
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d72f610> with N=60.4347826086
9565 done
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6956 done
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d72f610> with N=98.2608695652
1739 done
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d72f610> with N=199.130434782
6087 done
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d72f610> with N=123.478260869
5652 done
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d72f610> with N=173.913043478
26085 done
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d72f610> with N=186.521739130
43478 done
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d72f610> with N=110.869565217
3913 done
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d72f610> with N=161.304347826
08694 done
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d72f610> with N=136.086956521
73913 done
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d72f610> with N=148.695652173
91303 done
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d72f610> with N=262.173913043
```

```
47825 done
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d72f610> with N=249.565217391
30434 done
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d72f610> with N=211.739130434
7826 done
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d72f610> with N=274.782608695
65213 done
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d72f610> with N=224.347826086
9565 done
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d72f610> with N=236.956521739
1304 done
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d72f610> with N=287.391304347
82606 done
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d72f610> with N=300.0 done
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d71d520> with N=10.0 in loop
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d72f3a0> with N=22.6086956521
73914 in loop
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d72f3a0> with N=85.6521739130
4347 in loop
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d72f3a0> with N=73.0434782608
6956 in loop
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d72f3a0> with N=47.8260869565
21735 in loop
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d72f3a0> with N=35.2173913043
4783 in loop
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d72f3a0> with N=136.086956521
73913 in loop
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d72f3a0> with N=60.4347826086
9565 in loop
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d72f3a0> with N=123.478260869
5652 in loop
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d72f3a0> with N=110.869565217
3913 in loop
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d72f3a0> with N=98.2608695652
1739 in loop
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d72f3a0> with N=148.695652173
91303 in loop
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d72f3a0> with N=173.913043478
26085 in loop
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d72f3a0> with N=161.304347826
08694 in loop
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d72f3a0> with N=199.130434782
6087 in loop
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d72f3a0> with N=236.956521739
1304 in loop
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d72f3a0> with N=211.739130434
7826 in loop
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43478 in loop
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9565 in loop
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d72f3a0> with N=300.0 in loop
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d72f3a0> with N=274.782608695
65213 in loop
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d72f3a0> with N=287.391304347
82606 in loop
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30434 in loop
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d72f3a0> with N=262.173913043
47825 in loop
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73914 done
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4783 done
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6956 done
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4347 done
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1739 done
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08694 done
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d72f3a0> with N=199.130434782
6087 done
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5652 done
```

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26085 done
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1739 done
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4347 done
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5652 done
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6956 done
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3913 done
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d733040> with N=98.2608695652
1739 done
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73913 done
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91303 done
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7826 done
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30434 done
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6087 done
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26085 done
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82606 done
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21735 in loop
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WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d739190> with N=85.6521739130
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3913 in loop
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5652 in loop
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d739190> with N=173.913043478
26085 in loop
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73913 in loop
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43478 in loop
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d739190> with N=211.739130434
7826 in loop
```

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9565 in loop
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82606 in loop
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WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d739190> with N=262.173913043
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21735 done
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65213 done
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91303 in loop
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d6f7a90> with N=161.304347826
```

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08694 in loop
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d6f7a90> with N=173.913043478
26085 in loop
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d6f7a90> with N=211.739130434
7826 in loop
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d6f7a90> with N=186.521739130
43478 in loop
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6087 in loop
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1304 in loop
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9565 in loop
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65213 in loop
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47825 in loop
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82606 done
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47825 done
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73914 in loop
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1739 in loop
```

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26085 in loop
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08694 in loop
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6087 in loop
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65213 done
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d733a30> with N=287.391304347
82606 done
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21735 in loop
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WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca802ccb20> with N=10.0 in loop
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4347 in loop
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca802ccb20> with N=60.4347826086
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91303 in loop
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08694 in loop
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1304 in loop
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6956 done
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26085 done
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08694 done
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65213 done
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d68eb50> with N=85.6521739130
4347 done
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d68eb50> with N=123.478260869
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1304 done
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26085 done
WARNING:root:calculator <ml_hep_sim.stats.ul.UpperLimitCalculator object at 0x7fca4d6f7fd0> with N=199.130434782
6087 done
```

Out[15]:
```
<ml_hep_sim.pipeline.pipes.Pipeline at 0x7fca7c2541f0>
```

In [16]:
```
# idx for results from pipeline
idxs_gen = [-1, -3, -5, -7, -9, -11]
idxs_mc = [-13, -15, -17, -19, -21, -23]
```

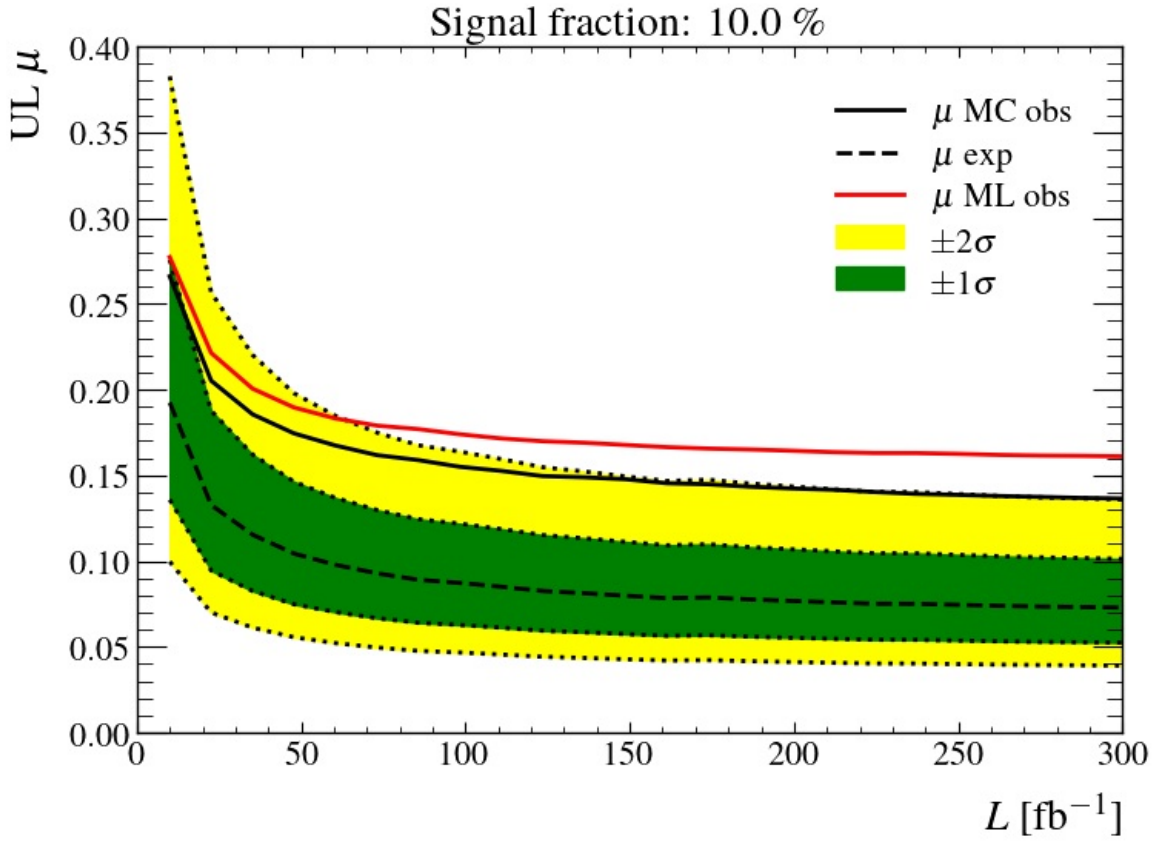
In [17]:
```
sig_fracs
```

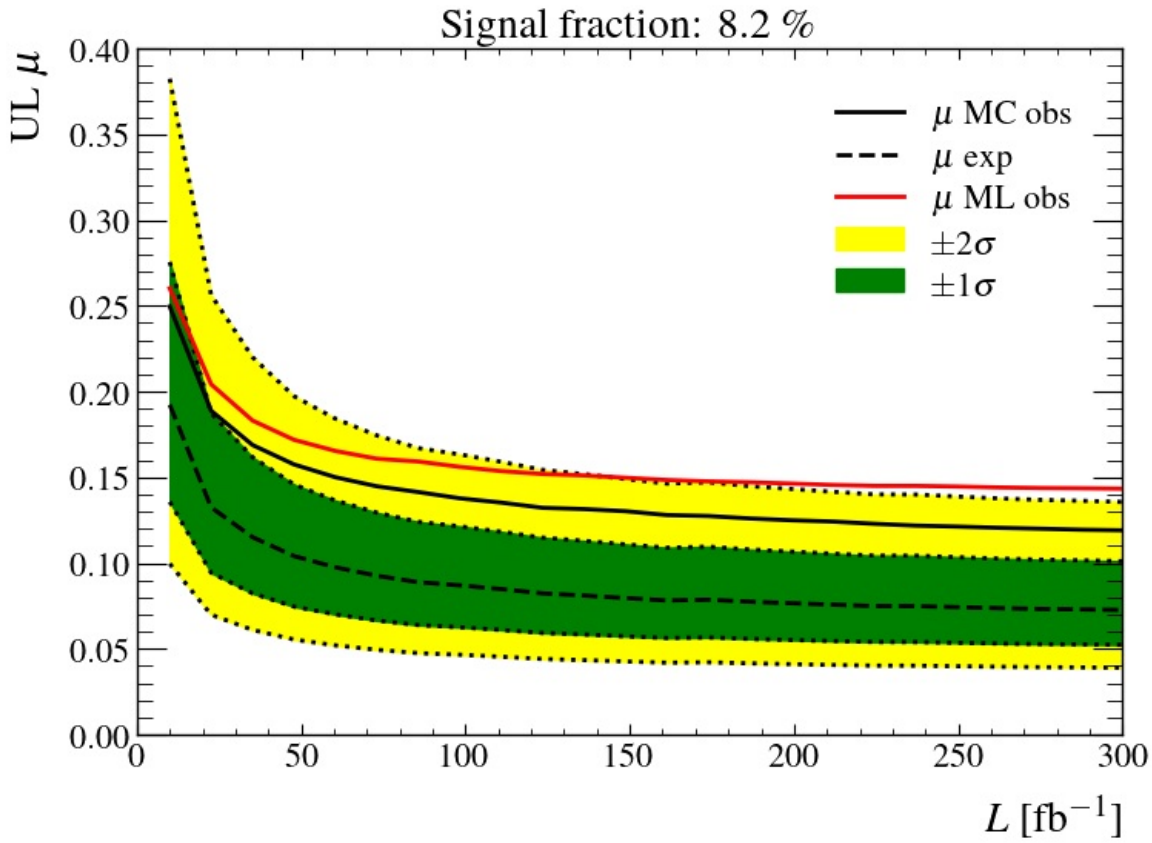
Out[17]:
```
array([0.01 , 0.028, 0.046, 0.064, 0.082, 0.1  ])
```

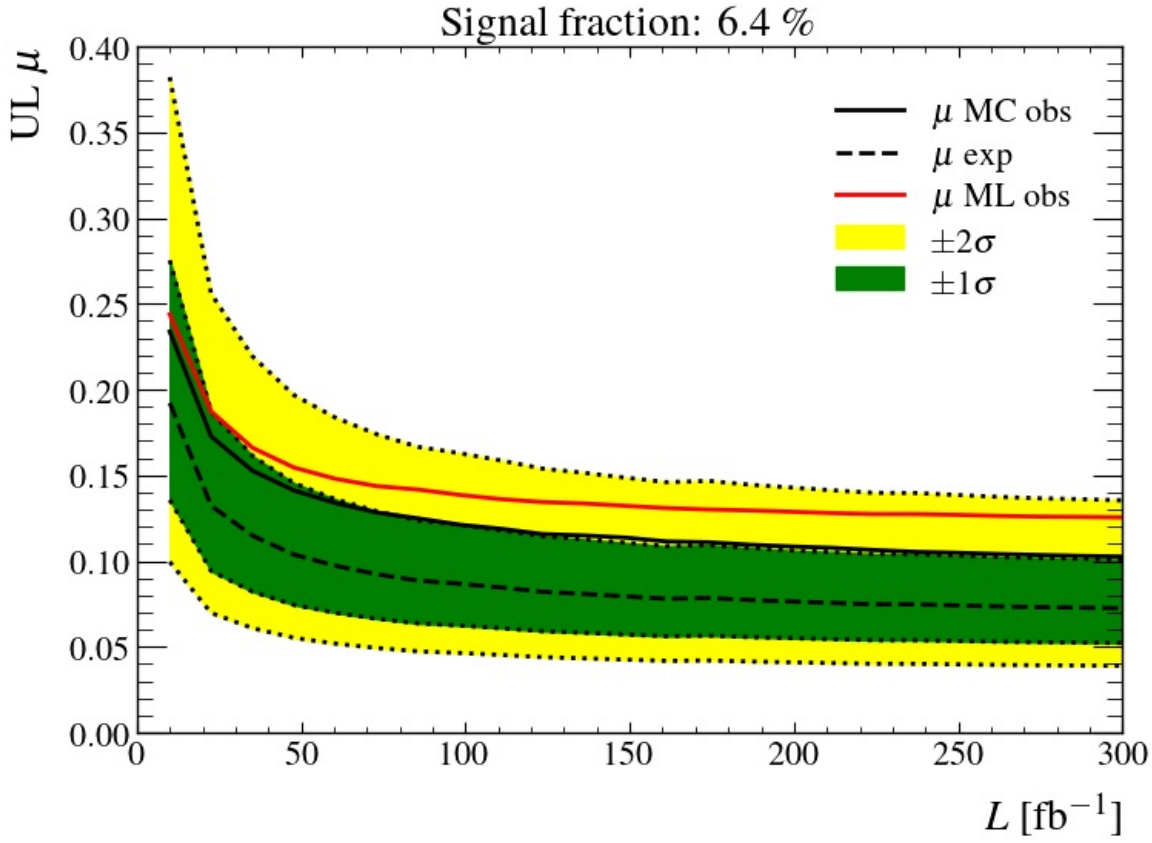
Plot UL

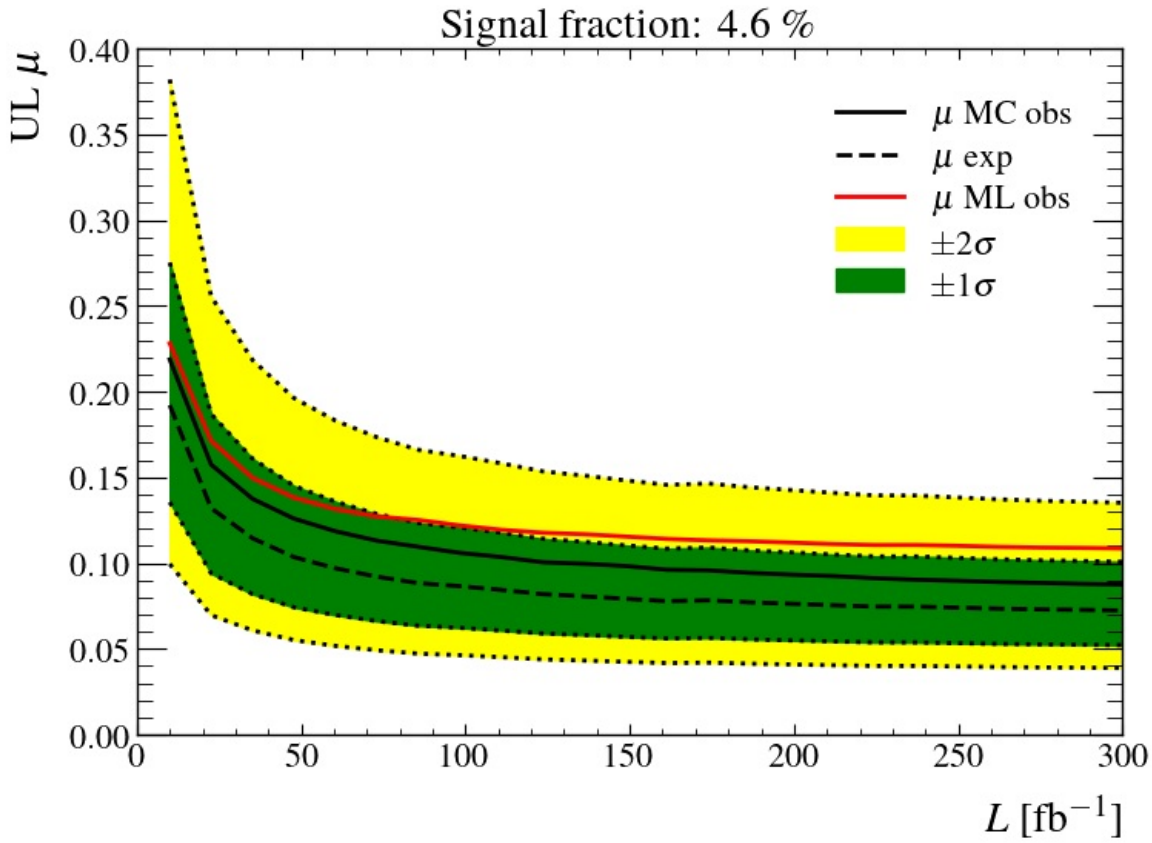
In [18]:
```
import matplotlib.pyplot as plt
from ml_hep_sim.plotting.style import style_setup, set_size

set_size()
style_setup(seaborn_pallete=True)
```

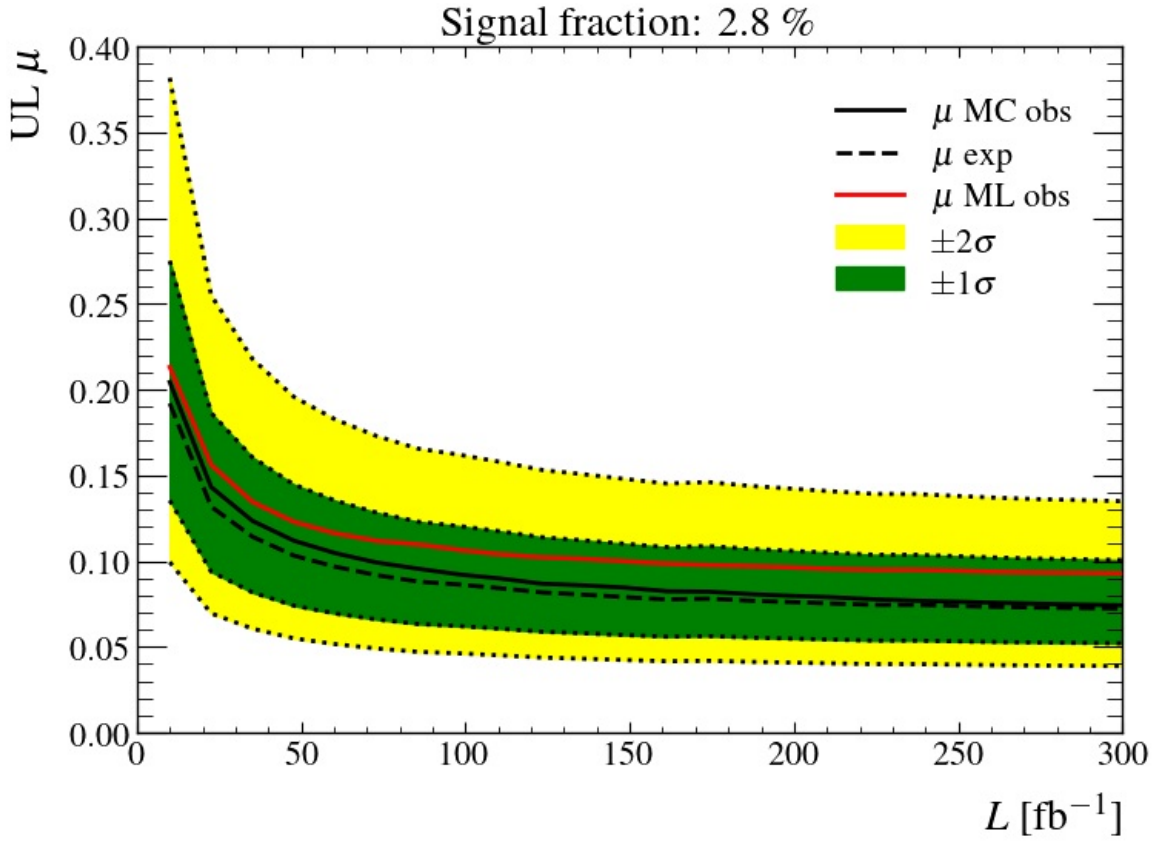
In [19]:
```
for i, (idx_gen, idx_mc) in enumerate(zip(idxs_gen, idxs_mc)):
    res_gen = pipe.pipes[idx_gen].results
    res_mc = pipe.pipes[idx_mc].results

    plt.fill_between(res_mc.N, res_mc.minus_sigma_2 , res_mc.plus_sigma_2, color="yellow", label="$\pm 2\sigma$
    plt.fill_between(res_mc.N, res_mc.minus_sigma_1, res_mc.plus_sigma_1, color="green", label="$\pm 1\sigma$")

    plt.plot(res_mc.N, res_mc.minus_sigma_1, c='k', ls='dotted')
    plt.plot(res_mc.N, res_mc.minus_sigma_2, c='k', ls='dotted')

    plt.plot(res_mc.N, res_mc.plus_sigma_1, c='k', ls='dotted')
    plt.plot(res_mc.N, res_mc.plus_sigma_2, c='k', ls='dotted')

    plt.plot(res_mc.N, res_mc.cls_obs, zorder=20, color='k', label="$\mu$ MC obs")
    plt.plot(res_mc.N, res_mc.cls_exp, color='k', ls='--', label="$\mu$ exp")

    plt.plot(res_gen.N, res_gen.cls_obs, zorder=20, color='r', label="$\mu$ ML obs")
    # plt.plot(res_gen.N, res_gen.cls_exp, color='r', ls='--', label="$\mu$ exp")

    # plt.xlabel("$N_{gen}^{bkg}$", loc="center")
    plt.xlabel("$L$ [fb$^{-1}$]")
    plt.ylabel("UL $\mu$")

    # plt.xscale("log")

    plt.title("Signal fraction: {:.1f} \%".format(sig_fracs[::-1][i] * 100))


    plt.legend()
    plt.tight_layout()
    plt.savefig(saved + f"ul_mu_alpha{i+1}.pdf")
    plt.show()
```

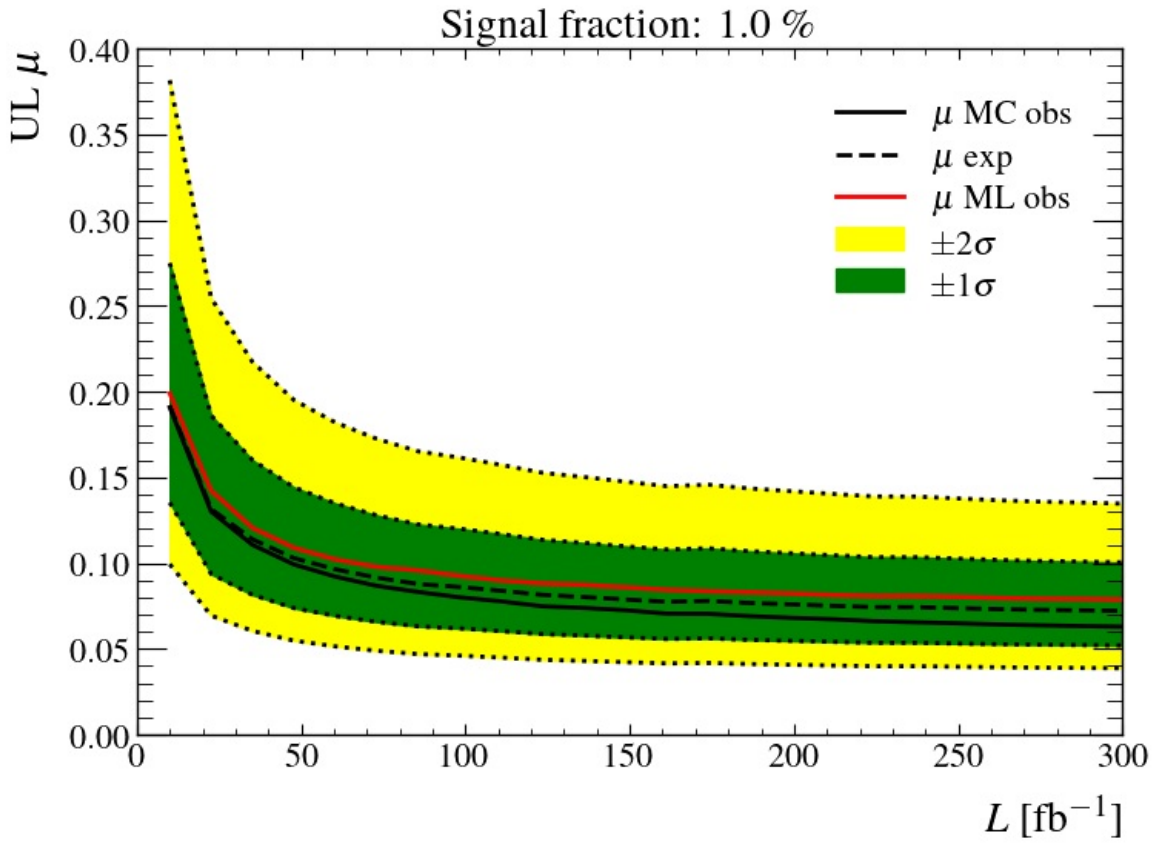

Signal fraction: 10.0 %
UL μ
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0
50
100
150
200
250
300
L [fb^{-1}]
μ MC obs
μ exp
μ ML obs
$\pm 2\sigma$
$\pm 1\sigma$


Signal fraction: 8.2 %
UL μ
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0
50
100
150
200
250
300
L [fb^{-1}]
μ MC obs
μ exp
μ ML obs
$\pm 2\sigma$
$\pm 1\sigma$


Signal fraction: 6.4 %
UL μ
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0
50
100
150
200
250
300
L [fb^{-1}]
μ MC obs
μ exp
μ ML obs
$\pm 2\sigma$
$\pm 1\sigma$


Signal fraction: 4.6 %
UL μ
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0
50
100
150
200
250
300
L [fb^{-1}]
μ MC obs
μ exp
μ ML obs
$\pm 2\sigma$
$\pm 1\sigma$


Signal fraction: 2.8 %
UL μ
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0
50
100
150
200
250
300
L [fb^{-1}]
μ MC obs
μ exp
μ ML obs
±2σ
±1σ


Signal fraction: 1.0 %
UL μ
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0
50
100
150
200
250
300
L [fb^{-1}]
μ MC obs
μ exp
μ ML obs
±2σ
±1σ

In [ ]: