10x275 GeV simulations with backgrounds

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Local simulation production

- We have simulated events for three configurations:
  1. 18x275 GeV setting with single DIS collision ($Q^2 > 1$ GeV^2) in each 2us long window (event): 1000 events with backgrounds (**18x275_Forced**) and without backgrounds (**18x275_noBG**).
  2. 10x275 GeV setting with single DIS collision ($Q^2 > 1$ GeV^2) in each 2us long window (event): 1000 events with backgrounds (**10x275_Forced**) and without backgrounds (**10x275_noBG**).
  3. 18x275 GeV setting with only backgrounds processes (i.e. no e-p collision) in each 2us long window (event): 1000 events (**18x275_BGOnly**).
- These files were run with the latest ePIC release and can be found here on the BNL (SDCC) machines: */gpfs02/eic/baraks/epic/running/condor/backgrounds*.
- We have communicated these details to the ePIC production group, and requested the above sets be included as part of the official simulation running.

How to run background simulations – event generation step

- The code we are using is located on the snippets repository.

```
38    ###############
39    ## background sources
40    ## SR, brems, coulomb, touschek, pgas
41    ## generatorStatus ID:
42    ## 2000, 3000, 4000, 5000, 6000
43    ###############
44    echo "Please select an option:"
45    echo "1: DIS 18x275"
46    echo "2: DIS 18x275, no SR"
47    echo "3: minbias 18x275"
48    echo "4: DIS 10x275, SR scaled from 18GeV"
49    echo "5: DIS 5x100, SR scaled from 18GeV"
50    echo "6: Backgrounds only 18x275"
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```
elif [[ "$option" == "4" ]]; then
    ebeam=10
    pbeam=275
    tag="_scaled_SR_"
    signal="pythia8NCDIS_10x275_minQ2=1_beamEffects_xAngle=-0.025_hiDiv_1.hepmc"

    bg_files=(
    "root://dtn-eic.jlab.org//volatile/eic/andrii/SynradG4_HepMC_Files_SR_on_IP6/data/
    "root://dtn-eic.jlab.org//volatile/eic/andrii/Xsuite_HepMC_Files_ESR_BeamLoss_on_e
    "root://dtn-eic.jlab.org//volatile/eic/andrii/Xsuite_HepMC_Files_ESR_BeamLoss_on_e
    "root://dtn-eic.jlab.org//volatile/eic/andrii/Xsuite_HepMC_Files_ESR_BeamLoss_on_e
    "root://dtn-eic.jlab.org//volatile/eic/EPIC/EVGEN/BACKGROUNDS/BEAMGAS/proton/pythi
    )

    freqs=(36608000 172.31 29.56 233.50 32.6) ## kHz
    statuses=(2000 3000 4000 5000 6000)
```

How to run background simulations – *npsim* step

- To run the background particles through the simulation, we need to tell DD4hep to recognize the background status codes as final-state particles:

```
#Run DIS events through npsim
npsim --compactFile $DETECTOR_PATH/epic_craterlake.xml \
--numberOfEvents ${NEVENTS} \
--skipNEvents ${START} --inputFiles ${INPUT_HEPMC} \
--physics.alternativeStableStatuses="2001 3001 4001 5001 6001" \
--physics.alternativeDecayStatuses="2002 3002 4002 5002 6002" \
--outputFile output.edm4hep.root
```

- To just use the DIS signal particles in the Geant simulation, we can turn off the "*alternativeStable[Decay]Statuses*" options. This is a good way to study to do a comparison with and without backgrounds using the same DIS collisions.
- The simulation is quite slow for 10x275 GeV – it took 3 hours for both *npsim* and *EICRecon* to complete 10 events of SDCC batch farm. The *npsim* output file is about 14 MB/event. In addition, for 10x275 GeV, I had to submit 100 jobs with 10 events each to keep the memory consumption manageable. This issue may have been resolve yesterday: see here.

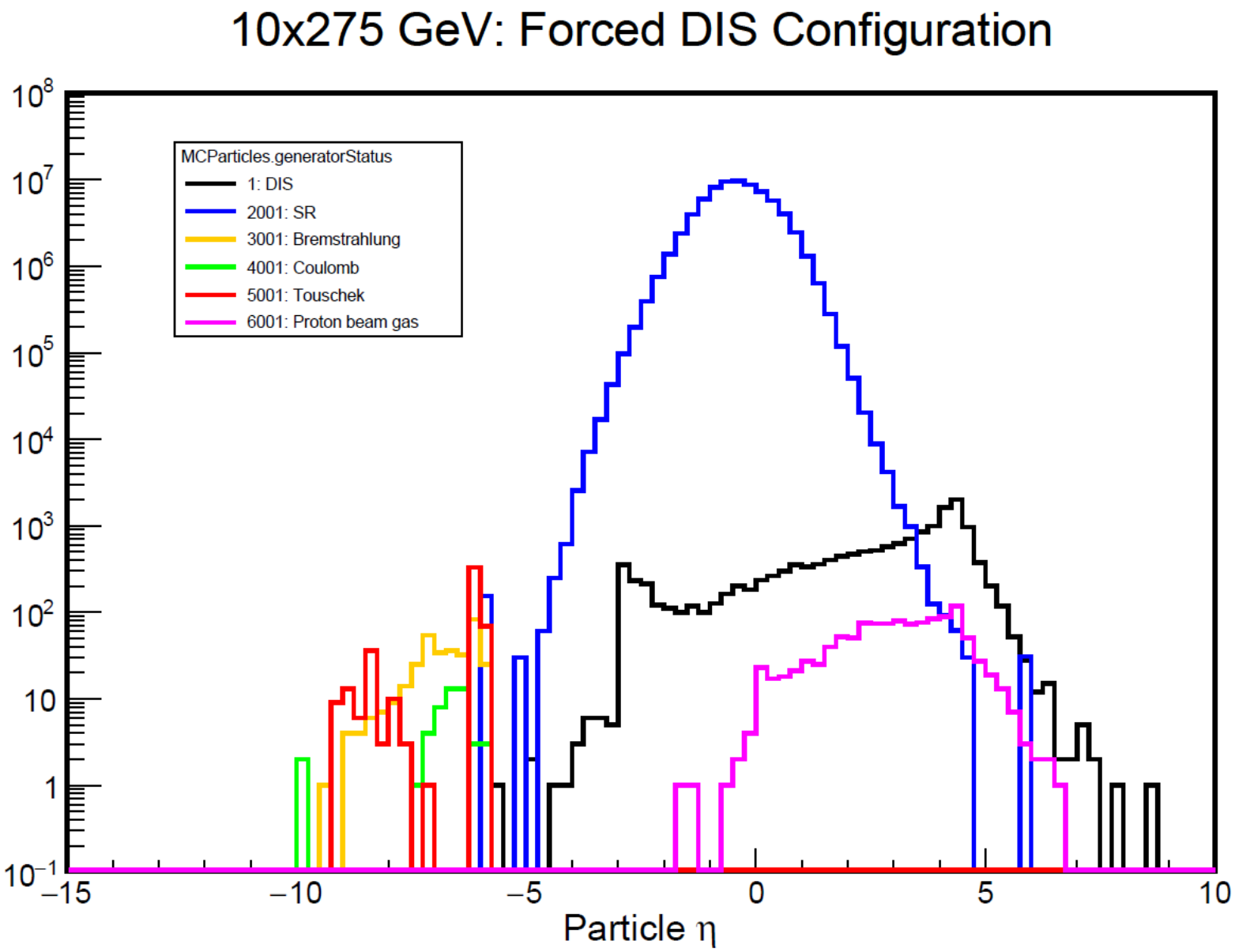
How to run background simulations – *EICRecon* step

- For *EICRecon*, the reconstruction will not work unless we disable the default timeout:

```
#Run reconstruction
eicrecon -Ppodio:output_file=eicrecon_out.root \
-Pjana:nevents=${NEVENTS} \
-Pdd4hep:xml_files=epic_craterlake.xml \
-Pjana:warmup_timeout=0 -Pjana:timeout=0 \
output.edm4hep.root
```

- The EICRecon file is again large for 10x275 GeV – it is about 41 MB/event.
- In the end, I was able to fully simulate 1000 events.

Generated particle distributions in output files



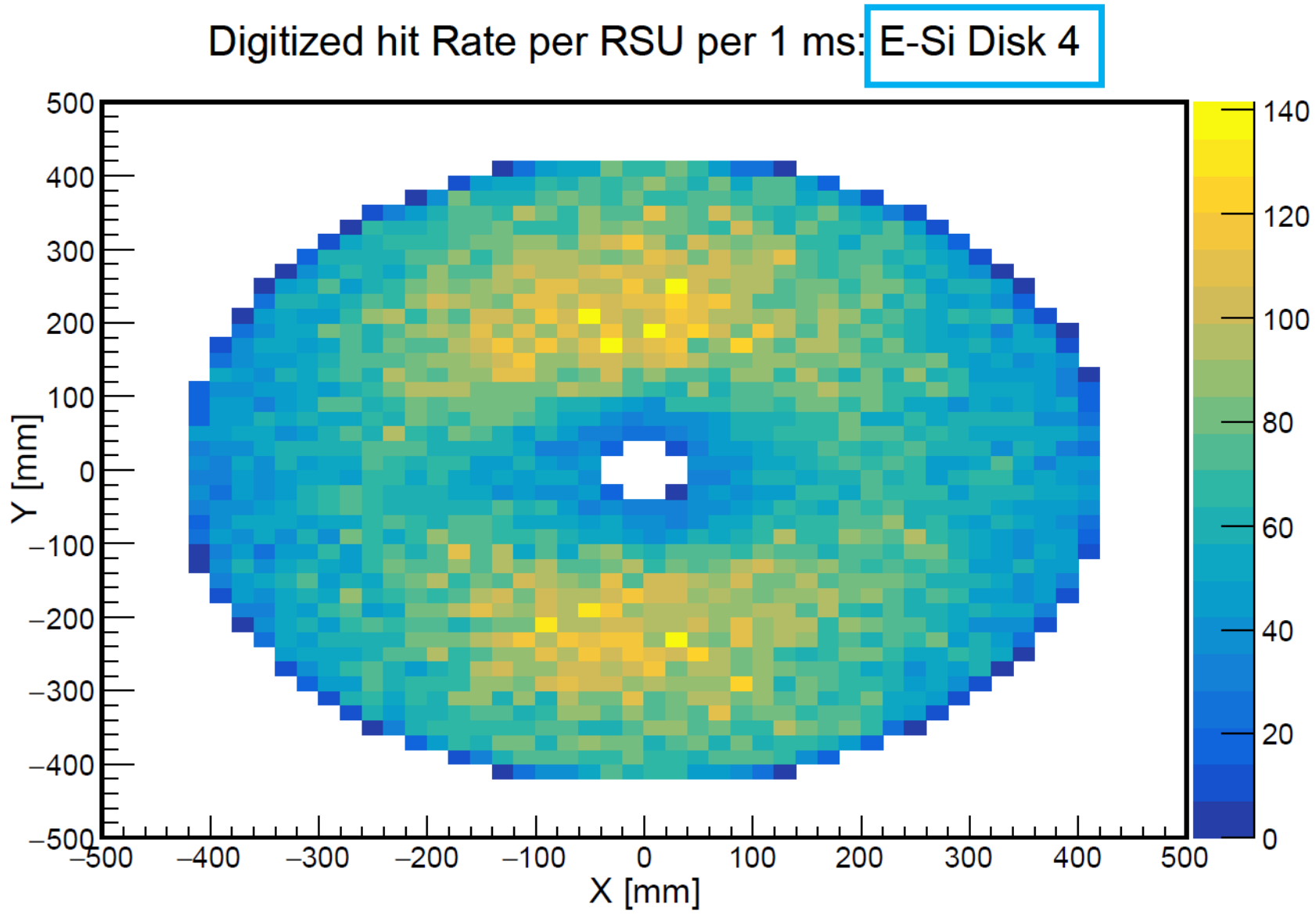
Sanity check for SR rate

Integral of blue histogram = 7.32202×10^7

Total time simulated = 2×10^{-6} sec/event x 1000 events = 2 ms

SR photon rate = 36610.1 MHz

SVT disks digitized hit rates: 10x275 GeV (forced DIS configuration)



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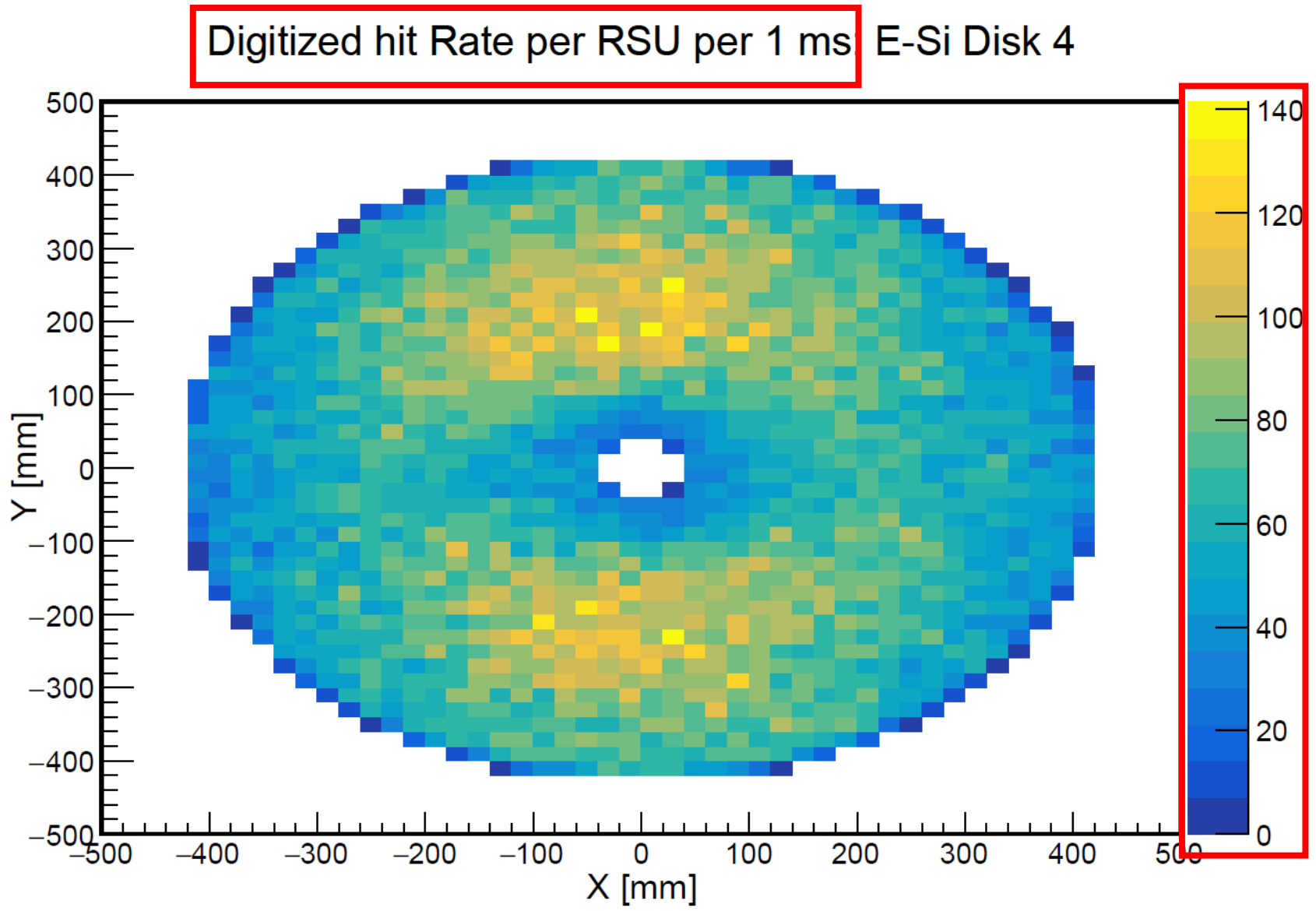
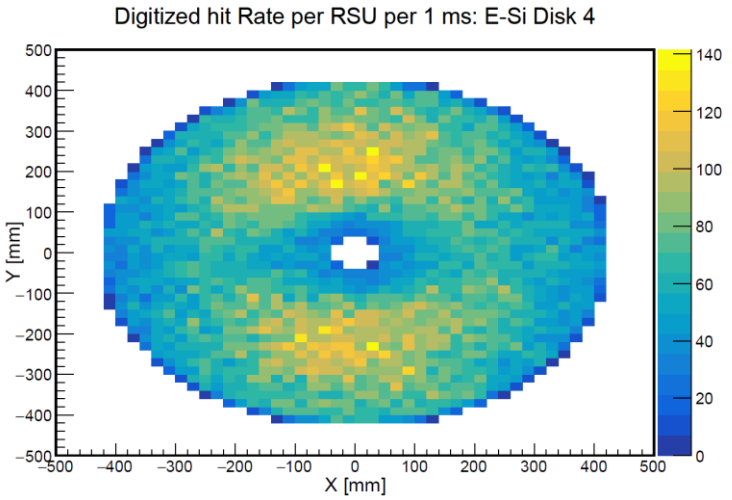
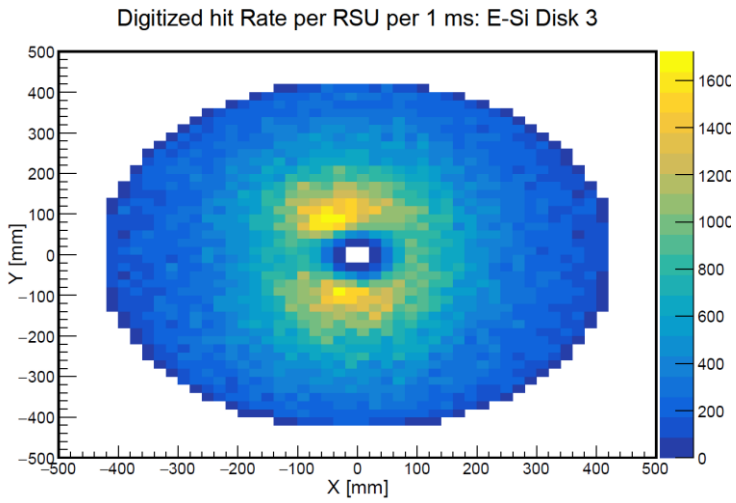
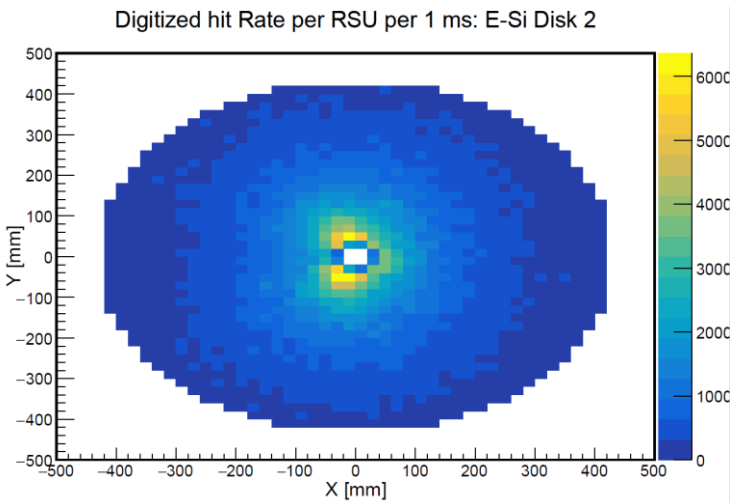
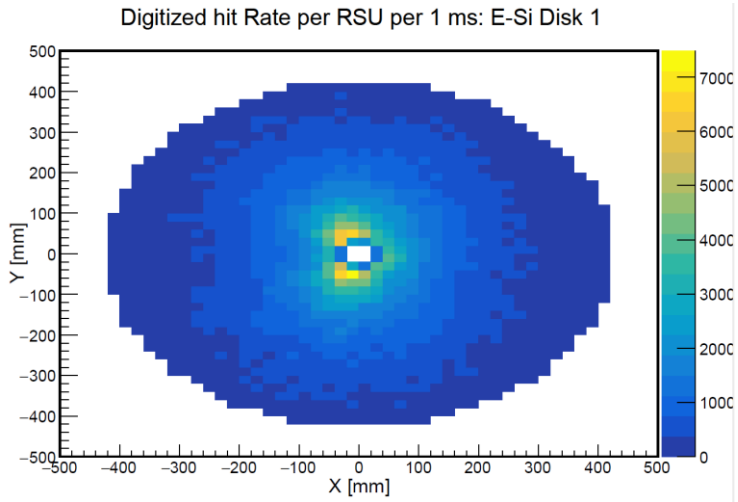


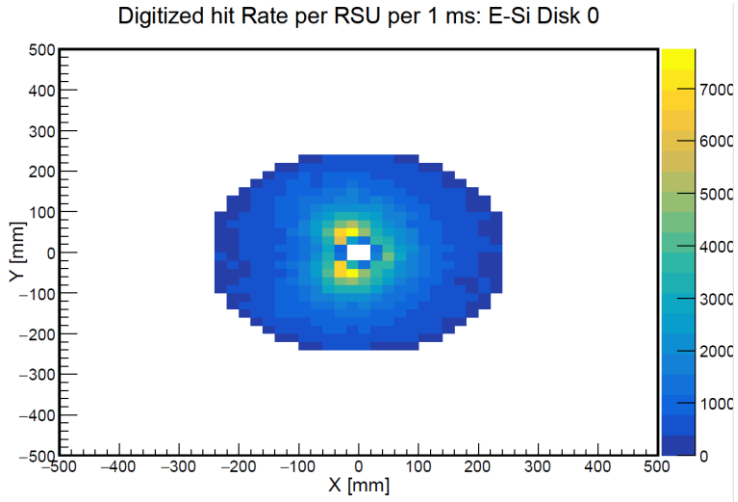
All SVT E-side disks: 10x275 GeV (forced DIS configuration)



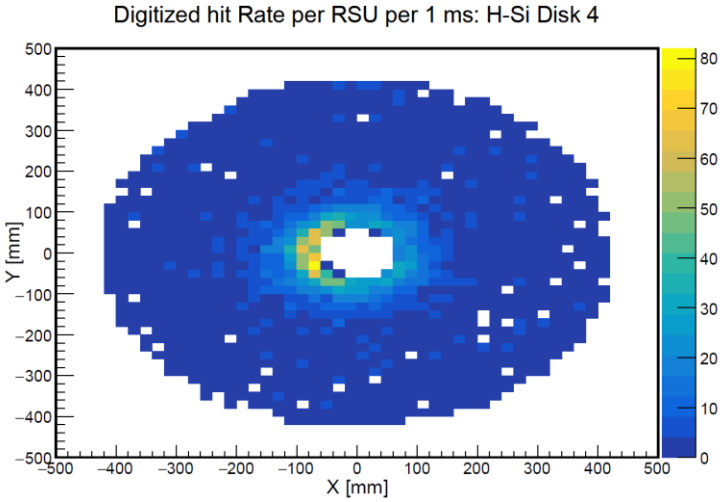


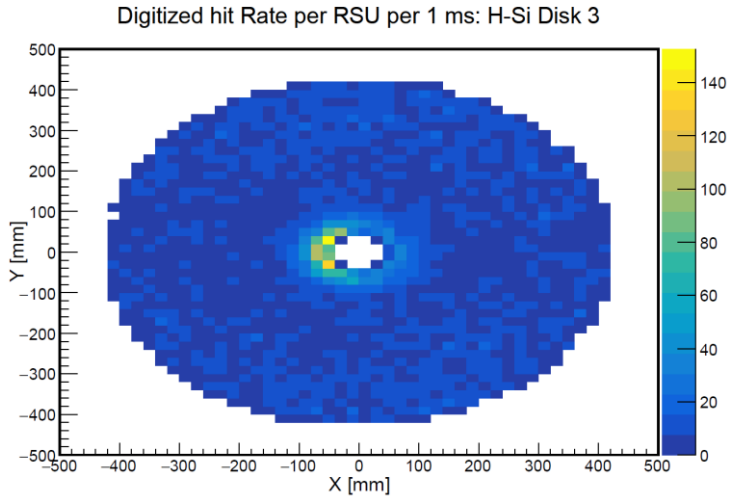


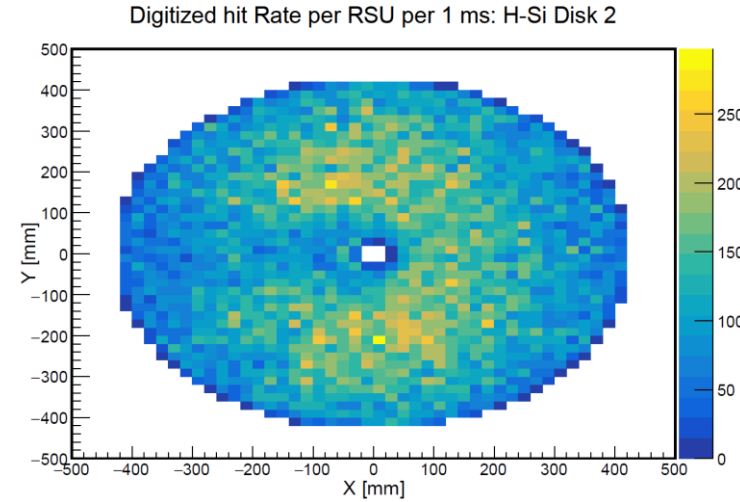


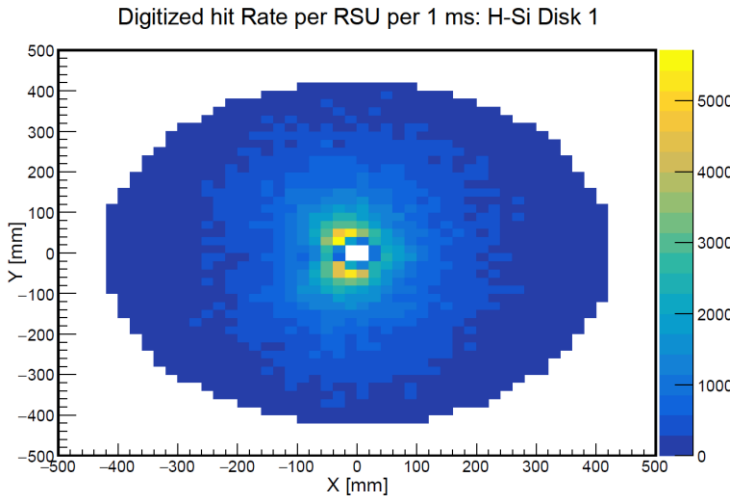


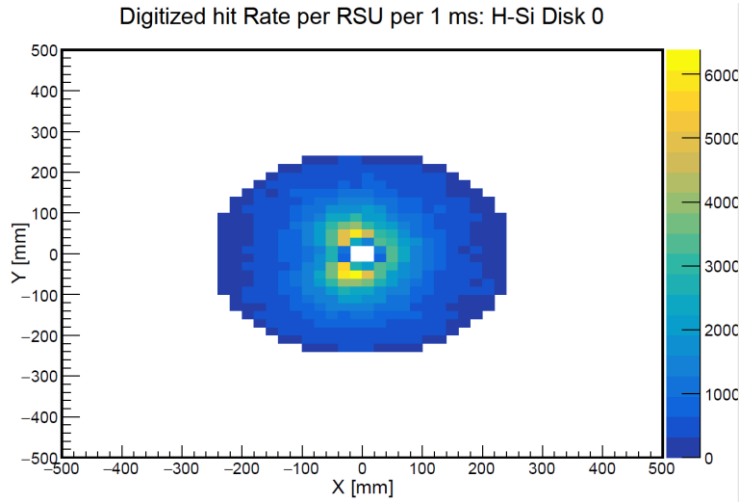
All SVT H-side disks: 10x275 GeV (forced DIS configuration)







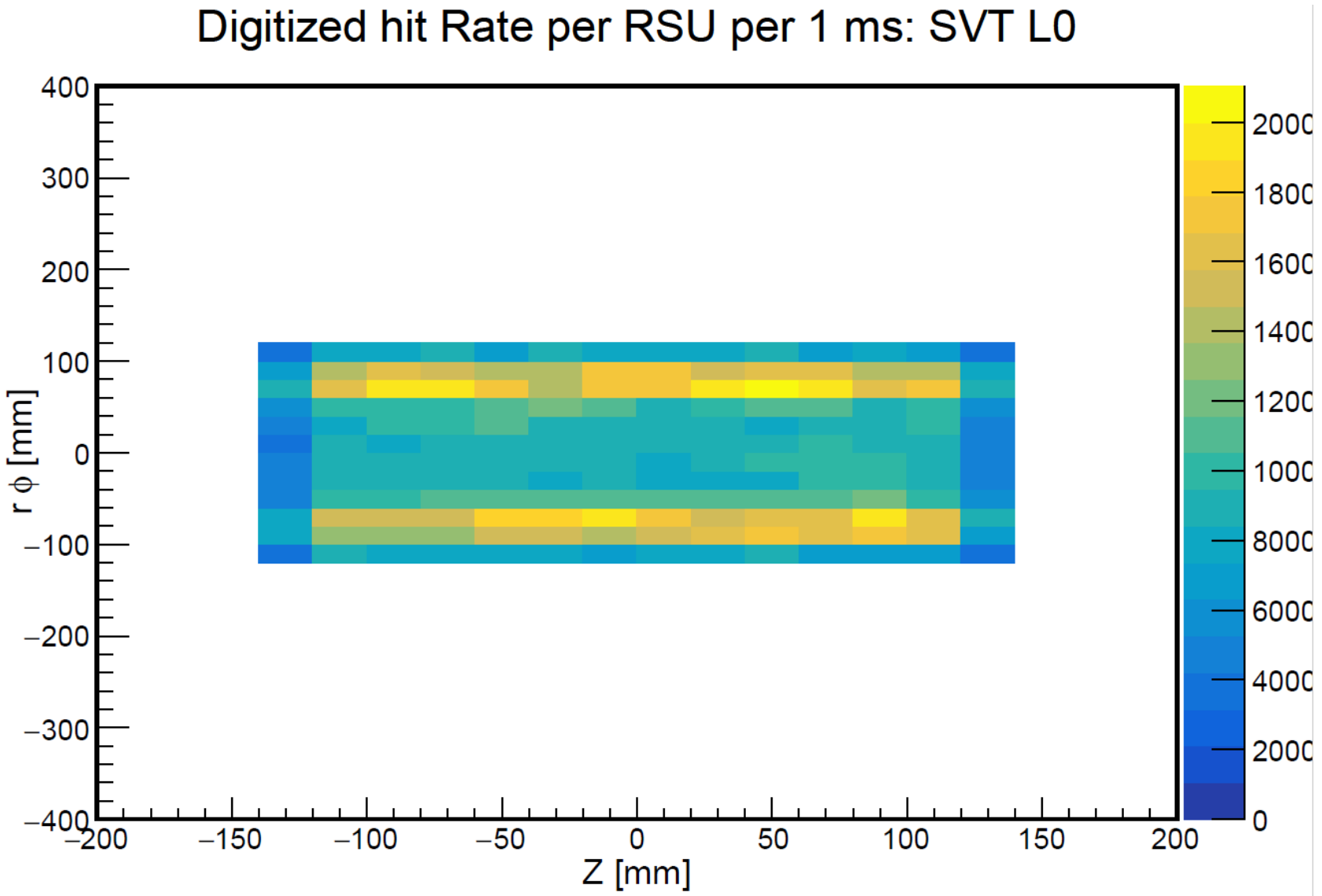




SVT L0: 10x275 GeV (forced DIS configuration)

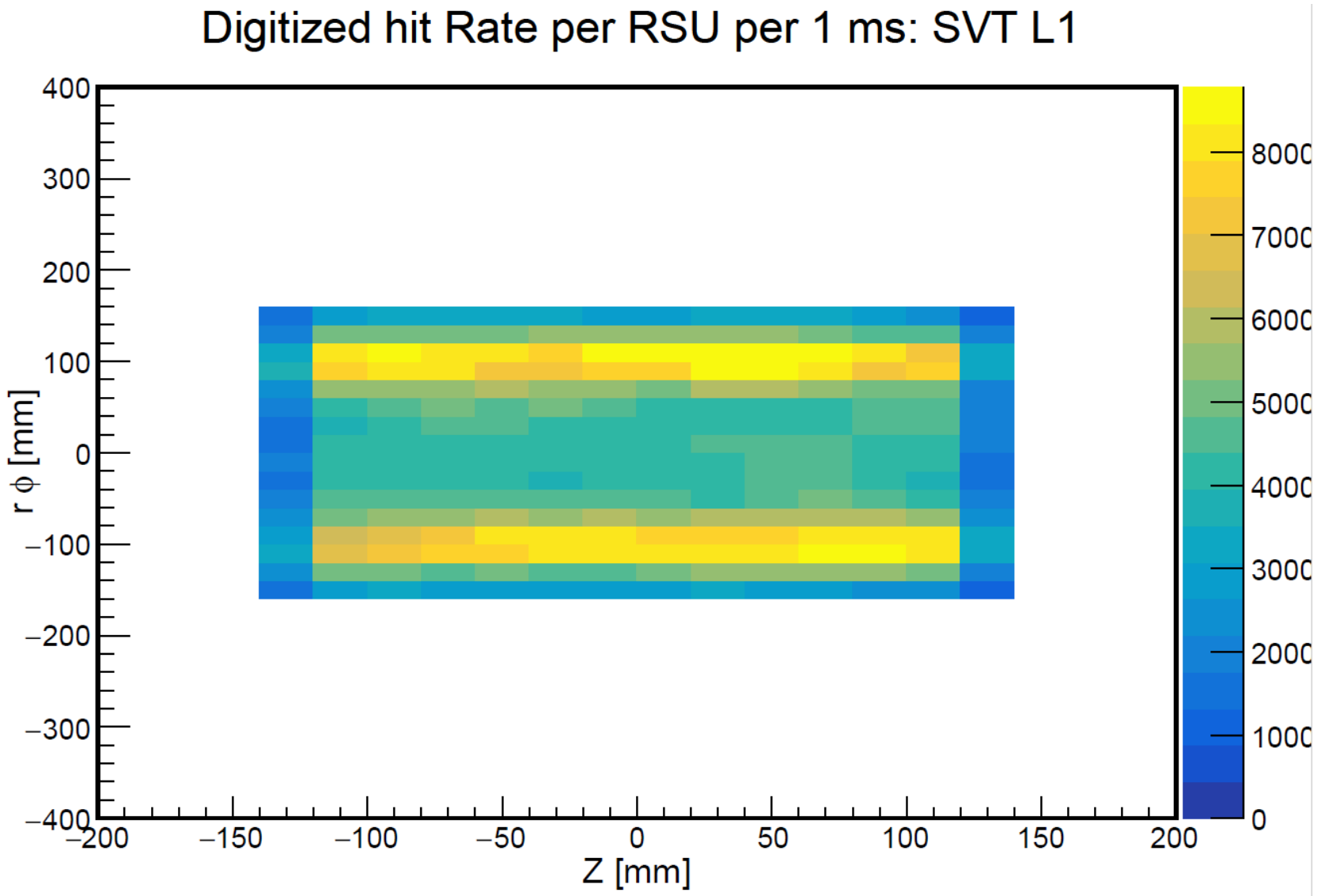
In latest geometry, r = 38 mm for L0.

So, rϕ should span ±120mm.



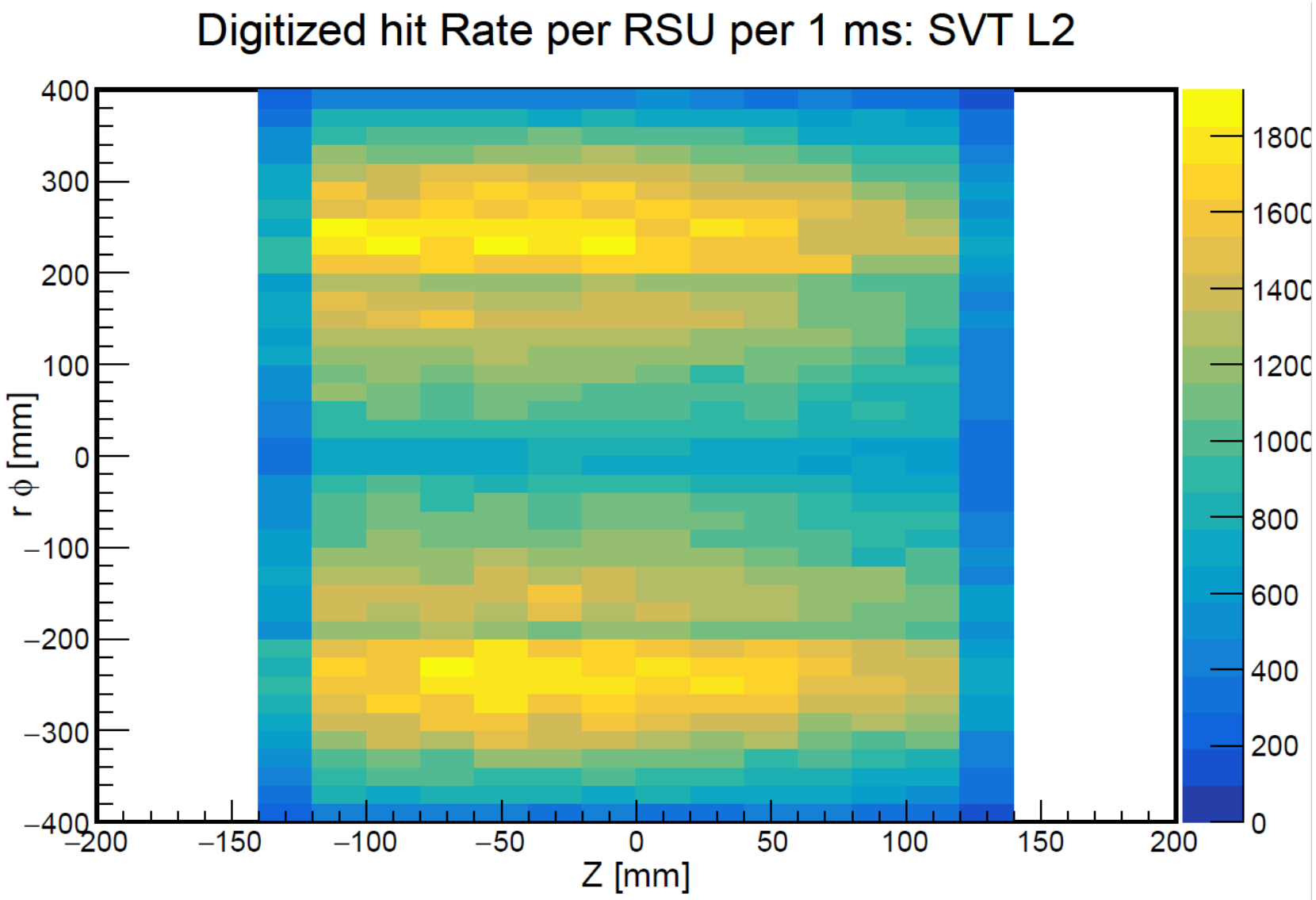
SVT L1: 10x275 GeV (forced DIS configuration)

In latest geometry, r = 50 mm for L1.



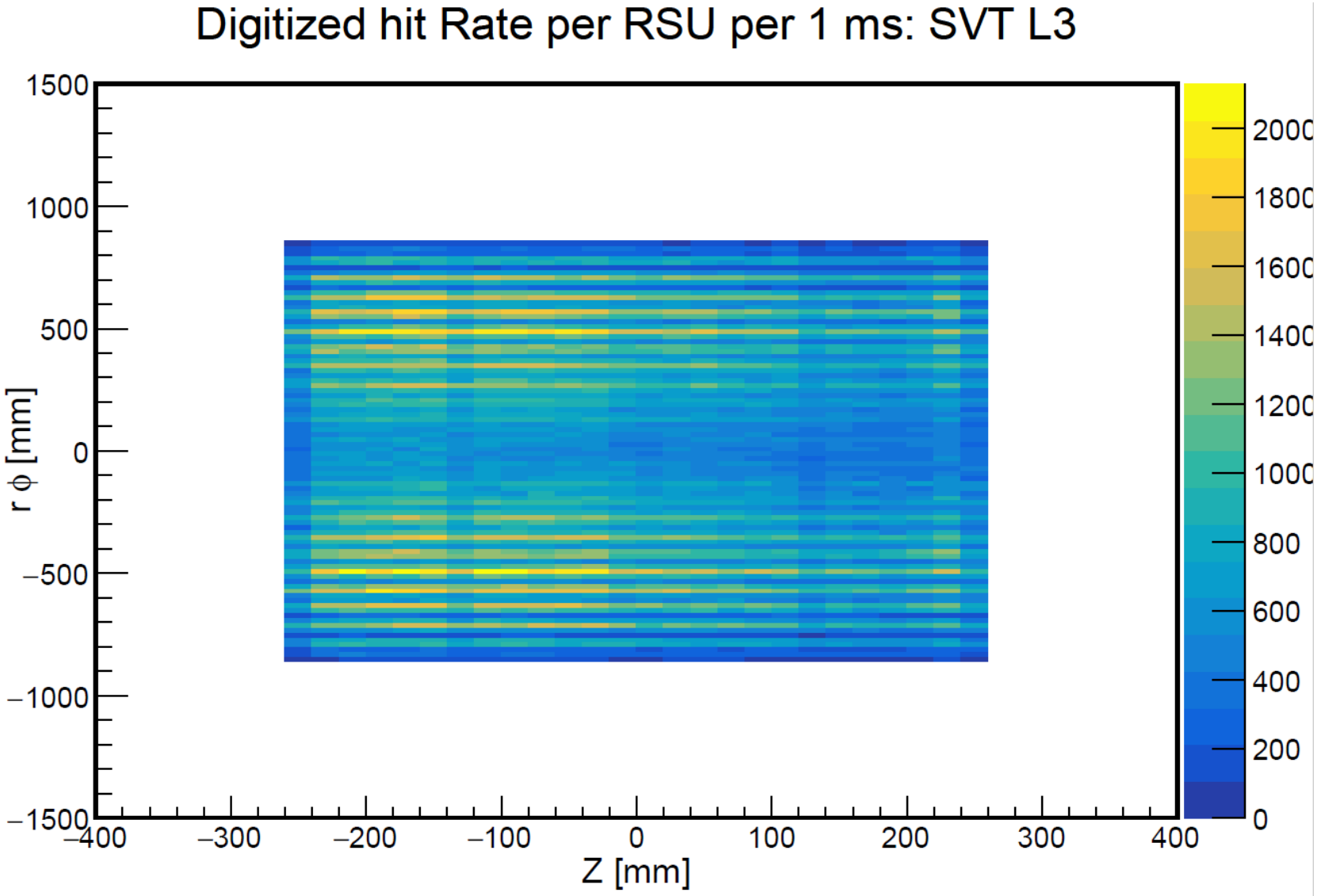
SVT L2: 10x275 GeV (forced DIS configuration)

In latest geometry, r = 125 mm for L2.



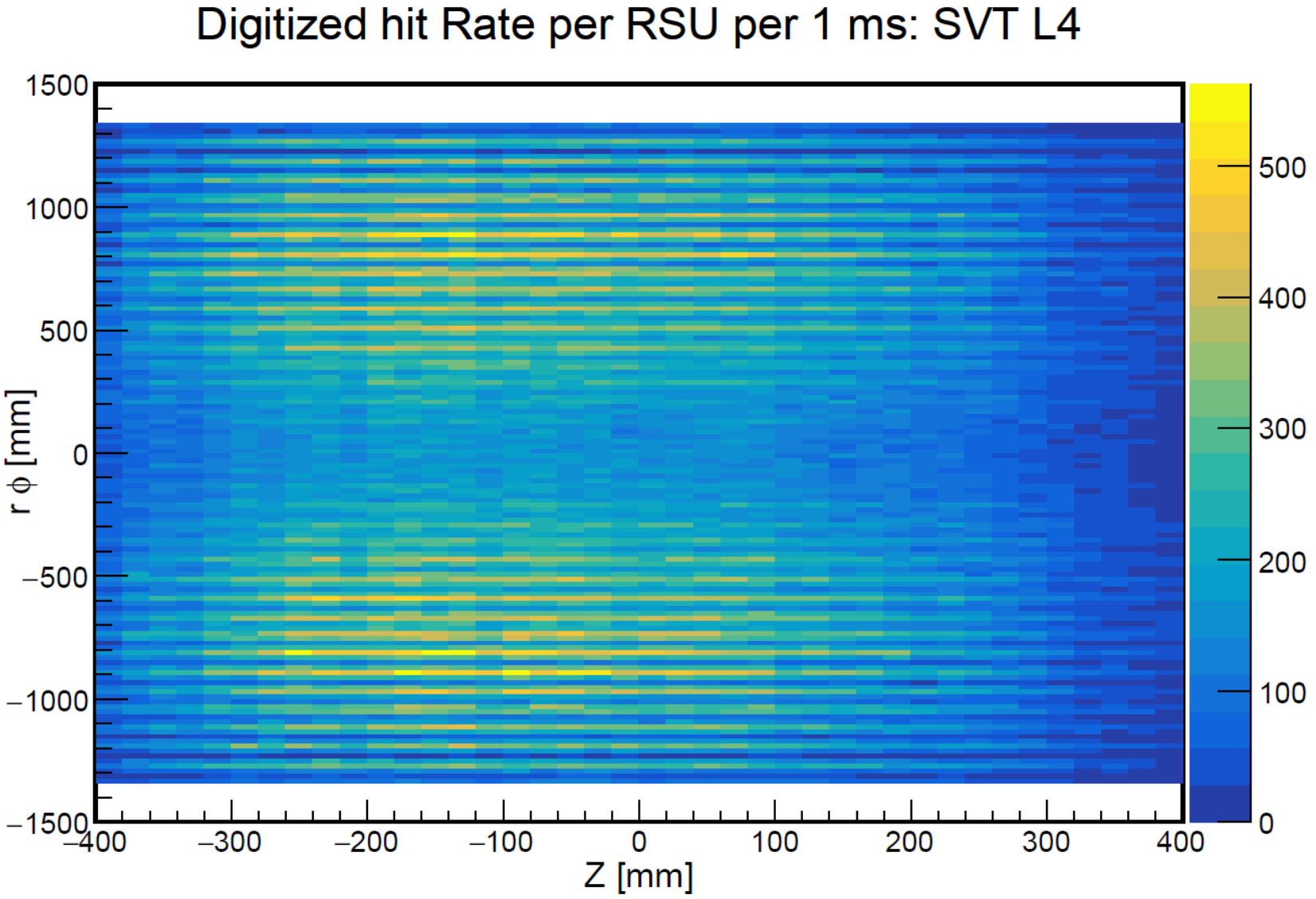
SVT L3: 10x275 GeV (forced DIS configuration)

In latest geometry, r = 263 mm and 269 mm for L3.



SVT L4: 10x275 GeV (forced DIS configuration)

In latest geometry, r = 418 mm and 2424 mm for L4.



Conclusions

- We were able to simulate 1000 events (i.e. time windows) at 10x275 GeV with the updated backgrounds.
- We have worked with the production team so that these events can be generated as part of the official campaigns.
- I showed plots of hit rates in each SVT layer today at this 10x275 GeV setting.
- The next step is to look at tracking performance with this configuration.