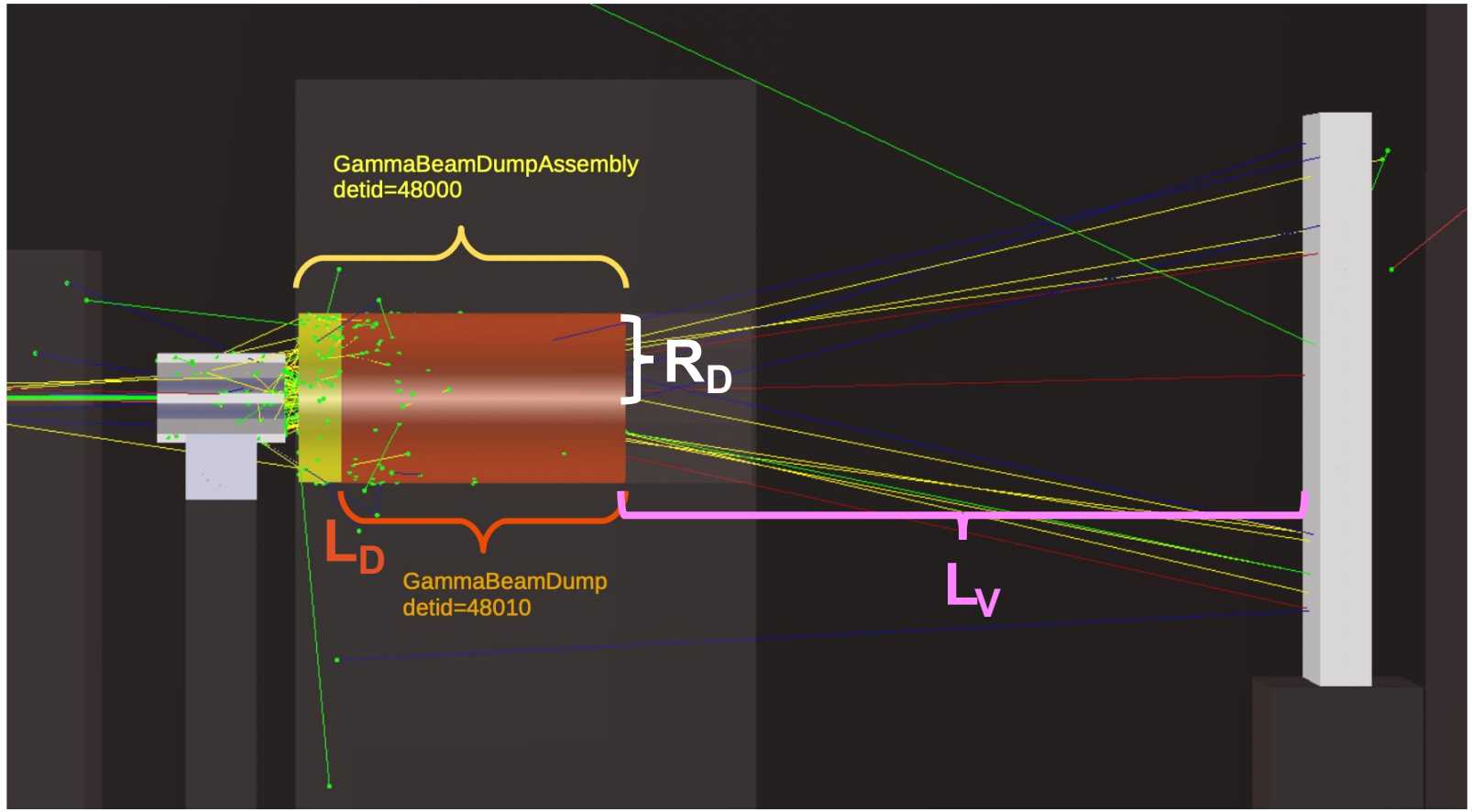
NPOD background simulation studies update

Raquel Quishpe

July 10th , 2023

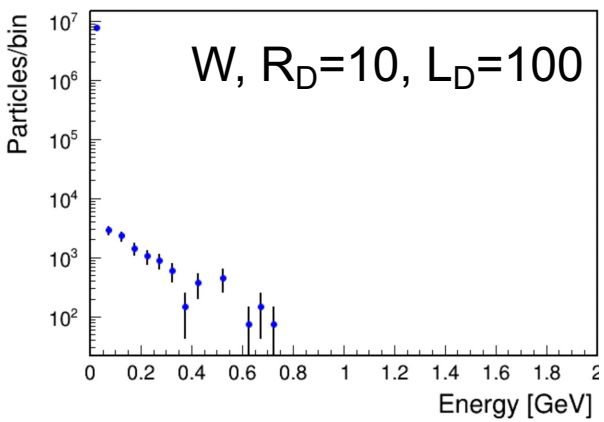
NPOD setup (reminder)

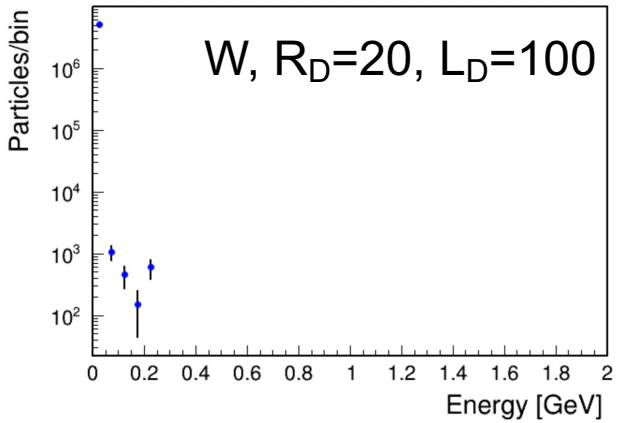


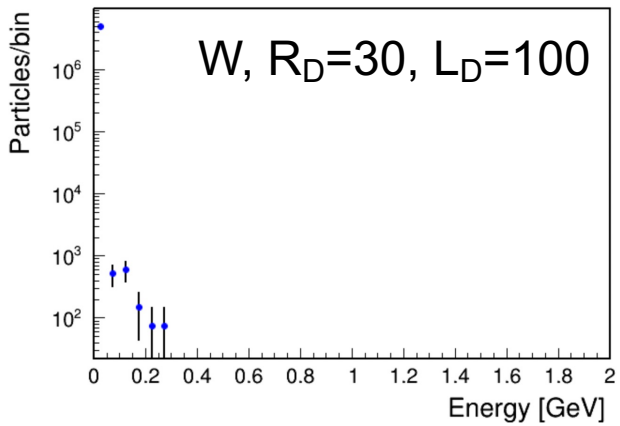
- Plug with hole at the beginning of the dump (air insert in the past)
- Dump enclosed in concrete wall
- G4 output includes flag "**status**" :
  - **0**: ideal case
  - **4**: particle escaped from the side of the dump
  - **6**: particle escaped the dump through the front plane and crossed the dump again so that it exited through the side
  - **8**: particle whose ancestor escaped the dump from the side

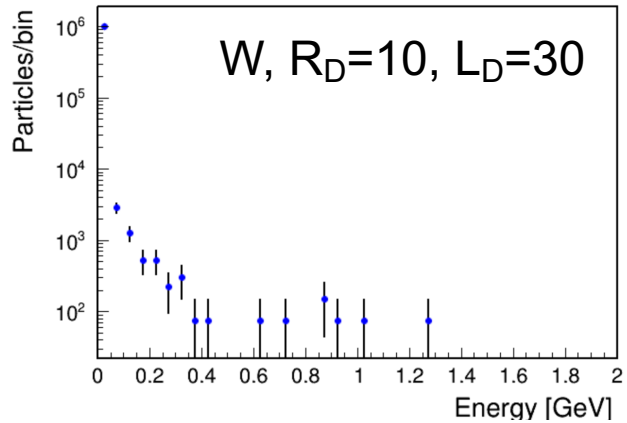
Neutrons energy distribution

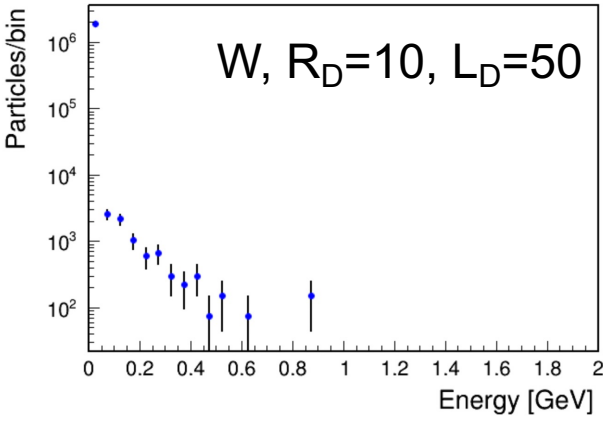
- Significant background seen from neutrons (photons in backup)
- L_V=100cm, 0.2BX
- cut (particles produced inside of the dump that reach the BSM detector): `detid==9000 && abs(z-{$calo_z})<0.1 && srqrt (x*x+y*y)<1000.0 && sqrt(vtxx*vtxx+vtxy*vtxy)<500.0 && vtxz>13705.0 && vtxz<{$dump_end}`

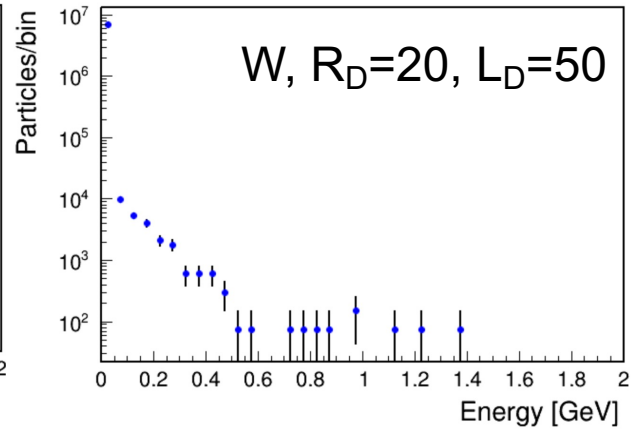


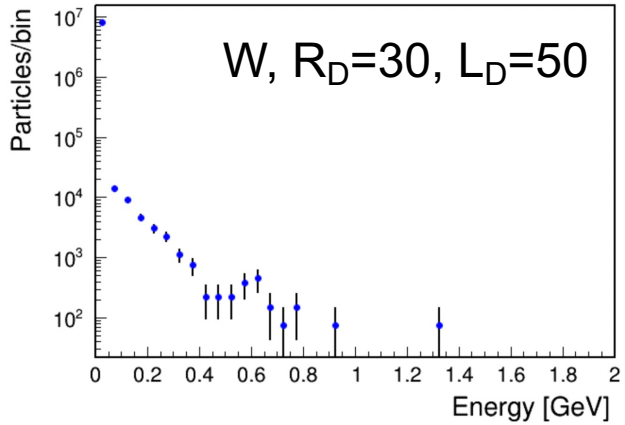


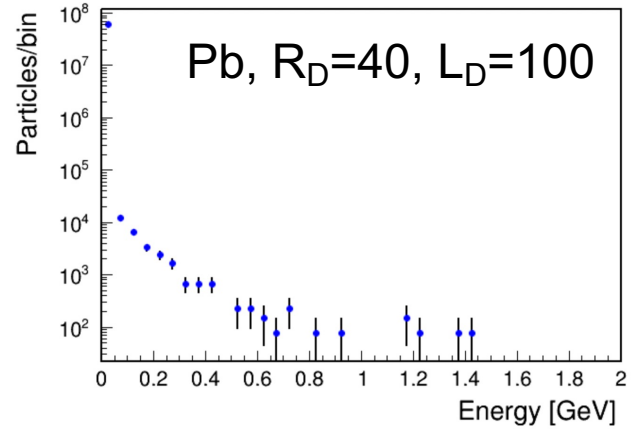






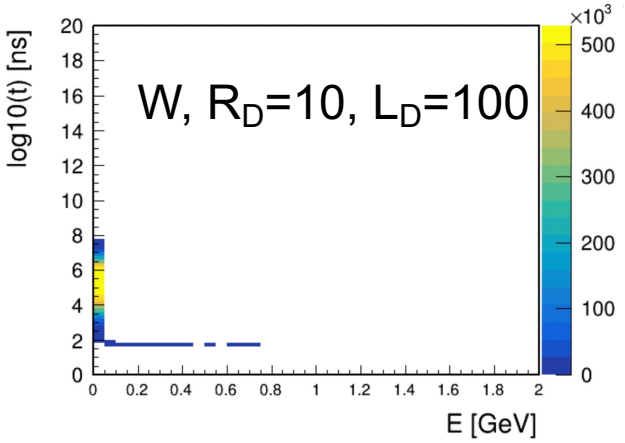


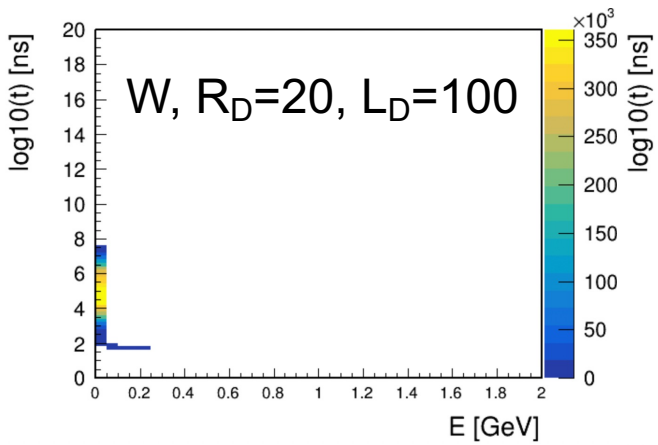


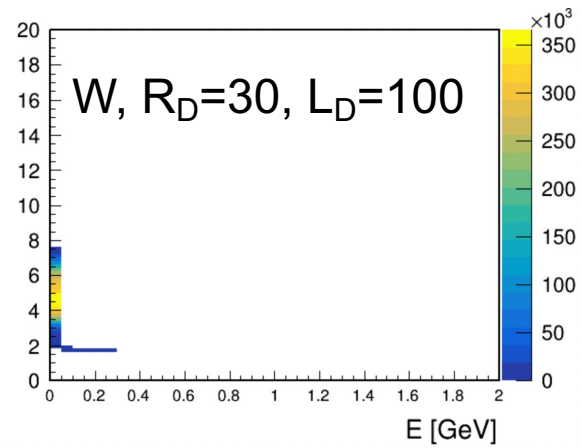


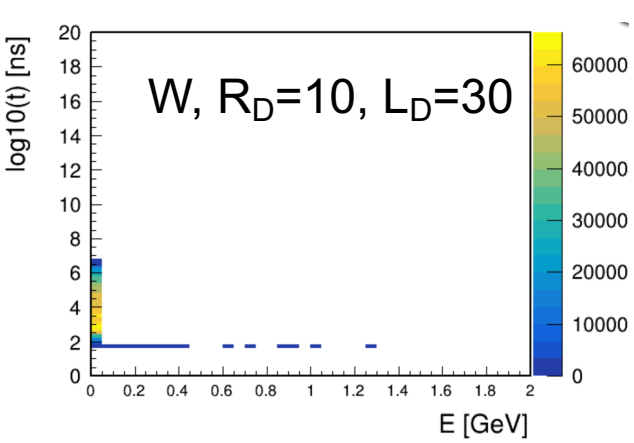
Neutrons time vs. energy

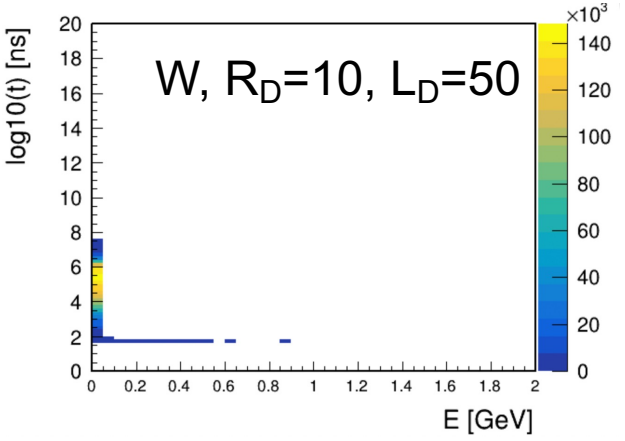
- L_V=100cm, 0.2BX
- cut (particles produced inside of the dump that reach the BSM detector): `detid==9000 && abs(z-{$calo_z})<0.1 && srqrt (x*x+y*y)<1000.0 && sqrt(vtxx*vtxx+vtxy*vtxy)<500.0 && vtxz>13705.0 && vtxz<{$dump_end}`
- Low energy particles arrive too late >100ns

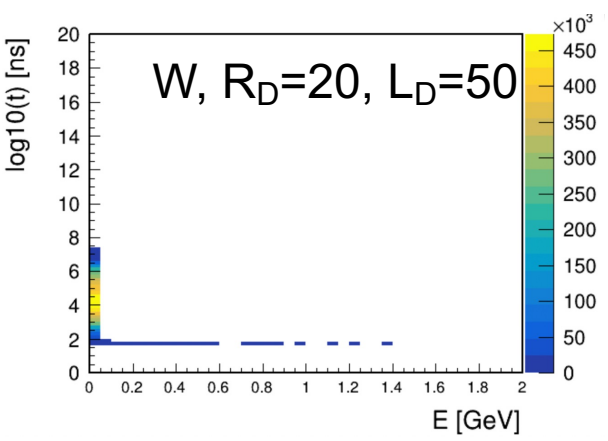


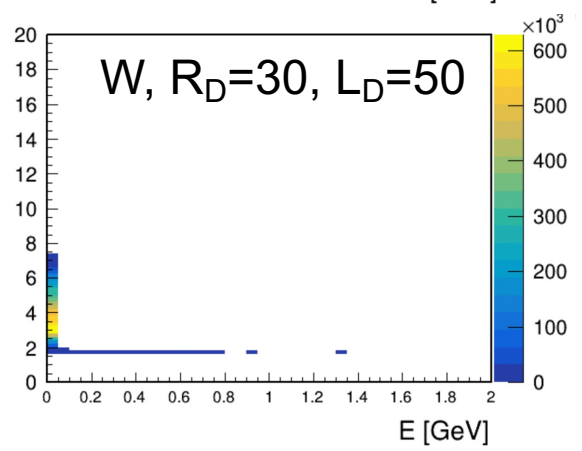


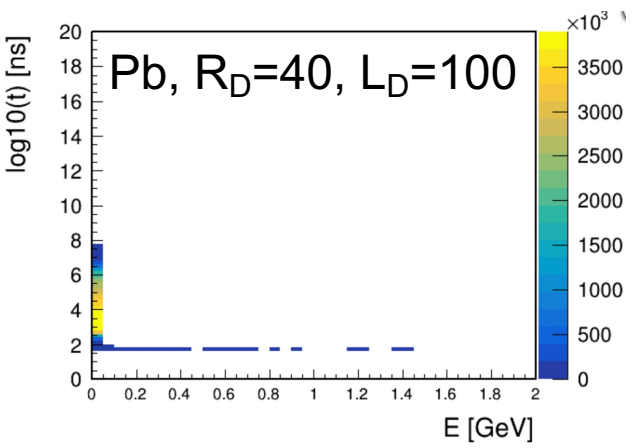






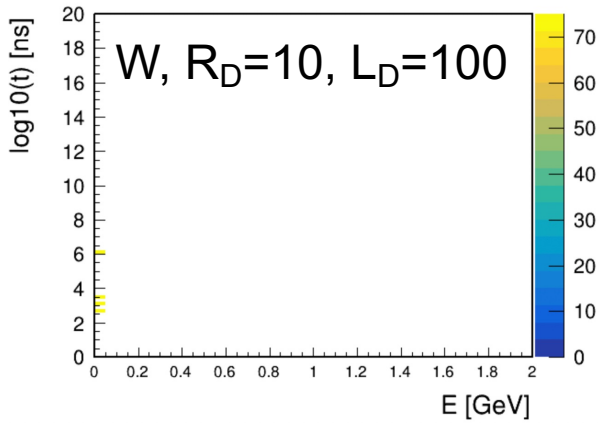


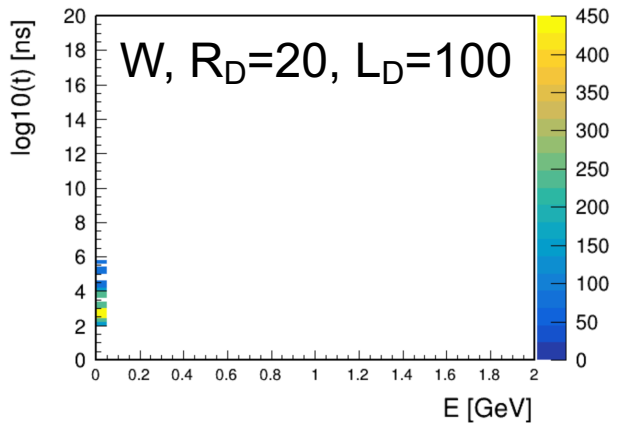


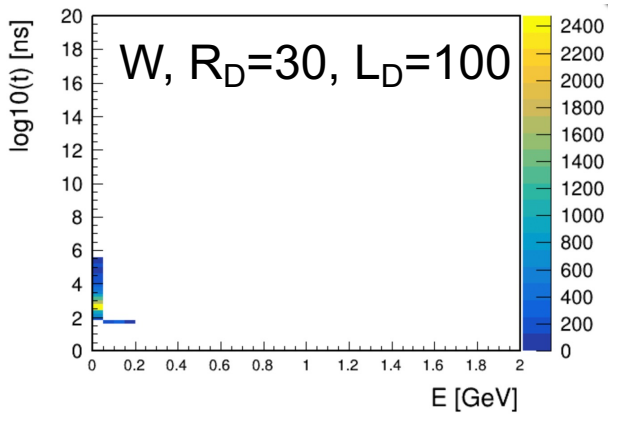


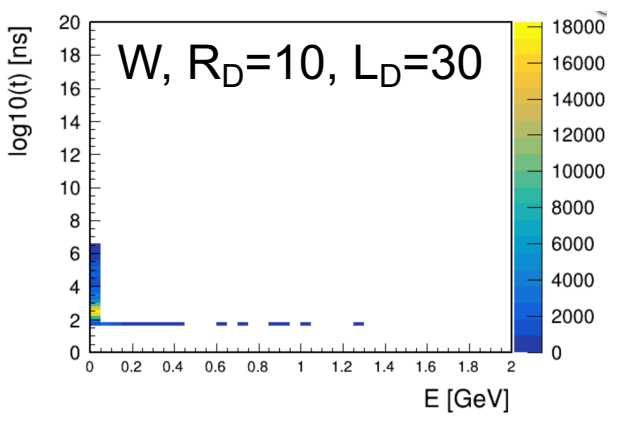
Neutrons time vs. energy status==0

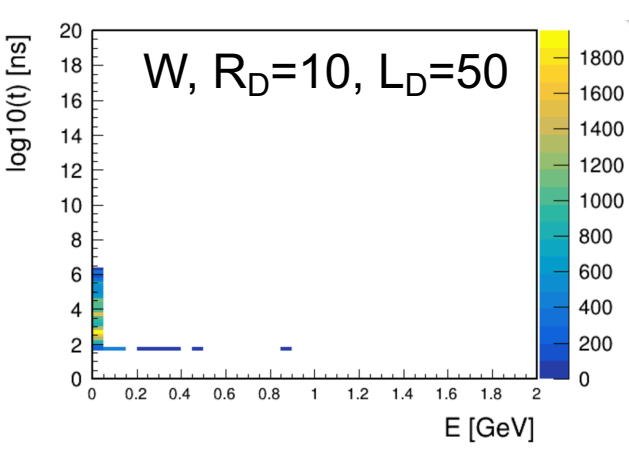
- L_V=100cm, 0.2BX
- cut (particles produced inside of the dump that reach the BSM detector): `detid==9000 && abs(z-{$calo_z})<0.1 && srqrt (x*x+y*y)<1000.0 && sqrt(vtxx*vtxx+vtxy*vtxy)<500.0 && vtxz>13705.0 && vtxz<{$dump_end}`
- For W, at shorter dump lengths, there are more energetic neutrons arrivining at ~100ns, hence dump cannot be too short in length

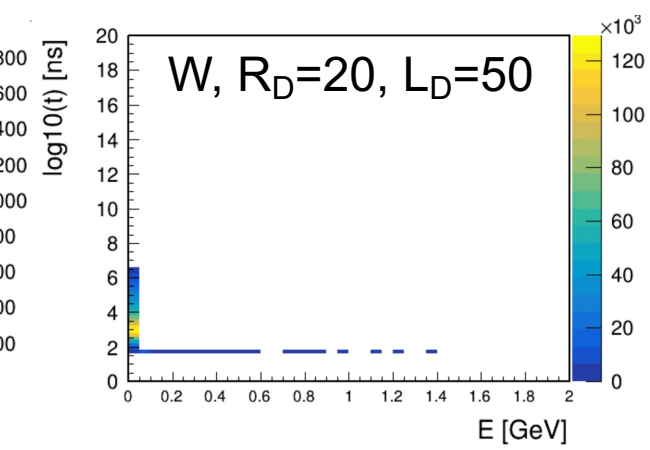


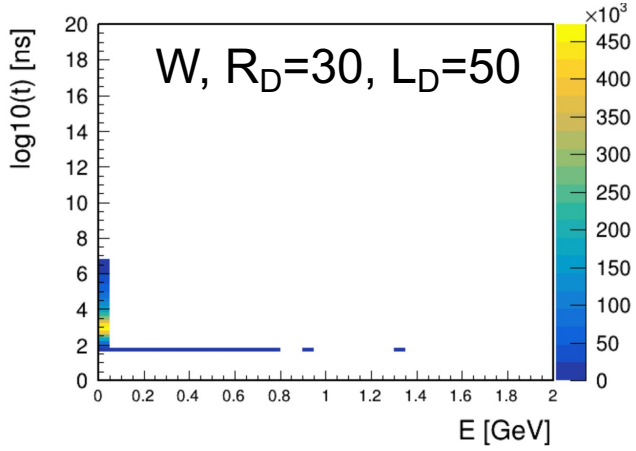


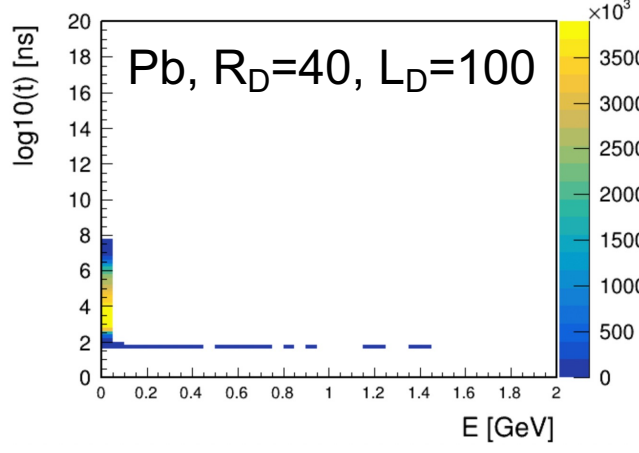






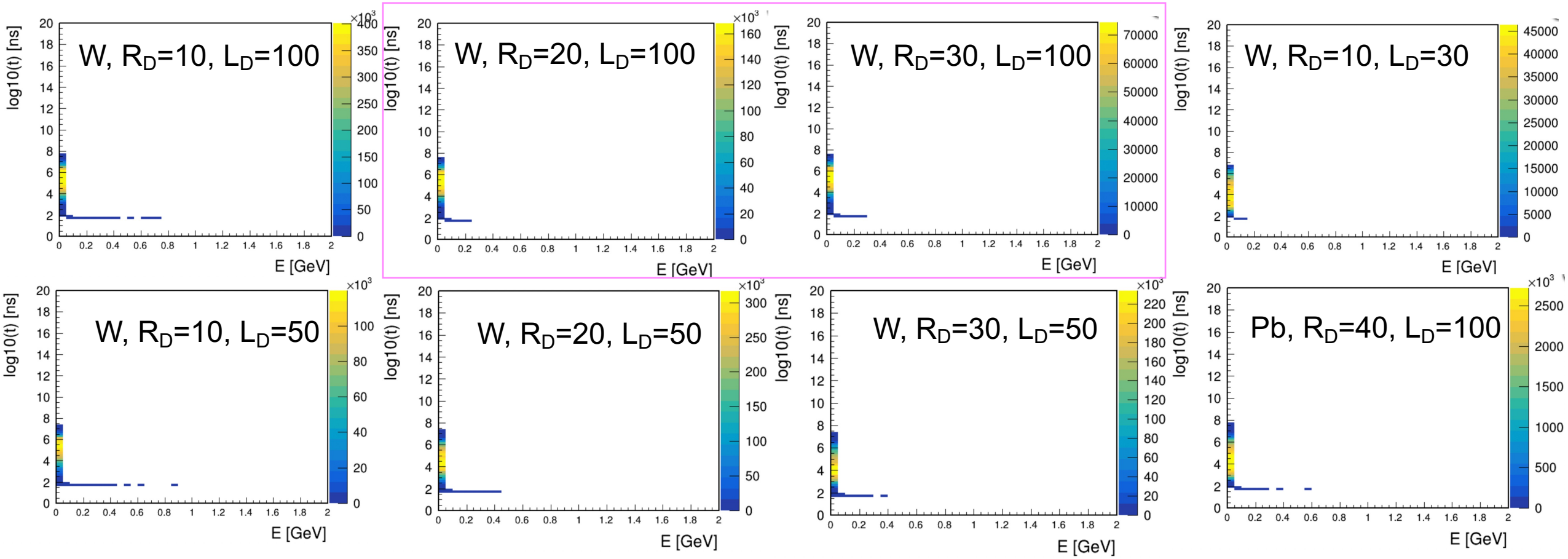






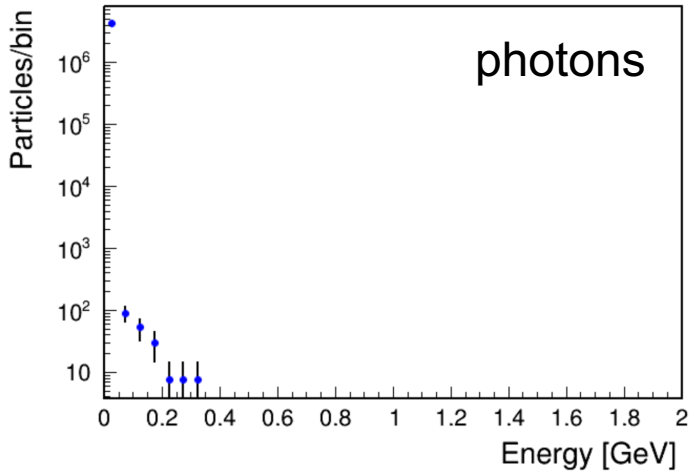
Neutrons time vs. energy status==4

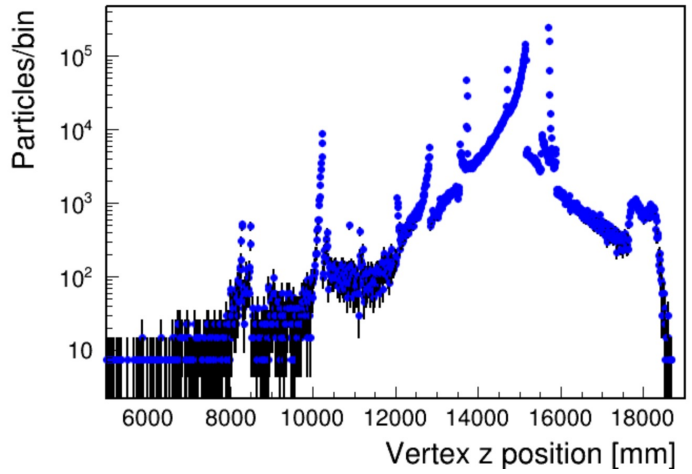
- L_V=100cm, 0.2BX
- cut (particles produced inside of the dump that reach the BSM detector): `detid==9000 && abs(z-{$calo_z})<0.1 && srqrt (x*x+y*y)<1000.0 && sqrt(vtxx*vtxx+vtxy*vtxy)<500.0 && vtxz>13705.0 && vtxz<{$dump_end}`
- Significant background produced by particles that escaped through the sides

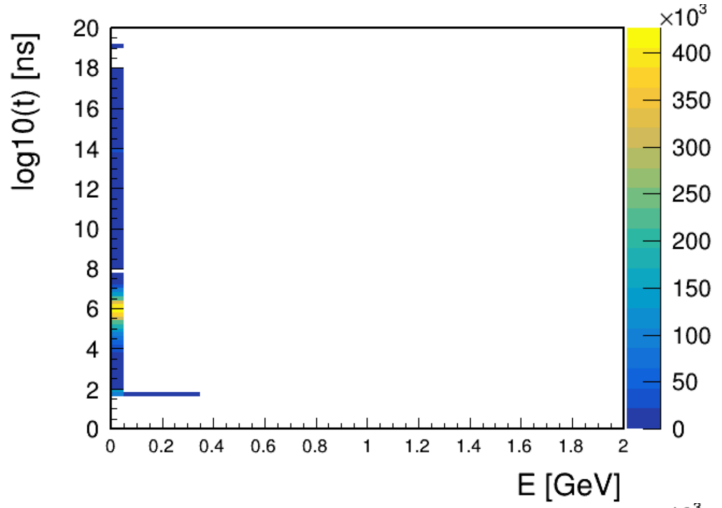


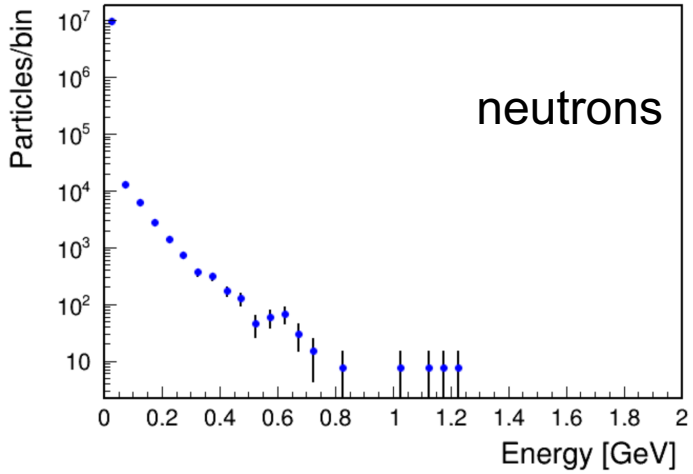
Tungsten dump (R_D=20cm, L_D=1m, L_V=1m, 2BXs)

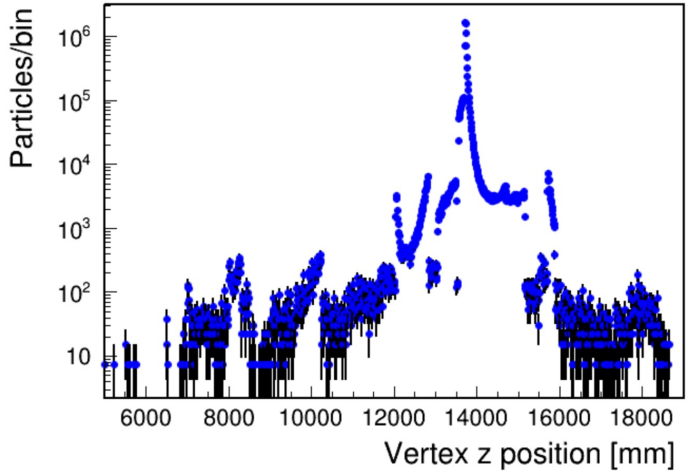
cut: `abs(z-{$calo_z})<0.1 && detid==9000`

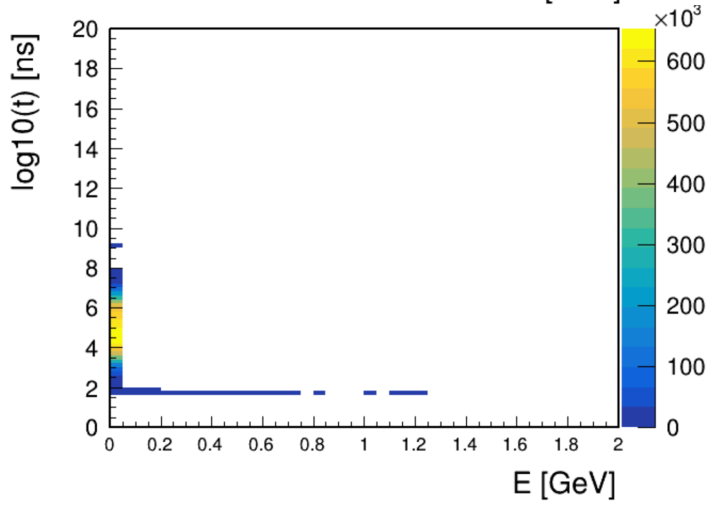






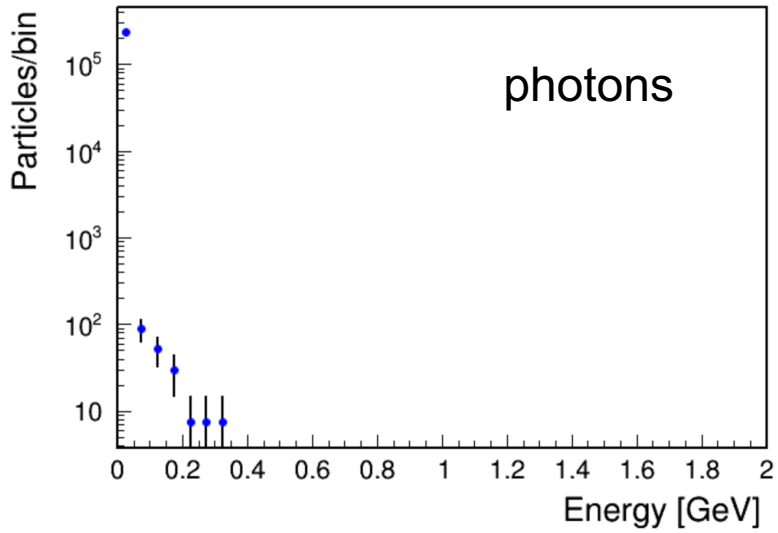


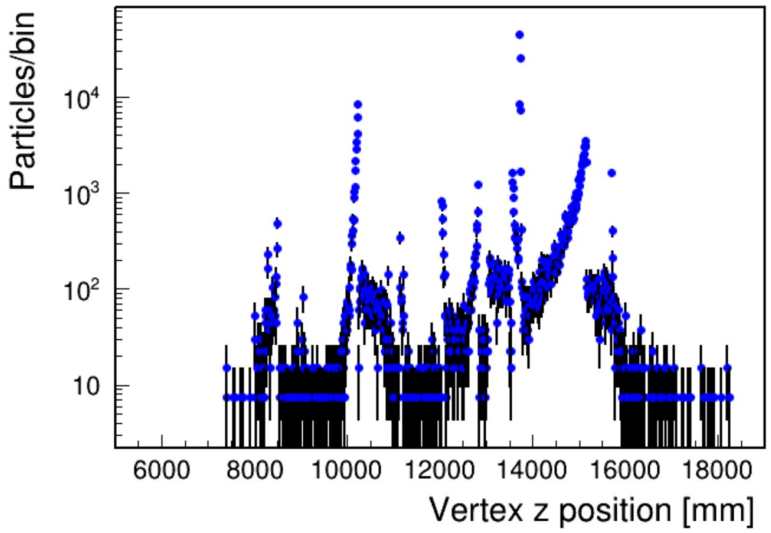


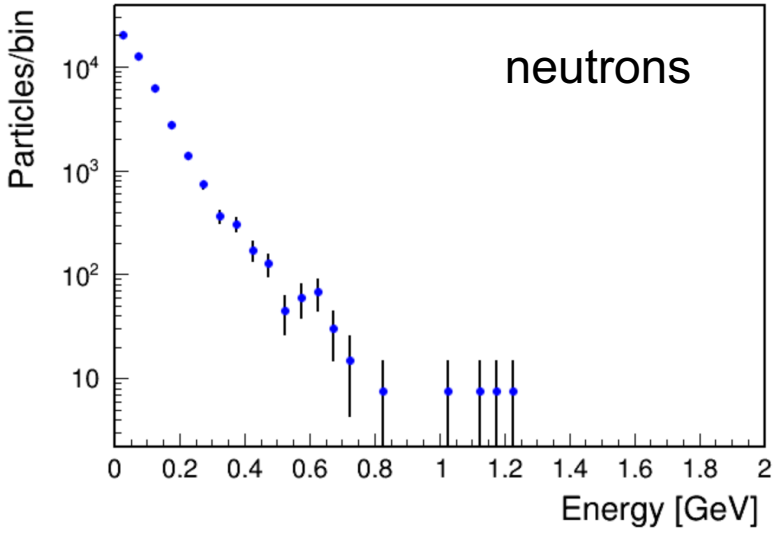


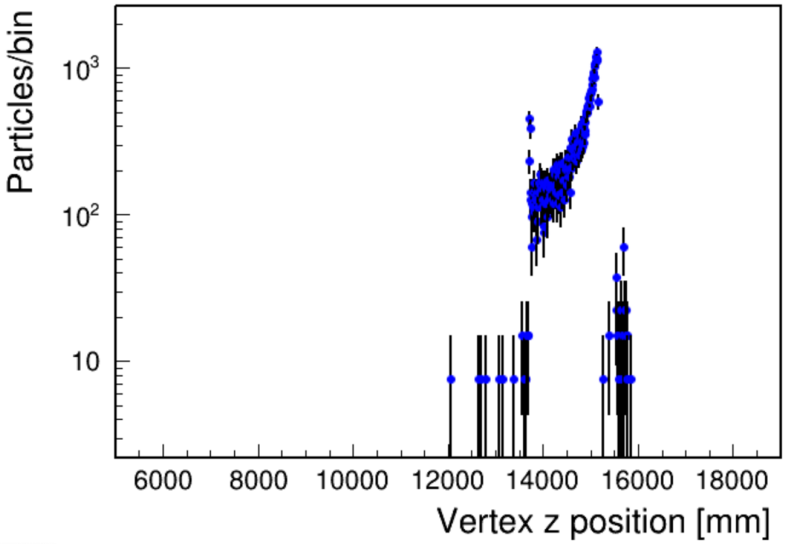
Tungsten dump (R_D=20cm, L_D=1m, L_V=1m, 2BXs)

cut: `abs(z-{$calo_z})<0.1 && detid==9000 &&` **`t<=100`**



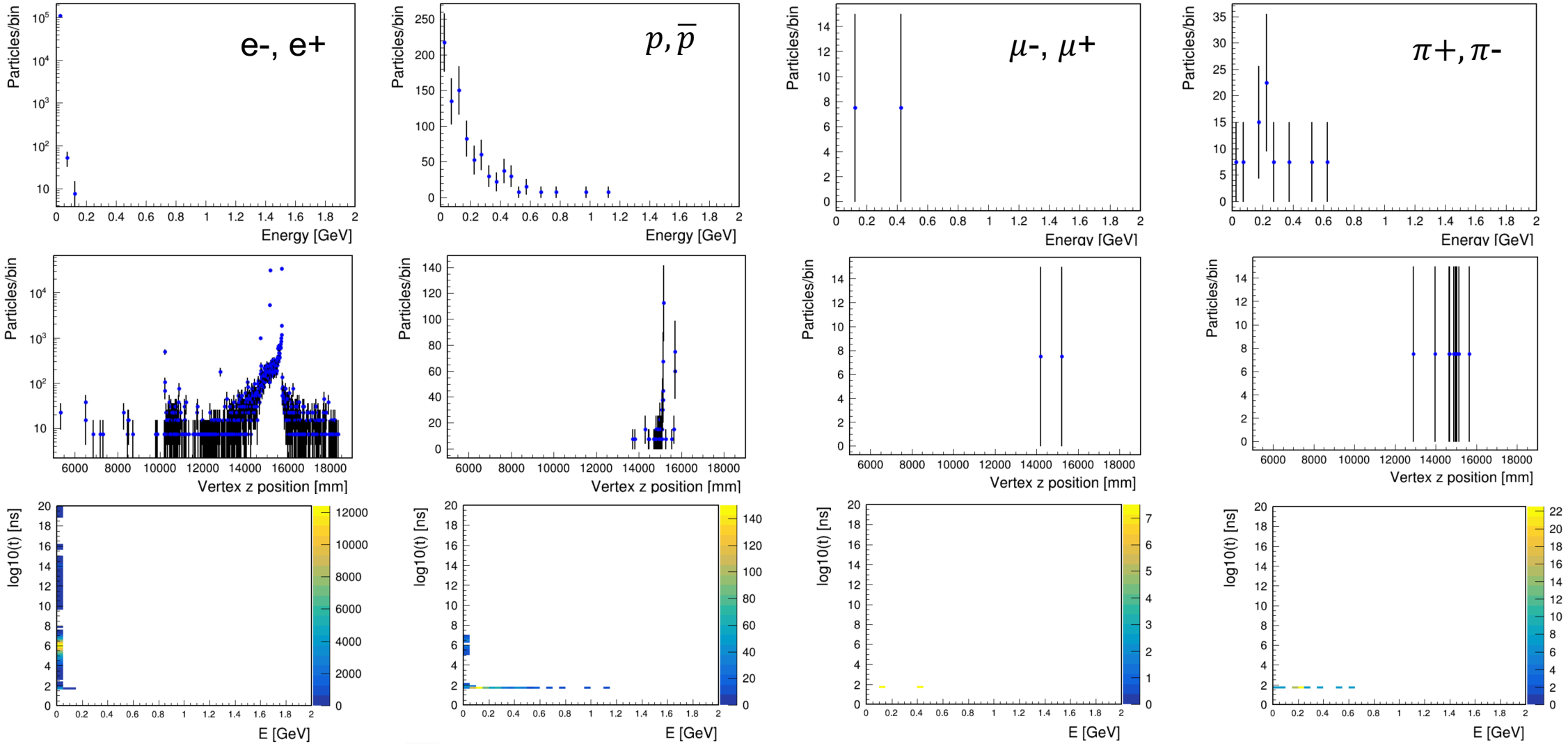






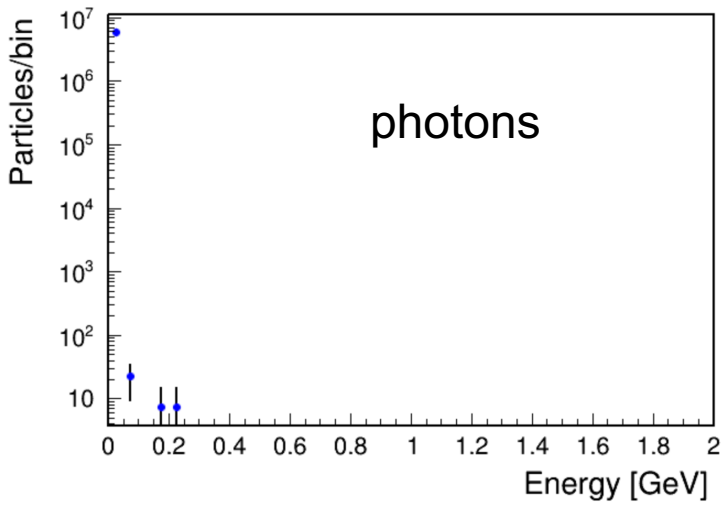
Charged particles (W, R_D=20cm, L_D=1m, L_V=1m, 2BXs)

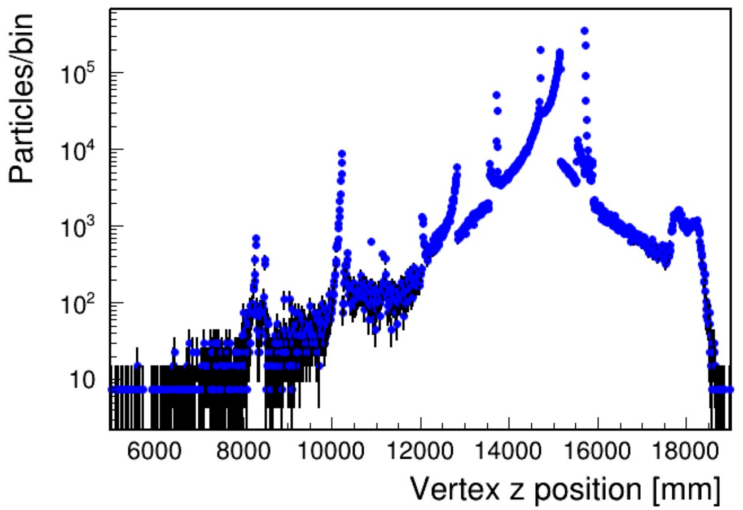
- cut (particles that arrive to the BSM detector in the z-direction): `abs(z-{$calo_z})<0.1 && detid==9000`
- Looked for long-lived charged particles (no kaons seen)

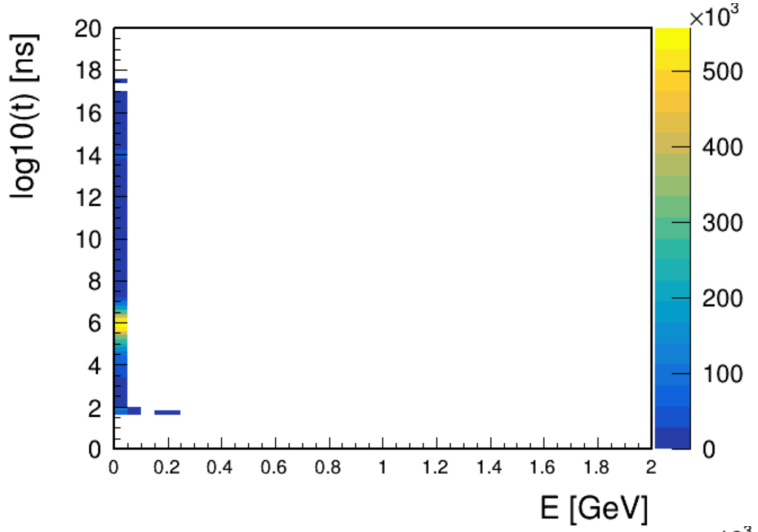


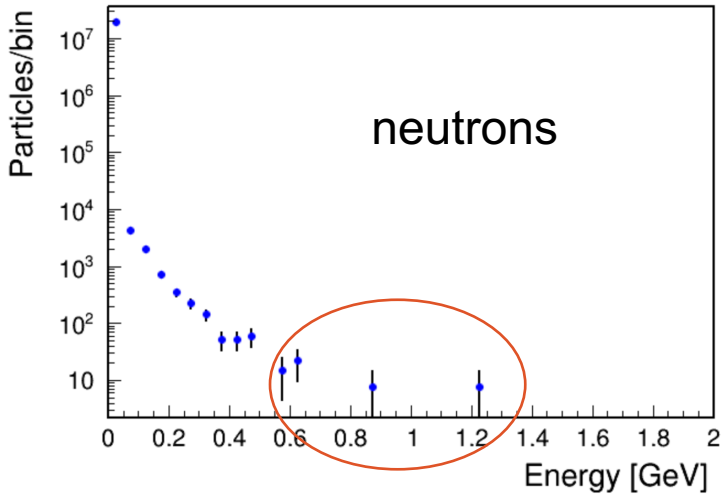
Tungsten dump with lead wrap

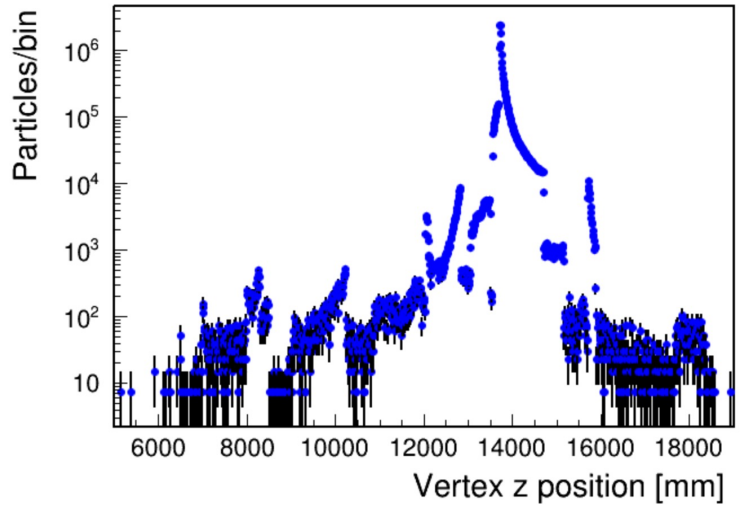
- $R_{D(W)}$=20cm, $R_{D(Pb)}$=50cm, L_D=1m, L_V=1m, 2BX
- cut (particles that reach the BSM detector in the z-direction): `detid==9000 && abs(z-{$calo_z})<0.1`

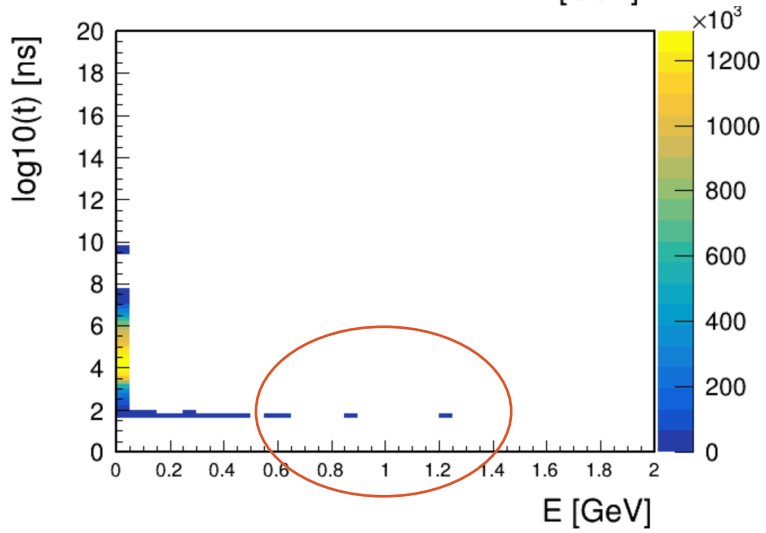








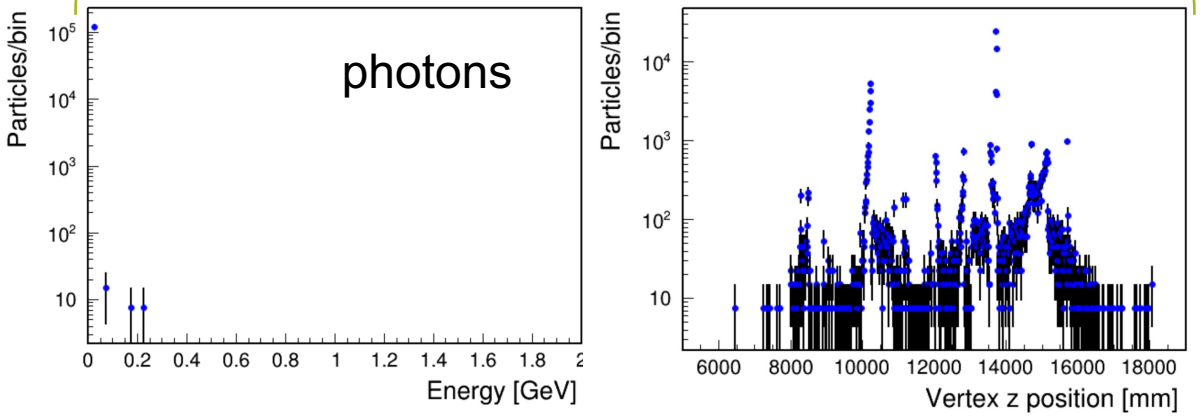


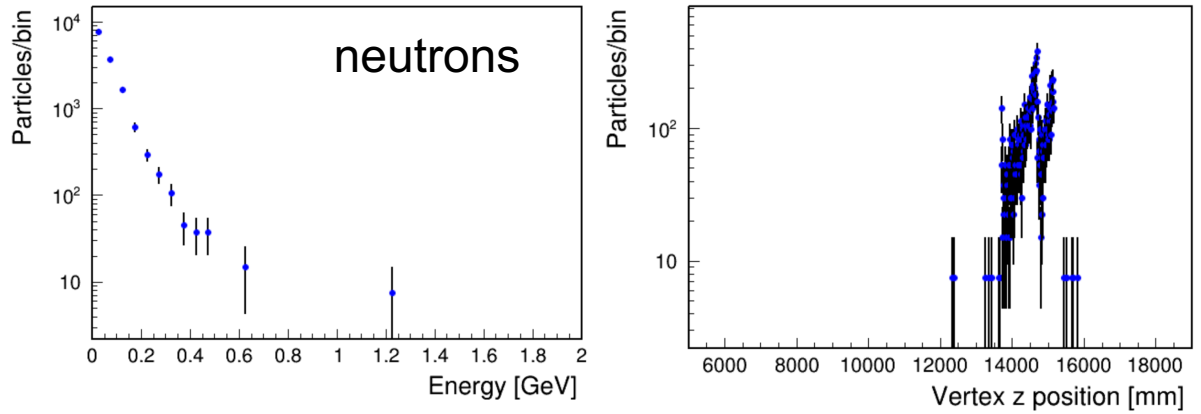


Tungsten dump with lead wrap

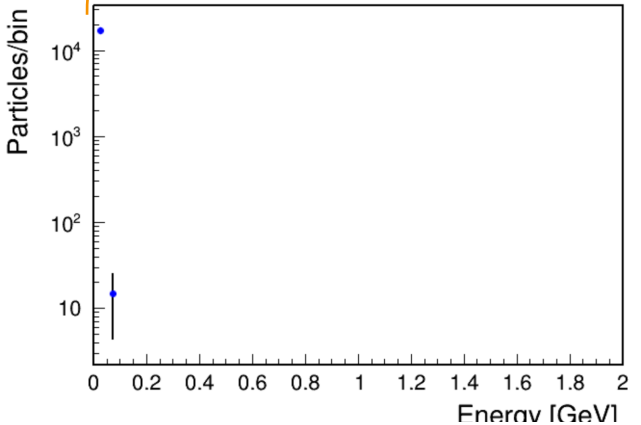
- $R_{D(W)}$=20cm, $R_{D(Pb)}$=50cm, L_D=1m, L_V=1m, 2BX
- cut (particles that reach the BSM detector): `detid==9000 && abs(z-{$calo_z})<0.1 && srqrt (x*x+y*y)<{$calo_r} && t<=100`

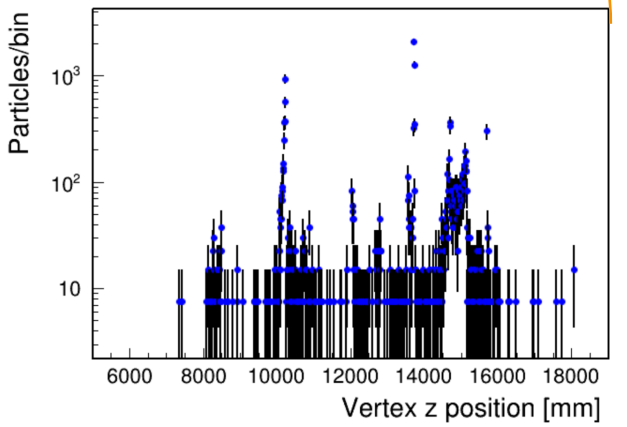
calo_r=100cm

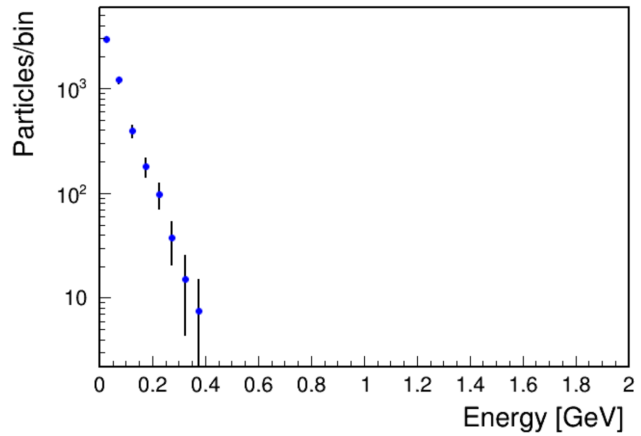


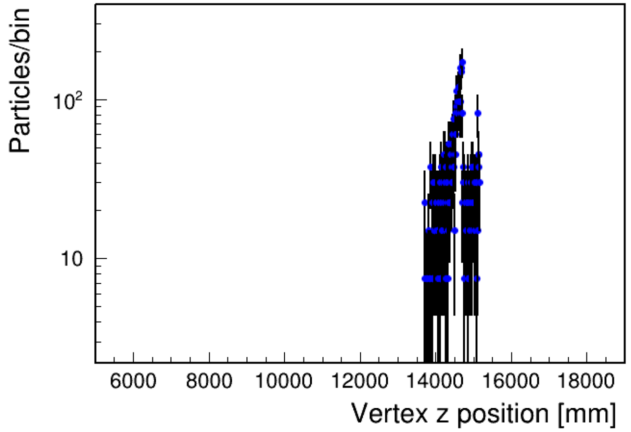


calo_r=50cm



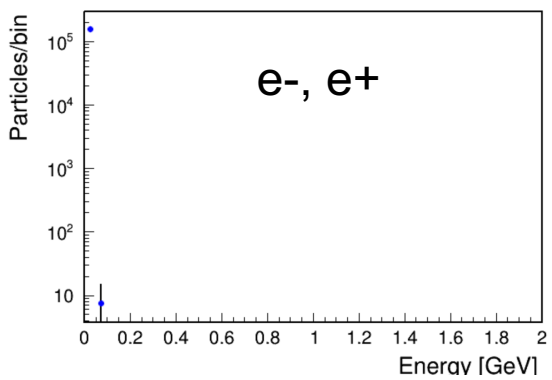


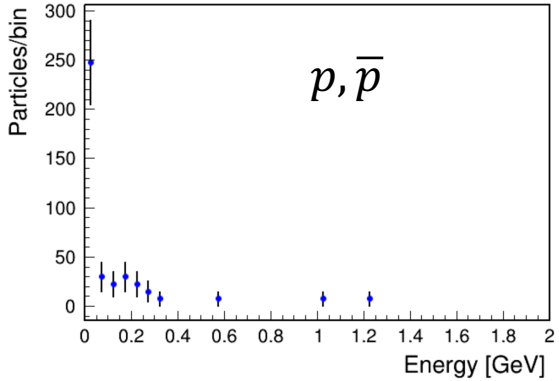


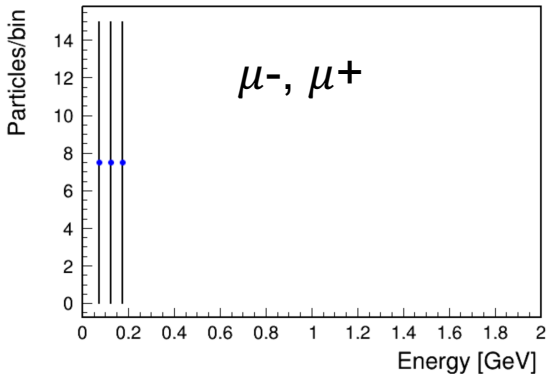


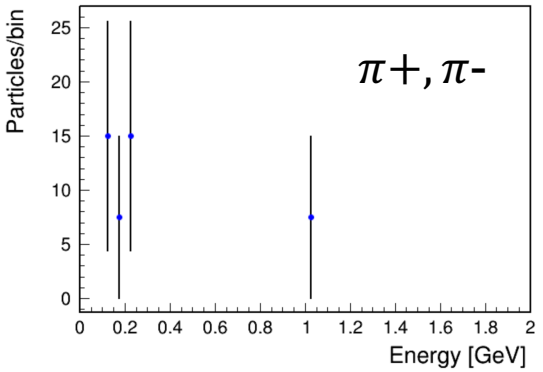
Charged particles ($R_{D(w)}$=20cm, $R_{D(Pb)}$=50cm, L_D=1m, L_V=1m, 2BX)

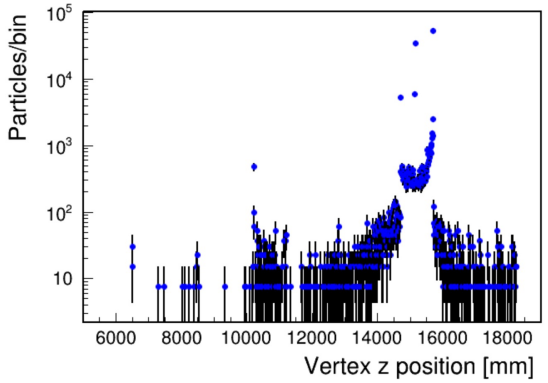
cut: `abs(z-{$calo z})<0.1 && detid==9000`

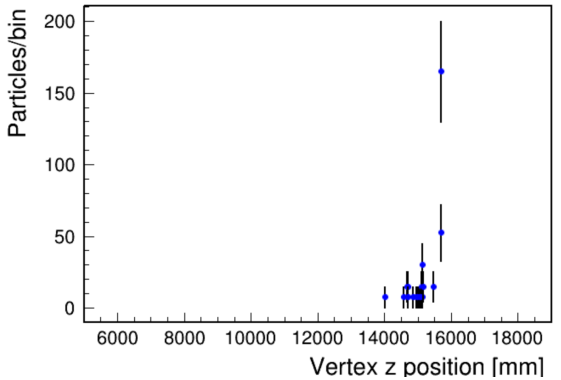


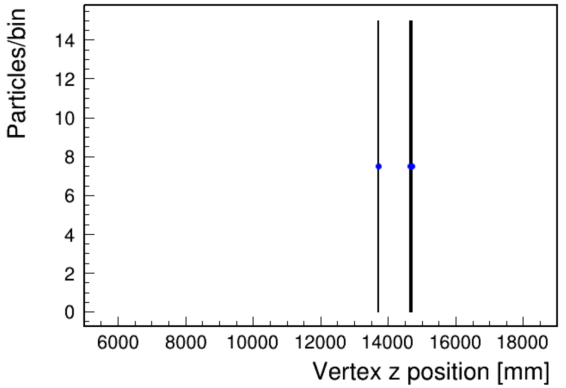


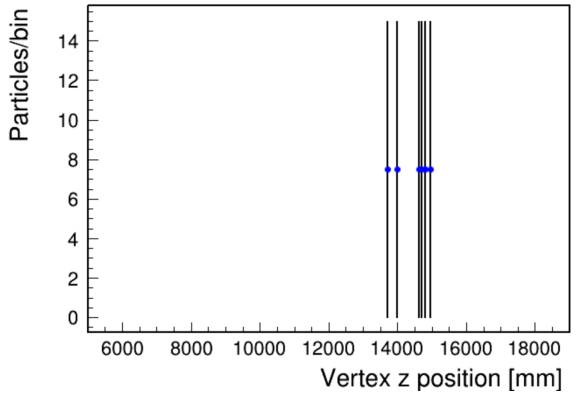


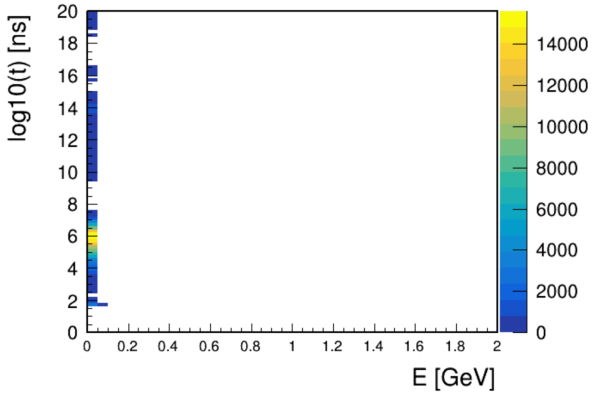


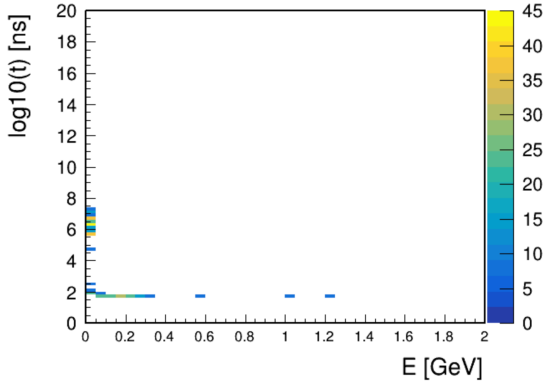


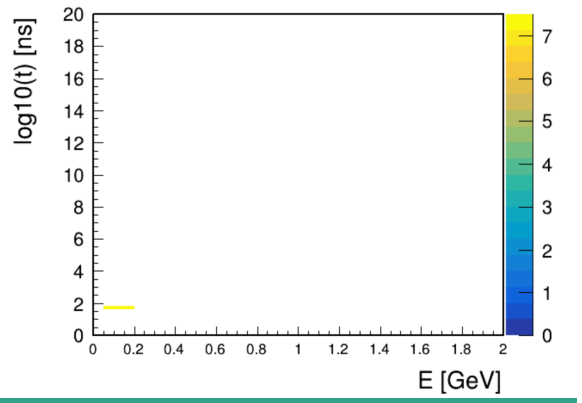


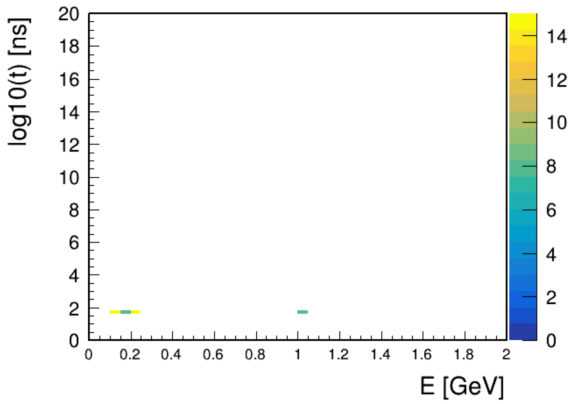












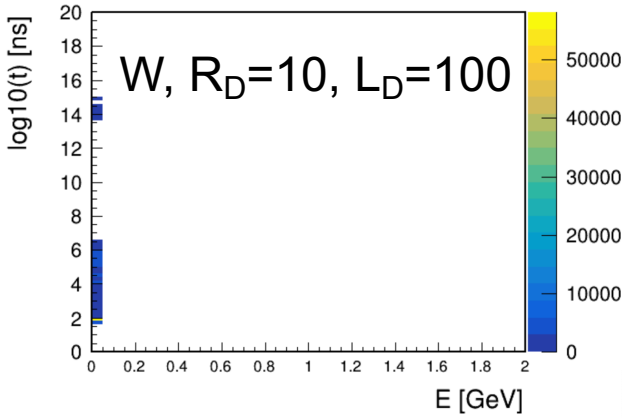
Summary & outlook

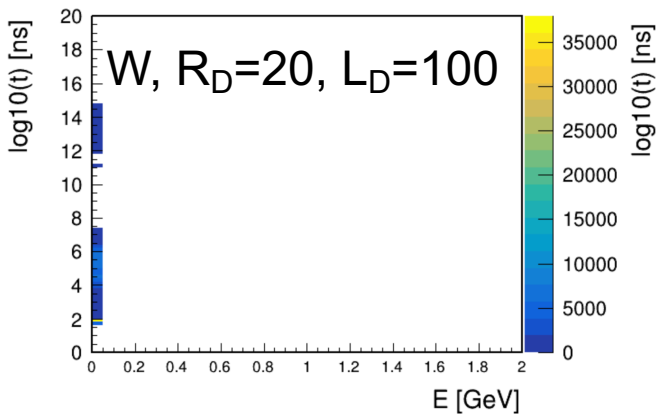
- W (R=20cm) dump with Pb (R=50cm) wrap reduces significantly particles (especially neutrons) escaping through the sides
  - Background rejection seems to depend on BSM geometry
  - Ongoing analysis for different dump lengths: 70, 80, 90 cm
- No significant background coming from charged particles above 0.5GeV
  - No kaons seen so far
- Ongoing signal simulation to co-optimize signal efficiency and background rejection
  - Different detector size and decay volume length

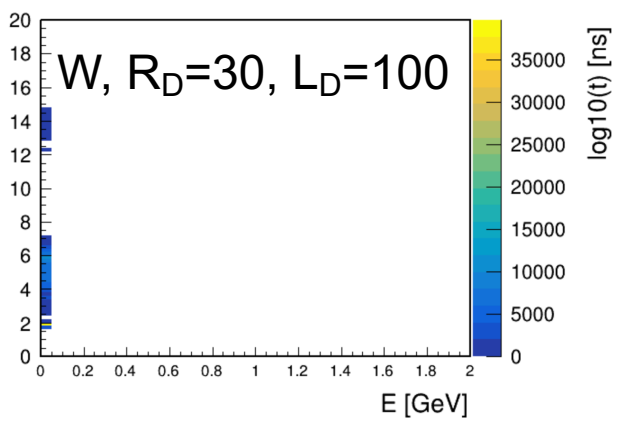
Backup

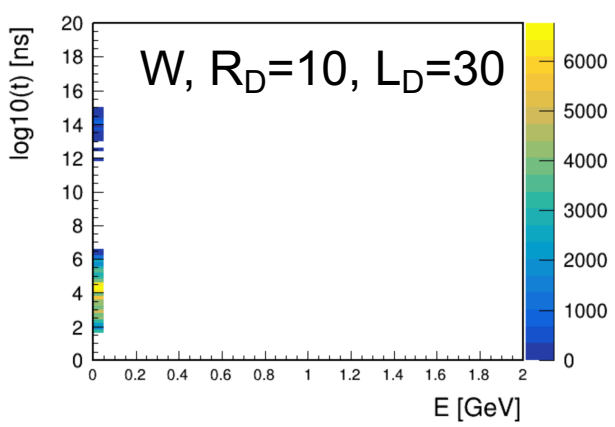
Photons time vs. energy

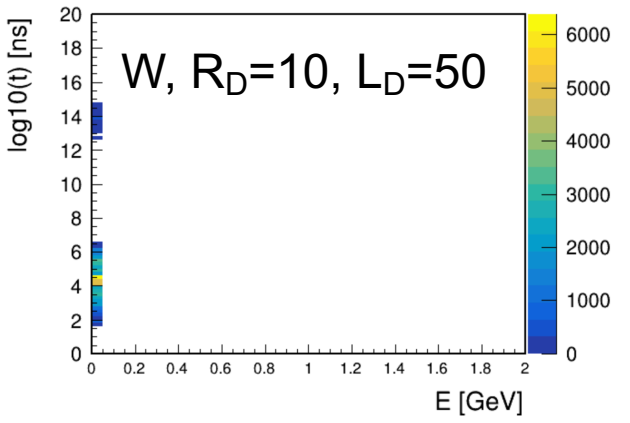
- L_V=100cm, 0.2BX
- cut (particles produced inside of the dump that reach the BSM detector): `detid==9000 && abs(z-{$calo_z})<0.1 && srqrt (x*x+y*y)<1000.0 && sqrt(vtxx*vtxx+vtxy*vtxy)<500.0 && vtxz>13705.0 && vtxz<{$dump_end}`

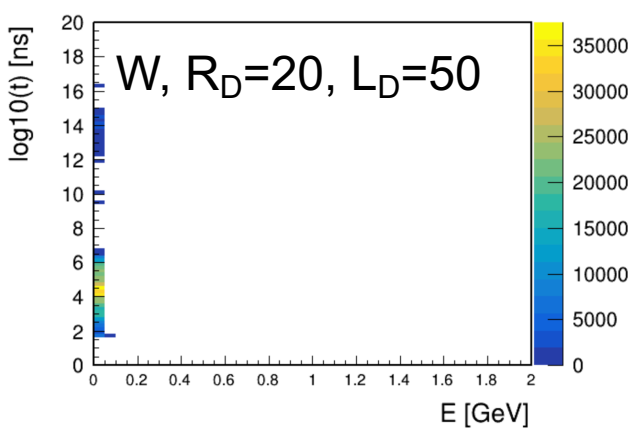


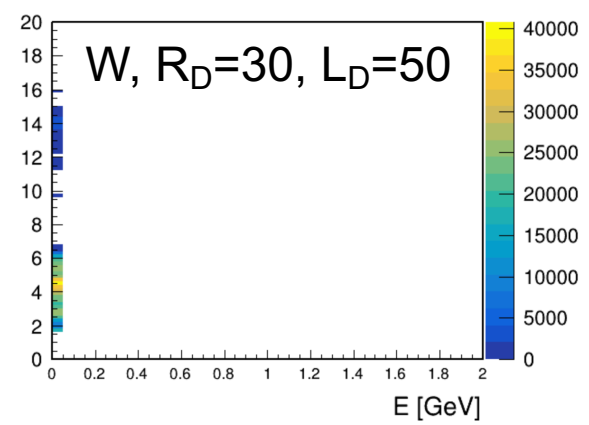


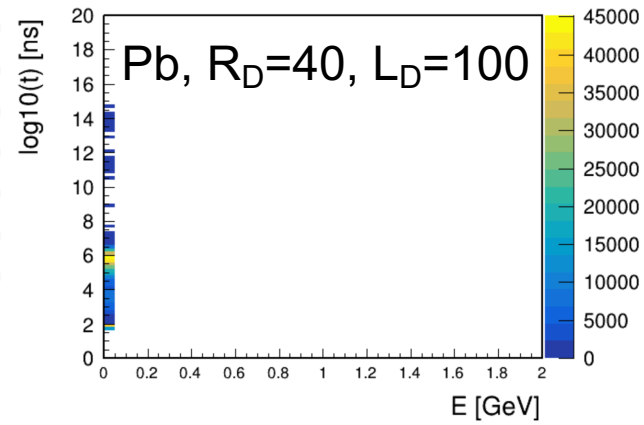




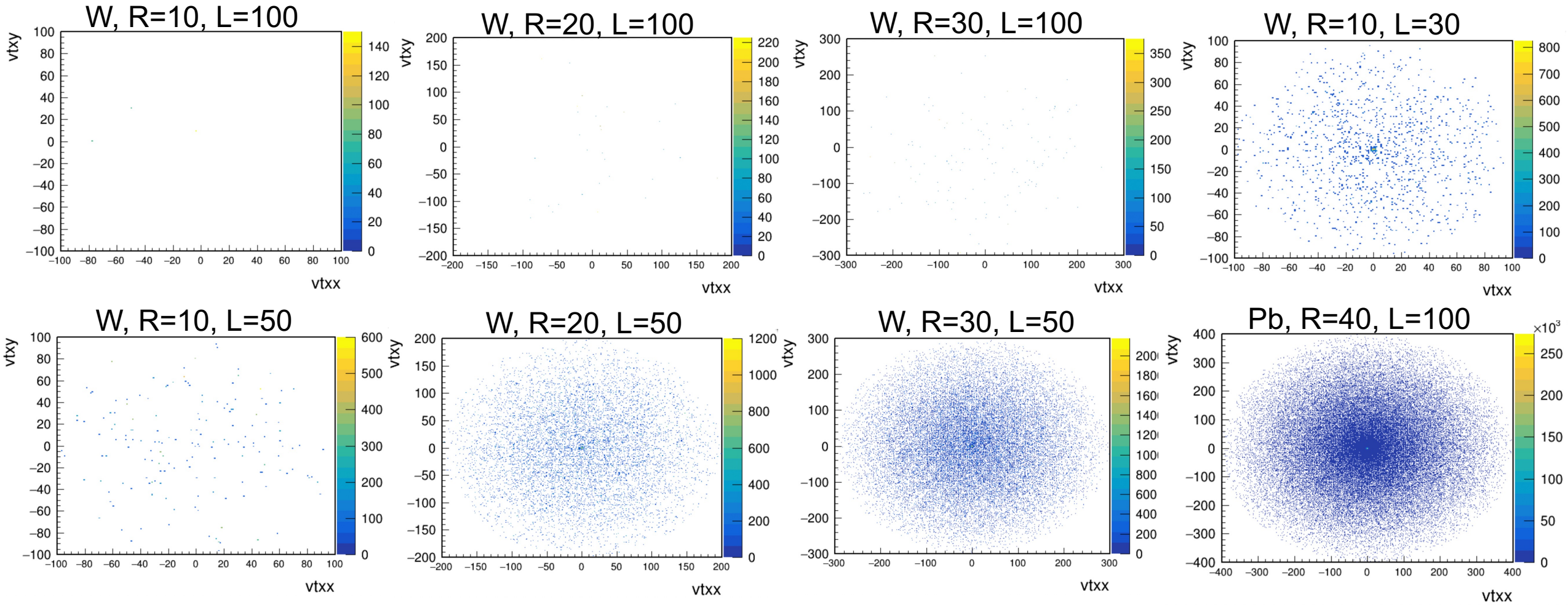






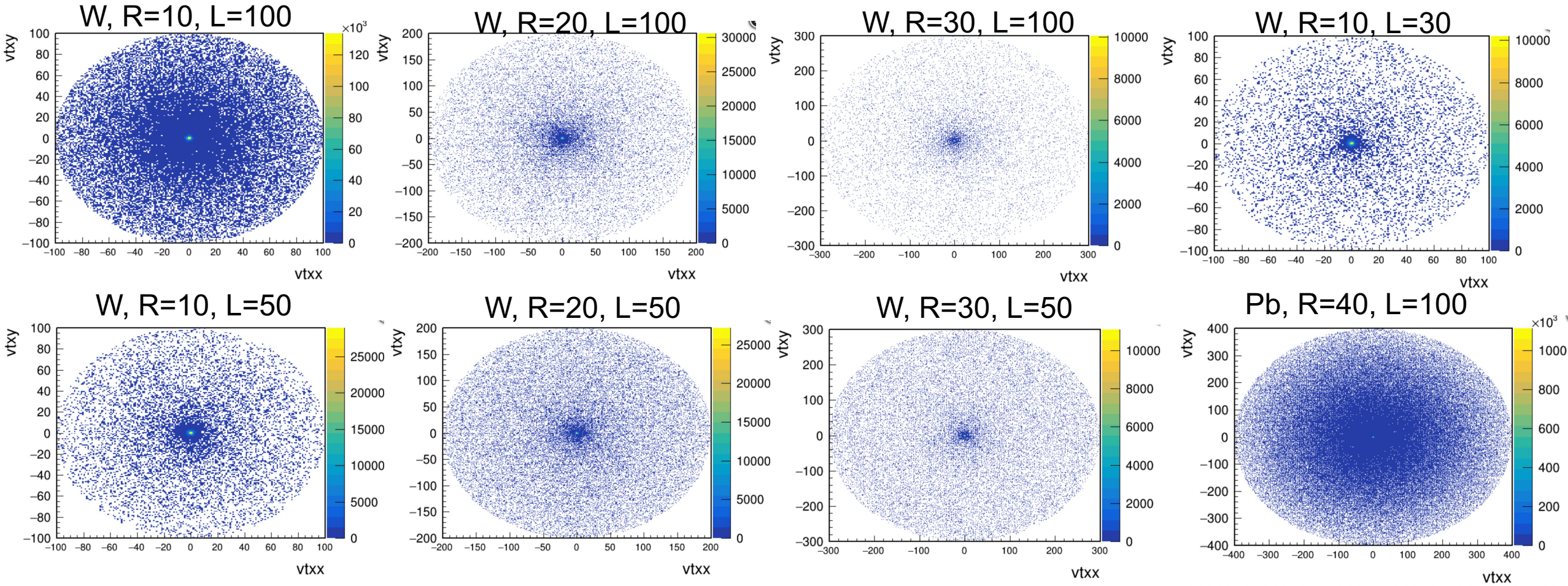


Neutrons vtxy vs vtxx status==0



- L_V=100cm, 0.2BX
- cut (particles produced inside of the dump that reach the BSM detector): detid==9000 && abs(z-{$calo_z})<0.1 && srqrt (x*x+y*y)<1000.0 && sqrt(vtxx*vtxx+vtxy*vtxy)<500.0 && vtxz>13705.0 && vtxz<{$dump_end}

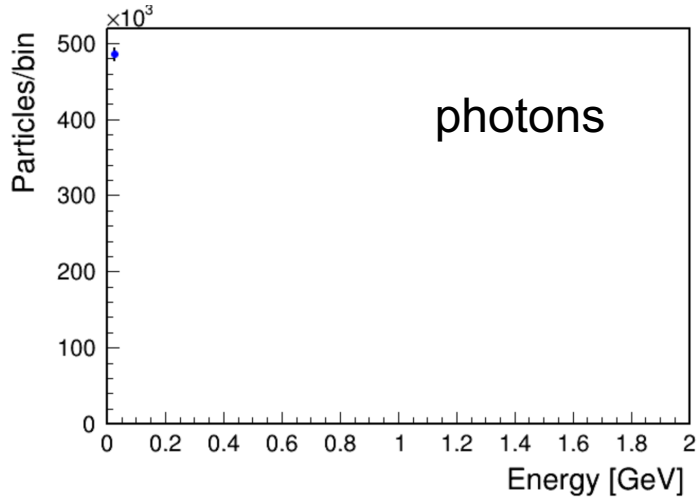
Neutrons vtxy vs vtxx status==4

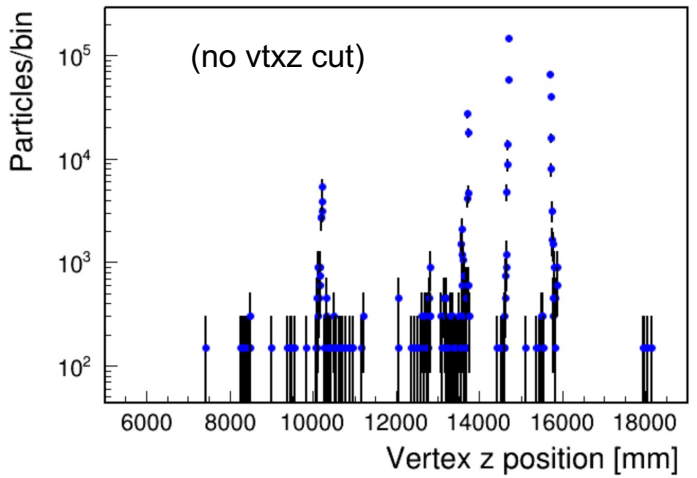


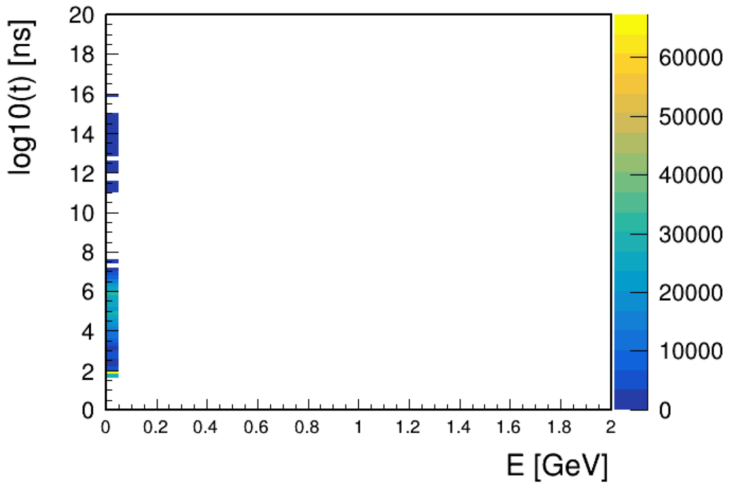
- L_V=100cm, 0.2BX
- cut (particles produced inside of the dump that reach the BSM detector): detid==9000 && abs(z-{$calo_z})<0.1 && srqrt (x*x+y*y)<1000.0 && sqrt(vtxx*vtxx+vtxy*vtxy)<500.0 && vtxz>13705.0 && vtxz<{$dump_end}

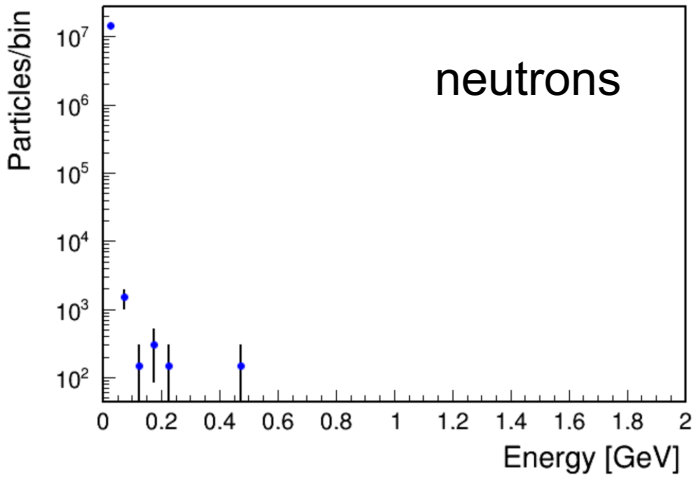
Tungsten dump with lead wrap

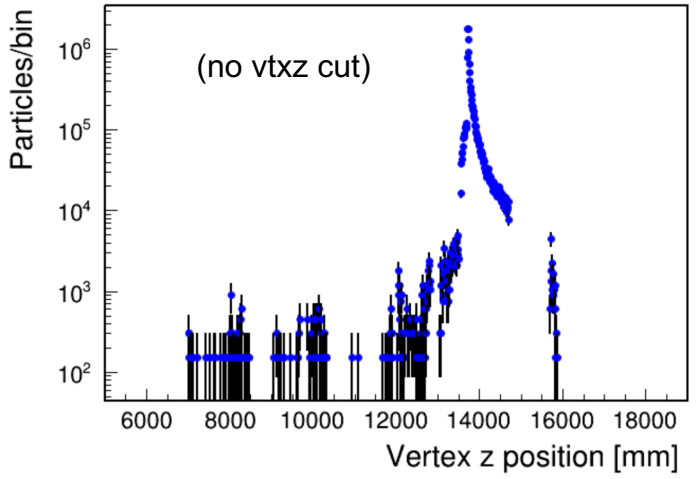
R_W=20cm, R_{Pb}=50cm, L_D=1m, L_V=1m, 0.1BX
cut: detid==9000 && abs(z-{$calo_z})<0.1 && srqrt (x*x+y*y)<1000.0 && sqrt(vtxx*vtxx+vtxy*vtxy)<500.0 && vtxz>13705.0 && vtxz<{$dump_end}

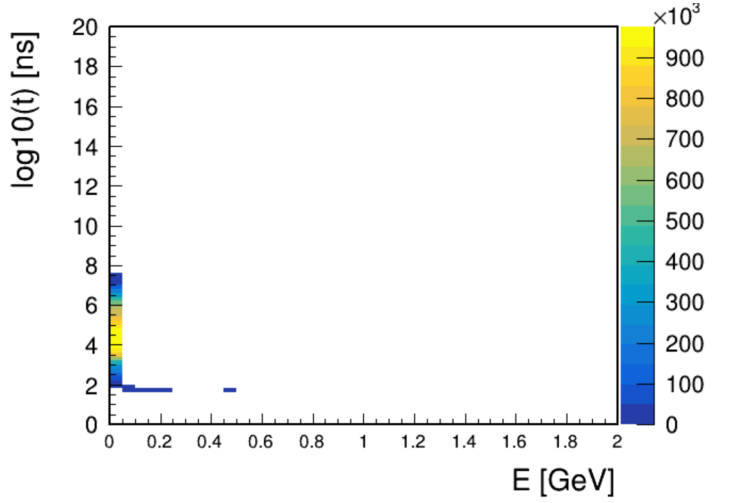






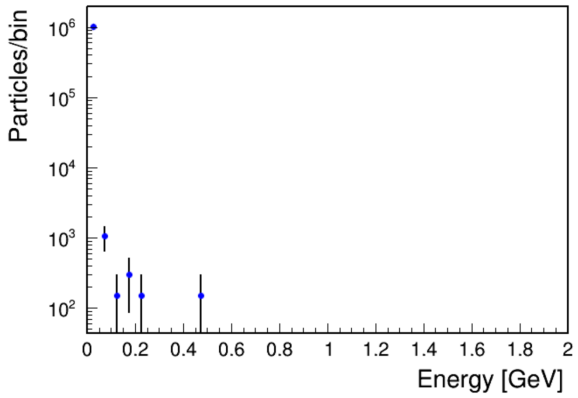




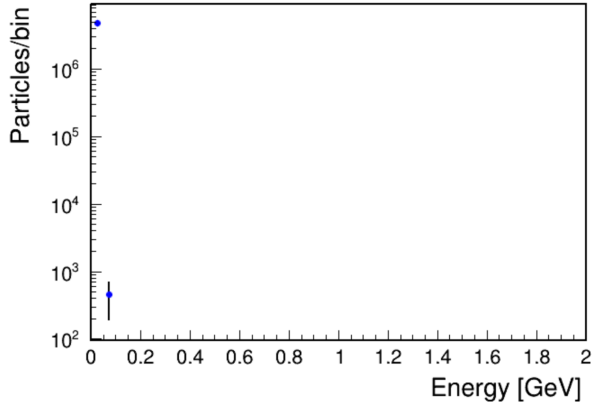


Tungsten dump with lead wrap - Neutrons

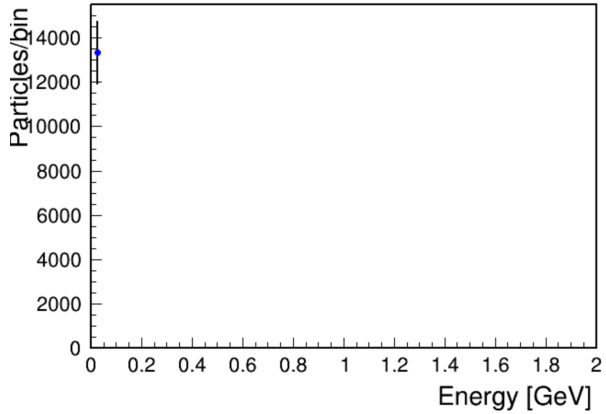
status==0



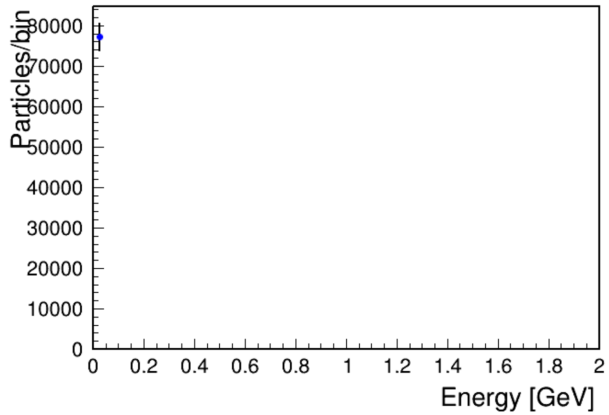
status==4

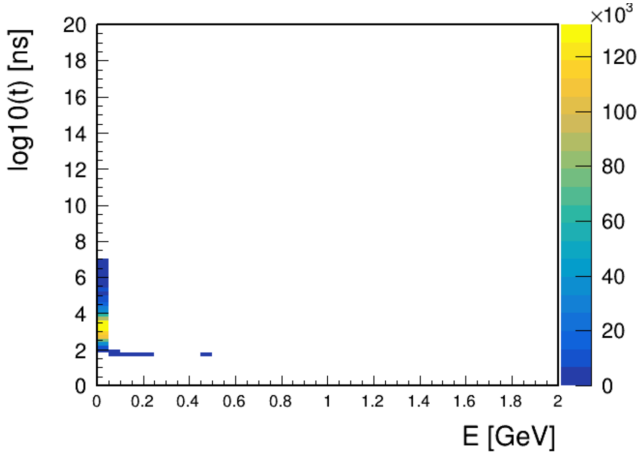


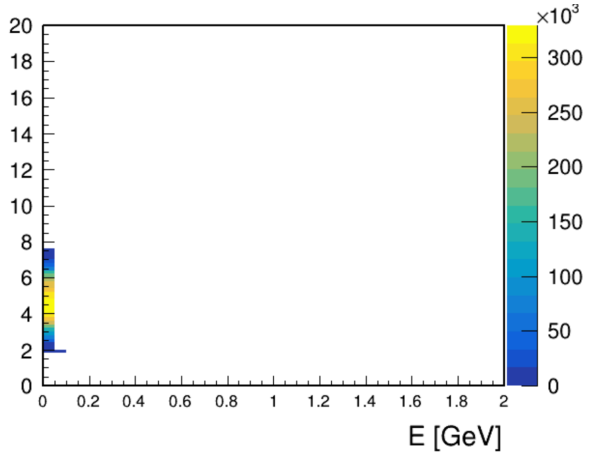
status==6

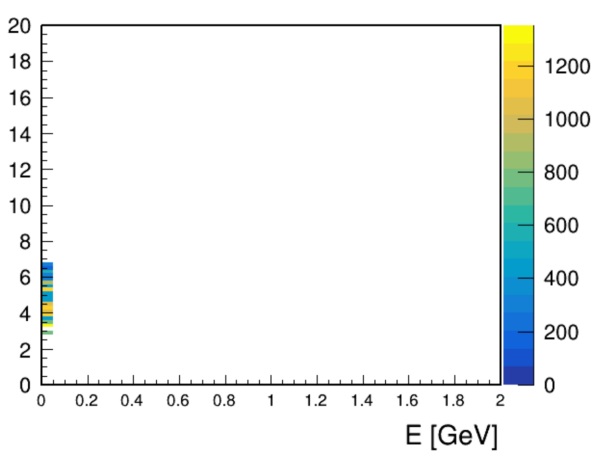


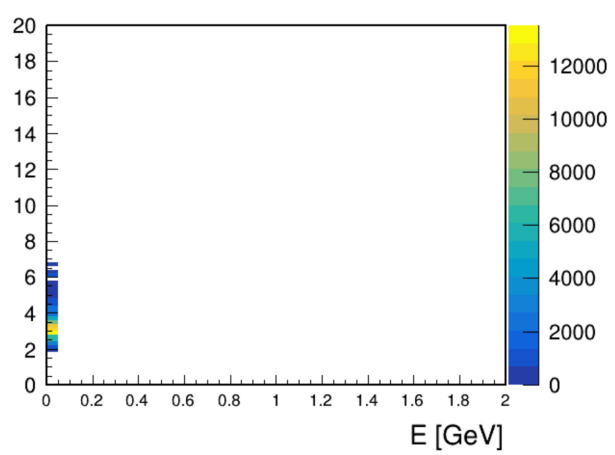
status==8







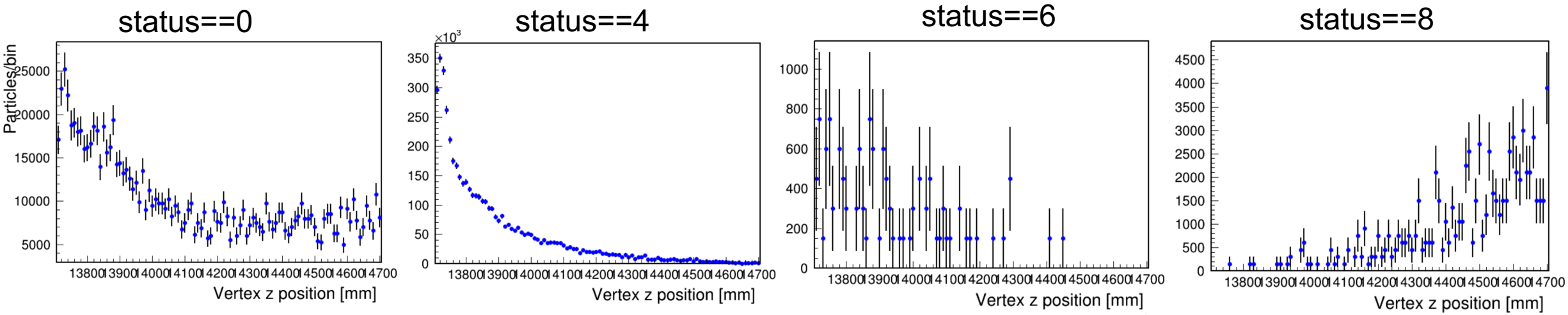


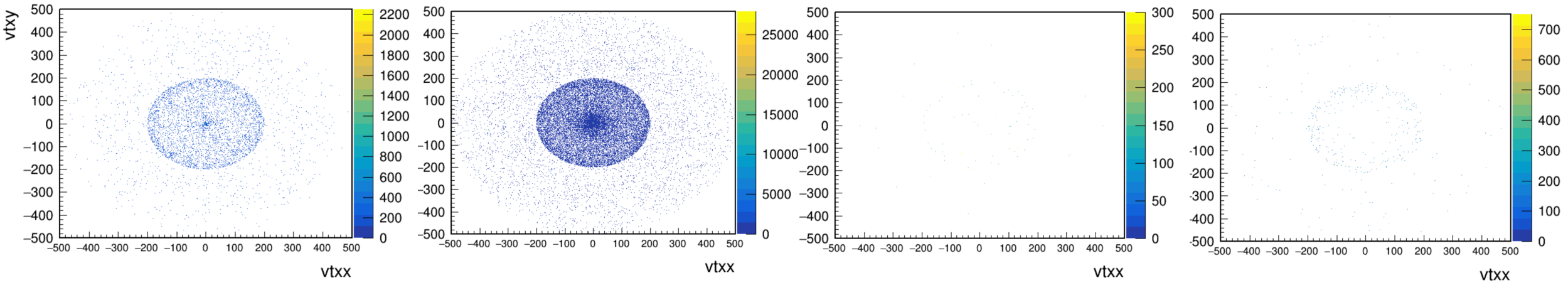


R_W=20cm, R_{Pb}=50cm, L_D=1m, L_V=1m, 0.1BX

cut: detid==9000 && abs(z-{$calo_z})<0.1 && srqrt (x*x+y*y)<1000.0 && sqrt(vtxx*vtxx+vtxy*vtxy)<500.0 && vtxz>13705.0 && vtxz<{$dump_end}

Tungsten dump with lead wrap - Neutrons





R_W=20cm, R_{Pb}=50cm, L_D=1m, L_V=1m, 0.1BX

cut: detid==9000 && abs(z-{$calo_z})<0.1 && srqrt (x*x+y*y)<1000.0 && sqrt(vtxx*vtxx+vtxy*vtxy)<500.0 && vtxz>13705.0 && vtxz<{$dump_end}