Question and Answer

1) A weighted Monte-Carlo ray trace of particles exiting the target/magnet assembly for all primary beam energies showing:
   a) Where the scattered ″good″ events go.
   b) Where the un-scattered primary beam goes.
   c) Where the ″photon″ beam produced goes - and what it hits.
   d) Where the inelastic ″sheet of flame″ (the fan of in-elastics sweep out of the target/magnet) goes and what structures it hits.

2) The proximity of significant magnetic material (support structures, other magnets, shielding, etc) and some argument or calculation that these won't effect the trajectories of charged particles discussed in (1) above.

3) A design for thin target exit window safety shielding (plastic or Al cover) that has cut outs only for the places where the ″good″ events exit. Or a credible argument that this cannot be done geometrically without compromising the measurement.

4) A clear written statement in the conduct of operation that they will never leave the target/magnet energized with no experiment personnel on duty in either the counting house or Hall A - 24/7 coverage when it is energized. With no ambiguous wording or wiggle room on this one.

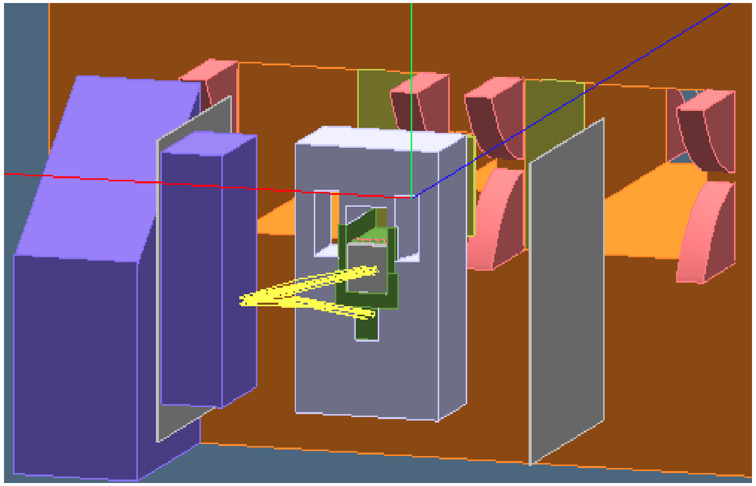
1) A weighted Monte-Carlo ray trace of particles exiting the target/magnet assembly for all primary beam energies showing:

   a) Where the scattered "good" events go.

The detector

   b) Where the un-scattered primary beam goes.

Local dump or the Hall A dump



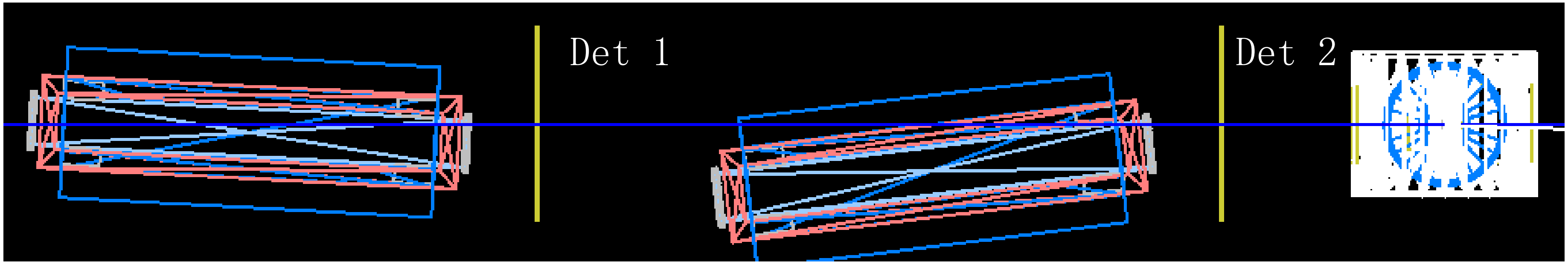
x	y	z	Px	Py	Pz	Beam	TargetField
-0.0001	0.0011	0.6400	-0.0002	0.0030	2.2570	2.2570	2.5T/7deg
-0.0003	0.0021	0.6400	-0.0005	0.0029	1.1590	1.1590	2.5T/7deg
-0.0001	0.0014	0.6400	-0.0003	0.0030	1.7060	1.7060	2.5T/7deg
-0.0003	0.0022	0.6400	-0.0010	0.0059	2.2570	2.2570	5.0T/7deg
-0.0001	0.0015	0.6400	-0.0007	0.0060	3.3550	3.3550	5.0T/7deg

x	y	z	Px	Py	Pz	Ptot	TargetField
-0.0000	0.0096	0.6400	-0.0000	0.0268	2.2568	2.2570	2.5T/90deg
-0.0000	0.0135	0.6400	-0.0000	0.0173	1.1589	1.1590	2.5T/90deg
-0.0000	0.0089	0.6400	-0.0000	0.0165	1.7059	1.7060	2.5T/90deg
-0.0000	-0.0548	0.6400	-0.0000	-0.2067	2.2475	2.2570	5.0T/90deg
-0.0000	-0.0368	0.6400	-0.0000	-0.2068	3.3486	3.3550	5.0T/90deg

c) Where the "photon" beam produced goes - and what it hits.

The photon beam could come from the sycrodron radiation in the chicane, or from the bremstrahlung radiation when beam hiting materials(windows, coils or the target itself). In the following several pages we will present simulation of them.

Sycrotron Radiation from Chicane

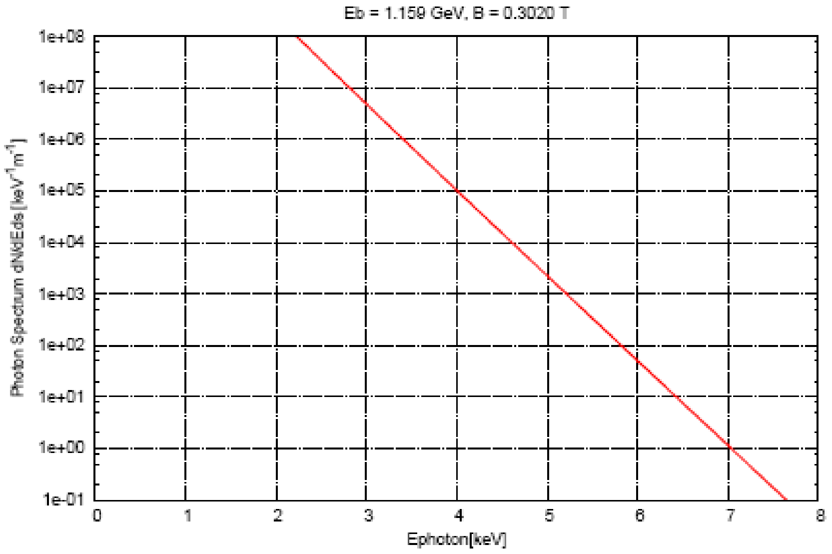


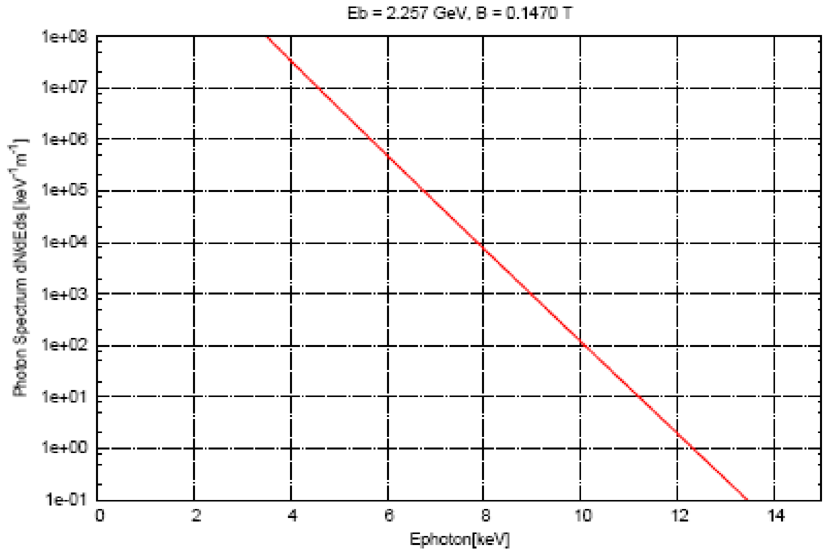
Placed one detector behine each FZ magnet. Shooting 100k electrons in GEANT4 simulation, detected very few photons at detector2. Most of them are block by the stainlesssteel vacuum box.
Those photons detected by detector 2 will hit the target chamber. Since their energies are as low as 50 keV, they can not go through the window at all.

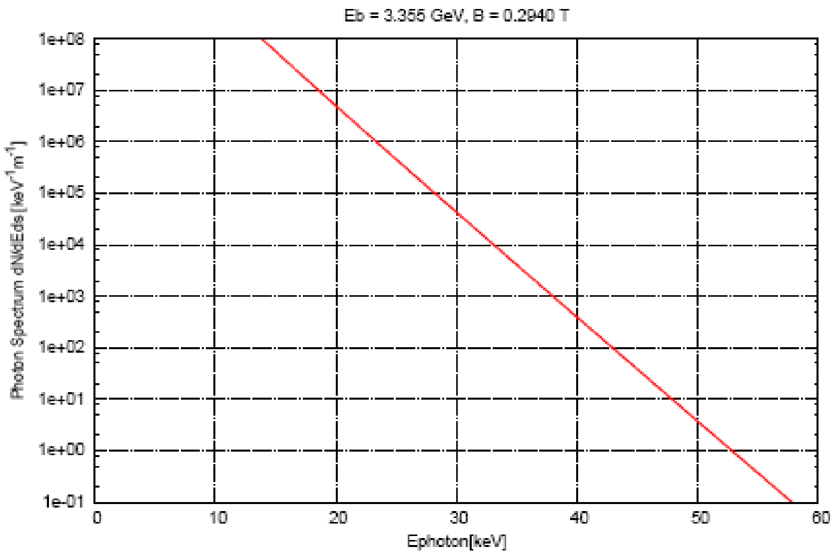
Radiation Power: $$P = \frac{e^2}{6\pi\epsilon_0 c}\left|\dot{\vec{\beta}}\right|^2 \gamma^4 = \frac{e^2 c}{6\pi\epsilon_0}\frac{\gamma^4}{\rho^2} = \frac{e^4}{6\pi\epsilon_0 m^4 c^5}E^2 B^2$$

Beam (GeV)	FZB1 (Tesla)	Critical Energy (KeV)	Radiation Power @100nA (Watt)
1.159	0.302	0.27	3.0E-05
2.257	0.147	0.50	2.7E-05
3.355	0.294	2.20	2.4E-05

Chicane Sycrotron Rates



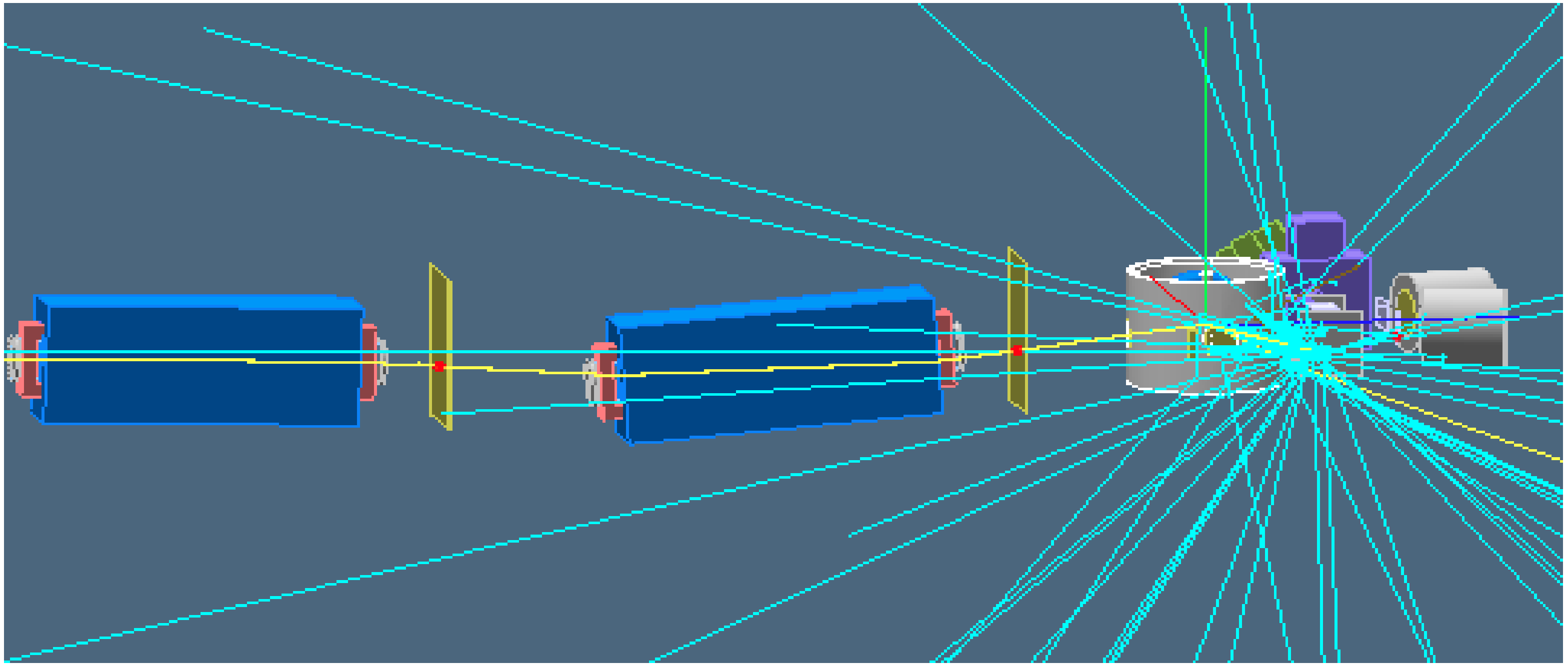




- Conclusion:

1. The Rate is small enough comparing to the beam electron
2. Photon energy is at KeV level
3. Total radiation power is very small

Bremstrahlung simulation

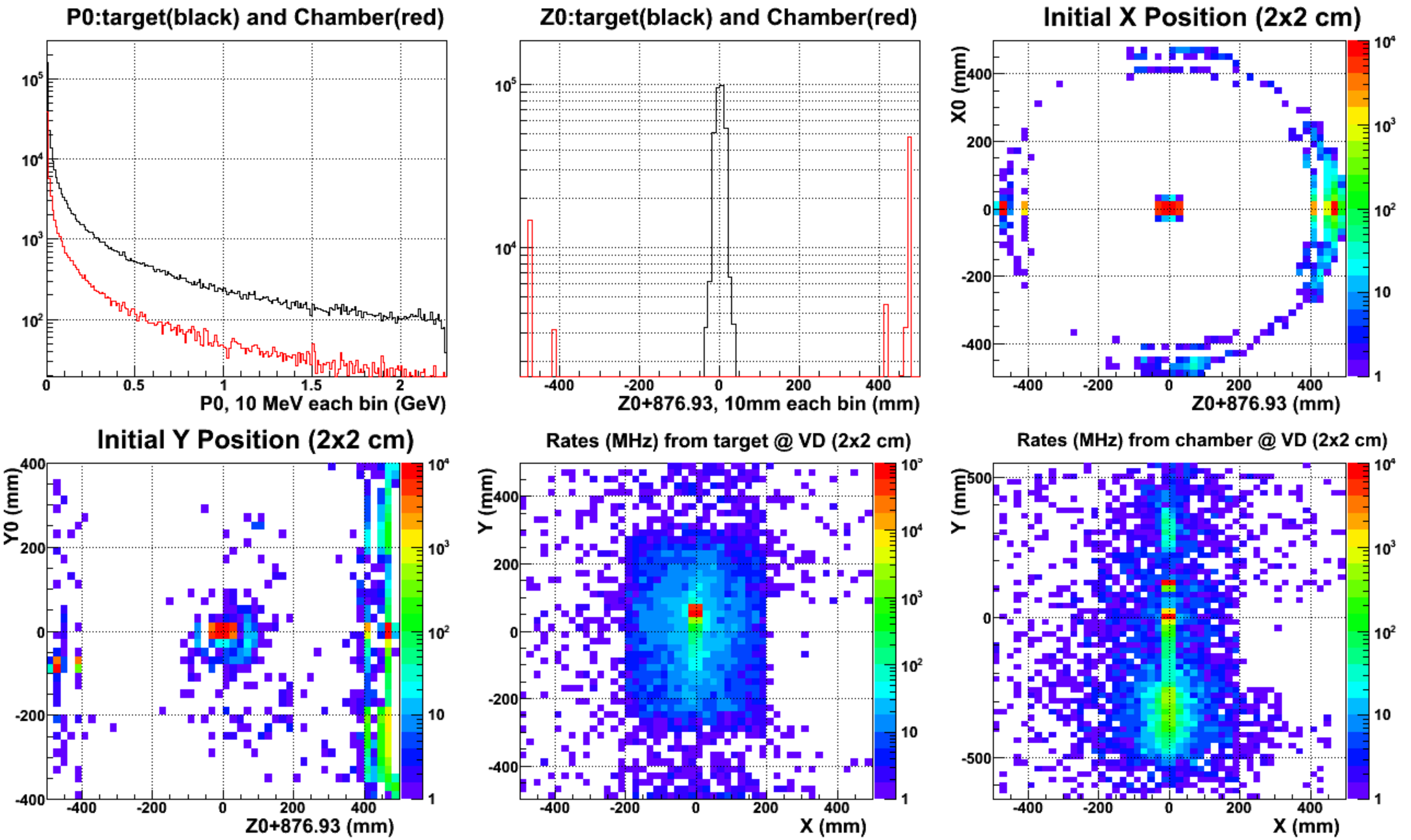


Lot of photons are created inside the target chamber and even more are created when beam is hiting the local dump! But they are backward photons. In this bremstrahlung simulation, we only consider those photons from either the scattering chamber (windows and coils) or from the target itself.

We simulated 2 situation, one is for beam goes to Hall A dump the other is for beam goes to local dump. See details in the next several pages.

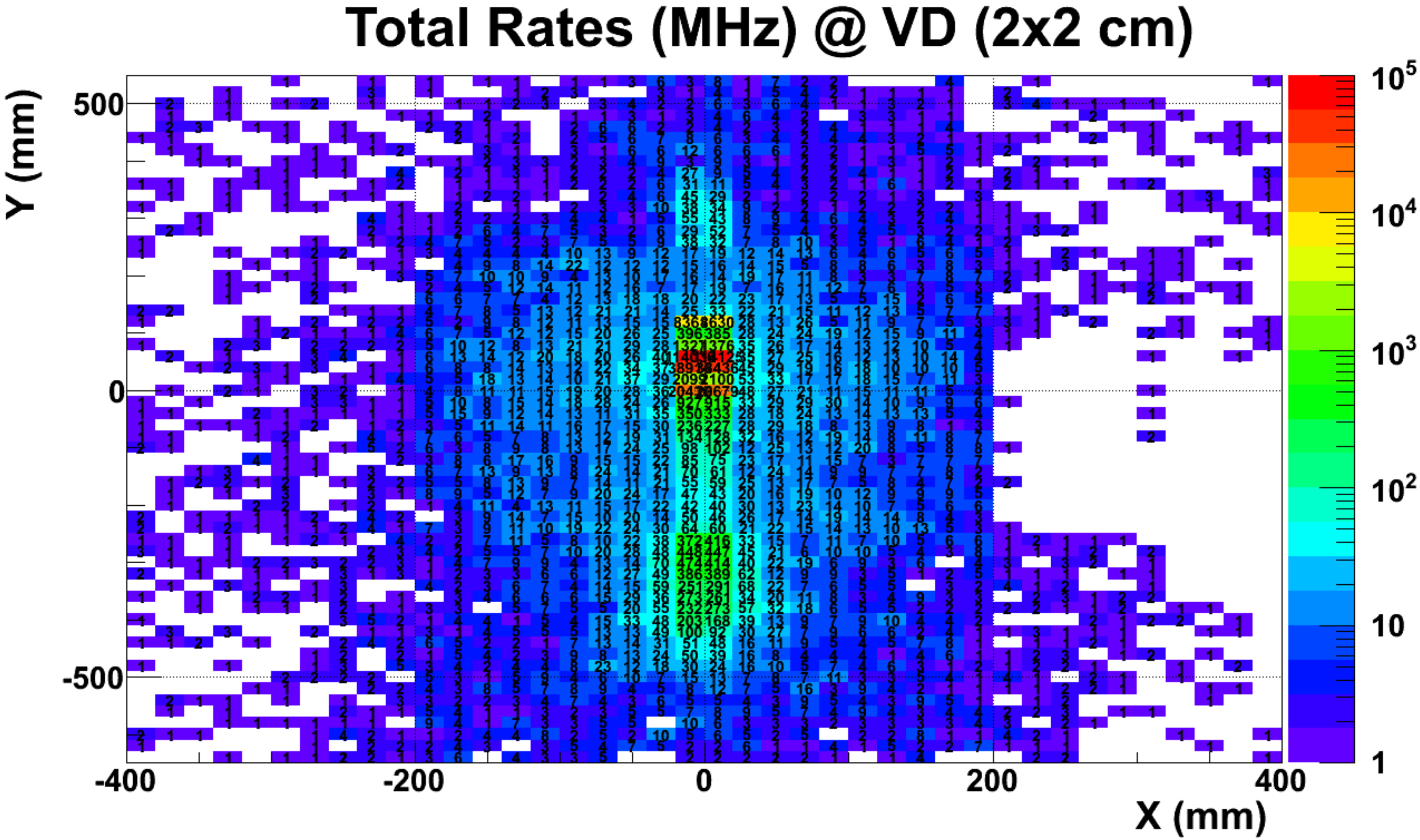
Bremstrahlung, Beam Goes to Hall A Dump

5T target field, E=2.257



Photon Rates @ 635 mm downstream

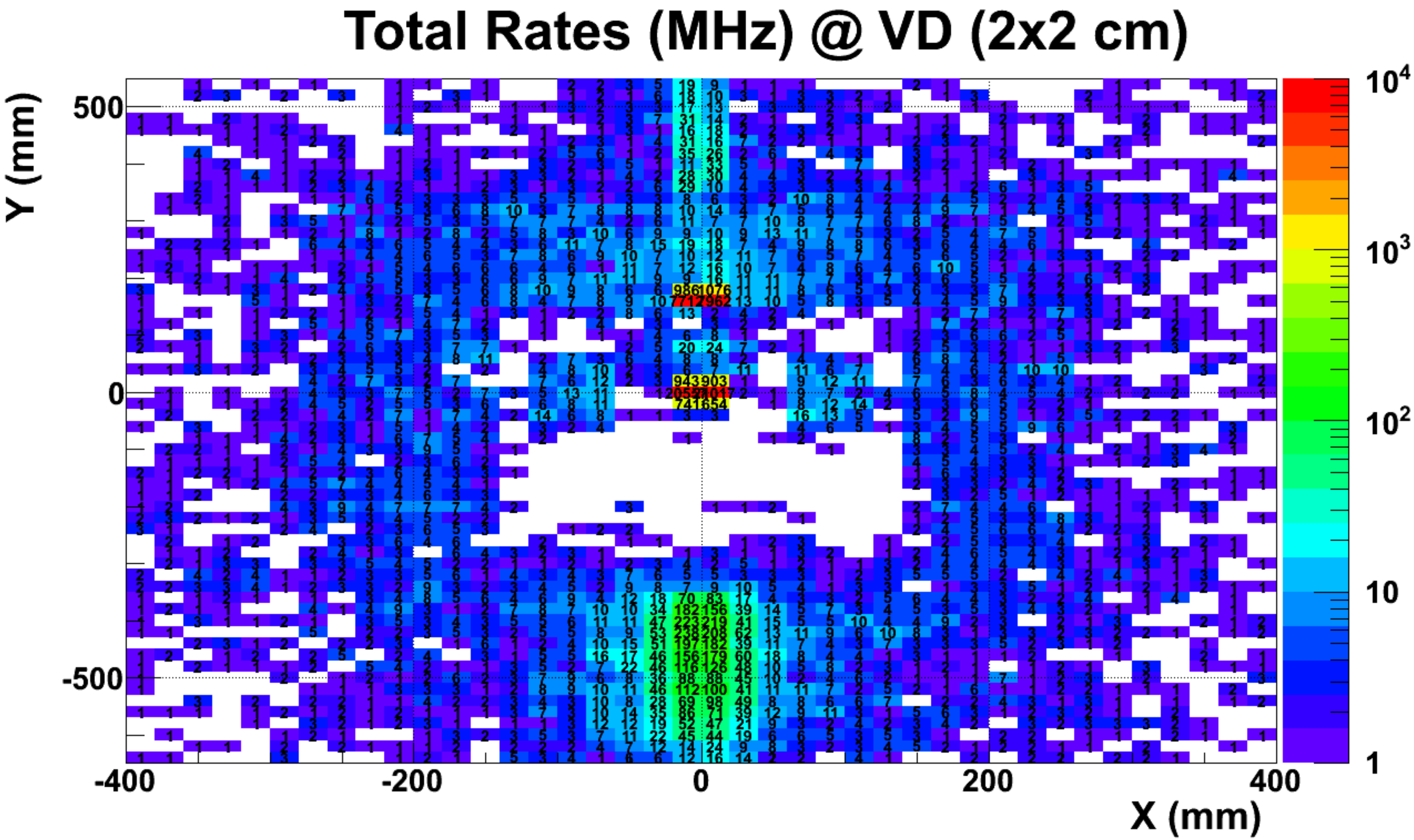
5T target field, E=2.257, Beam goes to Hall A dump



Most of these photons will be blocked by the local dump or its stand. Part of them will go from the top and bottom then hit the septum iron block.

Photon Rates behind the local dump

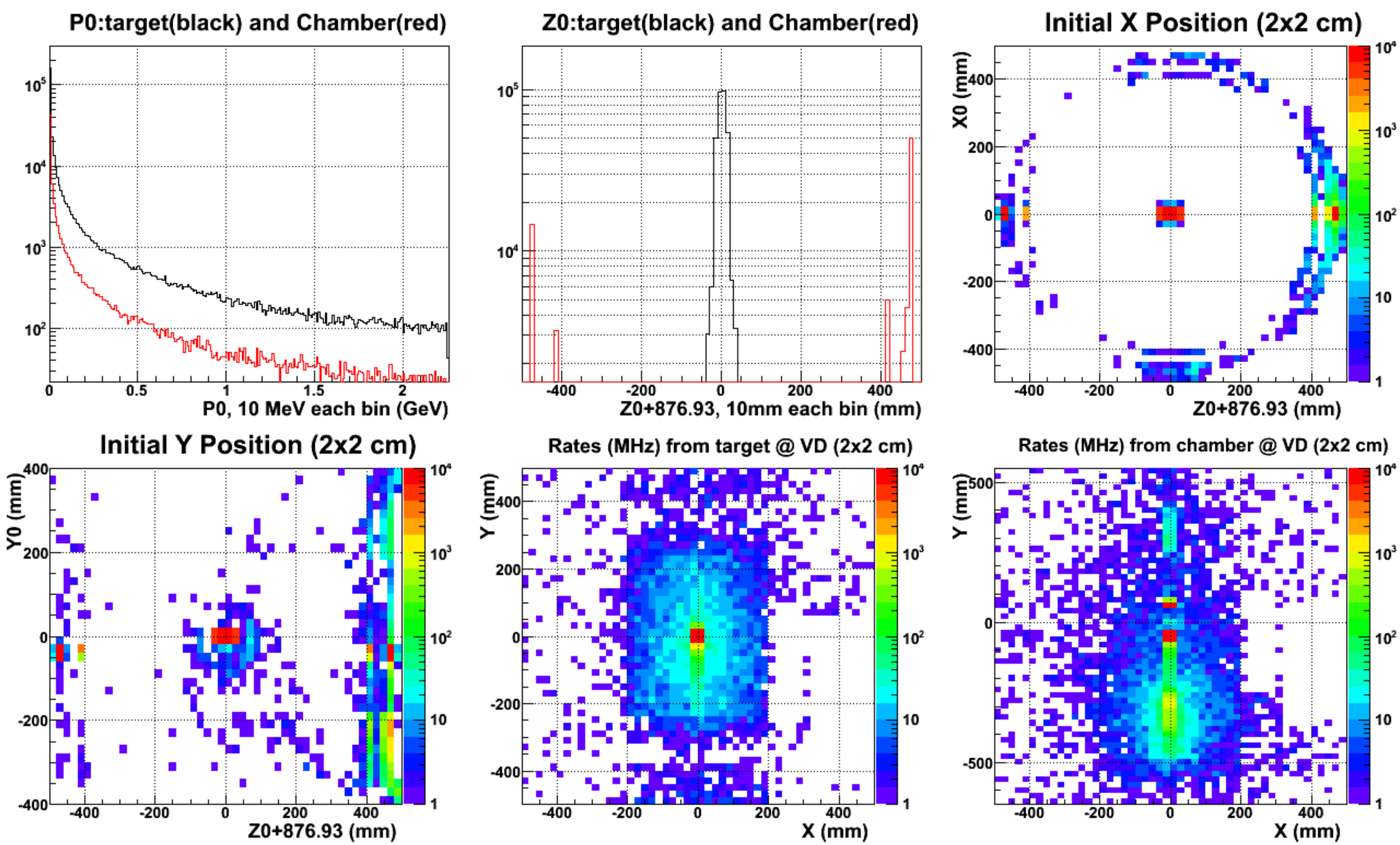
5T target field, E=2.257, Beam goes to Hall A dump



Most of these photons will be blocked by the septum iron block or the copper coils. The septum iron block covers +/-700 mm in X, +/-422 mm in Y.

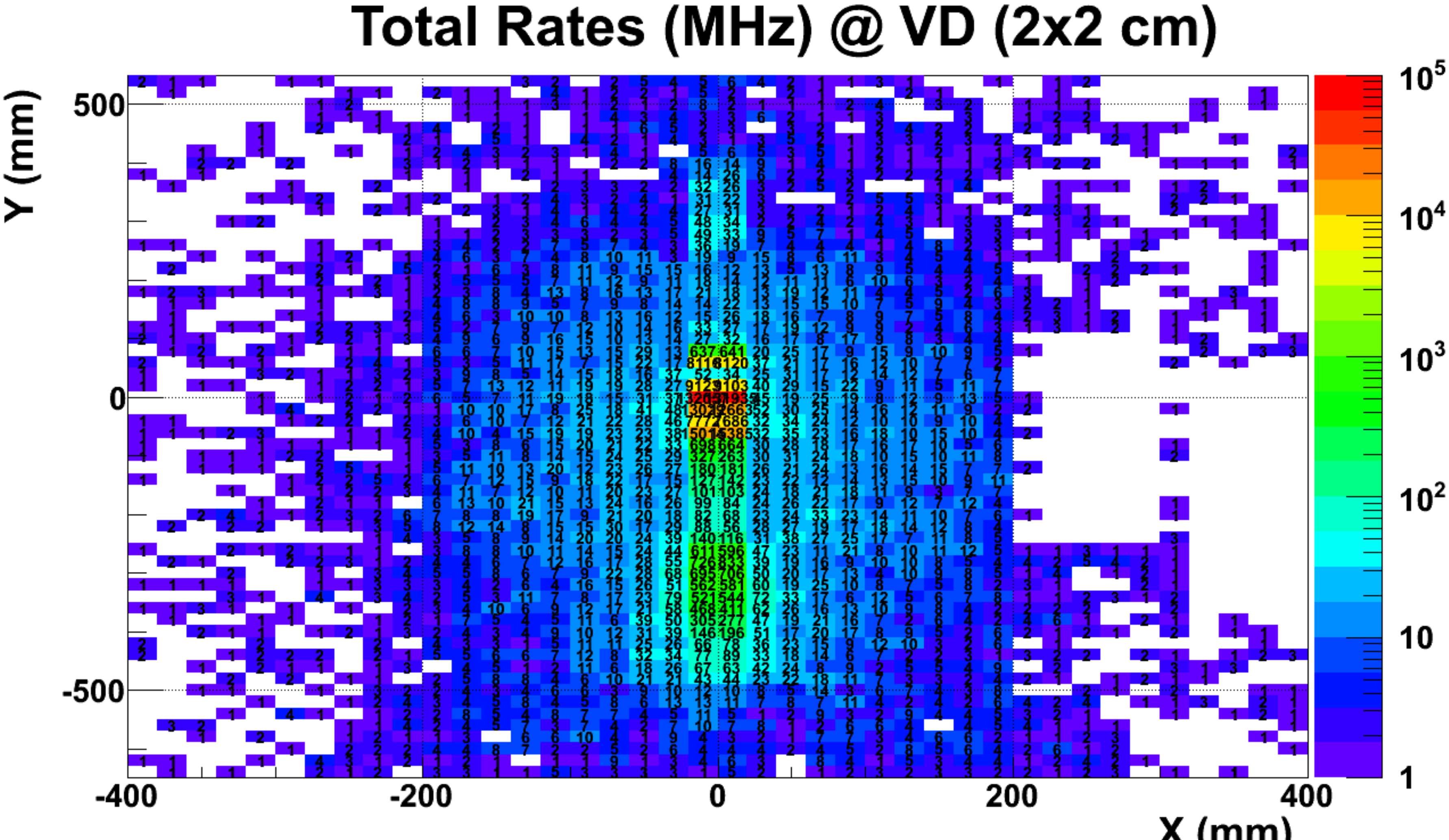
Bremstrahlung, Beam Goes to Local Dump

5T target field, E=2.257, Beam goes to local dump



Photon Rates @ 635 mm downstream

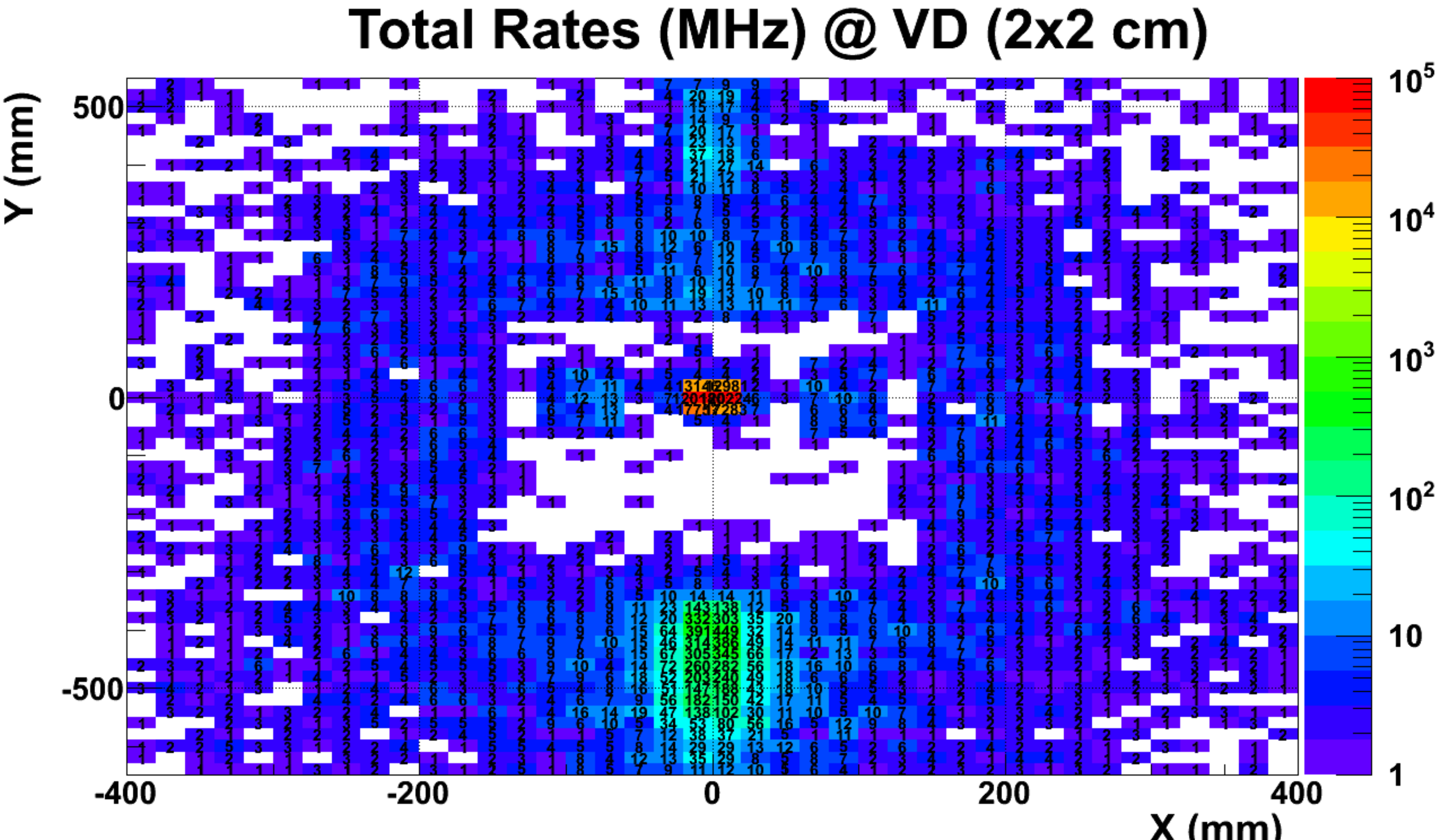
5T target field, E=2.257, Beam goes to local dump



Most of these photons will be blocked by the local dump or its stand. Part of them will go from the top and bottom then hit the septum iron block.

Photon Rates behind the local dump

5T target field, E=2.257, Beam goes to local dump



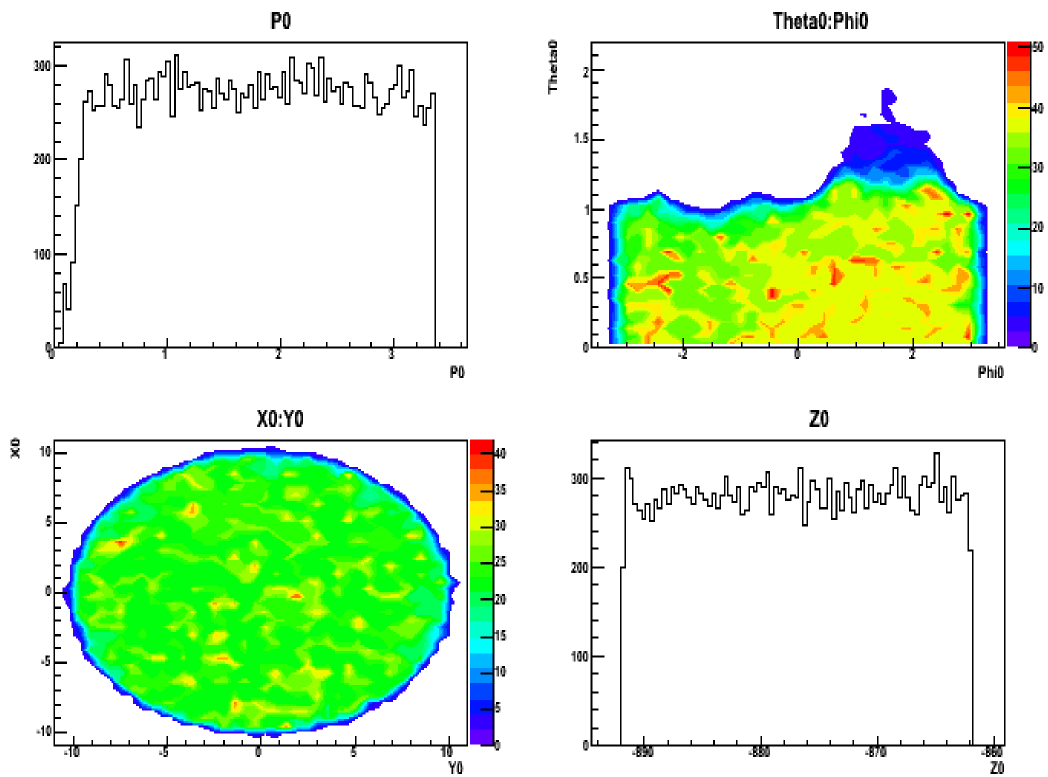
Most of these photons will be blocked by the septum iron block or the copper coils. The septum iron block covers +/-700 mm in X, +/-422 mm in Y.

d) Where the inelastic "sheet of flame" (the fan of in-elastics sweep out of the target/magnet) goes and what structures it hits.

Tried very hard to find the 'sheet of flame', but not succeed. Here is the detail:

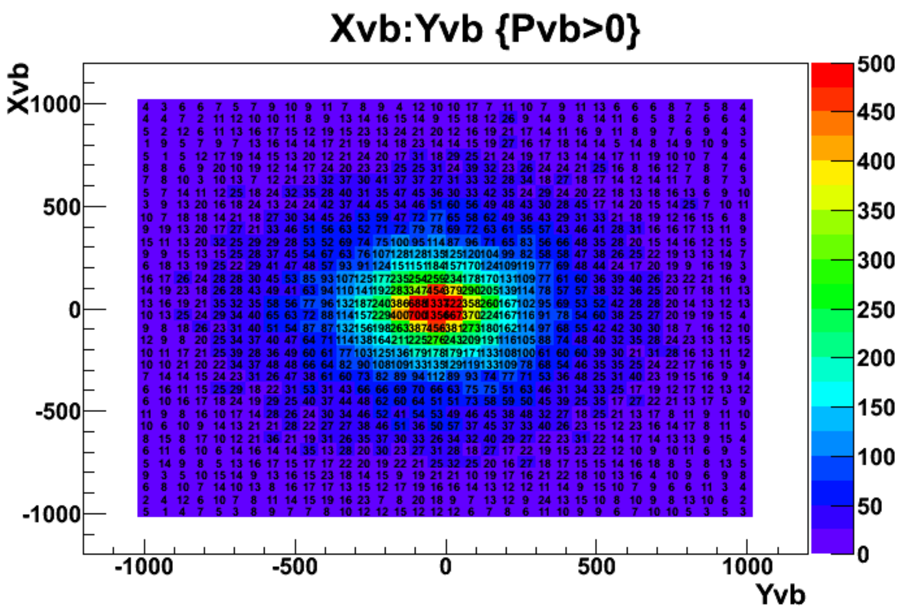
Place a flat layer detector at 600 mm downstream, which is 2000mm X 2000mm. Keeping the target field at 5 tesla, shoot electrons with flat distribution in energy(0-3.5GeV), theta(0-Pi) and phi(0-2Pi) under the following 2 situations:

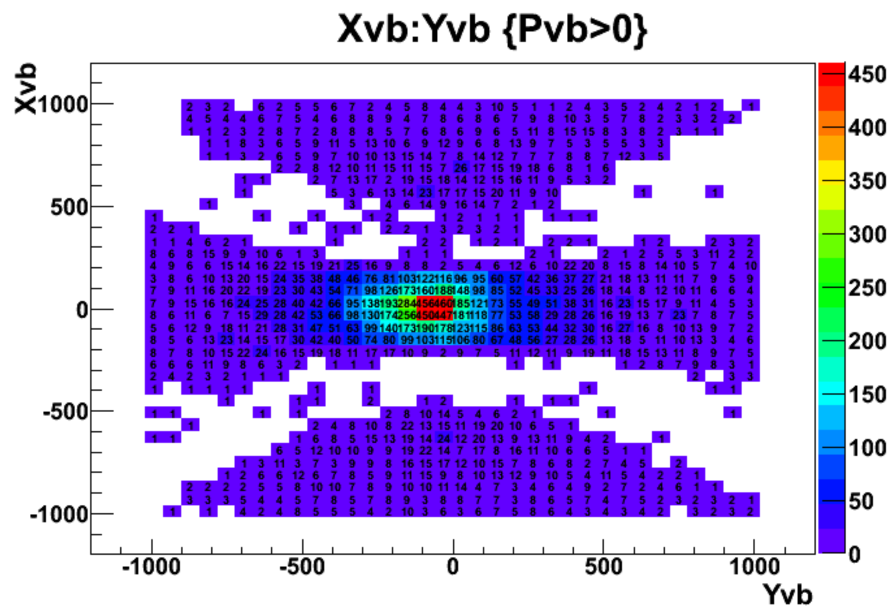
1) No coils and scattering chamber geometries.
2) With coils and scatering chamber geometries.



See more figures on the next page.

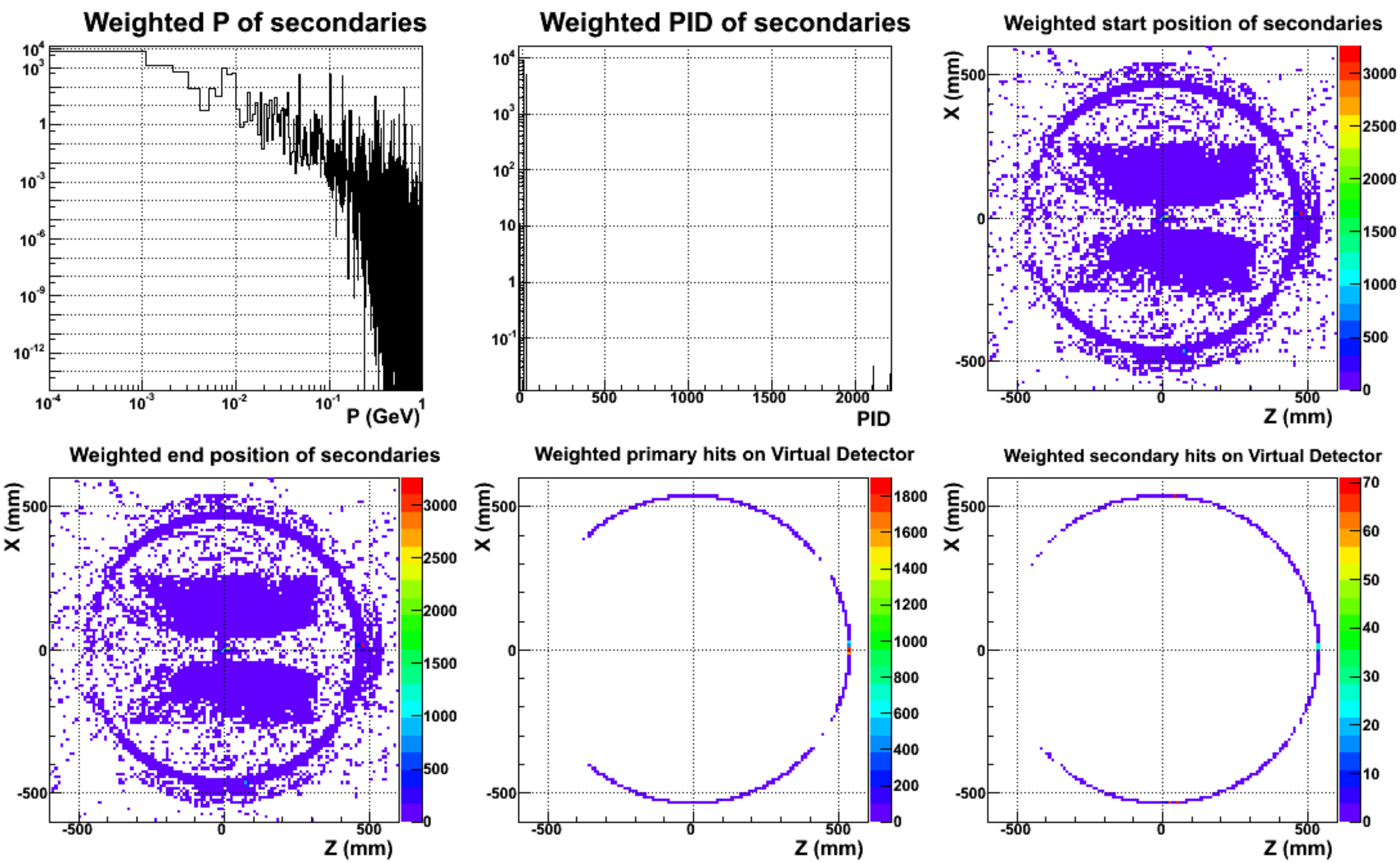
With(Left) and Without(Right) Coils and Scattering Chamber Geometry





Symmetrical distribution in phi in the left plot. Events lost due to the coil and scattering chamber in the right plot, but still symmetrical in phi.

Where the scattered electrons and their children go?



Place cylindrical detector with R=550mm surrounding the target chamber.

2) The proximity of significant magnetic material (support structures, other magnets, shielding, etc) and some argument or calculation that these won't effect the trajectories of charged particles discussed in (1) above.

3) A design for thin target exit window safety shielding (plastic or Al cover) that has cut outs only for the places where the "good" events exit. Or a credible argument that this cannot be done geometrically without compromising the measurement.

Already on position.

4) A clear written statement in the conduct of operation that they will never leave the target/magnet energized with no experiment personnel on duty in either the counting house or Hall A - 24/7 coverage when it is energized. With no ambiguous wording or wiggle room on this one.