Luminosity Monitoring in Post Collision Line

Armen Apyan

R.B. Appleby, L. Deacon, E. Gschwendtner

CERN
University of Manchester

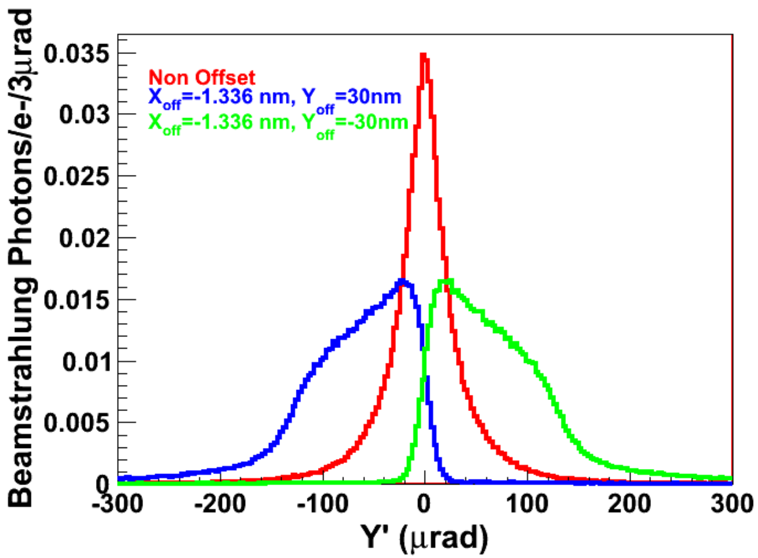
Outline

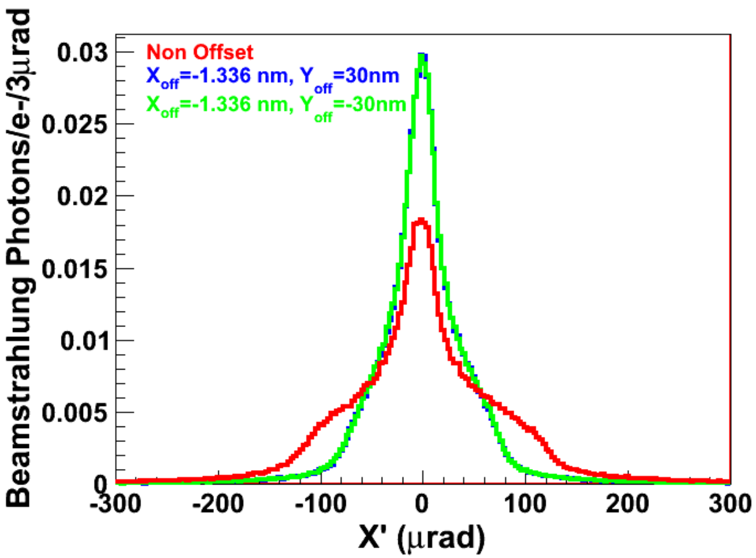
- The Concept
- Proposed Luminosity Monitors
- Simulation Results for Muons distribution behind the beam dump
- Summary

The Concept

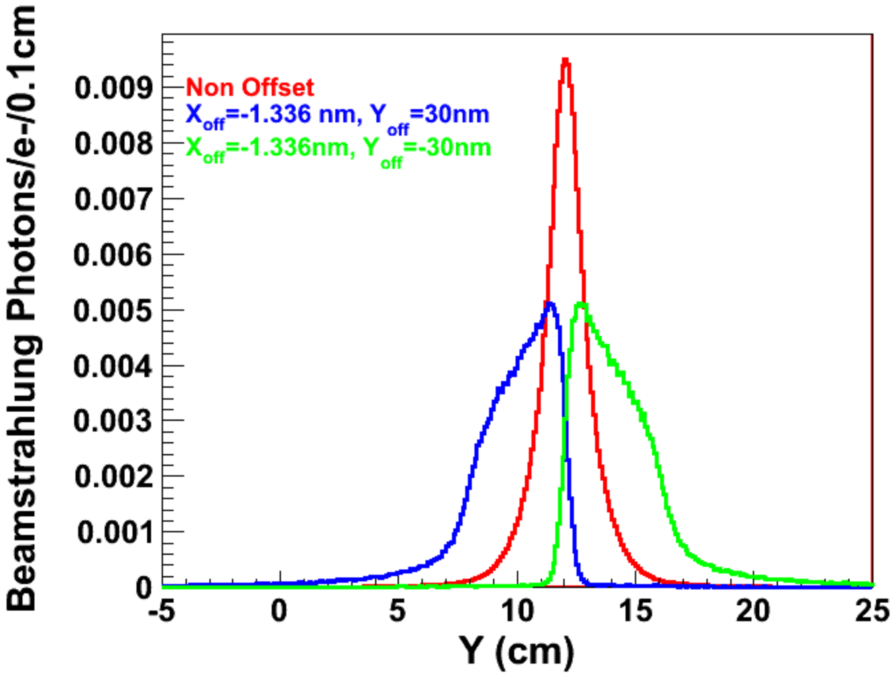
Electromagnetic forces will cause colliding bunches to be deflected

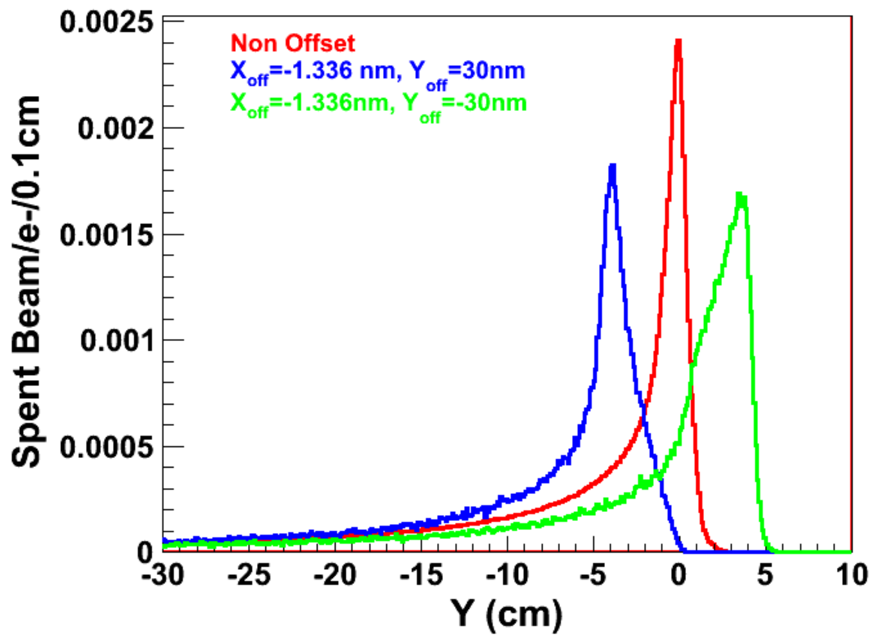
- ✓ ***The beam deflection angle depends on the offsets of the bunches and the charge distribution in the bunches.***
- ✓ ***There is no deflection when the beams are centered.***





Spatial distribution of photon and disrupted beams on the face of beam dump





Separation between disrupted and corresponding beamstrahlung photons.

Separation between non offset and offset beamstrahlung photons.

This shift allows the separation of:

- **Beamstrahlung muons from disrupted muons**
- **Non offset beamstrahlung muons from offset beamstrahlung muons**

Luminosity Monitors

1. Beamline beamstrahlung monitors are based on:

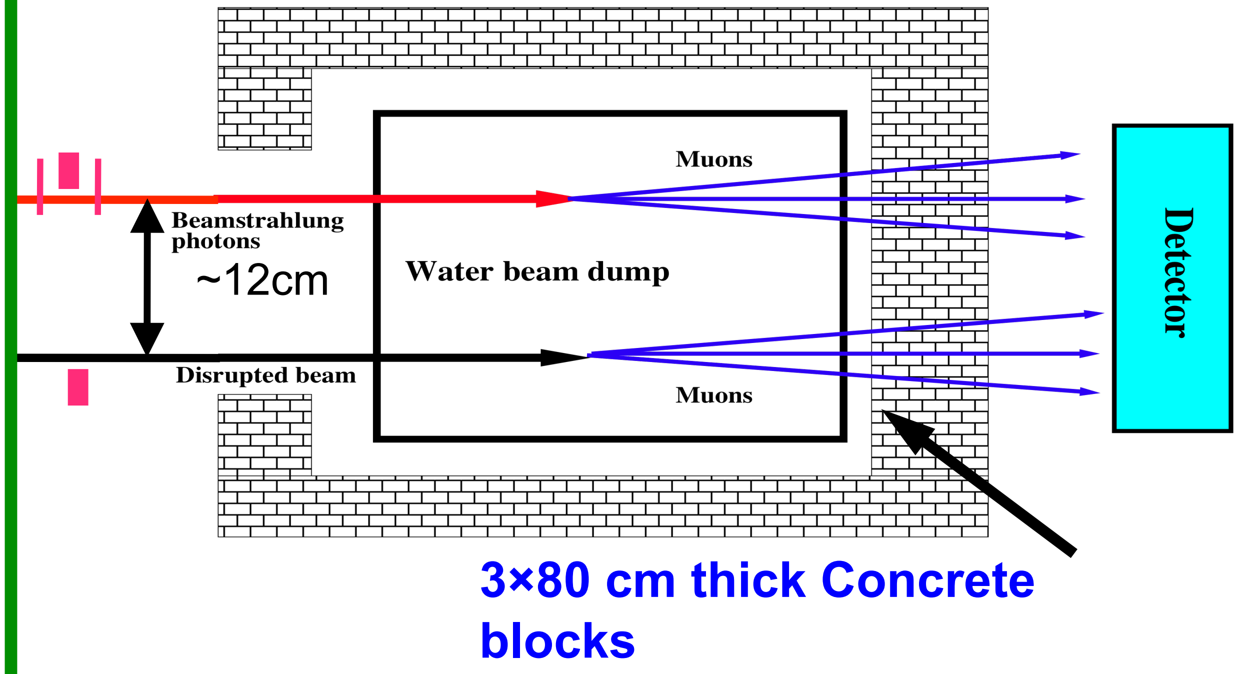
◆ *direct counting of beamstrahlung photons* **or**

◆ *indirect measurement, where the photons could be converted into e+e- pairs in a thin foil.*

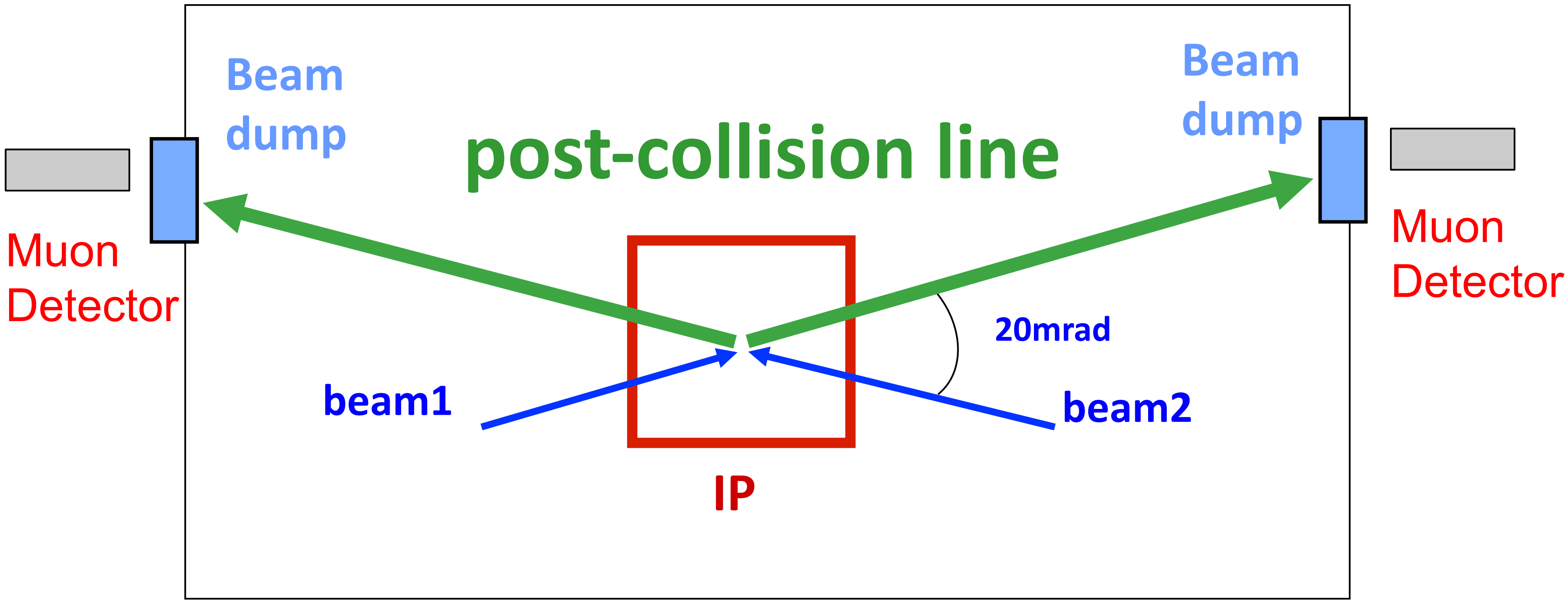
2. Beam dump luminosity monitor is based on detection of high energy muons

◆ *High energy muons escape the main dump nearly unaffected, except for small energy losses due to ionization.*

◆ *Transverse distribution of muons depends on the offset of primary beams.*



Symmetric Collision Lines

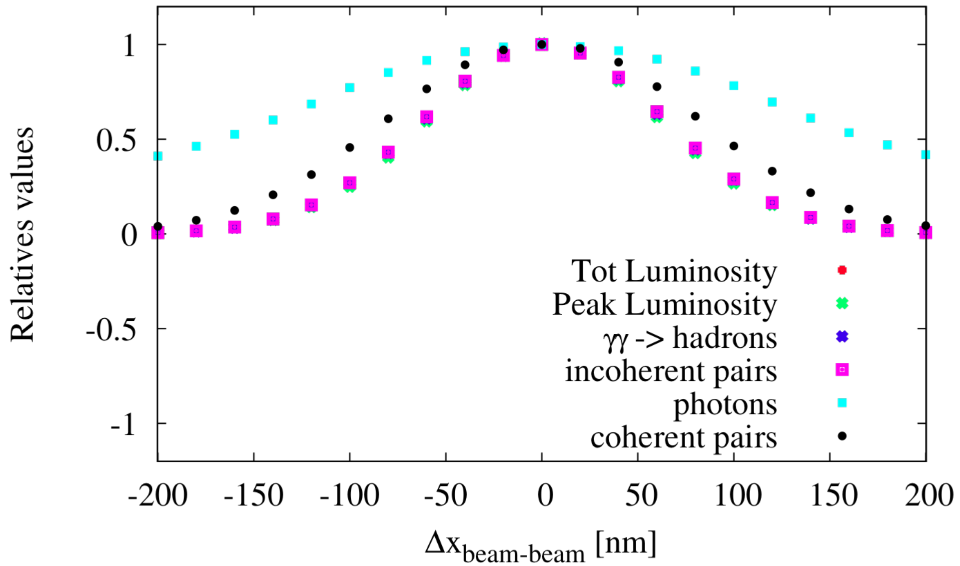


The symmetric machine can increase the accuracy of measurement.
Placing muon detectors in both sides symmetrically:

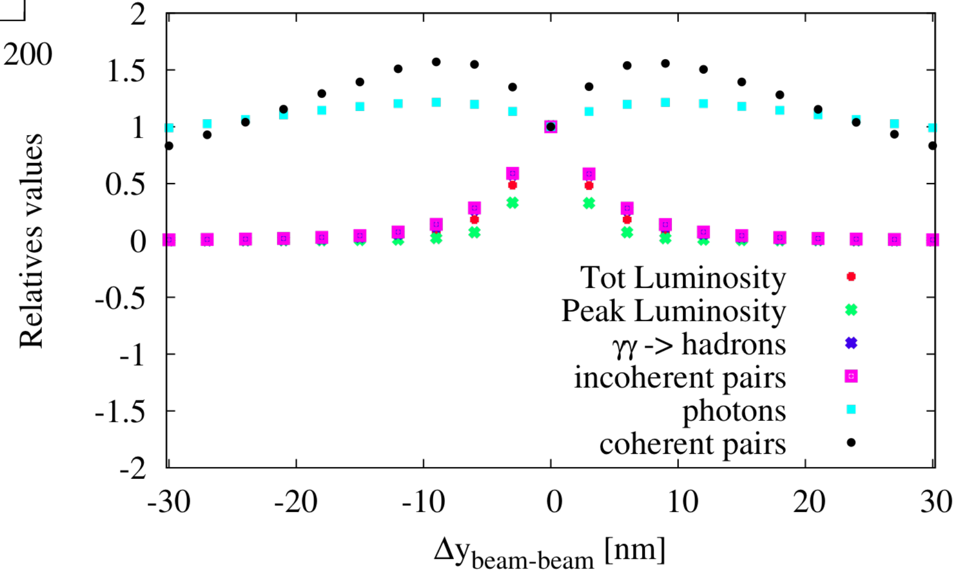
1. **The same signal in both sides --- Head on collision**
2. **Opposite signals in both sides --- Offset bunches**

Simulation Results for Beam Dump Luminosity Monitor

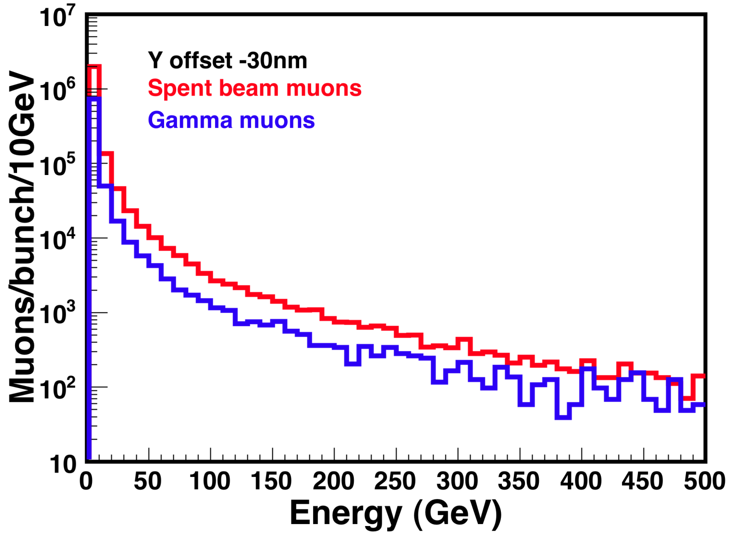
Luminosity and Backgrounds Beam-Beam Offset

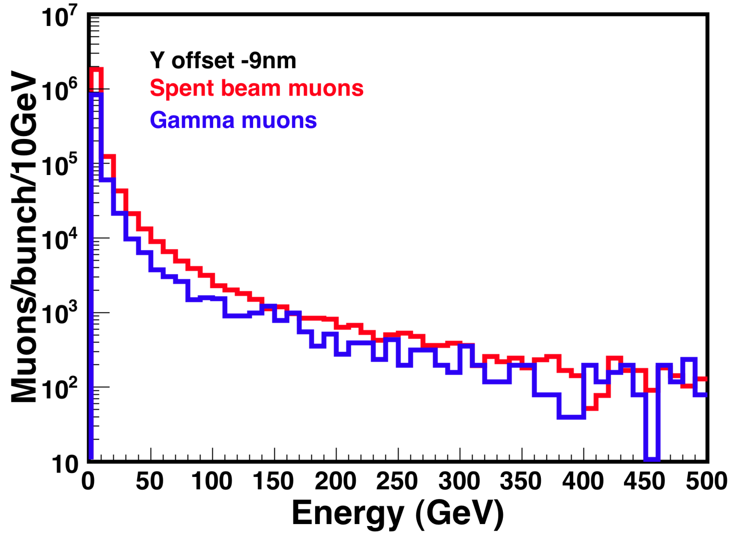


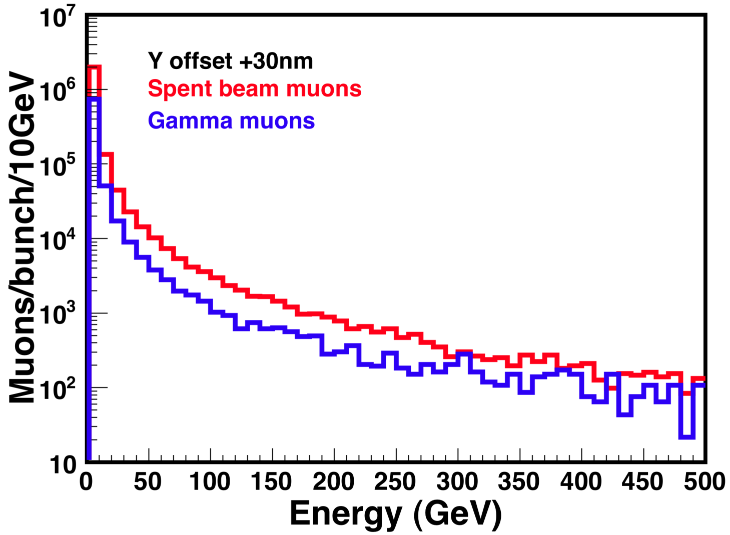
B. Dalena and D. Schulte

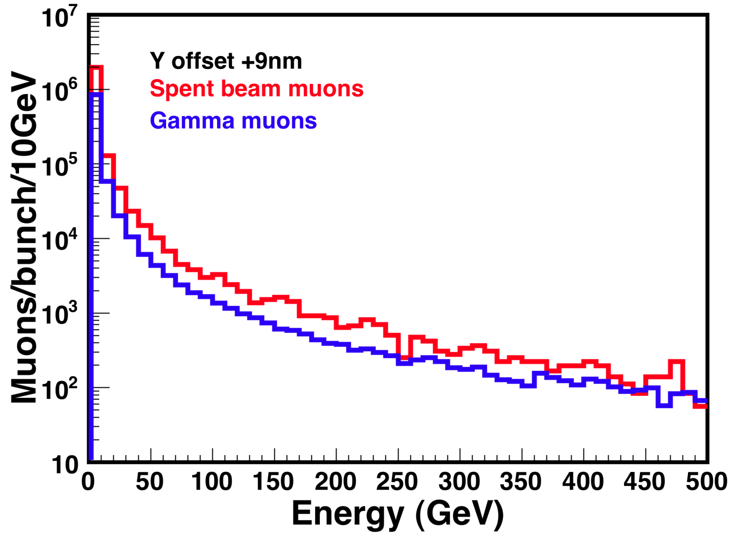


Muons spectra after Beam Dump (vertical offset)

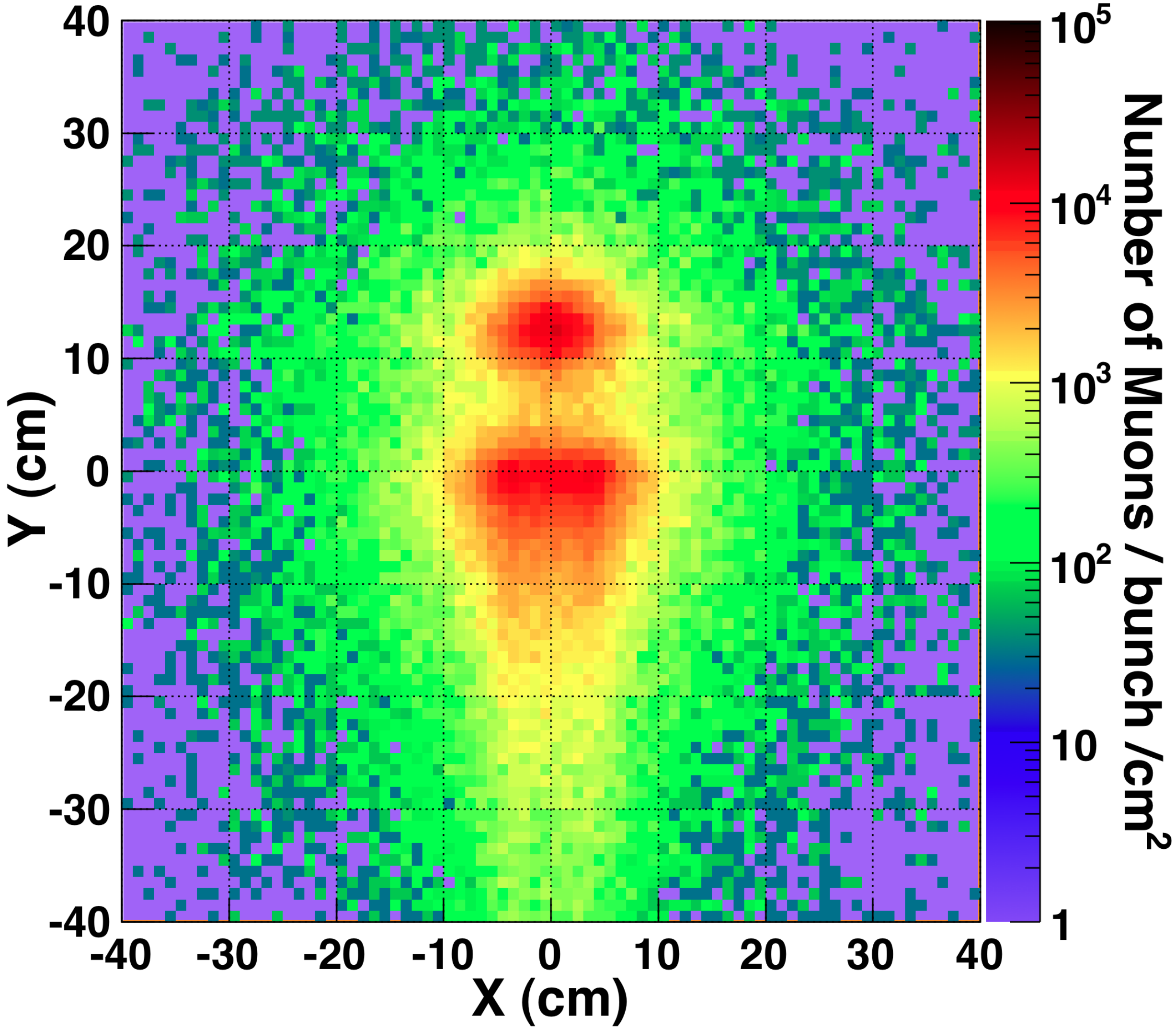






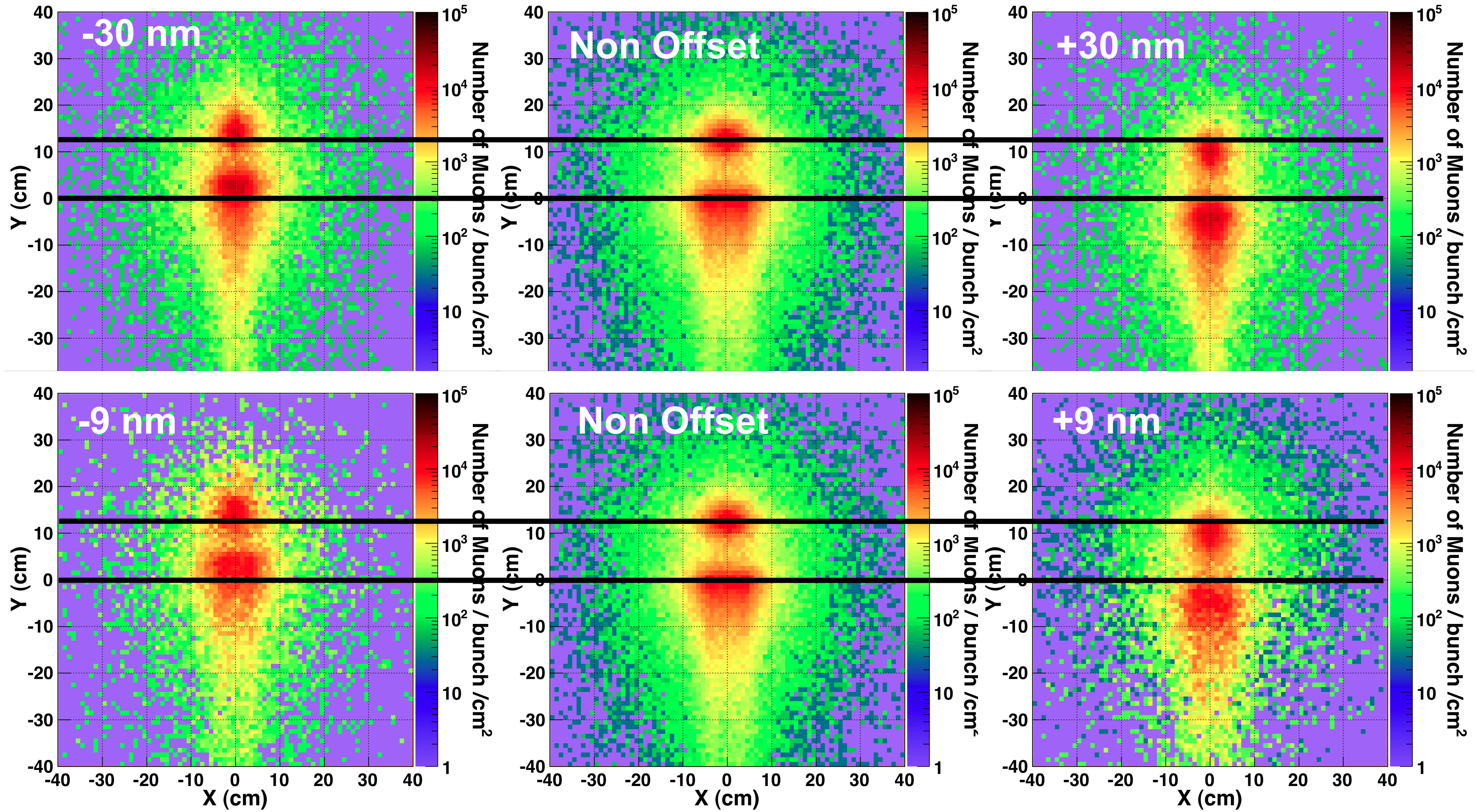


Spatial Distribution of Muons after Beam Dump (No Offset, E_μ > 13GeV)

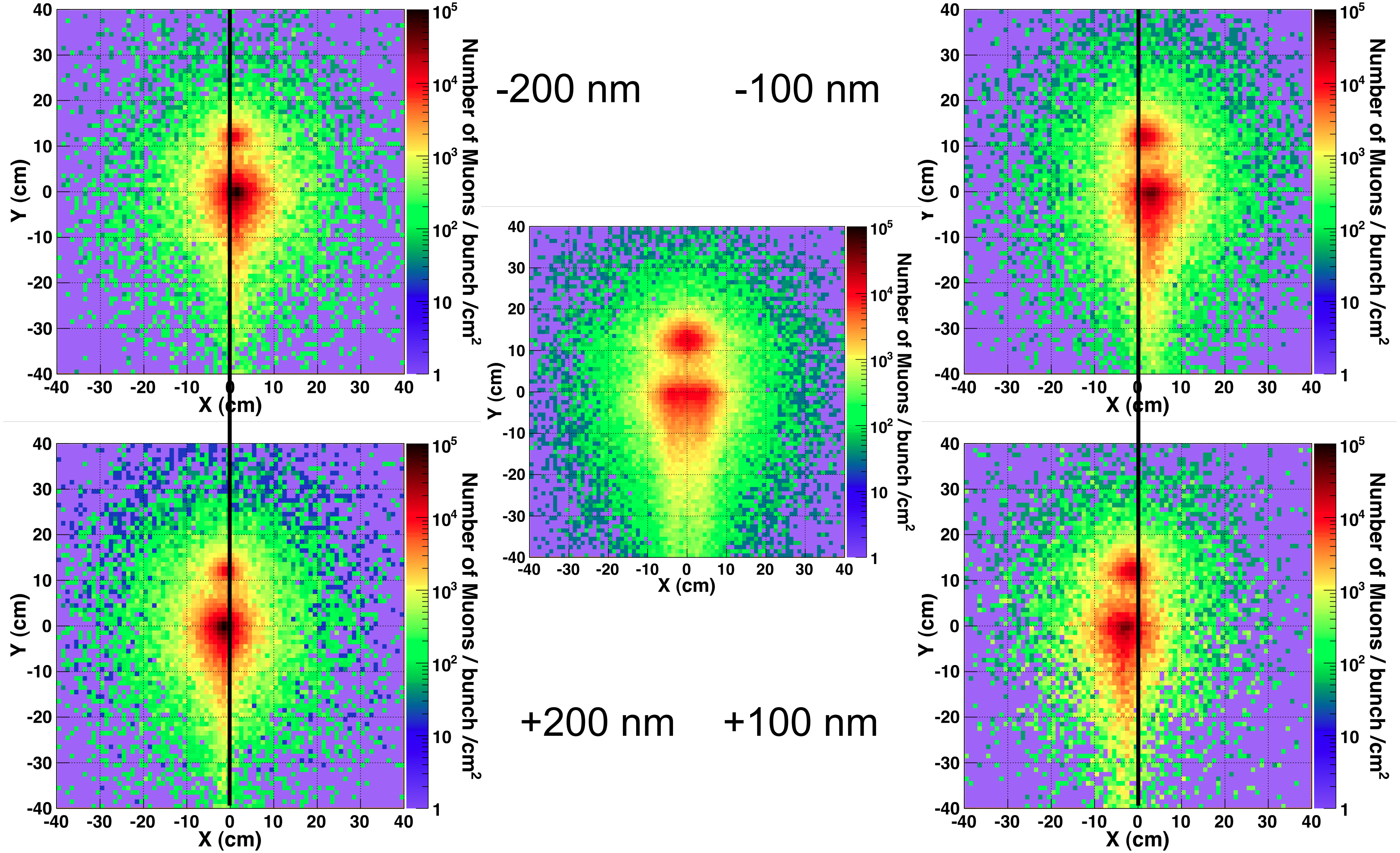


Spatial Distribution of Muons after Beam Dump

(Vertical Offset)

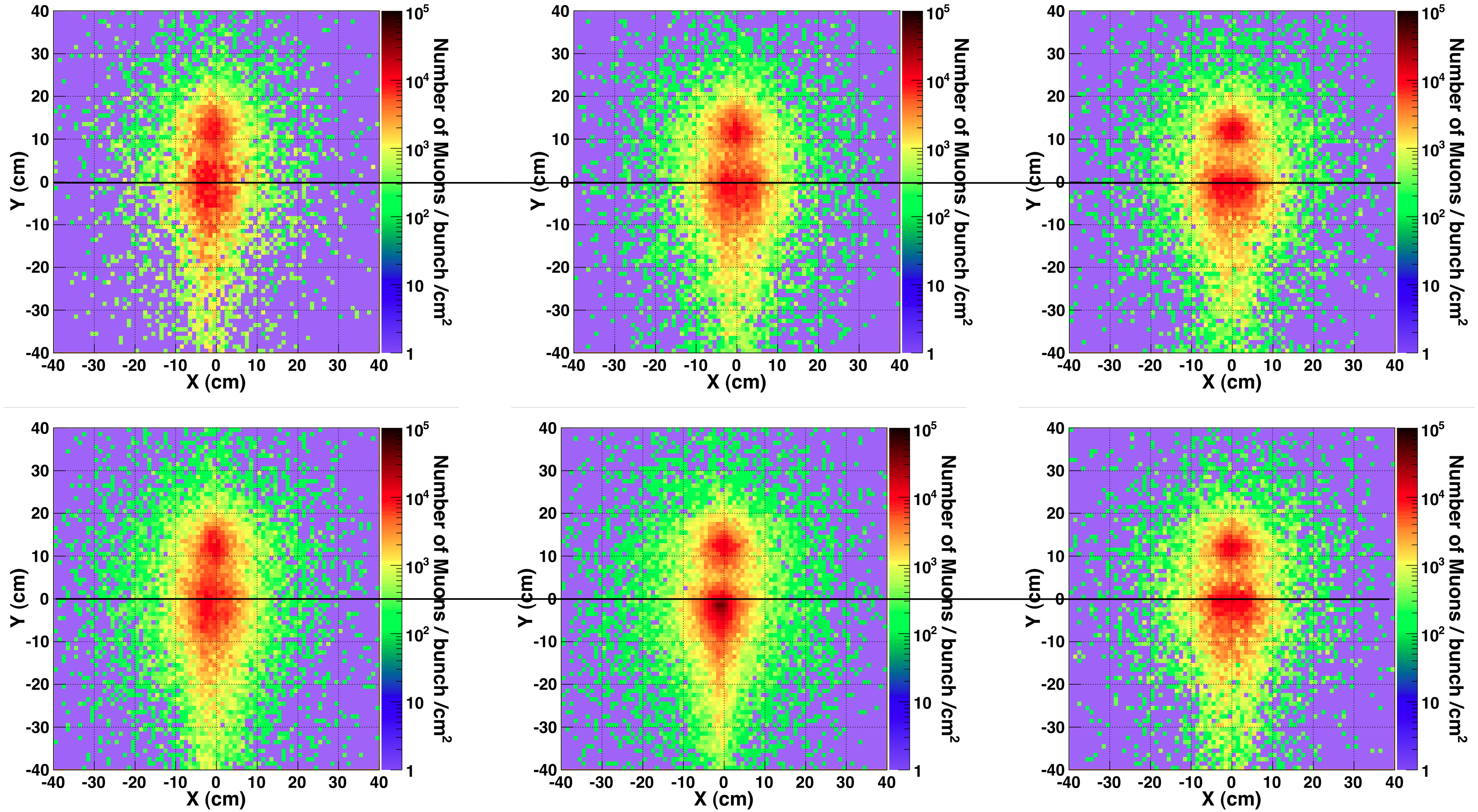


Spatial Distribution of Muons after Beam Dump (Hor. Offset)



Spatial Distribution of Muons after Beam Dump (Vertical Waist KAY)

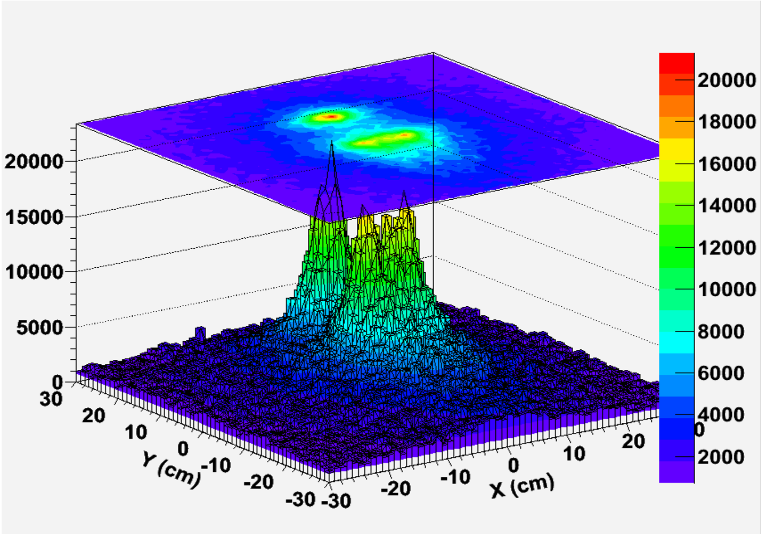
-300 nm -100 nm -30 nm



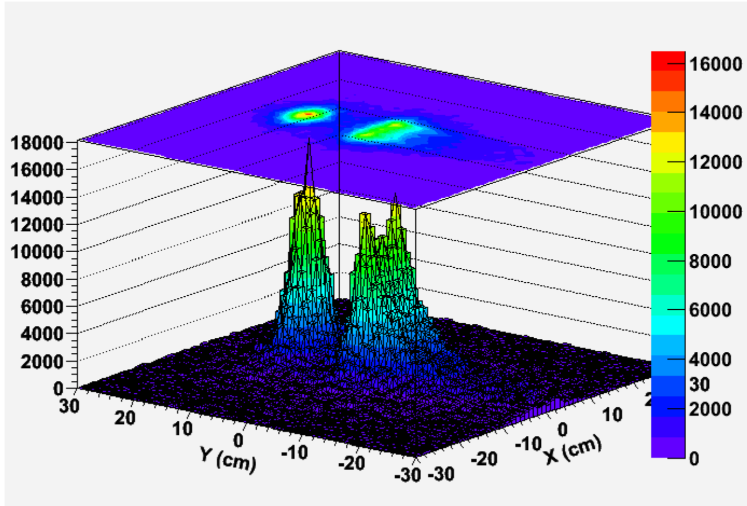
+ 300 nm +100 nm +30 nm

Separation of Muons Produced by Spent and Gamma Beams

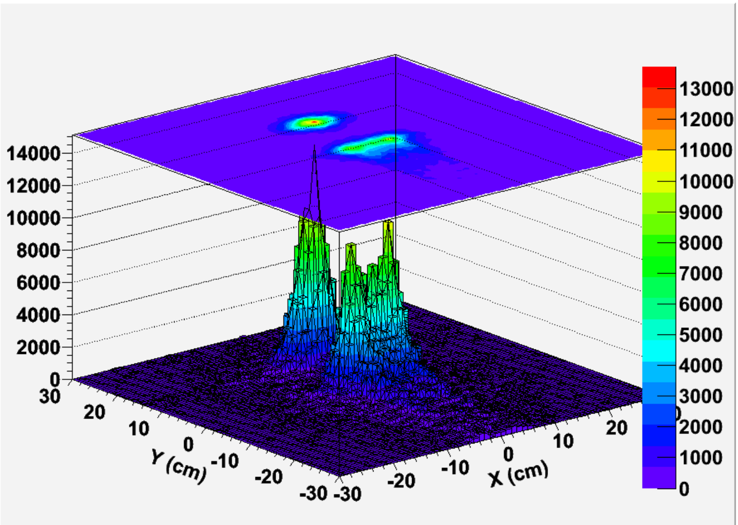
No energy cut



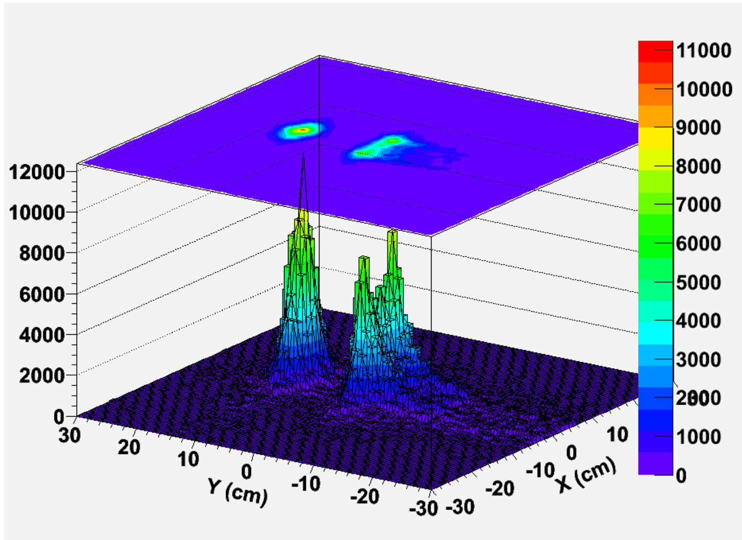
$E_\mu > 13$ GeV



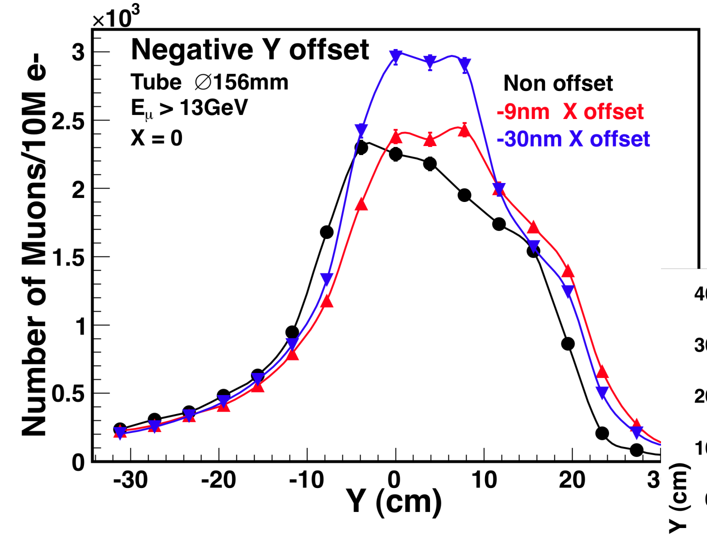
$E_\mu > 30$ GeV

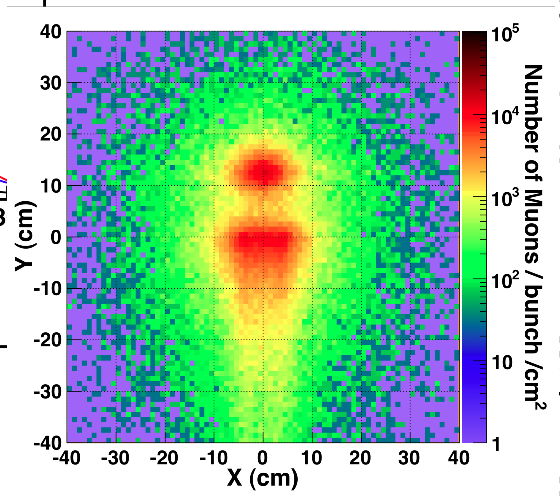


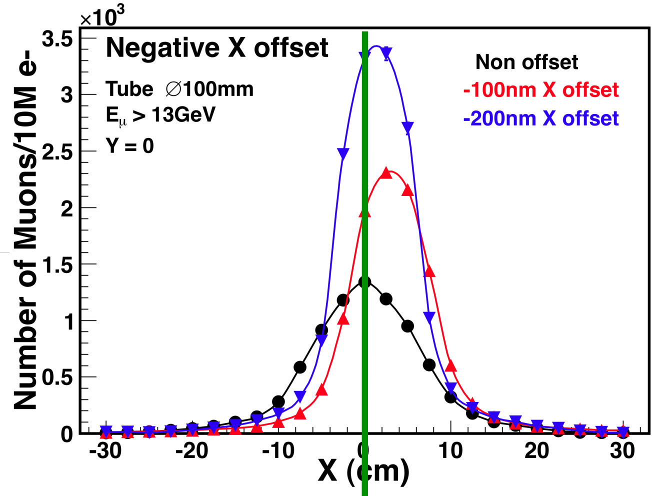
$E_\mu > 50$ GeV

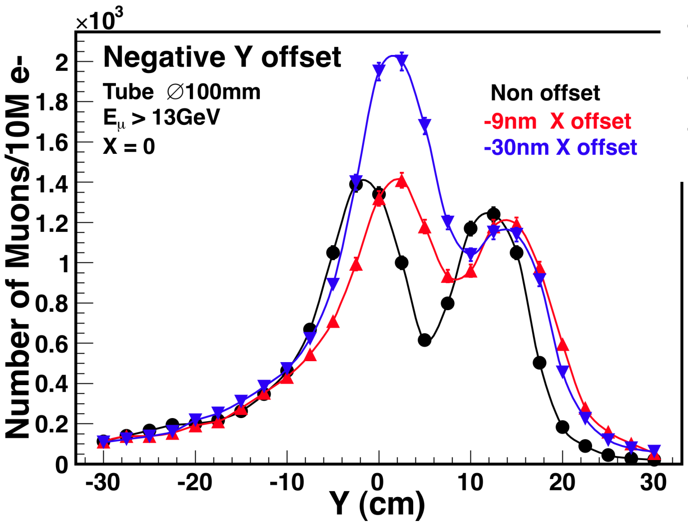


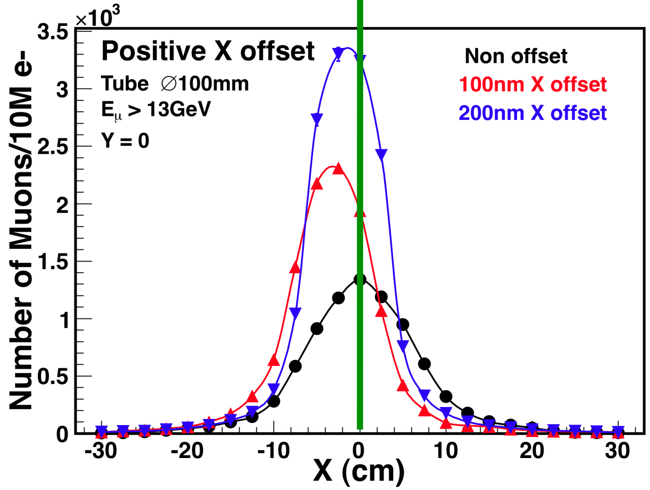
Possible placement of Cherenkov Tubes











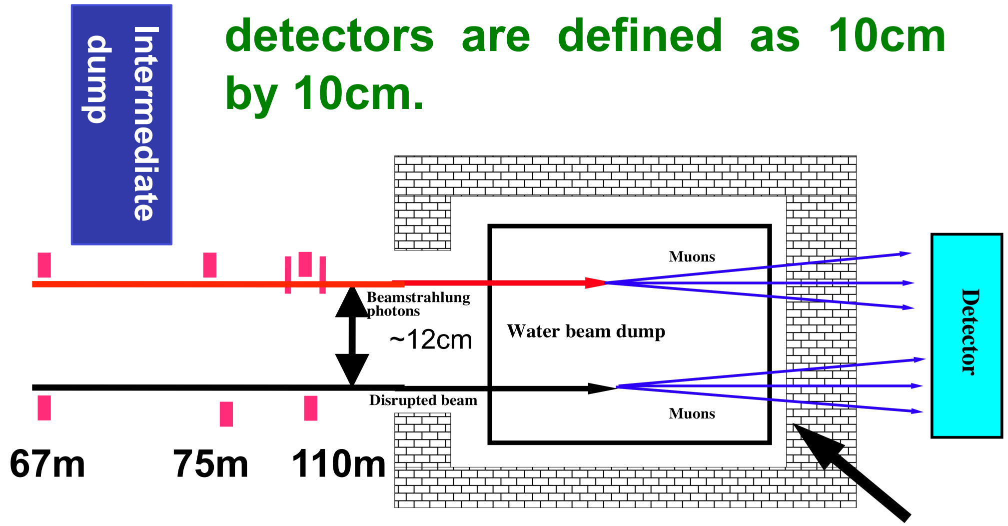
Beamline Bremstrahlung Luminosity Monitors

(R. Appleby)

Three candidate locations were chosen for photon detectors, with longitudinal locations: before and after the intermediate dump. The third longitudinal location is located after the intermediate dump and the C-shape magnets.

The detectors are located in the tail of the photon cone, beginning 5cm above the centre of the beamstrahlung cone.

The surface areas of each detectors are defined as 10cm by 10cm.



The simulations indicate that the dominate contribution to the photon signal comes from direct beamstrahlung detection, with a small contribution from EM showers in the post-collision line. Focusing on the detector located at 110m, the photon rate per bunch crossing is $1.1*10^7$, with a mean energy of 11 GeV. The simulation has shown sensitivity to beam-beam offsets at the interaction point.

Summary

Two independent diagnostic tools are under the study:

1. Beamline beamstrahlung monitor

A possible detector location has been studied and found to be at 67m, 75m and 110m downstream the interaction point.

2. Beam dump luminosity monitor

The simulation results show:

- **The separate distributions of muons produced by spent beam and beamstrahlung photons.**
- **The location and flux of the muon distributions are directly connected to different beam offsets in the interaction point and consequently to the luminosity quality.**

Summary

Future works:

- **Take into account muons background from IP and main beam line.**
- **The choice and detailed location of the muon detectors.**
- **Our first choice is gaseous Cherenkov threshold detector:**

Vary the size, pressure of gas for obtaining optimal signal from muons produced by post collision particles