The μ-Beam for Black Holes Production

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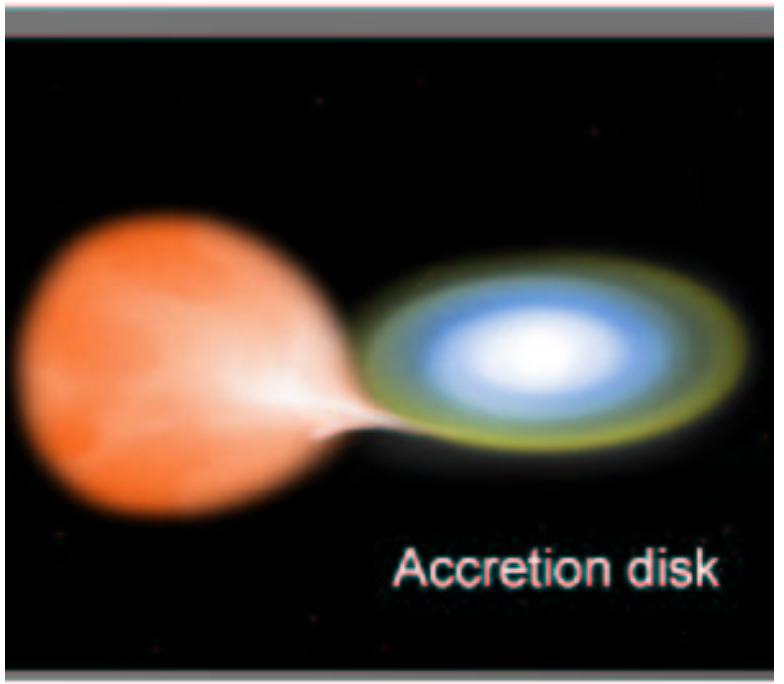
- **Black Holes Overview**
- **Black Holes Production**
- **Black Holes at Accelerators**
- **μ-Beam at 2 TeV Scale**

Black Holes

Overview

- There is no doubt that we could find the experimental evidence of the black holes
- We need to rely on indirect evidences to establish the existence of black holes since we cannot see a black hole
- There is an evidence of the astronomical black holes that exist from the nearby star **(related to matter accretion)**
- We are exploring the possibility of the miniature black holes production in lab

Astronomical Black Holes



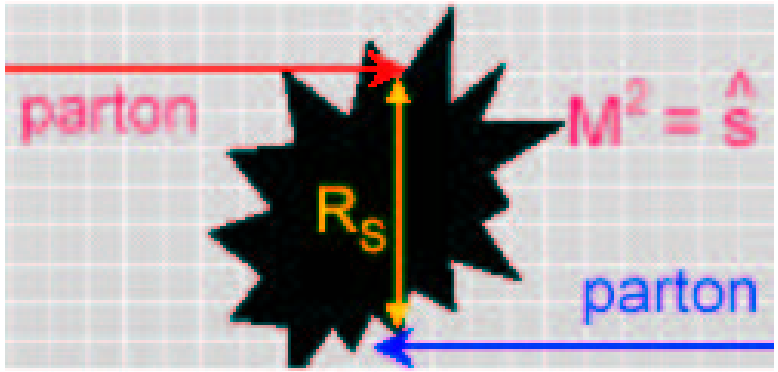
- **Accretion disk is related to a black hole from a nearly star**
- **There are some black hole candidates in the universe!**

Black Holes Production

Black Holes Approach

- **BH's lifetime:** $10^{-25} - 10^{-27}\ s$
- **Previous studies show the evidence of the black hole production at lab**
- **Black hole references :**
  - **M. Cavaglià : PLB 569, 7 ('03), Modern Physics A 18, 11 (2003)**
  - **Dimopoulos & Landsberg : PRL 87, 161602 (2001)**
  - **Giddings : hep-ph/0106219**
  - **Banks & Fishler : hep-ph/9906038**
  - **Argyres *at. al* : hep-ph/9808138**
  - **Harris *at. al* : hep-ph/0307305**

Black Hole Cross Section



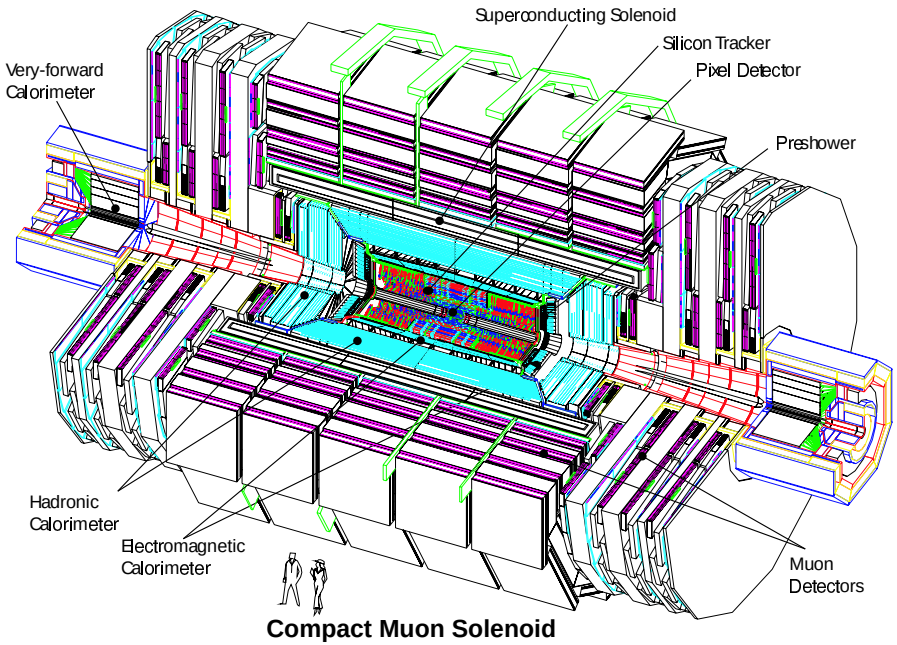
- R_s is Schwarzchild's radius
- A black hole is formed when the cms energy approaches the fundamental Planck scale : as low as $\sim$ TeV
- **Parton level cross section :**

$$\sigma(M_{BH}^2) \sim \pi R_s^2 \sim 1\ TeV^{-2}$$

- **Limitation : Lack of knowledge of quantum gravity effects**

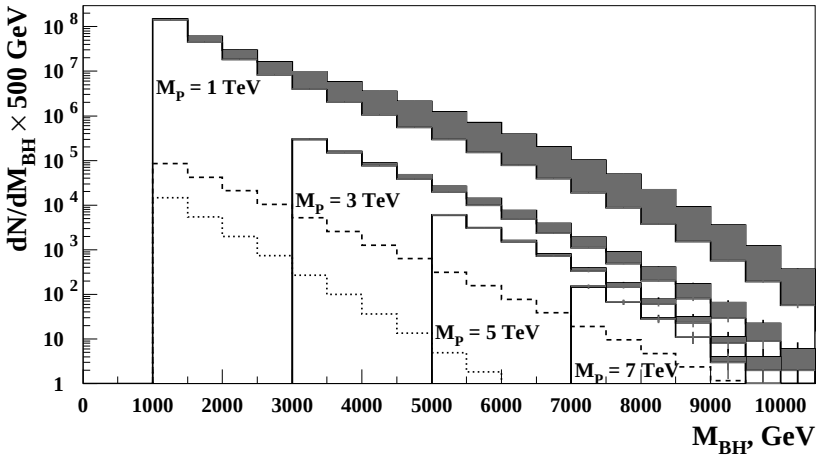
BH at Accelerators

CMS Detector



- We are planning to use a CMS detector simulation to search black holes
- CMS is a suitable detector to study of black holes since it has a good detection of muons and jets

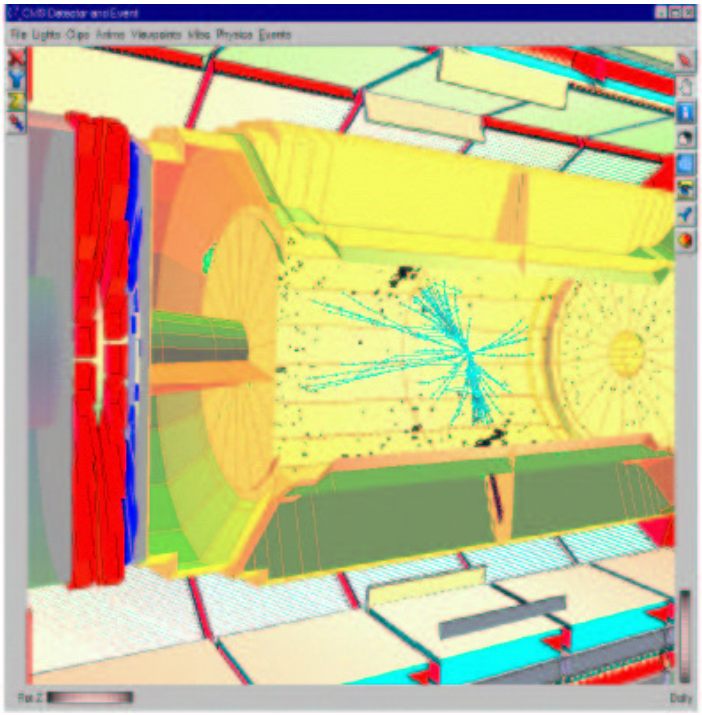
Black Hole Factory



- Spectrum of BH produced at LHC
- Number of BH as a function of M_{BH}
- Shaded region is number of events
- Dashed line is the total background
- Final states tagged with e or γ (PRL 87, 161602 (2001))

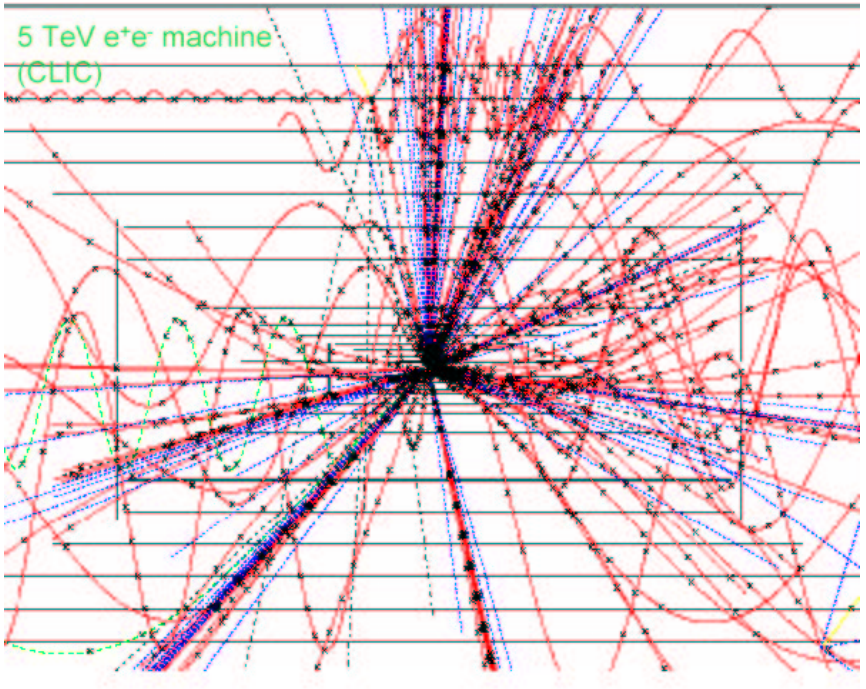
BH at Accelerators

Black Hole at CMS



- A black hole event with $M_{BH} \sim 8\ TeV$
- BH decays immediately by Hawking radiation (democratic evaporation): large multiplicity, small missing energy, and ratio jets/leptons ~ 5

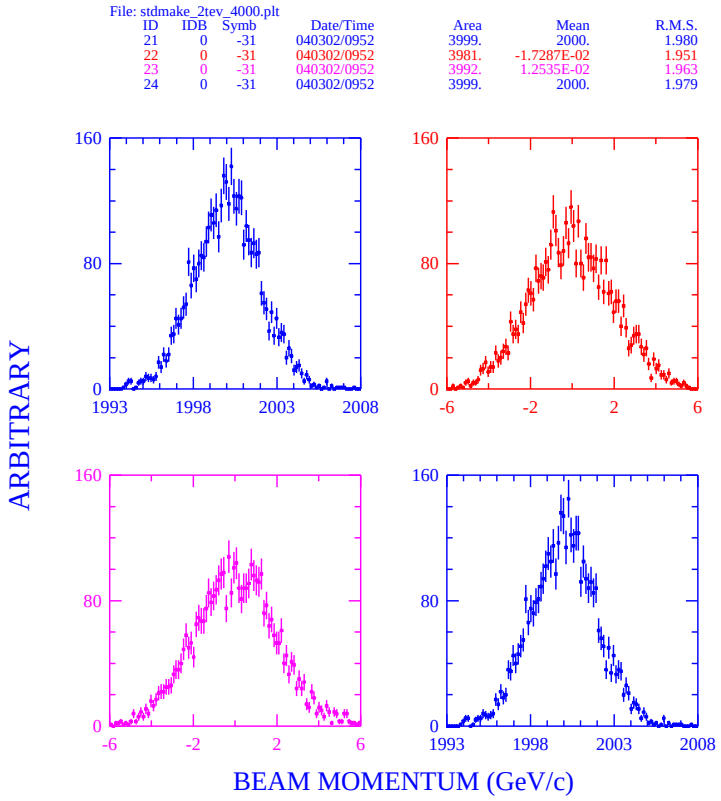
Black Hole at CLIC



- BH event display at CLIC at 5 TeV (simulated by A. De Roeck)
- This event has a large final state multiplicity as a typical BH event

μ-Beam for Black Holes

μ-Beam Generated

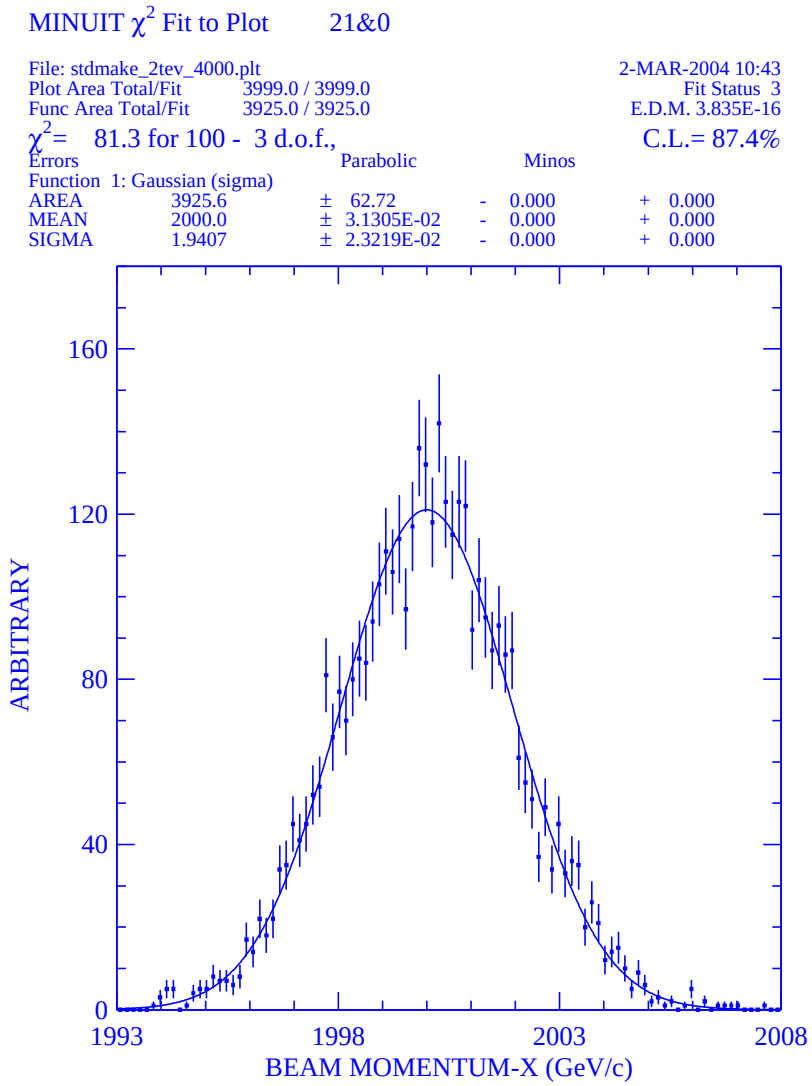


- We generate 2 TeV μ-beam with a Gaussian distribution

μ-Beam Parameters:

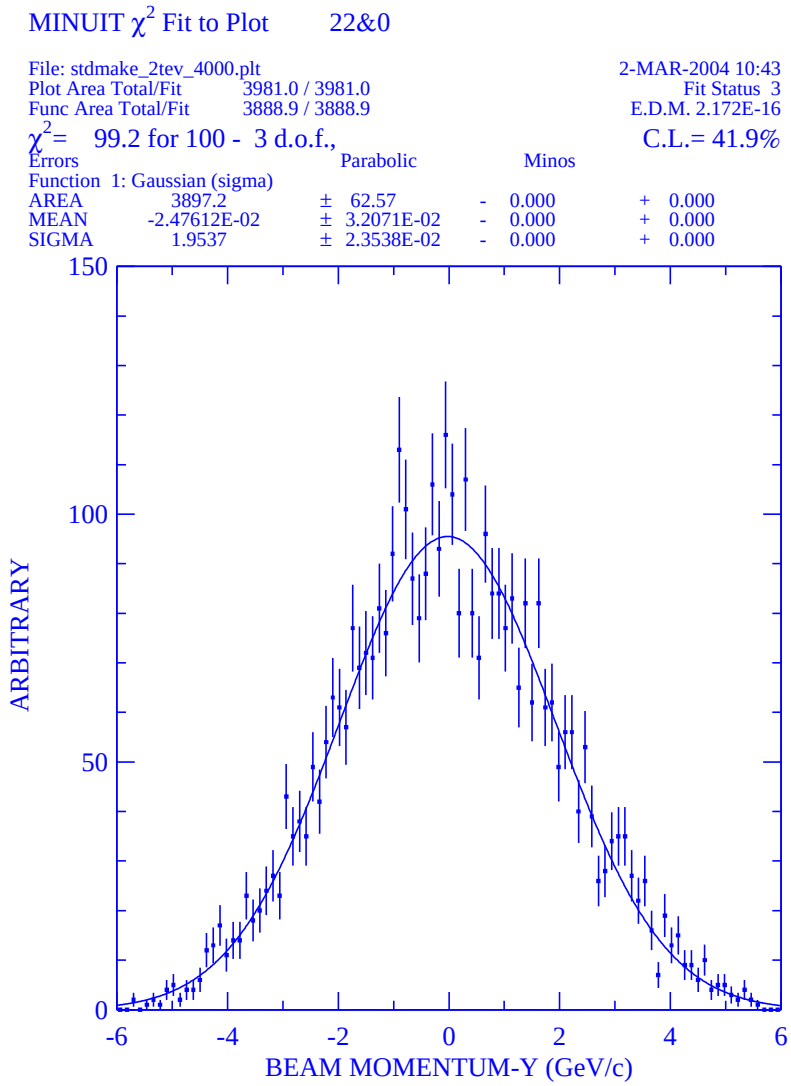
- 4000 particles of μ-beam'
- Beam's energy is 2 TeV
- σ_E is $\sim$ 2 GeV
- σ_z is $\sim$ 0.25-0.12 cm
- Note that the beam's parameters are as an output of the second rapid cycling synchrotrons (RCS2)
- Based on PRST-AB 6, 081001 (2003) for 4 TeV muon collider

μ-Beam for Black Holes



- Fitting the μ-Beam X-momentum

μ-Beam for Black Hole



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