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Observation of the first Bs--> J/Psi Phi Event in CMS

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Observation of the first $B_s \rightarrow J/\psi\ \phi$ Event at CMS

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for the
CMS Collaboration

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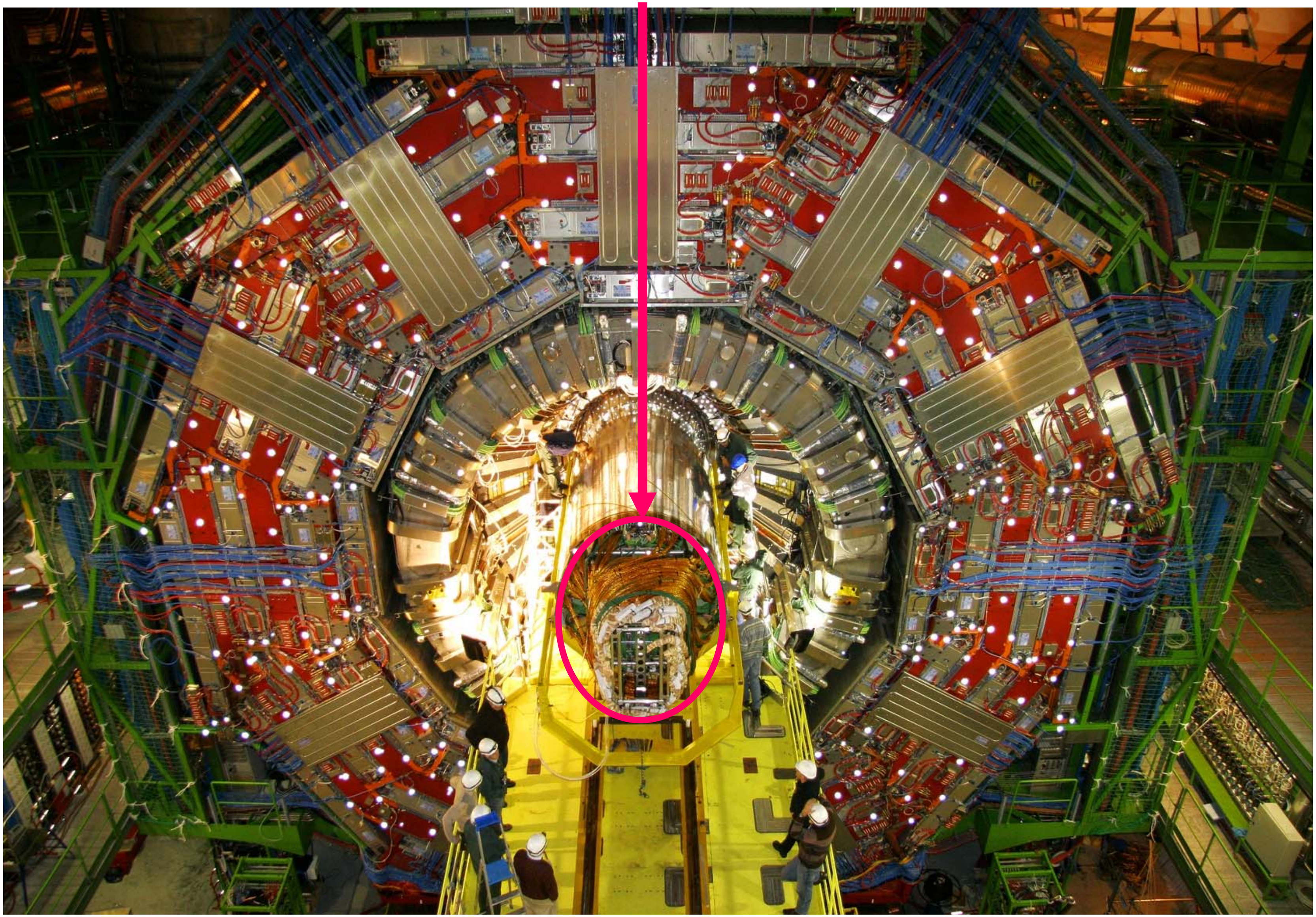
View into the open CMS detector – the **innermost cylinder** houses the silicon detector that measures the tracks of charged particles. The group at UTK contributes to this detector's operation and systematic studies. We also instrument the beam pipe below it with diamond detectors to protect it against adverse beam conditions.

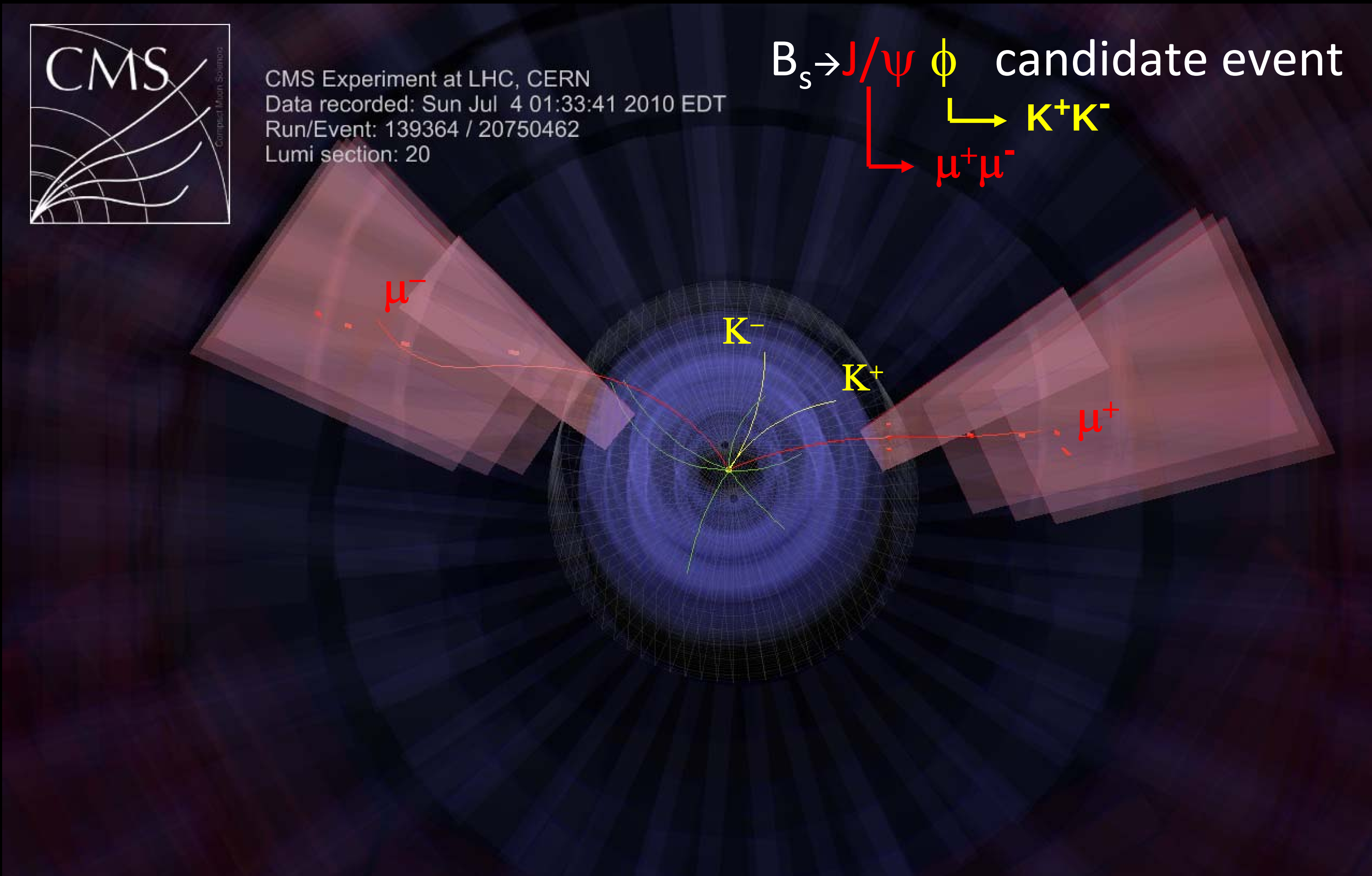


The B_s particle is produced in proton-proton collision with the Large Hadron Collider (LHC). It is observed in its decay into two particles, J/ψ and ϕ, that in turn decay into longer lived charged particles that can be detected by sub-detectors of the CMS experiment. The hit positions along the particle trajectories measured by several layers of particle track detectors are input to a track reconstruction algorithm. The reconstructed particle tracks are displayed on the next page.

The tracks in red correspond to the two particles from the sub-sequent decay of the J/ψ particle – the two particles are muons, particles that are abundant in the cosmic radiation. The yellow tracks correspond to the so-called kaons from the ϕ particle. The red and yellow tracks intersect at the point where the Bs particle decayed – this happens somewhat displaced from the point where the protons collide due to the long lifetime of this B_s particle. This displaced vertex is a distinct signature and allows to identify it. The green tracks are other by-products of the collision.

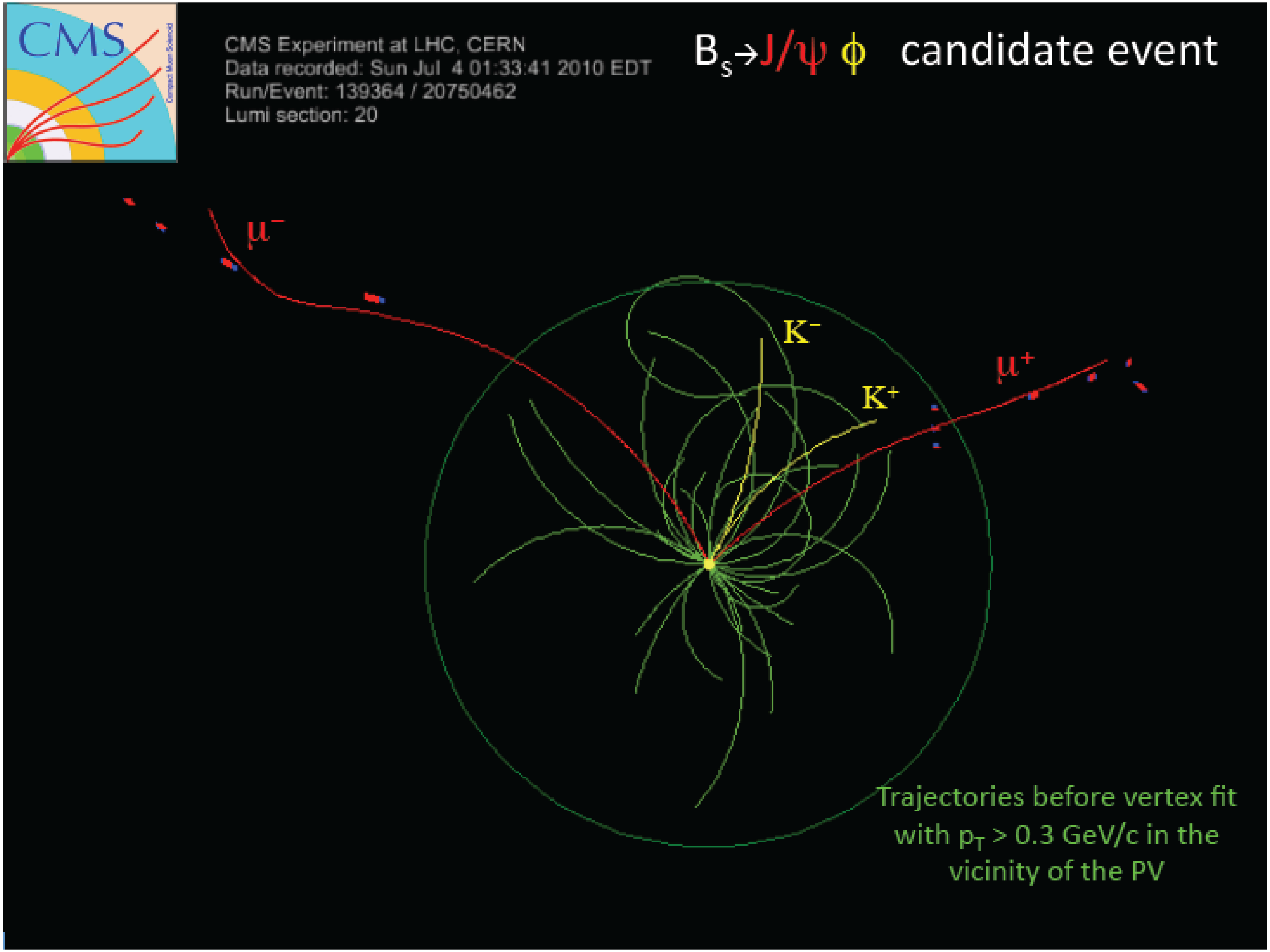
The Bs particle and its peculiar decay are of interest for us to study a fundamental symmetry that might explain how the apparent matter anti-matter asymmetry occurred during the evolution of the Universe starting from the Big-Bang.

$B_s \rightarrow J/\psi\ \phi$ candidate event

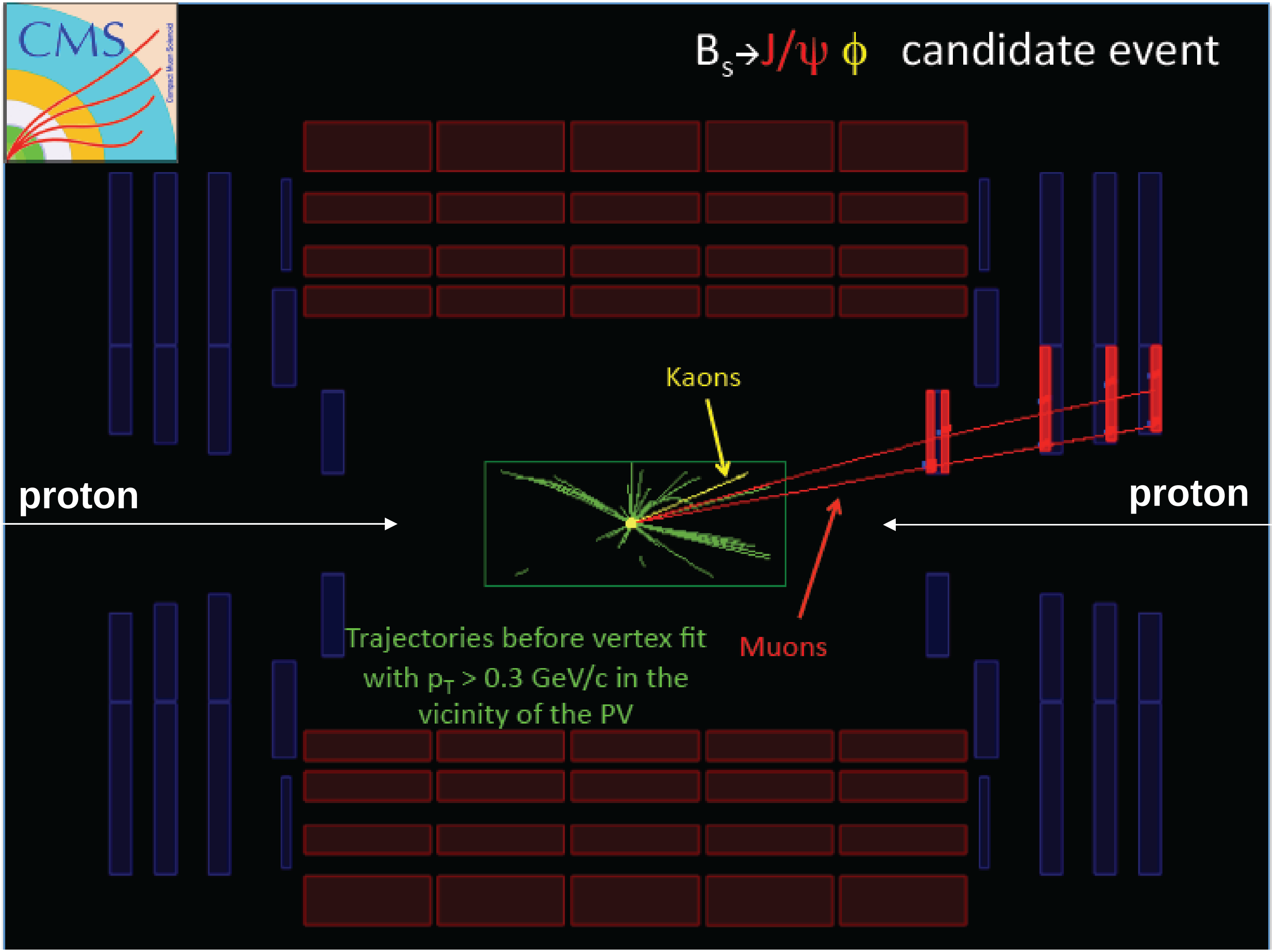


View along the proton beam – protons collided at the yellow point in the center.
Reconstructed charged particle tracks and hits in the outer muon detectors.

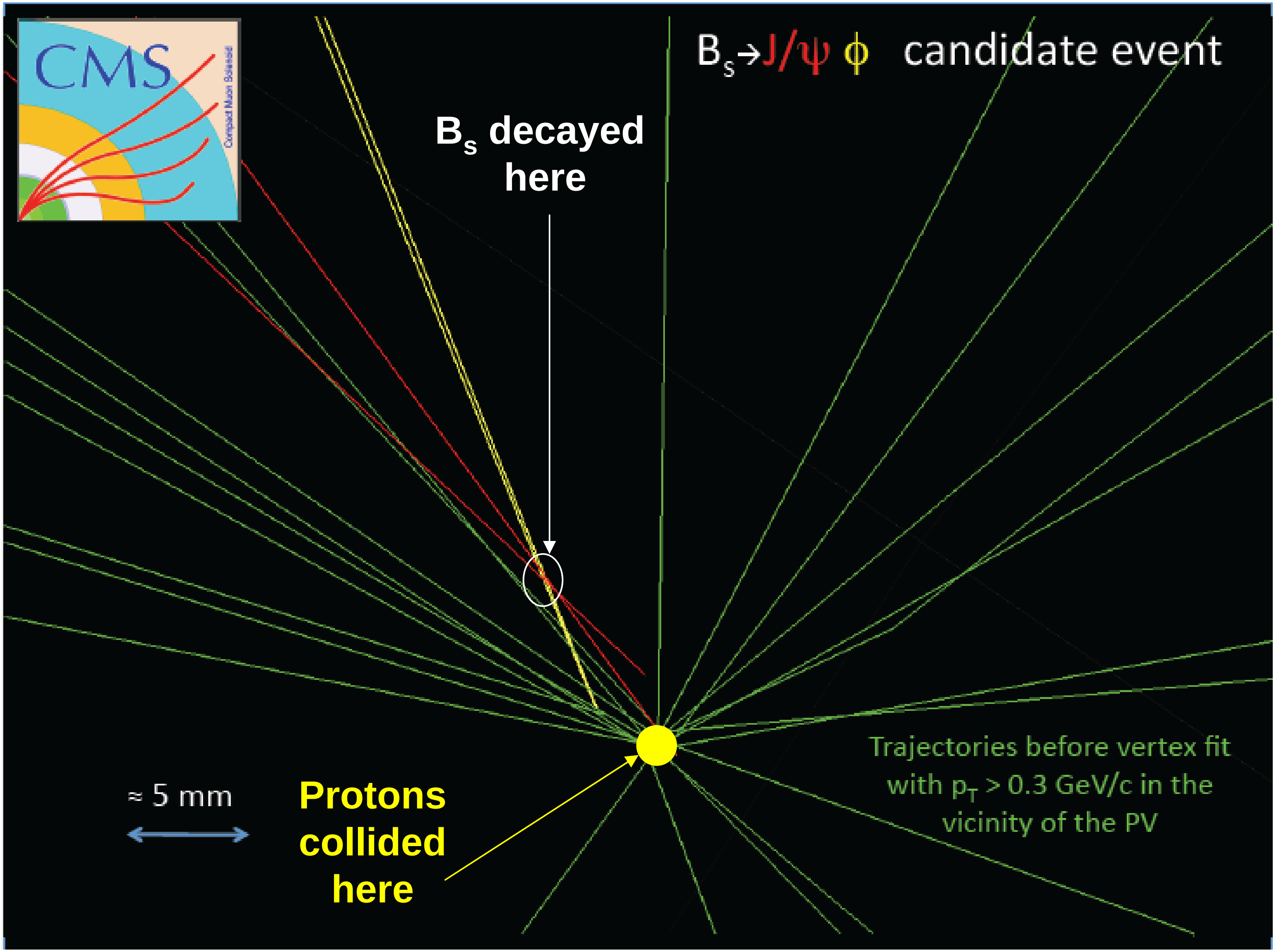
View along the proton beam



Side-view of the CMS detector



Zoom into the production region



The B_s particle was created on July 4th, 2010, in the CMS detector, and found soon thereafter by our graduate student Giordano Cerizza. He was able to measure several parameters that confirm the nature of this decay.

The particle moves with relativistic speed. Therefore its proper lifetime of only 1.5 10^{-12}s is dilated so that it travels nearly 5mm in the detector before it decays.

Measured parameters:

$Mass(J/\psi K^+K^-) = 5346.5\ MeV/c^2$
$Mass(\mu^+\mu^-) = 3104.3\ MeV/c^2$
$Mass(K^+K^-) = 1018.57\ MeV/c^2$
$B^{vtx}\ Prob. = 0.78$
$Proper\ decay\ length = 895 \pm 50\ \mu m$
$ct/\sigma_{ct} = 17.8$
$\beta\gamma = 5.9$

$p(\mu^+) = 15.5\ GeV/c\ (global)$
$p(\mu^-) = 7.6\ GeV/c\ (global)$
$p_T(\mu^+) = 2.9\ GeV/c\ (global)$
$p_T(\mu^-) = 2.1\ GeV/c\ (global)$
$p_T(K^+) = 1.4\ GeV/c$
$p_T(K^-) = 2.2\ GeV/c$