Search for Exotics with LHCb

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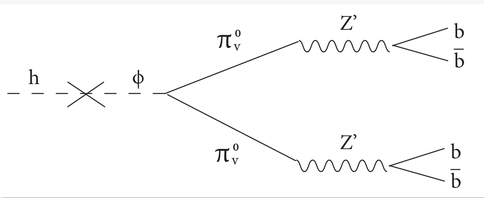
on behalf of the LHCb collaboration

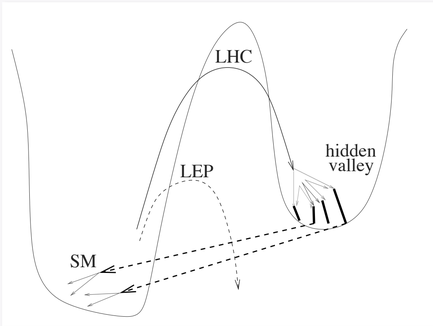
Theoretical motivation

Several models for Physics beyond the Standard Model predict the existence of new massive particles decaying into Standard Model particles. Two examples :

- neutralinos in mSUGRA with baryon or lepton number violation
- neutral π^0_v particles in the Hidden Valley (HV) framework with a non-abelian gauge symmetry (benchmark model)

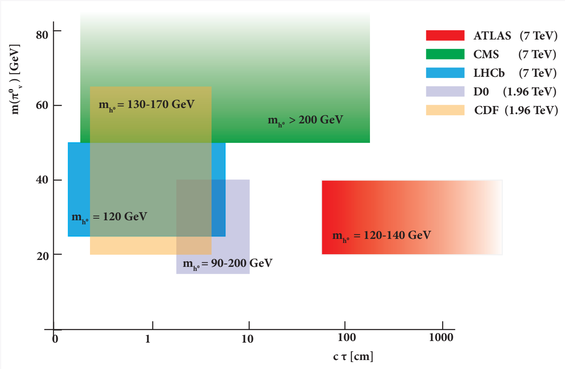


Long-lived particles can be produced in pairs through Higgs decay H-> π^0_v π^0_v, π^0_v ->qqbar



Massive particles with a lifetime between 1 ps and 1 ns can be identified by their displaced decay vertex. In particular, π^0_v candidates are identified by two hadronic jets originating from a displaced vertex.

LHCb has a unique coverage for long-lived particles with small mass and lifetime

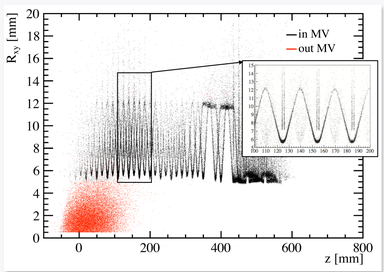


Event selection and analysis

Search for π^0_v with a mass between 25 and 50 GeV/c² and a lifetime between 1 and 200 ps for a SM-like Higgs particle mass of 120 GeV/c².
Measurement performed with 0.62 fb^{-1} of data collected in 2011.

Displaced vertex (DV) selection:

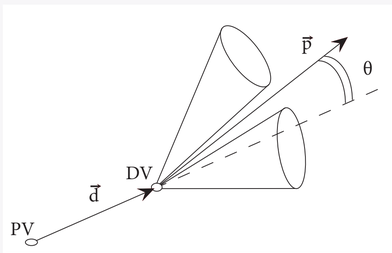
- DV are identified by combining charged tracks.
- DV are selected with a minimal distance R_{xy} from the beam line and a minimal invariant mass m_{vtx}
- vertices are rejected when reconstructed in the detector material (Matter Veto MV)
- at least 6 tracks per vertex, with a sum of the scalar p_T of tracks > 3 GeV/c



Jet reconstruction:

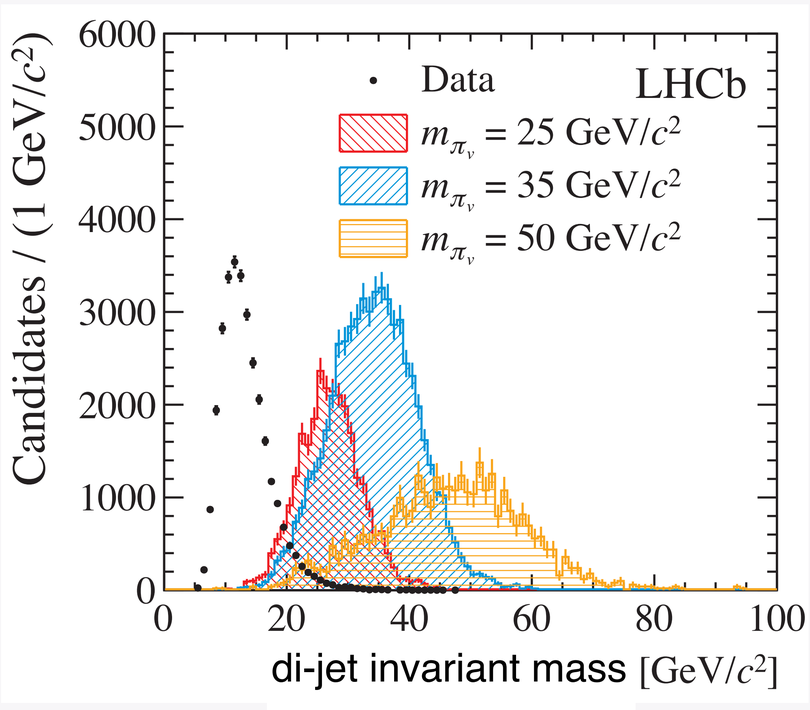
Anti-k_T algorithm with a cone size of 0.7.

- two jets with p_T > 5 GeV/c
- Only candidates with m_{corr}/m > 1/0.7 and a distance between the two jets of ΔR < 2.2 are selected



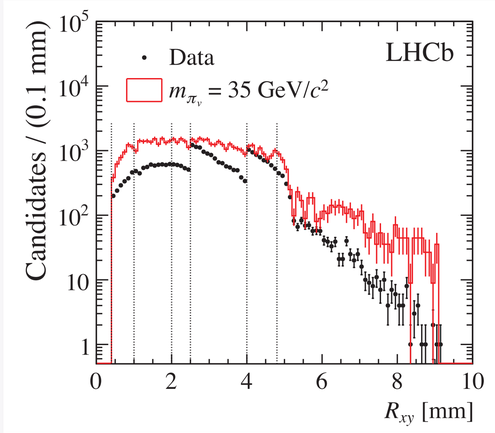
$$\frac{m_{corr}}{m} = \sqrt{1 + \left(\frac{p}{m}\sin\theta\right)^2} + \frac{p}{m}\sin\theta$$

Data compatible with the expected background from bbbar production

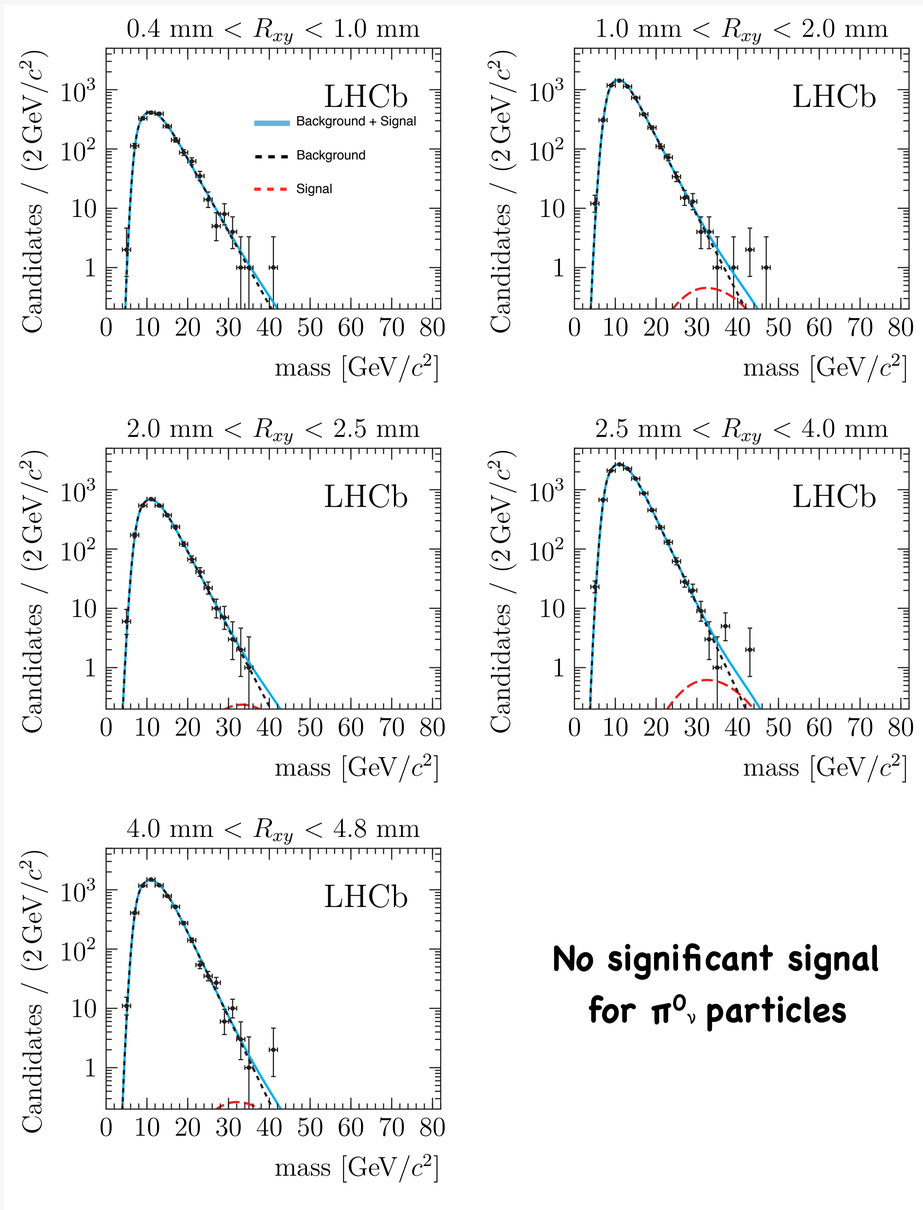


Results

The shape of the background invariant mass distribution, the selection efficiency and the background yield depend on the radial displacement R_{xy}.
Therefore, the signal yield is extracted by a fit of the invariant mass distribution in five bins of R_{xy} (0.4-4.8 mm) and with a minimal m_{vtx}.



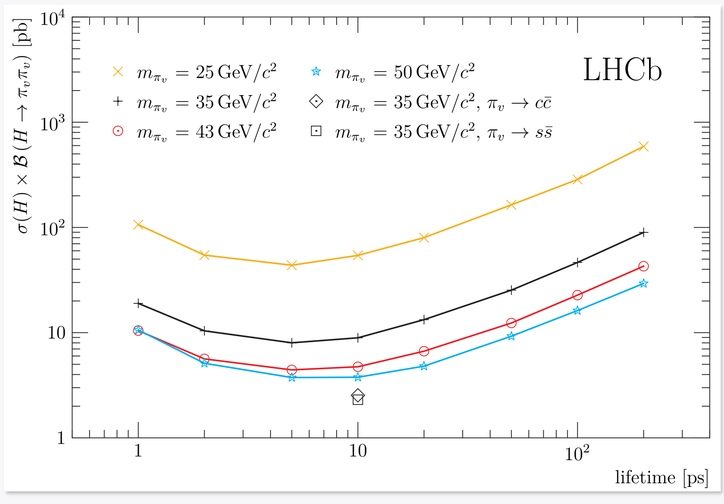
- Background is modelled by an exponential convolved with a bifurcated Gaussian.
- The signal is modelled by a bifurcated Gaussian (parameters obtained from simulation)



No significant signal for π^0_v particles

Limits

The systematic uncertainty on the selection efficiency and integrated luminosity for the different models is in the range 12.6% to 13.3% .
Upper limits on the production cross-section at 95% CL are extracted using the CL_s method.



The results cover an **unexplored** region at the LHC and the limites are **more restrictive** than results from the Tevatron in the same mass and lifetime range.
Branching fractions of greater than 25% are excluded for a SM Higgs to pair produce π^0_v particles that decay to two hadronic jets.

LHCb-PAPER-2014-062. Search for long-lived particles decaying to jet pairs. submitted to EPJC, 9 December 2014. arXiv:1412.3021 [hep-ex]