How to detect b's at the LHC?

$b \to cW^*$

m_b ? $m_c + m_W$

$4.2\,\text{GeV} < 81.3\,\text{GeV}$

how does this happen?

$\Delta E\,\Delta t \sim \hbar$

$m_W > m_b$

→ W is virtual!

$m_W = m_b - m_c \simeq 3\,\text{GeV}$

$W \to u\bar{d},\ u\bar{s}$

W → Light flavor jets.

Particle	Mass
u	2.16 MeV
d	4.67 MeV
s	93.4 MeV
c	1.27 GeV
b	4.18 GeV
t	172.69 GeV
W	80 GeV
Z	91 GeV

Why a displaced vertex?

Since b decays primarily by $b \to cW^*$ it has a narrow width, and a long lifetime.

$\tau \sim 10^{-12}\,s.$ $\quad \gamma c\tau = 10(10^8)(10^{-12}) \sim 10^{-3}\,m$

$$|V_{CKM}| = \begin{bmatrix} V_{ud} & V_{us} & V_{ub} \\ V_{cd} & V_{cs} & V_{cb} \\ V_{td} & V_{ts} & V_{tb} \end{bmatrix} \approx \begin{bmatrix} 0.974 & 0.225 & 0.004 \\ 0.225 & 0.973 & 0.042 \\ 0.009 & 0.041 & 0.999 \end{bmatrix}$$

$$\text{Prob}(W \to 12) \propto |V_{12}|^2 \qquad 1 = u, c, t \quad 2 = d, s, b$$

$b \to cW$ $\quad (0.04)^2 \sim 10^{-4} \sim 0.01\%$