ANTIPROTON PRODUCTION

- Production mechanism: pair production

$$p + p \rightarrow p + p + \boxed{p + \bar{p}}$$

E	m	m	m	m	m	energy
p	0	0	0	0	0	momentum

- Threshold energy in laboratory:
  - Relativistic invariant: length of 4-vector $P^\mu = (E,p)$
    - Energy and momentum conversation: $P_\mu P^\mu = p^2 - E^2$
    - After: $E_{tot} = 4\ m_p$, $p_{tot} = 0$: $P_\mu P^\mu = -16\ m_p^2$
    - Before: $E_{tot} = E + m_p$, $p_{tot}^2 = E^2 - m_p^2$: $E^2 - m_p^2 - (E + m_p)^2$
    - $E^2 - m_p^2 - (E + m_p)^2 = -2m_p^2 - 2m_pE = -16\ m_p^2$
    - $E = 7\ mp = T + mp$: $T = 6\ mp = 5.63$ GeV
  - Bound protons: Fermi momentum -> threshold lowers to 4.3 GeV