Comments on Several FTF Annihilation Model Parameters

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General Information (I)

- Our attention to anti-baryons, among other reasons, is prompted by interest from Mu2e in modeling annihilation of anti-protons (FTF)

- For about a year there have been several (email) discussions that involved, at different times, a several people from Geant4 as well as interested users

- One of the recent points to discuss was production of pions in anti-proton annihilation on nuclei (Mu2e background study)

- We understand that there is interest in anti-protons from other experiments (AD experiments at CERN, astro-particle experiments,…), be it modeled by FTF or perhaps by an alternative model

Simplistic Overview of G4FTFAnnihilation (I)

- **Subject to correction by experts** (Vladimir Uzh., sorry if there is any mistake here !)
- Modeling annihilation can be done via one of the following four scenarios:
  - "3-shirt" diagram (three quark-antiquark strings)
  - diquark-antidiquark string formation
  - two quark-antiquark strings
  - one quark-antiquark string
- The concept is the same for annihilation at rest or in flight although numerically there may be some differences
- Each scenario can be selected randomly according to the cross-section associated to it
- NOTE: Strings are subsequently fragmented but this is outside of the annihilation code

# Simplistic Overview of G4FTFAnnihilation (II)

- The cross-sections of the possible scenarios are defined through a collection of numeric parameters

- Such parameters, different sets for annihilation at rest or in flight, are currently hardcoded in G4FTFParameters class code, and **duplicated** within G4FTFAnnihilation

- There is one difference though: **in G4FTFAnnihilation the cross-section for the diquark-antidiquark string formation is set to zero**, thus the scenario is turned off, most likely because it's very CPU heavy.

- Varying the above mentioned parameters, and respectively the cross-sections, is likely to affect modeling of secondaries coming from the annihilation process; e.g. momentum spectra of secondary pions are likely to be sensitive.

Varying FTF/Annihilation Parameters by Hand
Data: C. Amsler and F. Myher, Ann. Rev. Nucl. Part. Sci. 41, 219 (1991)
C.B. Dover et al., Prog. Part. Nucl. Phys., Vol.29, pp.87-173 (1992)

pbar annihilation on H
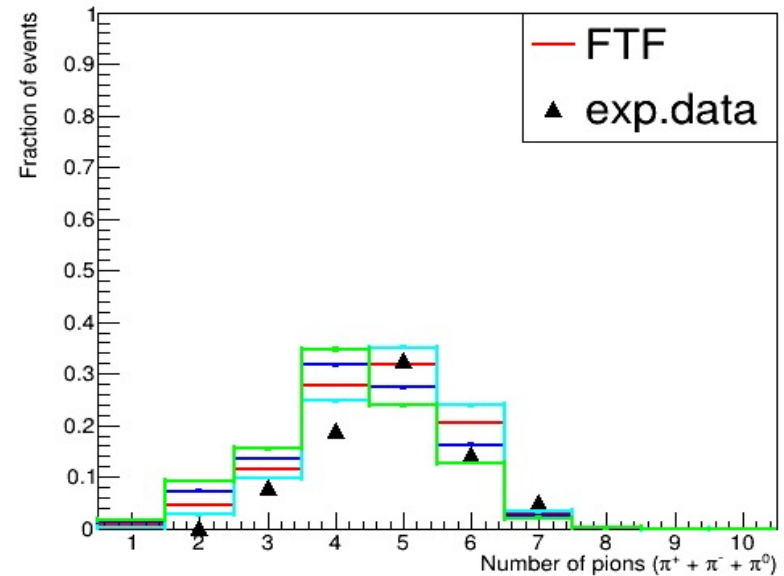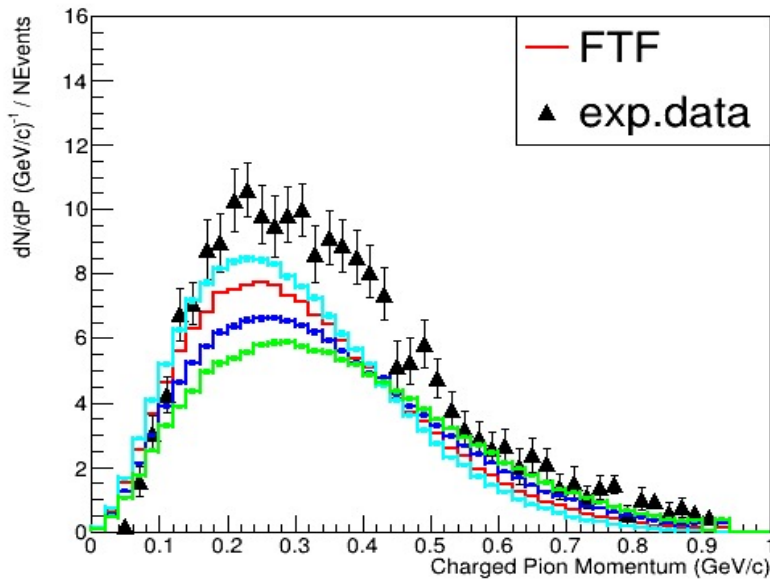
Increasing the probability of two quark-antiquark strings formation by a factor of 5

Turning OFF two quark-antiquark strings formation and one quark-antiquark string formation

Turning OFF "3-shirt" diagram and the probability of two quark-antiquark strings formation by a factor of 5

(Instead of) Summary

- **If agreed with FTF developers**, G4FTFAnnihilation can be updated to pick up the parameters in question from G4FTFParameters; and some (or maybe all) of these parameters can be made configurable through G4FTFParameters and G4HadronicDeveloperParameters, for further exploring

- Unrelated to FTF annihilation model but still related to FTF handling interactions of antibaryons, one can also make configurable the switch that turns ON/OFF nuclear destruction process at energy below 2 GeV

    - Of specific interest to Mu2e