Meson Production at Low Proton Beam Energy (Update)

X. Ding, UCLA

Target Studies
May 9, 2013

Introduction

- Recent interest in neutrino factory staging scenarios with a 3 GeV proton beam;
- Meson Production at low proton beam energy (below 4 GeV) seems higher for Ga than Hg from our previous simulation.

(1) X. Ding et al., http://www.hep.princeton.edu/~mcdonald/mumu/target/ipac12/MOPPC044.pdf

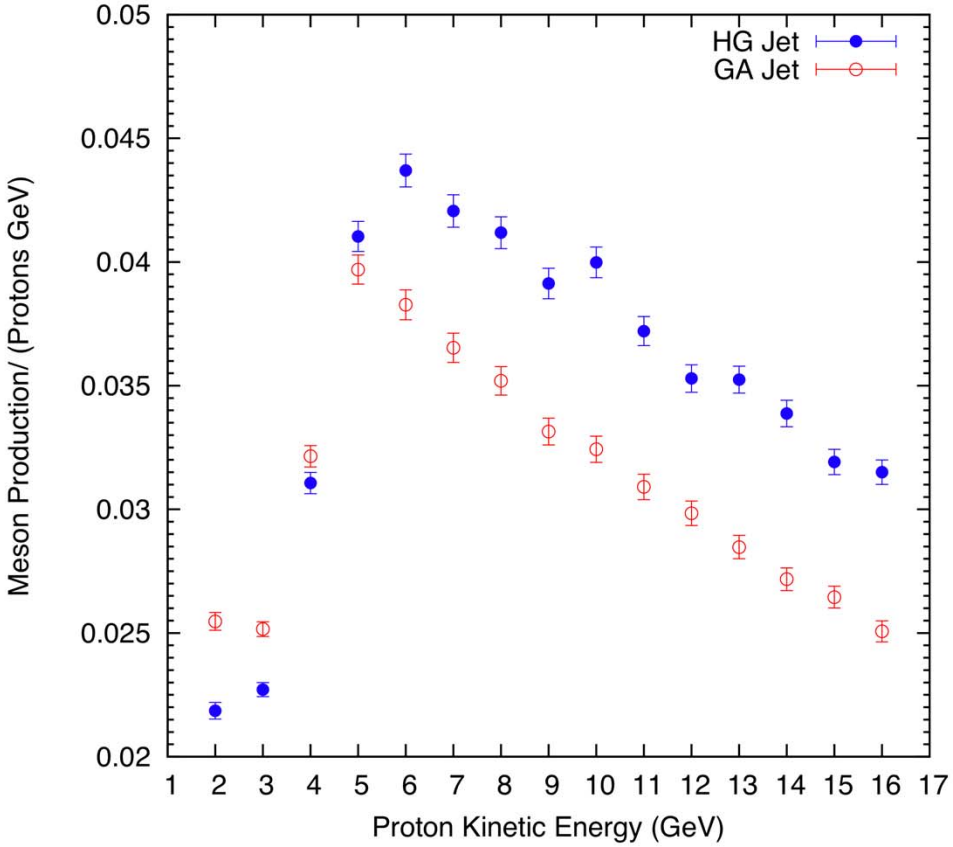
(2) J. Back et al., http://www.hep.princeton.edu/~mcdonald/examples/accel/back_prstab_16_021001_13.pdf

Introduction (Cont'd)

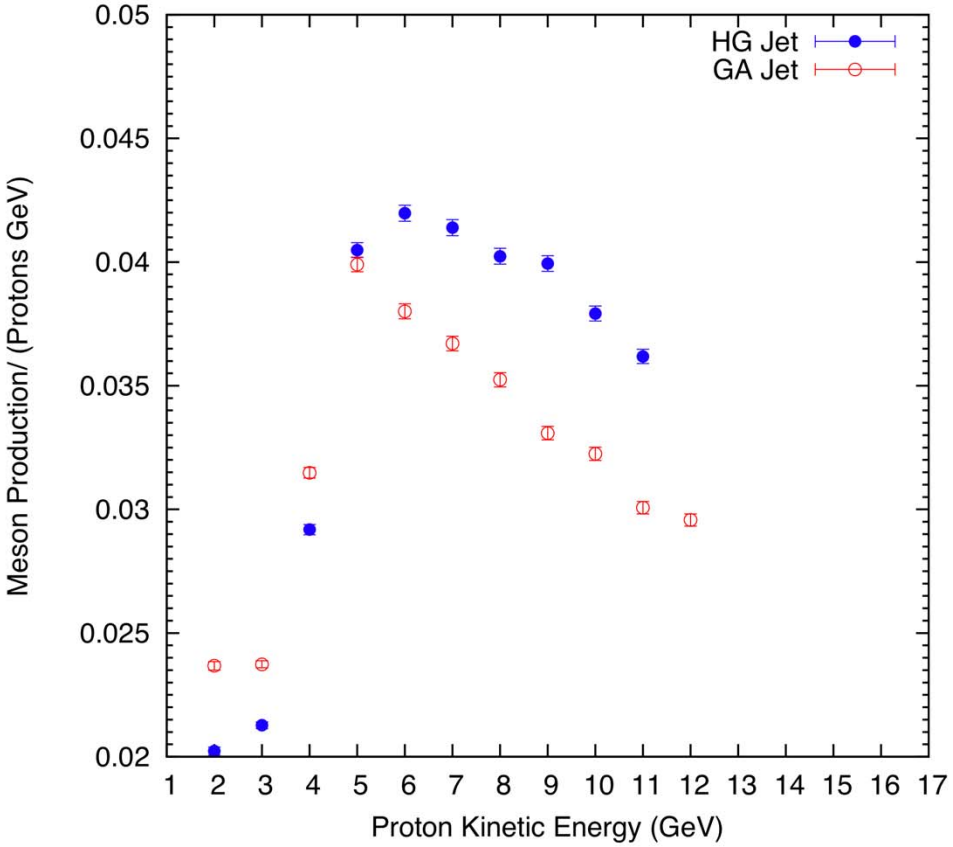
- Projects (Project X et al.) to be run at 3 GeV proton beam will be very interested in the possible reality of such "higher" points.
- Considerable effort has to be taken to assess our confidence on this "hot topic" of excess of Ga over Hg for proton beam below 4GeV.

Review of our simulations

- X. Ding et al., IPAC12/MOPPC044.pdf

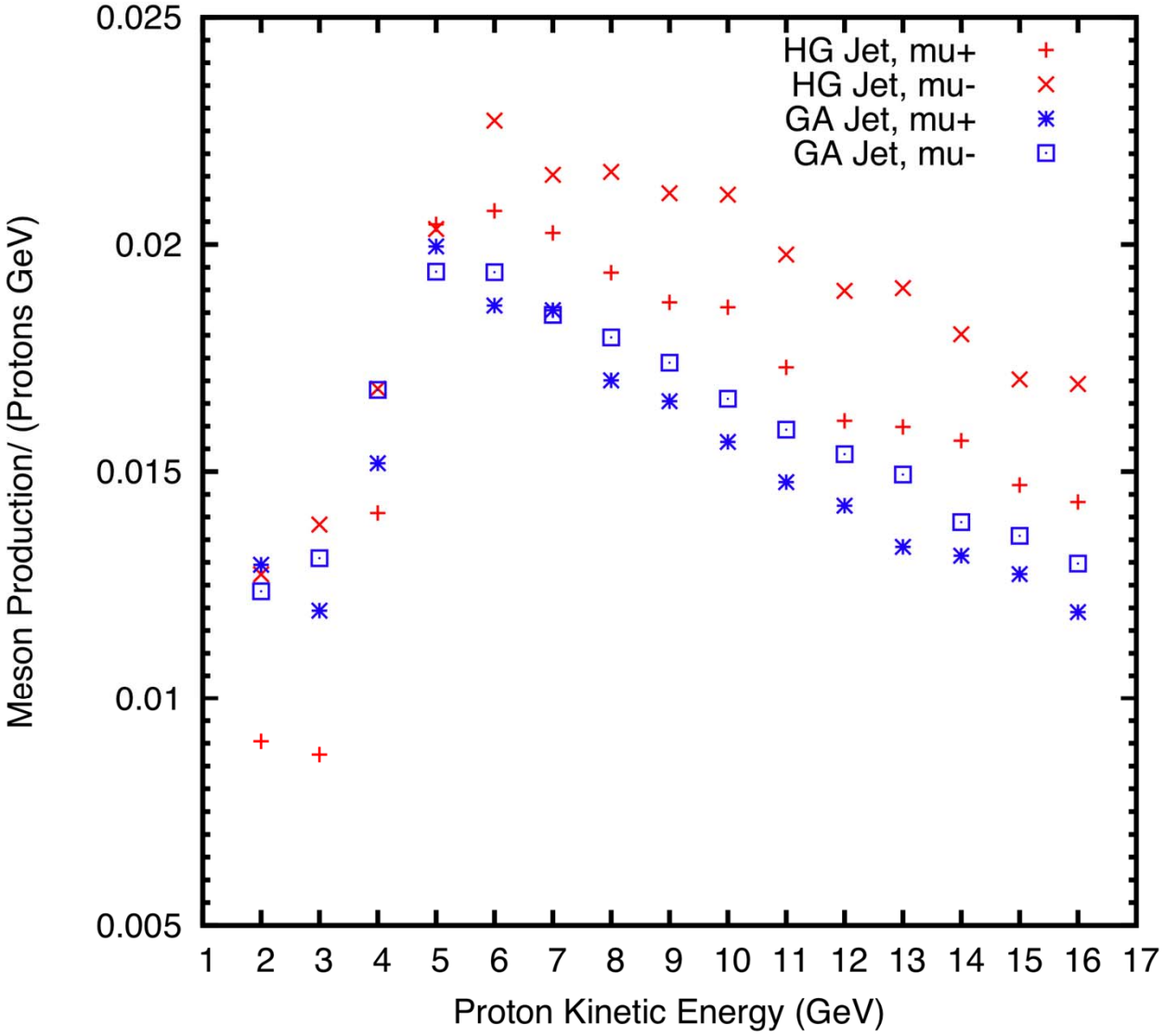


MARS15 (2010)



MARS15 (2012)

Review of our simulations (Cont'd)



2GeV Proton Beam:

Hg jet: mu+, 1809
mu-, 2547

Ga Jet: mu+, 2589
mu-, 2473

3GeV Proton Beam:

Hg jet: mu+, 2625
mu-, 4150

Ga Jet: mu+, 3582
mu-, 3927

At 2 and 3 GeV, we see more mu+ for Ga than Hg jet, but almost same mu- for both Ga and Hg.

Review of J. Back's simulation using FLUKA

Plot is of average of μ^+ and μ^-

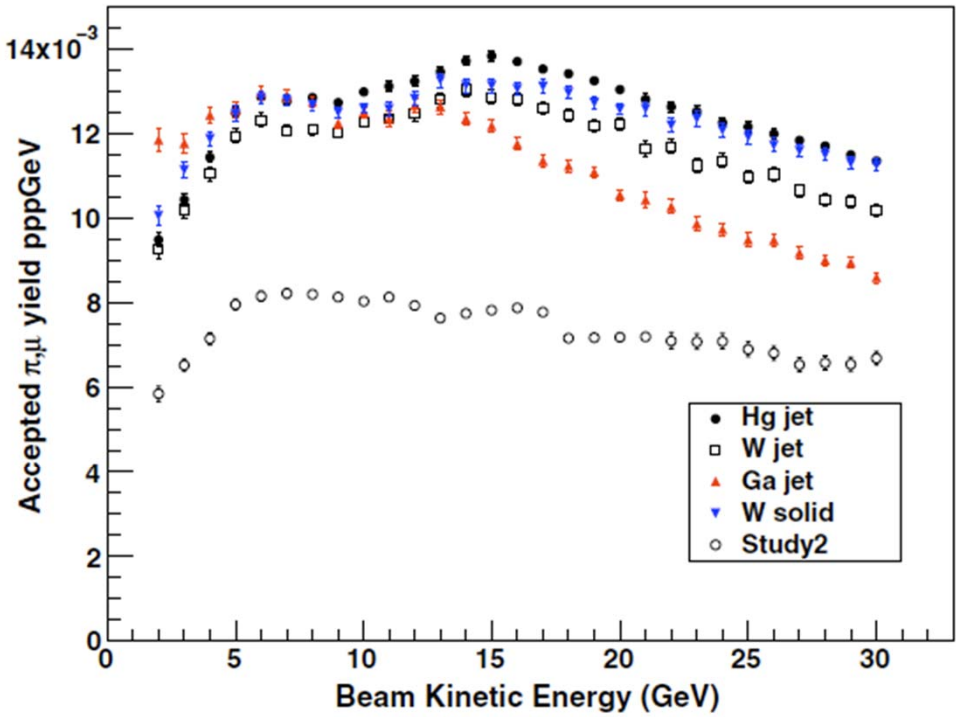


FIG. 6. The charged-averaged accepted pion and muon yield per proton per GeV for various targets in the new increased shielding geometry. Also shown are the equivalent yields for the mercury jet target in the Study 2 geometry.

(1) Yields are a factor of ~1.5 below MARS15;

(2) Meson Production below 4 GeV also shows higher for Ga than Hg;

(3) No significant drop in production when proton beam KE decreases under 5 GeV.

Future Work

- We plan to study the production of the forward beam onto a “Disk” target at 2, 3 and 4 GeV and compare the difference between Ga and Hg.
- We need to compare the analysis code between John and us for the meson counting.
- Repeat optimization at low KE is necessary but difficult due to high deflection in the SC field. We maybe can’t find a peak for the crossing angle of beam/jet as a function of beam KE and so on. High statistics is also required.

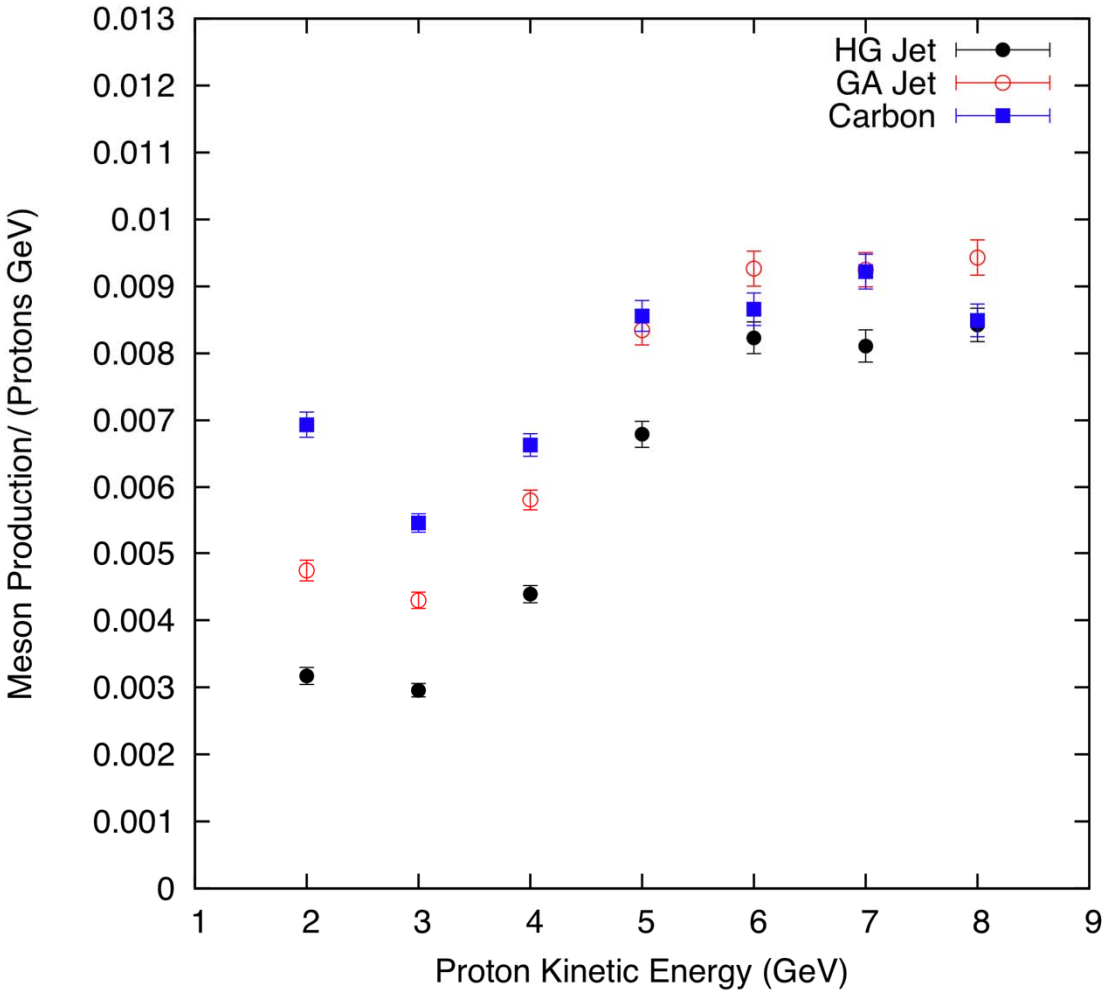
MARS vs. FLUKA

- Same setting (Study2, 8GeV, 18m, 1.25T);
- Same parameter: 0.5 (negYield+posYield);
- Mars15(2007)/0.01786 pppGeV,
  MARS15(2009)/0.01804 pppGeV,
  MARS15(2012)/0.01817 pppGeV;
- FLUKA/0.013 pppGeV;
- Factor of 1.4 (~1.5 in slide 6) for MARS vs. FLUKA

Running speed of MARS15 (2012)

- ENRG E0 EM EPSTAM EMCHR EMNEU EMIGA EMIEL
- E0: The incident particle kinetic energy
- EM: The hadron threshold energy (Default: 0.0145 GeV)
- EPSTAM: The star production threshold kinetic energy (Default:0.03 GeV)
- EMCHR: The threshold energy applied collectively to muons, heavy ions and charged hadrons (Default: 0.001 GeV)
- EMNEU: The threshold energy for neutrons (Default:10^{-4} GeV)
- EMIGA: The threshold energy for γ (Default:10^{-4} GeV)
- EMIEL: The threshold energy for $e^{\pm}$ (Default: $5*10^{-4}$ GeV)
- "ENRG 8.0" results in slow speed in m1512 (fast in m1510)
- "ENRG 8.0 0.02 0.03 0.01 0.05 0.01 0.01" gave about the same production as "ENRG 8.0" with ~ 1/10 the running time.

Preliminary Comparison



Target:
Cylinder shape;
Radius of 7.5 cm (large);
Thickness: C 86 cm
HG 30 cm
GA 48 cm
Interaction Nuclear Length
C/42.9 cm; HG/14.58 cm;
GA/23.92 cm

Proton Beam: zero radius and launched at the disk center of frontend of disk