Comparison between MARS1507 and MARS1510 at CERN & BNL

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MARS installation

- MARS1507:
  - last update 21-July-2009 at CERN.
  - benchmarked on x32 but not on x64 architecture.
  - comparison with m1507 at BNL was giving different yields.
- MARS1510:
  - installed in 11-February-2011 at CERN.
  - 64x architecture only.
  - need small modifications in the .INP file in order to run (e.g., space after comment sign C needed).
  - comparison with m1510 at BNL also giving different yields.

m1507 & m1510 @CERN (1/)

- Run to run comparison - 10^5 protons - ST2 – 5-10 GeV beams – Biggest deviation of $|N_{1507} - N_{1510}|/N_{1507}$.

PID#	Name	0 m	50 m
1	p	3%	10 %
2	n	2%	-
3	π+	3%	7%
4	π-	2%	9%
5	K+	21%	-
6	K-	10%	-
7	μ+	19%	6%
8	μ-	13%	3%
9	γ	7%	-
10	e-	5%	5%
11	e+	10%	8%

PID#	Name	0 m	50 m
12	pbar	-	-
13	π0	-	-
14	d	11%	21%
15	t	-	-
16	3He	-	-
17	4He	-	-
18	νμ	8%	34%
19	νμbar	10%	39%
20	νe	13%	38%
21	νebar	42%	-
22	ντ	38%	-

Weighted yield > 100.

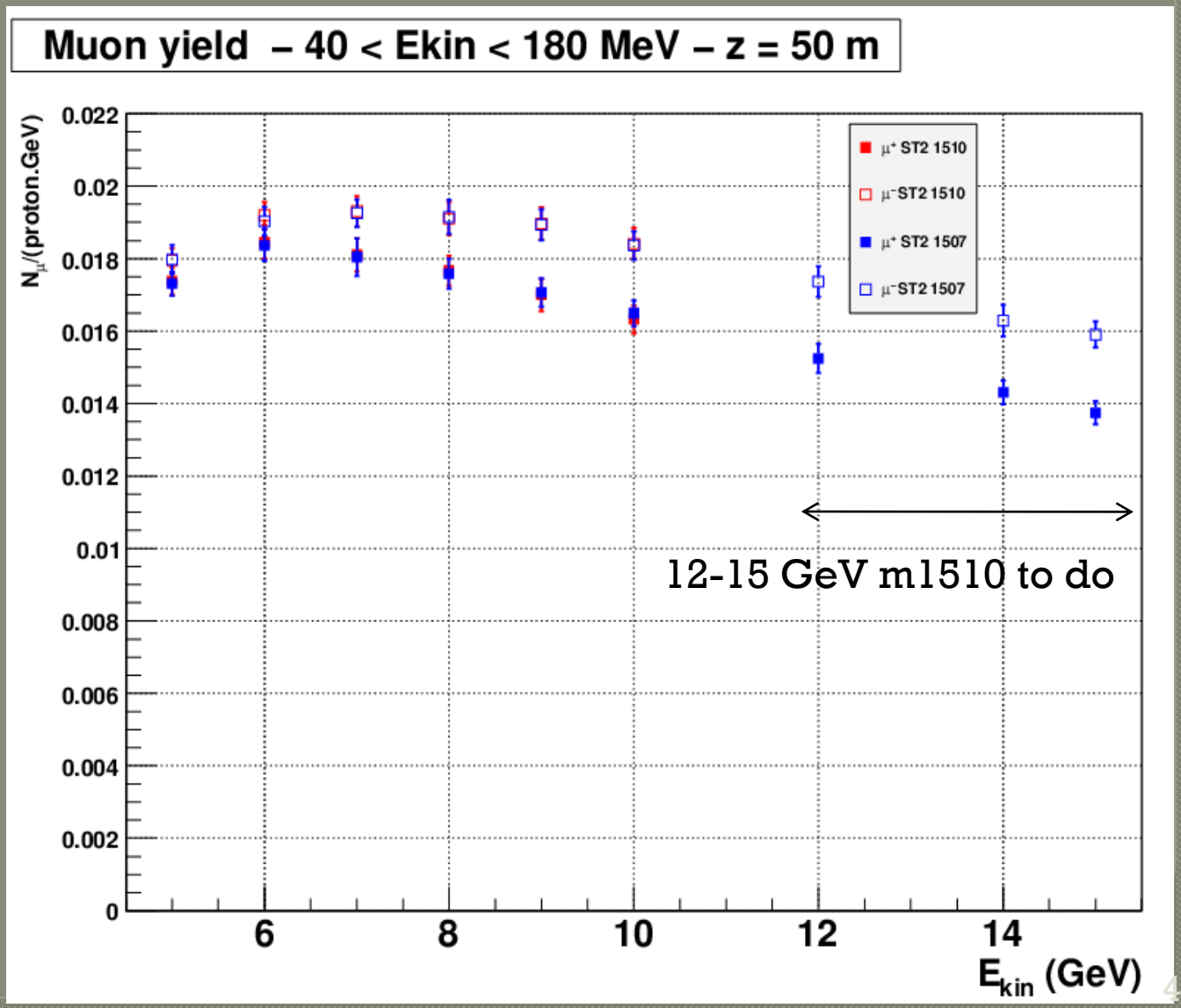
black < 5 % - green 5-10% - blue 10-20% - red > 20%

m1507 & m1510 @CERN (2/)

- Statistical fluctuation (σ for 50 runs with different random seeds) is ~2-3% (as for MARS1507).

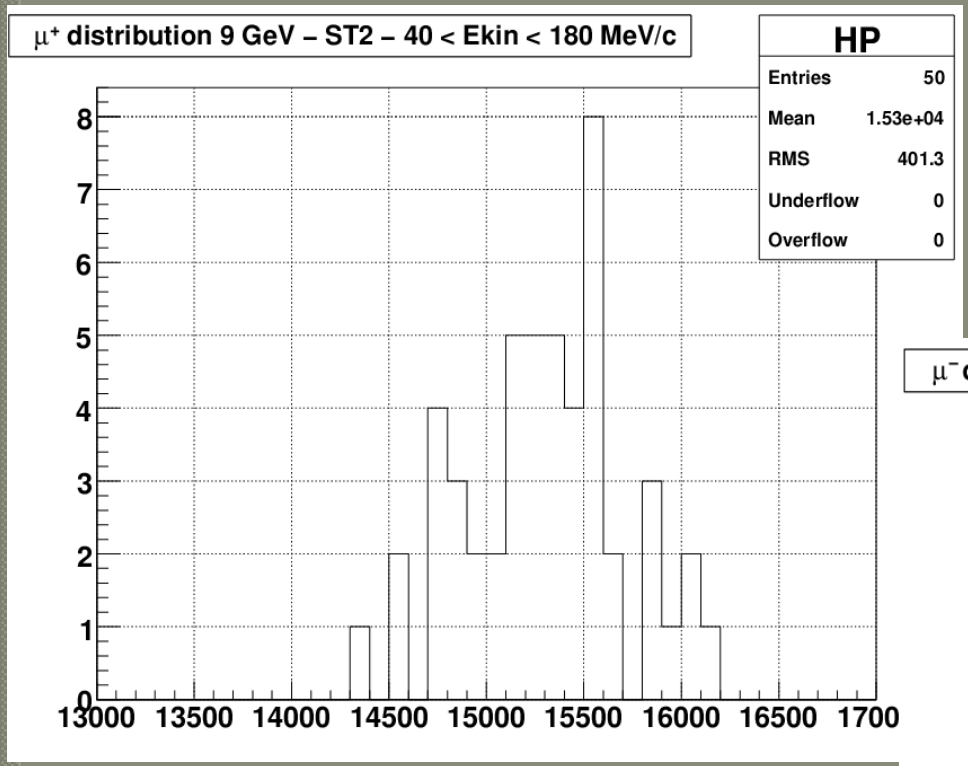
- Figure of merit for muons at 50 m.

Difference in versions within stat. errors.



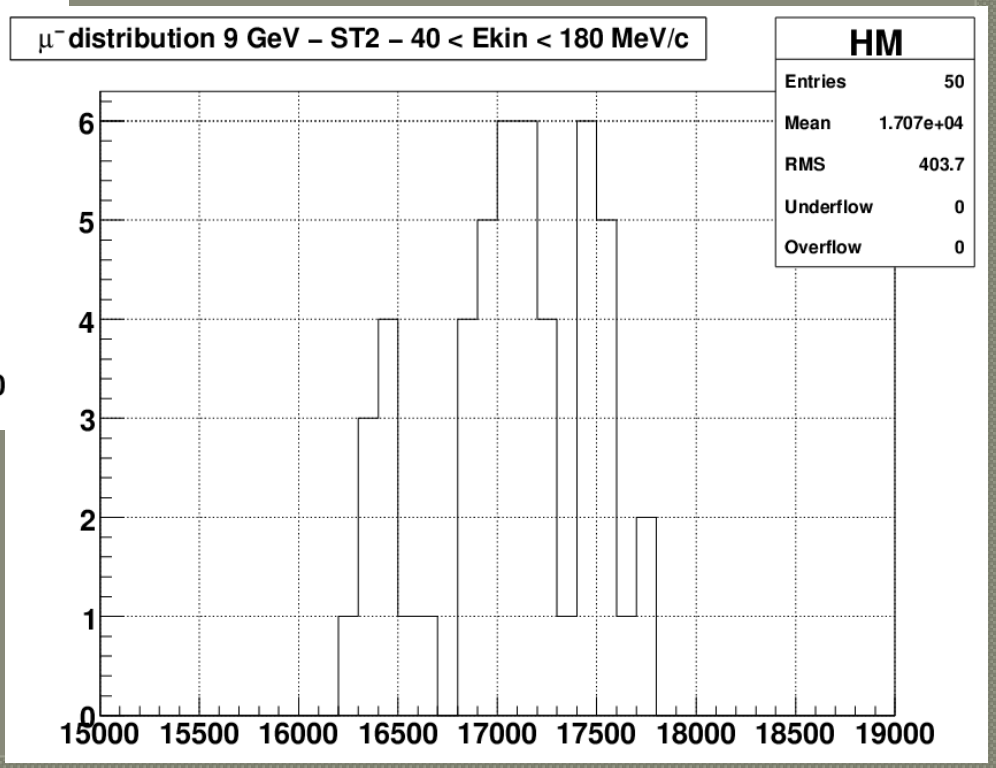
m1510 @CERN (1/)

- Checking particles distribution for 50 runs with different seeds.
- 5-10 GeV – ST2 at z = 50 m.



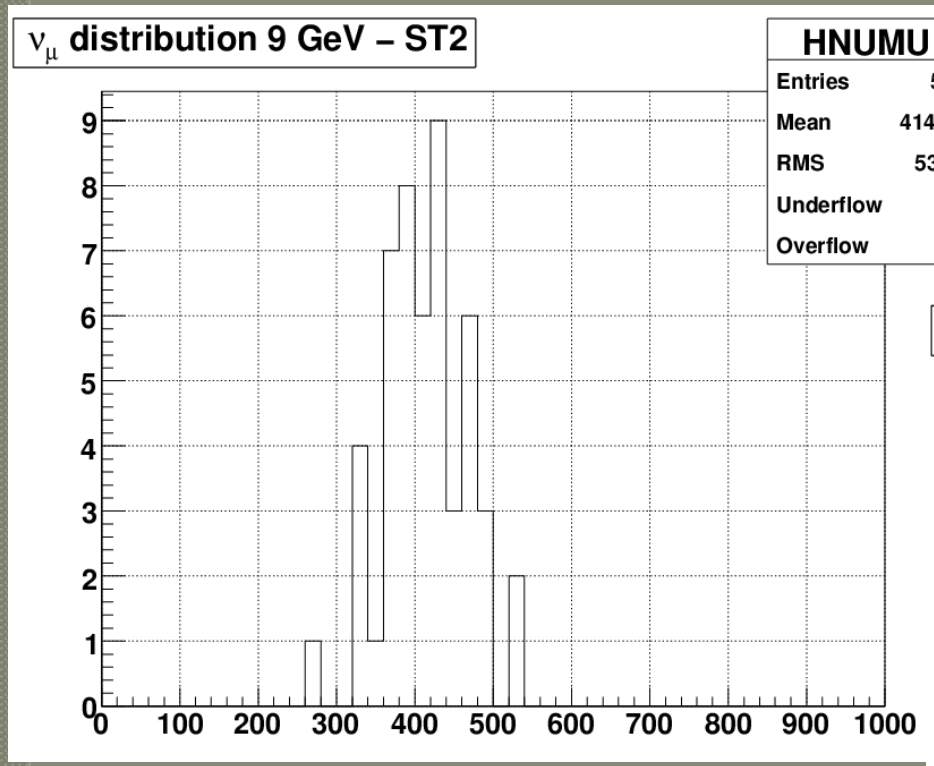
Standard deviation (σ) below 3% for the muons (within an energy cut).

Consistent across the beam energy range.

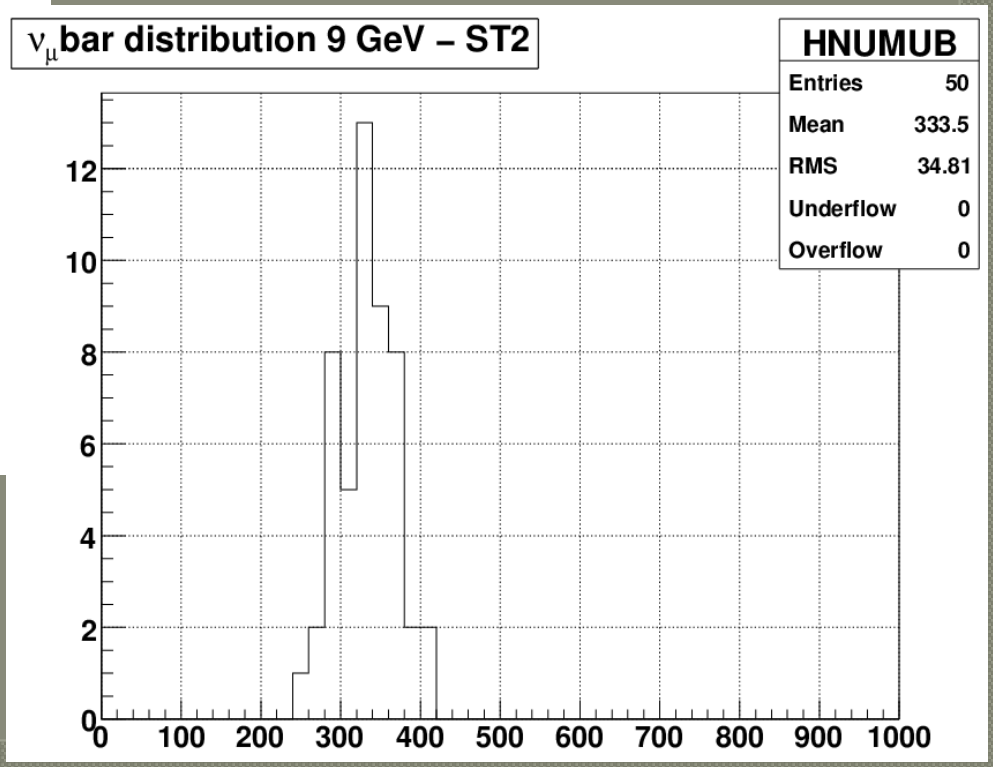


m1510 @CERN (2/)

- Checking particles distribution for 50 runs with different seeds.
- 9-10 GeV – ST2 at z = 50 m.
- ! I discovered a bug in my code, please ignore previous plots.



Standard deviation (σ) is 13% (νμ) and 10% (νμb).
Consistent across the beam energy range.

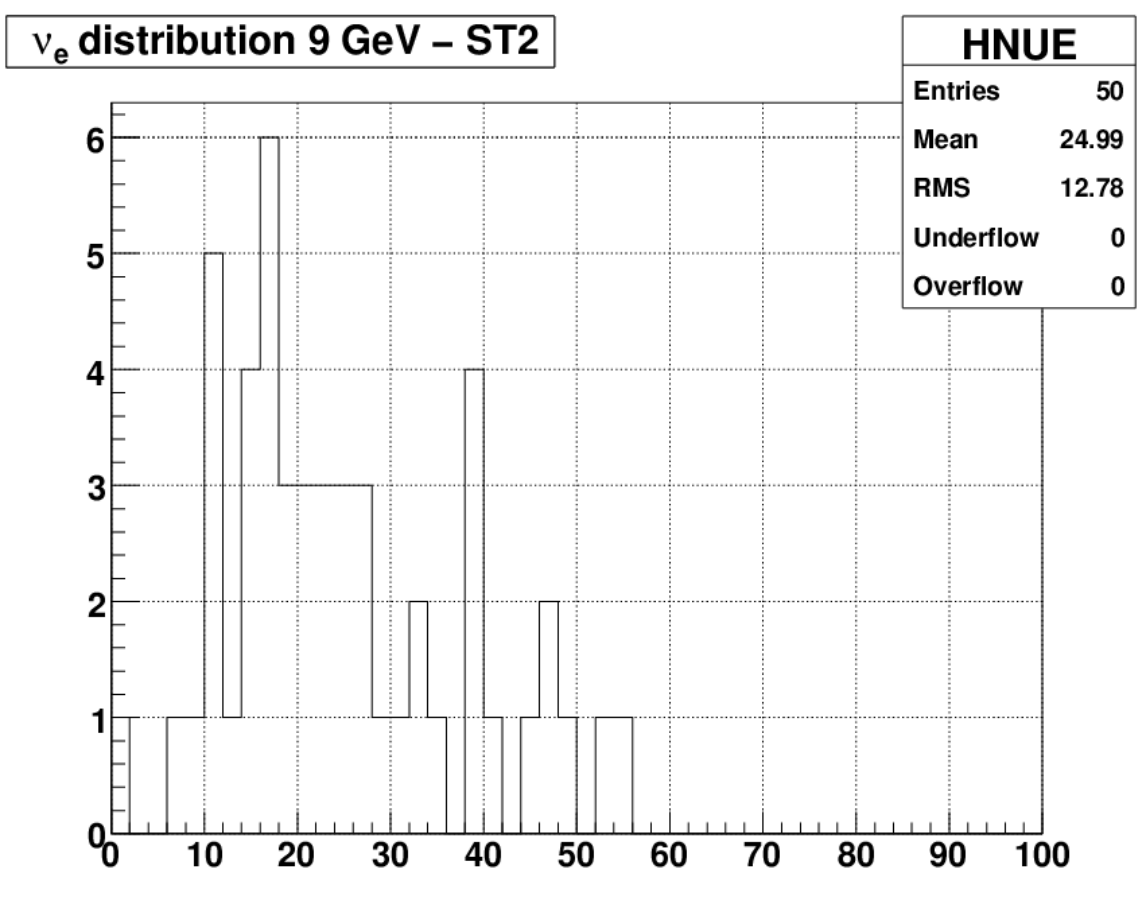


m1510 @CERN (3/)

- Checking particles distribution for 50 runs with different seeds.
- 9-10 GeV – ST2 at z = 50 m.
- ! I discovered a bug in my code, please ignore previous plots.

Standard deviation (σ) of 51%.

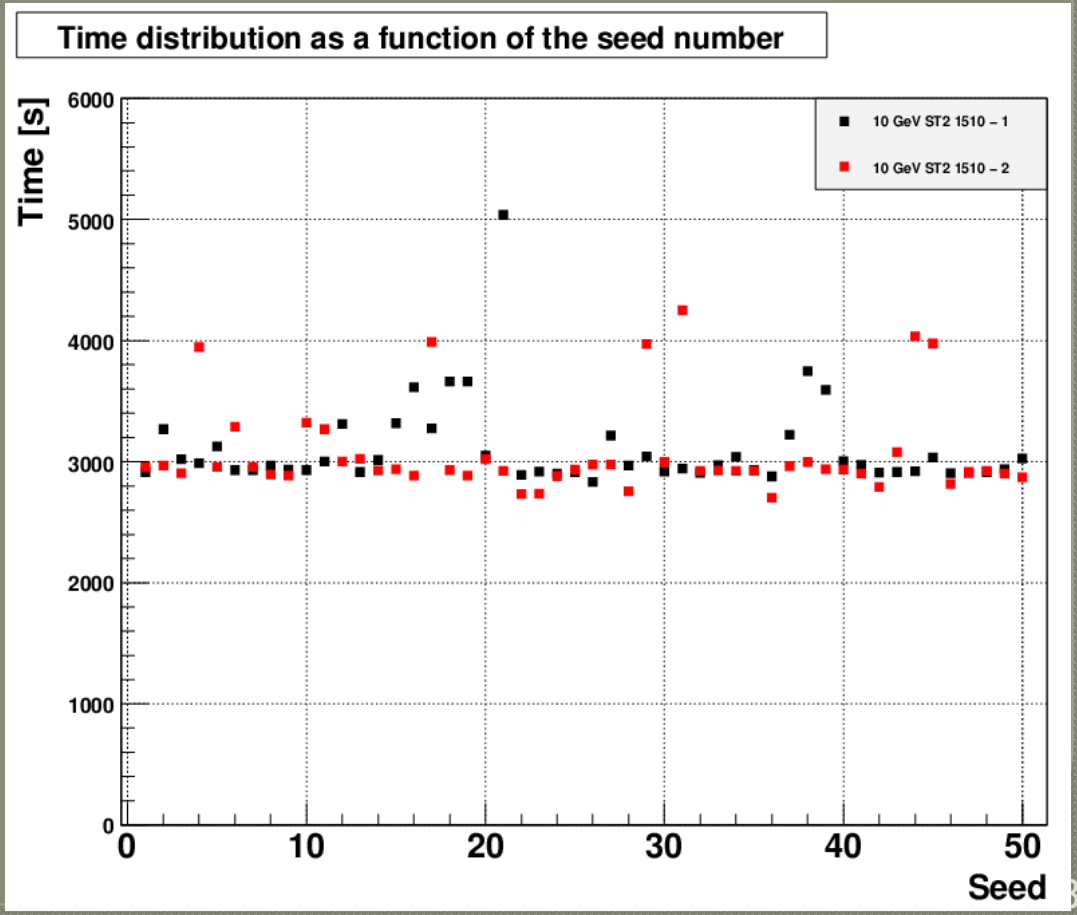
Consistent across the beam energy range.



Unfortunately cannot check back 1507 since the code is not available.

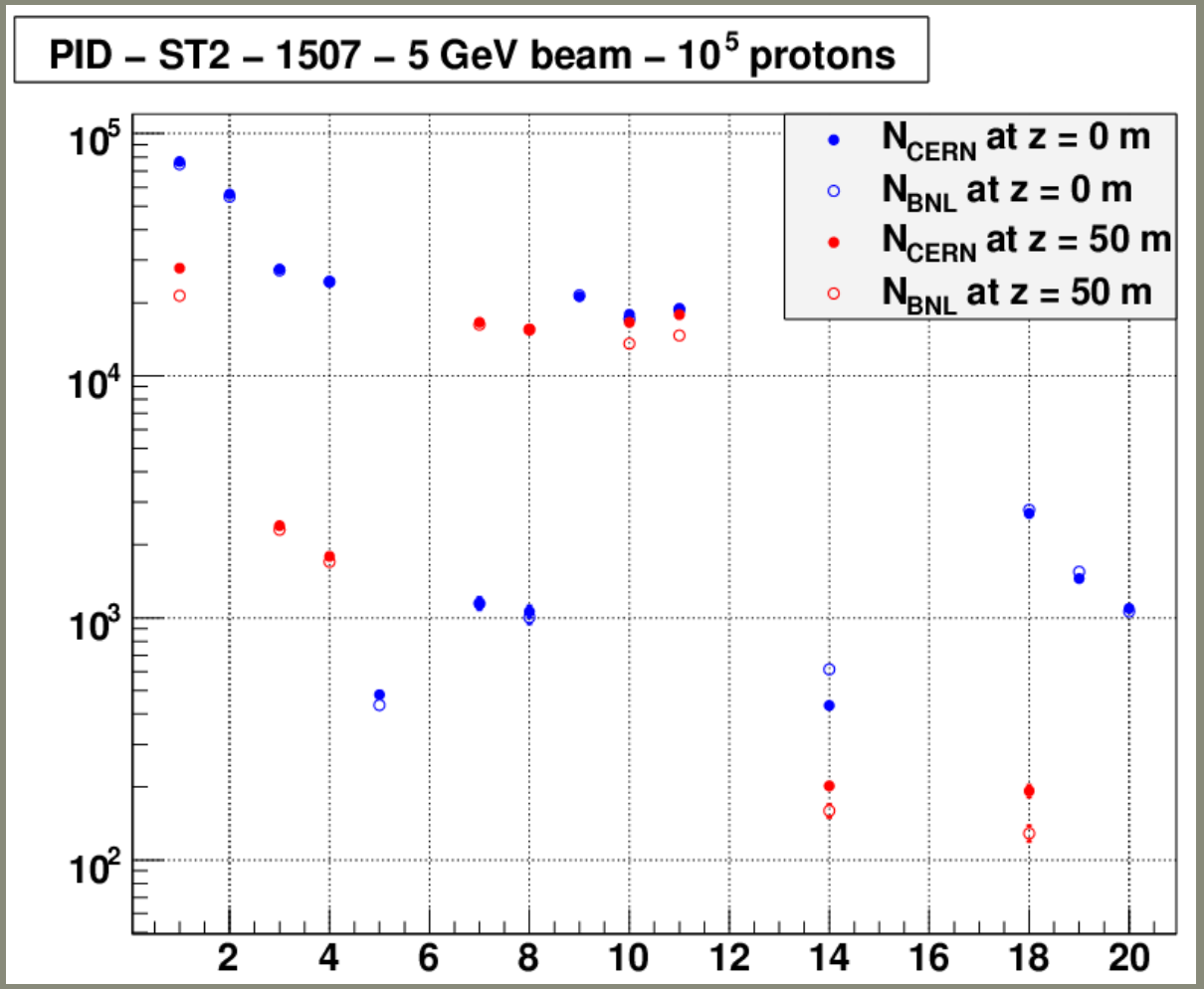
m1510 @CERN (4/)

- N. Souchlas noticed that some runs were taking longer.
- Checking length of the runs for each seed.
- 10 GeV – ST2.
- Some runs take 15 min or 35 min more but not depending on the starting seed value.



m1507 at CERN and BNL (1/)

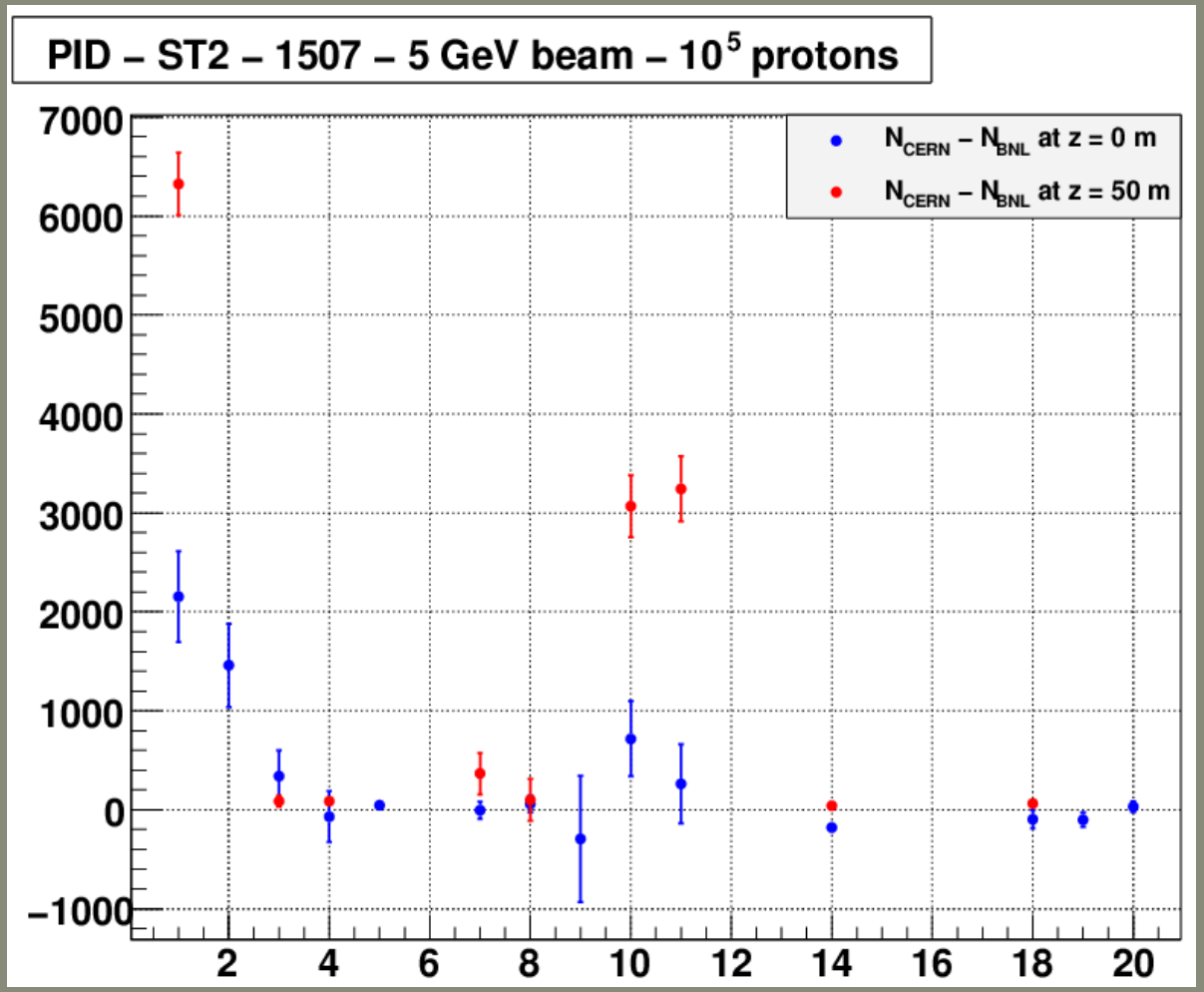
- 10^5 protons - ST2 – 5 GeV beam – N.



1 p - 2 n - 3 π^+ - 4 π^- - 5 K^+ - 6 K^- - 7 μ^+ - 8 μ^- - 9 γ - 10 e^- -11 e^+ - 12 pbar – 13 π^0 - 14 d
15 t – 16 ^{3}He – 17 ^{4}He - 18 $\nu\mu$ – 19 $\nu\mu$bar – 20 νe – 21 νebar – 22 $\nu\tau$

m1507 at CERN and BNL (2/)

- 10^5 protons - ST2 – 5 GeV beam – Diff = $N_{CERN} - N_{BNL}$.

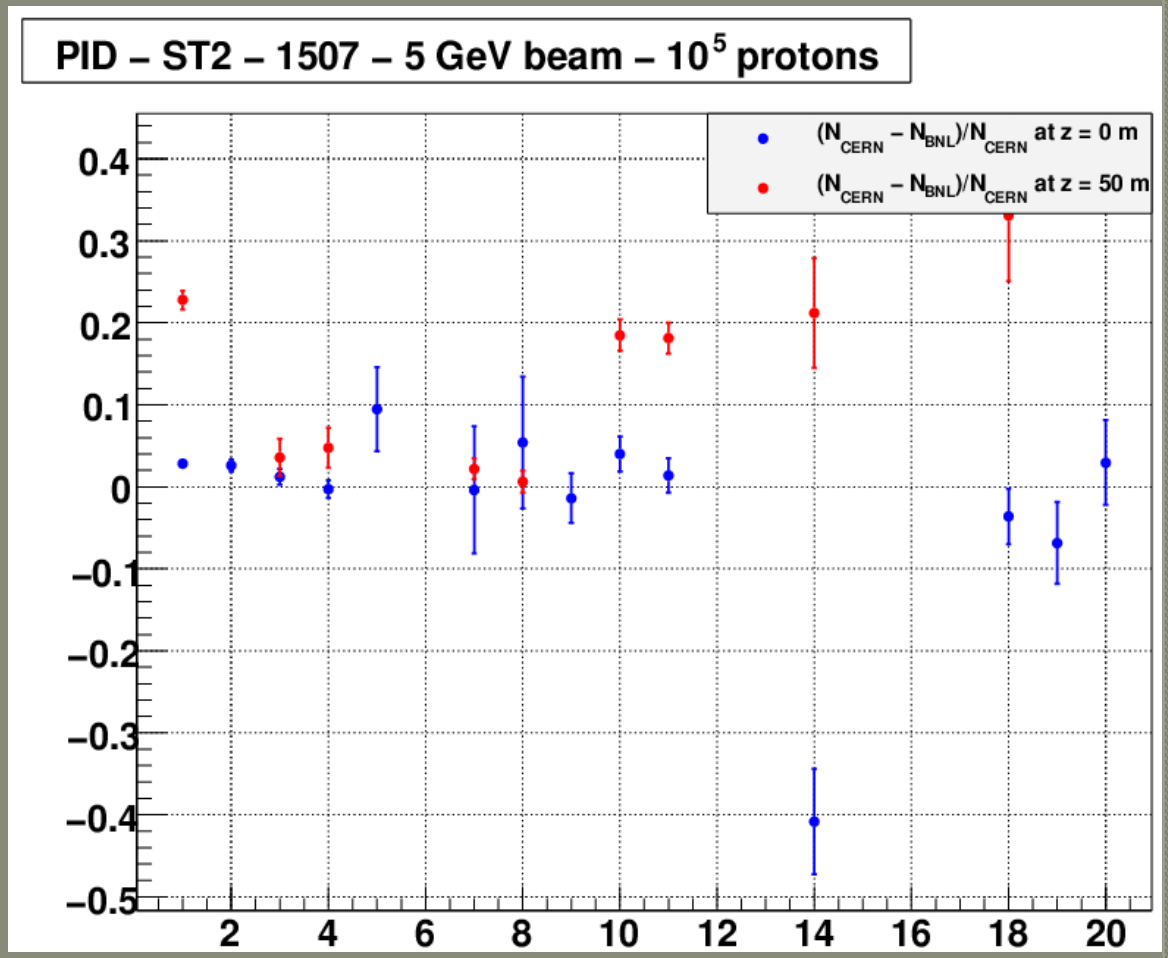


1 p - 2 n - 3 π^+ - 4 π^- - 5 K^+ - 6 K^- - 7 μ^+ - 8 μ^- - 9 γ - 10 e^- -11 e^+ - 12 pbar – 13 π^0 - 14 d 15 t – 16 ^{3}He – 17 ^{4}He - 18 $\nu\mu$ – 19 $\nu\mu$bar – 20 νe – 21 νebar – 22 $\nu\tau$

m1507 at CERN and BNL (3/)

- 10^5 protons – ST2 – 5 GeV beam.
- Frac = $(N_{CERN} - N_{BNL})/N_{CERN}$
- ! Some errors bars were missing in previous talk.

d (0 m), νμ (0 and 50 m) and p (50 m) difference not in agreement with statistics.



1 p - 2 n - 3 π^+ - 4 π^- - 5 K^+ - 6 K^- - 7 μ^+ - 8 μ^- - 9 γ - 10 e^- -11 e^+ - 12 pbar – 13 π^0 - 14 d 15 t – 16 ^{3}He – 17 ^{4}He - 18 νμ – 19 νμbar – 20 νe – 21 νebar – 22 ντ

m1507 at CERN and BNL (4/)

- 10^5 protons - ST2 – 5 -15 GeV beam max. of $|N_{CERN} - N_{BNL}|/N_{CERN}$.

PID#	Name	0 m	50 m
1	p	3%	25%
2	n	3%	-
3	π+	11%	7%
4	π-	4%	5%
5	K+	13%	-
6	K-	14%	-
7	μ+	10%	5%
8	μ-	10%	6%
9	γ	4%	9736%
10	e-	4%	19%
11	e+	7%	21%

PID#	Name	0 m	50 m
12	pbar	-	-
13	π0	-	-
14	d	41%	32%
15	t	-	-
16	3He	-	-
17	4He	-	-
18	νμ	7%	33%
19	νμbar	14%	32%
20	νe	19%	-
21	νebar	-	-
22	ντ	15%	-

Weighted yield > 100.

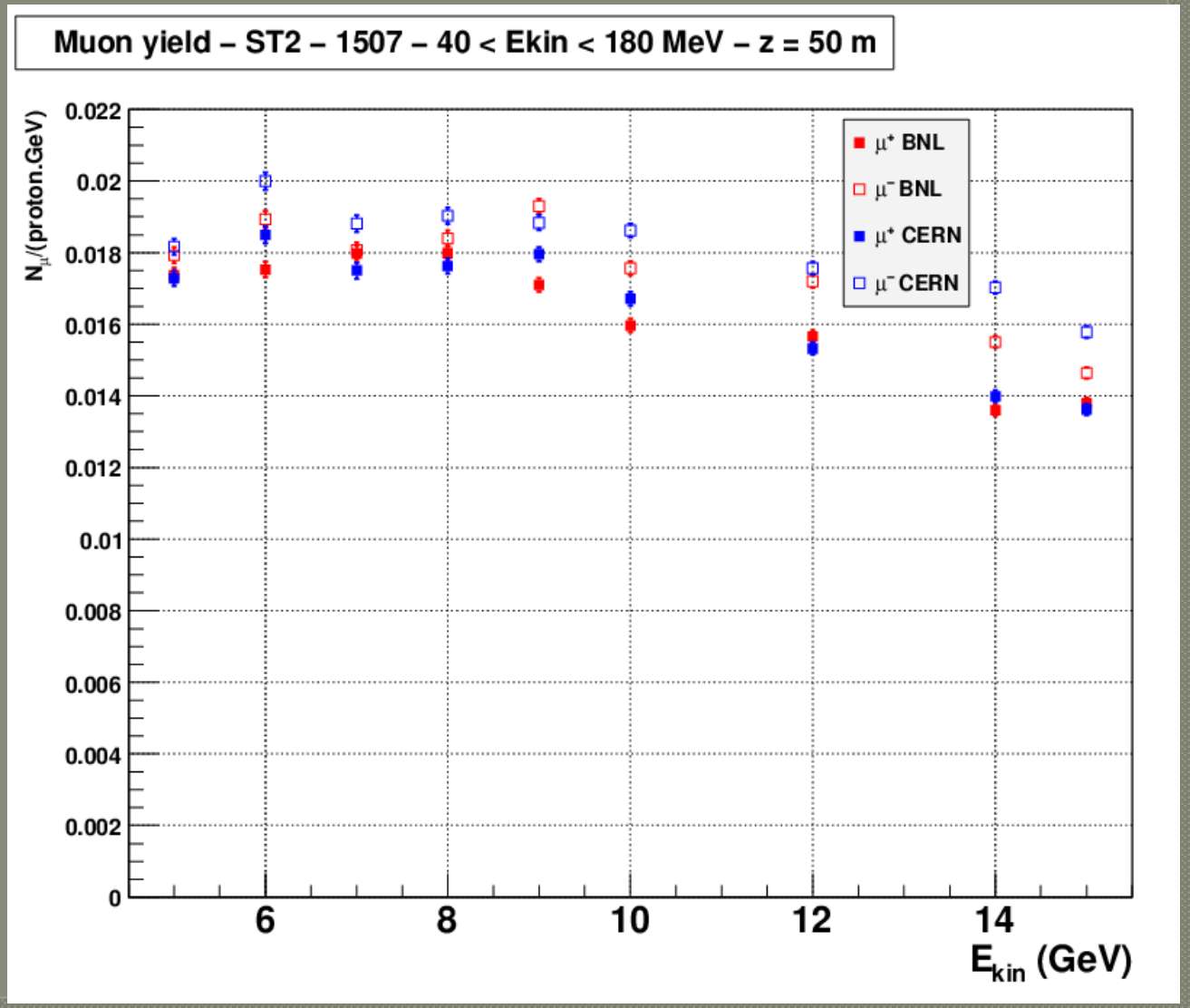
black < 5 % - green 5-10% - blue 10-20% - red > 20%

m1507 at CERN and BNL (4/)

- 10^5 protons - ST2 – run to run comparison:

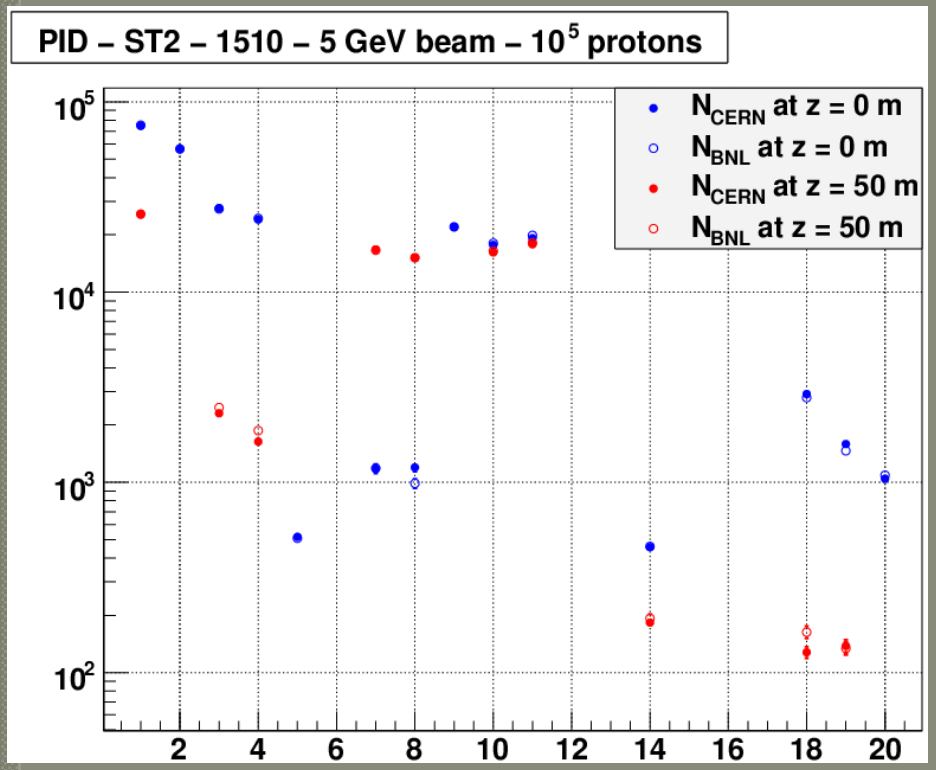
- Figure of merit at 50 m.

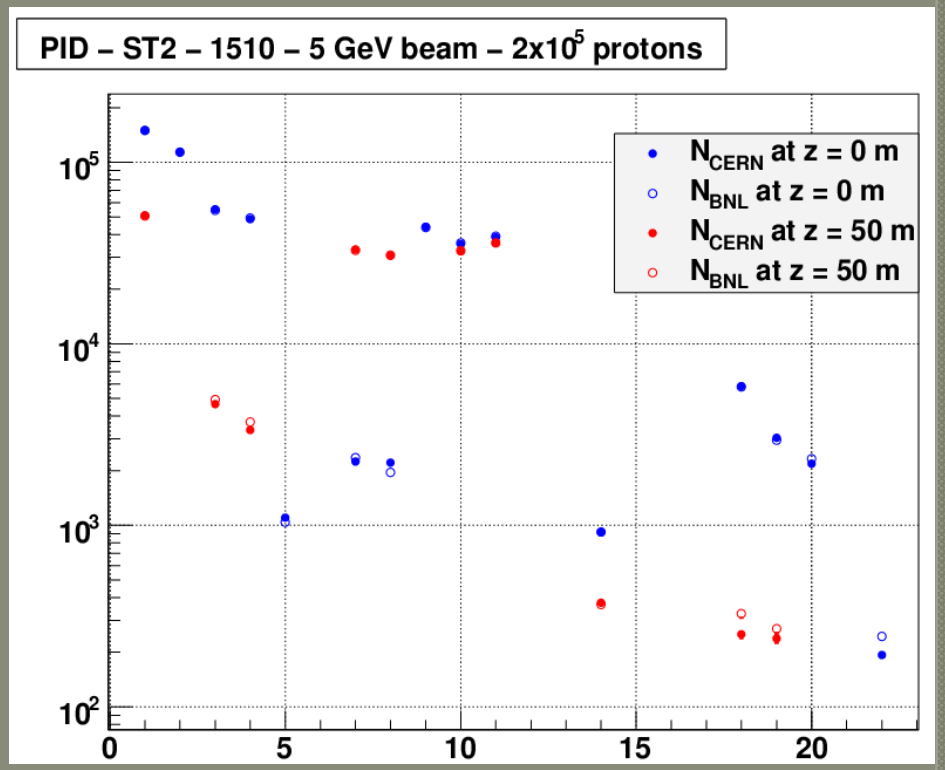
Up to 10% difference between BNL and CERN.



m1510 at CERN and BNL (1/)

- ST2 – 5 GeV beam – one run – 10^5 and $2x10^5$ protons – N.

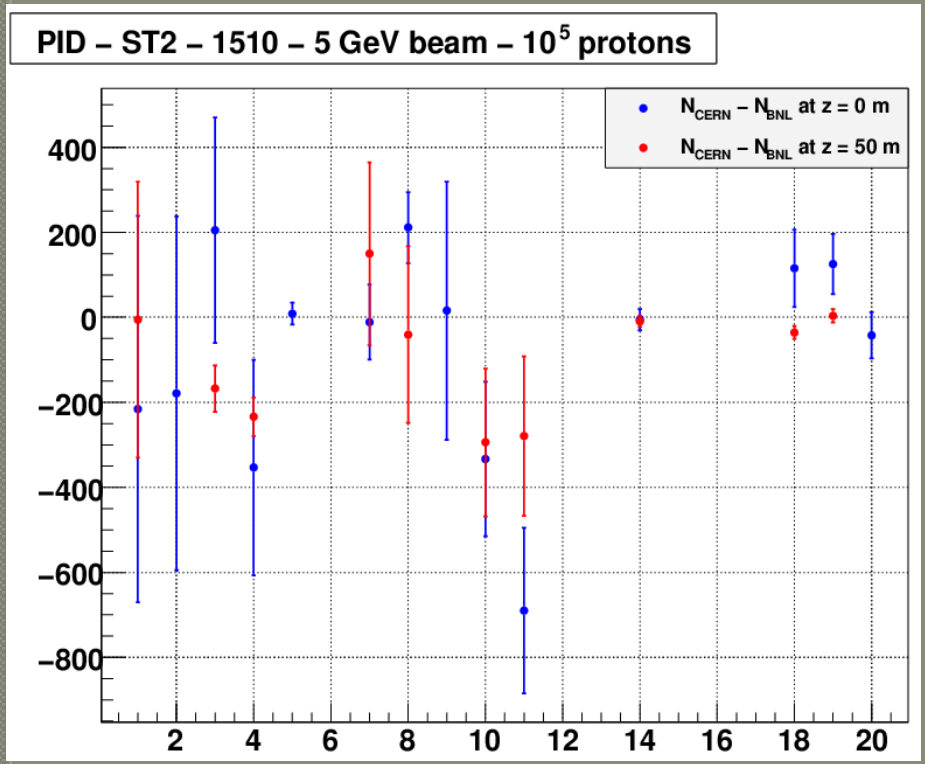


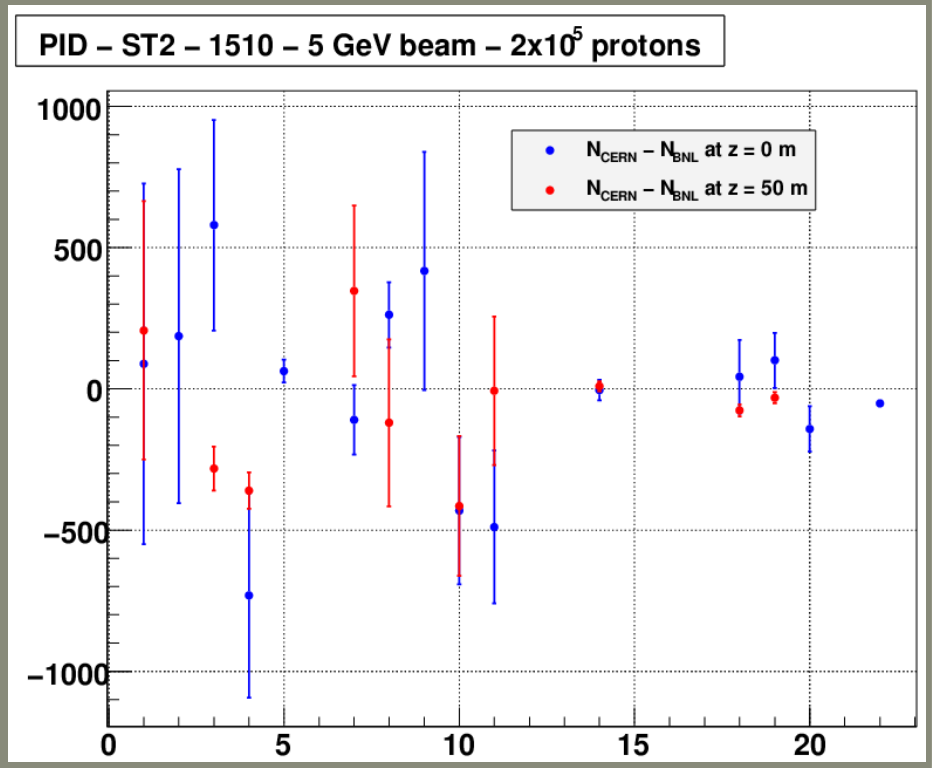


1 p - 2 n - 3 π^+ - 4 π^- - 5 K^+ - 6 K^- - 7 μ^+ - 8 μ^- - 9 γ - 10 e^- -11 e^+ - 12 pbar – 13 π^0 - 14 d
15 t – 16 ^{3}He – 17 ^{4}He - 18 $\nu\mu$ – 19 $\nu\mu$bar – 20 νe – 21 νebar – 22 $\nu\tau$

m1510 at CERN and BNL (2/)

- ST2 – 5 GeV beam – 10^5 and $2x10^5$ protons - $N_{CERN} - N_{BNL}$.



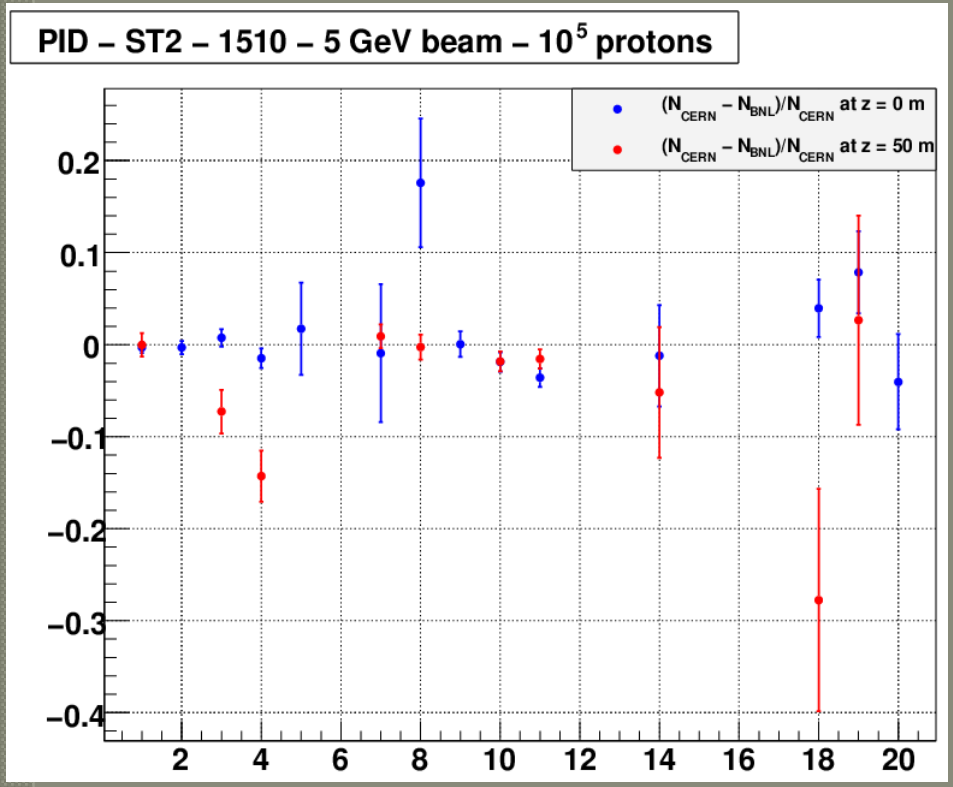


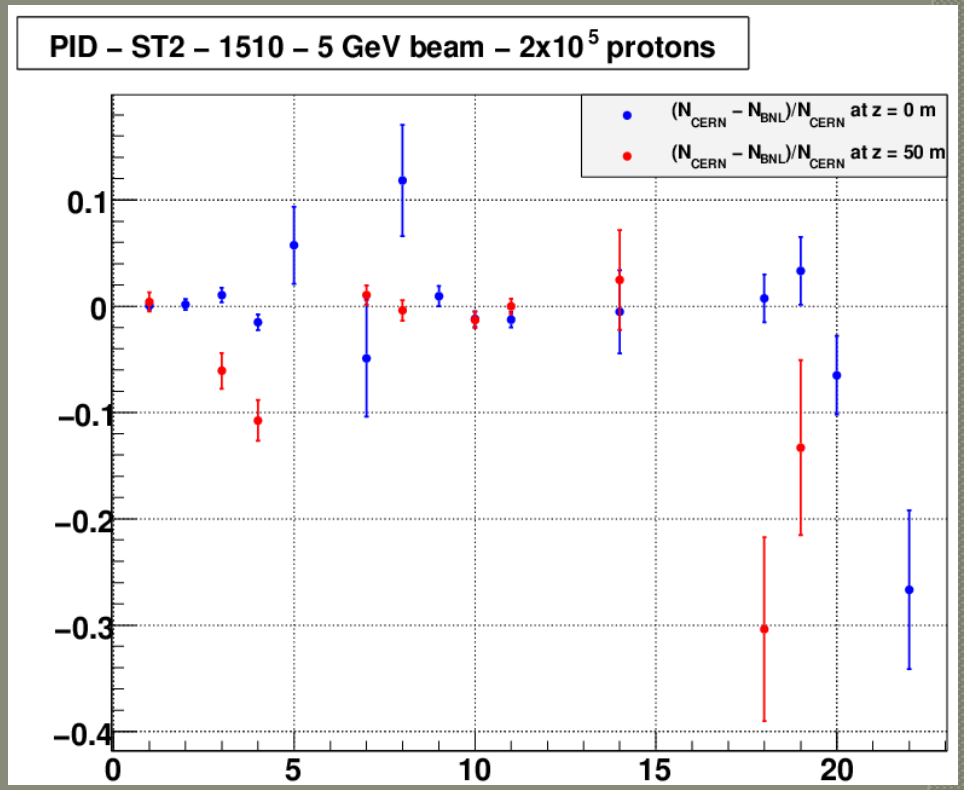
1 p - 2 n - 3 π^+ - 4 π^- - 5 K^+ - 6 K^- - 7 μ^+ - 8 μ^- - 9 γ - 10 e^- -11 e^+ - 12 pbar – 13 π^0 - 14 d 15 t – 16 ^{3}He – 17 ^{4}He - 18 $\nu\mu$ – 19 $\nu\mu$bar – 20 νe – 21 νebar – 22 $\nu\tau$

m1510 at CERN and BNL (3/)

- ST2 – 5 GeV beam – 10^5 and $2x10^5$ protons
- ! SOME ERRORS BARS WERE MISSING IN PREVIOUS TALK.
- $(N_{CERN} - N_{BNL})/N_{CERN}$.

For νμ (50 m) and ντ(0 m) large difference not explained by statistics.





1 p - 2 n - 3 π^+ - 4 π^- - 5 K^+ - 6 K^- - 7 μ^+ - 8 μ^- - 9 γ - 10 e^- -11 e^+ - 12 pbar – 13 π^0 - 14 d
15 t – 16 ^{3}He – 17 ^{4}He - 18 νμ – 19 νμbar – 20 νe – 21 νebar – 22 ντ

m1510 at CERN and BNL (4/)

- Random seeds run at BNL need to verify the beam energy (7 or 5 GeV ?).

- Feedback from N. Mokhov (03 June 2011)
  "No doubt, this TINY difference comes from the different compiler versions on the two sites resulting in a shift of random numbers in the course of Monte Carlo. For the statistics you studied, the agreement and differences are fully consistent. You can do a test with a simple toy model to see this. I will look myself later, just let me know what machines have exactly been used for this study at CERN and BNL ".

- Example of ICOOL 3.20 (which contains also random generators/seeds) on two different machines, SLC5 - 64x - gcc 4.1.2 and SLC4 – 32x – gcc 3.4.6 produces the EXACT same output for ~1000 particles ~ 100 m lattice with RF and solenoids.

  Some of the PID, to me are not in agreement (discussing with Nikolai).
  Shift of random seeds due to compiler, seems still a strange explanation.
  Need the information on the BNL computers.

Conclusion & todo

- m1507 & m1510 comparison @CERN:
  - 5-10 GeV beams, muons yield @50 m within statistical errors (for 50 runs - using Ekin cuts).
  - $\nu\mu$ distribution (50 runs - m1510) spread 10-13% of the mean, excepted for νe at 51% (but also small statistics).
- m1507 at CERN & BNL comparison:
  - 5-15 GeV beams muons yield @50 m difference up to 10% (run to run – using Ekin cuts).
- m1510 at CERN & BNL comparison:
  - 5 GeV beam – difference does not seem to be due to statistics.

- 12-15 GeV beams to do in m1510 @CERN.
- Verify beam energy of BNL random seeds simulation.
- Get detailed feedback from N. Mokhov.
- Run in LAQGSM mode (m1510 only).

Thanks to Xiaoping & Nicholas for the help with the MARS simulation comparison.

Will try to finish the comparison work started by Nicholas at BNL.