CERN

SPS BSI calibration

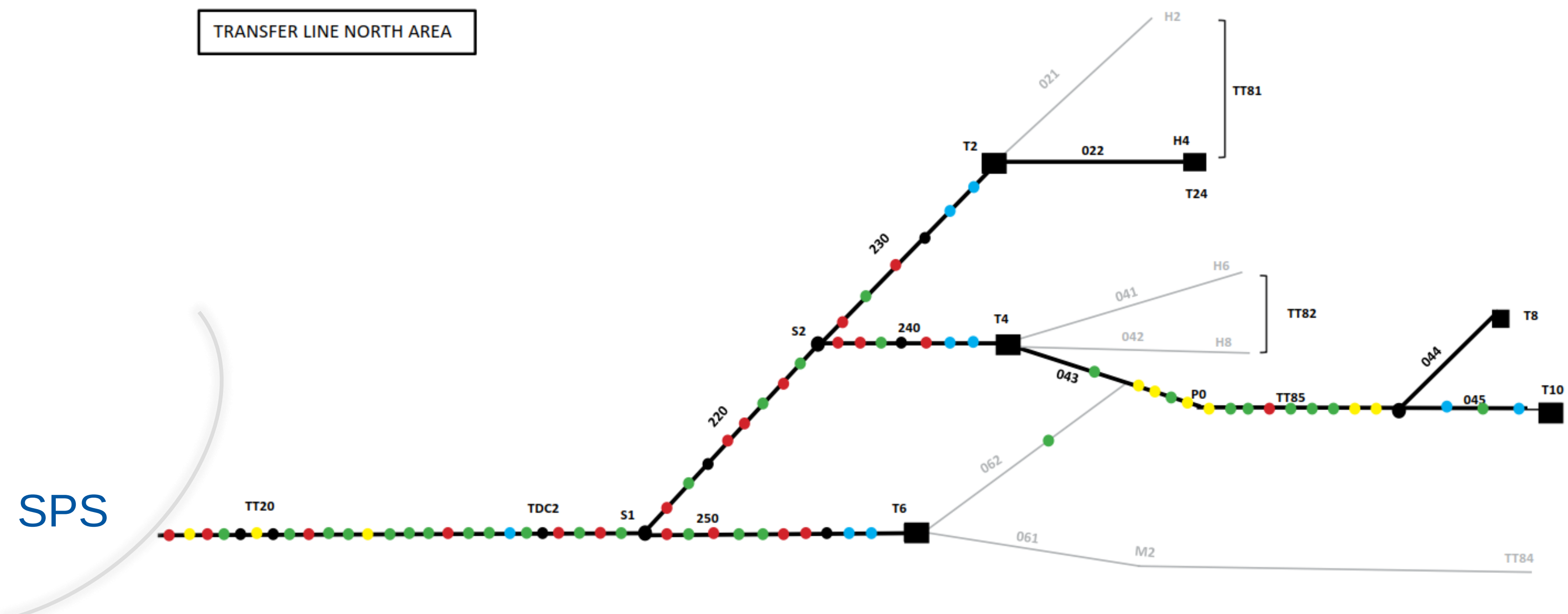
23-Nov-2017, BI-TB, F.Roncarolo

Many thanks to M.Duraffourg, L.Jensen

The Problem

OP and N.A. experiments believe the BSI monitors measure a too low number of protons

Calibration factors estimated XXX year ago



The solution

Recalibrate the BSI detectors …

Of course not possible in TT20 (DC beam, slow spill, no BCT)

2016-17 EYETS:

Installed BSI monitors in TT10, aim at comparing to DC BCT

This presentation

Summary of 2017 data analysed so far

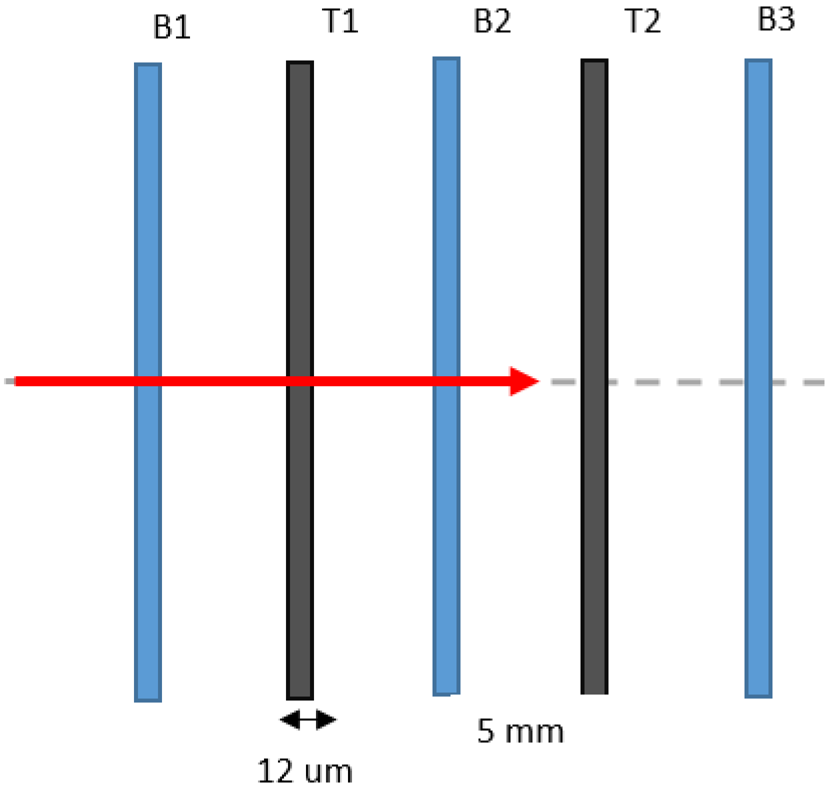
TT10 (first inj., 10us, almost de-bunched)

- 2 Titanium foils (one new, one aged)
- Comparisons to TT10 BCT

TT20 (slow spill xxx seconds, fully debunched)

- 2 Titanium foils (new, installed EYETS)
- Comparison to SPS ring BCT → slow extraction losses in between

BSI layout (TT10 and TT20)



B1,2,3 = BIAS foils (hole in the centre)
T1,2 = Ti foils

Now … the conclusions

Theoretical SEY

	dE/dx GeV cm2/g	SEY 1st Formula	SEY 2nd Formula	Diff 2nd – 1st
14 GeV	1.32e-5	0.01	0.01176	0.7%
400 GeV	1.27e-5			

Two different approximation formulas, both using FLUKA energy deposition

- 14 → 400 GeV, small difference in dE/dX, even smaller difference in SEY

x[54]=400000, y[54]=0.0100178
x[55]=14000, y[55]=0.010018

x[54]=400000, y[54]=0.0117677
x[55]=14000, y[55]=0.0117677

SEY summary

Based on some values measured in October

	CAL Factor	SEY	Diff w.r.t. Operational	Diff w.r.t. Jung-Fer
	[1E10 p / ADC count]	[%]	[%]	[%]
Operational	1.6	1.6	0.0	-55.6
Jung-Ferioli 1997	0.6	3.6	125.0	0.0
TT10 Plate A	2.15	1.21	**-24.4**	-66.4
TT10 Plate B	1.95	1.32	-17.5	-63.3
TT20 Plate A	2.2	1.15	-28.1	-68.1
TT20 Plate B	1.9	1.32	-17.5	-63.3

This would confirm that the present calibration is underestimating the real protons

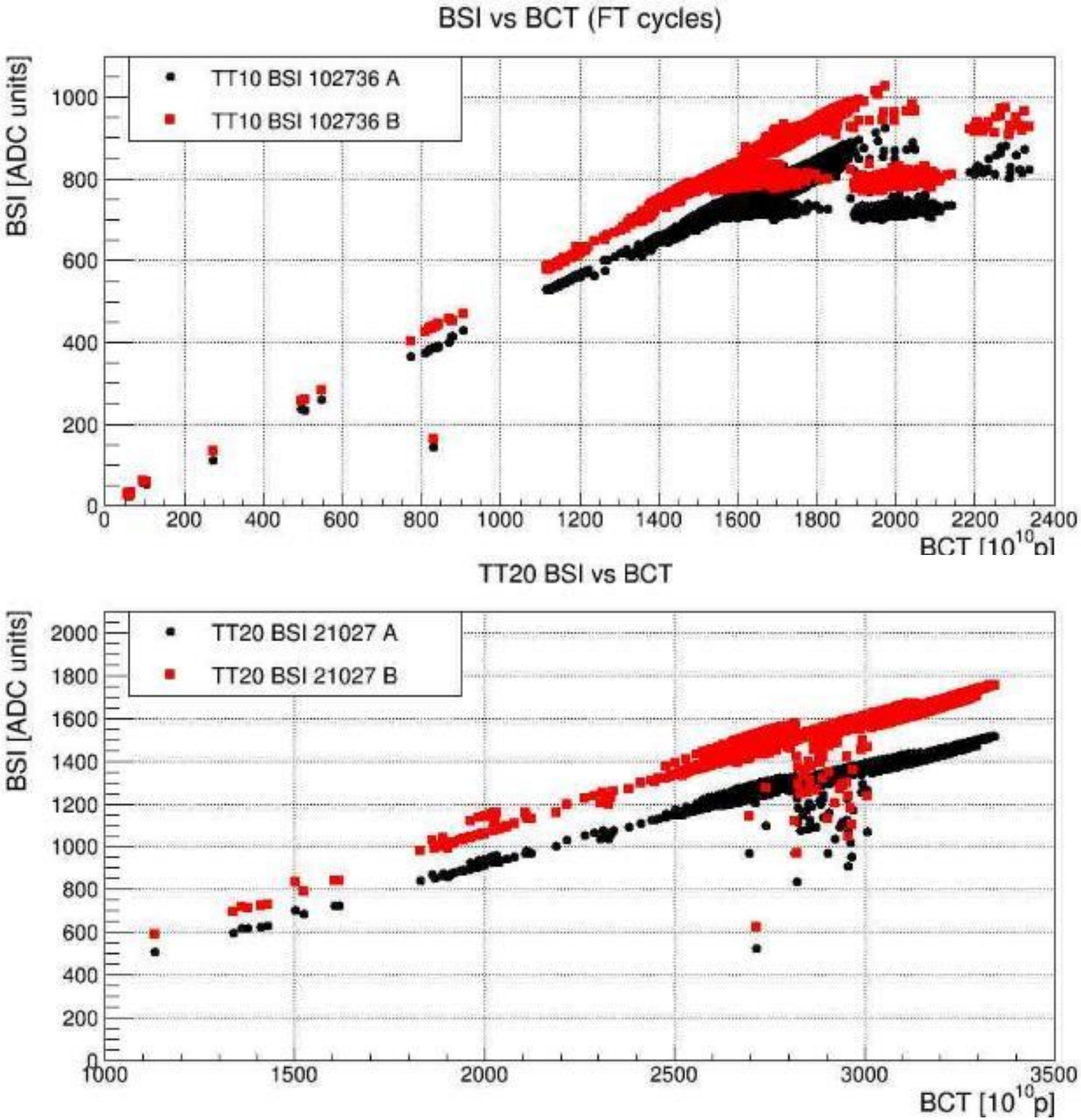
Table 1: Secondary Emission Efficiencies as a function of total charge density passed through various foils

	Ti	Al	Al + Au	Au
New	3.5 %	6.8 %	6.7 %	~7.2%
10^{18} p/cm^2	3.6 %	6.5 %	7.0 %	~7.1%
10^{20} p/cm^2	3.8 %	4.0 %	4.9 %	

More details….

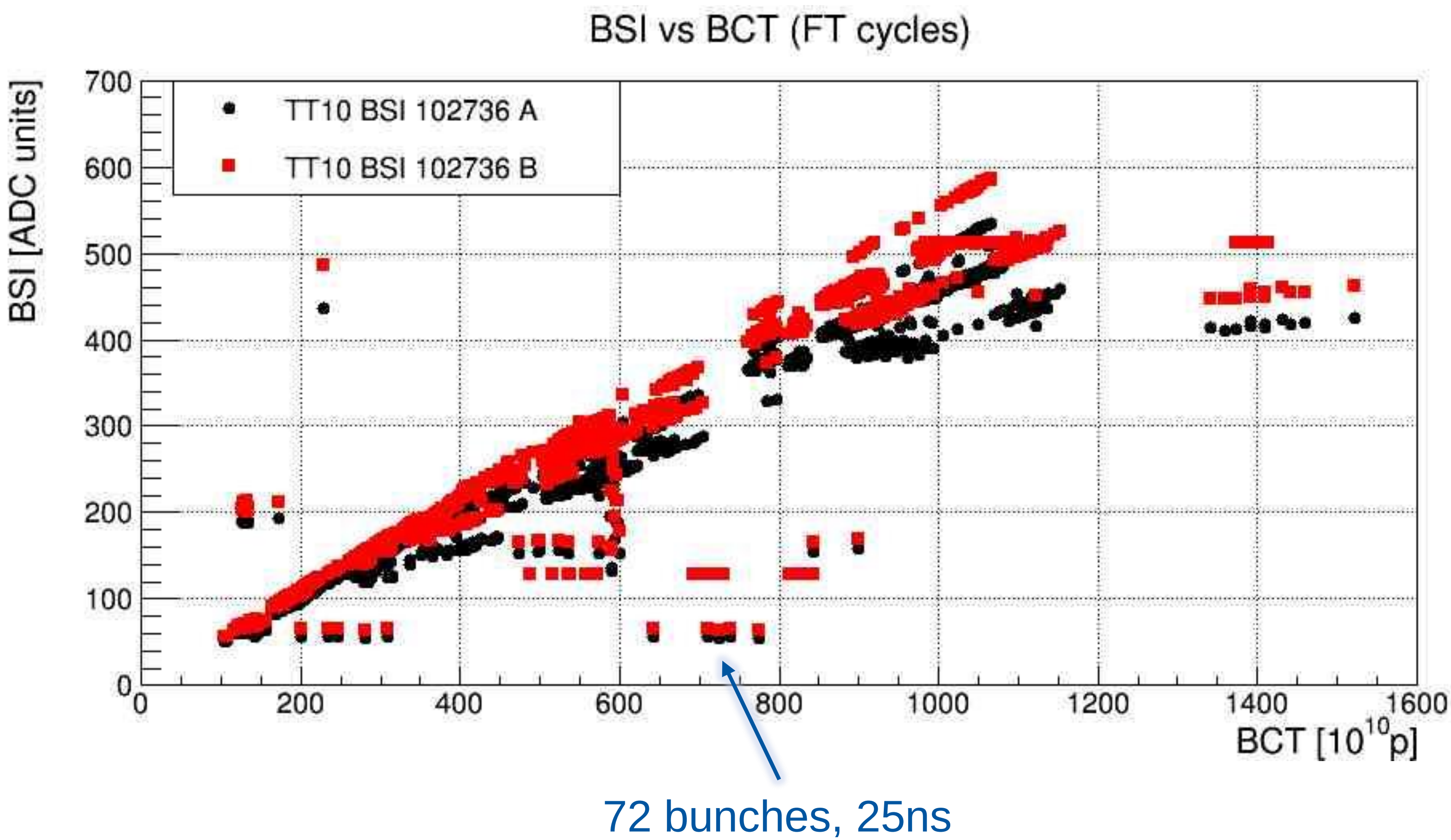
BSI vs BCT

TT10



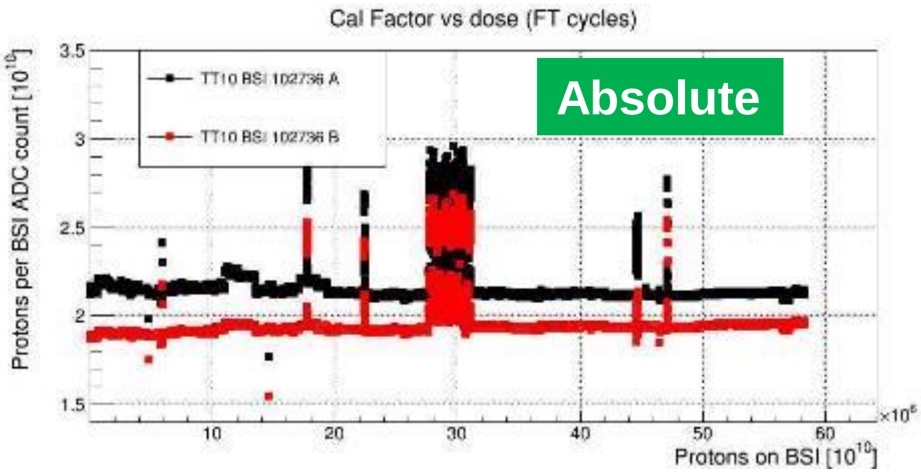
TT20

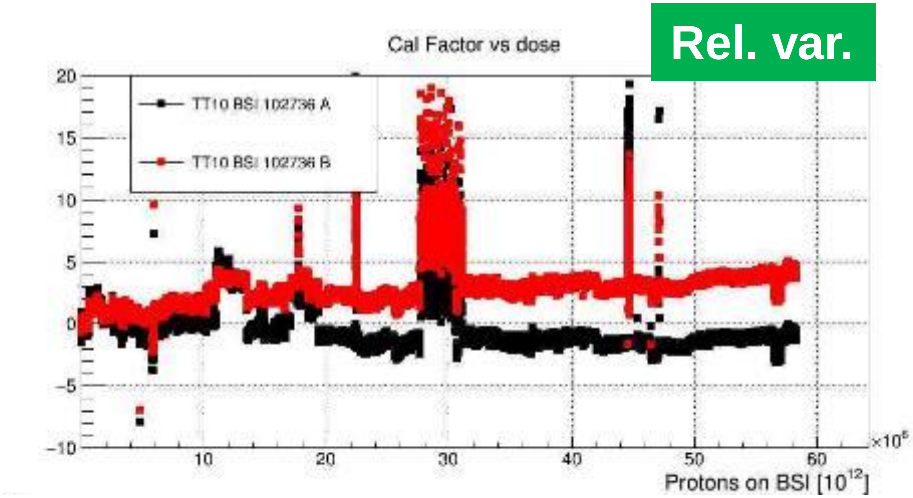
BSI vs BCT – TT10, LHC cycles

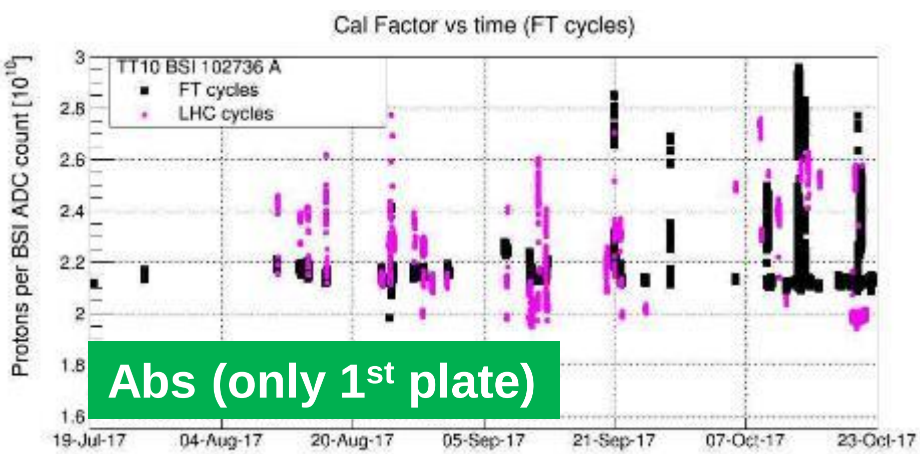


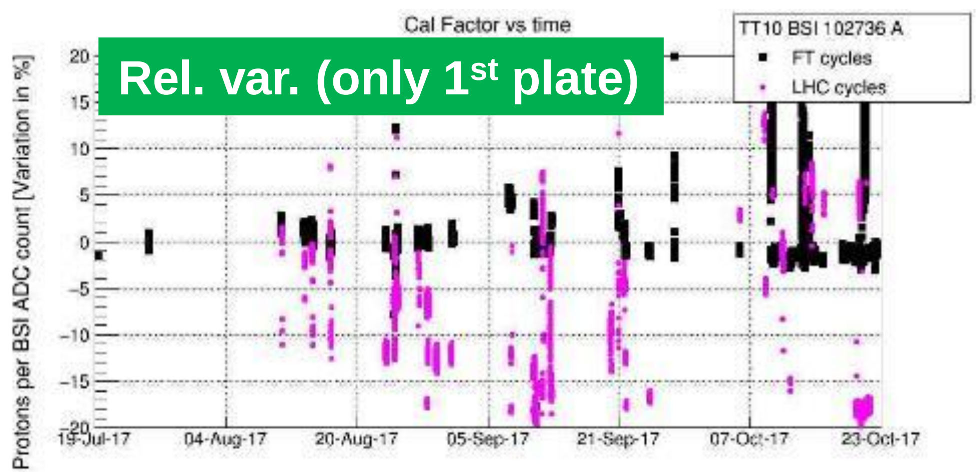
LHC cycles == each NOT FT beam (LHC, MDs, AWAKE, HIRADMAT …)

Cal Factor – TT10



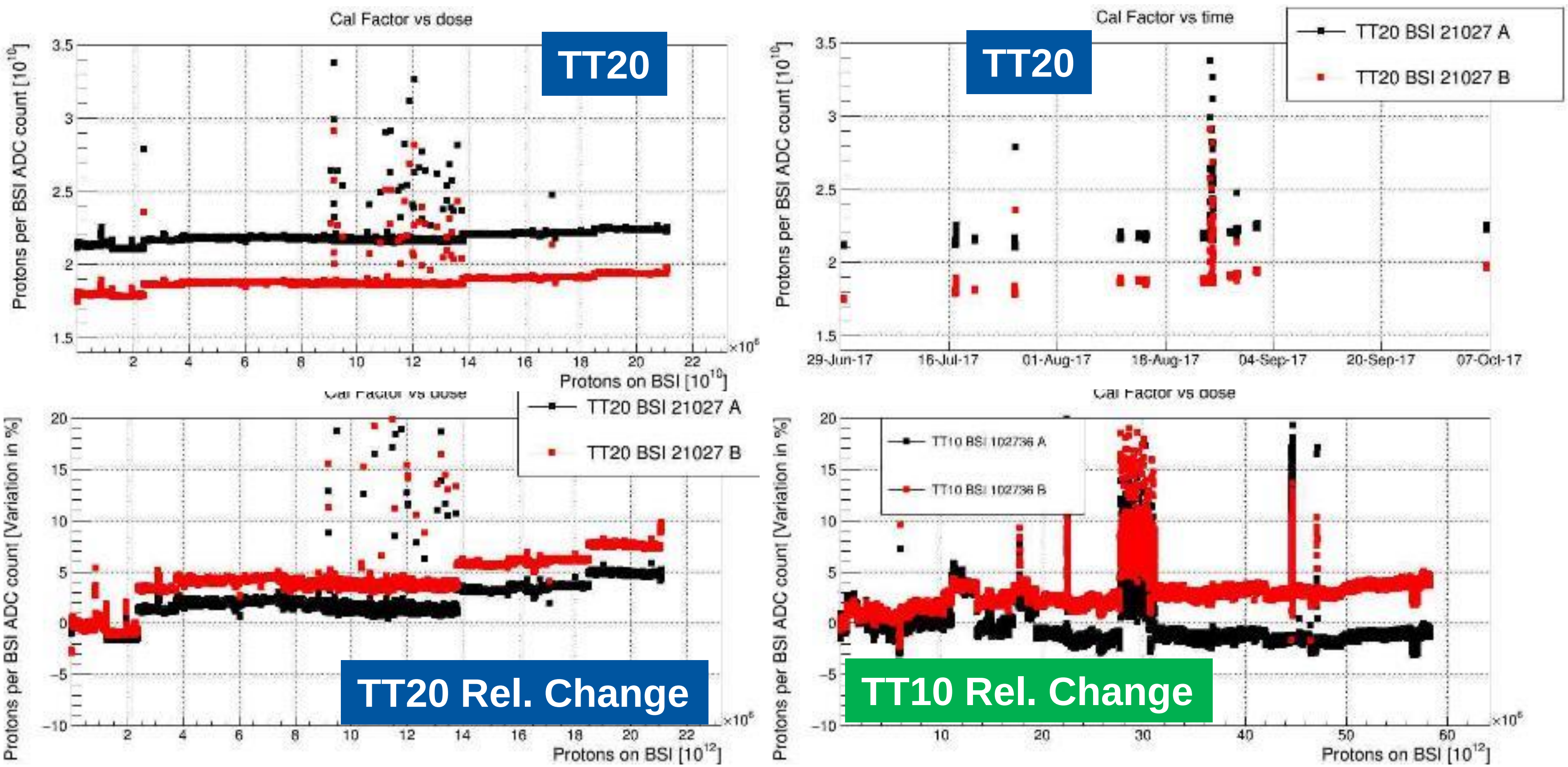






LHC cycles == each NOT FT beam (LHC, MDs, AWAKE, HIRADMAT …)

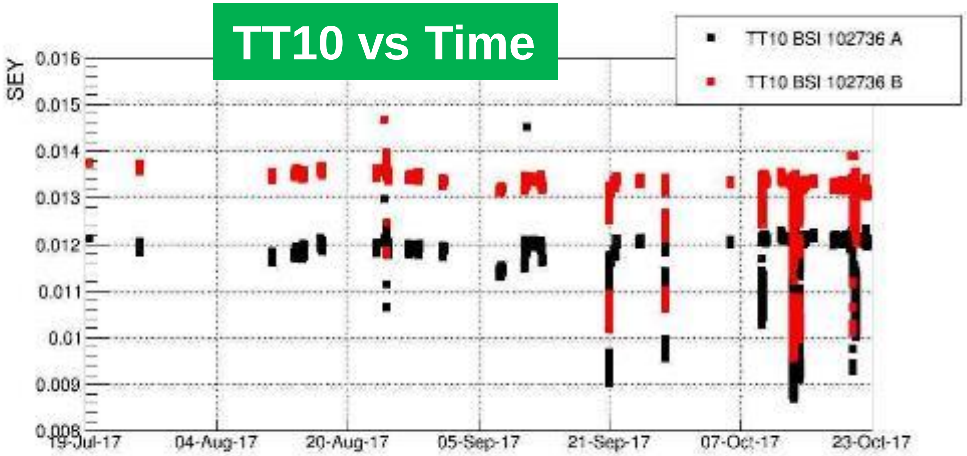
Cal Factor – TT20



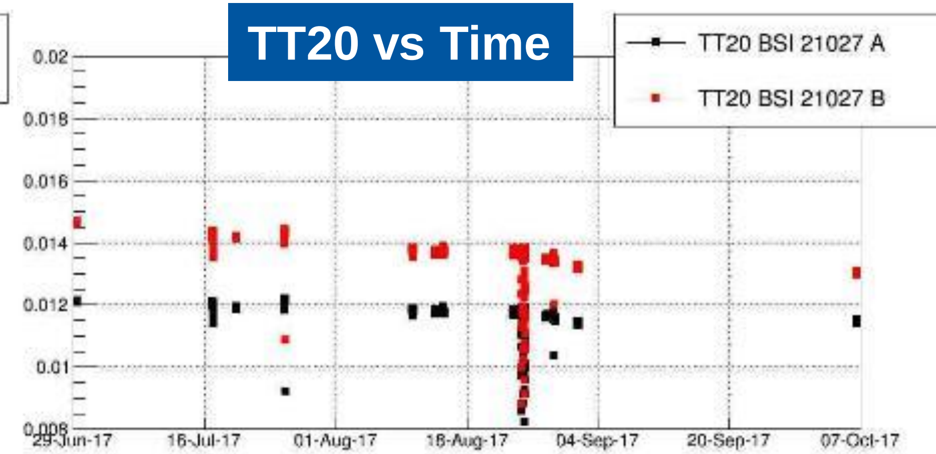
First plate TT10 the only one not changing on average during the year
The others changed of 5-8 % (in TT20 slow extraction efficiency could have changed!)

Secondary Emission Yield (SEY)

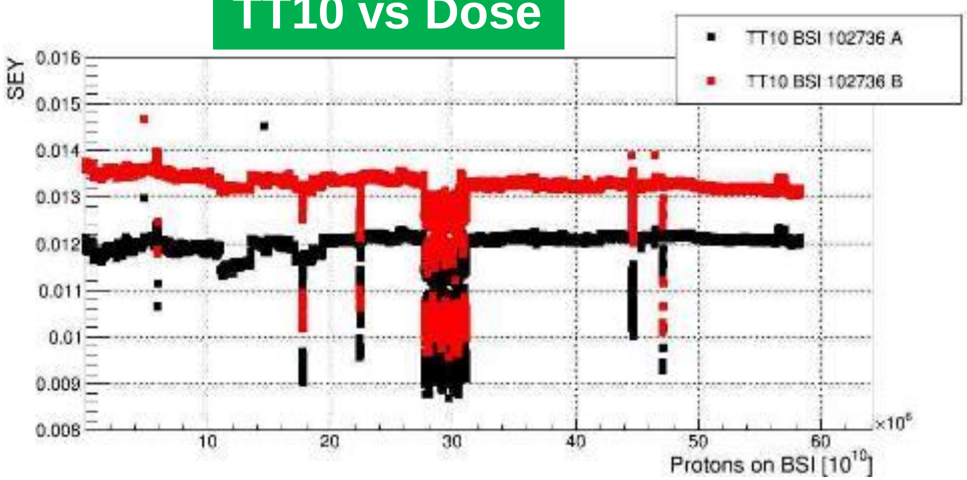
TT10 vs Time



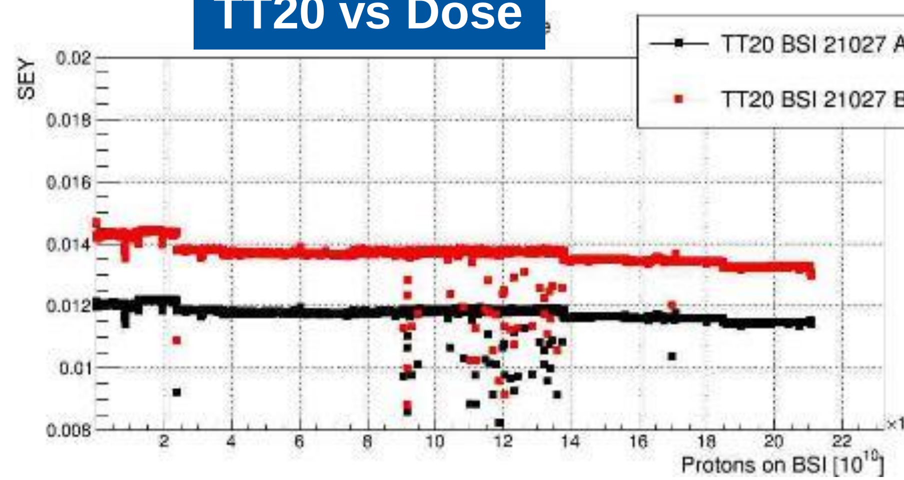
TT20 vs Time



TT10 vs Dose

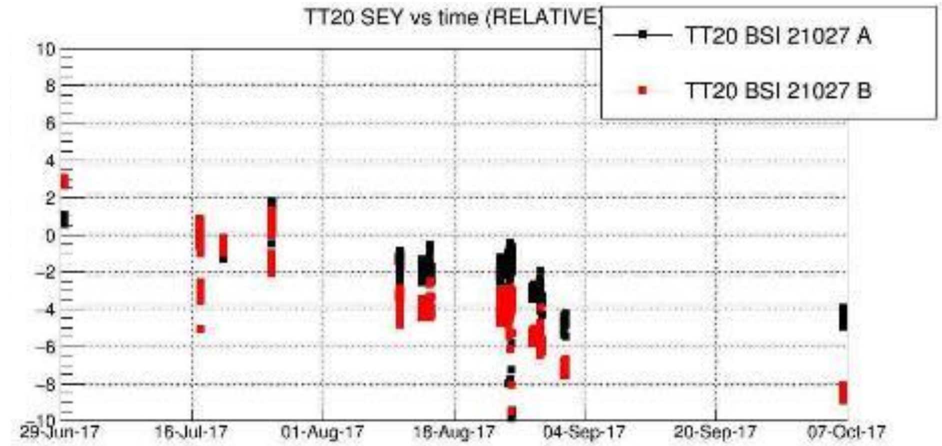


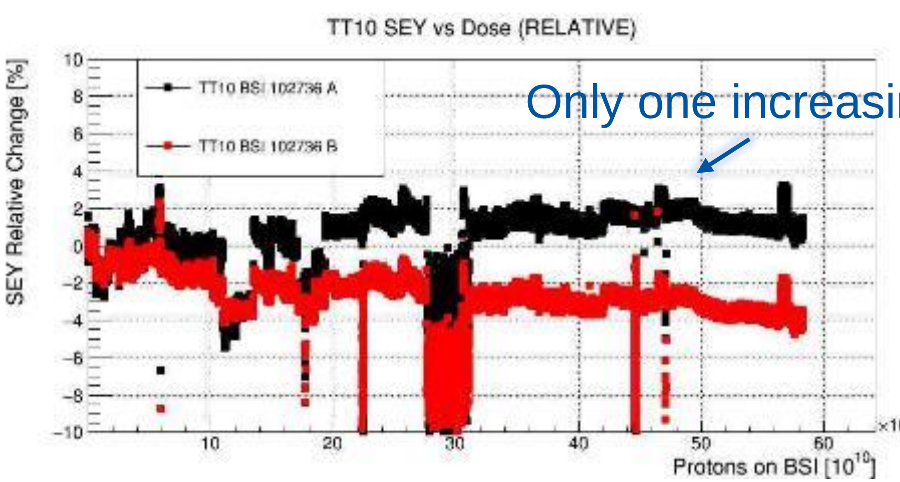
TT20 vs Dose



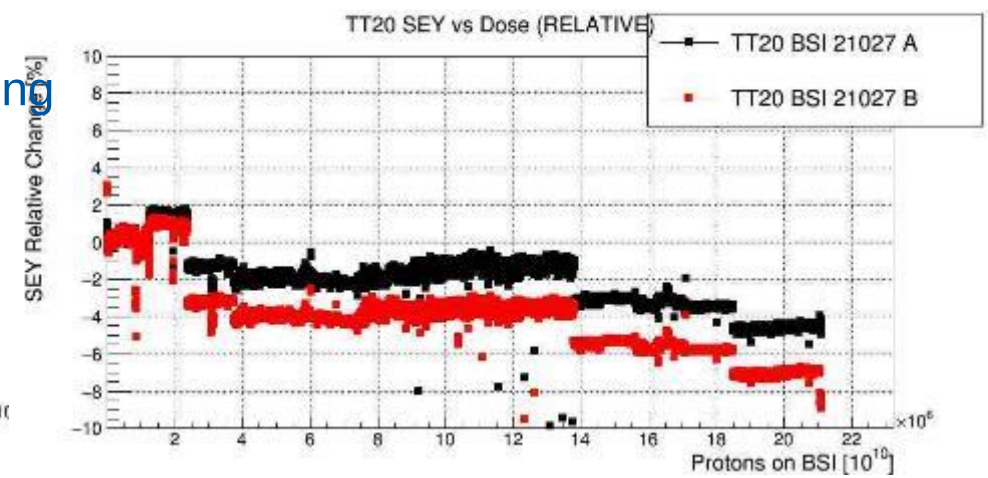
Variation more linear with time than with dose ?

SEY – Relative Change



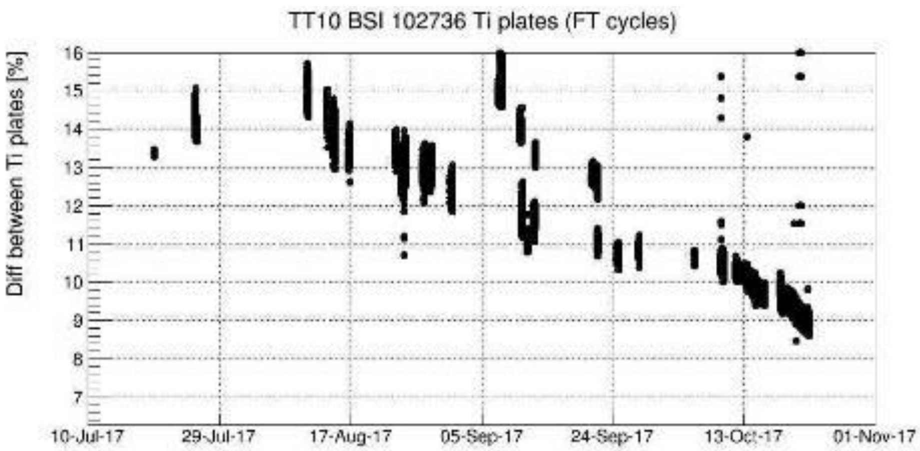


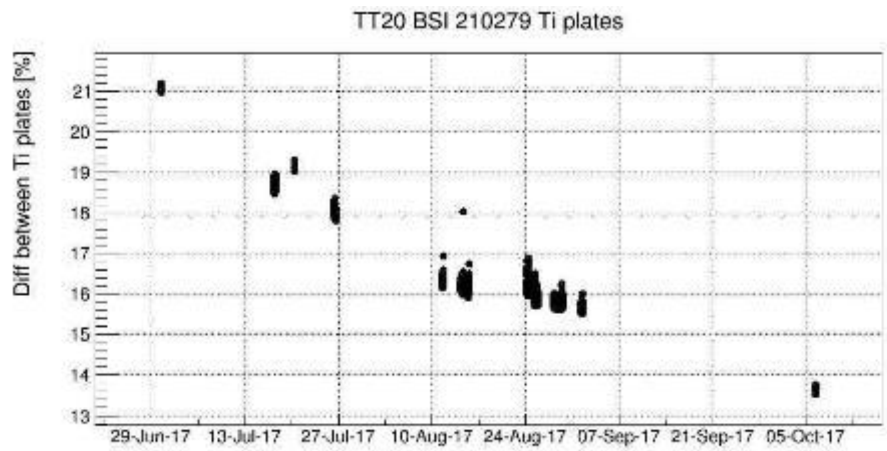
Only one increasing



Is TT10 plate A the old one and B the new one as the ones in TT20?

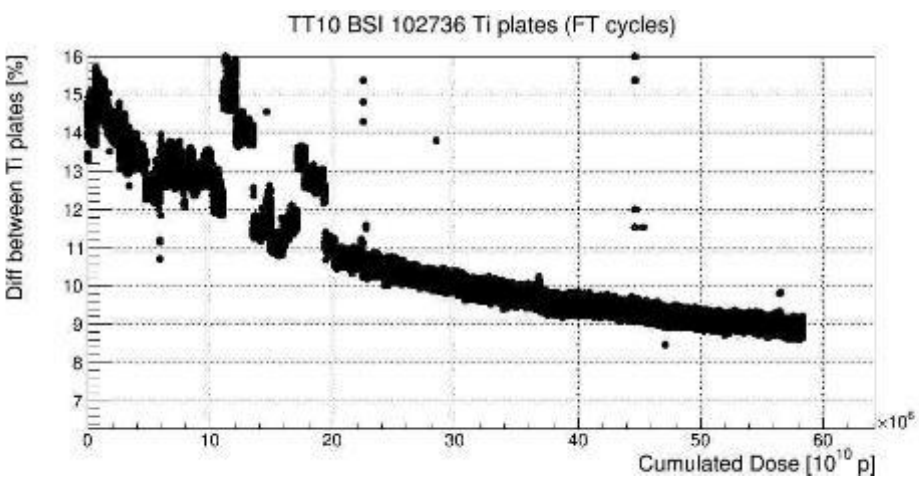
BSI B – A difference

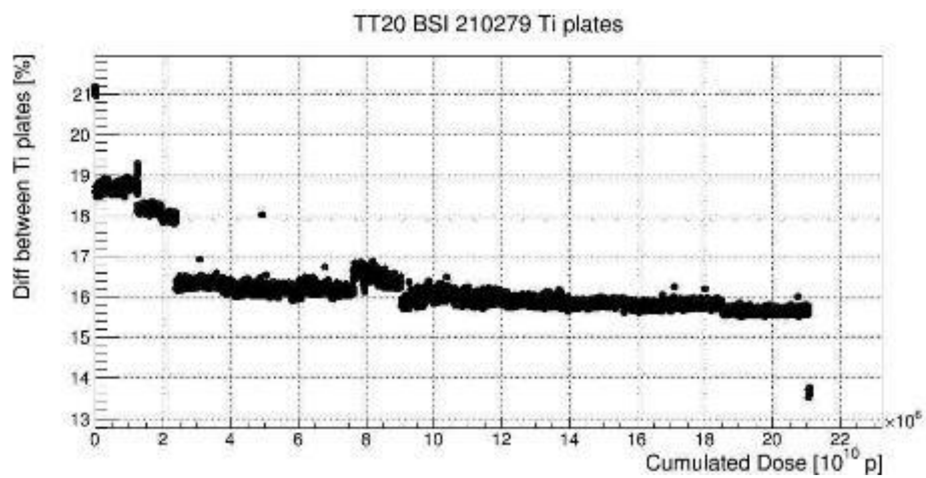




TT10

TT20

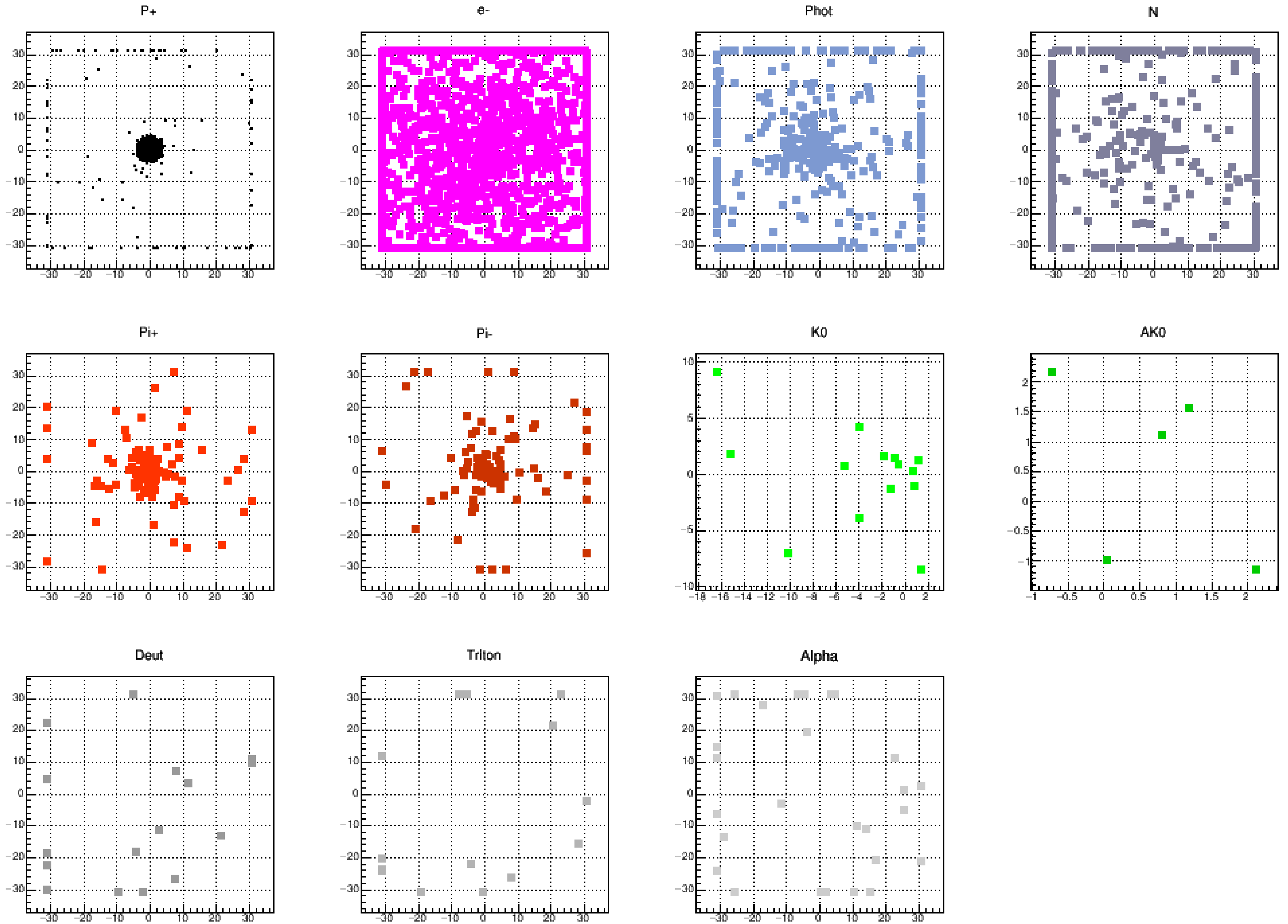




Variation more linear with time than with dose

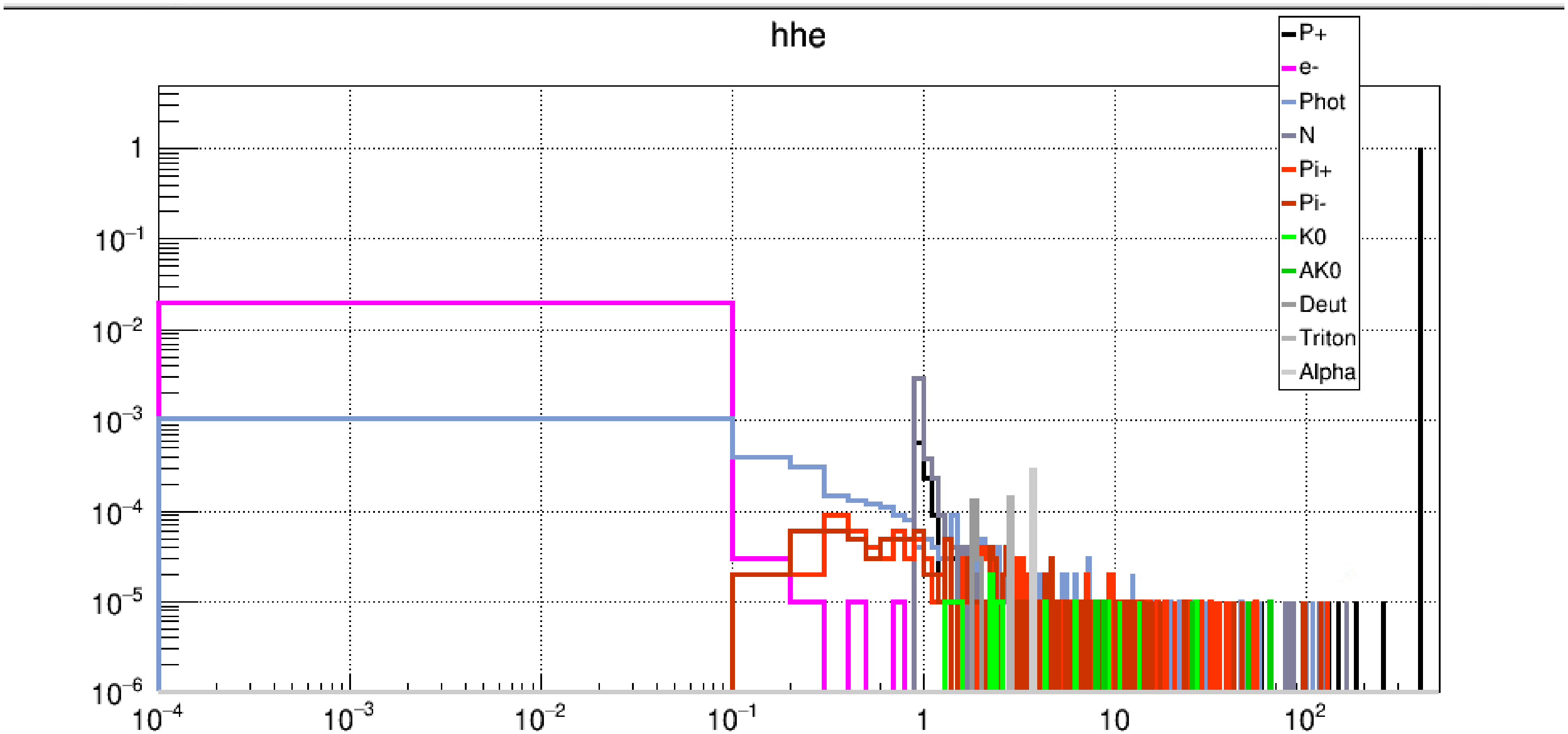
FLUKA simulations

Particles emerging from first plate



FLUKA – Energy spectrum

The number of particles and their energy do not explain an additional signal on the second plate (s)



Final Remarks

- If we trust TT10 calibration of plate A → TT20 present calibration wrong of ~25%
- Suspect the 1st plate in TT10 is the old one
- SEY decreases with time/dose for all 4 plates except TT10 A (Jung-Ferioli saw increasing SEY)
- Several % variation in TT20 during the year, but do not know what is contribution of extraction efficiency changes
- 25 ns beams conditioning the material or only giving wrong signals due to electron cloud?
- Did not check/address yet:
    - BCT accuracy issues, detailed comparison to M.Fraser studies in TT20 (BSI vs BLMs vs SPS ring BCT)
    - FLUKA experts opinion

- Steering exercise in TT10 was very confusing, need to repeat it
- Should simulate effect of BIAS plates with CST Particle Studio → maybe room for explaining observations and optimizing the system
- Need to start from here to
    - Address long term TT20 beam current measurements
        - Request is 1% accuracy on POT (!)
    - Freeze design SPS SEM electronics CONS