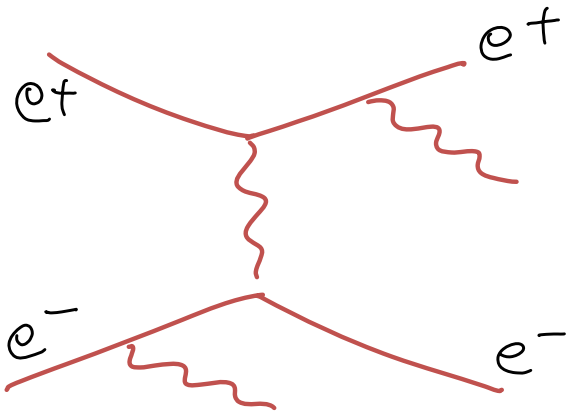
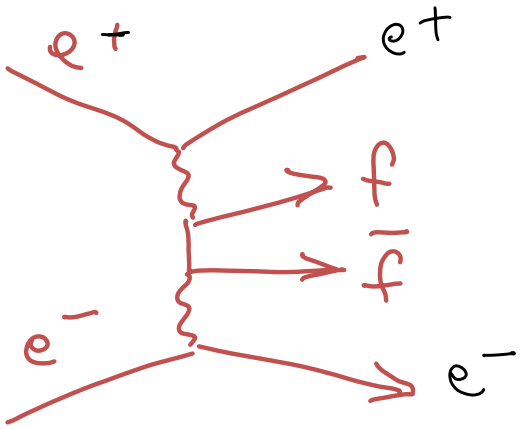
QED Background: Beam Tests with Belle

Recent Preparatory Studies
(analysis by Elena Nedelkovska)



Bhabha scattering



2-photon-processes

Occupancy is an Issue!

- SuperB QED simulations (Frascati workshop): 10MHz/cm^2

  they use the BDK generator

  yields 1.5 % occupancy for PXD (inner layer)

  this is dangerously close to the „limit“ of 2 %!

- Set of MCs studied in our Collaboration:

  BDK, Grace and KoralW give consistent results, but inconsistent with SuperB simulations (they use BDK also!) (~ order of magnitude smaller!)

- Do beam tests with Belle with colliding and separated beams to discriminate between BG (~I) and QED (~L ~ I^2)

Random Triggers in Belle

Belle provides 3 types of Random Triggers:

„Bunch 0“

„Physics Random“: physics trigger + 100 µs delay

„Lumi Random“: lumi trigger + 100 µs delay

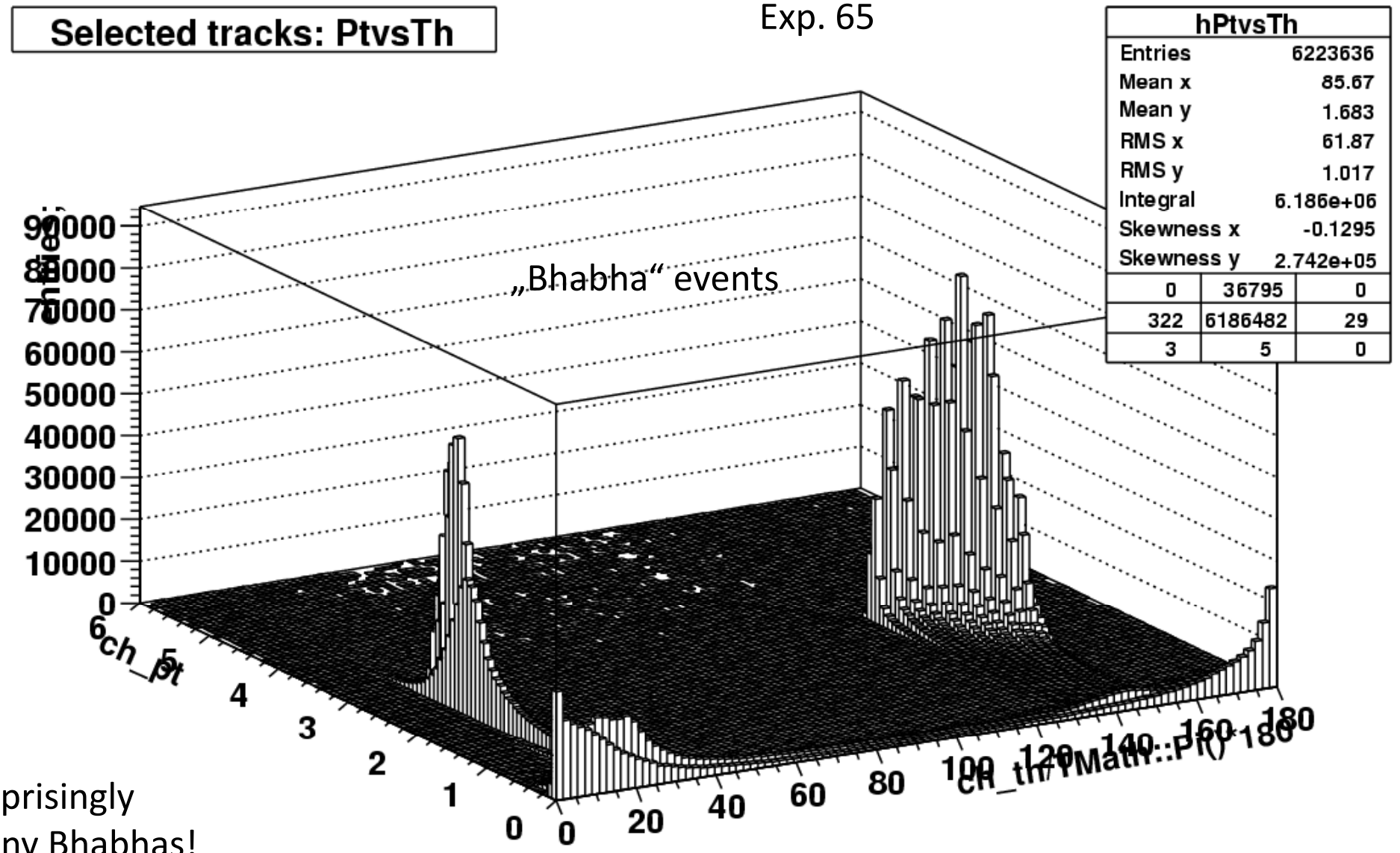
Initial studies using Exp. 65: too many Bhabha‘s observed

info from Y. Iwasaki:

RT did not work for runs < 1103

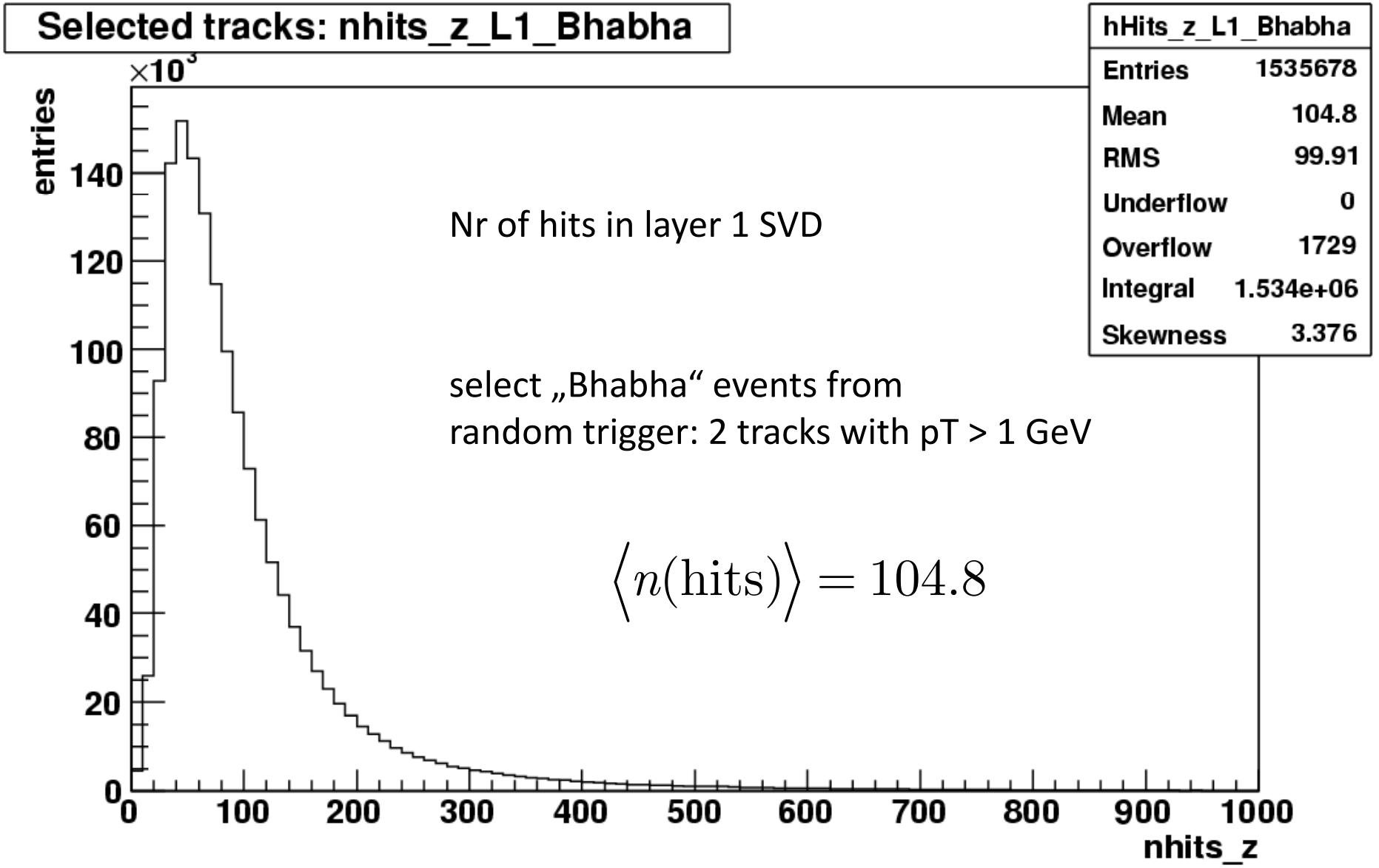
→ look at runs > 1104

Random Triggers: Polar angle vs pT



surprisingly
many Bhabhas!
Reason: Random Trigger did not work

Random Triggers: Bhabha selection

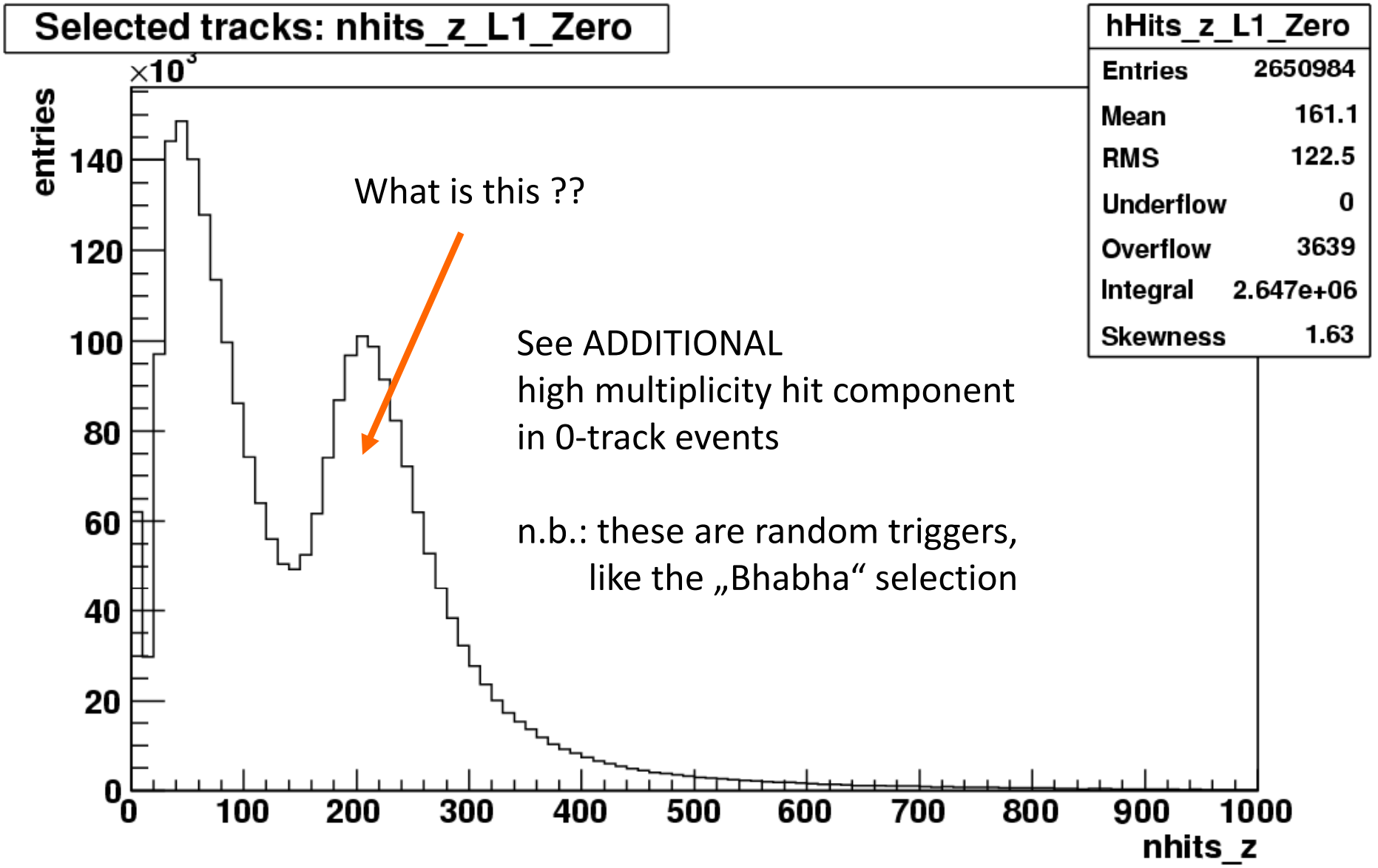


Nr of hits in layer 1 SVD

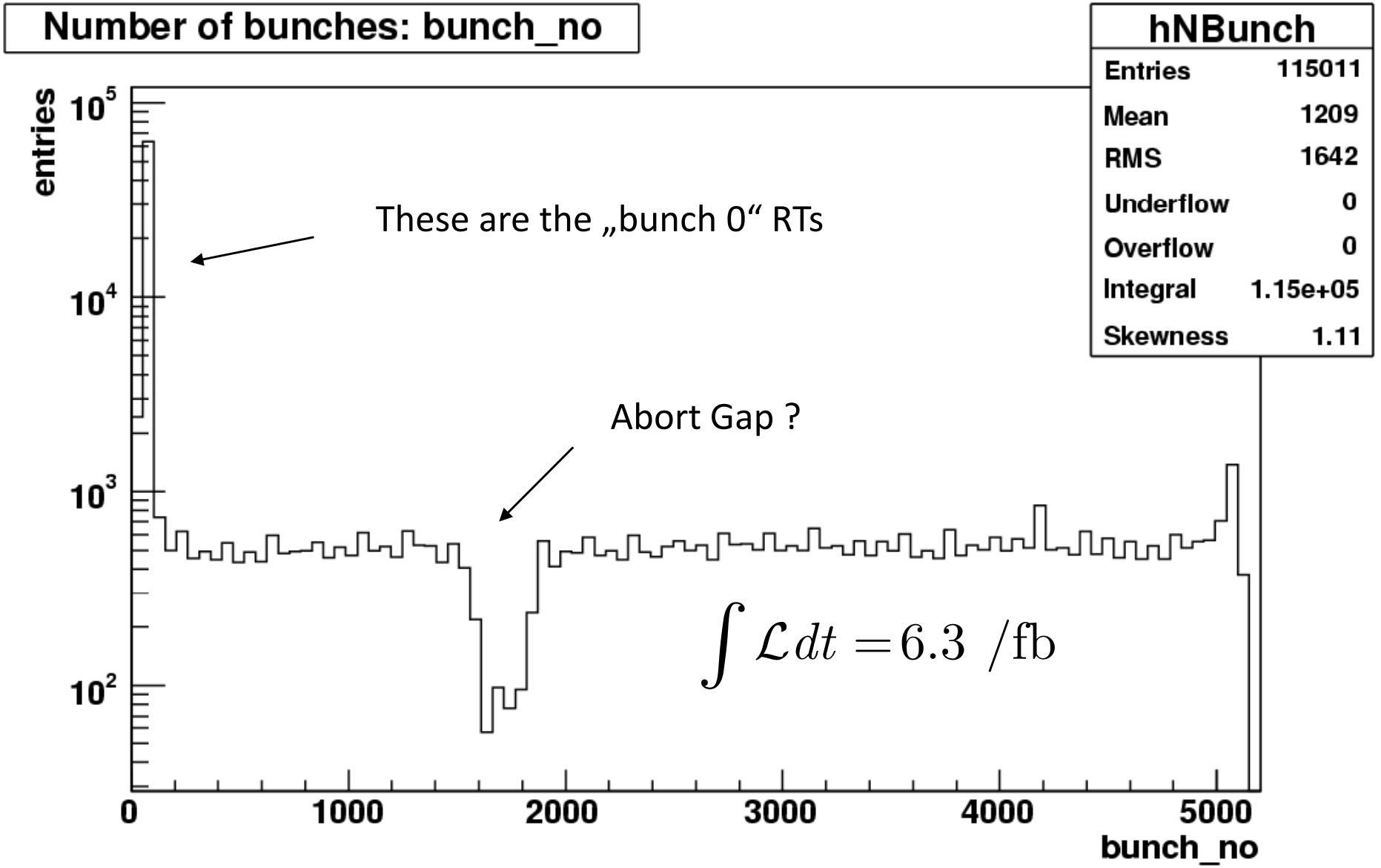
select „Bhabha“ events from
random trigger: 2 tracks with pT > 1 GeV

$$\langle n(\text{hits}) \rangle = 104.8$$

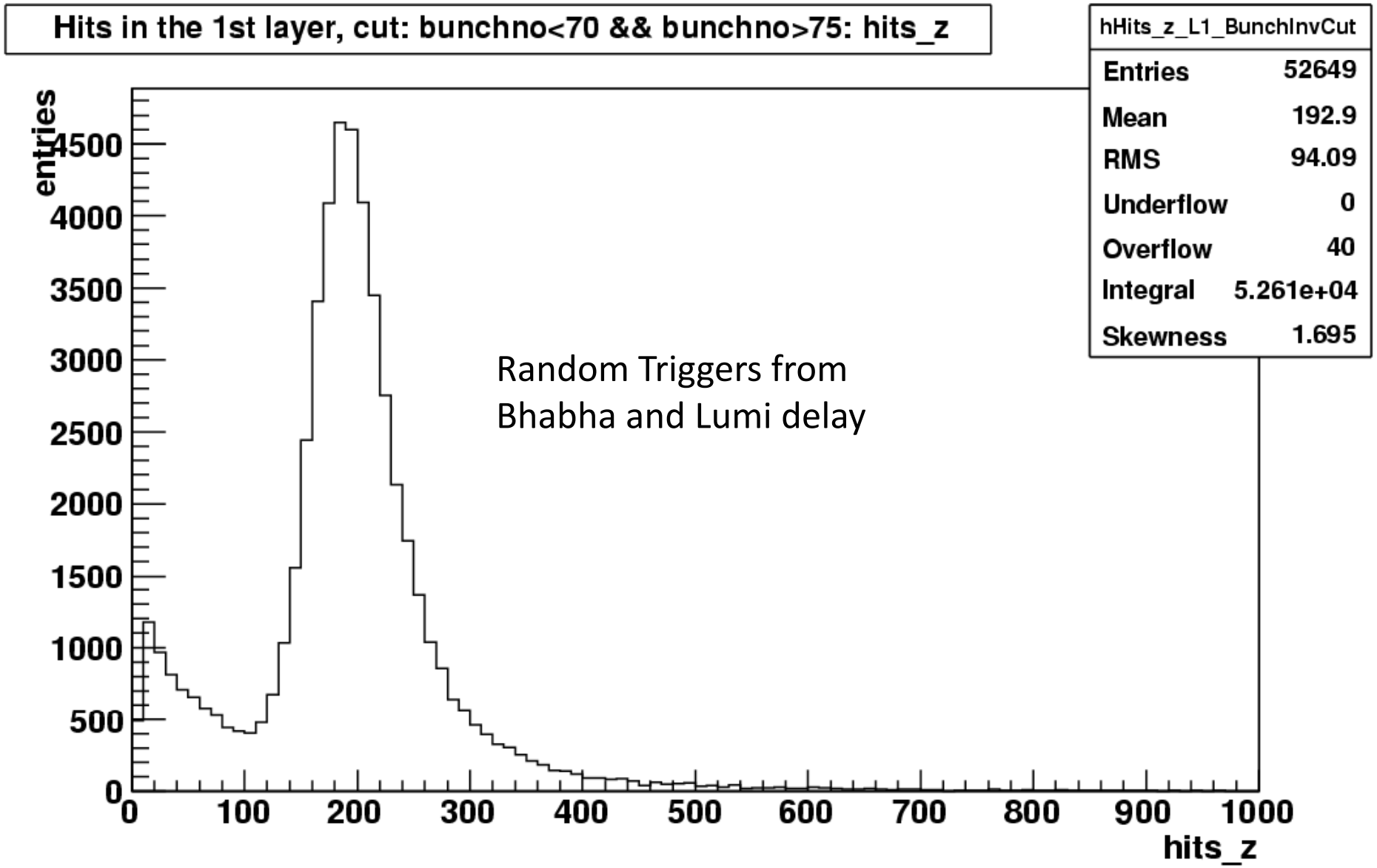
Random Triggers: 0-track selection



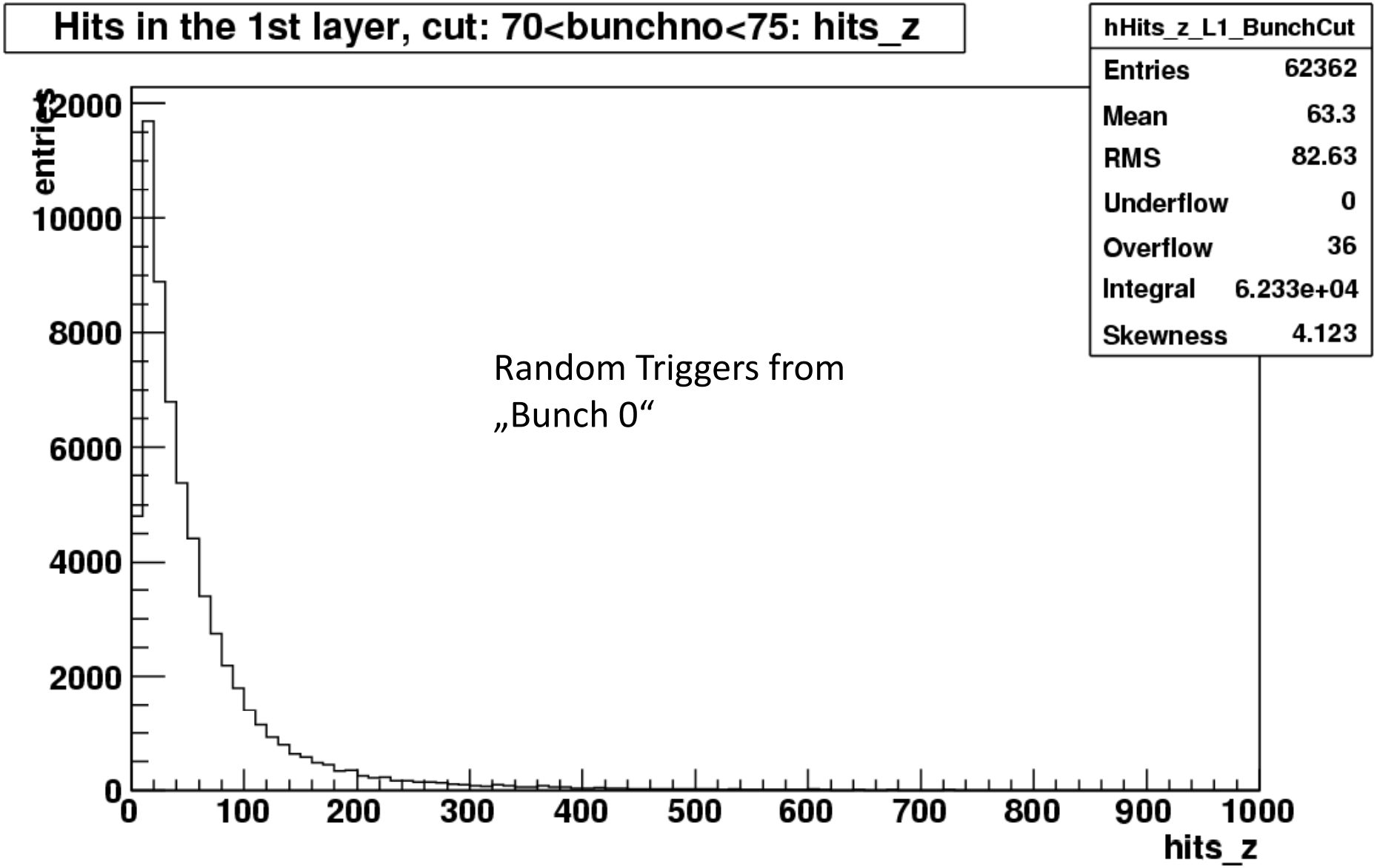
Random Triggers, Exp. 65, runs > 1104



Random Triggers, Exp. 65, runs > 1104

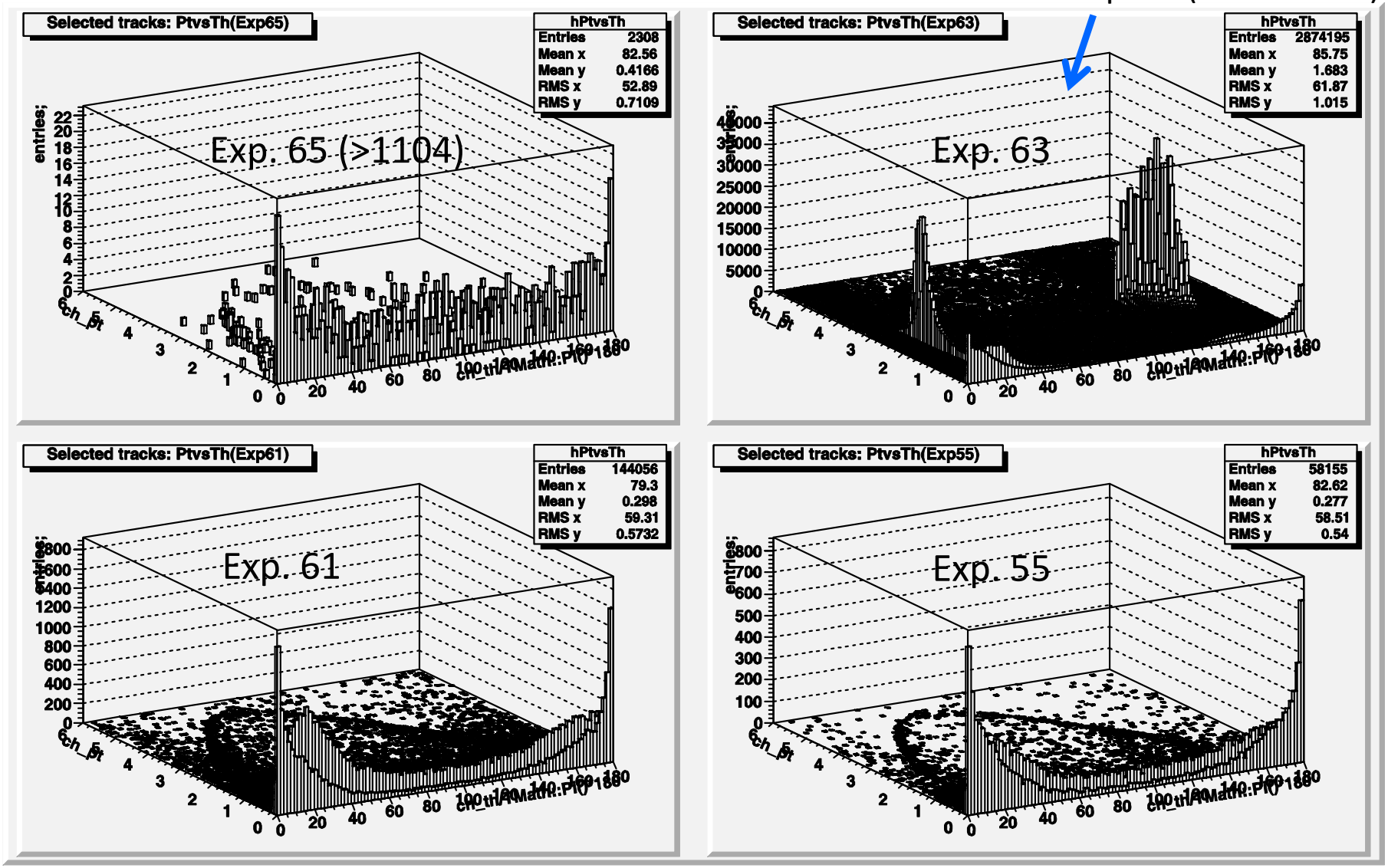


Random Triggers, Exp. 65, runs > 1104



Comparison with other experiments

same problem
as exp. 65 (runs < 1104)



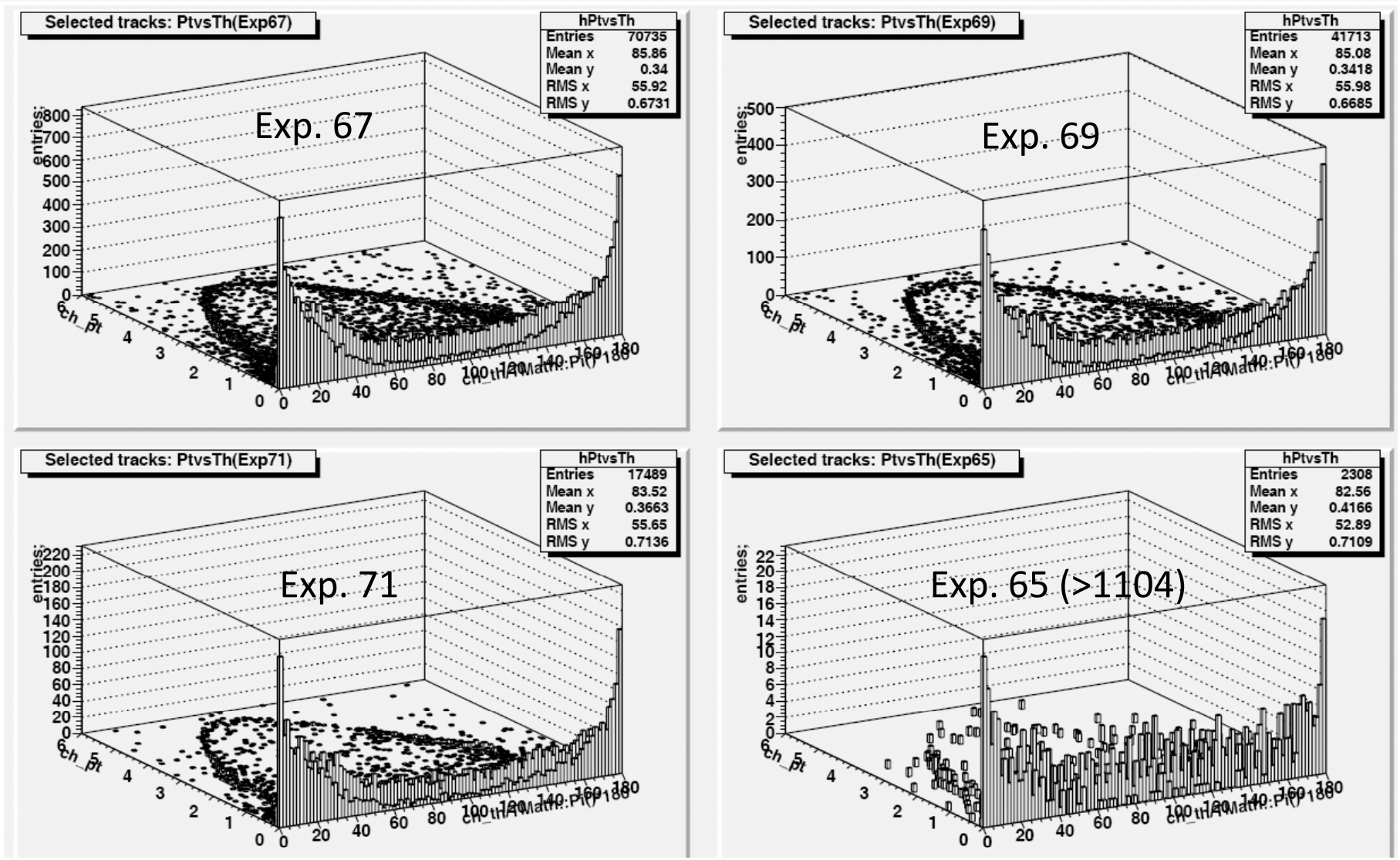
Comparison of various Experiments

Exp.	55 (4S)	61 (4S)	63 (4S)	65 (3S)
Lum (1/fb)	31.2	18.1	26.4	6.3
Time (10^6 s)	2.72	1.91	2.71	0.74
R rate (1/s)	0.29	1.22	0.97	0.16
# of Bhabha	508	1271	707000**	63
Bha xs *	56.1	57.6		62.5
Lum (1/nbs)	11.5	9.5	9.7	8.5
<hits>(0)	201	105	98	63
<hits>/lumi	17.5	11.1	10.1	7.4

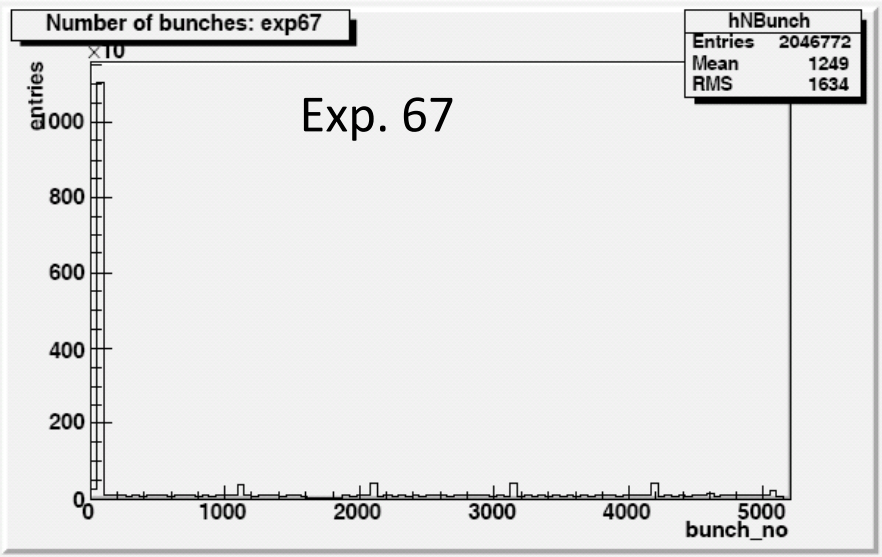
$$\sigma = \frac{N}{L \cdot R}$$

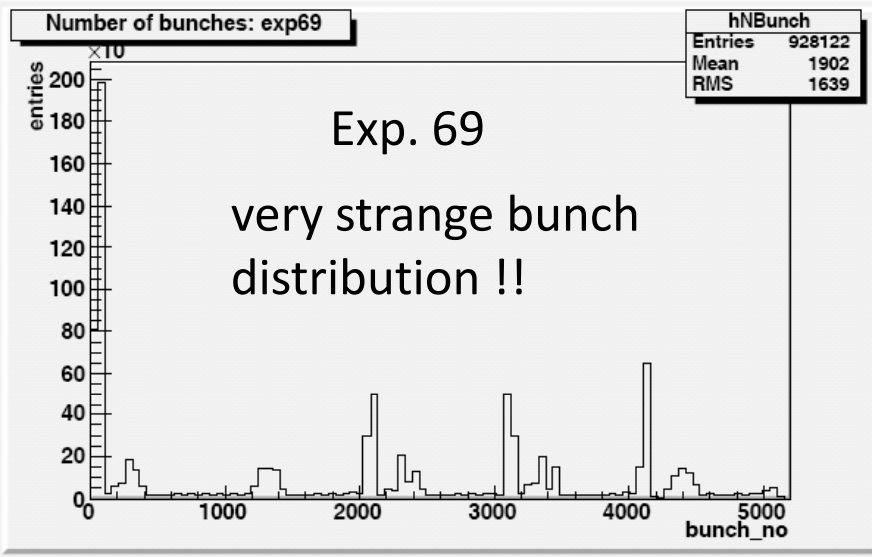
** delay did not work

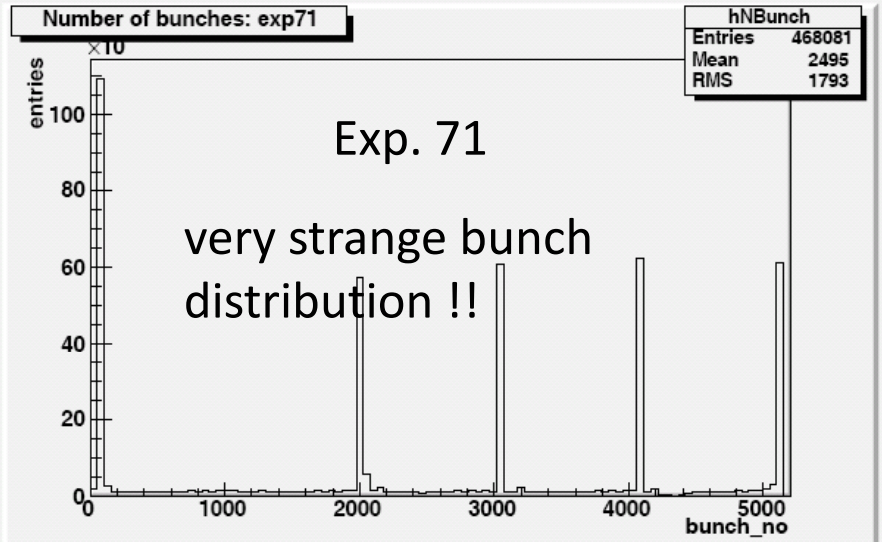
Comparison with experiments at the Y(5S)

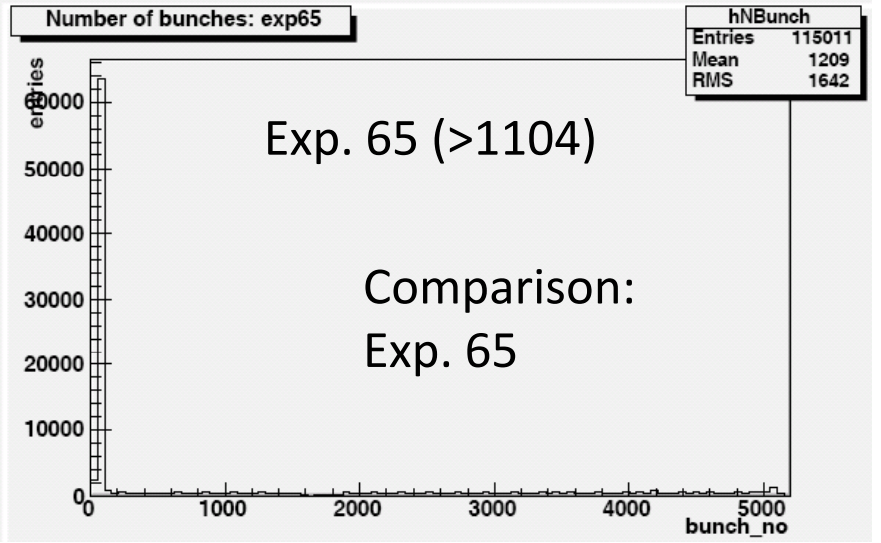


Bunch Distribution at the Y(5S)

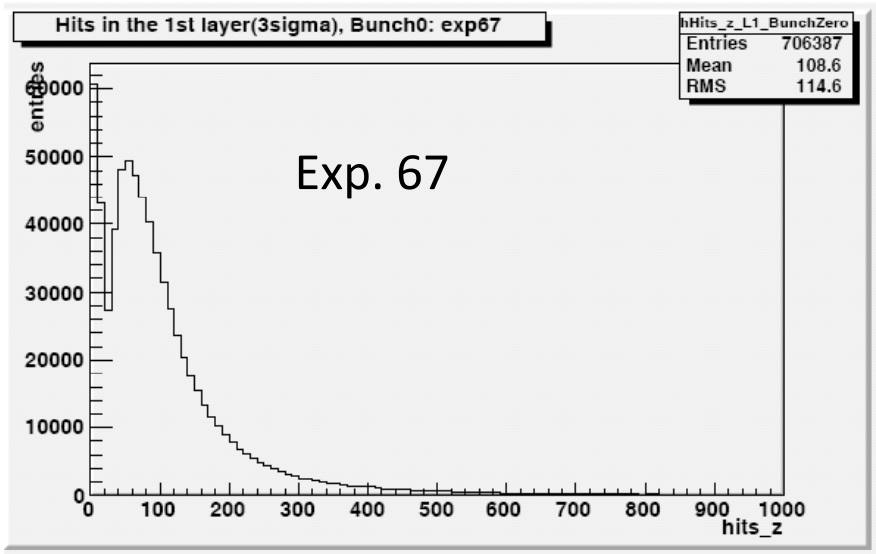


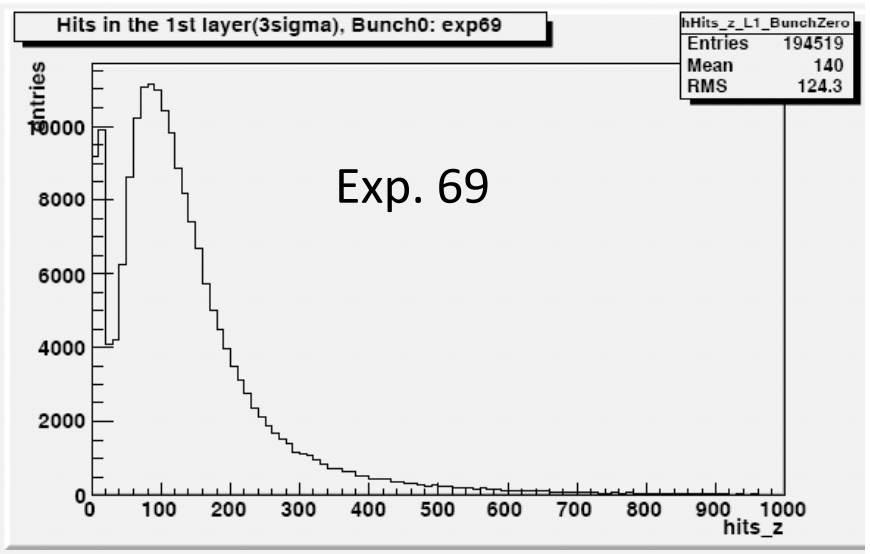


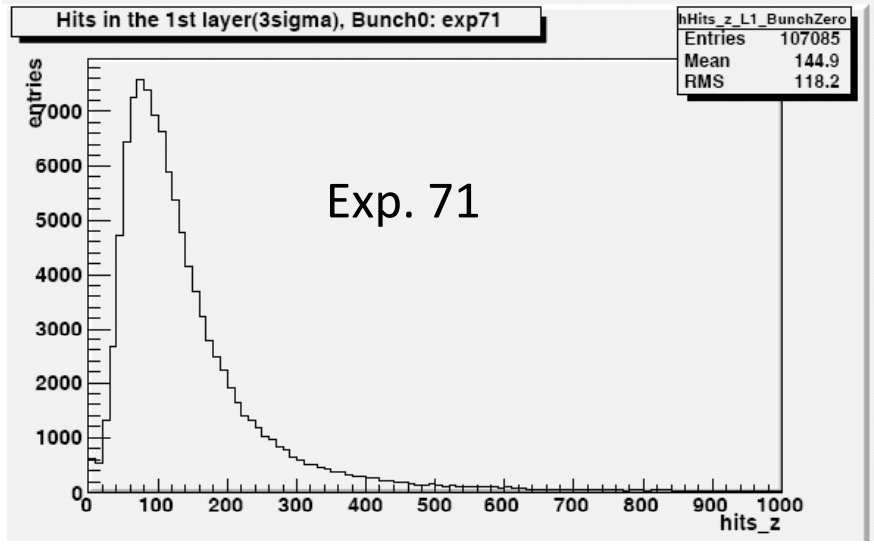


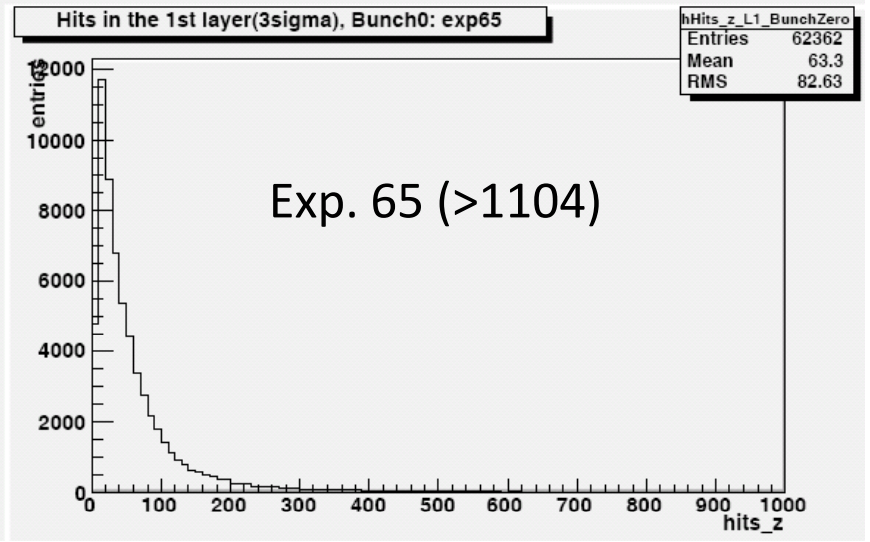


Layer 1, Bunch 0: Hit Distribution at the Y(5S)



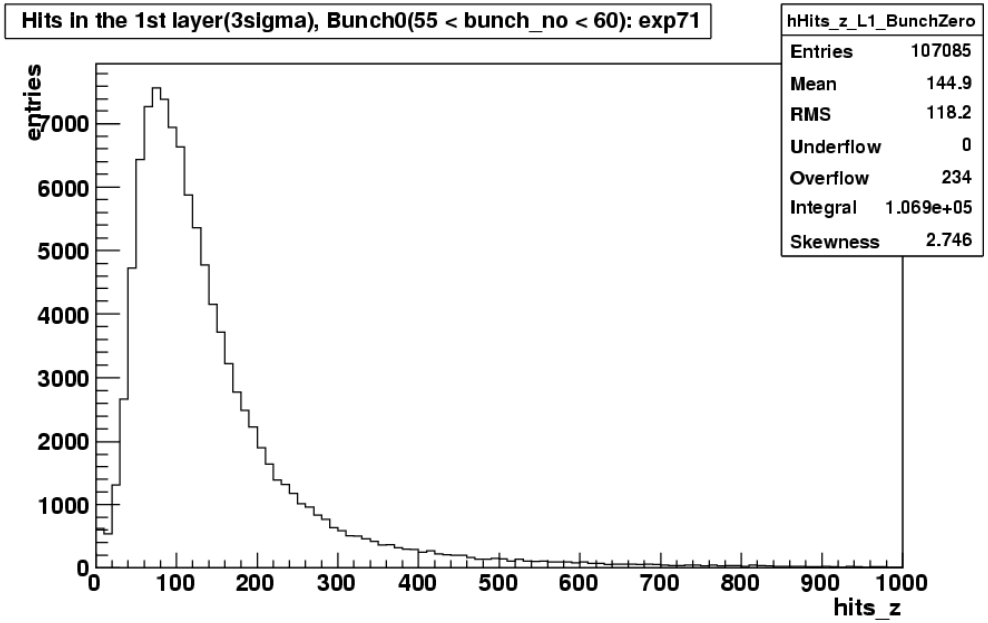


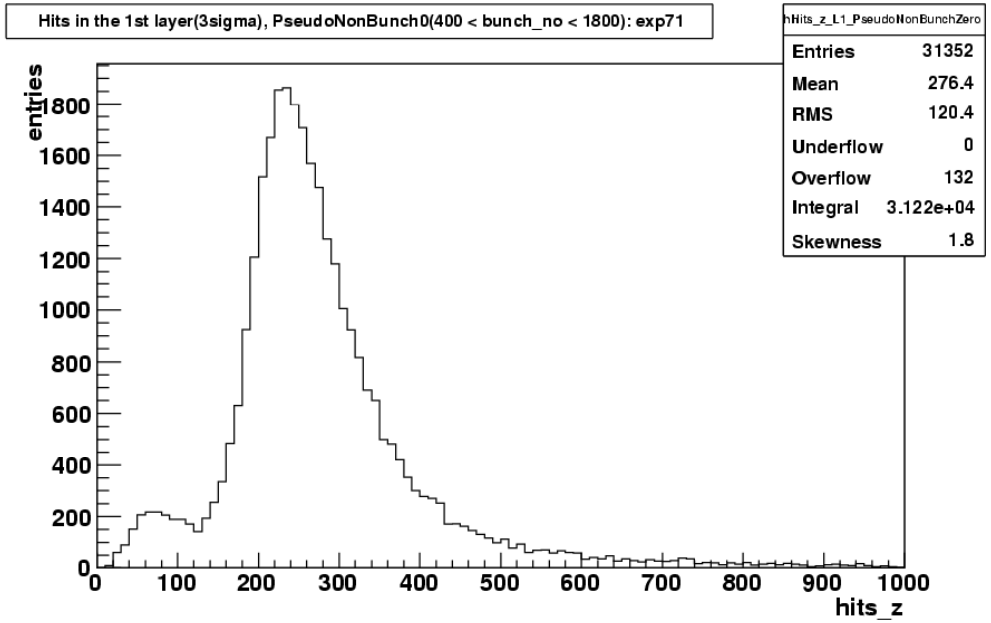


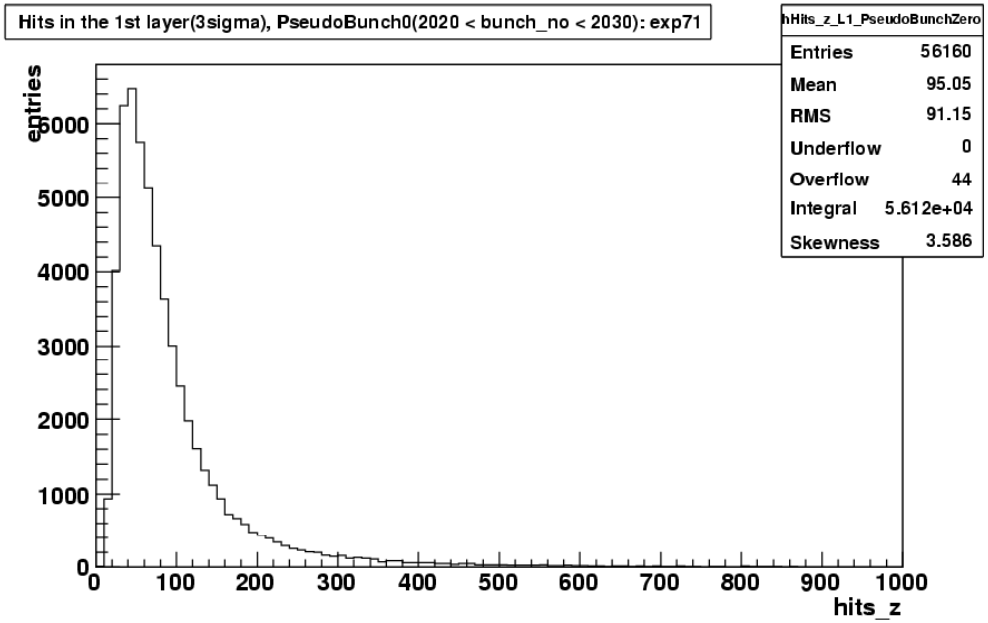


Hit distributions are similar

Layer 1, Bunch 0 and „Pseudo“- Bunch 0







Conclusion:

The additional peaks come from undelayed „bunch 0“-like triggers

(timing or counting the bunches does not seem to work)

Proposal for Random Trigger Runs

Assumption: The additional hits in the SVD are generated by:

- → beam background (roughly proportional to the beam current)
- → QED processes (proportional to luminosity)

Idea: try to separate the two components and thus determine the QED cross section

„simple“ solution: run with colliding and sepatated beams

colliding: beam-gas + QED

separated: only beam-gas

Exp. A

Proposal for Random Trigger Runs (cont.)

Cross check of the beam separation method:

colliding beam runs with

- changing transverse size of beam spot (**Exp. B**)
- changing beam currents (beam optics unchanged) (**Exp. C**)

For each of the 3 experiments we propose a set of 8 runs with
a total of 200 k – 400 k random triggers and 50 k Bhabha (lumi) triggers.

The number of events is determined by requiring a <1% accuracy for the average number of hits in each of the four SVD layers

(for Exp. A there are no Bhabha events.
Still the Bhabha trigger should be enabled during all time)

Proposal for Exp. A (colliding / separated beams)

Random trigger rate: 100 Hz

Bhabha trigger rate: 50 Hz

adjust prescale at nominal, but moderate luminosity.

It would be sufficient to run with 5 /nb s (normal running: ~ 15-20 /nbs)

Run unit: 200 k triggers at 100 Hz = 1hour

8 run units (4 with colliding, 4 with separated beams)

Together with setup for beams: 2 full shifts

Proposal for Exp. B (change beam size)

Random trigger rate: 100 Hz

Bhabha trigger rate: 50 Hz

adjust prescale at nominal, but moderate luminosity.

It would be sufficient to run with 10 /nb s

Run unit: 200 k triggers at 100 Hz = 1hour (including beam setup)

4 run units with decreasing lumi:

10, 8, 6, 4 /nb s
200 300 400 500

Together with setup for beams: 1 full shift

Proposal for Exp. C (change beam current)

Random trigger rate: 100 Hz

Bhabha trigger rate: 50 Hz

adjust prescale at nominal, but moderate luminosity.

It would be sufficient to run with 10 /nb s

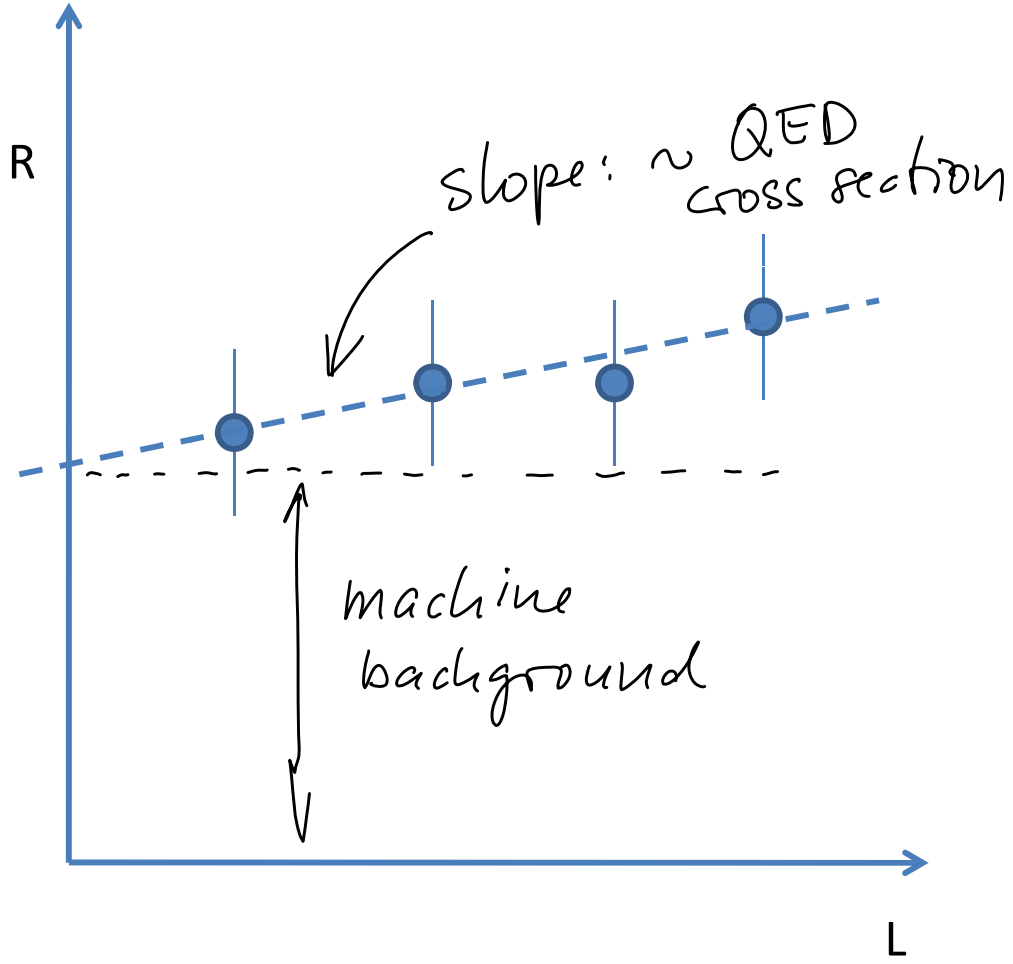
Run unit: 400 k triggers at 100 Hz = 1.5 hours (including beam setup)

5 run units with decreasing beam current
(changing number of filled bunches, default optics):

full machine, 3/4, 1/2, 1/4 , 1/6, 1/8

Together with setup for beams: 1 full shift

Analysis



Machine Program:

Run on the Y(5S) from May 20

Take QED data starting on May 27 (at the earliest)

Run with 400 Hz rndm trigs

Do online analysis with programs (plots) developed