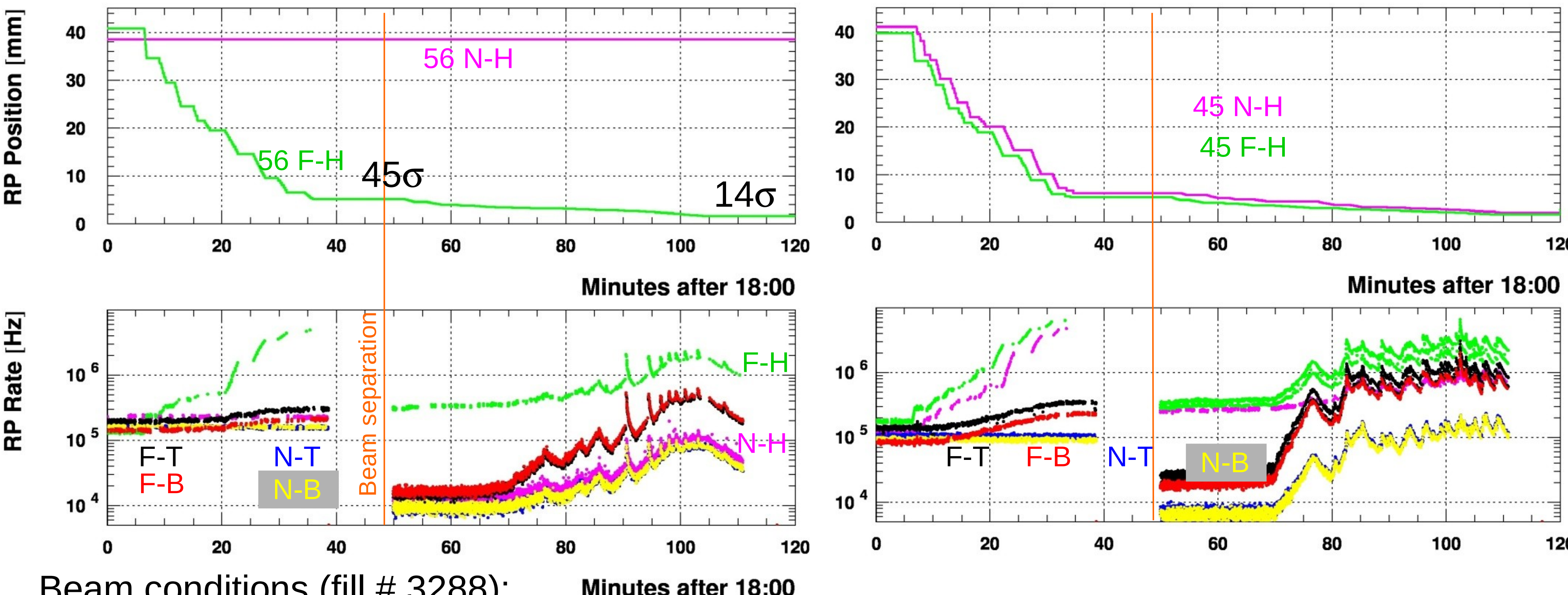
What can we learn from data?

RP insertion 15/11/2012

TCL5 at 60 sigma = 21 mm

Reference time: 15 November 2012, 18:00 h



Beam conditions (fill # 3288):

$N_p \leq 1.6 \times 10^{11}$ p/b

E = 4 TeV

$\beta^* = 0.6$ m

$\varepsilon_n = 2.8\ \mu$m rad

$\mu = 31$ (without separation)

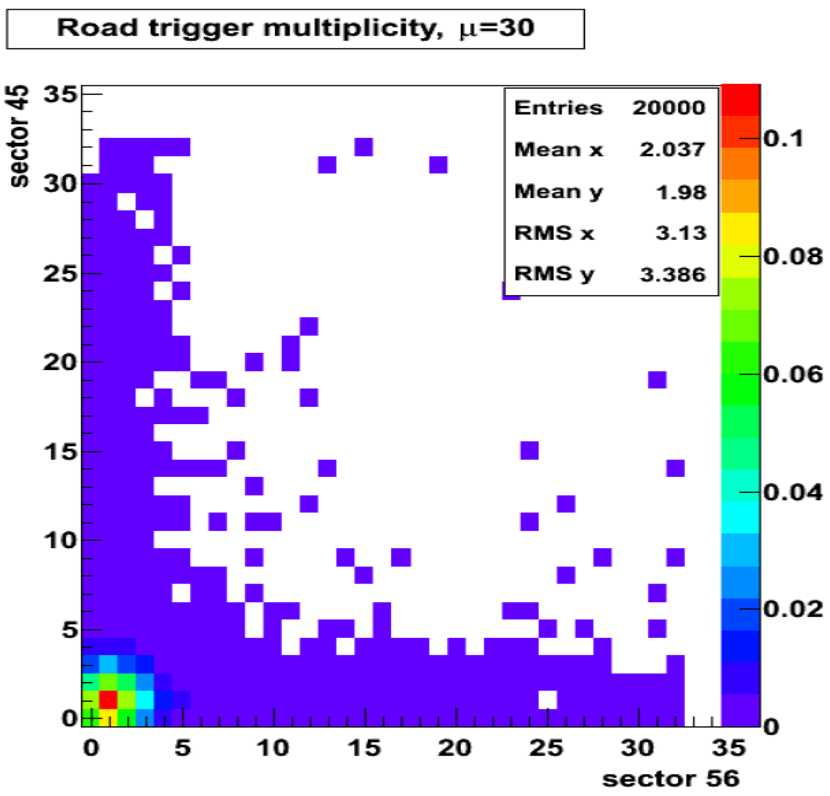
Extrapolated rate for 1368 b without separ.	56 F-H 31 MHz	45 N-H 19 MHz	45 F-H 68 MHz

What can we learn from data?

Sample

β^* = 0.6 m ; E = 4 TeV ; N_p ~ 0.8 x 10^{11} p/b ; ε_n ~ 2.5 μm rad ; 1 bunch; μ ~ 9 ; $\mathcal{L}$ ~ 10^{30} Hz/cm^2

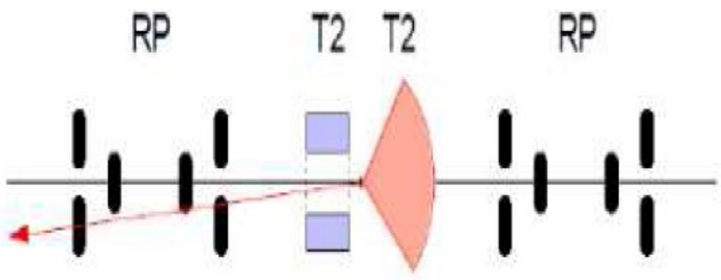
RP Alignment (6σ)



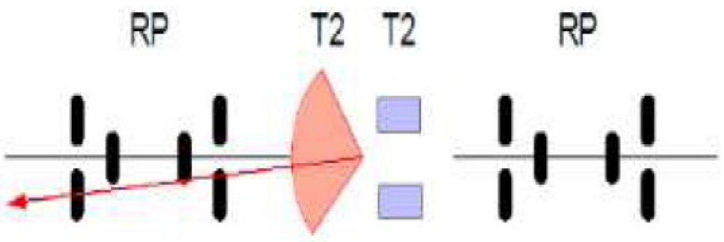
rate/bunch (khz)	DATA μ=9	
RP_45 || RP_56	RP_1arm	RP_2arms
6.6	4.3	1.4

rate/bunch (khz)	EXTRAPOLATED μ=30	
RP_45 || RP_56	RP_1arm	RP_2arms
10	4	6.5

Background estimate: **collision debris (low β) & beam halo (high β)**



"RPT2 Opposite" enriched of diffractive protons



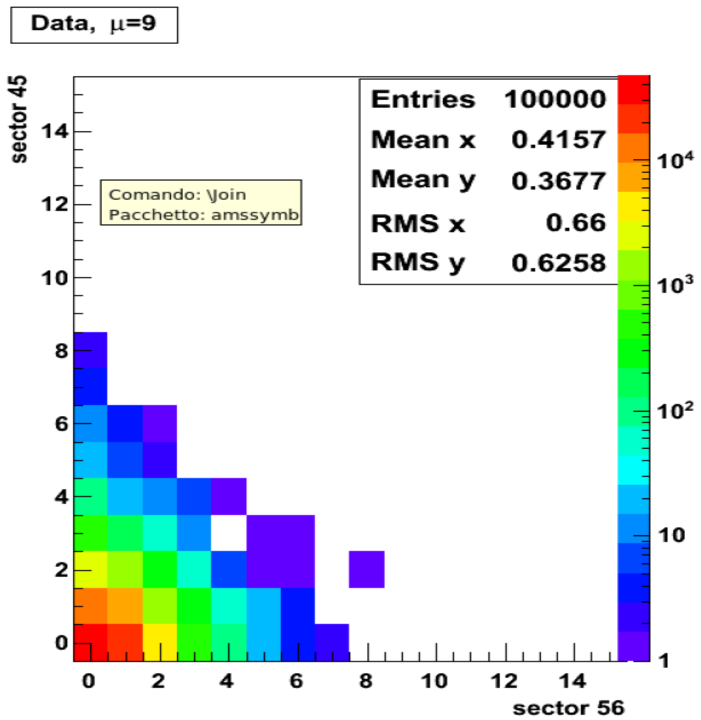
"RPT2 Same" enriched of background protons

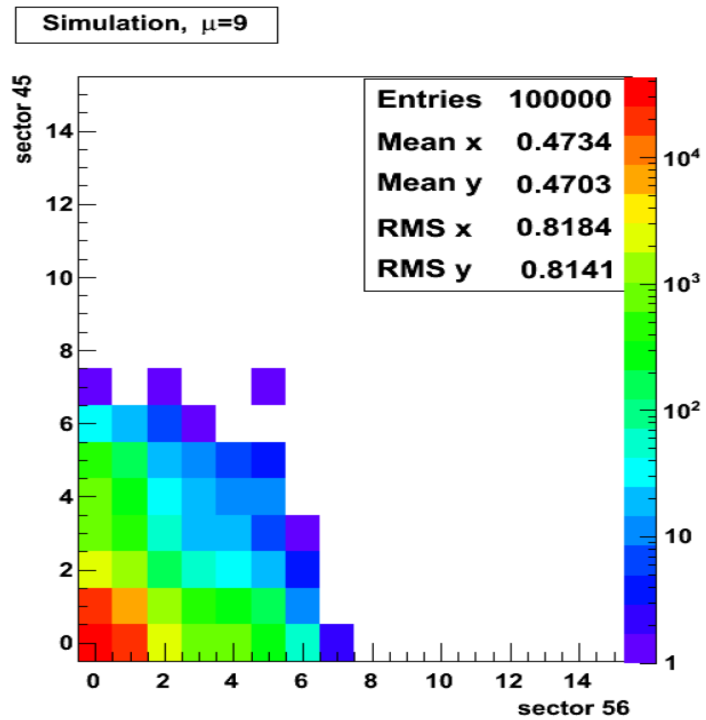
From data: background probability ~ 17%

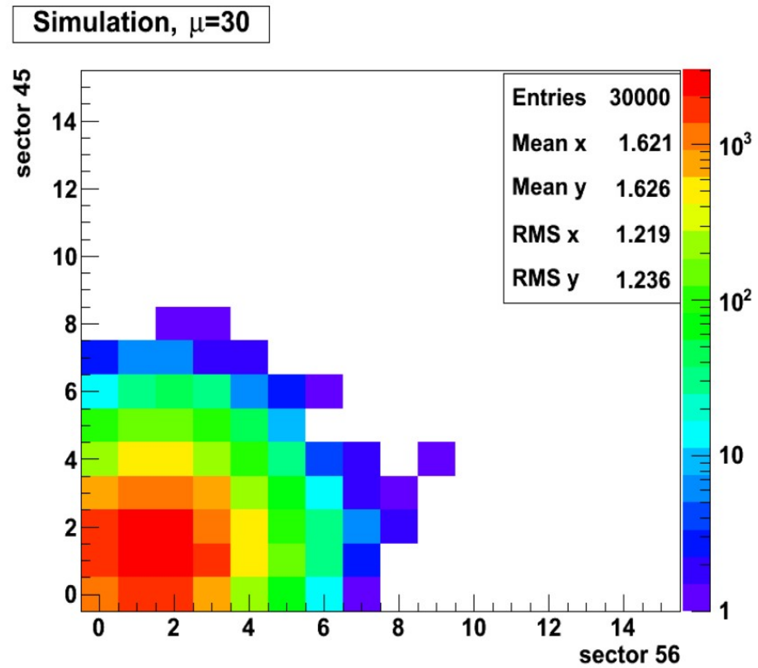
Strategy to extrapolate the background cross checked with simulation in order to reproduce the track multiplicity in data (some rescale factor needs to be applied!)

Estimate of the collision debris for high-β in progress

Simulation vs Data : Track multiplicity – low β



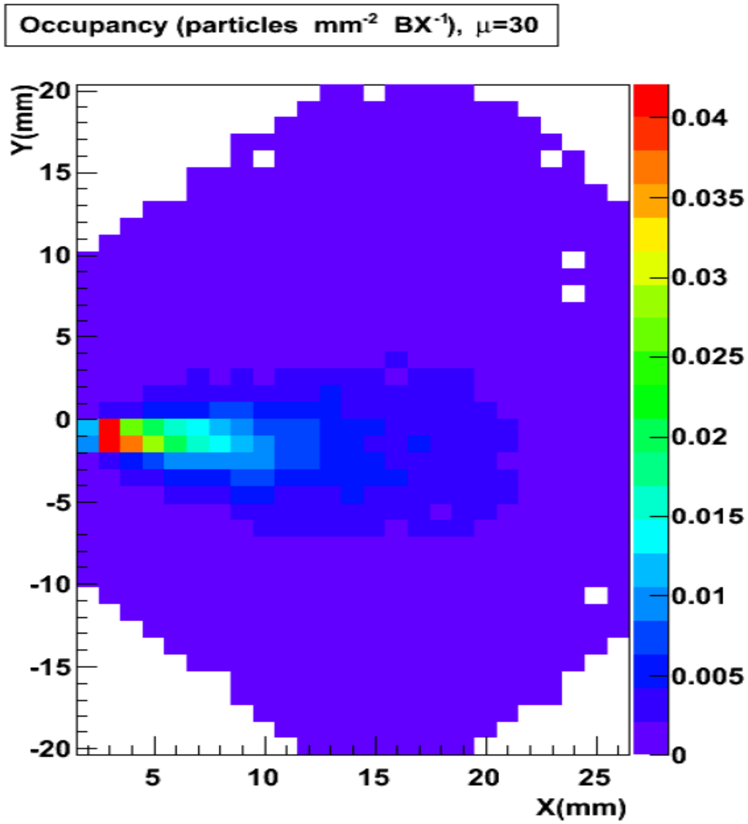




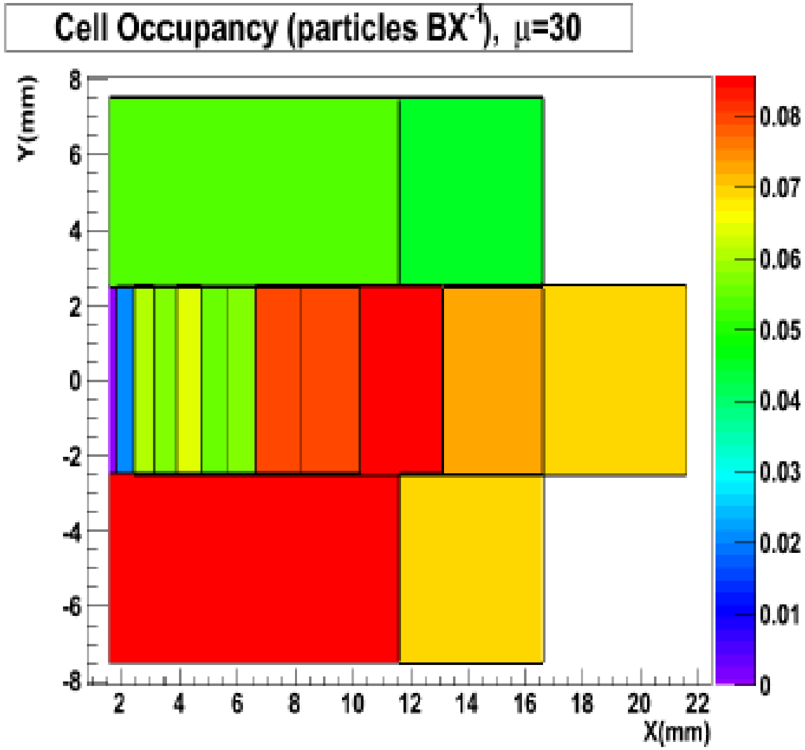
We assume we can simulate the background, also in terms of spacial coordinate.

This allows to:

- study optimization of the read out geometry of timing detectors
- study trigger algorithms (L1, HLT) to detect central diffractive events at very high pile-up



Timing detector geometry: optimization of cell geometry



Inefficiency (CD event) due to multiple hits in one cell

	μ =30 M-Cut	μ =30, No M-Cut	μ =50, No M-Cut
Optimised geometry	9%	19%	29%
Fixed square cells	18%	36%	50%

Trigger studies: low β

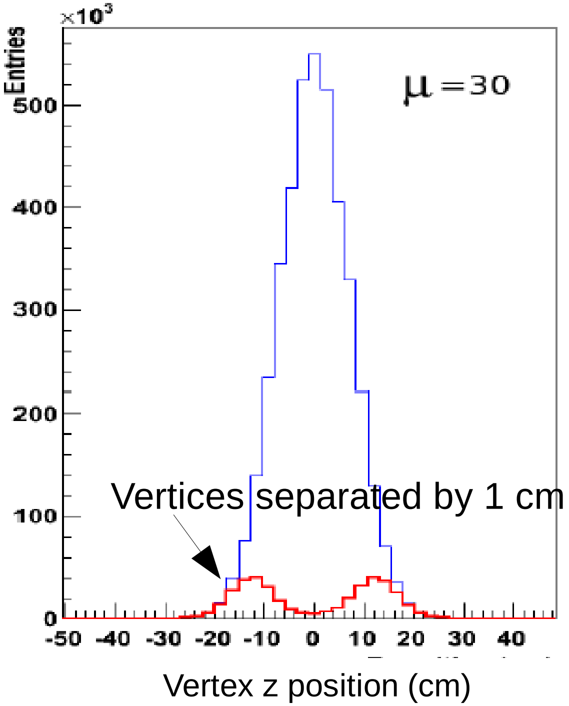
Definition of cuts:

➢ Double Arm : signal in left & right arm to tag Central Diffraction
➢ 2x2 trigger roads: max 2 roads on each arm – to exclude showers generated close to the detector

➢Timing detector resolution = 25ps

➢Observables: t_{p1} , t_{p2}
$t_{IP} = (t_{p1} + t_{p2})/2 - t_{detector}$ → time of the collision
$\Delta t = t_{p1} - t_{p2} \sim z_{vertex}$ → position of the vertex

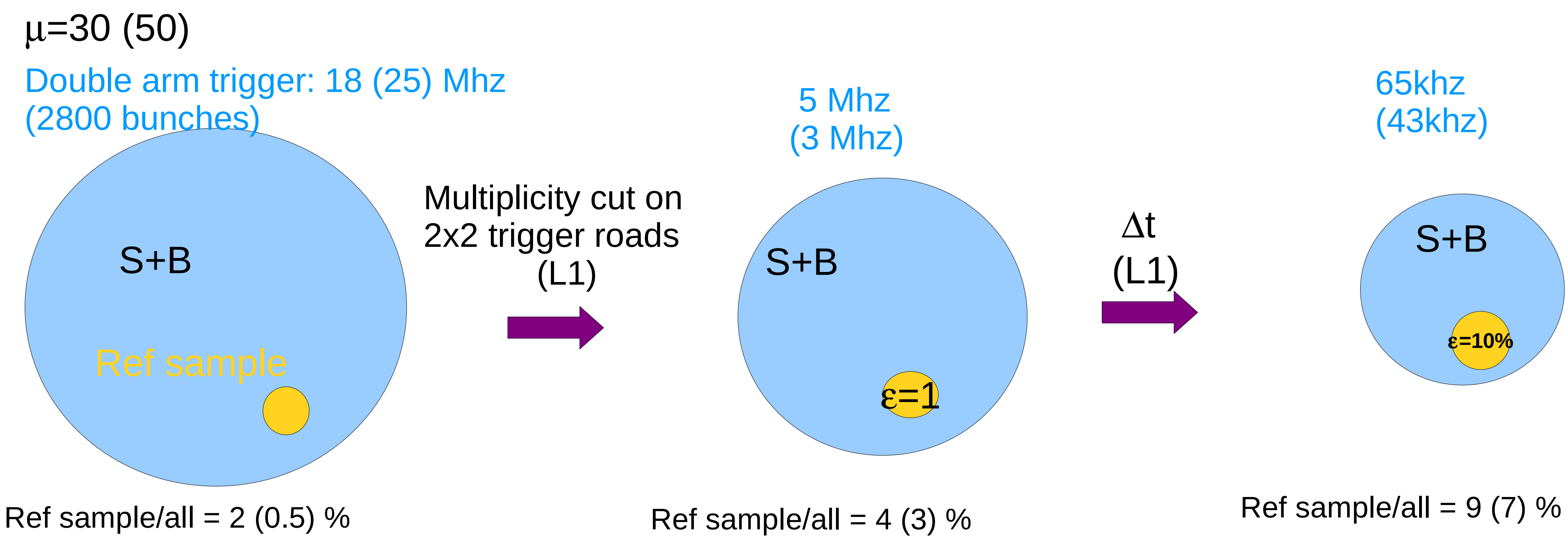
➢ Background: a little delay is added as the path should be different from the protons in the beam

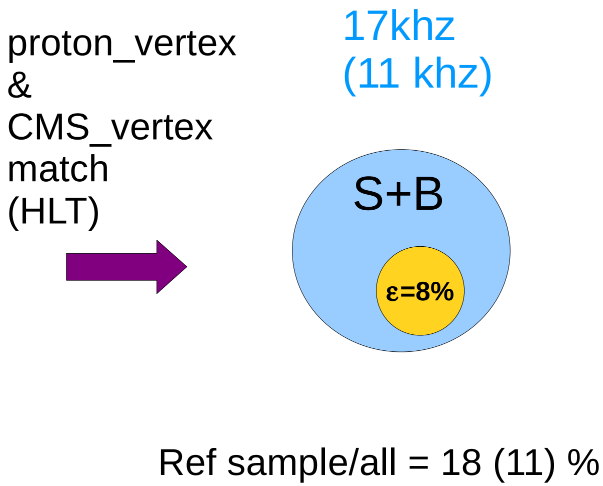


Reference sample:

Central Diffractive events
2x2 trigger roads max
vertex separated by 1cm

Trigger studies: low β





Trigger cuts allow to suppress the rate by 3 order of magnitude; further reduction can be achieved including central object selection

The purity of the reference sample is increasing

Trigger selection for CD events with an isolated vertex:

$\mu=30 \quad \sigma_{eff} \sim 2 \cdot 10^{-4}\, \sigma_{CD} \sim 2 \cdot 10^{8}$ *event/day*

$\mu=50 \quad \sigma_{eff} \sim 4.3 \cdot 10^{-5}\, \sigma_{CD} \sim 8 \cdot 10^{7}$ *event/day*

Running Conditions (for TDR)

β^* ~ 0.5-0.6 m
E= 6500 GeV

N bunch ~ 2800

N_{pp}~ 1.5 · 10^{11}

μ ~ 40-50

L ~ 1 / fb/ day

Central exclusive production of WW pairs

Let me choose central exclusive production of WW pairs. These events will be identified by two leptons (e or mu) plus missing ET in the central detector, and two protons in the forward spectrometer.

Selection cuts will include leptons PT, dilepton invariant mass, WW invariant mass, vertex matching (central vs timing), invariant mass matching (central vs pps).

The sources of background are hard pp collisions producing:

- QCD jets (fake leptons, leptons from heavy flavors decays)
- Drell-Yan lepton pairs including Z peak
- top quark pairs in dilepton final states
- dibosons (WW, ZZ)
- may be others

in coincidence with two forward protons from pileup events:

- two independent SD interactions
- diffractive production of excited states decaying with a proton seen in pps
- may be others

We would need to have these diffractive events included in the pileup simulation, such that we could:

- extrapolate the protons in these events to pps
- smear the proton kinematics as measured in pps
- smear the protons time
- merge this information with the central detector event data (all background processes above)
- apply the rejection cuts vertex matching and invariant mass matching
- apply all other central kinematics cuts
- estimate the number of surviving background events.

This estimation of background events is mandatory to assess the sensitivity of pps to quartic gauge couplings, in this particular case.

A similar thing will be needed to assess the backgound events in cep dijet production.

Joao

Central exclusive production of WW pairs

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- dibosons (WW, ZZ)
- may be others

in coincidence with two forward protons from pileup events:

- two independent SD interactions
- diffractive production of excited states decaying with a proton seen in pps **(known ?)**
- may be others -> beam-beam background / beam halo background

We would need to have these diffractive events included in the pileup simulation, such that we could:

- extrapolate the protons in these events to pps
- smear the proton kinematics as measured in pps
- smear the protons time

→ **+ Reco efficiency (p interaction in the RP material)**
+ multiplicity selection?

- merge this information with the central detector event data (all background processes above)
- apply the rejection cuts vertex matching and invariant mass matching
- apply all other central kinematics cuts
- estimate the number of surviving background events.
- **Trigger efficiency**

This estimation of background events is mandatory to assess the sensitivity of pps to quartic gauge couplings, in this particular case.

A similar thing will be needed to assess the backgound events in cep dijet production.

Joao

Central exclusive production of WW pairs

My understanding:

- Trigger CMS (no protons) *[check the rates and if there will be any prescale] -> Trigger efficiency*

- Generate signal + physics background including protons

- HLT/Analysis :

  * Central selection
  * include the two protons: $t_{p1} \sim t_{p2}$

    $Vertex_{central} \sim Vertex_{p1p2}$

    → timing detector resolution (could bring some cut on the vertex position?)
    → pixel/timing detector occupancy (including beam background): how many tracks can be accepted?
    → RP proton interaction (generating showers) ~ 2%

Can we disantangle the simulation of the timing detector performance?

Central exclusive jet production

My understanding:

- Trigger CMS (dijets p_T>200 GeV?) + 2 protons : rate very high, need to apply several cuts (see before)
  -> *Trigger efficiency*

- Generate signal + physics background including protons

- HLT/Analysis :

  * Apply the cuts foreseen at L1/HLT

  * as before timing information needed:
    Can we disantangle the simulation of the timing detector performance?