FTT Video Conference

Wednesday, Okt. 20, 1999.

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FTT L1 Design Studies

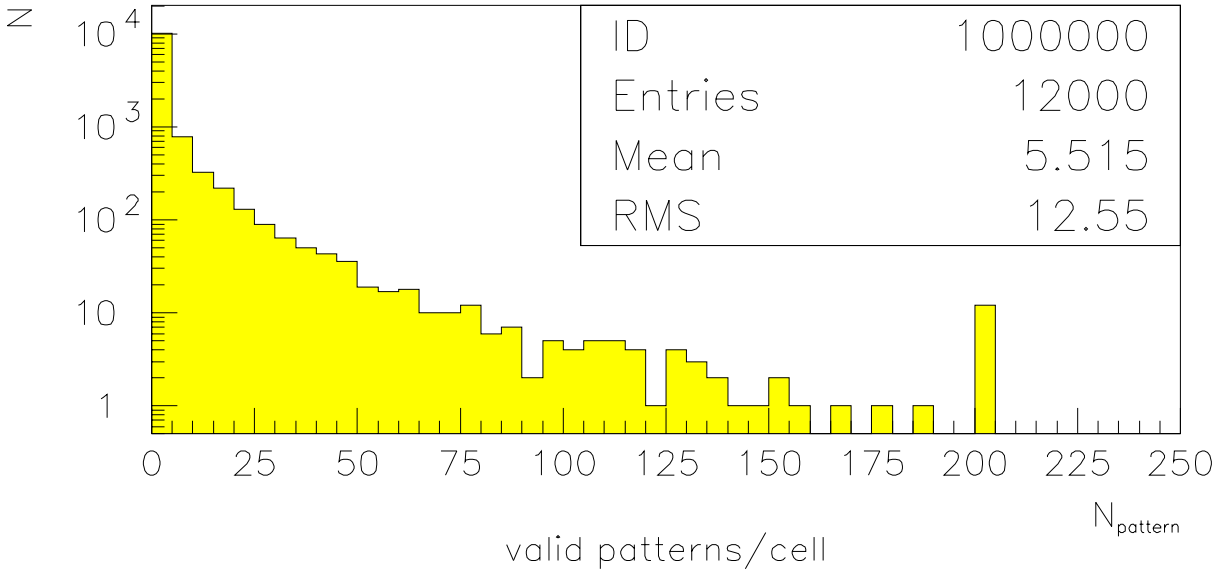
- Special code for L1 to FTTEMU added
- Starting point are D^* events from 1997
- Same L1 Scheme as shown on last meetings studied (pivot element technique)
- Synchronisation frequencies 80/20MHz used
- Valid masks are evaluated by the ”fit method” (chi2 cut not optimised)

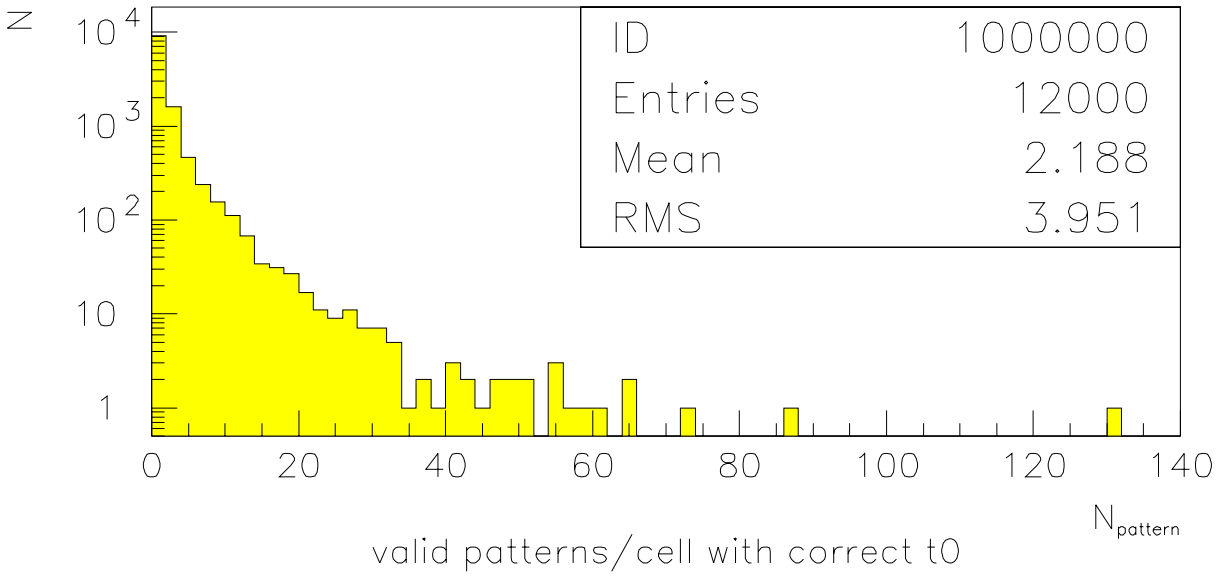
Typical Simulation Output

Printed from ufenau

```
****************************************************************

SHIFT REGISTER  f_synch=20MHZ  with  24 bins

****************************************************************
printout for   ievt=     1    group=     1  cell=     6
               nsh2=    11  nsh2tok=     3
           P
000000000000000000010000   11  6  2    0
000000000000001112110000   11  6  2    0
000000000000000000001100   11  6  5    0
000000000000000110000000    5  6  2   -1
000000000000000012000000    7  6  2   -1
000000000000000000100000    7  6  2   -1
000000000000000010000000    5  9  2   -1
000000000000001000000000    5  6  5   -1
000000000000000100000000    7  6  5   -1
000000000000002000000000    5  9  5   -1
000000000000000100000000    7  9  5   -1


printout for   ievt=     1    group=     1  cell=     5
               nsh2=     4  nsh2tok=     1
           P
000000000001100000000000    5 10  2    3
000000000000120000000000    5 10  5    3
000000000110000000000000    7 10  2    3
000000000001000000000000    7 10  5    3


printout for   ievt=     1    group=     2  cell=     6
               nsh2=     2  nsh2tok=     2
           P
000000000000000000002000    0  3  7    0
000000000011111111112000    0  3  7    0


****************************************************************

 Description:    1 valid mask
                 2 valid mask correct t0

****************************************************************
```

Multiplicity of Valid Patterns

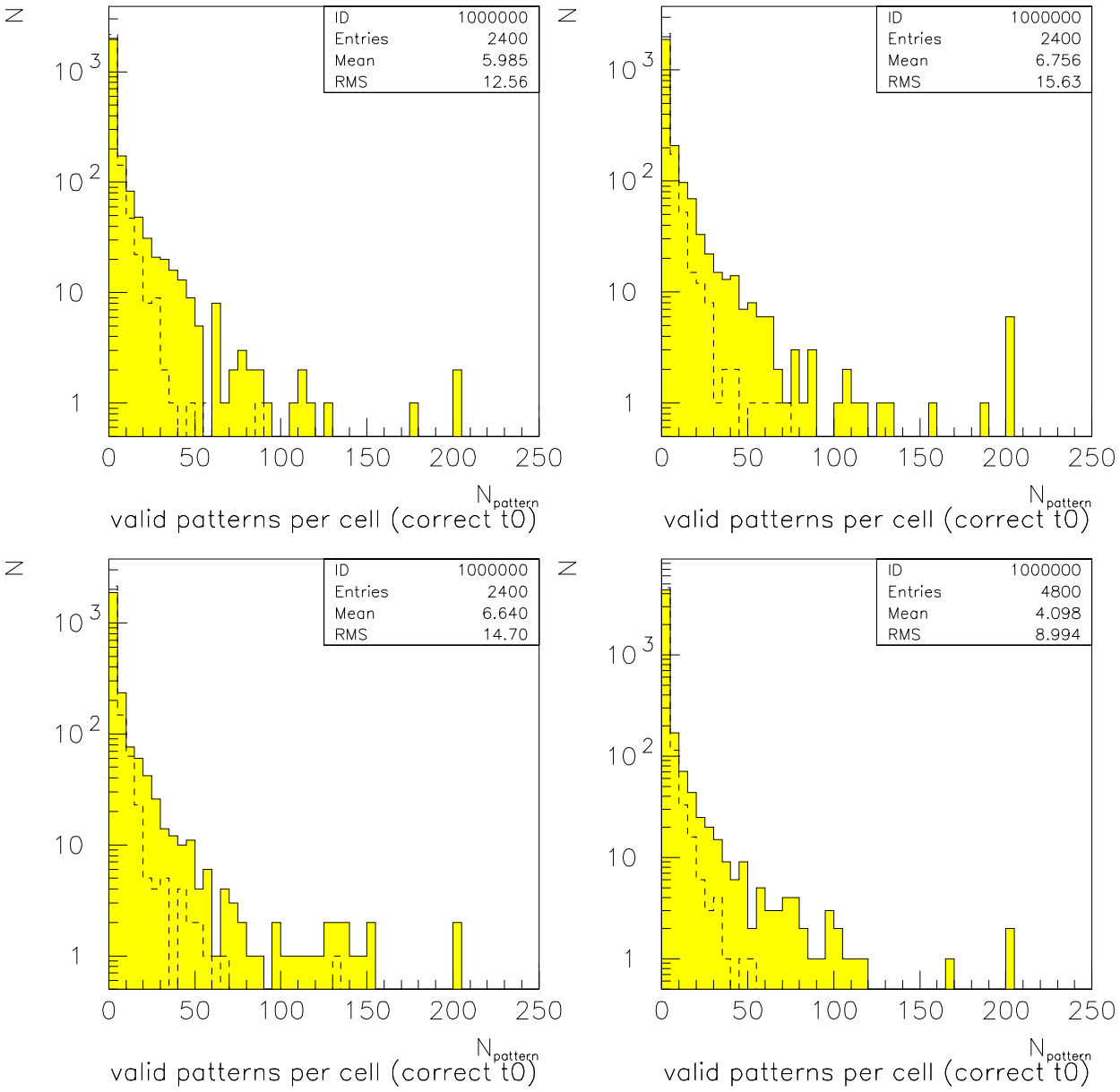




- overflow at 200 entries
- 70% of patterns do not include correct t0

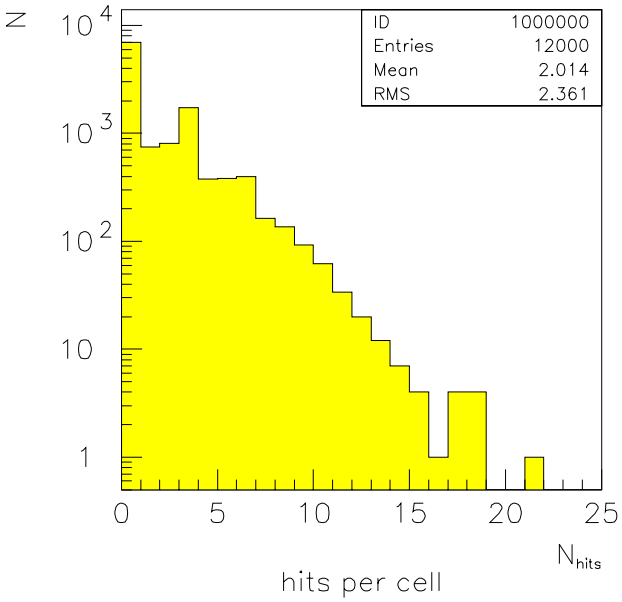
Definition: A pattern is time invariant hit combination

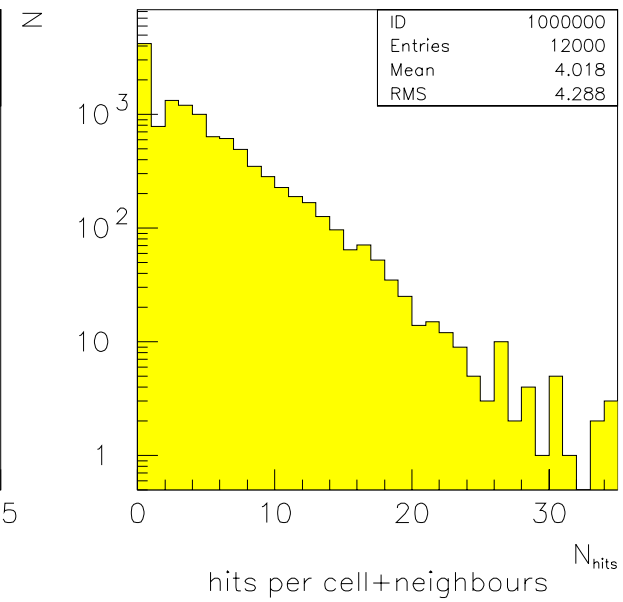
Multiplicity of Valid Patterns II

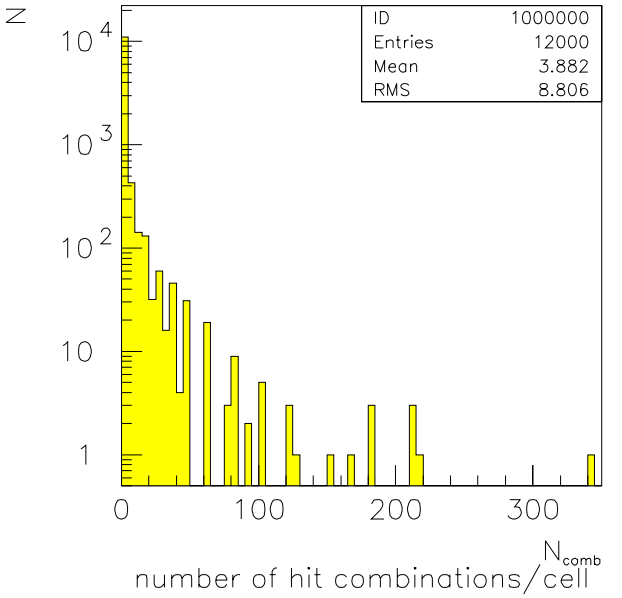


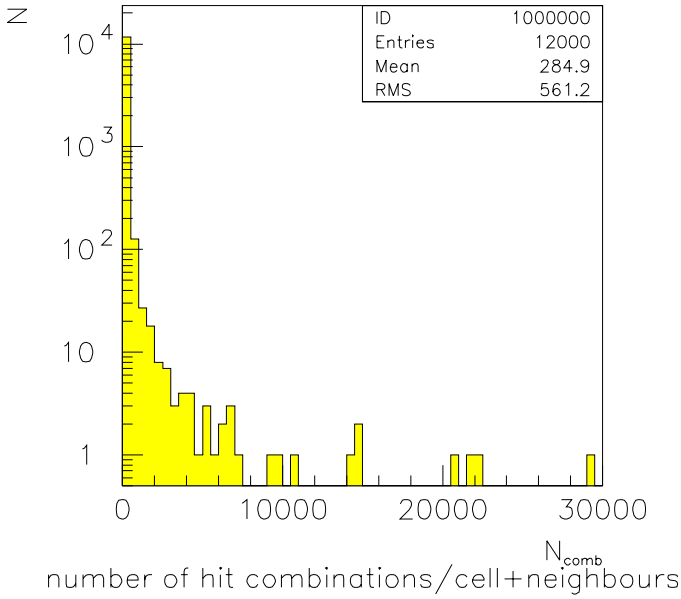
- For L1 Trigger decision all patterns up to 200 have to be taken
- For Track segment finding up to 50 patterns have to be taken

Hit Multiplicities per cell



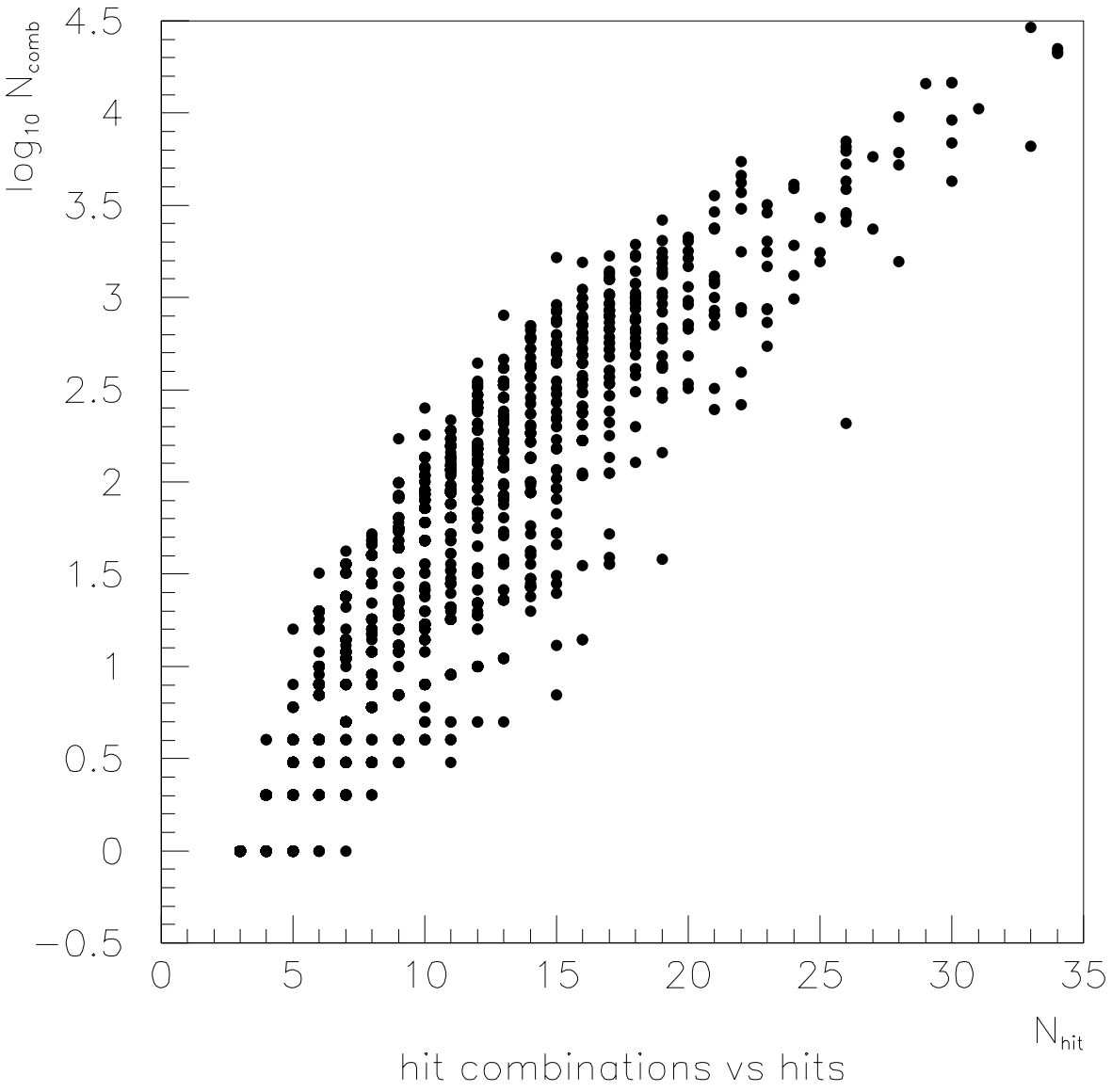






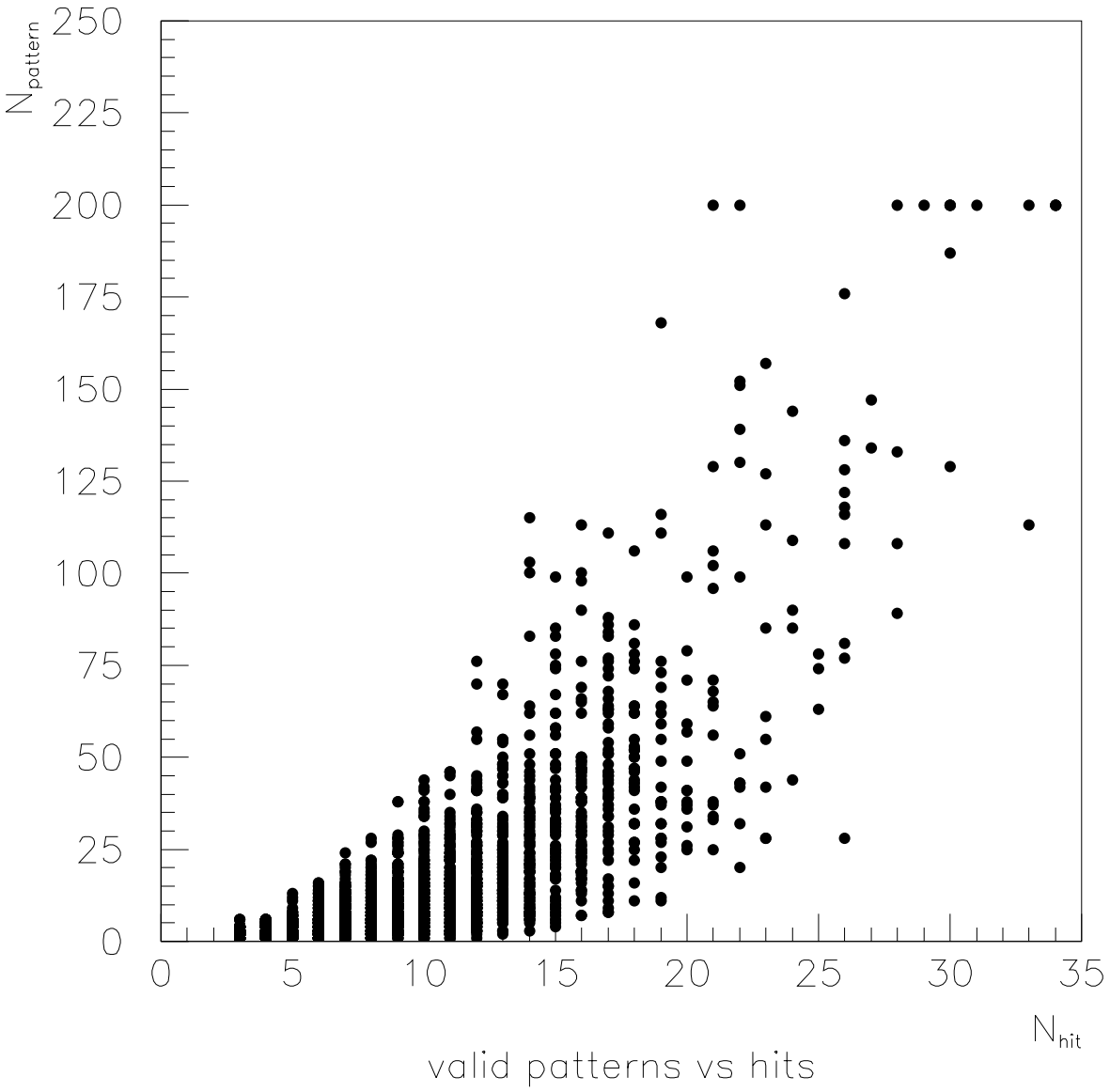
- Huge number of hit combinations to be validated
- Inclusion of adjacent hits let the number of combinations explode

Correlation hit combinations vs. hit multiplicity



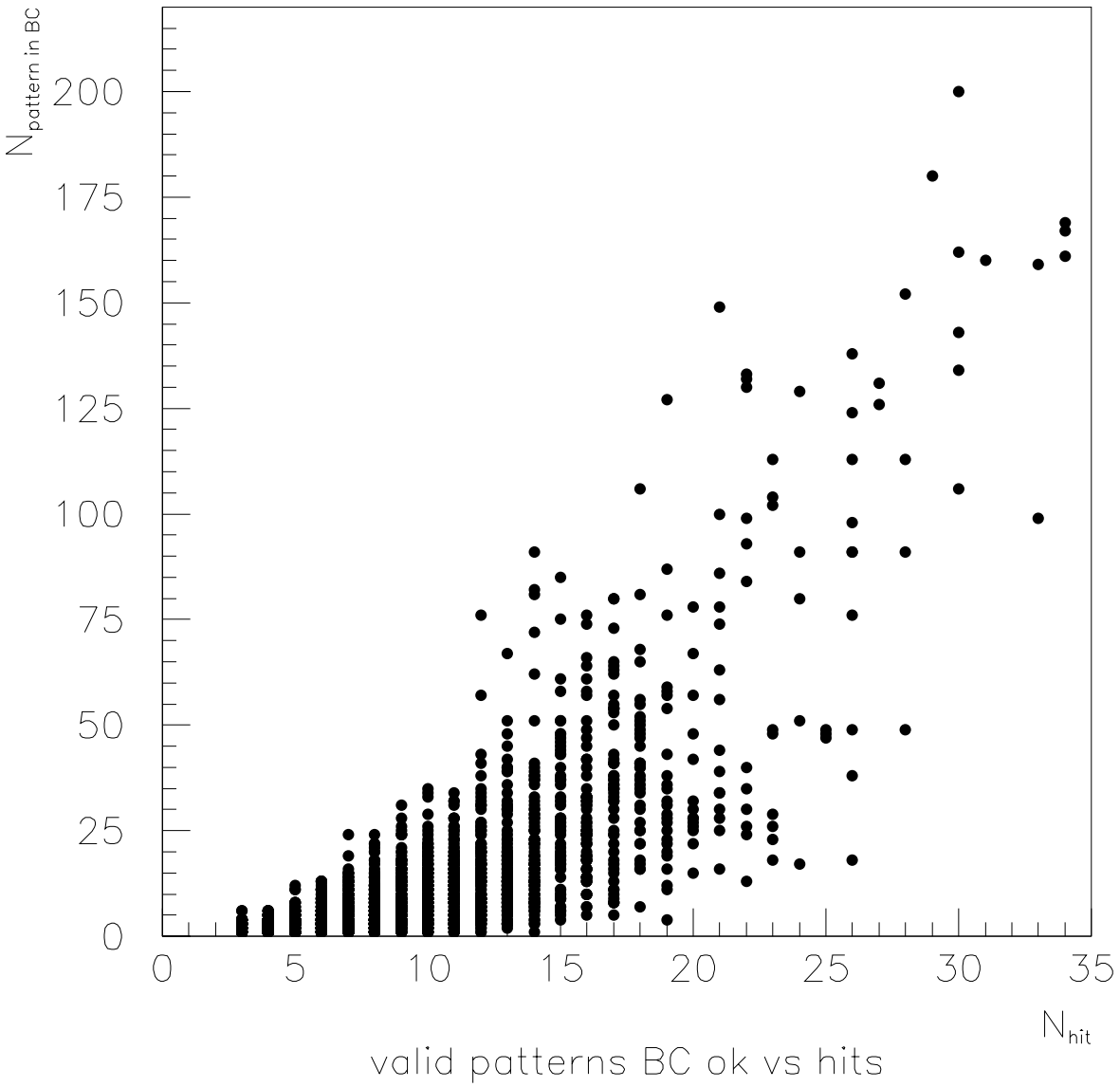
- Strong correlation
- Question: should the number of hits per cell be limited?

Correlation valid patterns vs. hit multiplicity



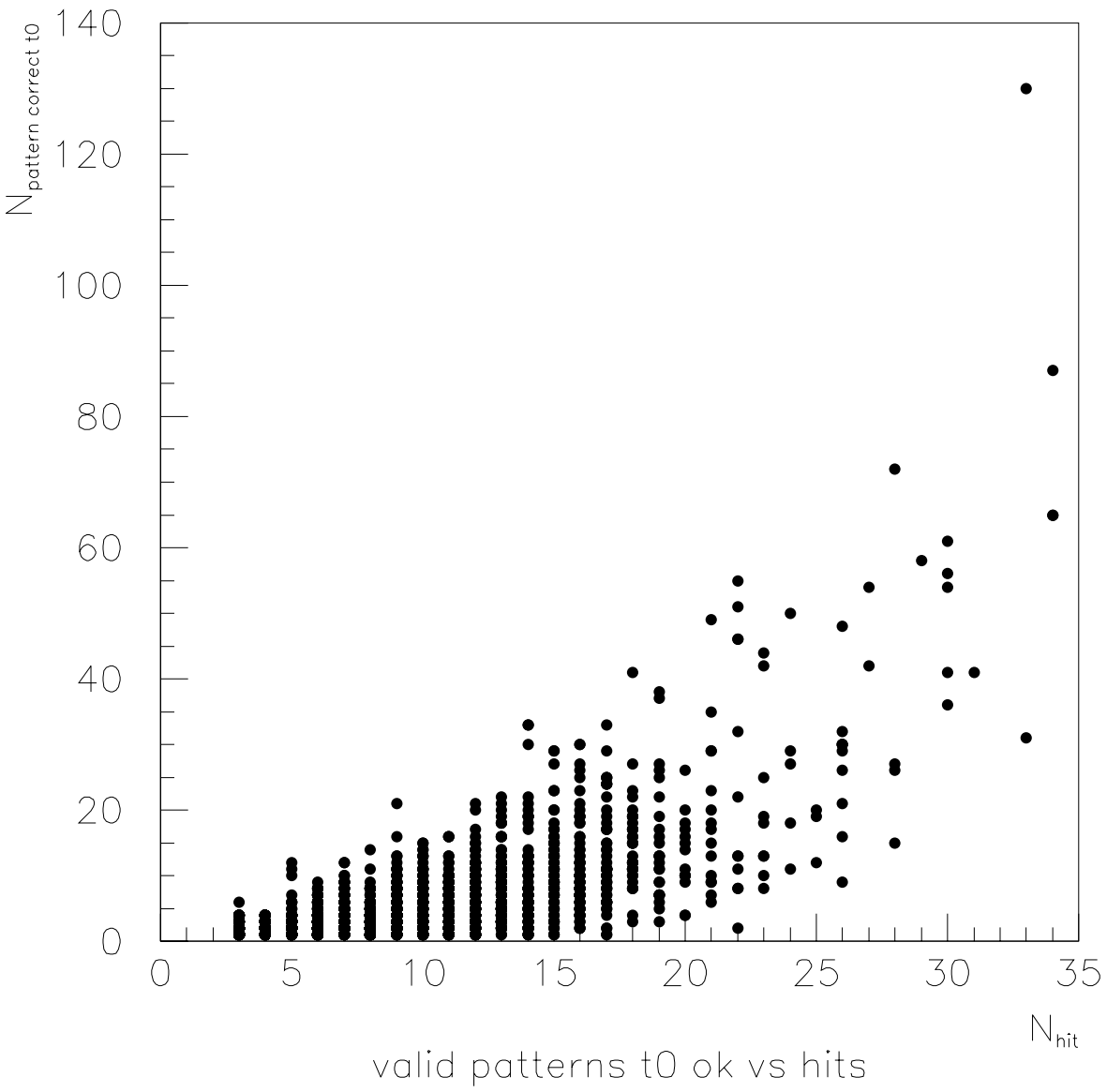
- Possible overflows for $N_{\mathrm{hit}} > 20$

Correlation valid patterns vs. hit multiplicity consistent with BC



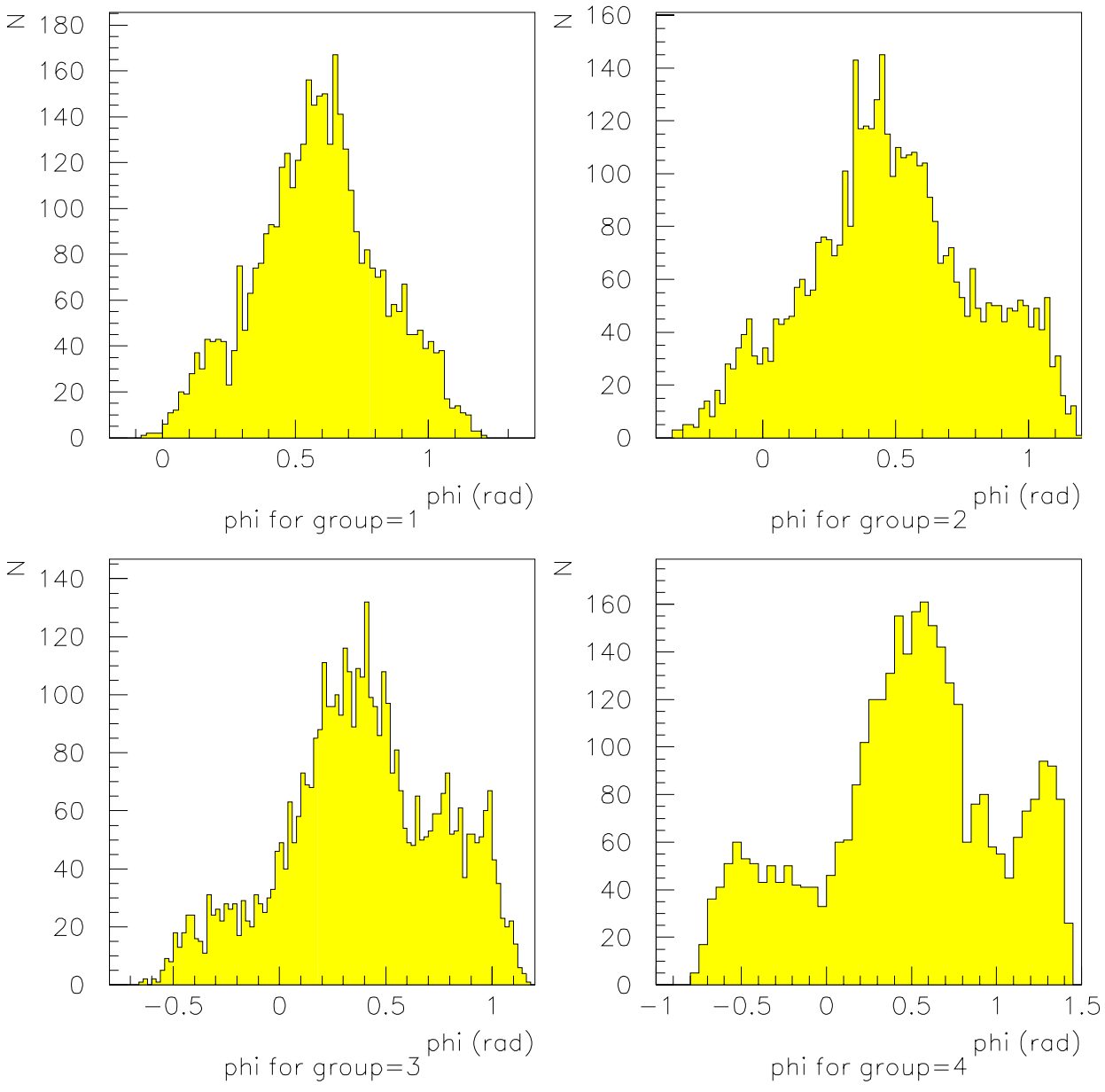
- Only patterns consistent with BC (20Mhz = 2 · 10MHz)
- Number of patterns slightly reduced

Correlation valid patterns vs. hit multiplicity with correct timing included



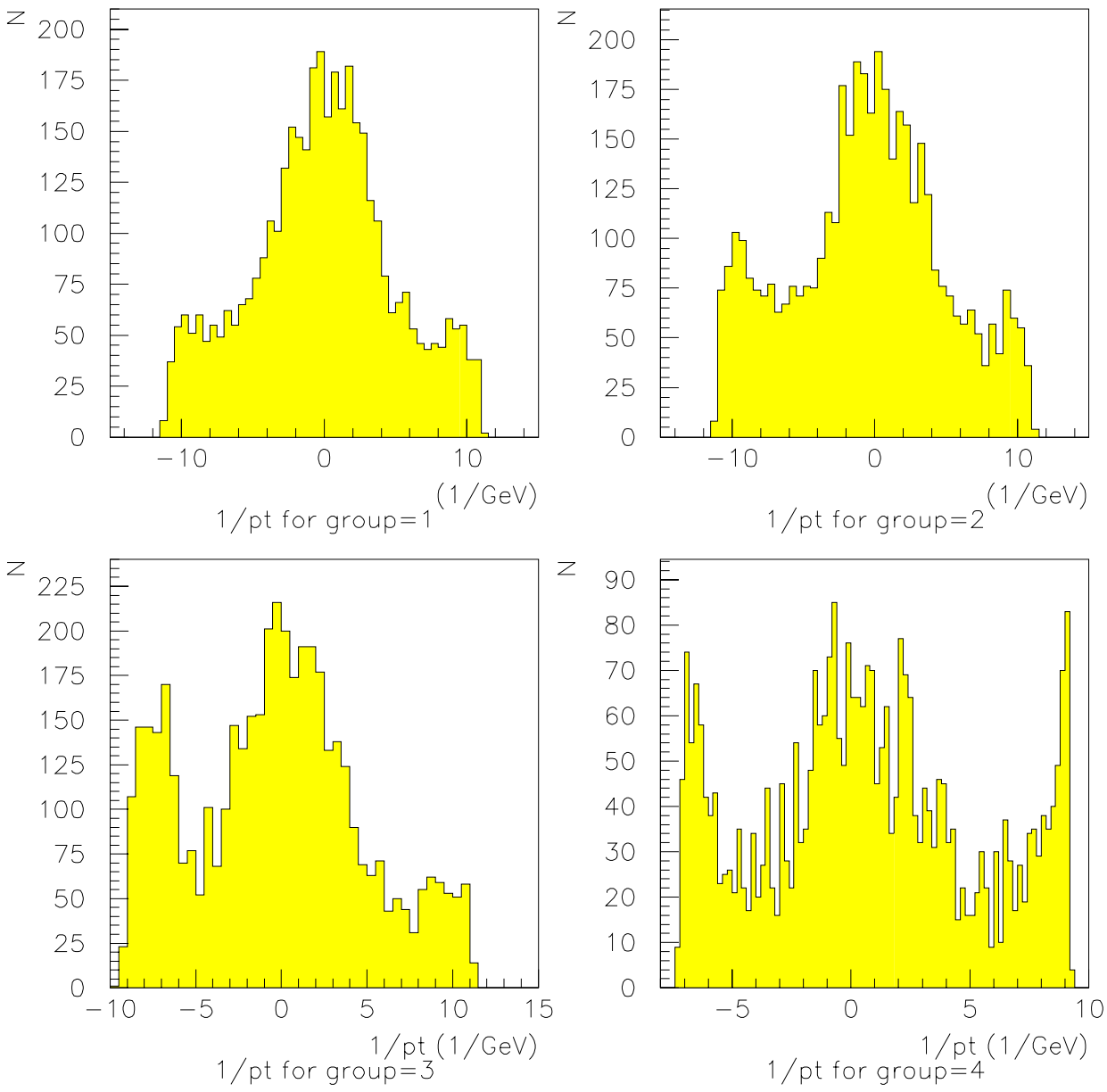
- Number of patterns reduced when t0 known

Distribution of ϕ



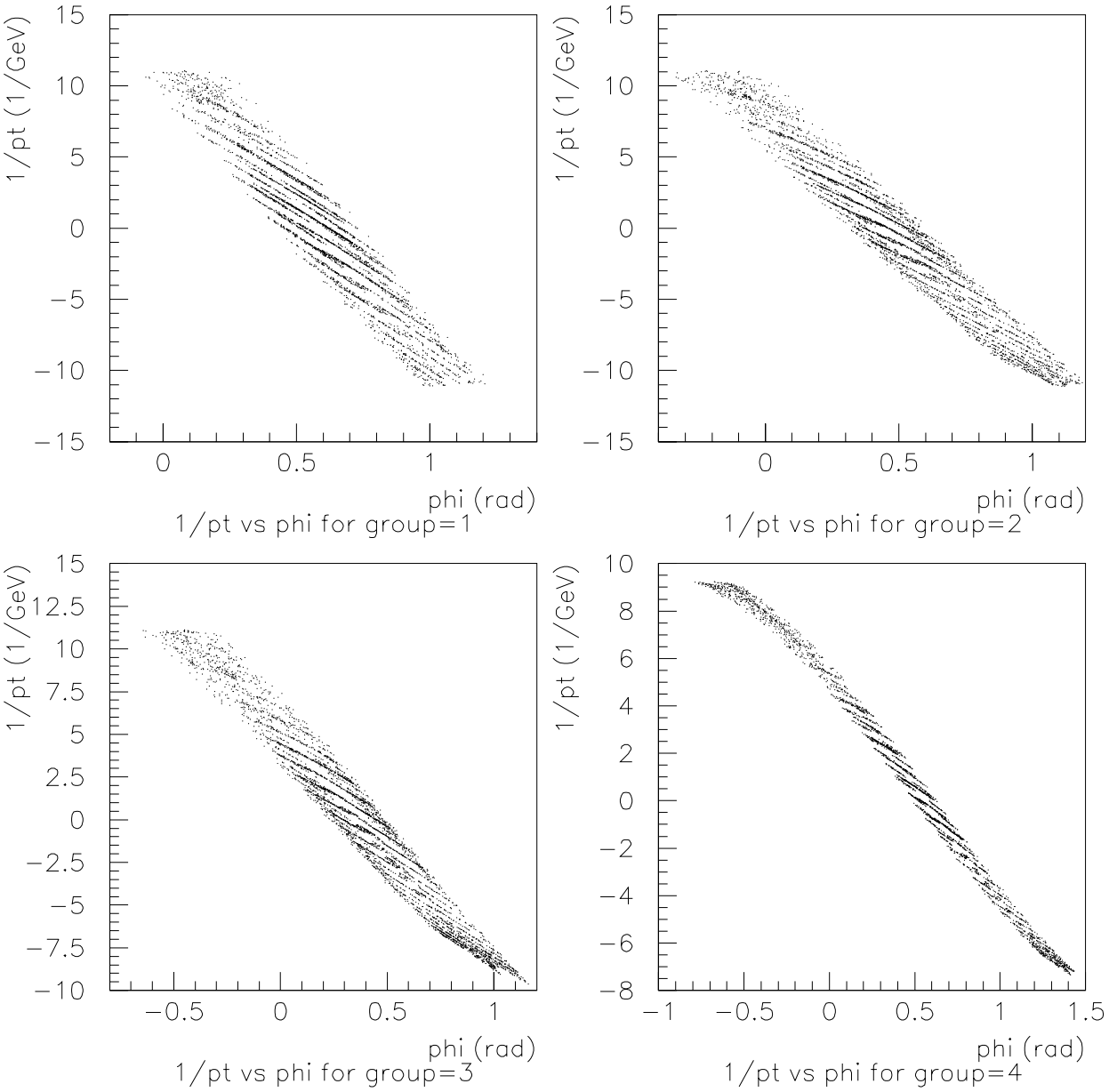
- ϕ is measured with respect to cell position

Distribution of $1/p_t$



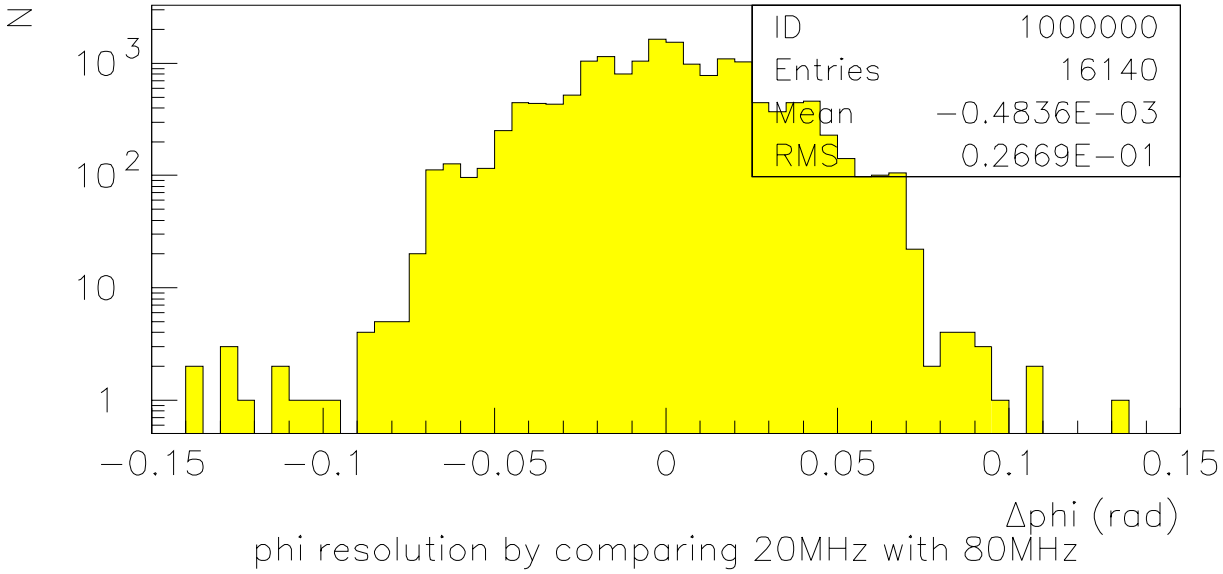
- Large combinatorial backgrounds at low p_t for outer trigger groups

Correlation between ϕ and $1/p_t$

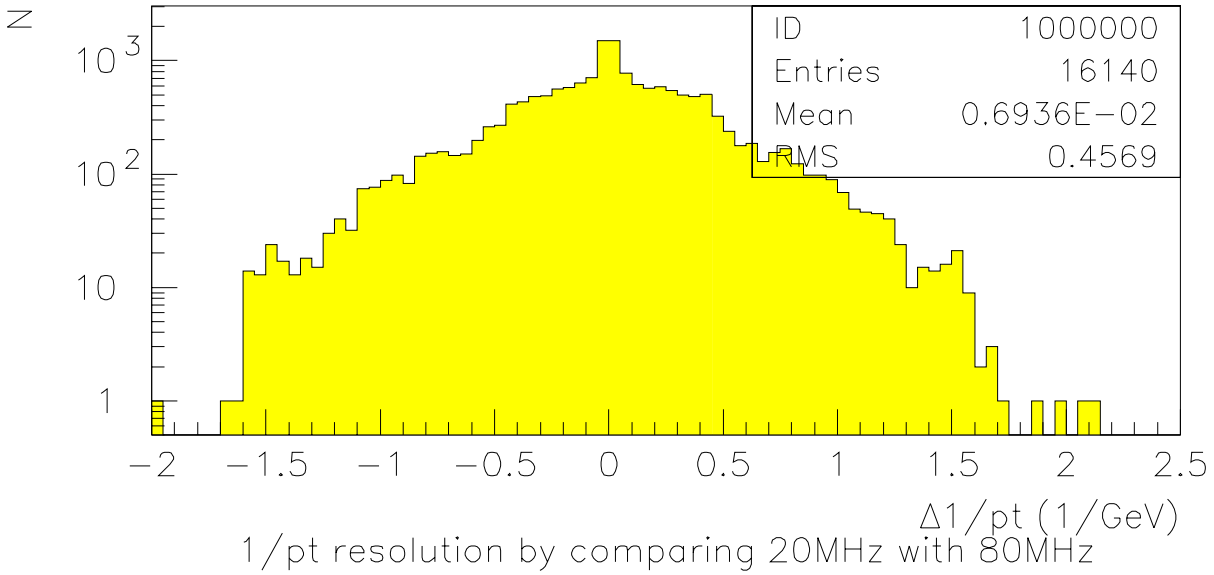


- Strong correlation between ϕ and $1/p_t$
- For trigger purposes 2*16 bins (5bits) should be sufficient for description

Resolution comparing 80MHz and 20MHz result



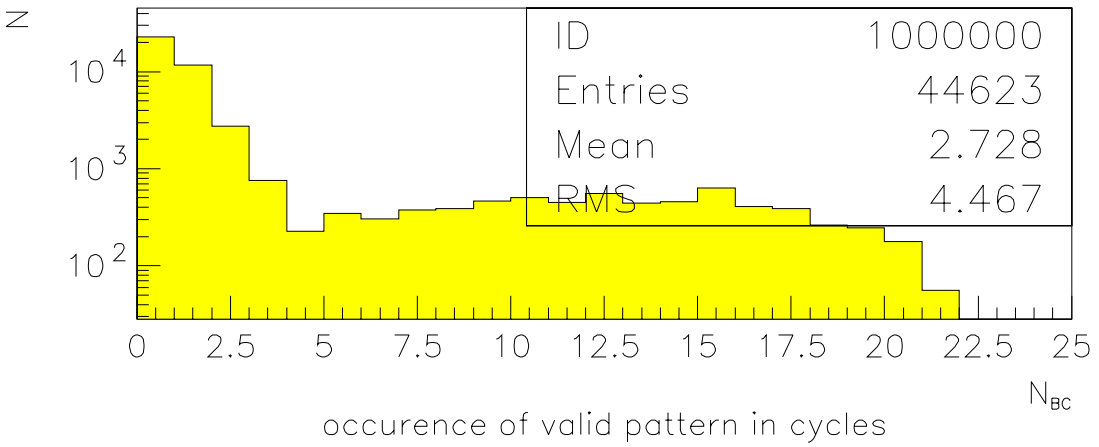
phi resolution by comparing 20MHz with 80MHz



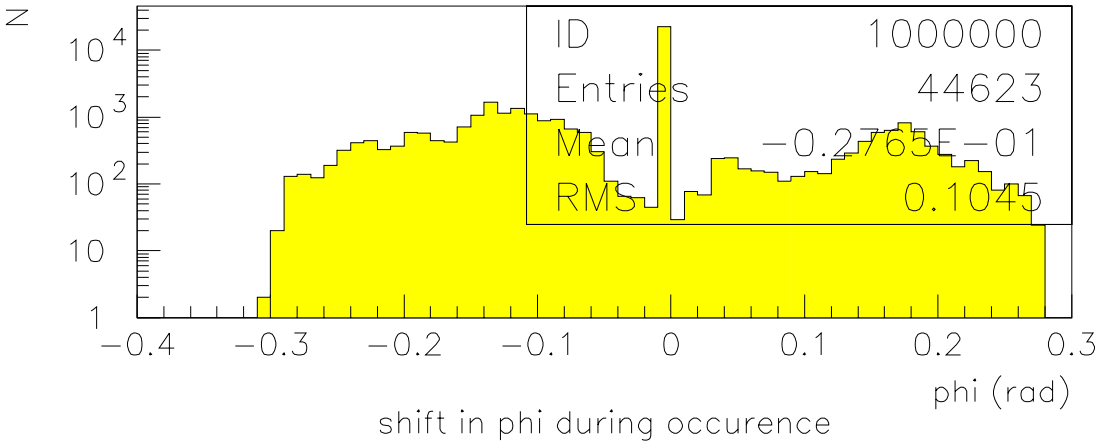
1/pt resolution by comparing 20MHz with 80MHz

- plots show mainly effect of shift register granularity
- For L1 trigger purposes resolution in ϕ is sufficient
- Resolution in $1/p_t$ could be improved (necessary?)

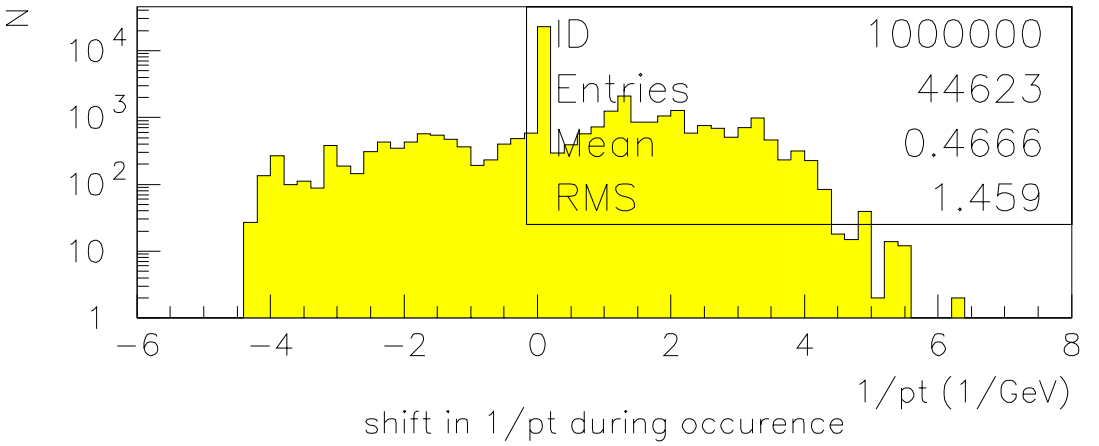
Time depends of valid patterns



occurence of valid pattern in cycles



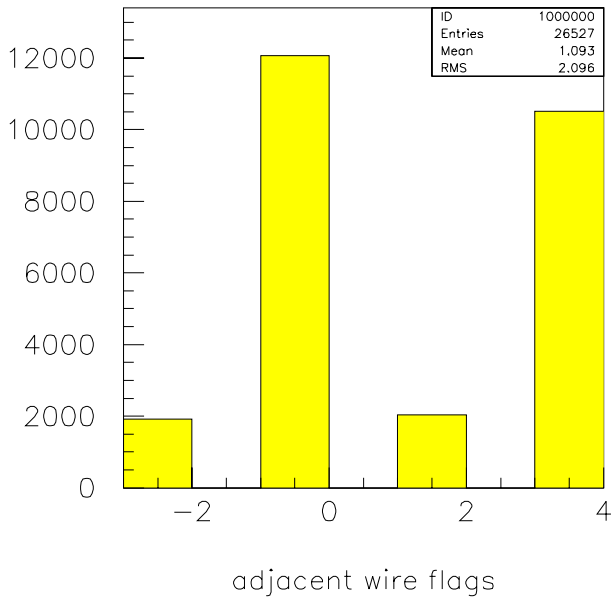
shift in phi during occurence

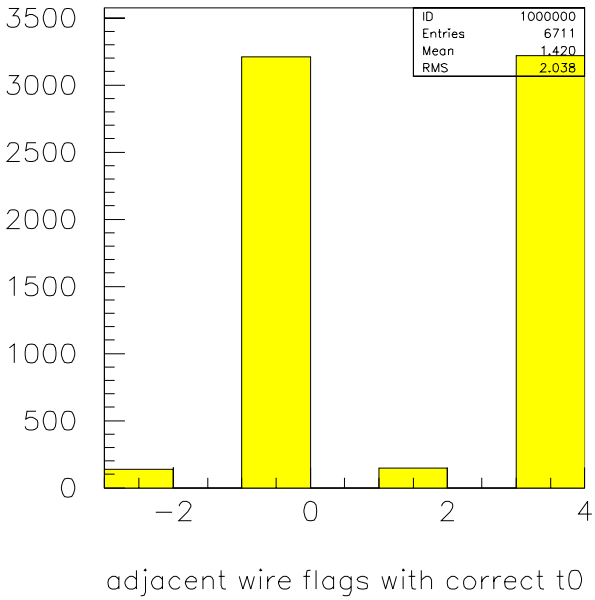


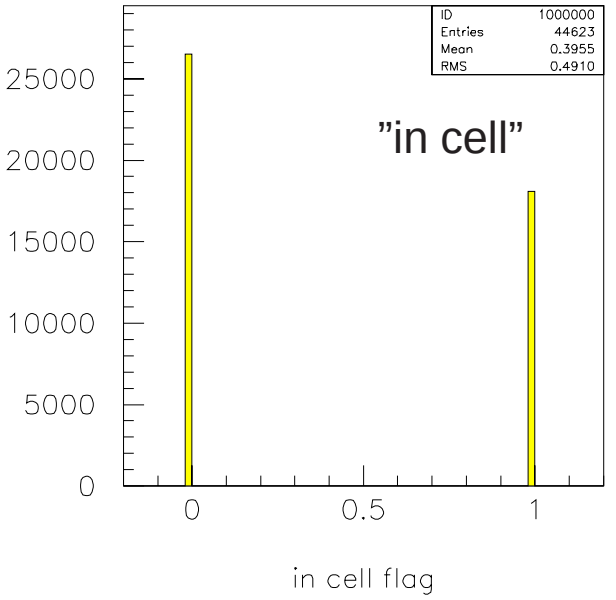
shift in 1/pt during occurence

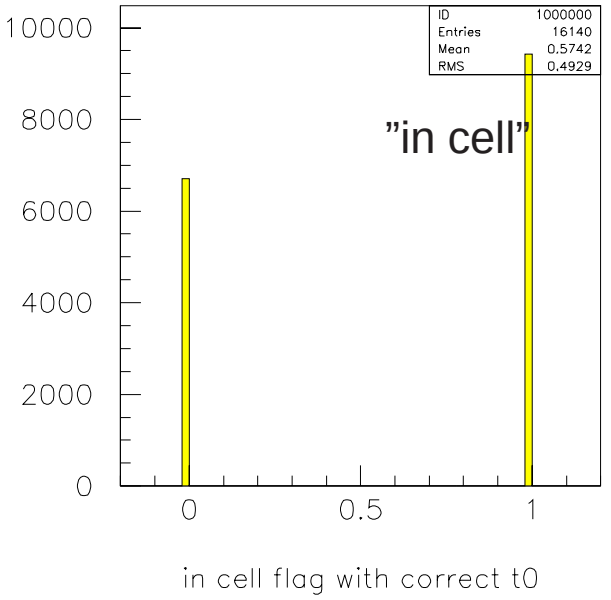
- Most patterns are valid only for 1-2 cycles and resolve BC
- Interpretation of $1/p_t$ and ϕ of valid patterns is changing drastically

Statistics



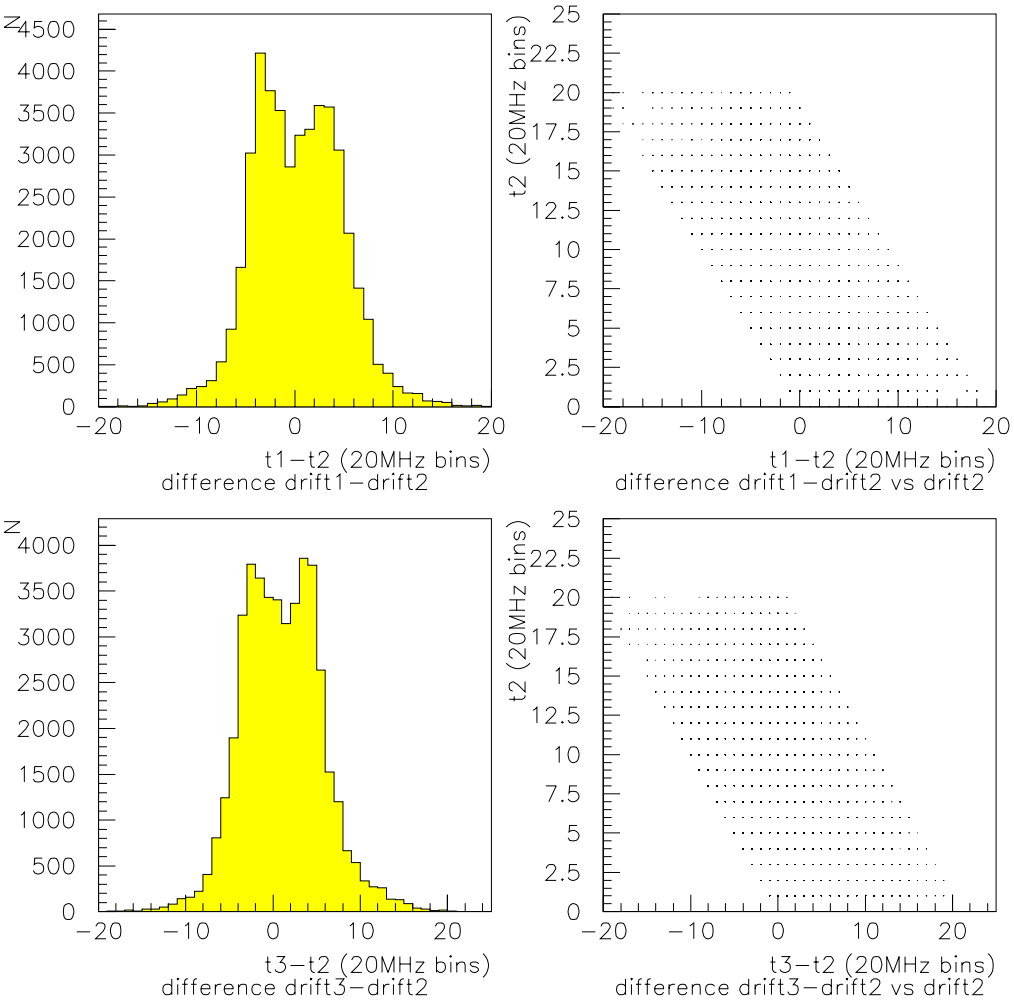






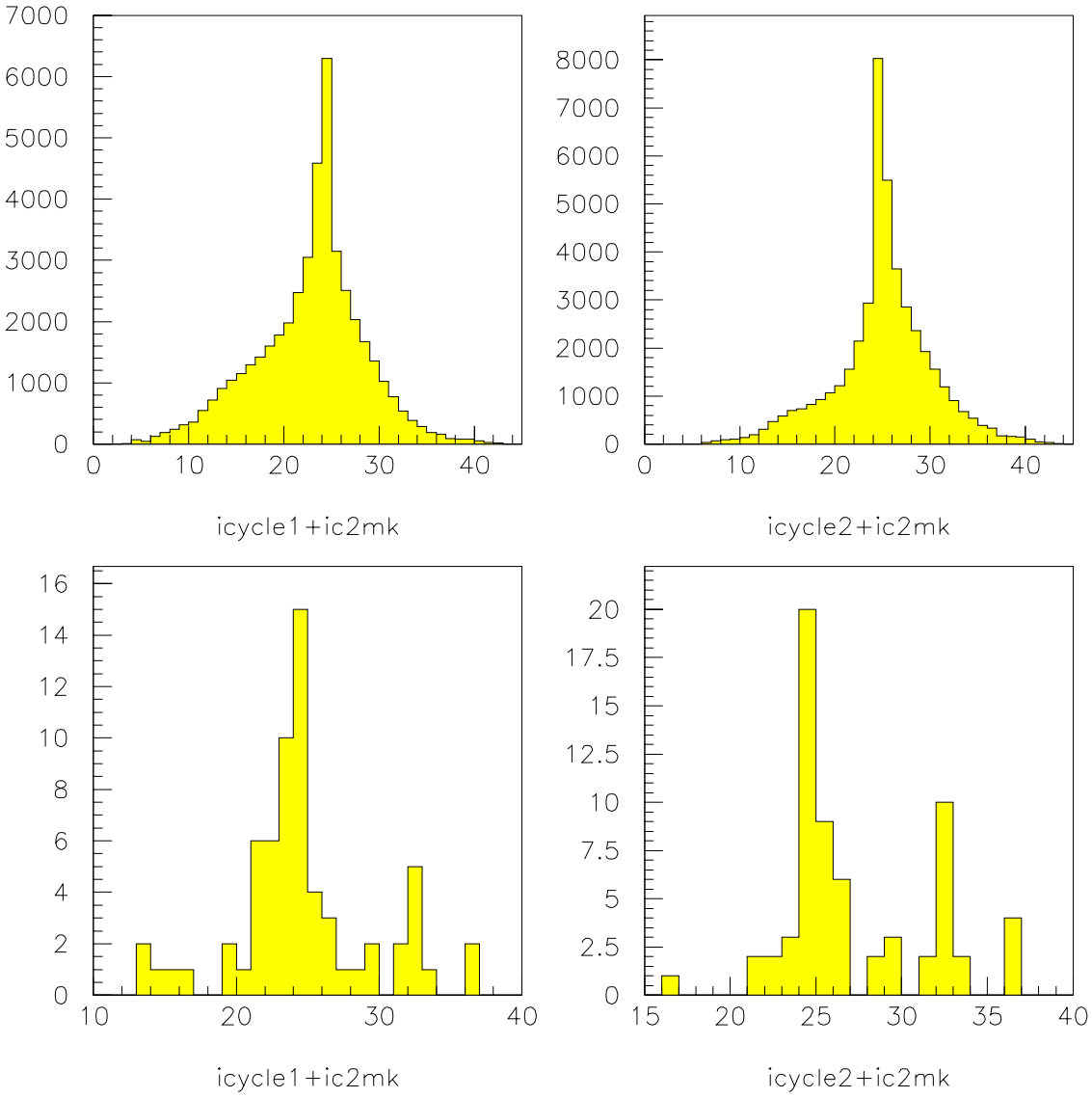
- adjacent cells have to be taken into account only for one wire per side!
- rate of combinations with correct t0 is higher for ”in cell” combinations: 52% compared to 25% (priority for processing?)

Timing I



- Current simulation allows drift time differences ± 12 cycles (± 6 BCs)
- Maximum delay time to reach pivot element is 20 cycles (10BCs) plus 12 cycles (6 BCs) if using only 1 pivot element
- Only 4-5 BCs left for remaining calculations!
- Shift register could be made larger to include tails in the difference distribution but would cause additional delay

Timing II



- time distribution of all validated masks are shown for time when validation starts and when vaidation ends

Constraints for Design and Conclusion I

For L1 Trigger:

- 5 trigger bits for kappa and phi plus t0 indicator (1bit) to describe valid patterns
- Two 32 bit words containing the kappa-phi histogram per cell could be send to the L1 trigger card where one word contains the t0 information
- Maximum amount of all valid patterns per cell is (5+1) bit $\cdot$ 200 lines $\cdot$ 20 BCs = 24000 bit to be stored in an internal RAM $\Rightarrow$ big FPGA
- Look Up table has to deal with about 1000 patterns without subaddresses. Amount of space is 1000 times (5+1) bit for L1 trigger $\cdot$ 2.5 BCs (mean value) = 21000. (still managable for all 10 BCs?)
- Design should aim for high kinematic acceptance down to low p_t than for high precision on L1 to allow triggering of $\rho \rightarrow \pi\pi$ and $\Phi \rightarrow KK$

Constraints for Design and Conclusion II

For L1 track segment finding:

- additional z-information has to be processed
- κ and ϕ resolution has to be improved by using subaddress information
- track segments have only to be processed for the right bunch crossing. Can we wait so long?
- Refined track parameters have to be looked up from an external SRAM. Address defined by mask number (9/10 bit) subaddress (6 bit) and BC number (X bit) $\Rightarrow$ problem?
- More studies clearly needed
- Routine to generate systematically valid patterns would be helpful