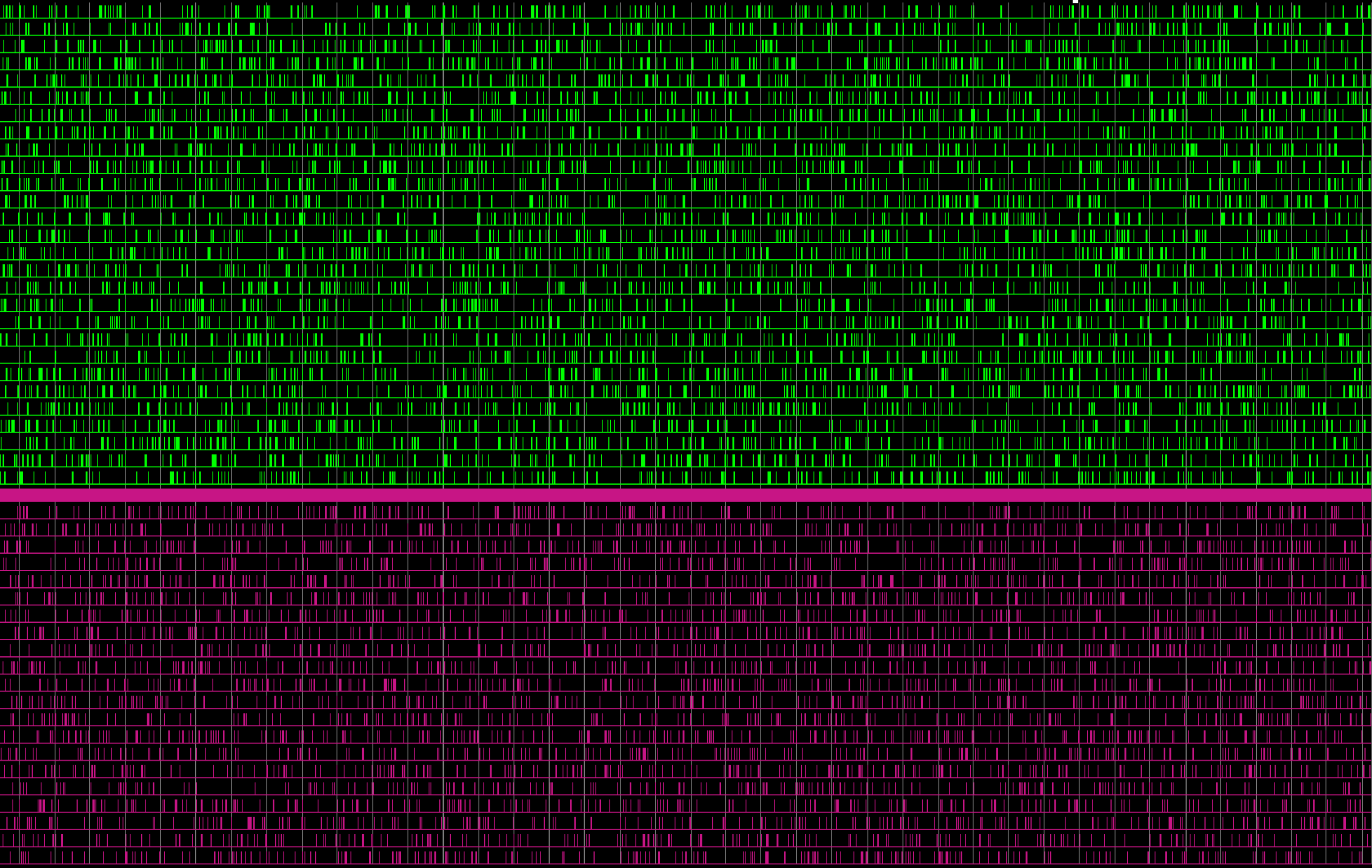
Pixel readout simulation updates



SuperB General Meeting - LNF Frascati

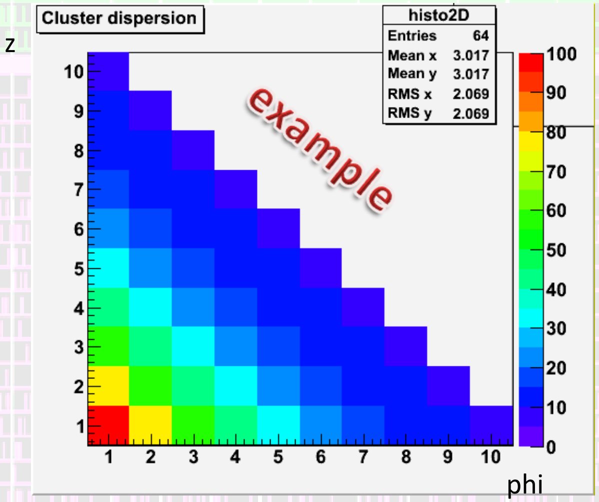
27-09-2010 F.M. Giorgi

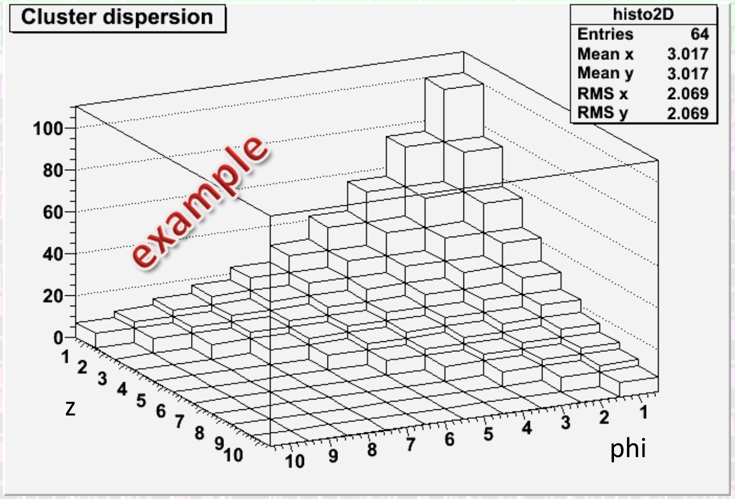
Outline

- Updates on:
  - Monte Carlo Hit generator
  - Simulation Environment
  - Integration of Cluster Distributions from Physics Simulations
  - SQUARE Readout Core

Monte Carlo Hit Generator

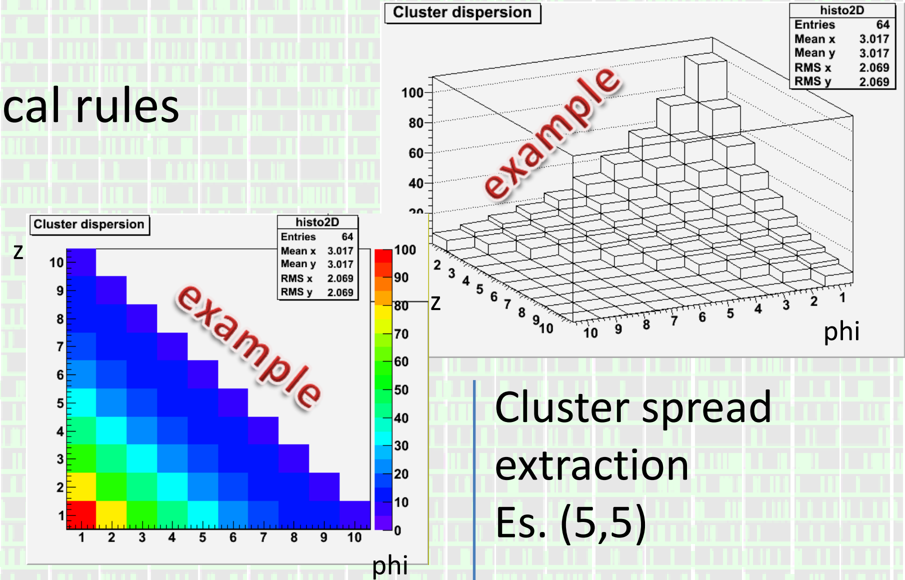
- Monte Carlo generator
  - Rewritten from scratch
  - Now generation of **clustered** events
  - **Knobs**:
    - Cluster dispersion distribution in (z,phi)
    - Physical time resolution (test_clock), hit/miss thresholds =Global hit rate





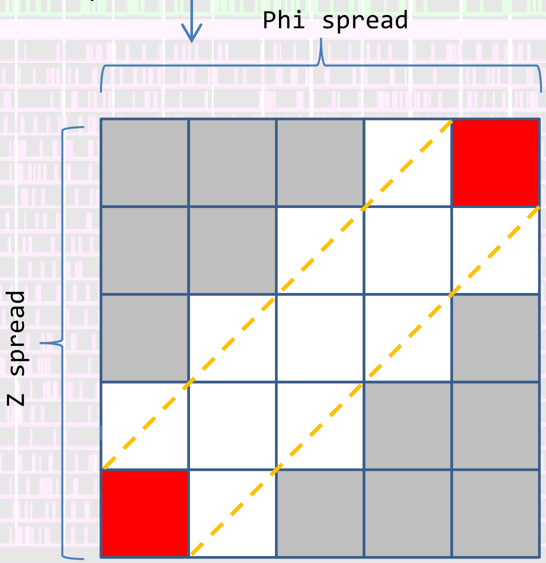
Monte Carlo Hit Generator

- Arbitrary pattern extraction by geometrical rules



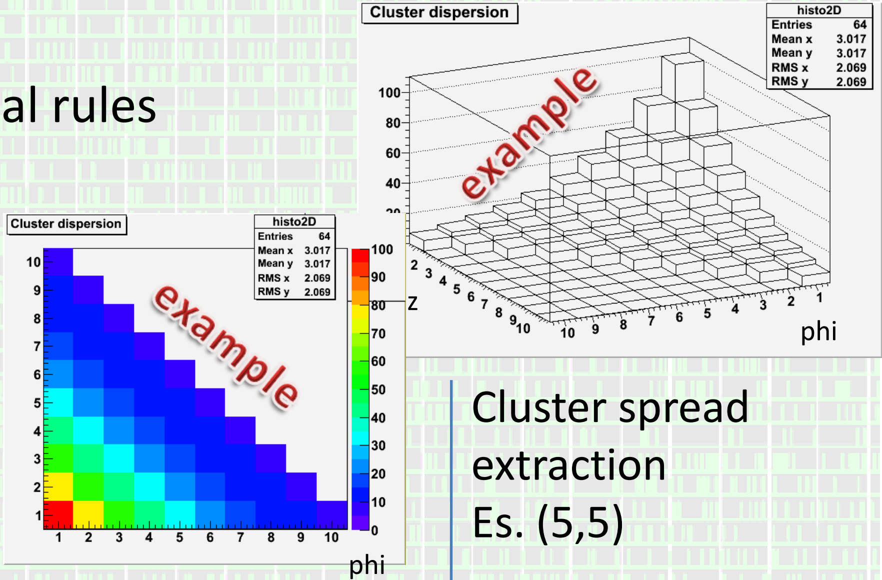
Cluster spread extraction

Es. (5,5)

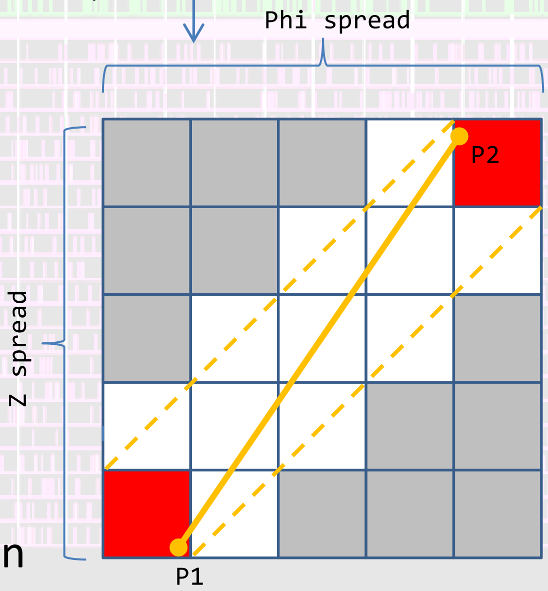


Monte Carlo Hit Generator

- Arbitrary pattern extraction by geometrical rules



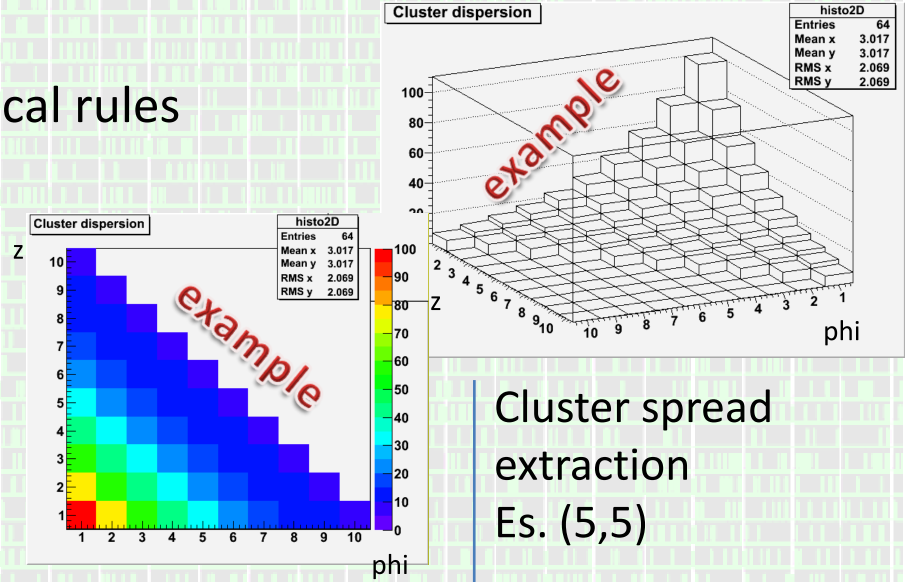
Cluster spread extraction
Es. (5,5)



P1- P2 points extraction

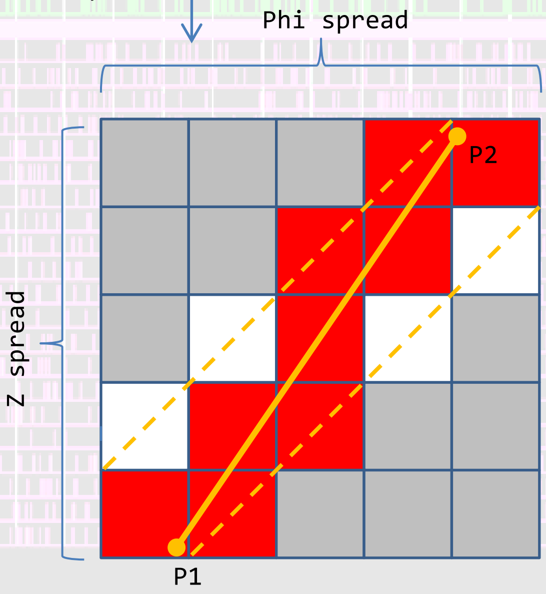
Monte Carlo Hit Generator

- Arbitrary pattern extraction by geometrical rules



Cluster spread extraction

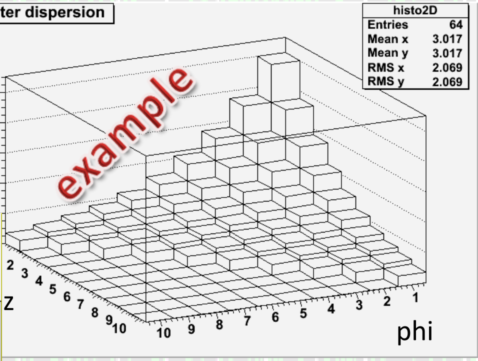
Es. (5,5)

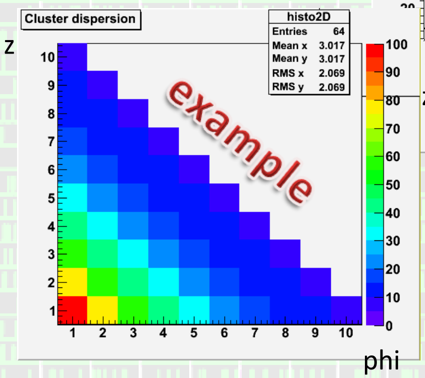


Pattern evaluation

Monte Carlo Hit Generator

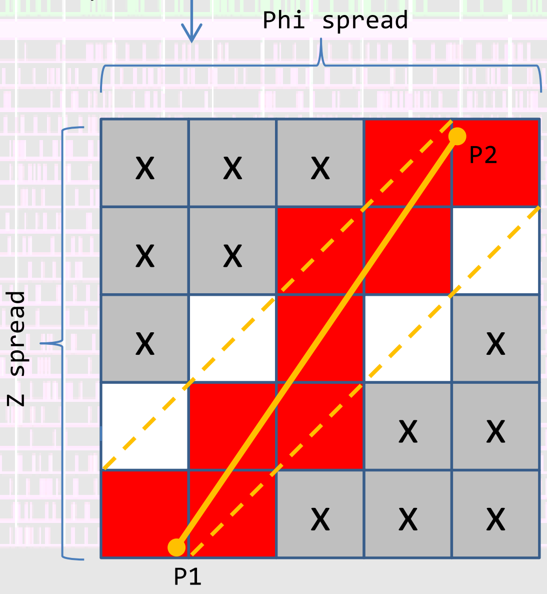
- Arbitrary pattern extraction by geometrical rules
- Pattern check (grey pixels are forbidden)





Cluster spread extraction

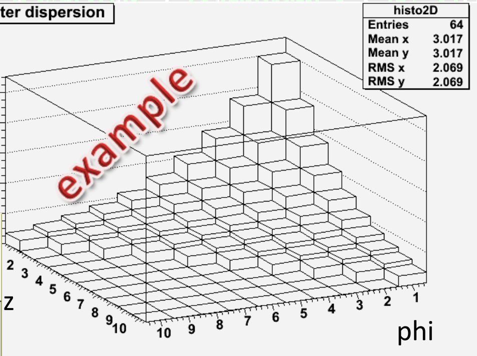
Es. (5,5)

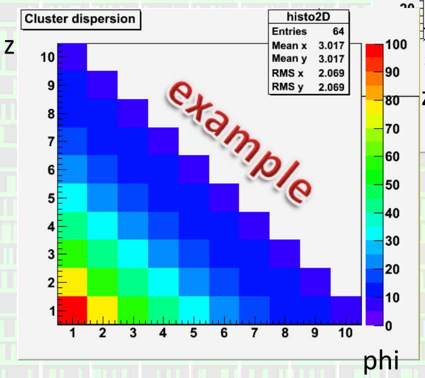


Pattern check

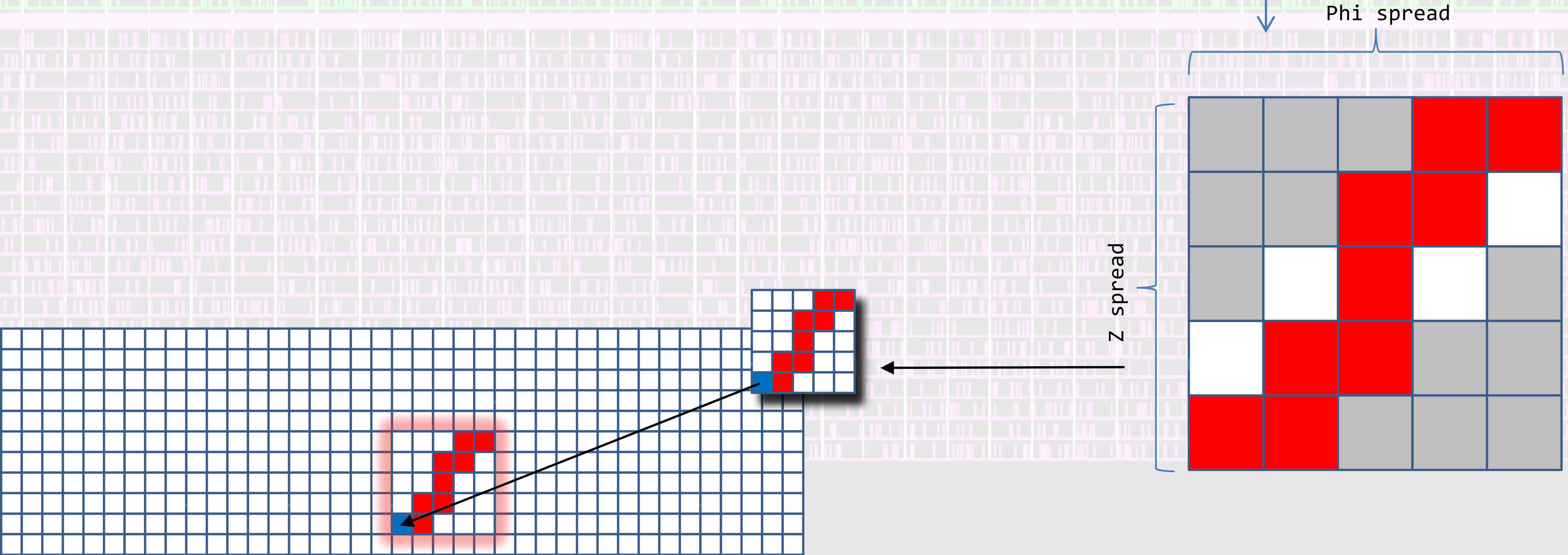
Monte Carlo Hit Generator

- Arbitrary pattern extraction by geometrical rules
- Pattern check (grey pixels are forbidden)
- Pattern application to a random pixel of the matrix



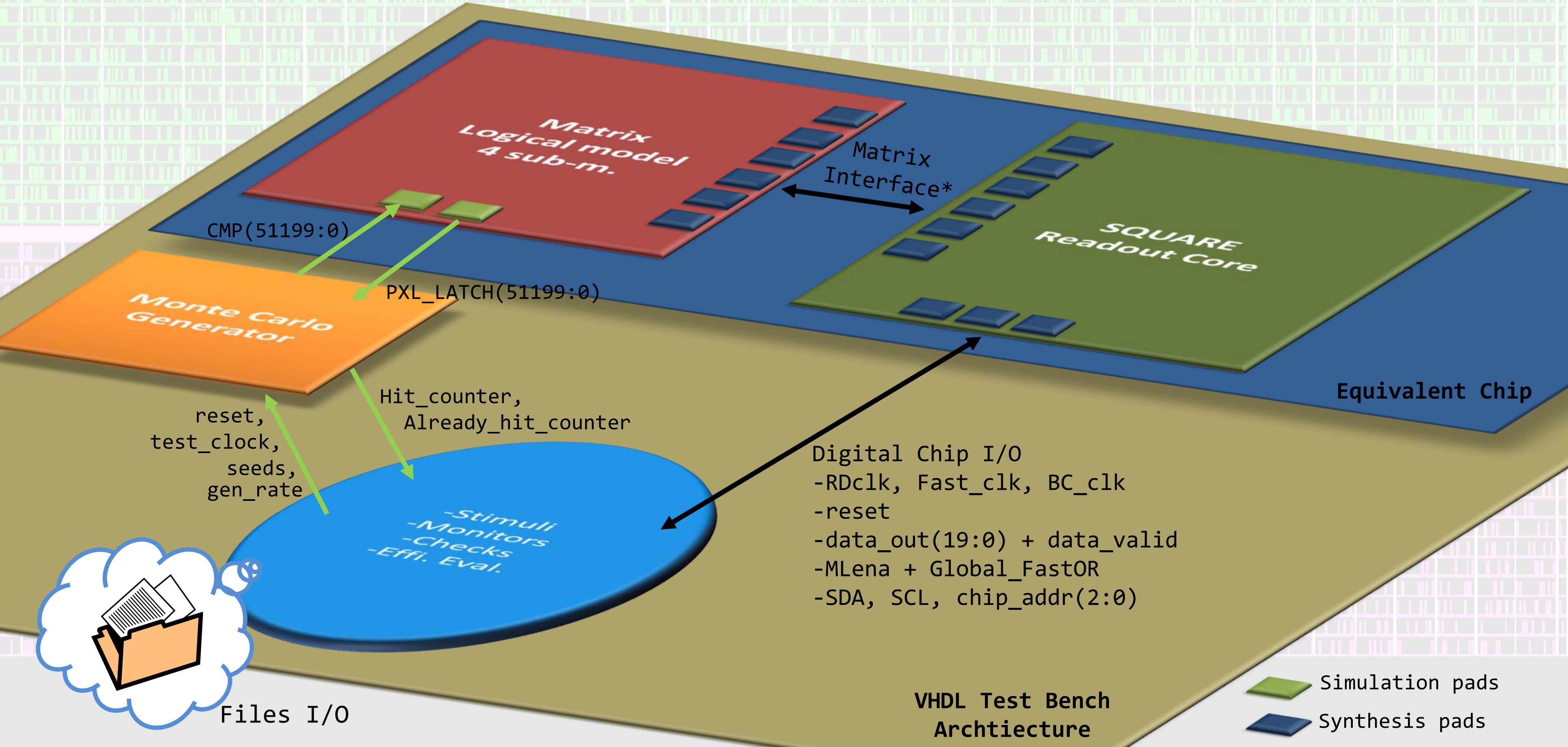


Cluster spread extraction
Es. (5,5)



Simulation Environment

- Simulation Tool: **Modelsim SE 6.3f**
- Simulation components
  - **Readout Core Arch. SQUARE** (.vhd synthesizable code)
  - **Monte Carlo Generator** (.vhd NOT synthesizable code)
  - **Matrix Behavioral Model** (.vhd/.v code)
  - **Test Bench** (.vhd code)



Matrix
Logical model
4 sub-m.

Matrix
Interface*

SQUARE
Readout Core

CMP(51199:0)

PXL_LATCH(51199:0)

Monte Carlo
Generator

Equivalent Chip

reset,
test_clock,
seeds,
gen_rate

Hit_counter,
Already_hit_counter

-Stimuli
-Monitors
-Checks
-Effi. Eval.

Digital Chip I/O
-RDclk, Fast_clk, BC_clk
-reset
-data_out(19:0) + data_valid
-MLena + Global_FastOR
-SDA, SCL, chip_addr(2:0)

Files I/O

VHDL Test Bench
Archtiecture

🟩 Simulation pads

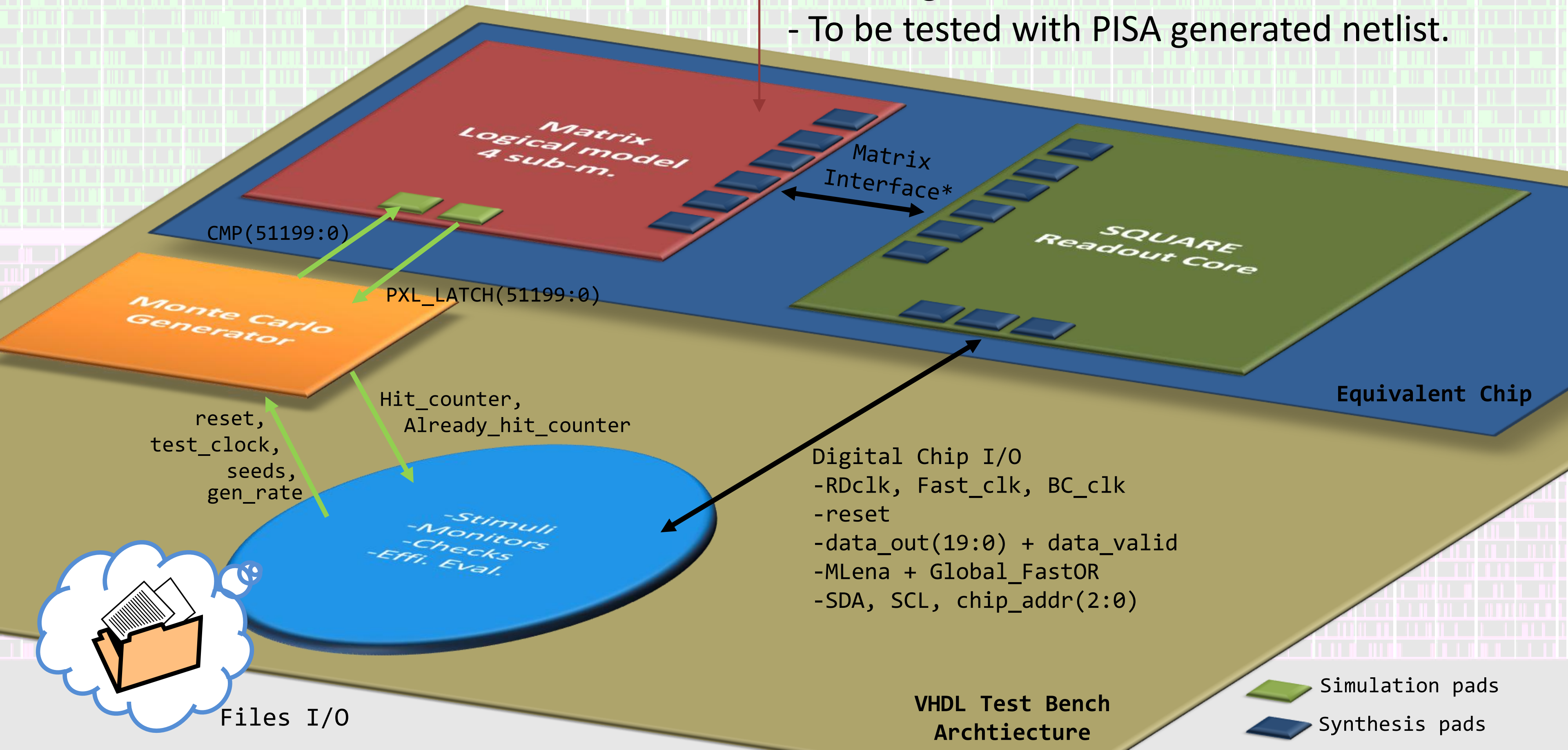
🟦 Synthesis pads

Simulation Environment

- Simulation Tool: **Modelsim SE 6.3f**
- Simulation components
  - Readout Core Arch. SQUARE (.vhd synthesizable code)
  - Monte Carlo Generator (.vhd NOT synthesizable code)
  - Matrix Behavioral Model (.vhd/.v code)
  - Test Bench (.vhd code)

Logical model of digital matrix components:

- Now logic model made in BO.
- To be tested with PISA generated netlist.



Digital Chip I/O
-RDclk, Fast_clk, BC_clk
-reset
-data_out(19:0) + data_valid
-MLena + Global_FastOR
-SDA, SCL, chip_addr(2:0)

🟩 Simulation pads

🟦 Synthesis pads

SQUARE architecture tests with new test bench infrastructure

Preliminary simulations with matrix model
made in Bo and hypothetic cluster distribution

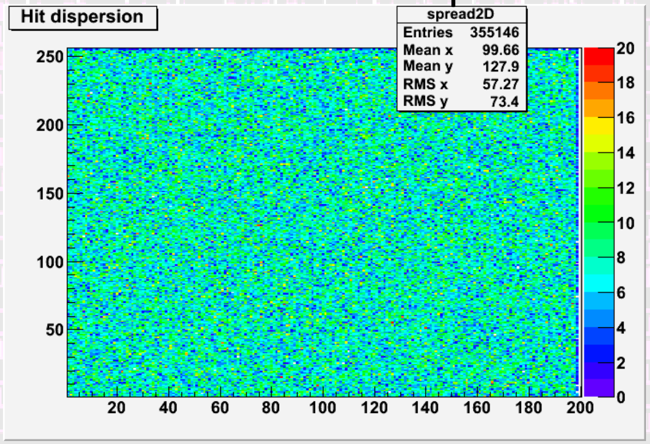
Try-outs
(rate: 100MHz/cm2, duration: 3 ms, statistics: 350k/400k hits):

classic simulation, 100 MHz/cm^2, NO cluster

	1	2	3	4
1	100%	0%	0%	0%
2	0%	0%	0%	0%
3	0%	0%	0%	0%
4	0%	0%	0%	0%

Cluster Factor=1

Generated XY hit dispersion



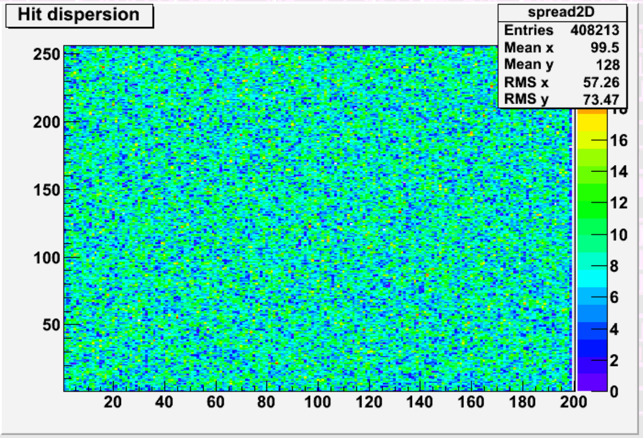
About optimization: 350k hits → >350k words

TEST: Symmetrical Cluster spread in zeta/phi

	1	2	3	4
1	50%	12.5%	4%	1%
2	12.5%	4%	1%	0%
3	4%	1%	0%	0%
4	1%	0%	0%	0%

Cluster Factor 1.4

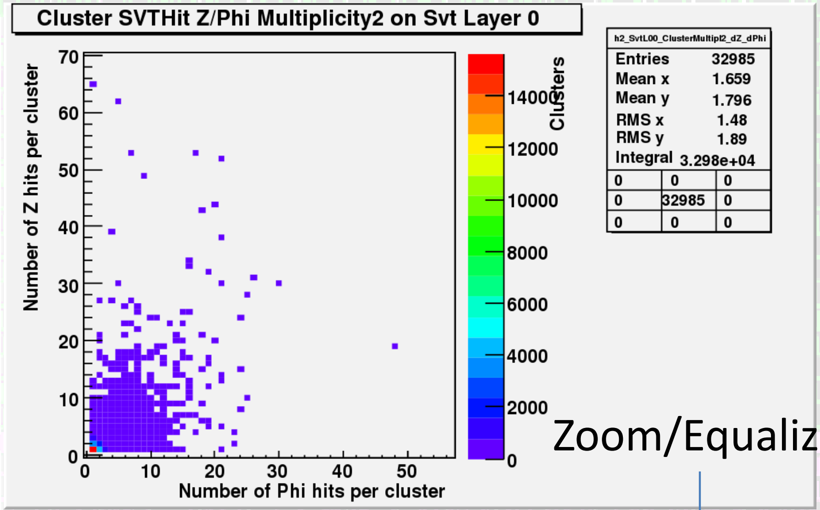
Generated XY hit dispersion



400k hits → ~300k words, save 25% bandwidth

Integration of physical cluster distribution

- **CLUSTER SPREAD DISTRIBUTION** NOW FROM **PHYSICS SIMULATIONS**
- Connection point between physics and electronics simulation

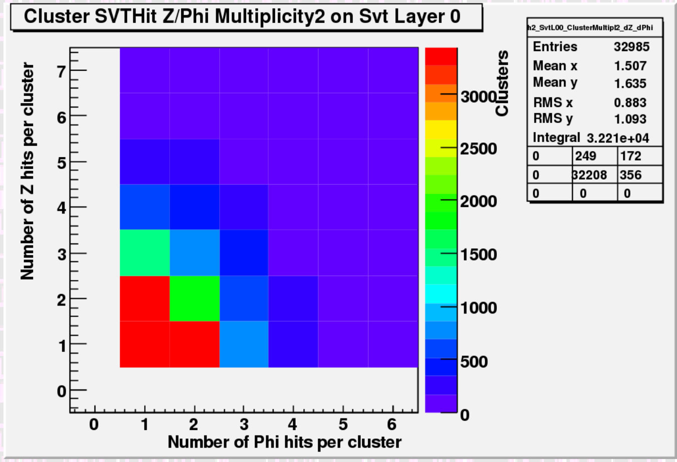


```
h2_SvtL00_ClusterMultipl2_dZ_dPhi
Entries       32985
Mean x        1.659
Mean y        1.796
RMS x          1.48
RMS y          1.89
Integral  3.298e+04
0    0       0
0    32985   0
0    0       0
```

%	1	2	3	4	phi
1	47,28	12,65	2,47	0,71	…
2	10,62	5,81	1,77	0,56	
3	4,32	2,31	1,07	0,40	
4	2,01	1,15	0,57	0,27	
zeta	…				

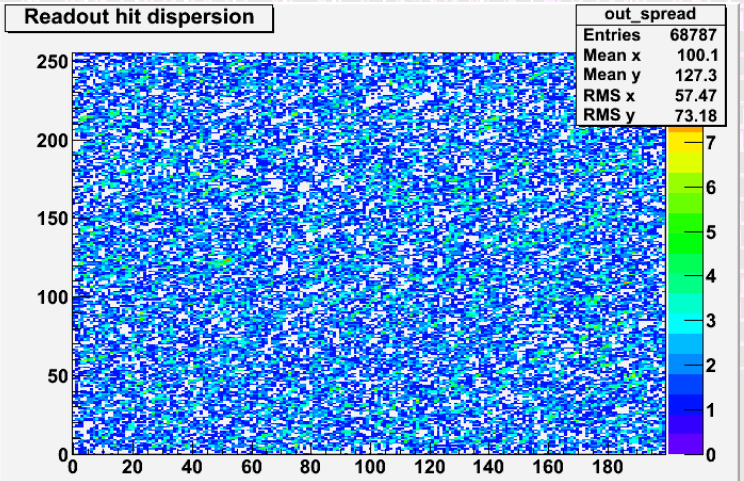
Data from physic simulations by R.Cenci

Zoom/Equalize



```
h2_SvtL00_ClusterMultipl2_dZ_dPhi
Entries       32985
Mean x        1.507
Mean y        1.635
RMS x         0.883
RMS y         1.093
Integral  3.221e+04
0    249     172
0    32208   356
0    0       0
```

Implemented and simulated



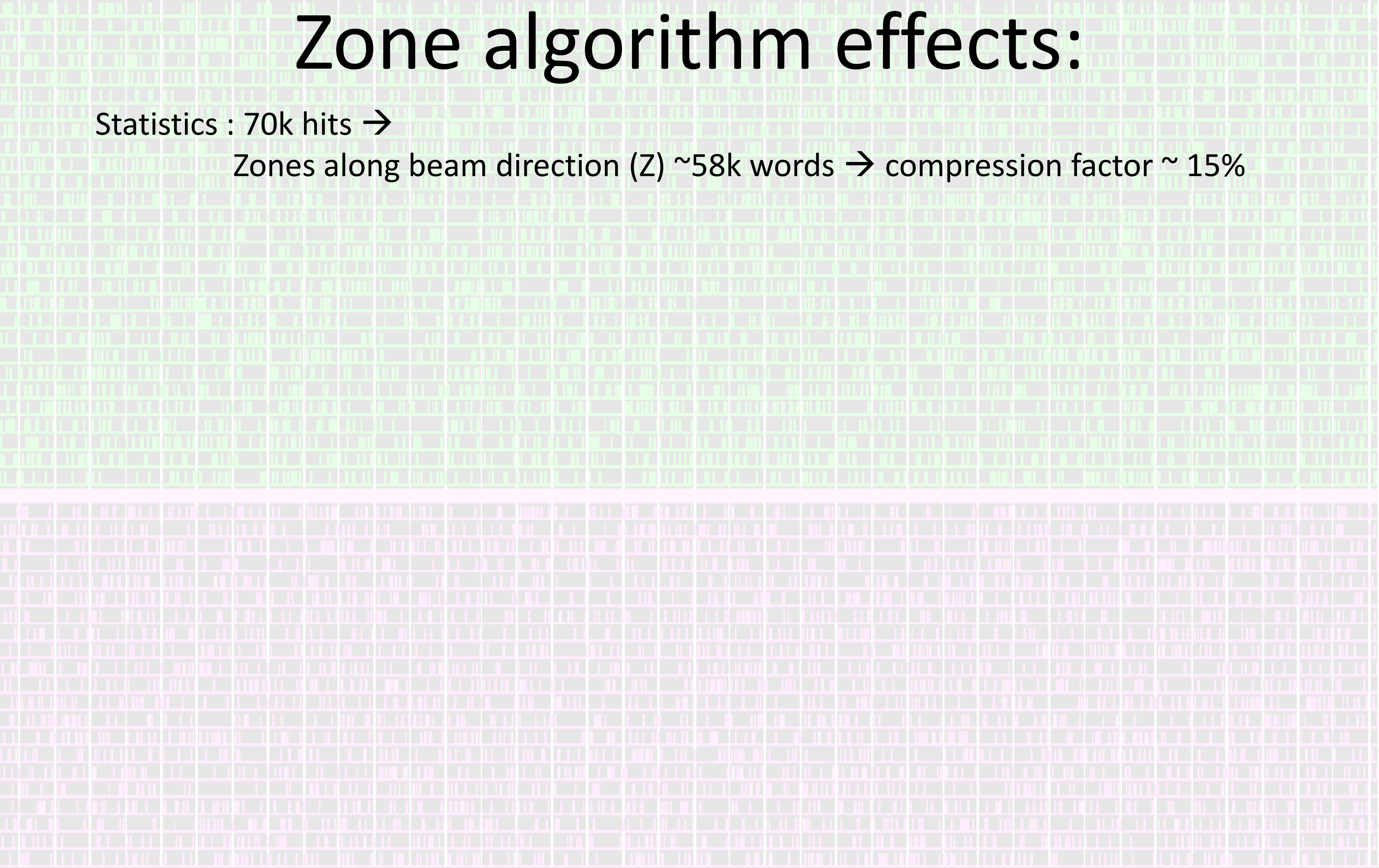
```
out_spread
Entries    68787
Mean x     100.1
Mean y     127.3
RMS x      57.47
RMS y      73.18
```

XY Hit disperion on sensor (electronics simulation)

Zone algorithm effects:

Statistics : 70k hits →

Zones along beam direction (Z) ~58k words → compression factor ~ 15%

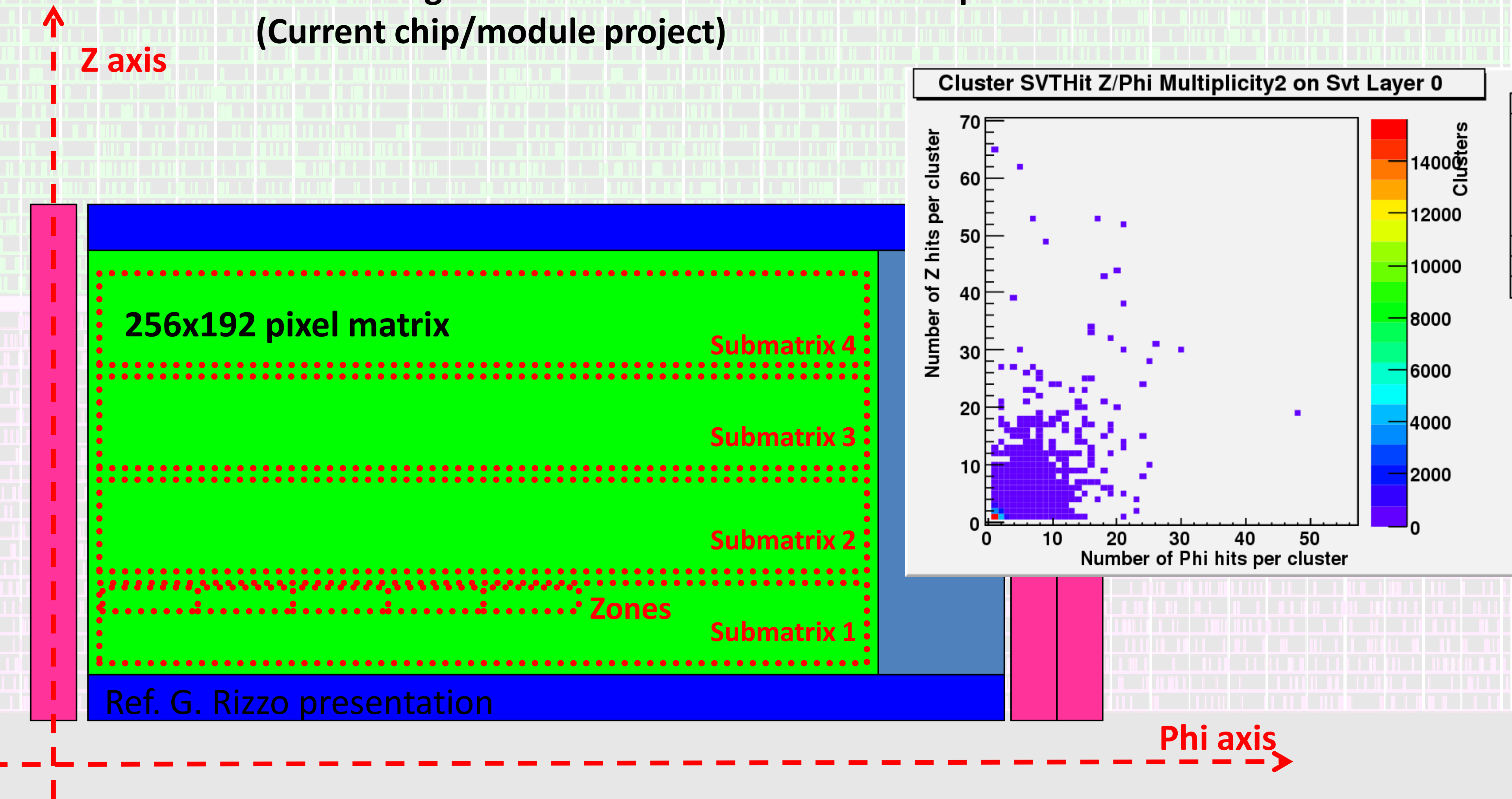


Zone algorithm effects:

Statistics : 70k hits →

Zones along beam direction (Z) ~58k words → compression factor ~ 15%

Zones along Phi direction ~62k words → compression factor ~ 10% (Current chip/module project)



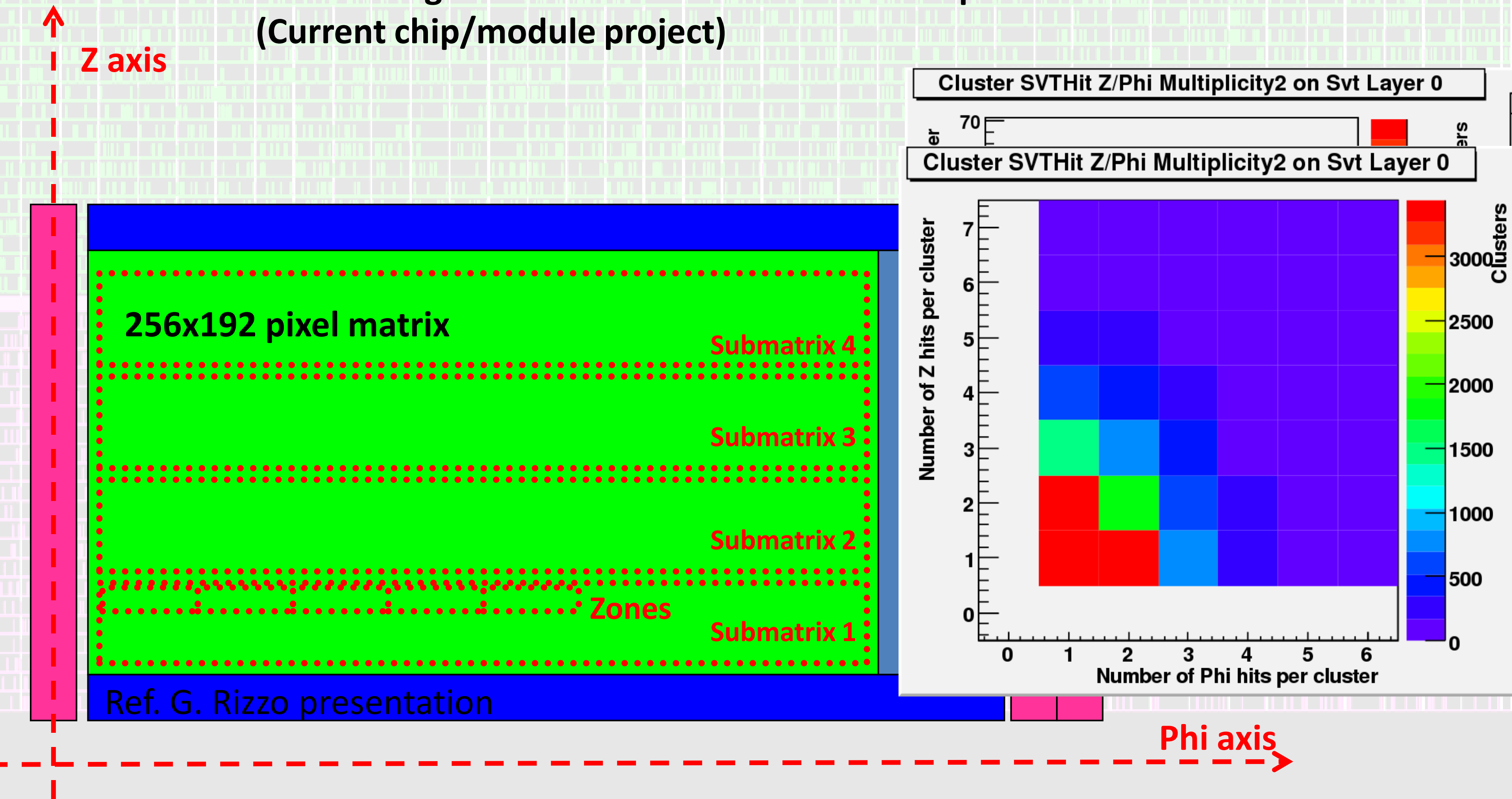
Ref. G. Rizzo presentation

Zone algorithm effects:

Statistics : 70k hits →

Zones along beam direction (Z) ~58k words → compression factor ~ 15%

Zones along Phi direction ~62k words → compression factor ~ 10%
(Current chip/module project)



Ref. G. Rizzo presentation

Simulation Checks

- Time Stamps Check (all for all sub-matrices, sorting)
- Generated hits VS Read Out hits (cross check)
- Barrels overflow monitor
- Barrels average fill level monitor
- Errors detection at concentrators level (Missing TS...)

SQUARE READOUT CORE

- NEWS
  - Improved algorithm on concentrators (shorter BC → more chaotic time sorting).
  - Re-organized register set.
  - Row and column masks (Readout masks) over I2C.
  - Matrix masks setting protocol over I2C.

- On the Way...
  - Triggered sweeper algorithms with selectable latency.
  - Code optimization for clock speed and synthesis time.

- TO DO
  - Calibration mode
  - Tailor the SQUARE readout for APSEL_VI & SuperPX1
  - First Synthesis with new Design Kit

Conclusions

- Simulation environment ready for:
    - Intensive simulations with Physical events for efficiency estimations.

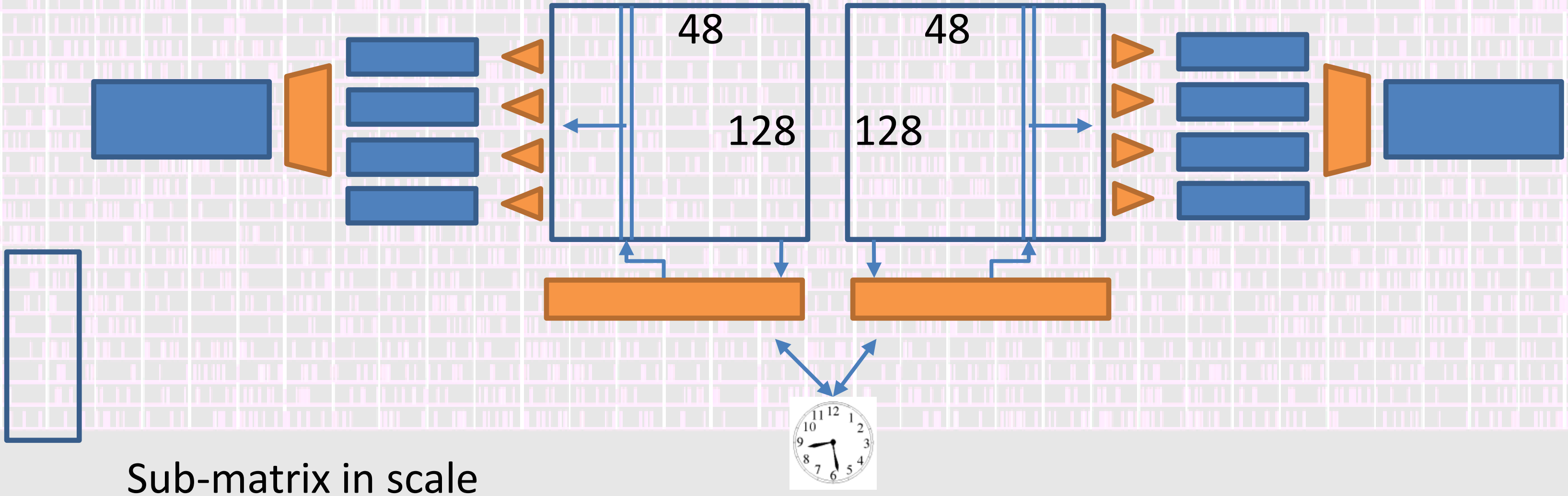
Conclusions

- Simulation environment ready for:
  - Intensive simulations with Physical events for efficiency estimations.
  - Intensive simulations with extracted netlist of matrix for **bug-hunting**.

BackUp

Readout for ApselVI Tezz. Char.

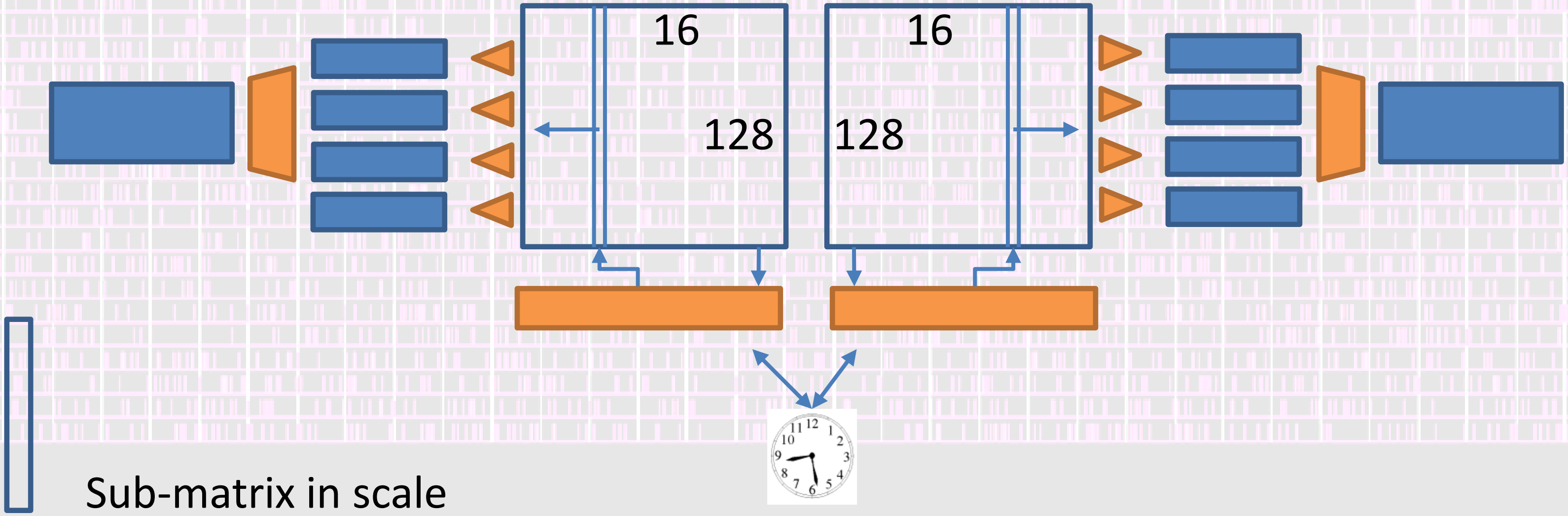
- MATRIX 128x96 (2 sub-m. 48x128)
  - 4 sparsifiers
  - 32 rows for each sparsifier
  - 8 zones for each sparsifier (W_{zone}=4 pixels)



Sub-matrix in scale

Readout for Superpix1 Tezz. Char.

- MATRIX 32x128 (2 sub-m. 16x128)
  - 4 sparsifiers
  - 32rows for each sparsifier
  - 8 zones for each sparsifier (W_{zone}= 4 pixels)



Sub-matrix in scale