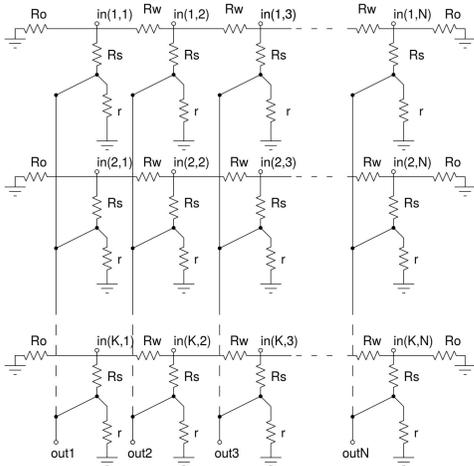


Abstract

The WRM (Weighting Resistive Matrix) is a conceptually simple device born for triggering tracks from beam-beam interaction experiments. Cause of its passive nature, is possible to perform track recognition with a time transition in about **10ns** from digital inputs. The study and development of this device has brought to a theorization of a WRM able to elaborate analog inputs with highest measuring performance, not necessary restricted to beam-beam experiments. More general studies are involving connectivity topology logic in the device, that could be the key for understand more general applications of it.

Weighting Resistive Matrix [1]

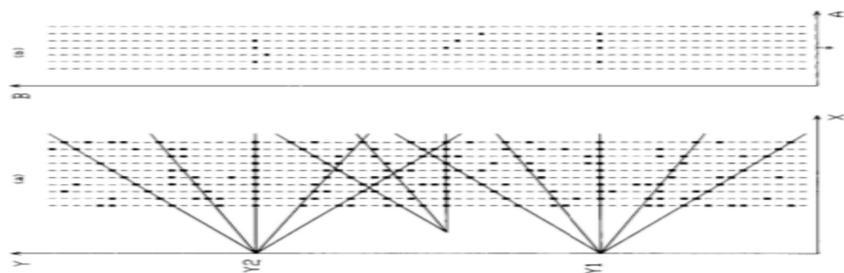
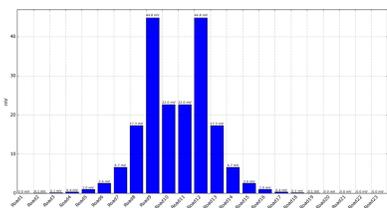
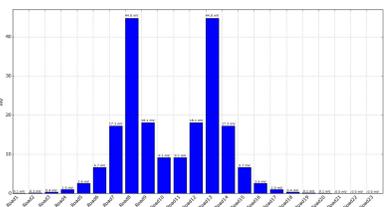
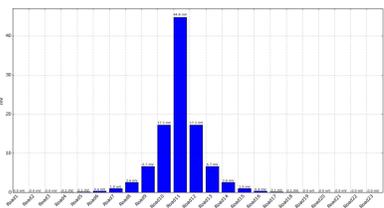
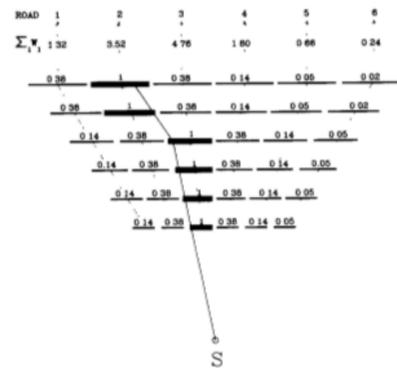


- ▶ **Process elements:**
 - ▶ *Roads topology* → set of hypothesis of the input patterns
 - ▶ *Confidence rule* → how experiment fit with expected patterns
- ▶ **Conventional Triggers vs WRM:**
 - ▶ *Real time response* → limited only by the diffusion effect's delay!
 - ▶ *Costless* → no supply is needed!
 - ▶ *Non integer weights* → define correlations between roads giving the physical meaning of track fit!

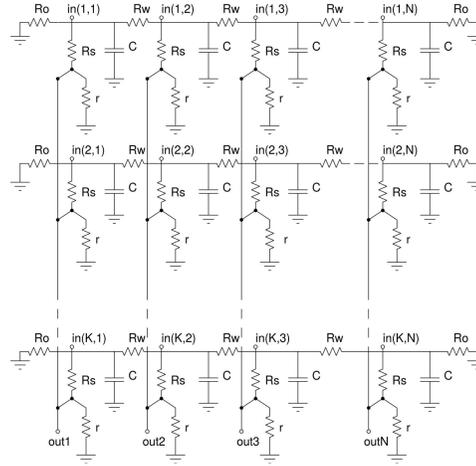
- ▶ linearity: $r \ll \frac{R_s}{K}$
- ▶ dispersion factor:

$$f = \left(1 + \frac{R_w}{R_s} + \frac{1}{2 + \sqrt{\frac{1}{4} + \frac{R_s}{R_w}}}\right)^{-1} < 1$$

$$V(x) = e^{-\frac{|x-m|}{\lambda(f)}}$$

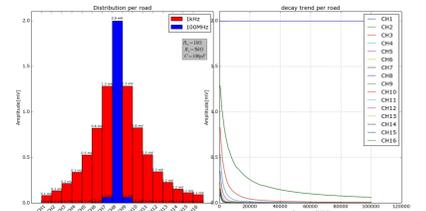


Analog Weighting Matrix



- ▶ **Additional property:**
 - ▶ analogic inputs (es. sin waves) are discriminated by their frequency (ω)

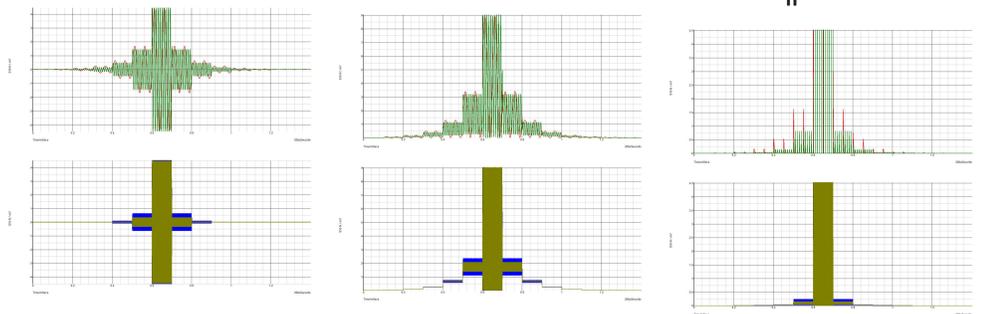
$$V(x) = e^{-\frac{|x-m|}{\lambda(\omega)}}$$



$$V_s = \sin(\omega t)$$

$$V_s = V_0 + \sin(\omega t)$$

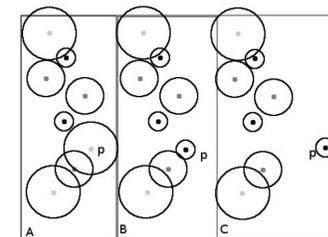
$$V_s = \sum_n \delta(t - nT)$$



Measuring paradigm

physical quantity → **Conversion** → ω → **AWM** → Diffusion ~ $V(\frac{1}{\omega})$

Number of photons
→ I_{ij}



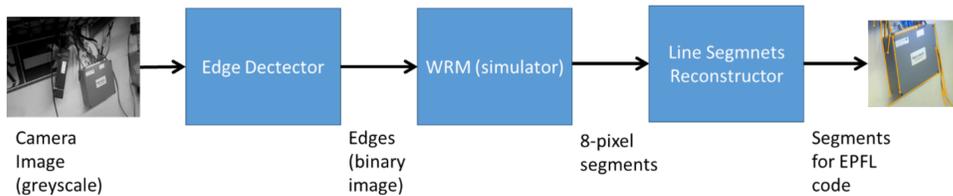
$$V(x) = e^{-\frac{|x-m|}{I_{ij}^{-1}}}$$

$$\lambda = \frac{1}{I_{ij}}$$

$$\chi^2 = \frac{S I_s}{N} (x_s - E)^2 + \frac{1}{N} \sum_{k \notin s} I_k (x_k - E)^2$$

Segment detection in image processing [2]

WRM method:

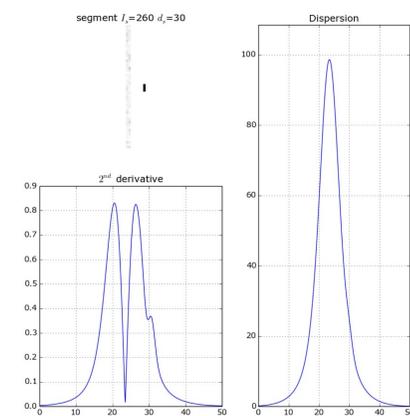


$$K = \left(\left(\frac{1}{2}\right)^N, \dots, \frac{1}{2}, 1, \frac{1}{2}, \dots, \left(\frac{1}{2}\right)^N \right) \rightarrow \left| \frac{d^2 V_i}{d i^2} \right| < th$$

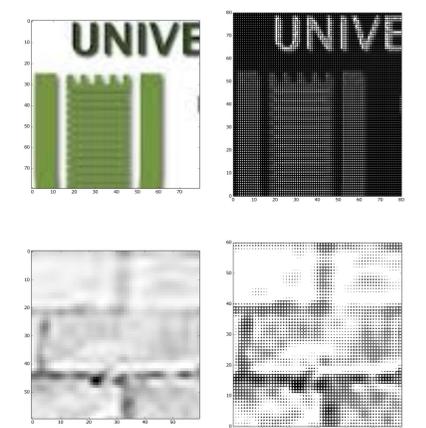
- ▶ *WRM diffusion reinforces linear correlations*
- ▶ *High speed processing*

WRM method	Laptop Intel i7-3632QM	Server Xeon(R) CPU E5-2620	Laptop ASPIRE AMD AthlonX2
	150ms	170ms	500ms

- ▶ Random straight line:



- ▶ Image:



References

- [1] R. Cardarelli et al. *On a very fast topological trigger* 1993.
- [2] A. Abdallah, R. Cardarelli, G. Aielli, *On a fast discrete straight line segment detection* 2014.

Work in progress and prospective

- ▶ Mathematical approach to the computational power of the WRM/AWM roads
- ▶ Study and development of a WRM-like device with dynamic topology
- ▶ full custom production and test

acknowledgements

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