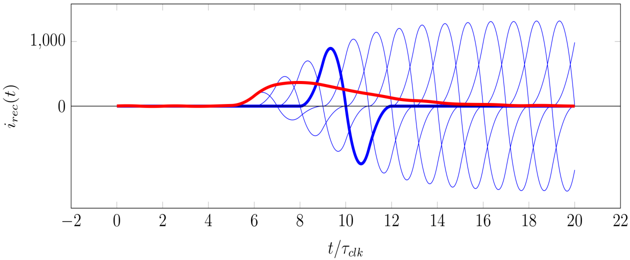

First results of the DIGIGARF experiment: extracting signal's shape parameters using real-time interpolation

Pietro Ottanelli
INFN Sezione di FIrenze

EUNPC Bologna
05 September 2018

Charged Particle Identification

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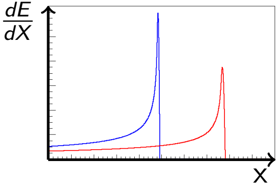
- Isotopic distributions of products:
  - ◇ Isospin transport phenomena (**S. Piantelli**);
  - ◇ E_{sym} term of nEOS;
  - ◇ link with Nuclear Astrophysics

Charged Particle Identification
Pulse Shape Analysis (PSA)



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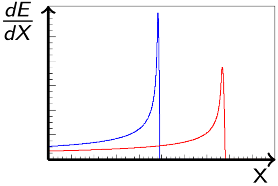

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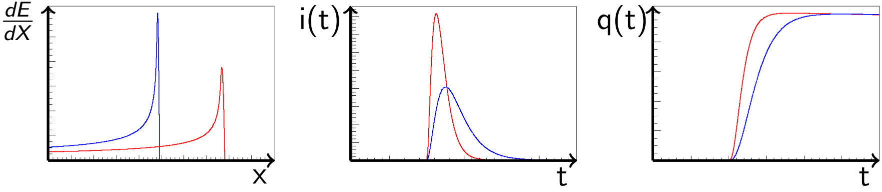

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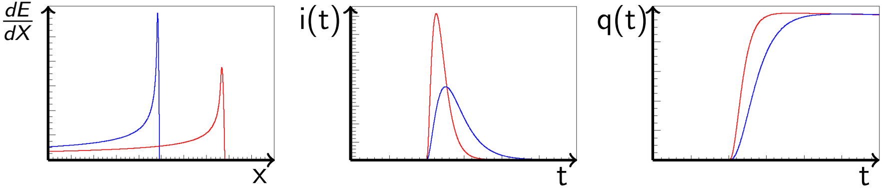

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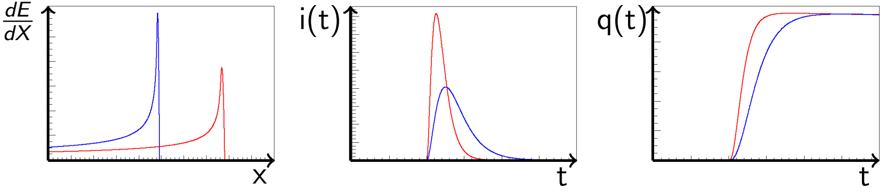

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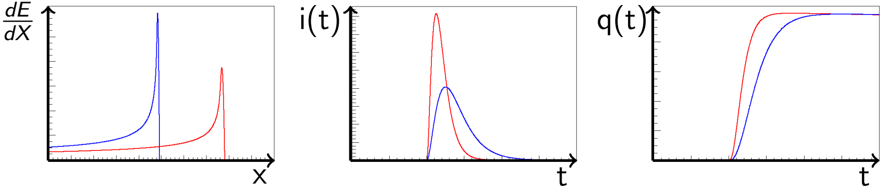

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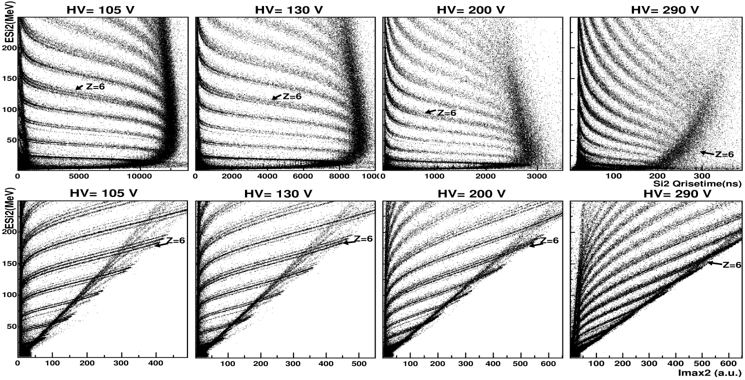
- possibility to use shape-dependent quantities (e.g Q_{rise},I_{max});
- FAZIA R&D studies $\Rightarrow$ I_{max} is better than Q_{rise}.

Charged Particle Identification
Pulse Shape Analysis (PSA)



G.Pasquali et al., EPJ A 50(2014)

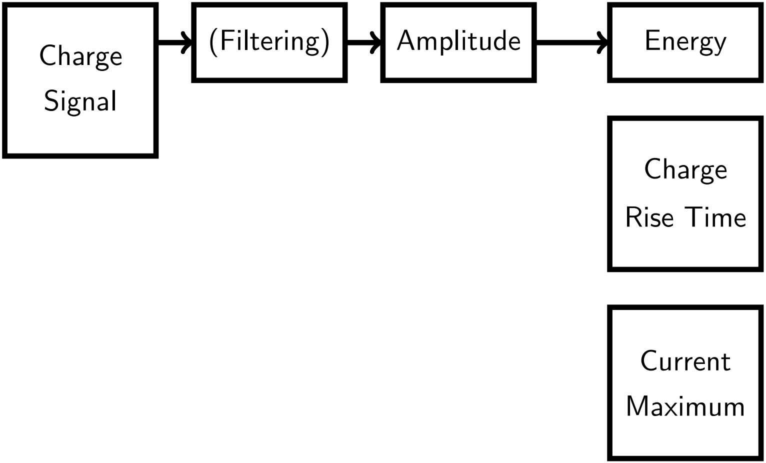
Pulse Shape Analysis
Gathering the ingredients

Energy

Charge
Rise Time

Current
Maximum

Pulse Shape Analysis
Gathering the ingredients



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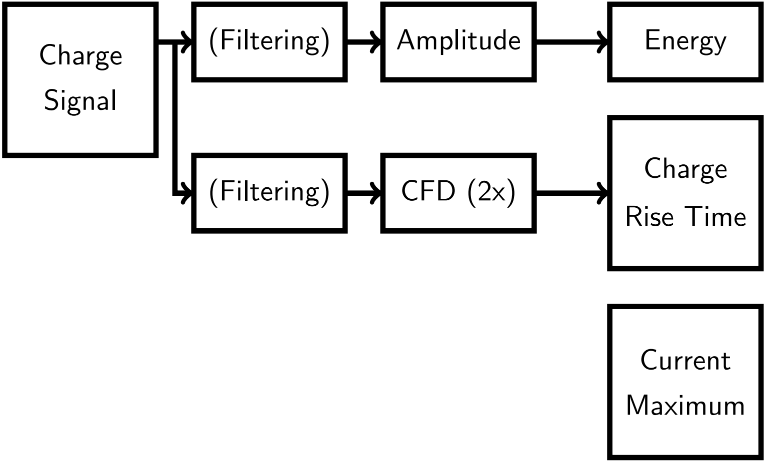

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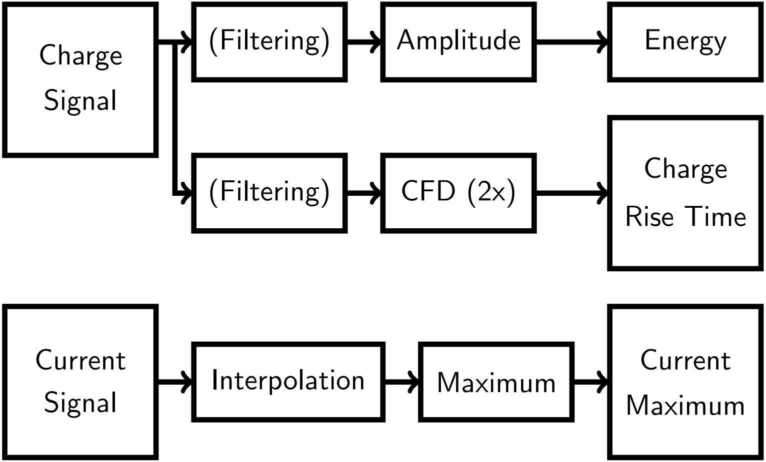

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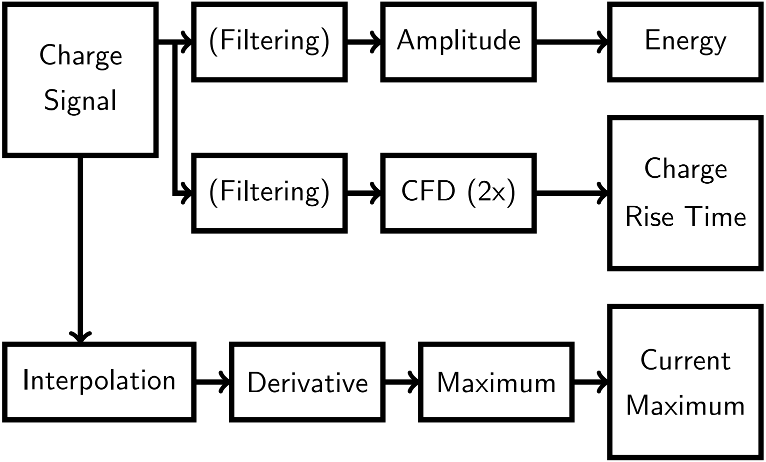

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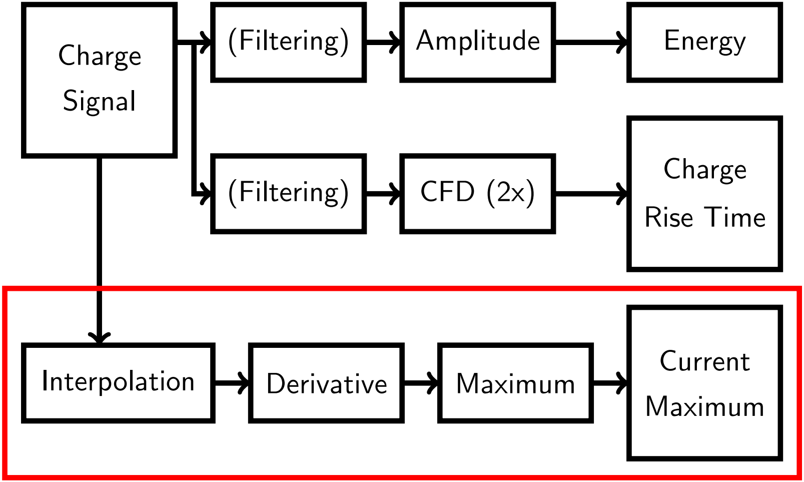
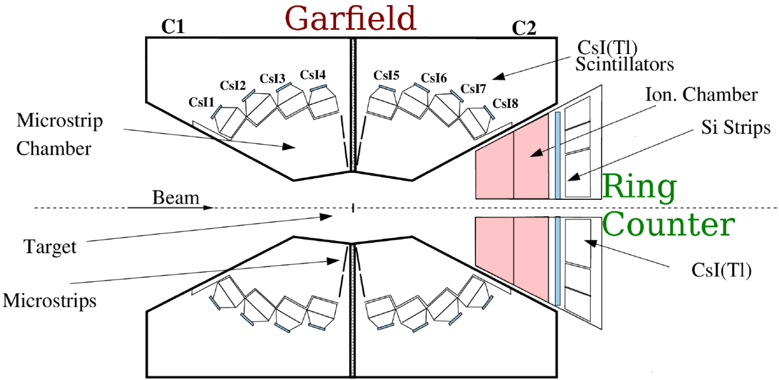


M.Unser et al., IEEE TSP 41 (1993)

The GARFIELD+RCo apparatus
An overview



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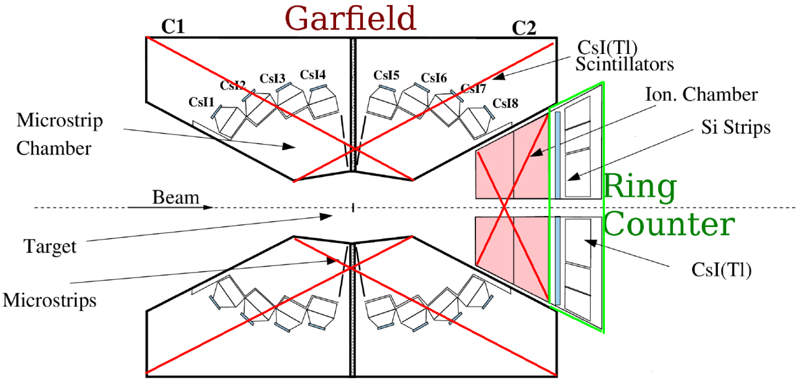
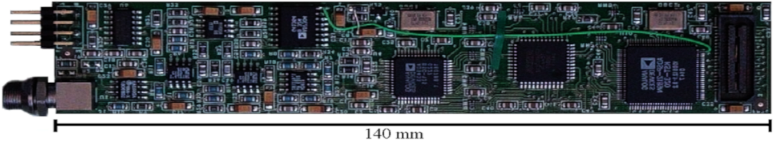


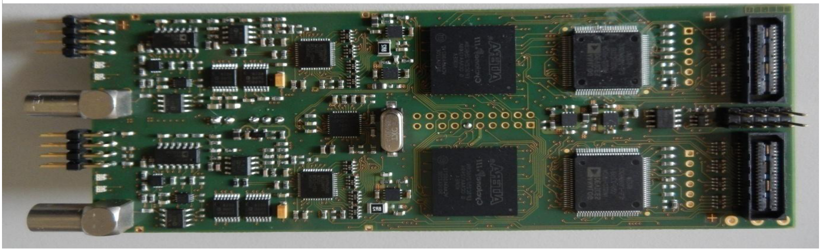
M. Bruno et al., EPJ A 49(2013)

The GARFIELD+RCo apparatus
Electronics Upgrade

Garfield FEE upgrade

Board	Channels	ADC	DSP	FPGA
Old	1	12bit	yes	no
New	2	**14bit**	yes	**yes**





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CODE	Parameter	Energy	Electronics
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RT_DSP_NEW	RiseTime	DSP	New
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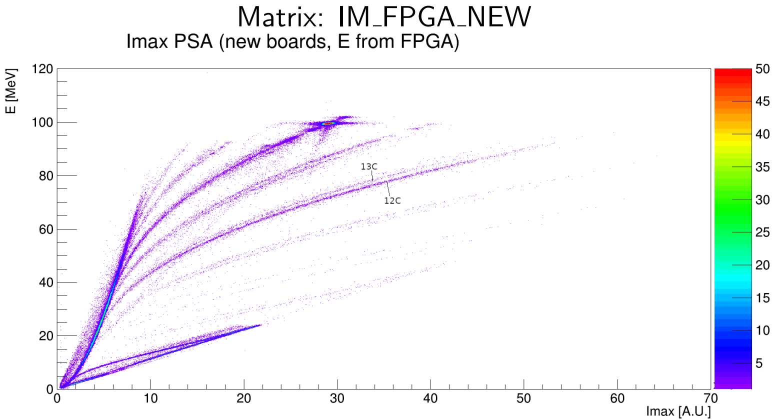
Presenting results from the best performing detector.

The DIGIGARF experiment: first Results

PSA Matrices - PRELIMINARY



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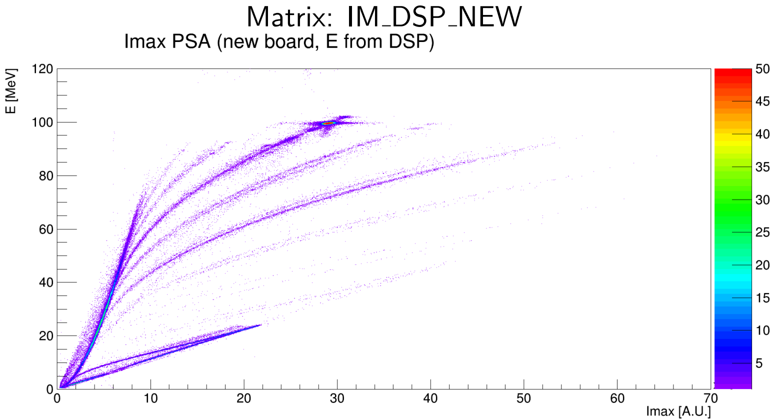

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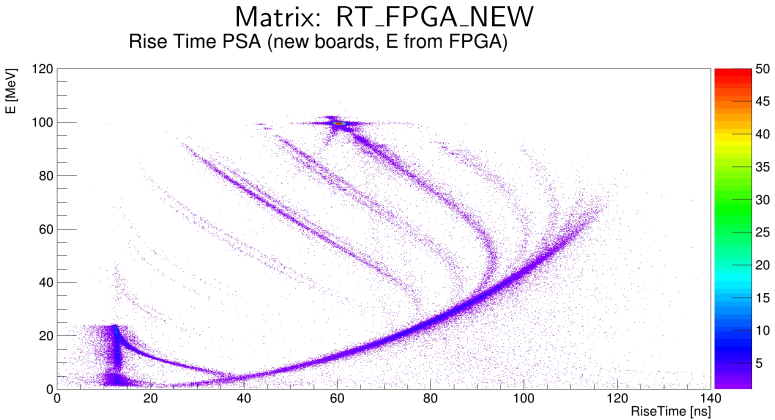

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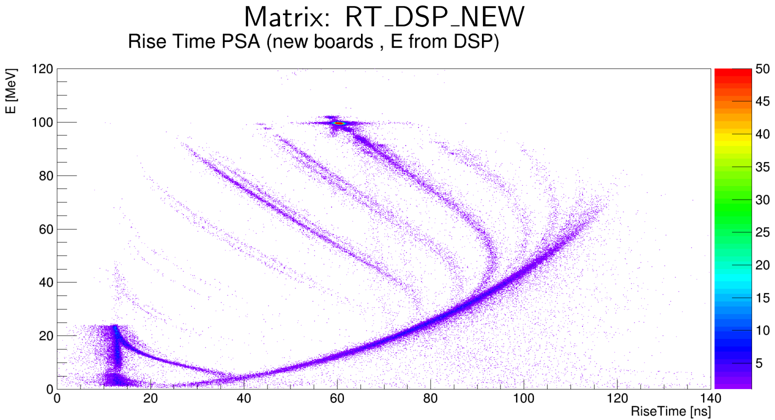

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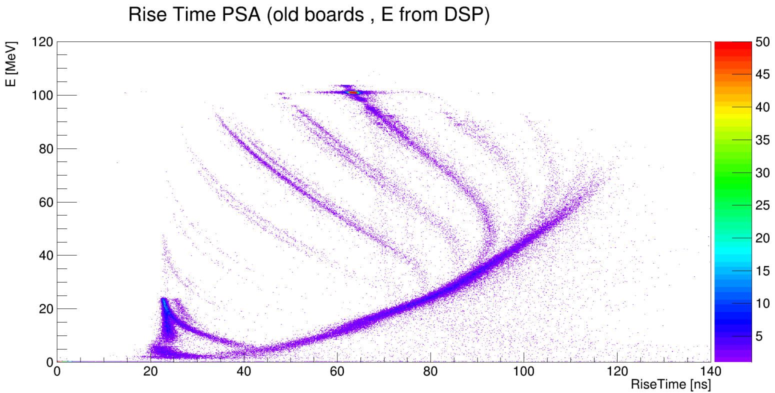
PSA Matrices - PRELIMINARY

Matrix: RT_DSP_OLD



The DIGIGARF experiment: first Results

Identification thresholds - PRELIMINARY

Energy thresholds for mass identification (MeV)

Z	RT_DSP_OLD	RT_DSP_NEW	RT_FPGA_NEW	IM_DSP_NEW	IM_FPGA_NEW
5	40	40	38	40	38
6	44	44	44	44	44
7	56	52	50	52	52

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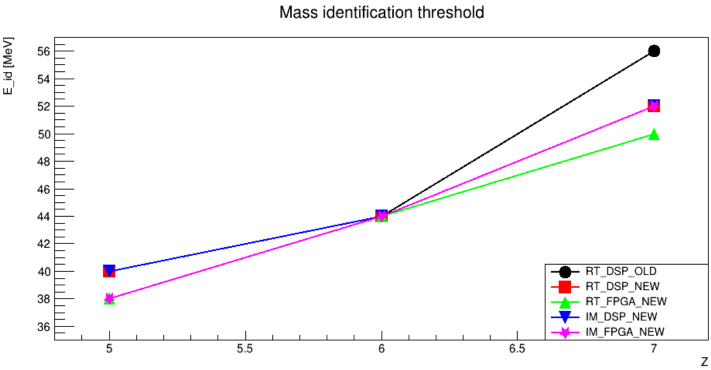
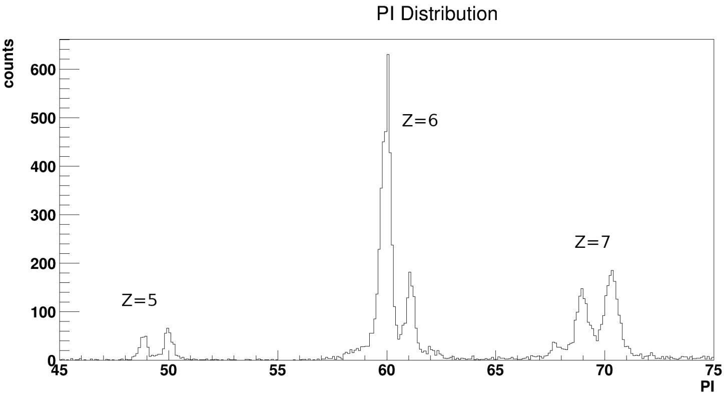


The DIGIGARF experiment: first Results
Identification plots - PRELIMINARY

Matrix: IM_FPGA_NEW



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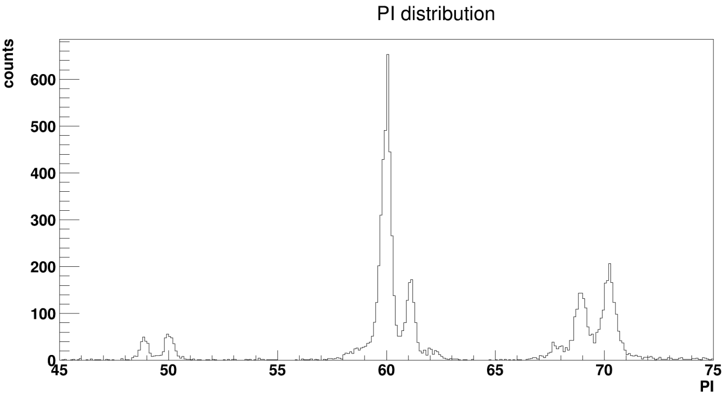

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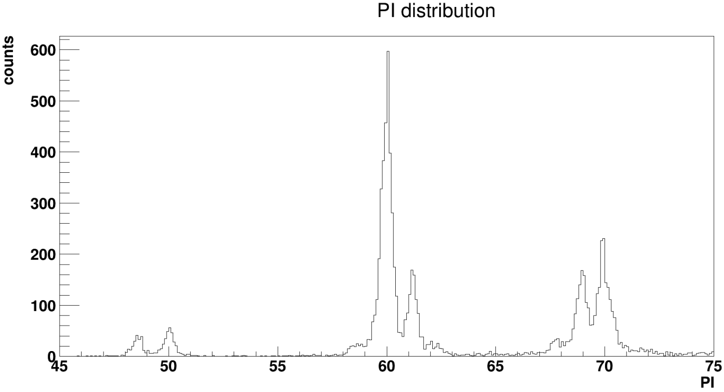

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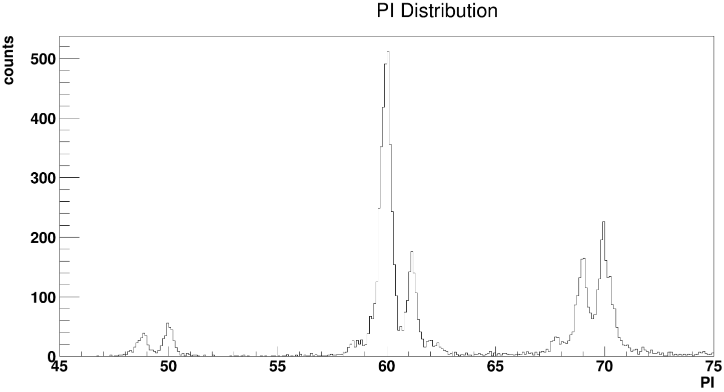

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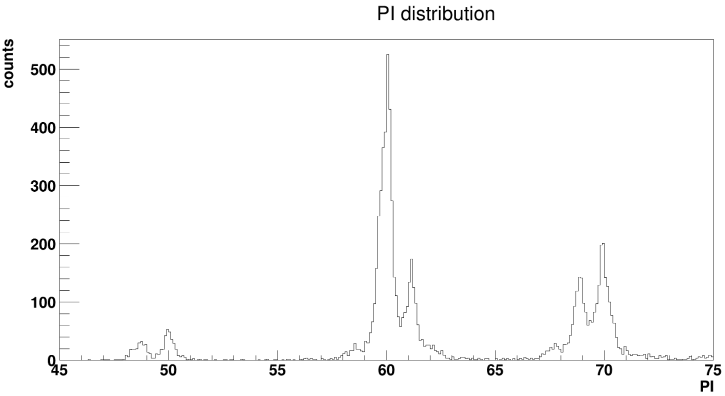

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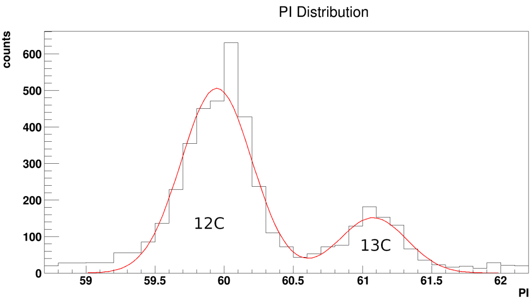

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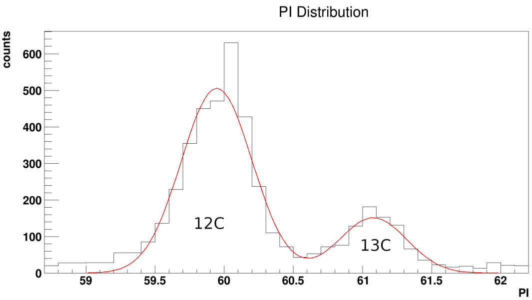
- separation limit: FoM>0.7 (FAZIA collaboration)
- Higher FoM means better separation.



The DIGIGARF experiment: first Results
FOM values - PRELIMINARY

FoM of the two main peaks

Z	Peaks	RT_DSP_OLD	RT_DSP_NEW	RT_FPGA_NEW	IM_DSP_NEW	IM_FPGA_NEW
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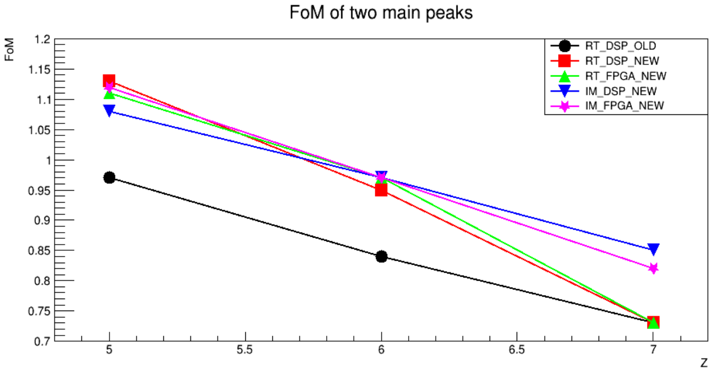

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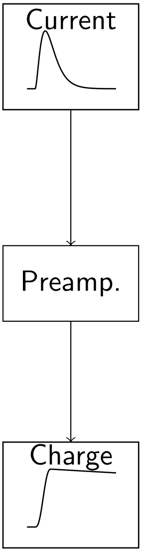
- GARFIELD+RCo is the first apparatus to implement this kind of signal processing;
- FAZIA papers: even better results expected with better detectors;

Thanks for your attention!

On-board PSA: I_{max} evaluation
From current and charge signal!



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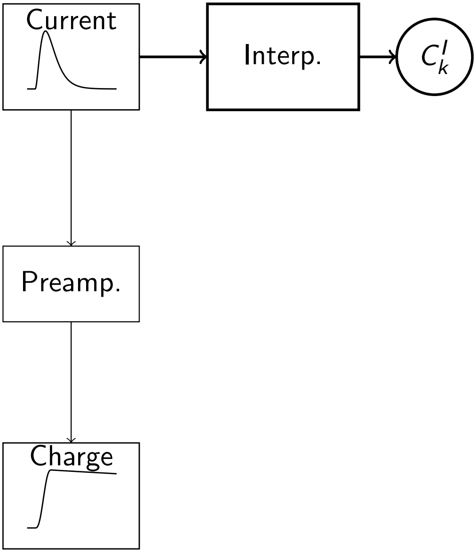

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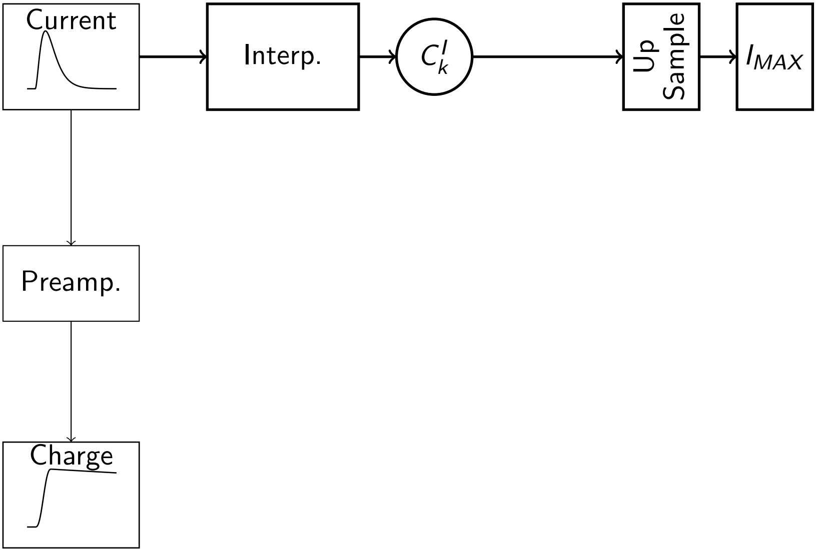

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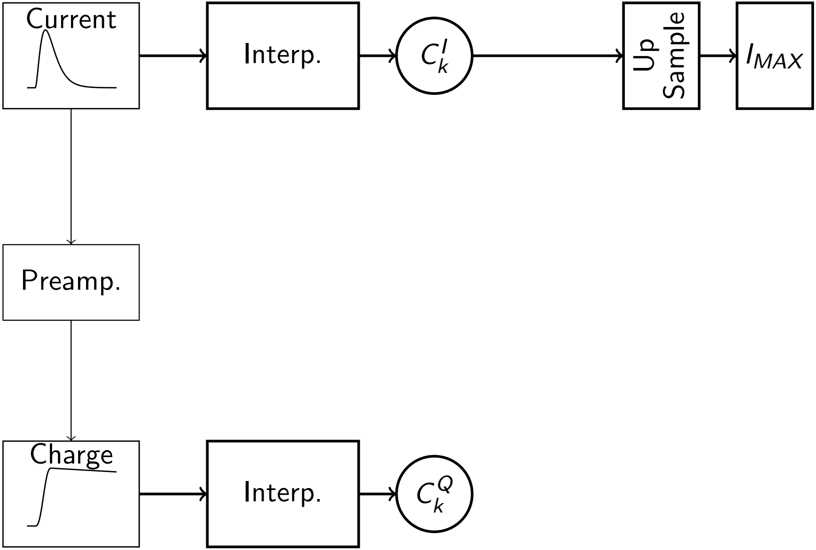

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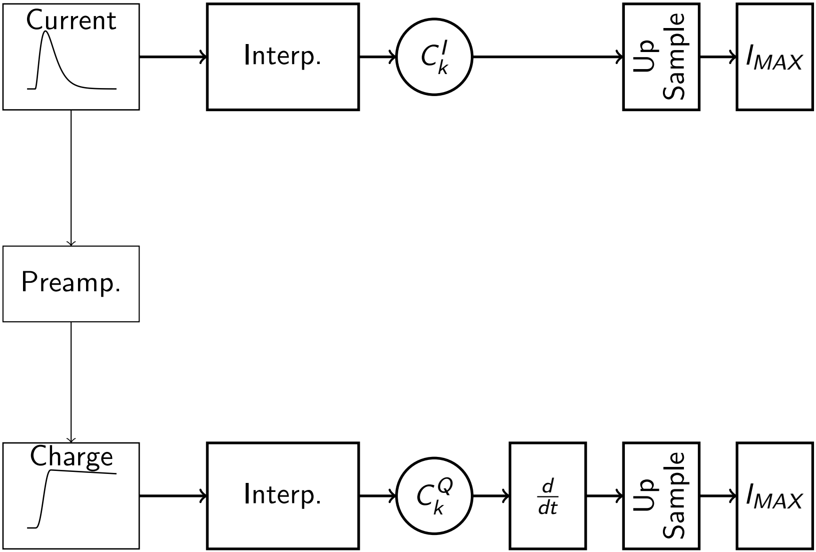

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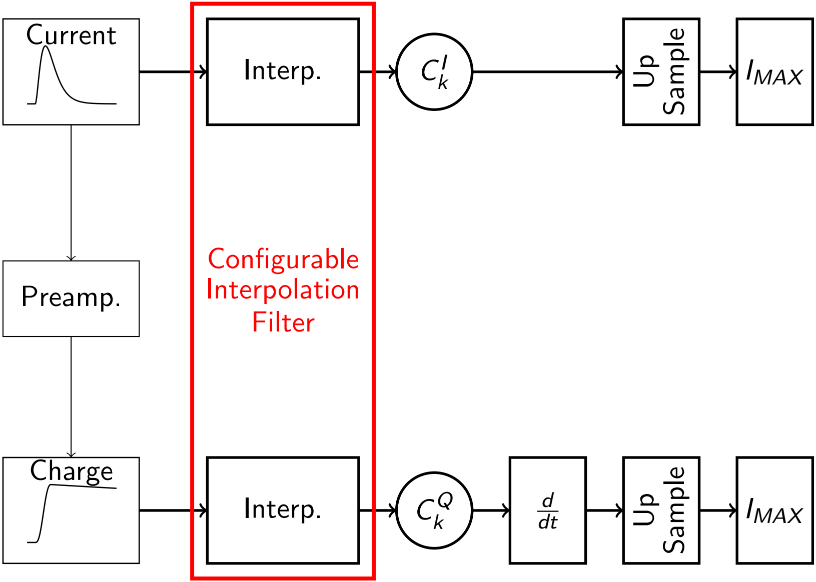

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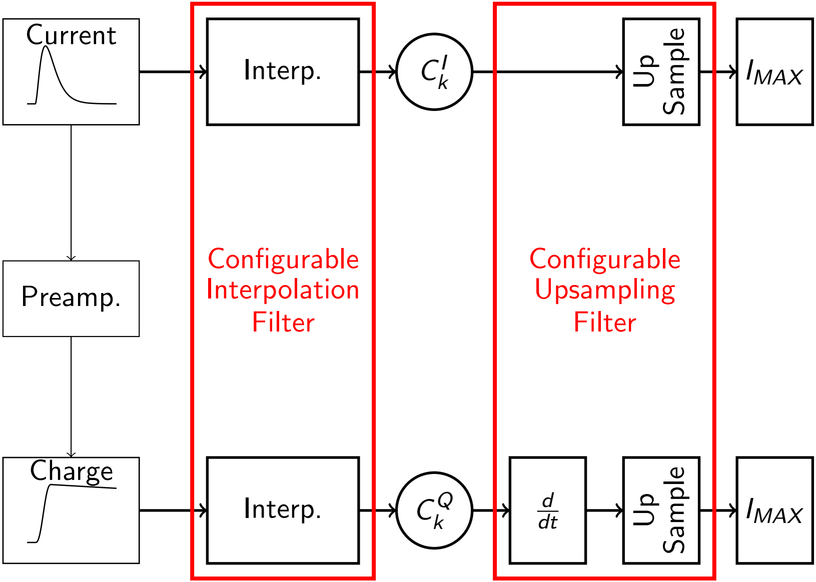

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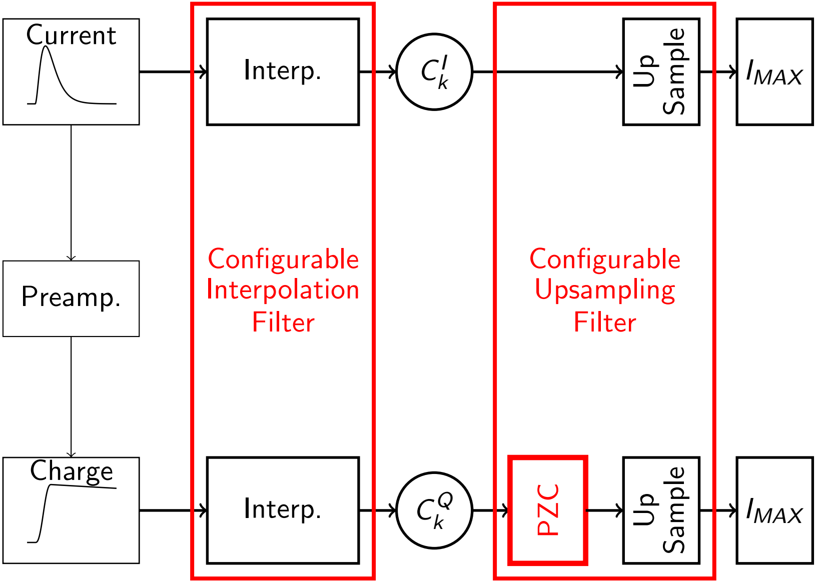

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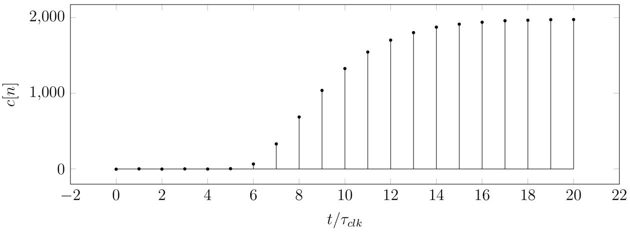
An example



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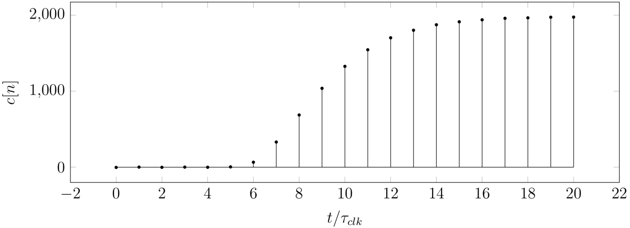

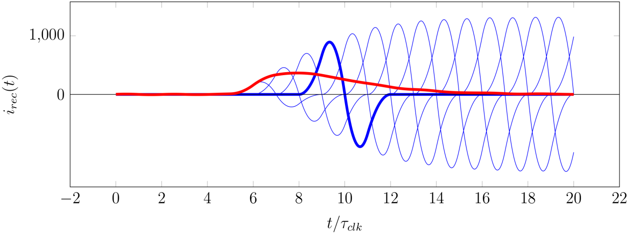

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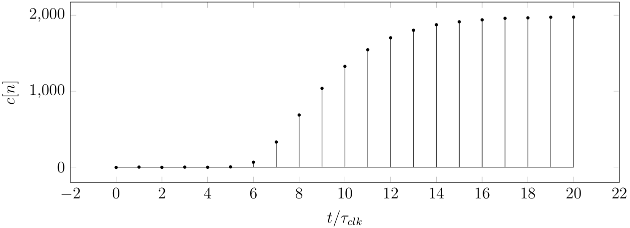

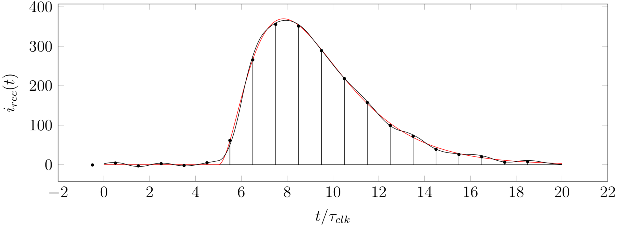

Tempo di plasma

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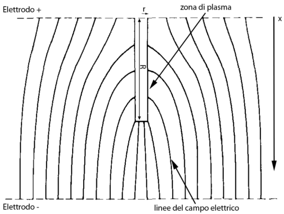

Tempo di plasma

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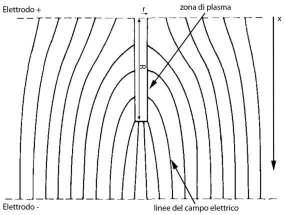
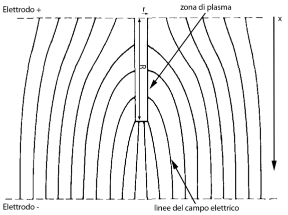
- plasma erosion time depends on density, size, $\vec{E}$.



Tempo di plasma

- impinging particle $\Longrightarrow$ charge carriers;
- e-h plasma shields the Electric Field ($\vec{E}$);
- plasma erosion time depends on density, size, $\vec{E}$.



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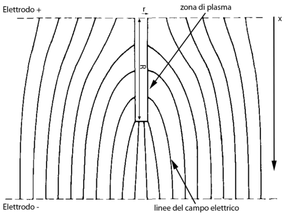


Collection time

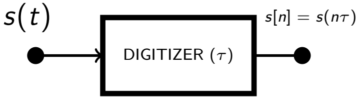
- carriers drifting towards electrodes;
- depends on distance of carriers from electrodes.

Current extracion from Charge signal

On board interpolation

$s(t)$

Current extracion from Charge signal
On board interpolation



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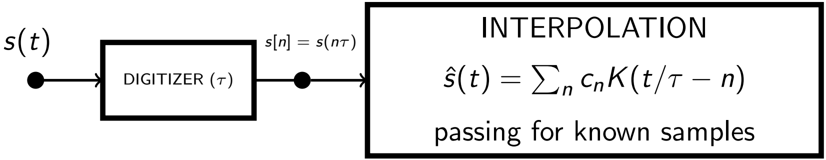
On board interpolation



Current extracion from Charge signal
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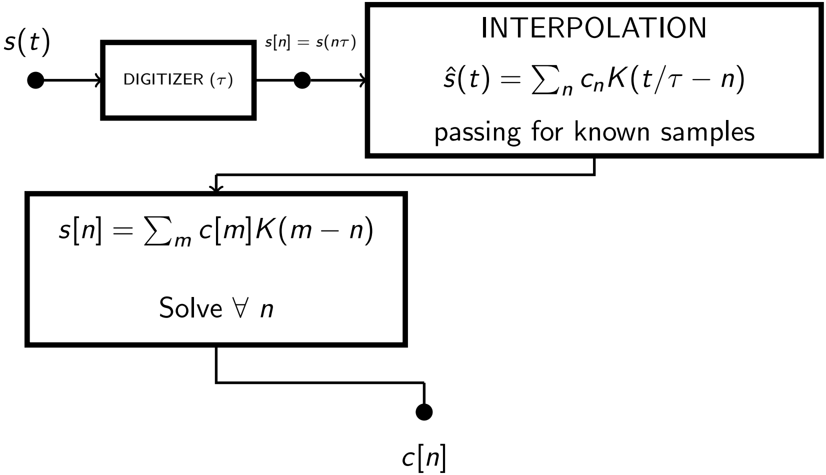

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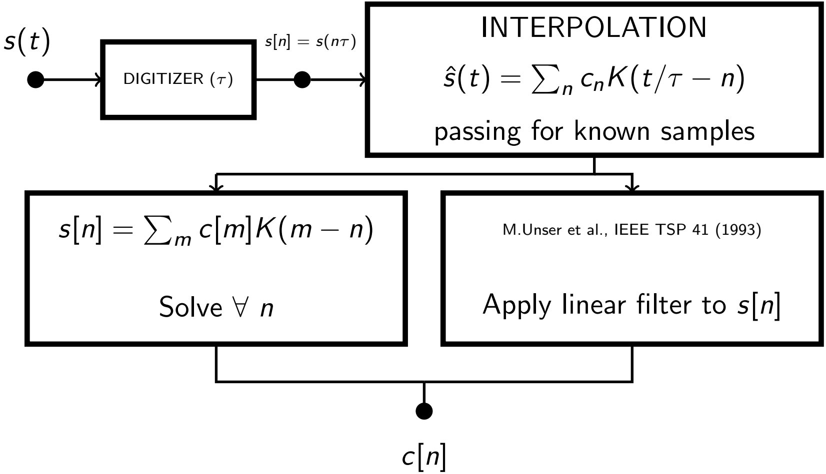

Application of linear filter (F) to the signal:

$\hat{s}(t) = \sum_n c_n K(t/\tau - n) \Rightarrow F(\hat{s}(t)) = \sum_n c_n F(K(t/\tau - n))$

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Can be used to obtain current signal from charge signal (PSA).

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Case 2: upsampling factor U

$$v[m,j] = v((m+j/U)\tau) = \sum_n c_n K_F(m-n+j/U) \; j = 0,..,U-1$$
$$\Rightarrow \text{U linear filters!}$$

Linearization procedure