



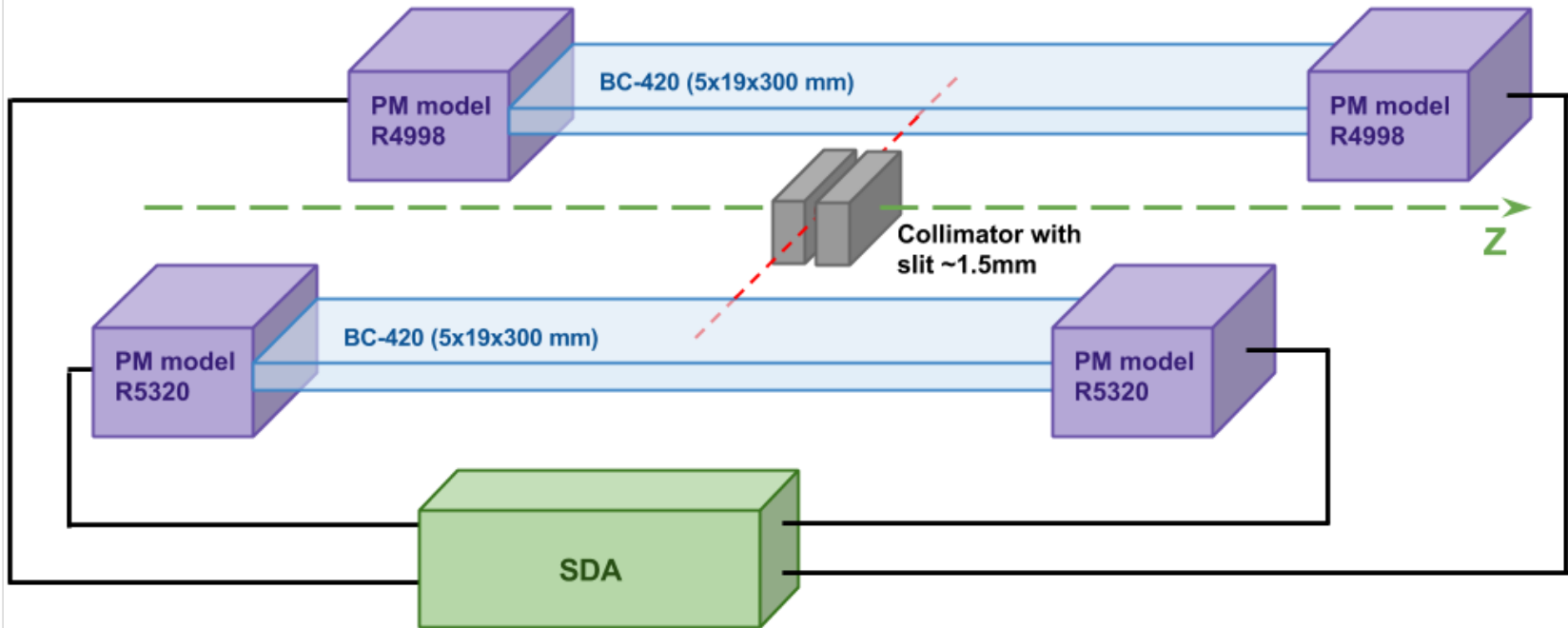
Line-of-response and time-of-flight reconstruction based on library of synchronized model signals

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and
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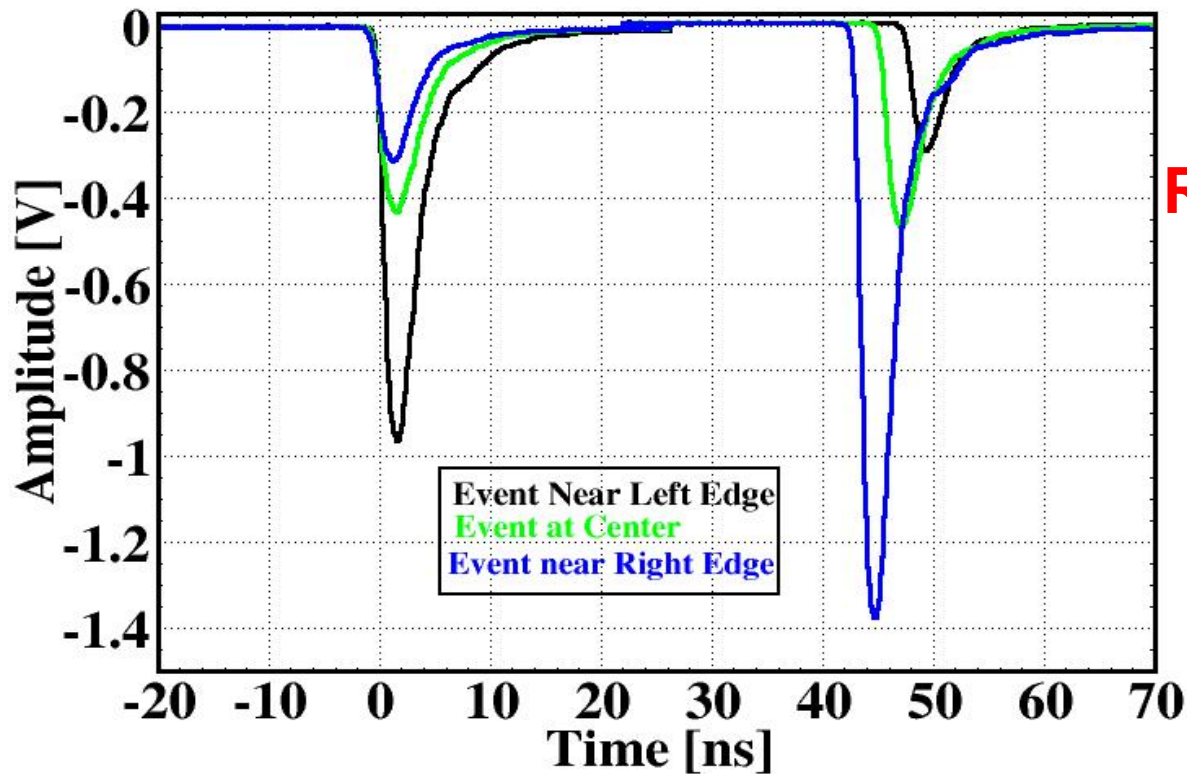
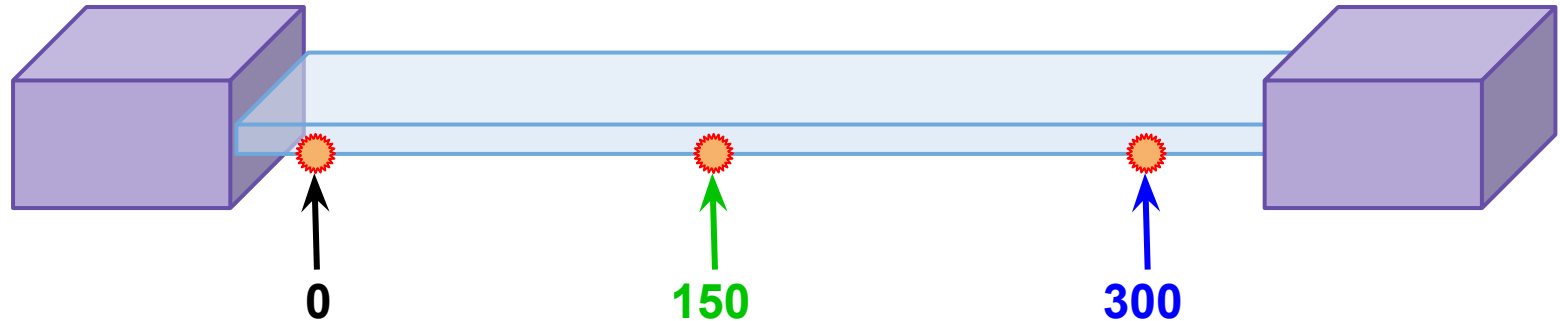
Outline

- **Schematic of the experiment**
- **Reconstruction methods**
- **Results**
- **Conclusions**

Experiment Schematic

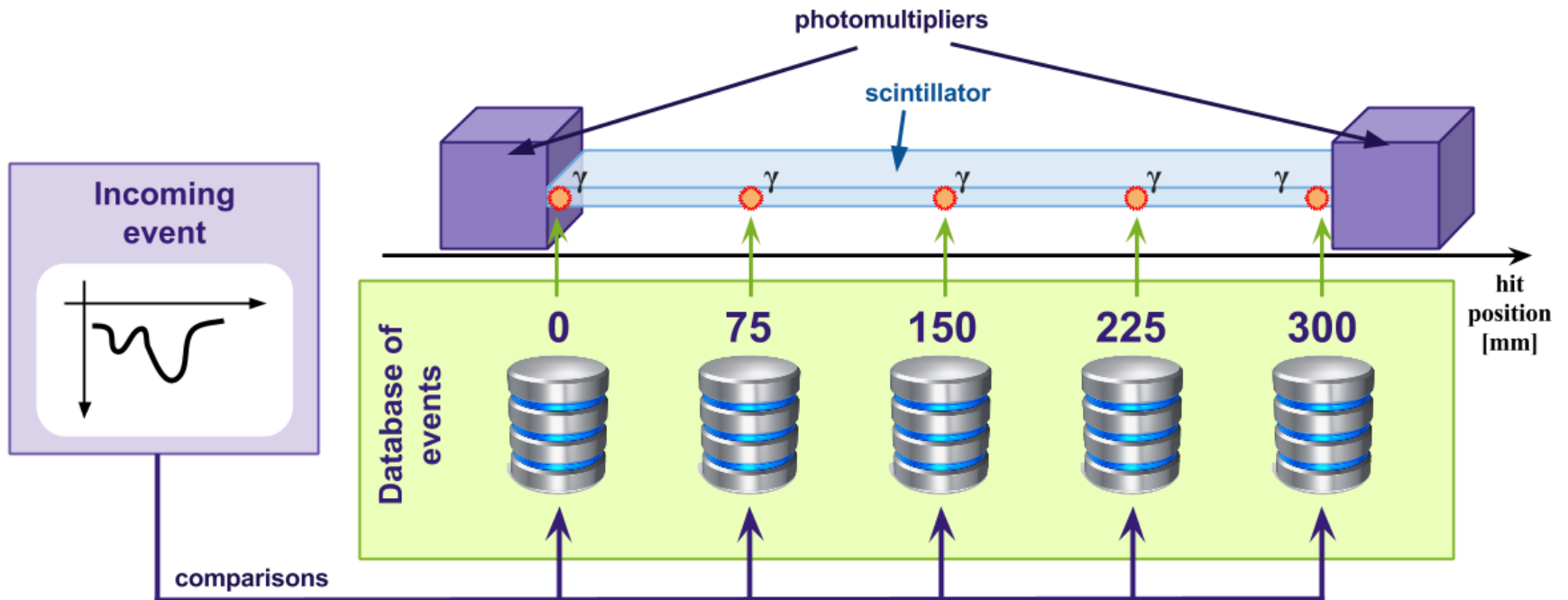


Varying shape of signals



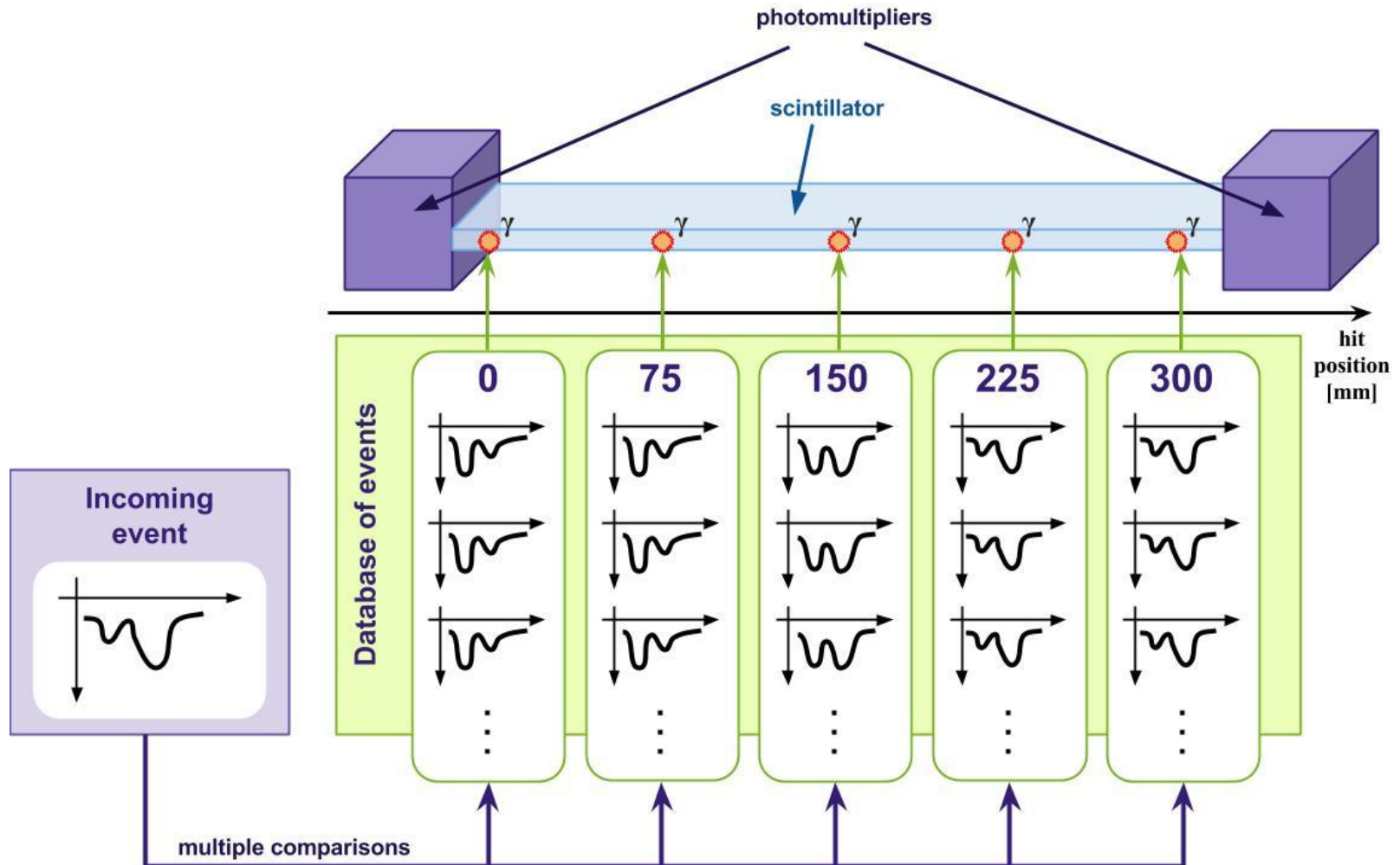
Real Signals

Database-search based reconstruction methods



Method 1

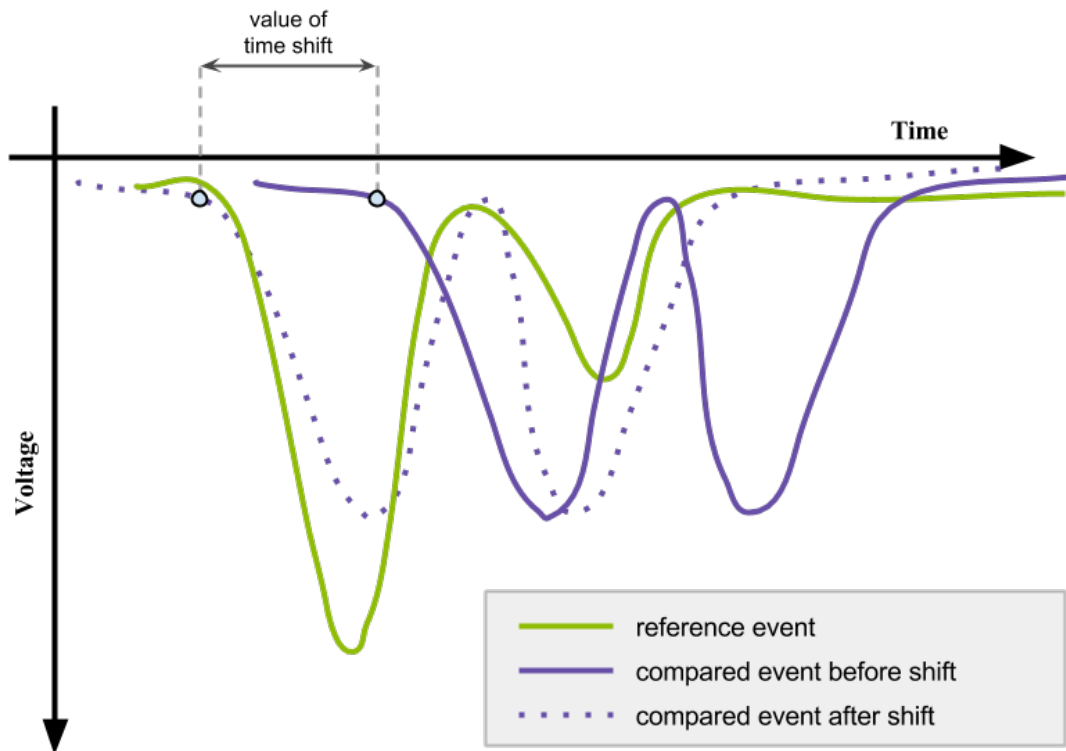
multiple comparisons with database signals



Method 1

the comparison algorithm

1. Time offset between two compared events is minimized (disregarded)



Method 1

the comparison algorithm

2. Calculation of the distance between two compared events

2.1. χ^2 method

$$\chi^2(event_1, event_2) = \frac{\sum_{i=0}^{n-1} (t_{1(Left),i} - t_{2(Left),i})^2}{n} + \frac{\sum_{i=0}^{m-1} (t_{1(Right),i} - t_{2(Right),i})^2}{m}$$

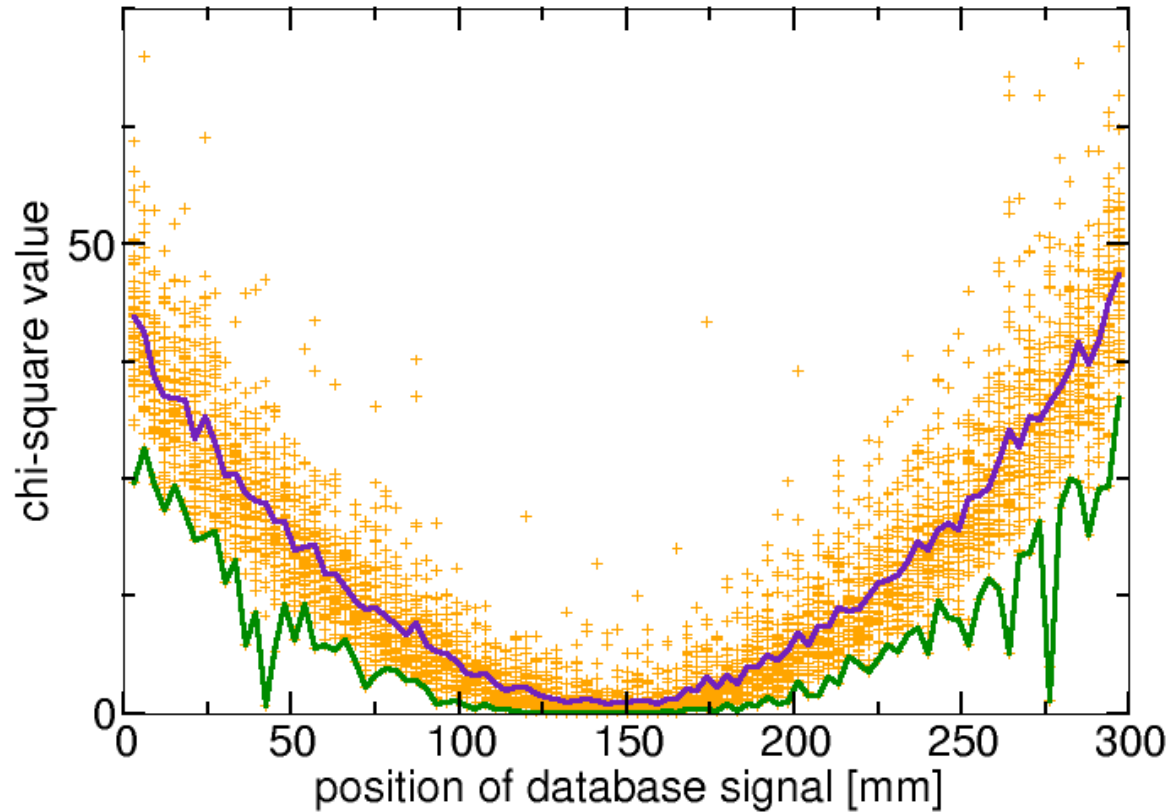
2.2. Fréchet method

$$F(A, B) = \inf_{\alpha, \beta} \max_{t \in [0,1]} \left\{ d\left(A(\alpha(t)), B(\beta(t))\right) \right\}$$

Method 1

χ^2 results

input signal: 150 mm

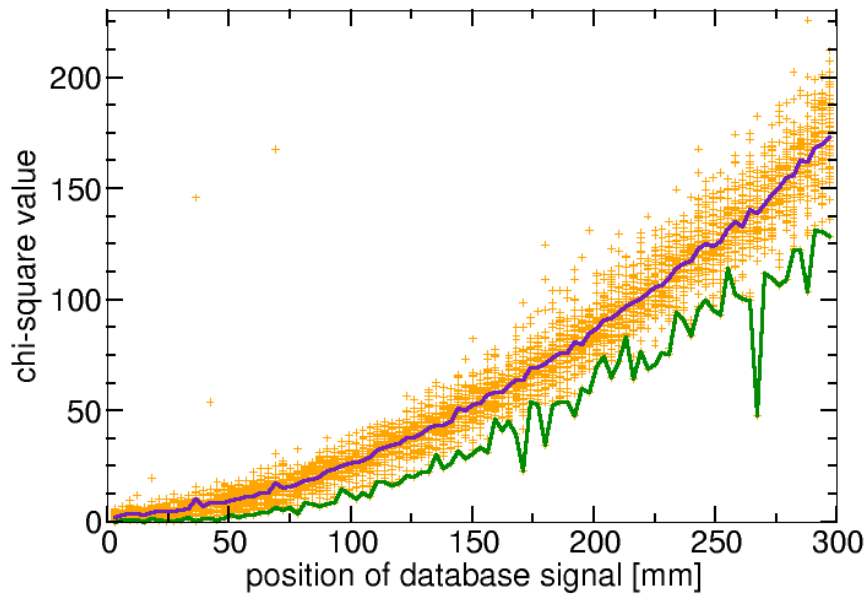


- + a single comparison
- average chi-square per position
- minimum chi-square per position

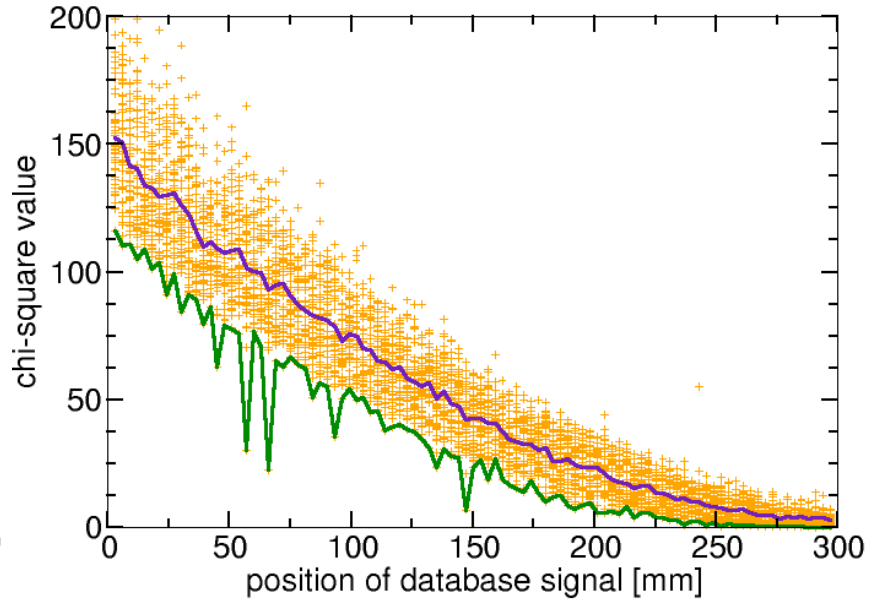
Method 1

χ^2 results

input signal: 3 mm



input signal: 297 mm

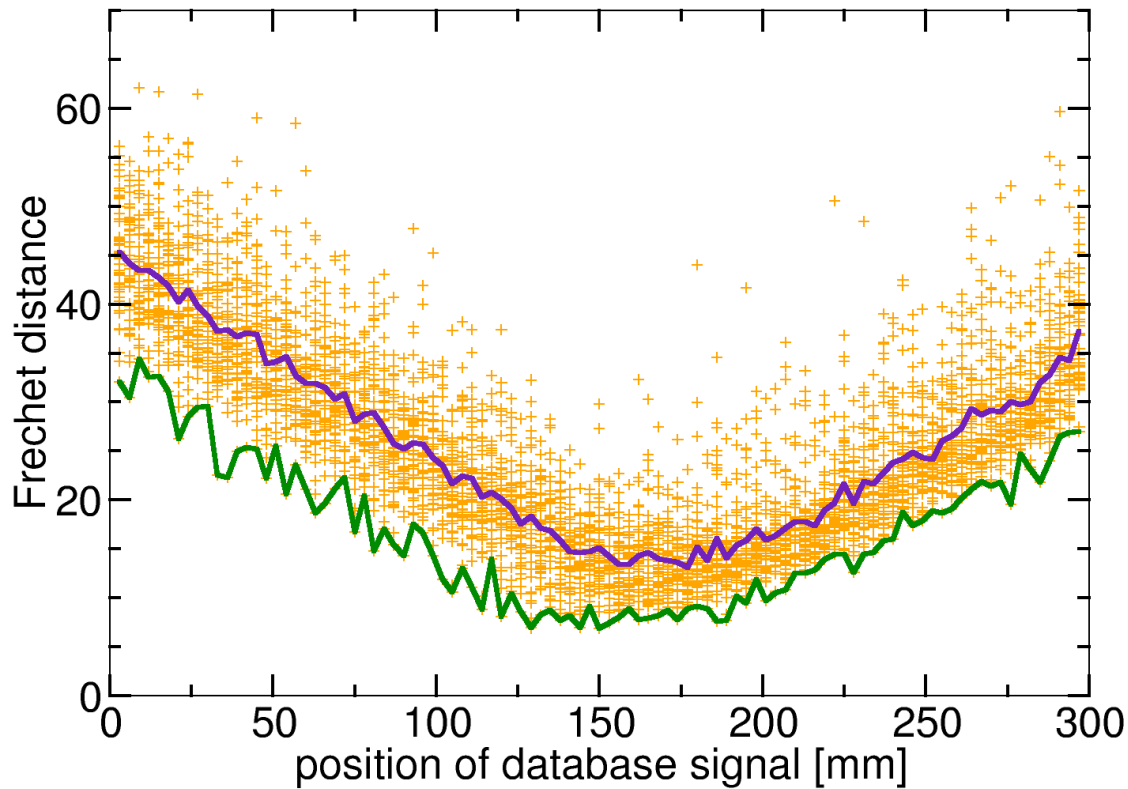


- + a single comparison
- average chi-square per position
- minimum chi-square per position

Method 1

Fréchet results

input signal: 150 mm

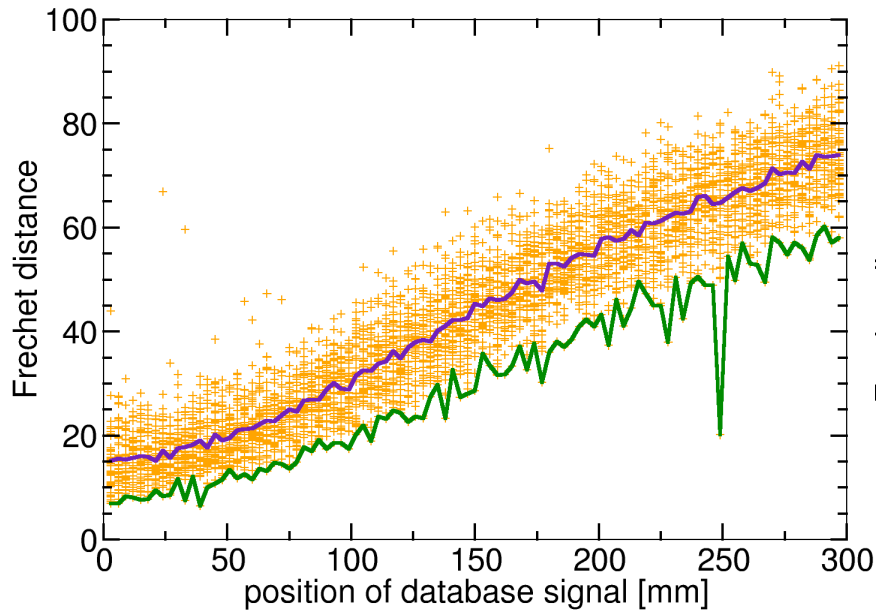


- + a single comparison
- average Fréchet distance per position
- minimum Fréchet distance per position

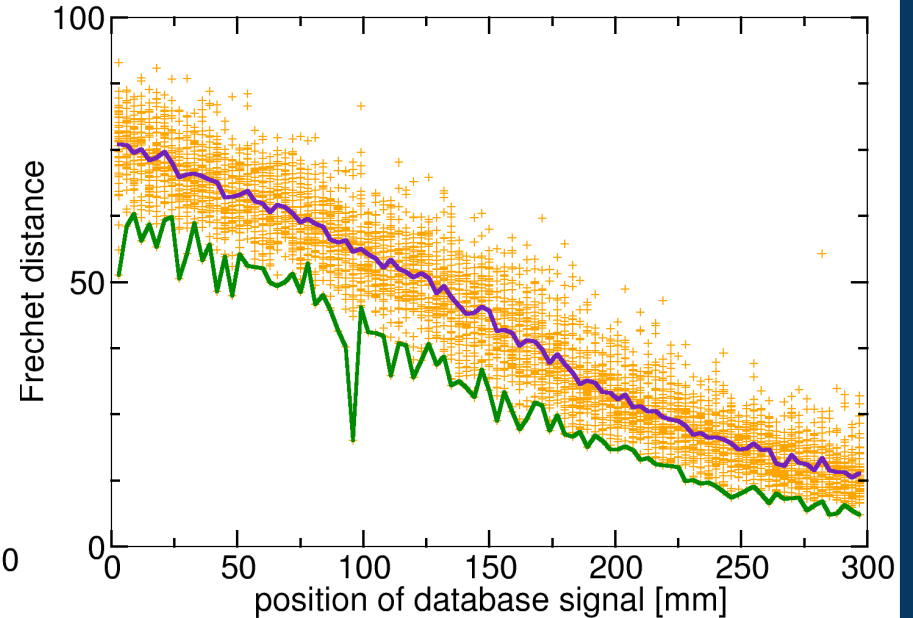
Method 1

Fréchet results

input signal: 3 mm



input signal: 297 mm

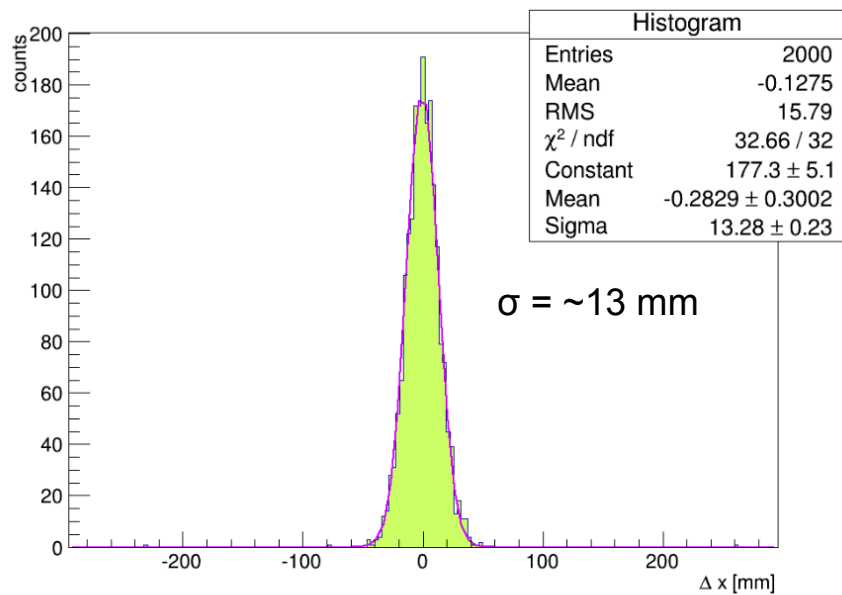


- + a single comparison
- average Fréchet distance per position
- minimum Fréchet distance per position

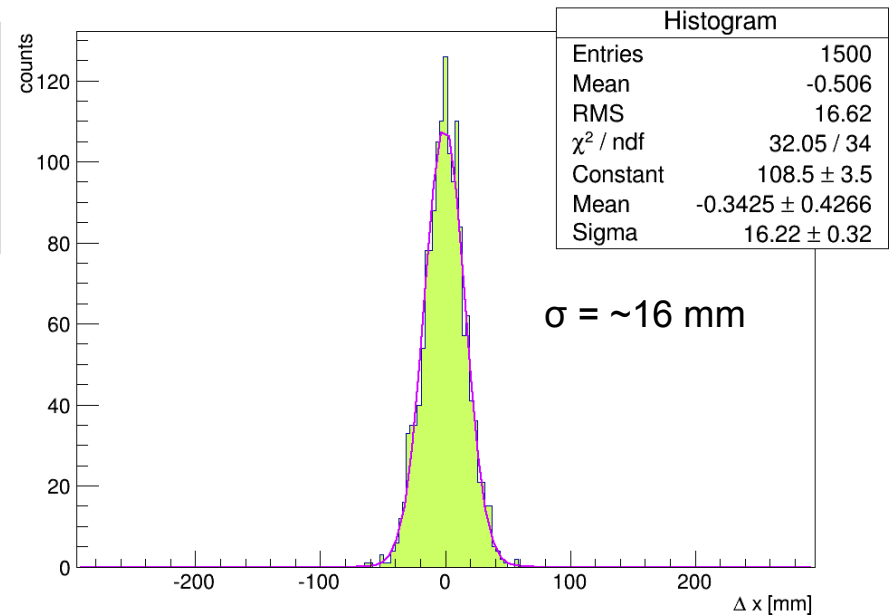
Method 1

Spatial resolution results

χ^2 method

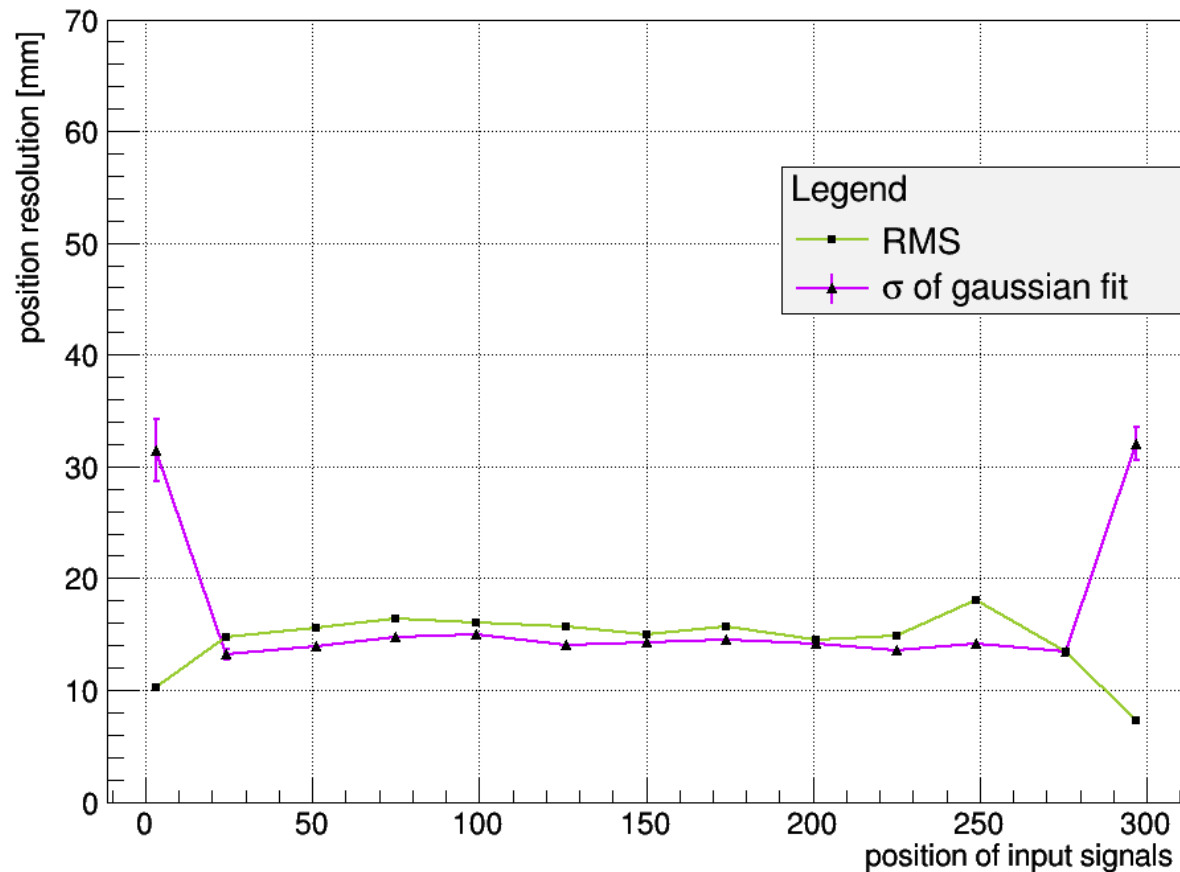


Fréchet method

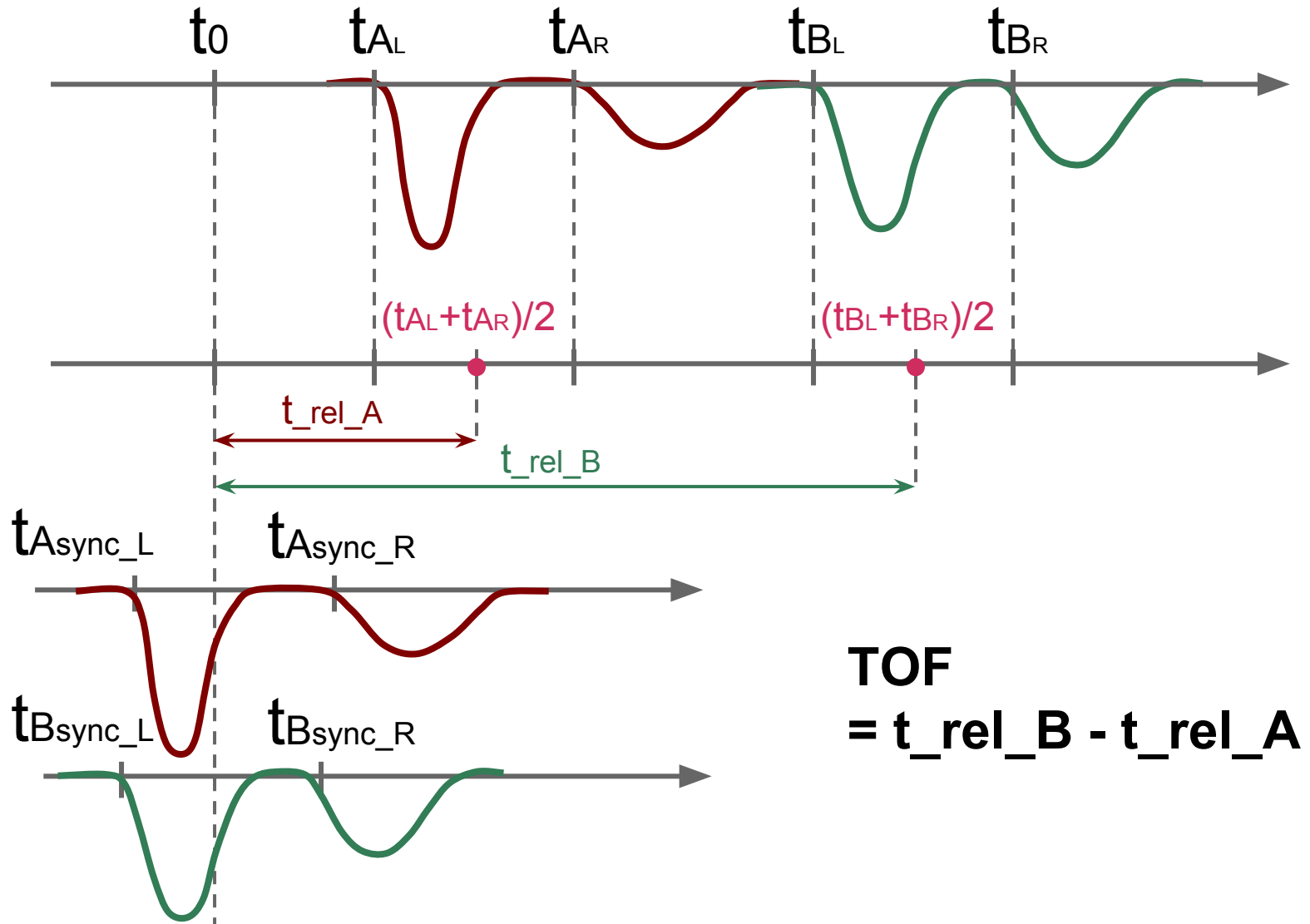


Method 1

Spatial resolution results as function of position of input signals

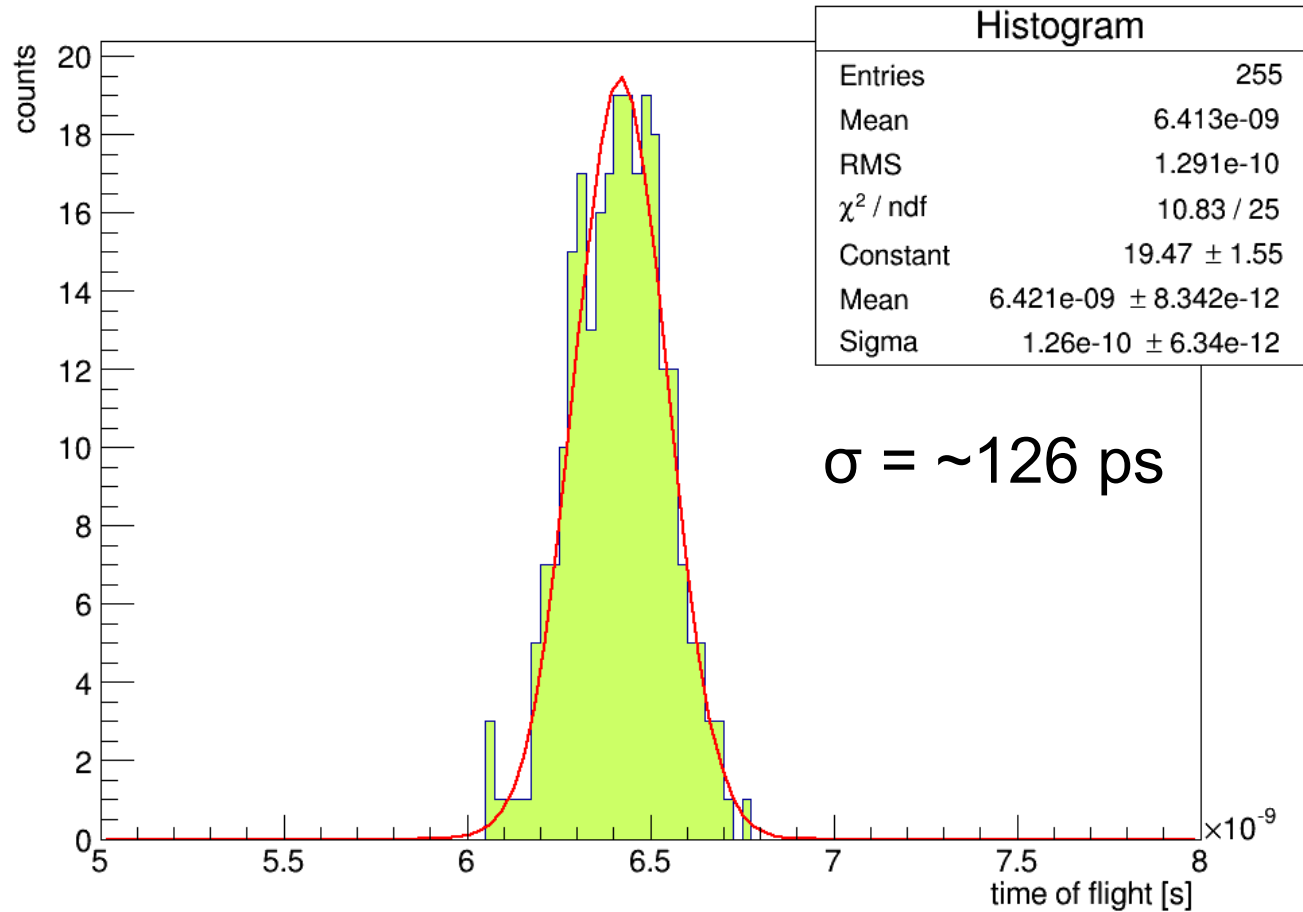


Method 1 Time resolution

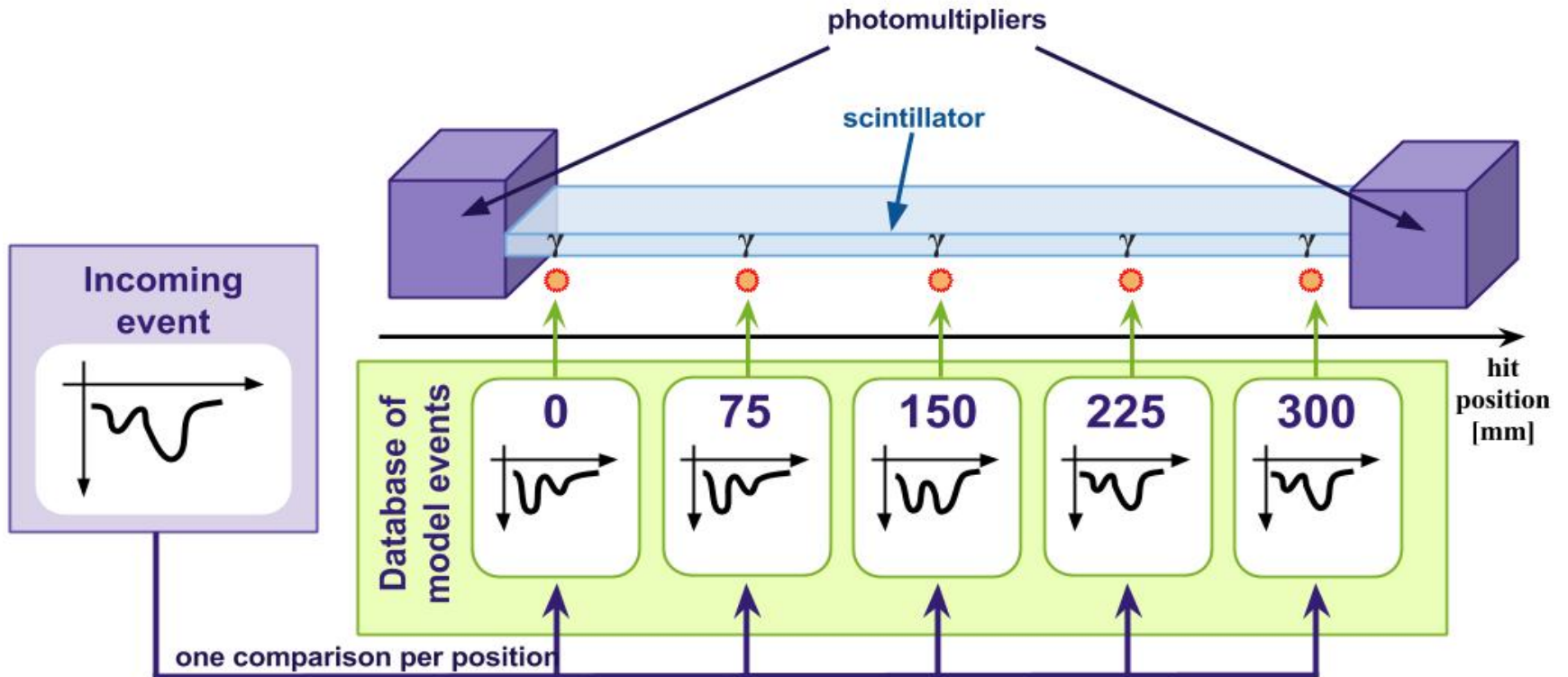


Method 1

Time resolution - results



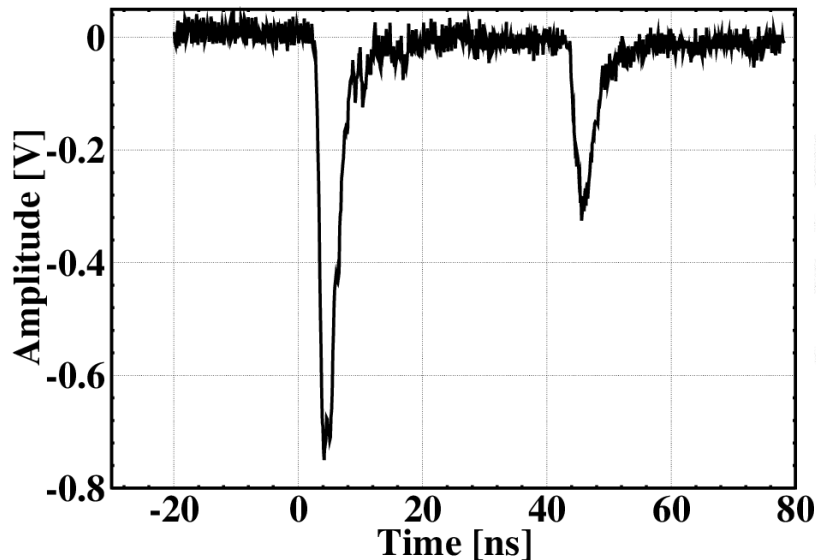
Schematic of Method 2



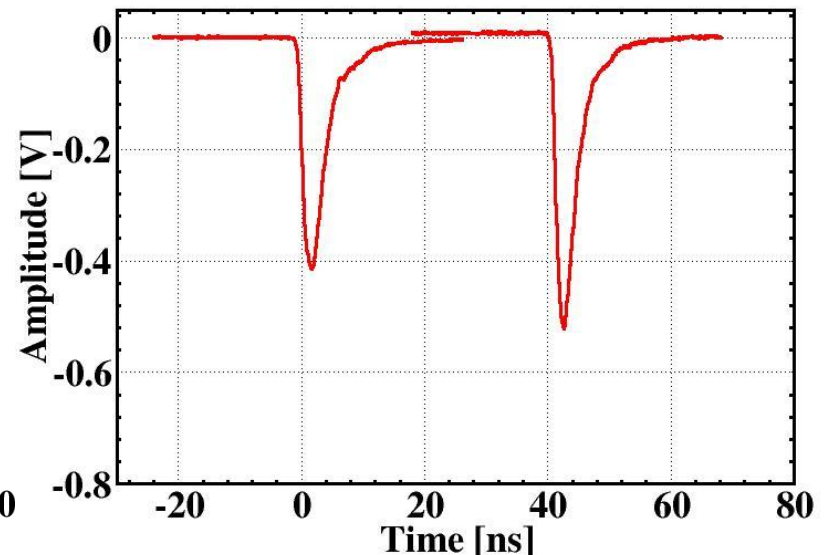
Description of Method 2

- Calculate an average event correspond to each position from its all measured events

Measured Event Sample



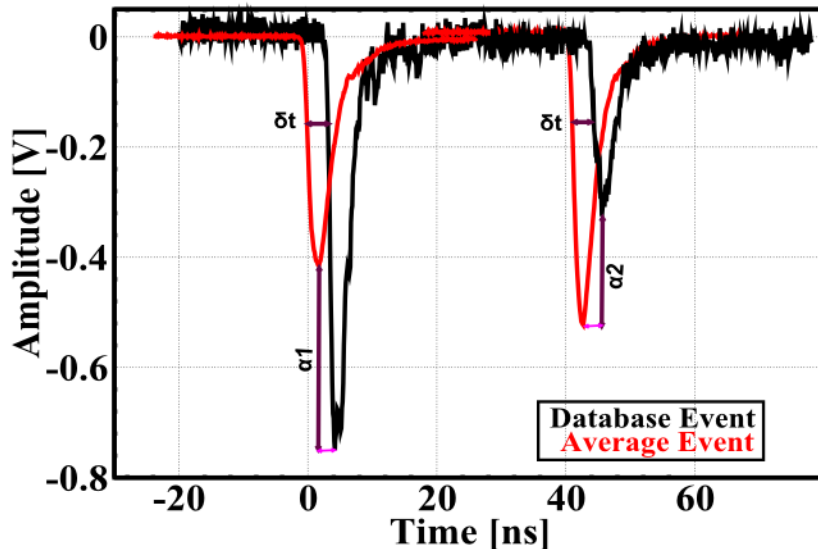
Average Event Sample



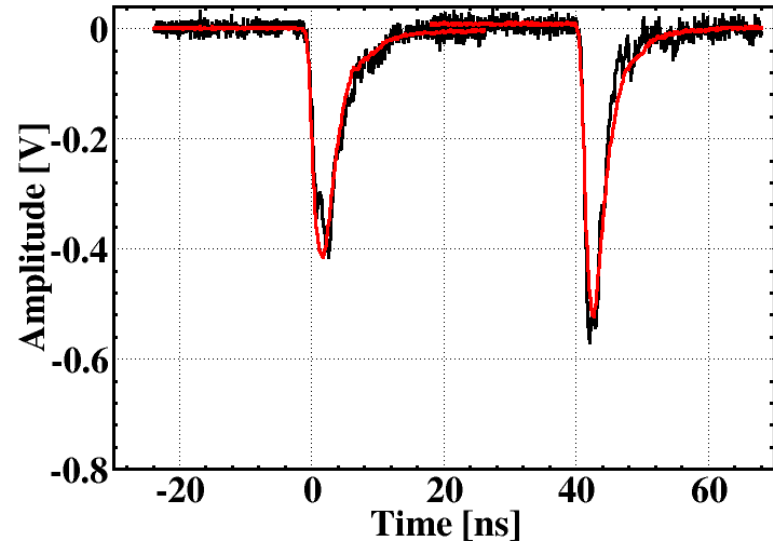
Description of Method 2

- Modification of measured events **wrt** their average event using Chi-square minimization function

Measured Event Sample **Before** Modification



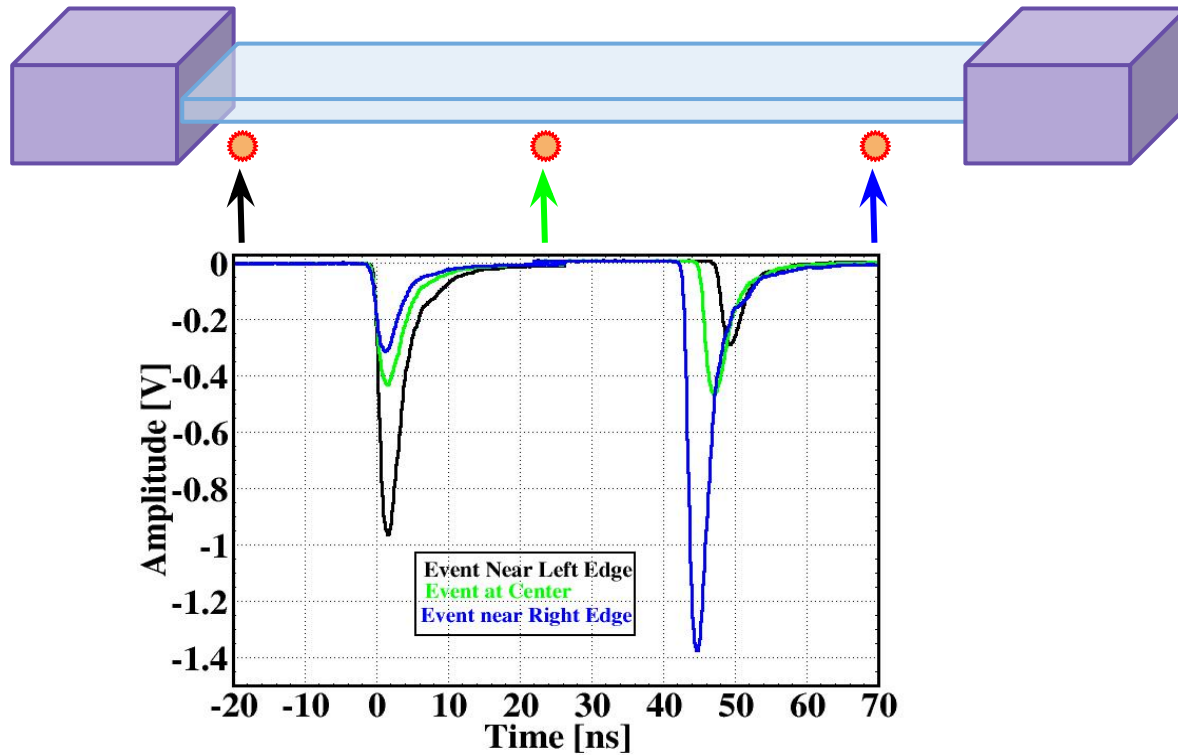
Measured Event Sample **After** Modification



$$\chi^2(\alpha_1, \alpha_2, \delta t) = \sum_{i=1}^n \frac{(t_{\text{avgLeft}}(V_i) - t_{\text{dbLeft}}(\alpha_1 V_i - \delta t))^2 + (t_{\text{avgRight}}(V_i) - t_{\text{dbRight}}(\alpha_2 V_i - \delta t))^2}{n}$$

Description of Method 2

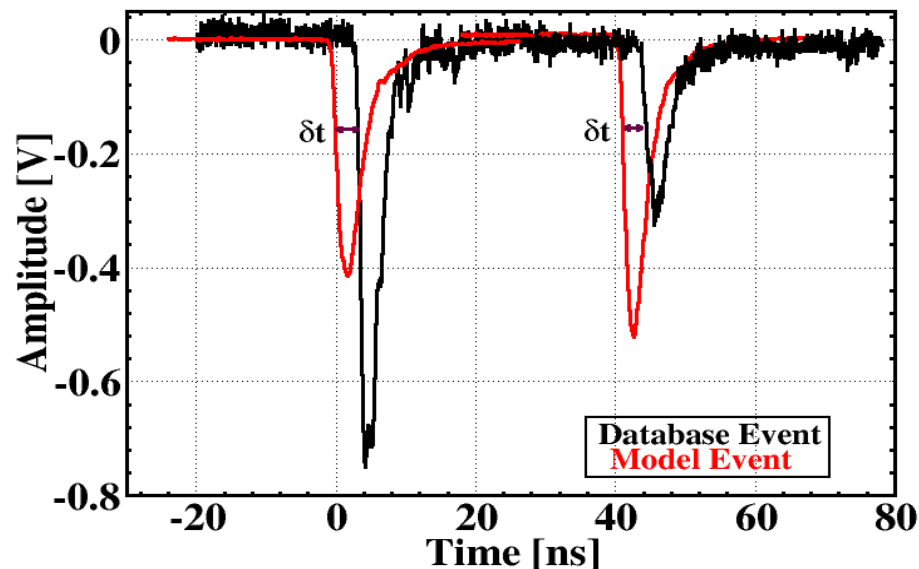
- **Average over modified events** correspond to each position was calculated, which called as **MODEL EVENT**



❑ Spatial resolution

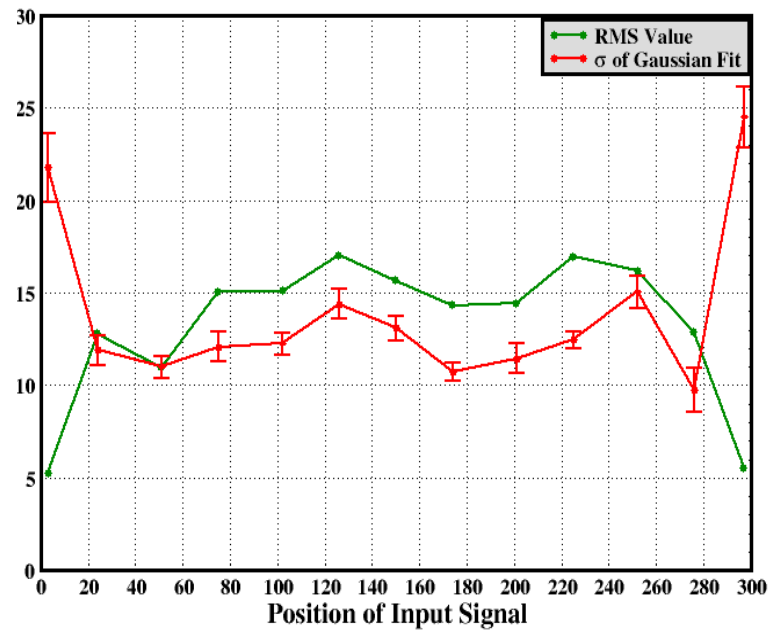
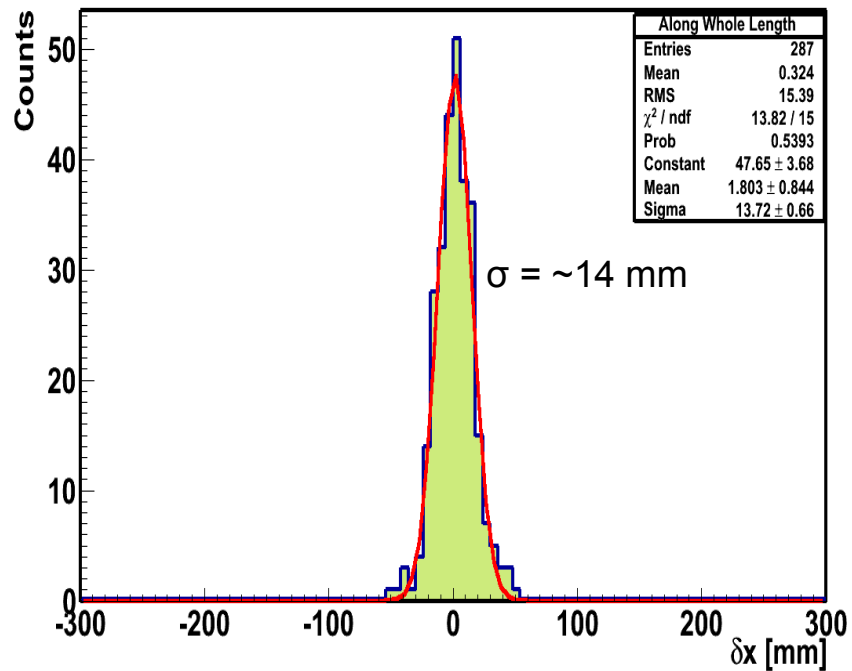
→ Comparison between random and each **positional** Model event performed

$$\chi^2(\delta t) = \sum_{i=0}^{n-1} \frac{(t_{\text{modelLeft},i} - t_{\text{dbLeft},i})^2}{n} + \sum_{i=0}^{m-1} \frac{(t_{\text{modelRight},i} - t_{\text{dbRight},i})^2}{m}$$

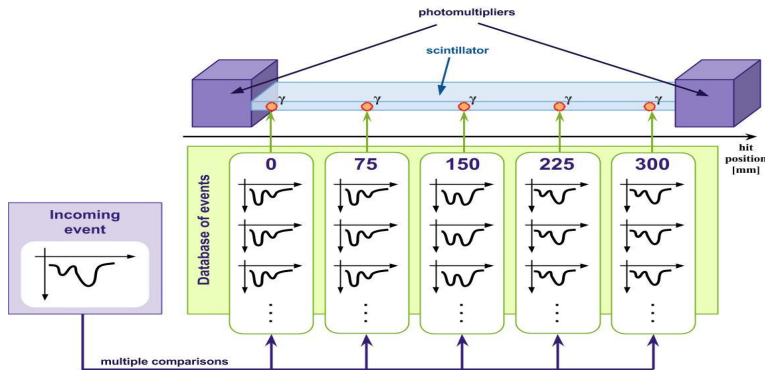


Results

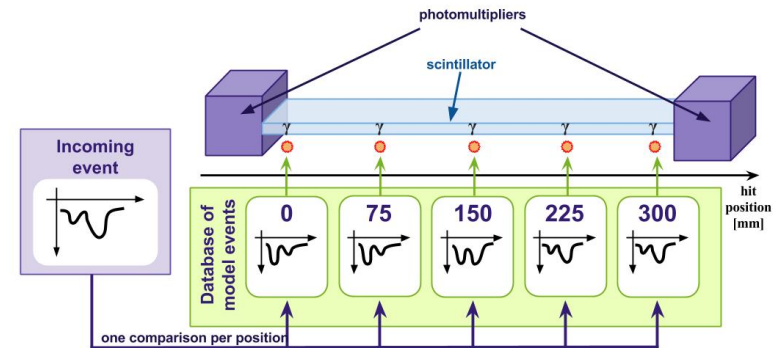
❏ Spatial resolution



Conclusions



- **Multiple comparisons performed between random and database events**
- **Obtained results:**
 1. **Spatial resolution: ~13 mm**
 2. **Time of Flight: ~126 ps**



- **A single comparison was performed between random and each Model events**
- **Obtained results:**
 1. **Spatial resolution: ~14 mm**



**Thank You For Your
Attention**

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