Modeling and Reducing Spatial Jitter caused by Asynchronous Input and Output Rates

Evaluation Hcéres de l'UMR 9189 CRIStAL (8-10 octobre 2024)

Créneau Sciences I2C

Contexte

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- **Equipe Loki**
  Réconcilier la conception de systèmes interactifs avec les capacités humaines
- **Membre IUF Junior de 2018 à 2023**
  Projet : “Redesigning the interaction loop in interactive systems”
- **Google Faculty Research Award en 2019**
- **Article publié à ACM UIST en 2020**

Loki
technology & knowledge for interaction

institut universitaire de France

Google Faculty Research Awards

UIST 2020

Session 10B: Interaction Models UIST '20, October 20–23, 2020, Virtual Event, USA

Modeling and Reducing Spatial Jitter caused by Asynchronous Input and Output Rates

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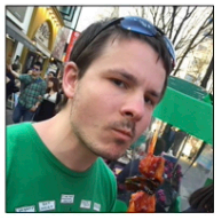
ABSTRACT
Jitter in interactive systems occurs when visual feedback is perceived as unstable or trembling even though the input signal is smooth or stationary. It can have multiple causes such as sensing noise, or feedback calculations introducing or exacerbating sensing imprecisions. Jitter can however occur even when

INTRODUCTION
Jitter is defined as "*irregular random movement (as of a pointer or an image on a television screen); also : vibratory motion*" [20]. In signal processing, jitter is defined as a form of timing noise, which can have deterministic and random components. In the HCI literature however, it tends to denote




11:04
Lorem Ipsum is simply dummy text of the printing and typesetting industry. Lorem Ipsum has been the industry's standard dummy text ever since the 1500s, when an unknown printer took a galley of type and scrambled it to make a type specimen book. It has survived not only five centuries, but also the leap into electronic typesetting, remaining essentially unchanged. It was popularised in the 1960s with the release of Letraset sheets containing Lorem Ipsum passages, and more recently with desktop publishing software like Aldus PageMaker including versions of Lorem Ipsum.
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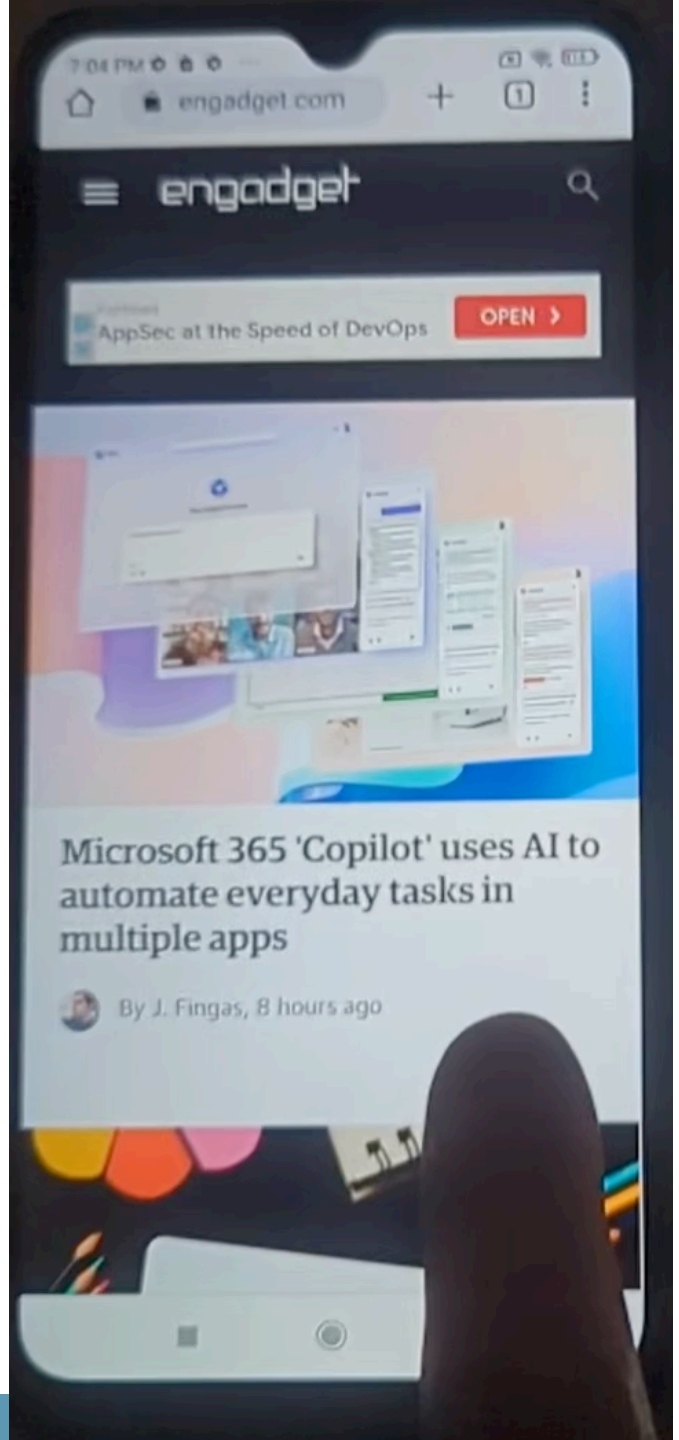
60 Hz



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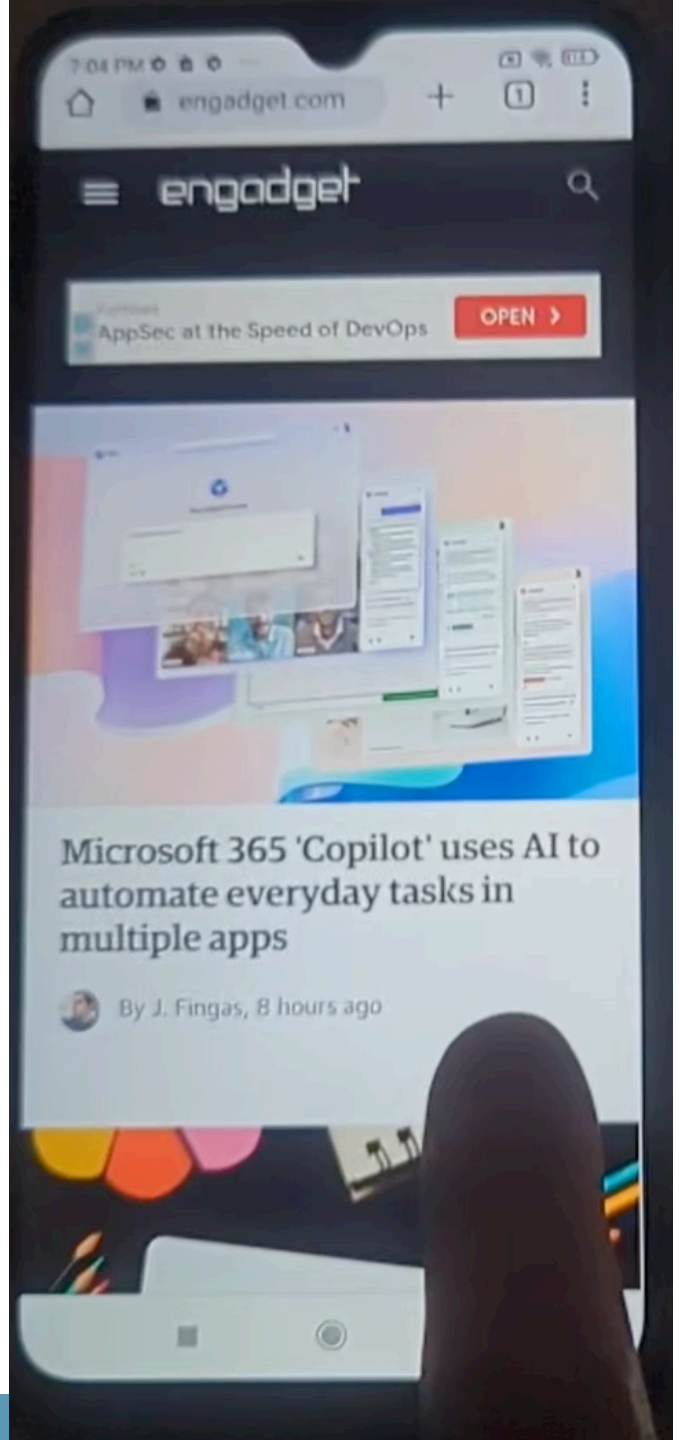
60 Hz



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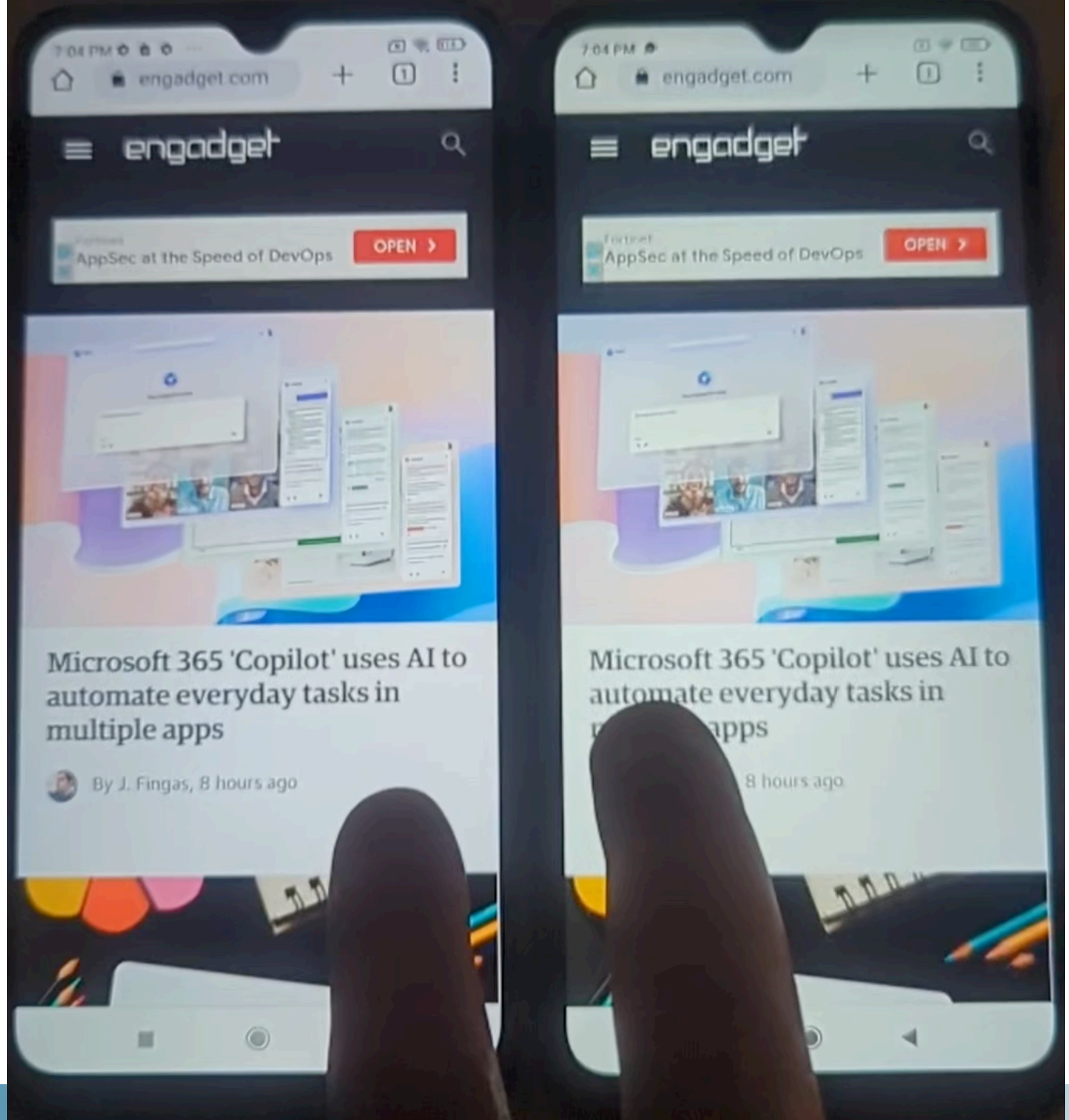
60 Hz



90 Hz

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Filtrage du bruit dans les systèmes interactifs

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https://gery.casiez.net/1euro/

[G. Casiez et al. CHI'12]

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Illustration du problème

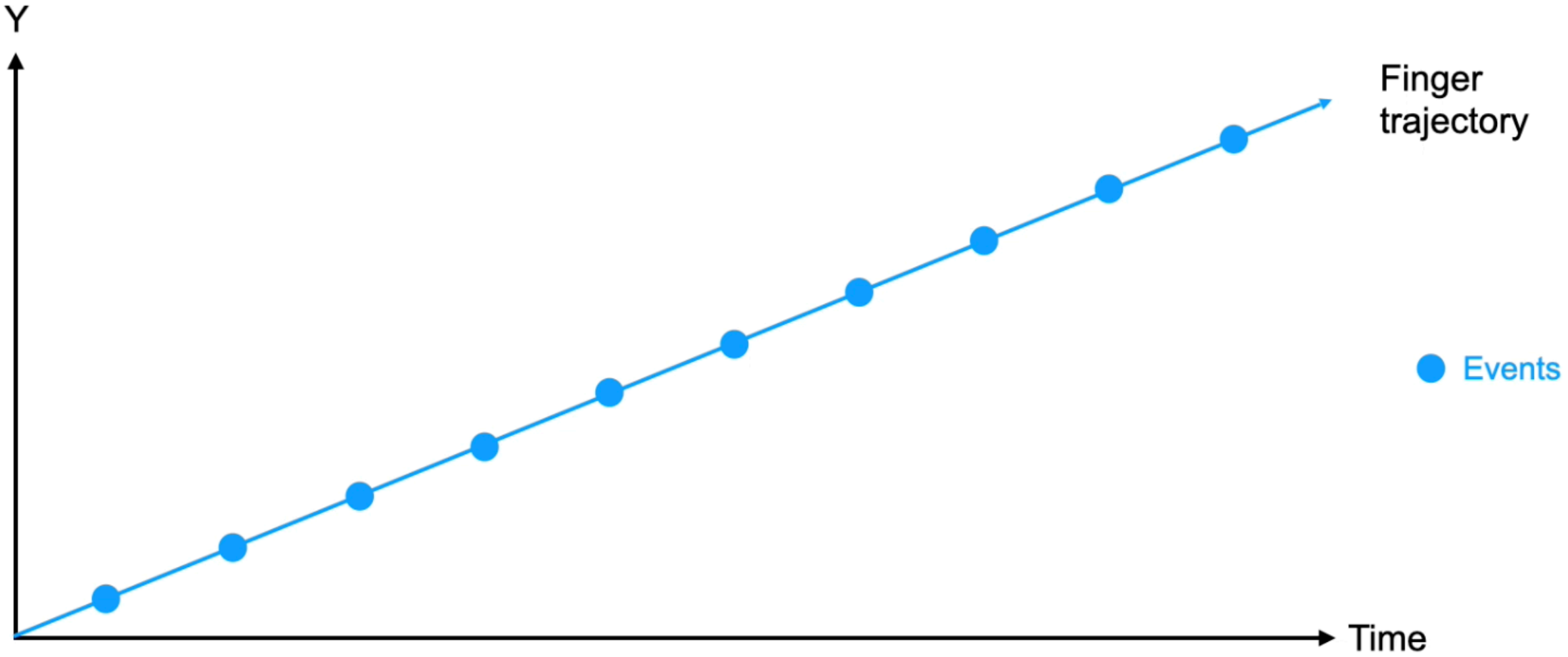

Illustration du problème

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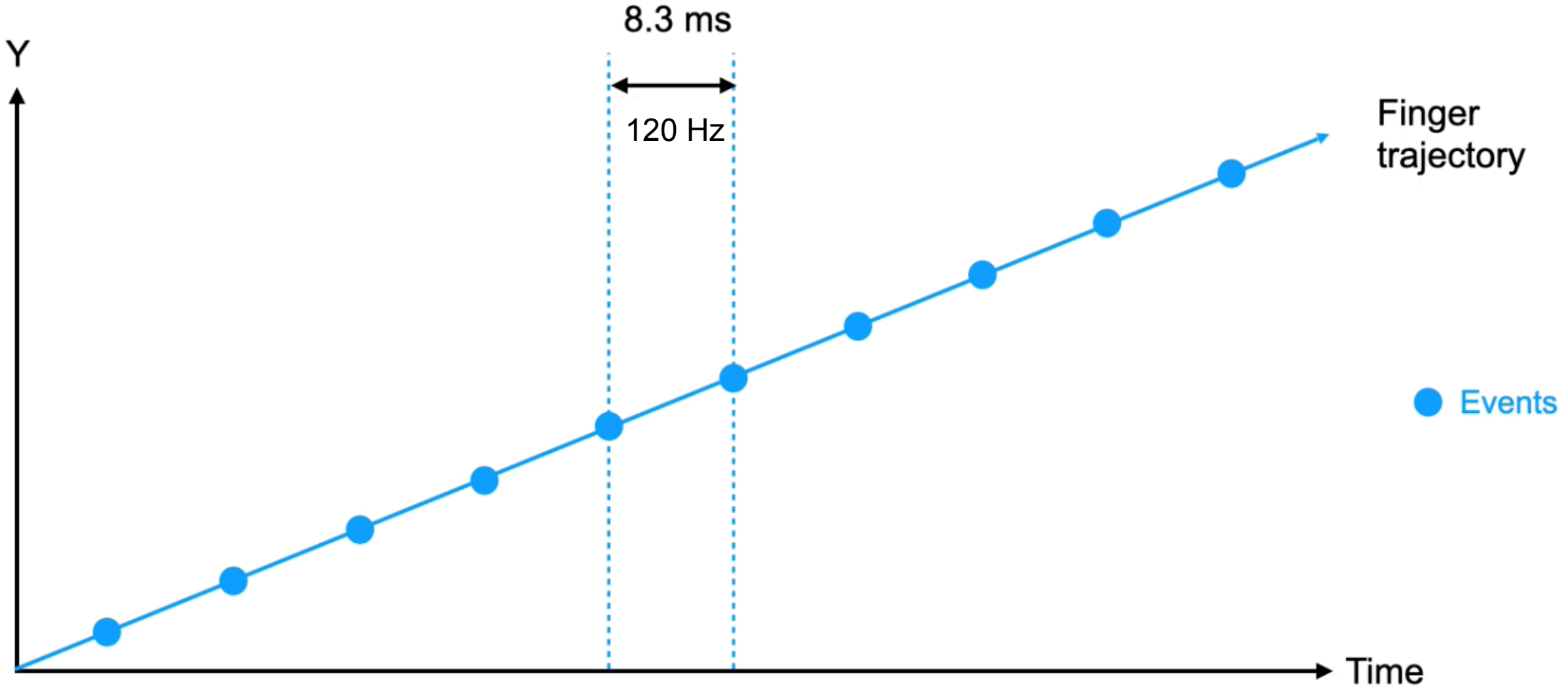

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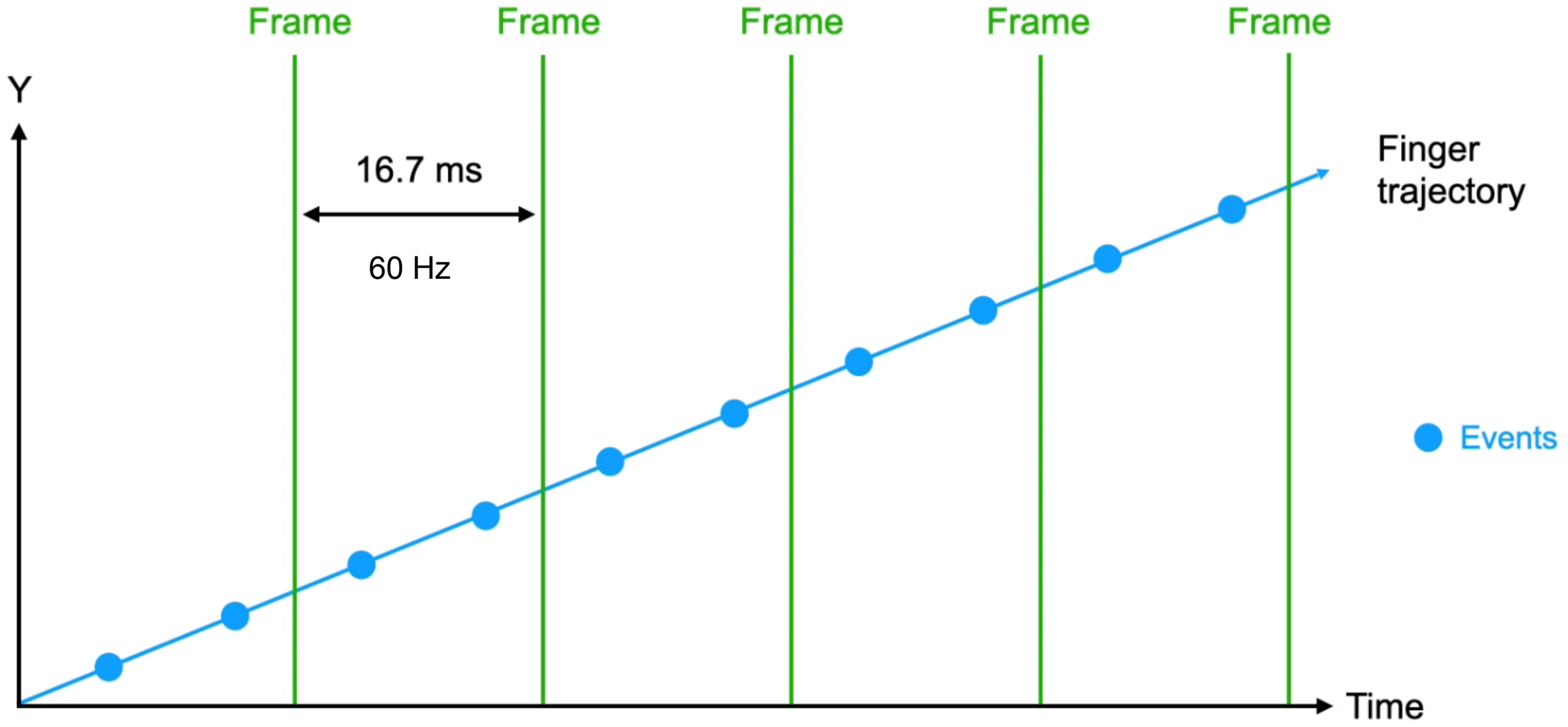

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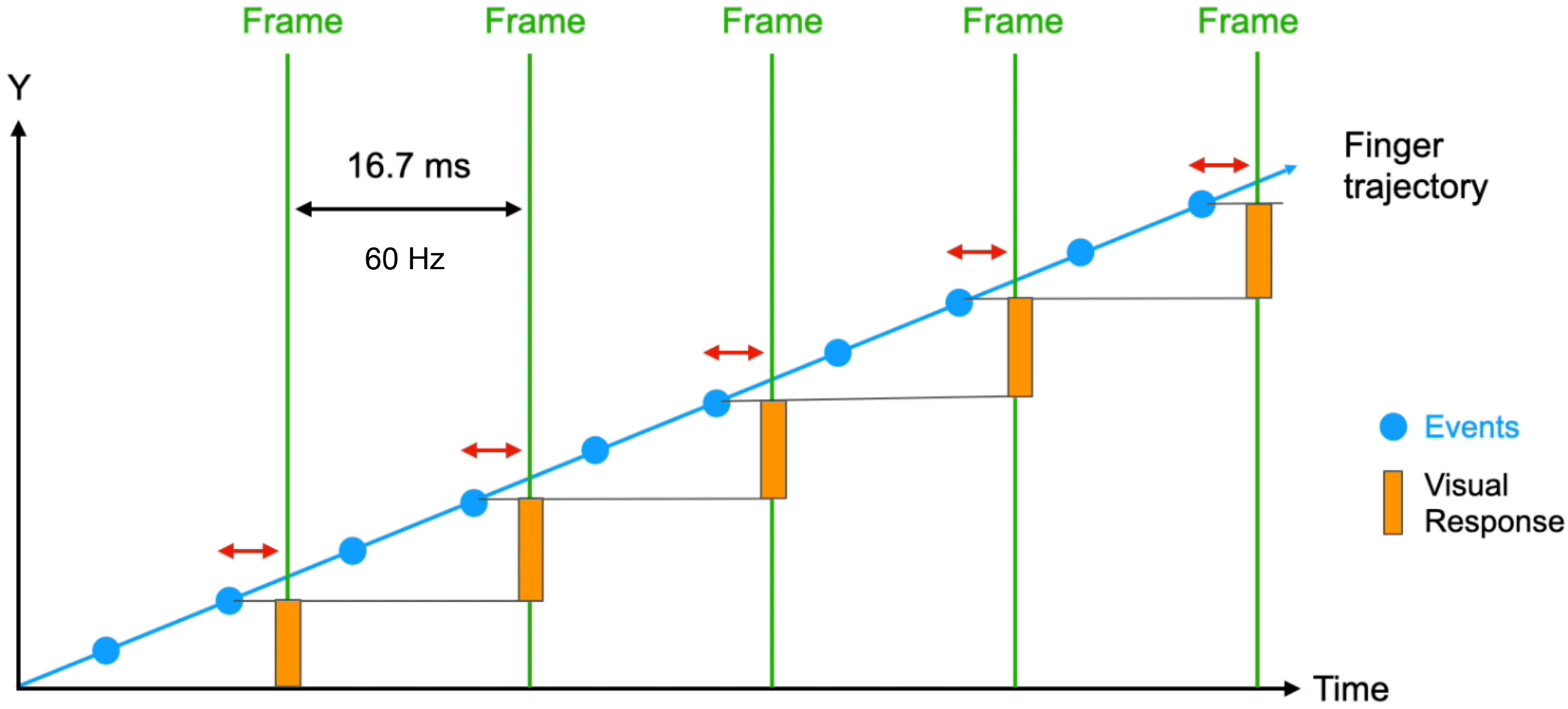

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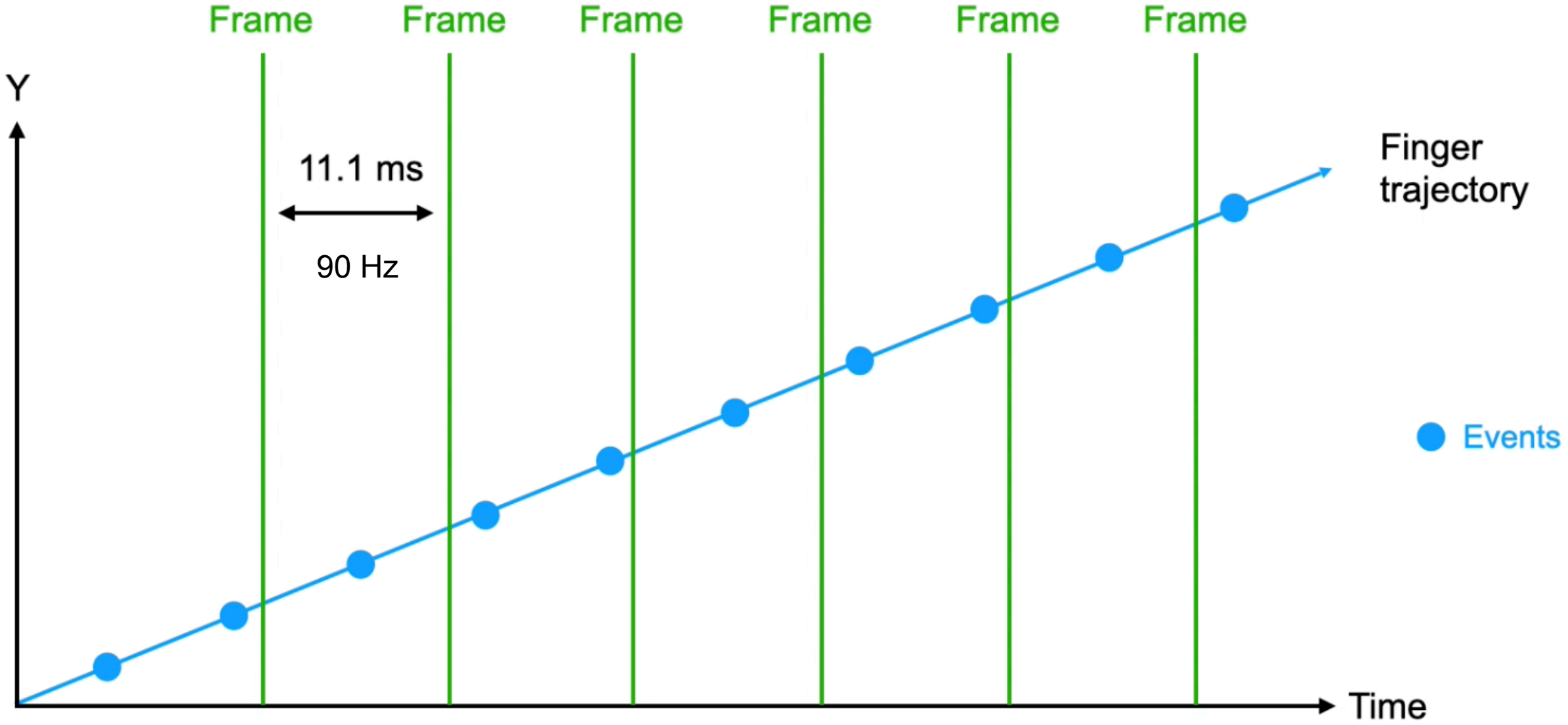

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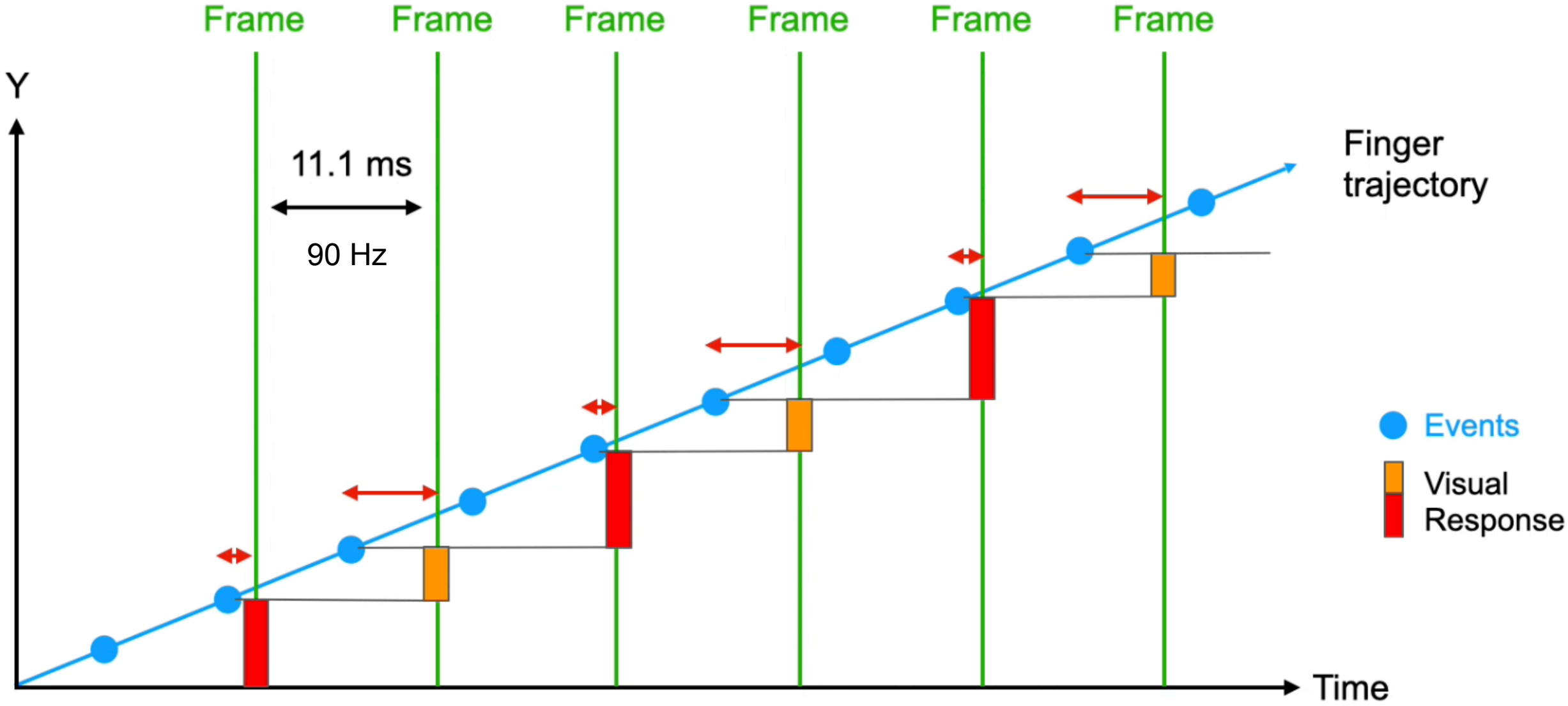
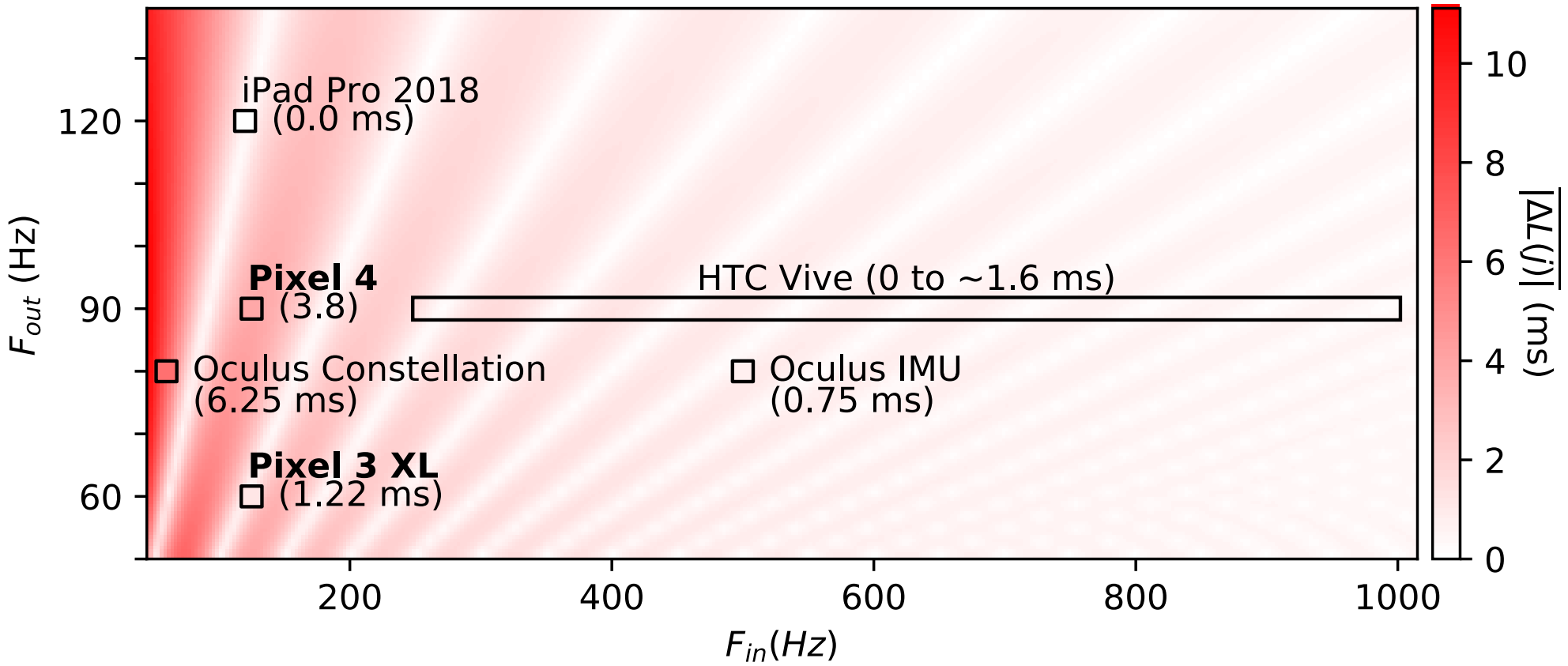


Modélisation

$$\overline{|\Delta L|} = \frac{2\frac{F_{in}}{F_{out}}\left(1-\frac{F_{in}}{F_{out}}\right)}{F_{in}}$$

Modélisation



Mesure du bruit spatial

$$\overline{|\Delta D|} = \frac{1}{n}\sum_{i=1}^{n-1} |\Delta D(t_{\mathrm{i}})|$$

$$= \frac{1}{n}\sum_{i=1}^{n-1} |P_{\mathrm{out}}(t_{\mathrm{i}}) - P_{\mathrm{in}}(t_{\mathrm{i}}) - P_{\mathrm{out}}(t_{\mathrm{i-1}}) + P_{\mathrm{in}}(t_{\mathrm{i-1}})|$$

Expérience

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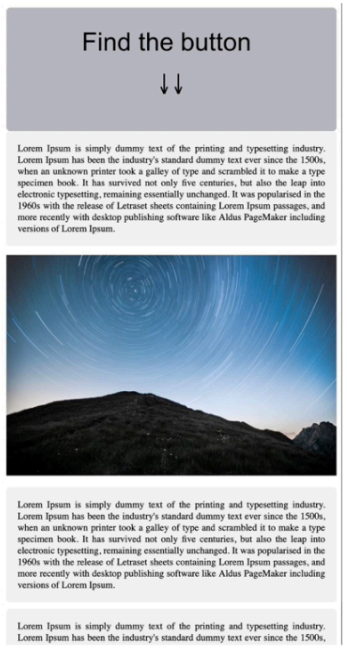
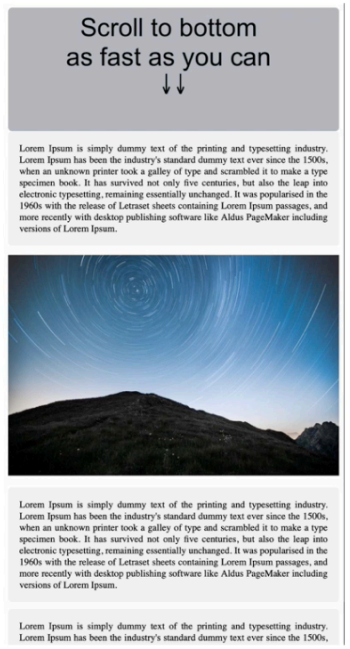
- 12 participants
- 2 smartphones (Pixel 3 XL ou Pixel 4)
  x 3 tâches (recherche, navigation, lecture)
  x 3 tailles de pages (10, 20, 30 sections)
  x 2 directions (haut en bas et bas en haut)



Search task



Navigation task

Read task

Simulateur

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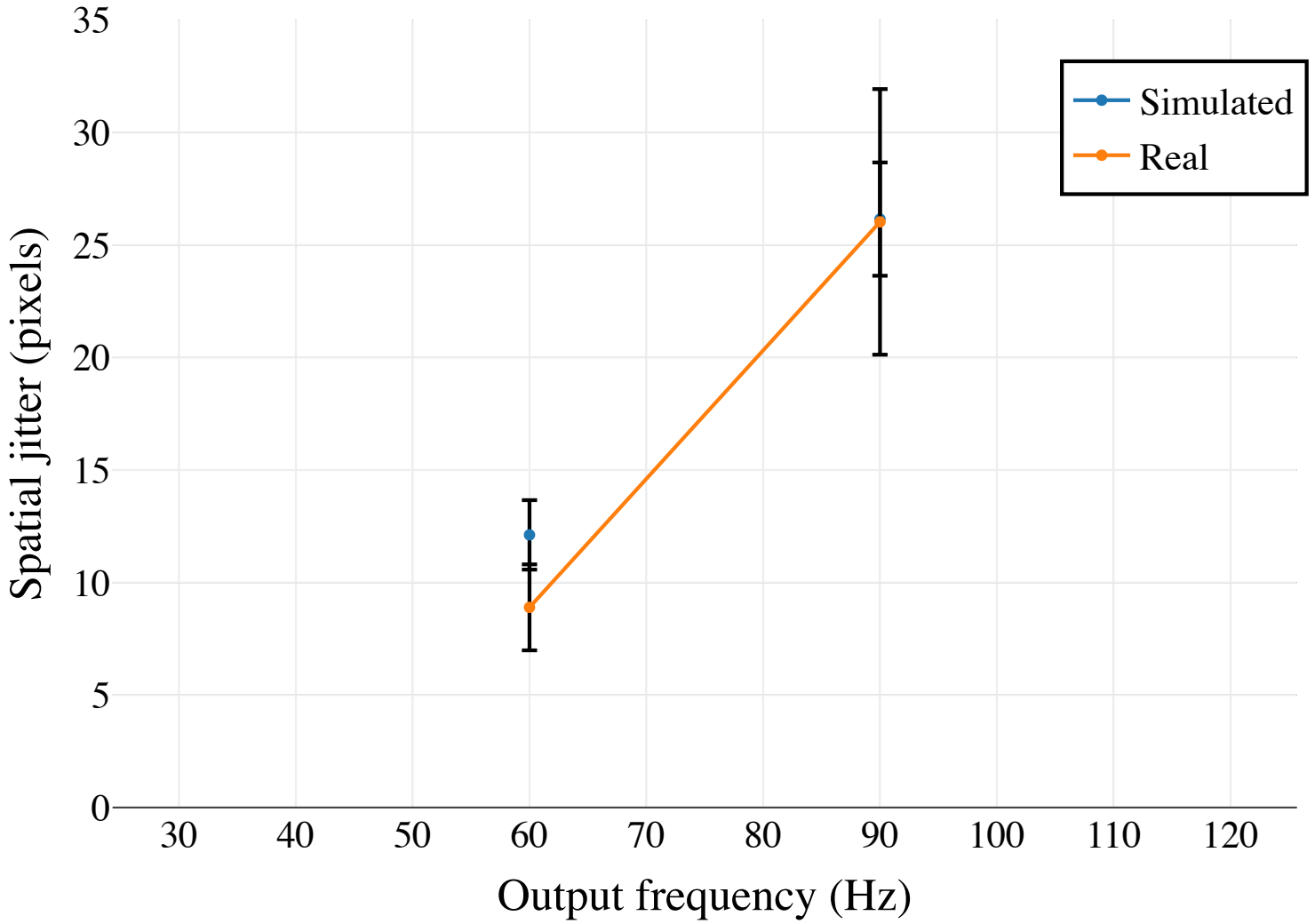

Simulateur

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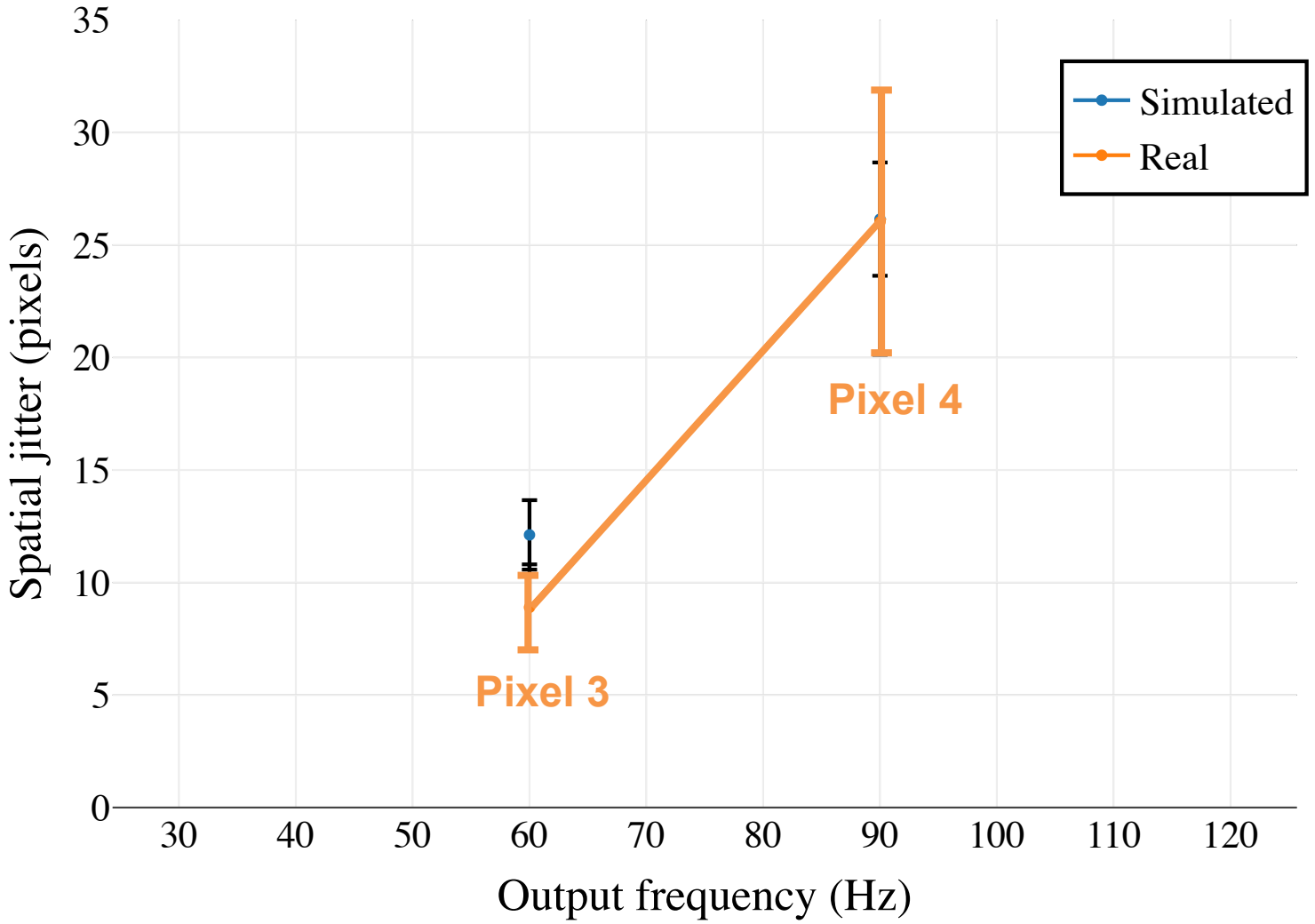

Simulateur

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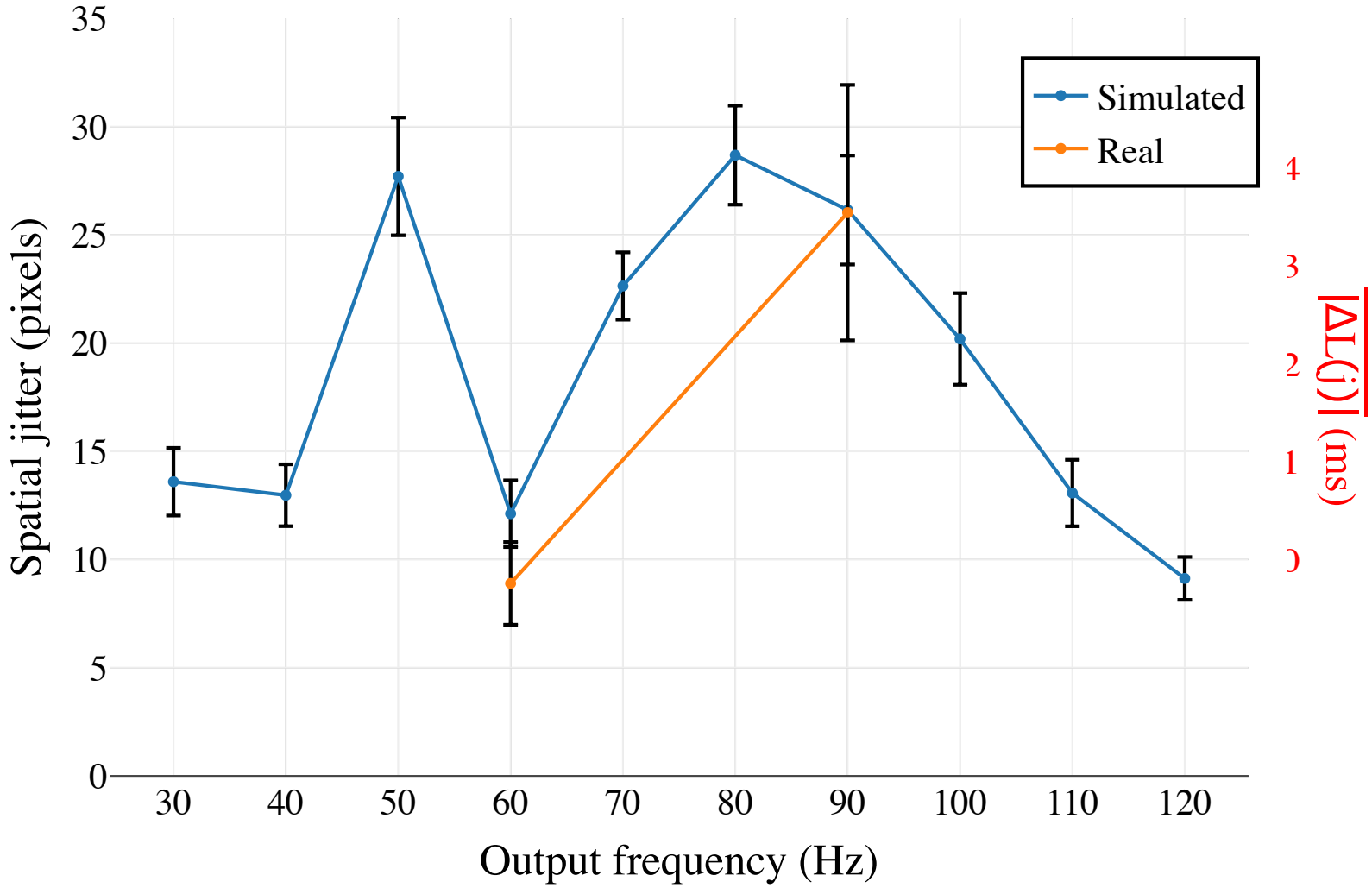

Simulateur

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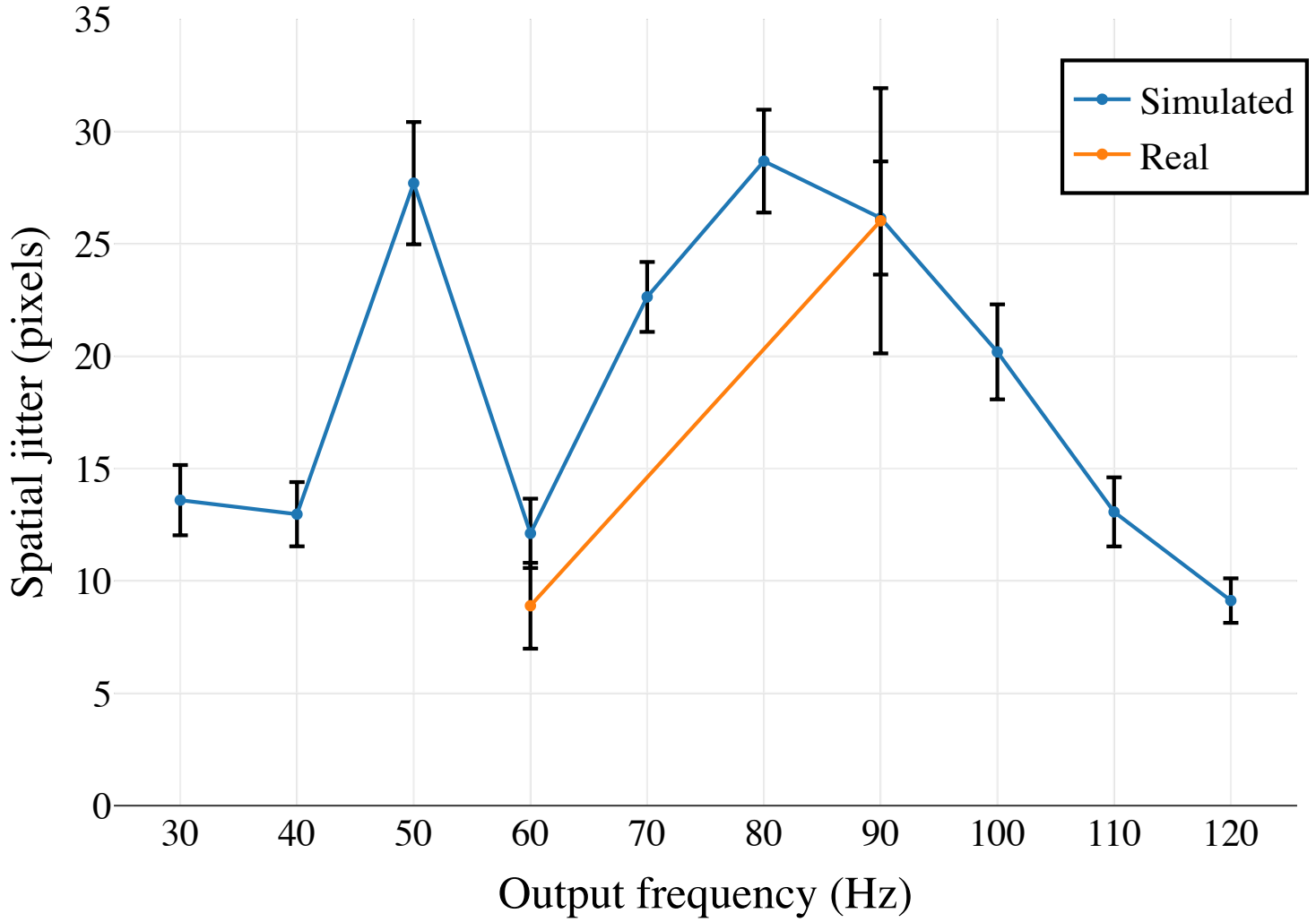
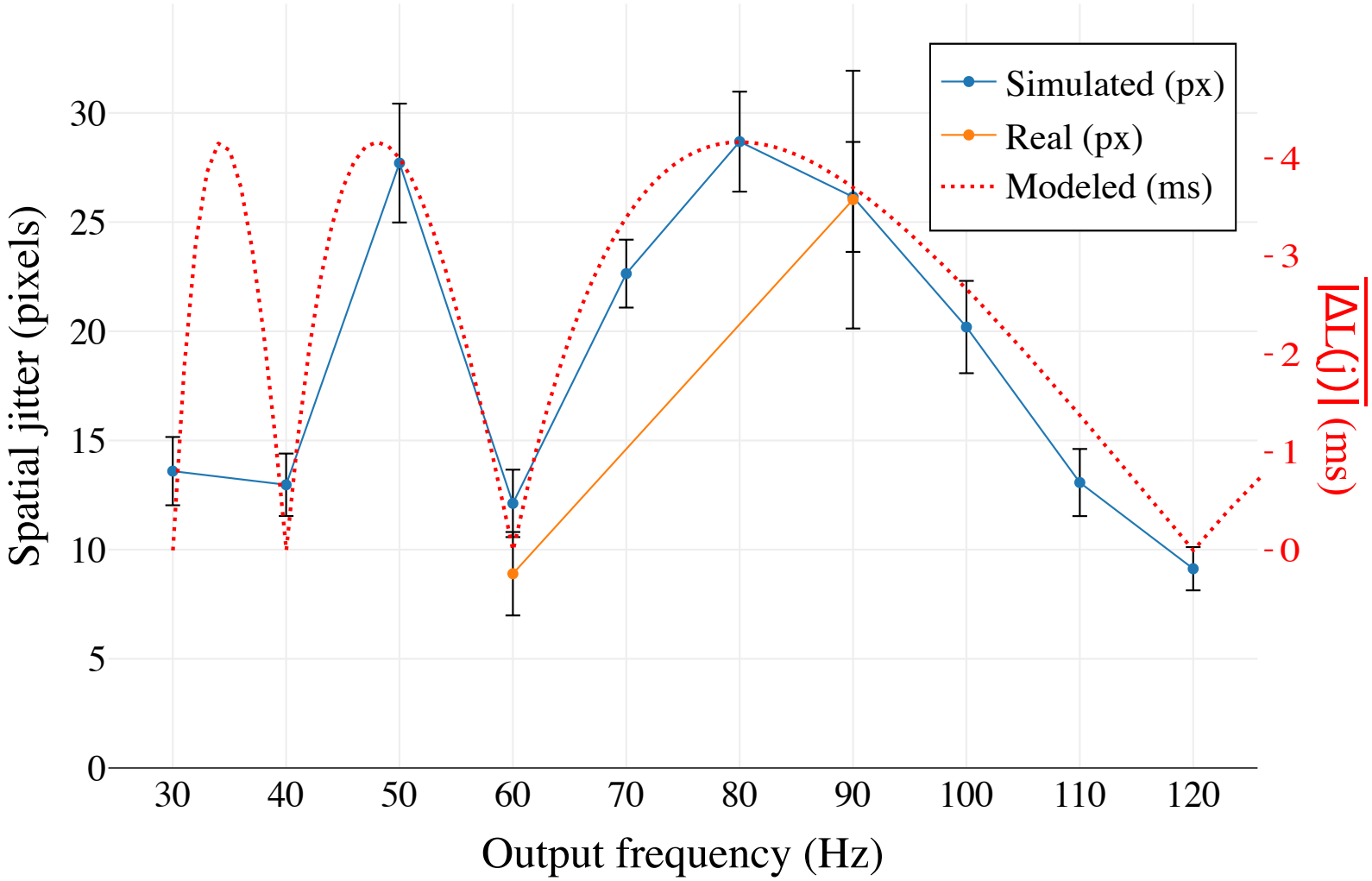


Simulateur


Simulated (px)
Real (px)
Modeled (ms)
Spatial jitter (pixels)
|ΔL(j)| (ms)
Output frequency (Hz)
0
5
10
15
20
25
30
0
1
2
3
4
30
40
50
60
70
80
90
100
110
120

Ré-échantillonnage

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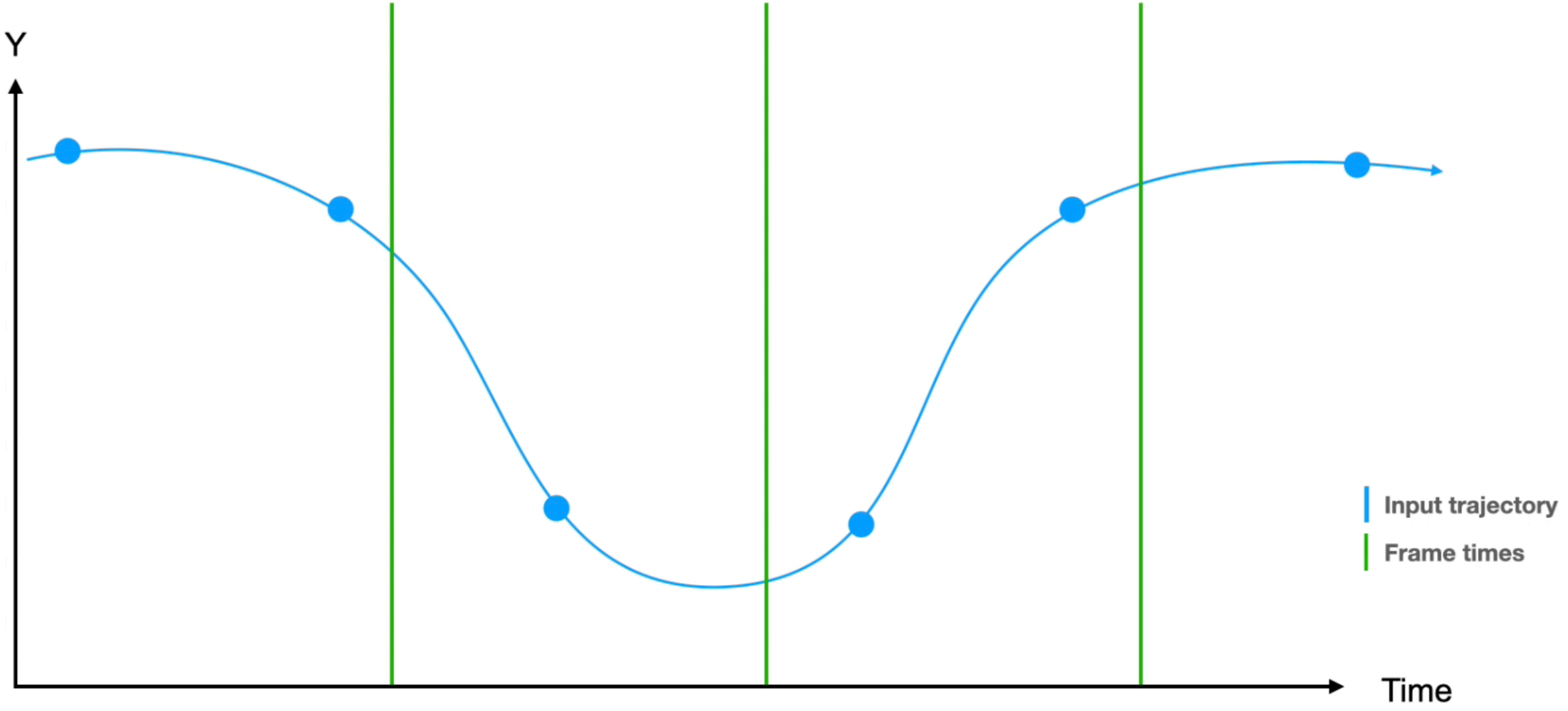

Ré-échantillonnage

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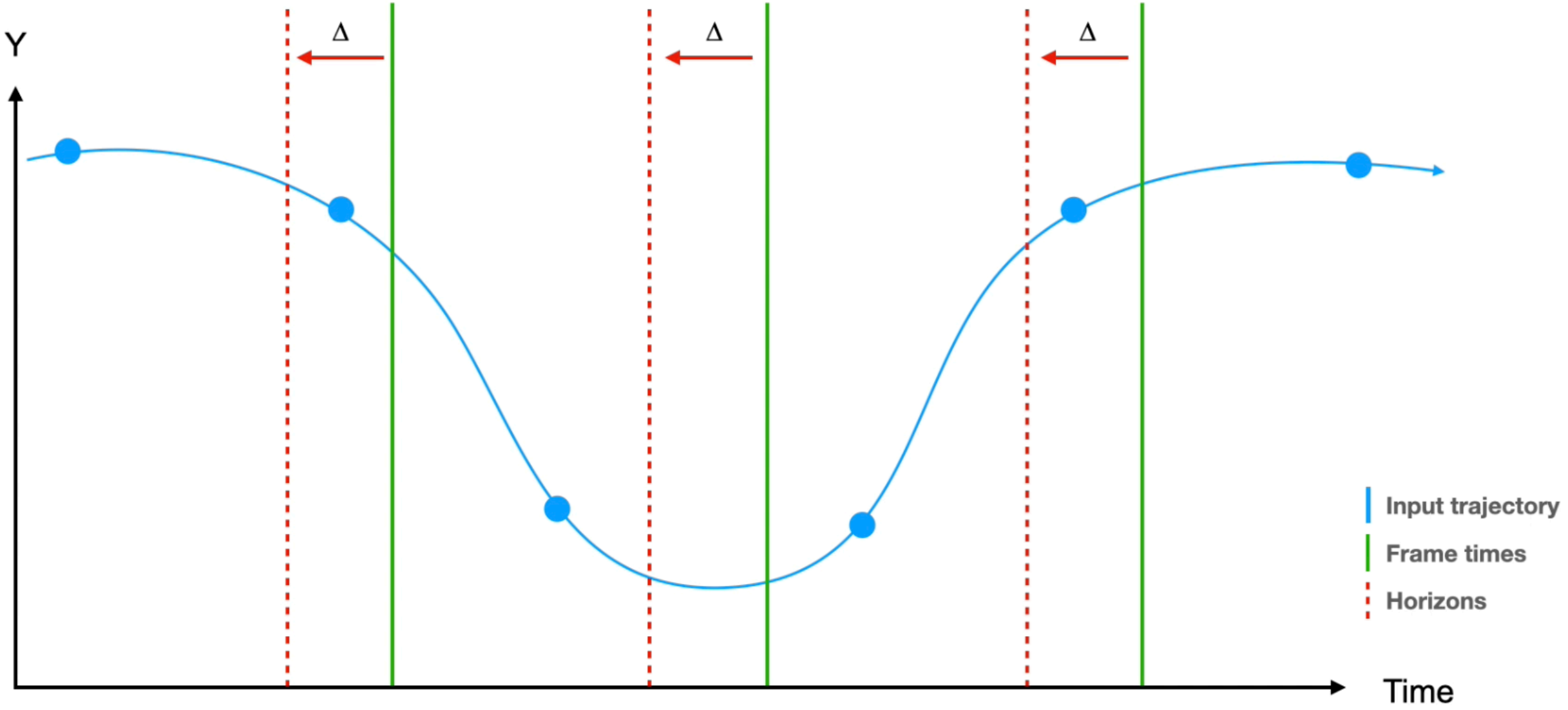

Ré-échantillonnage

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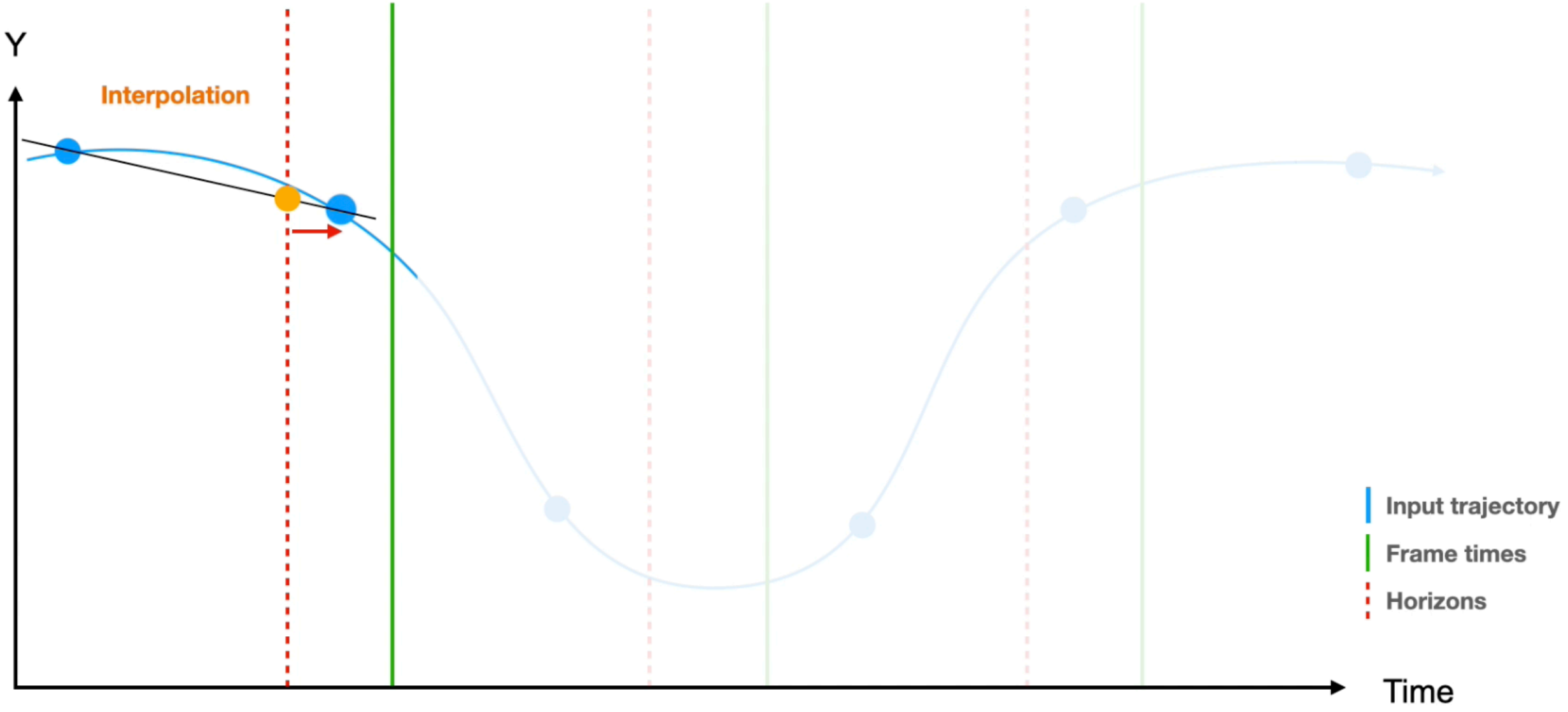
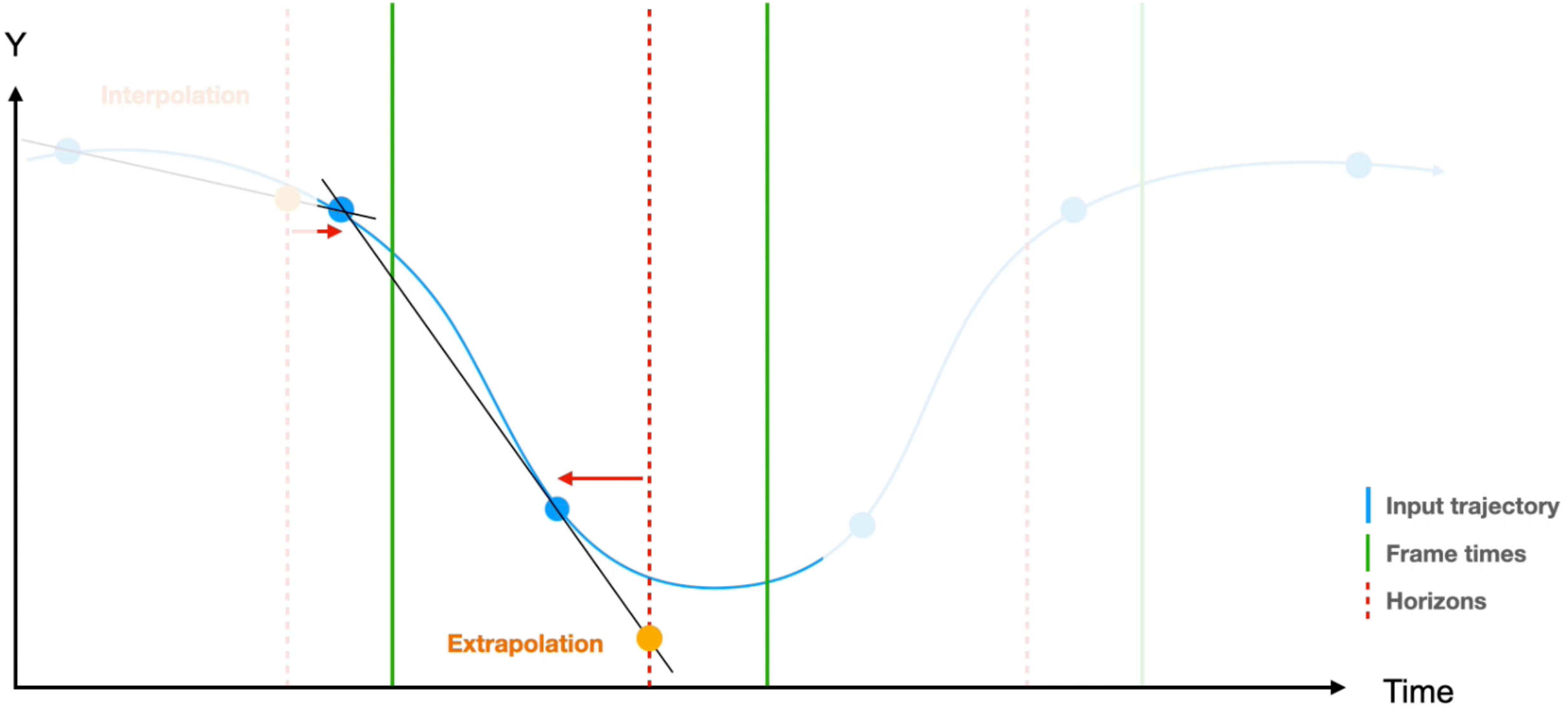


Ré-échantillonnage



Ré-échantillonnage

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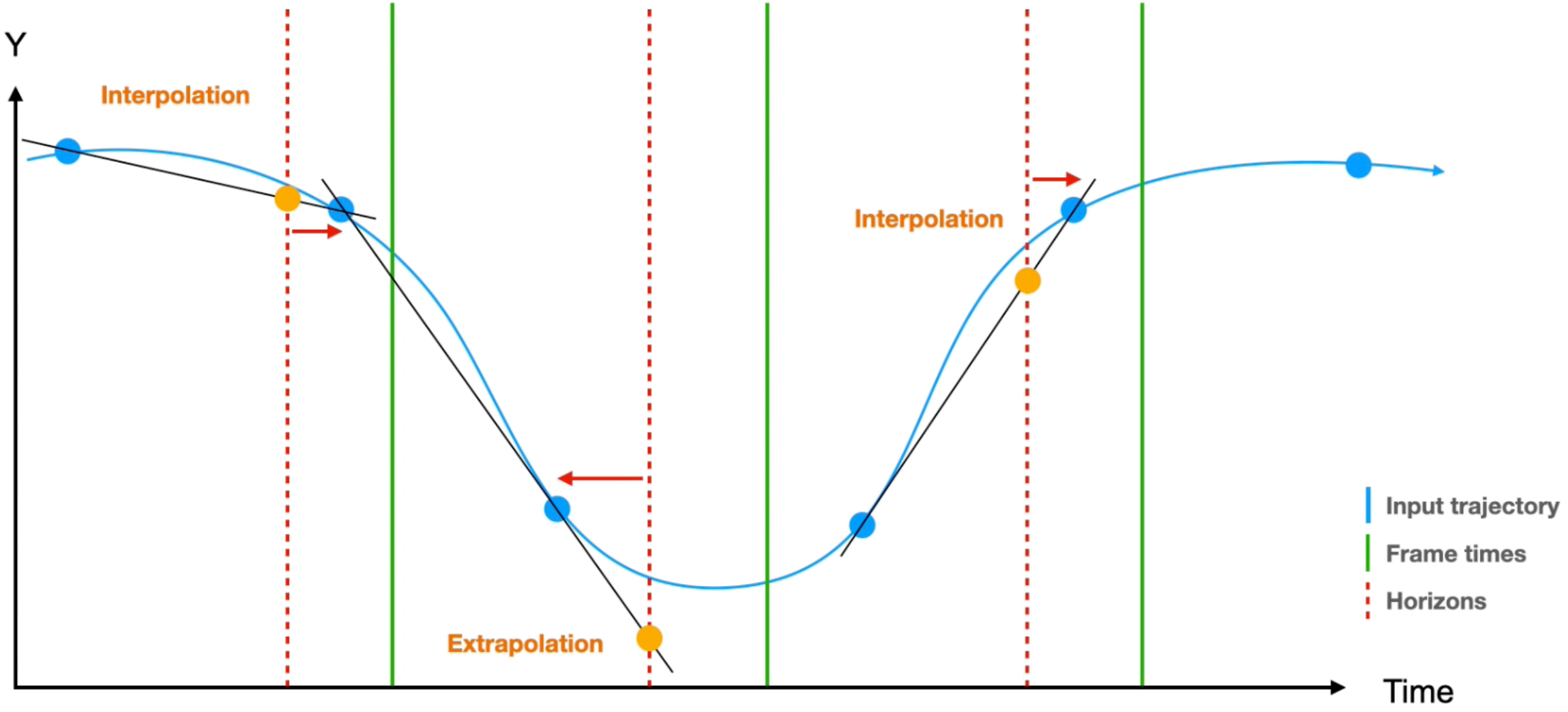

Résultats

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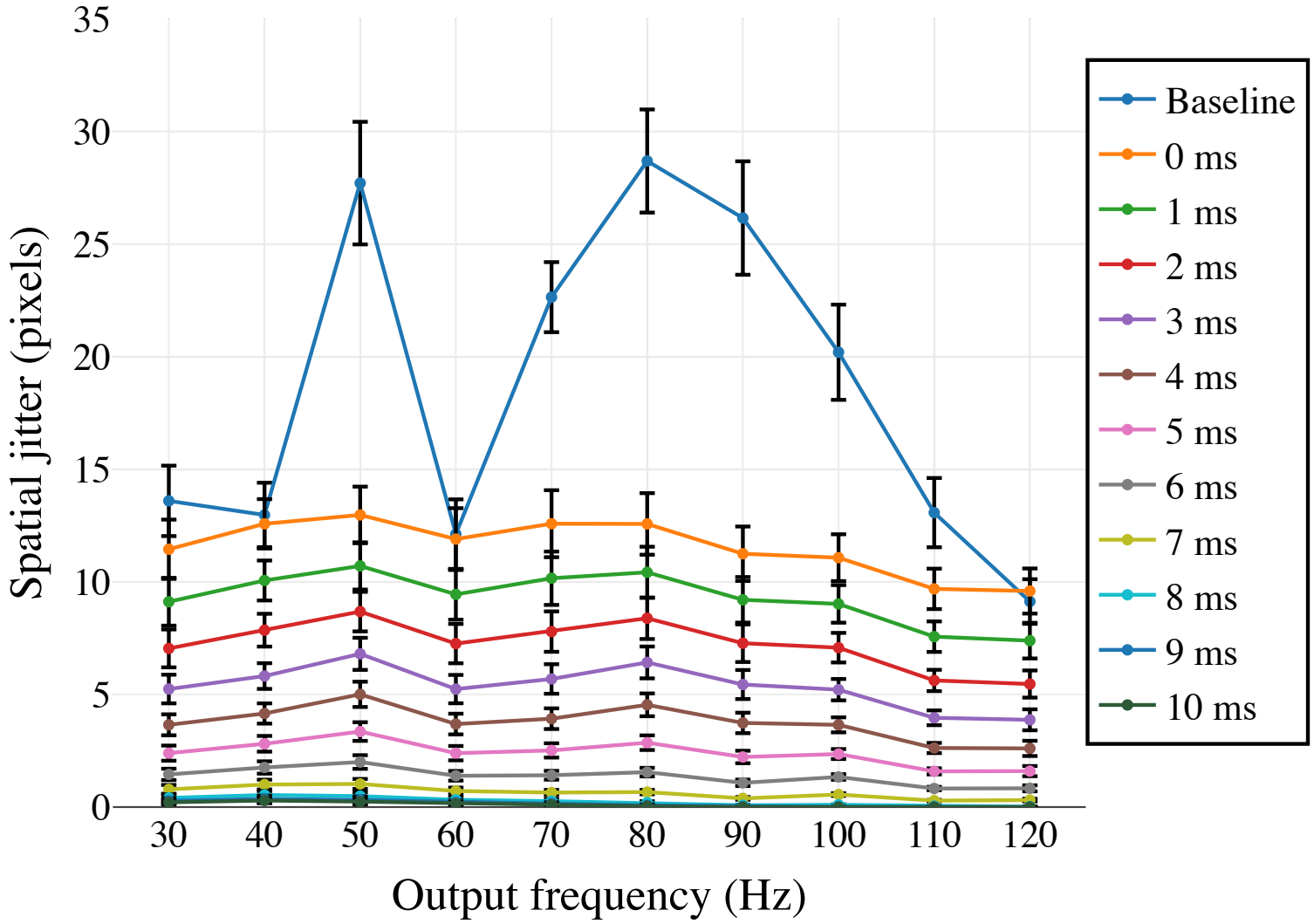

Résultats

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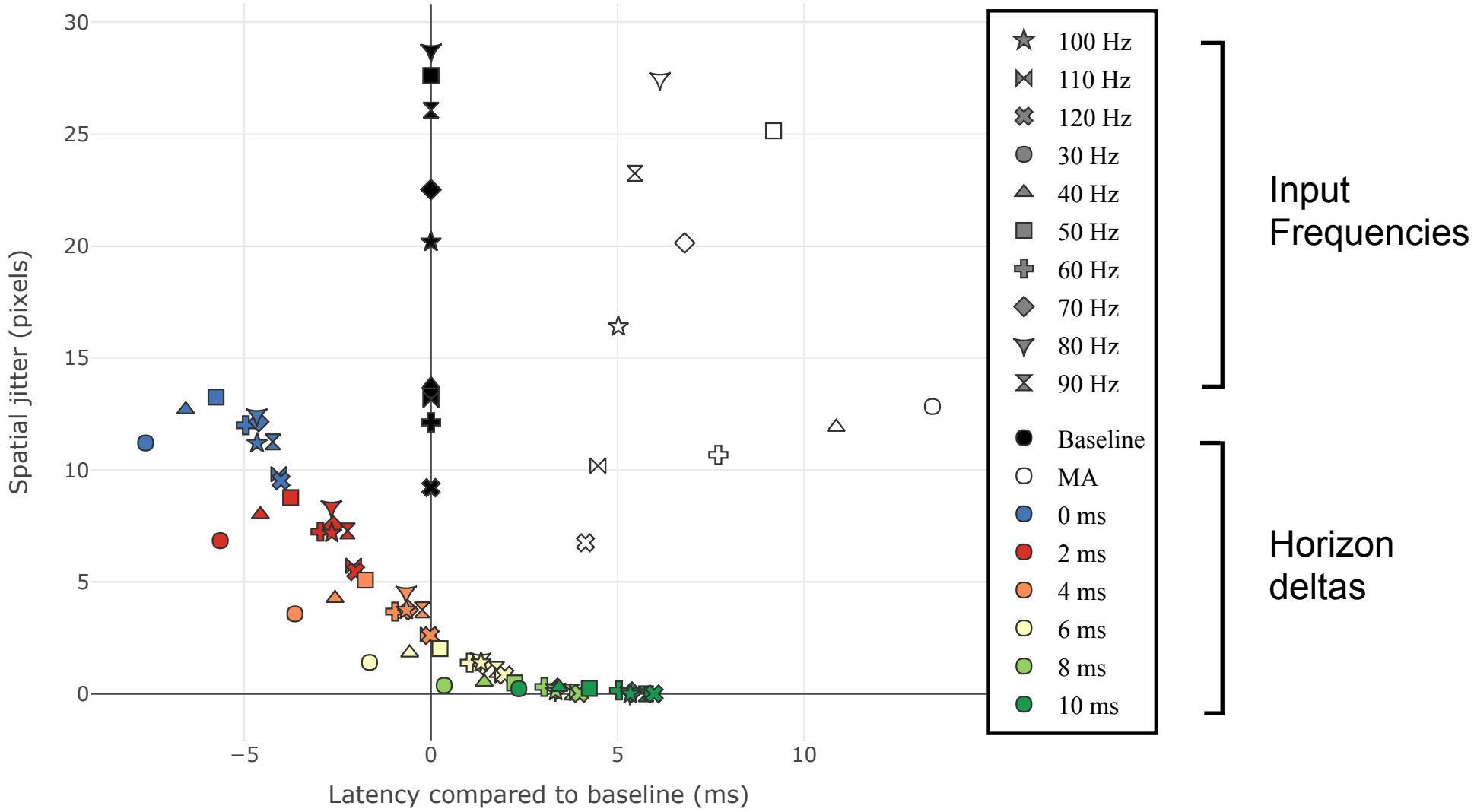

Résultats

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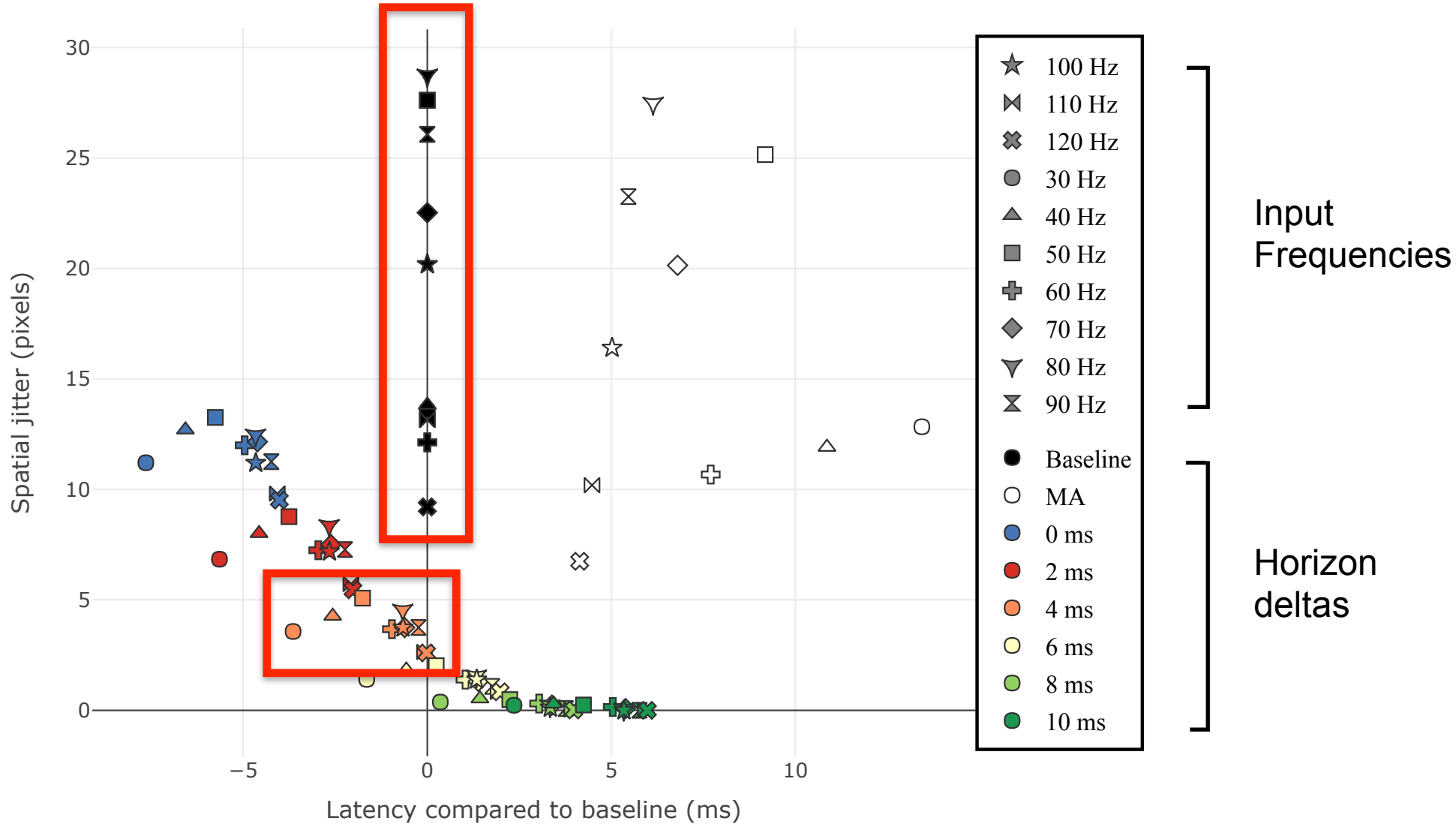

Comparaison de techniques d'extrapolation

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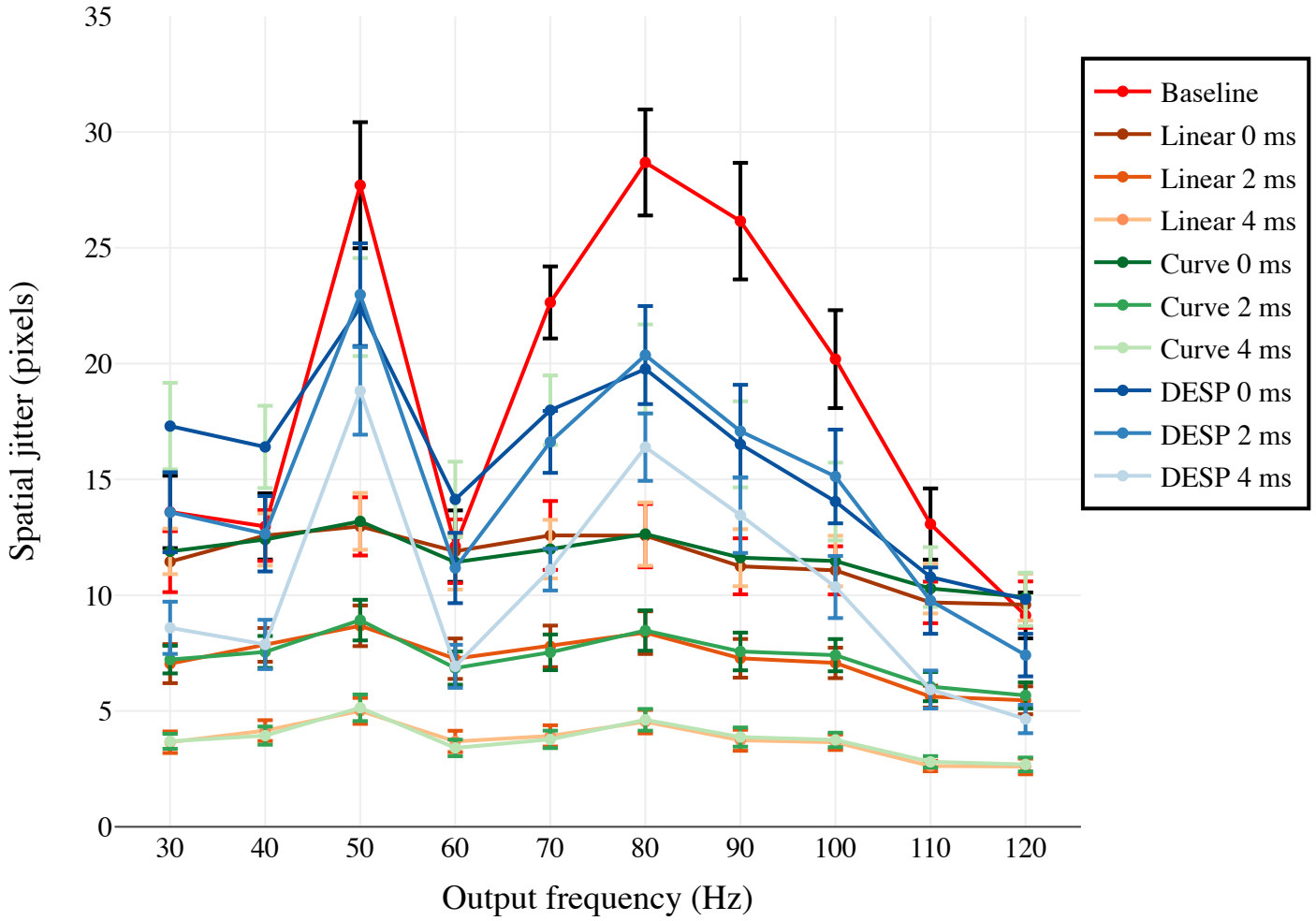
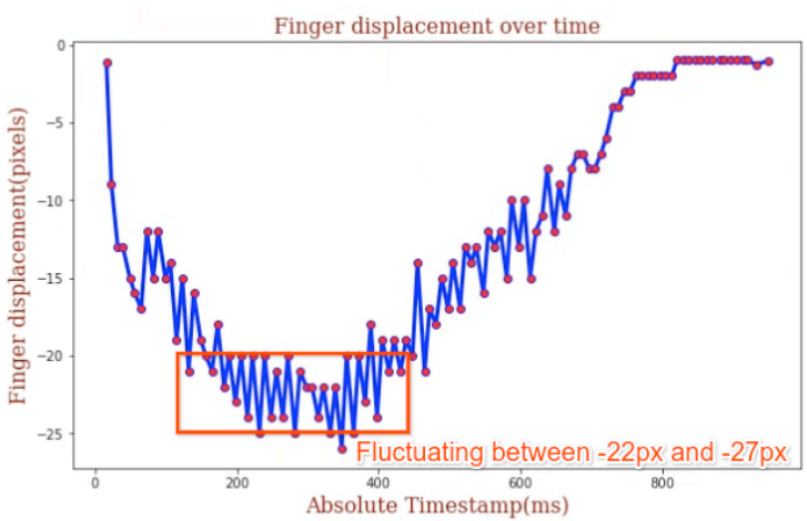
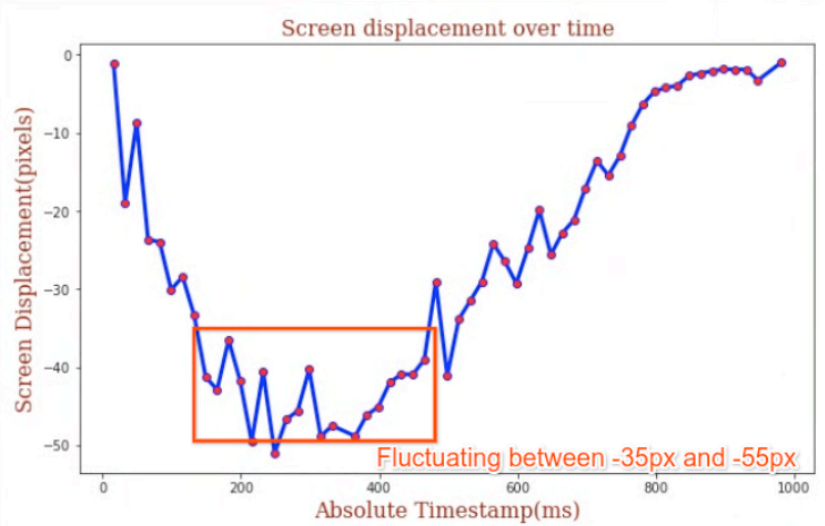


Implémentation dans Chromium





"*To improve on it, we experimented with different algorithms, using automation to replay the same input over and over again and evaluating the screen displacement curves. After tuning,* ***this landed at the 1€ filter*** *implementation* ***that visibly and drastically improved the scrolling experience****. With this filter,* ***the screen tracks closely to your finger and websites smoothly scroll****, preventing jank caused by inconsistent input events. The improvement is visible in our manual validation, on both top-end and low-end devices*"

https://blog.chromium.org/2023/08/smoothing-out-scrolling-experience-in.html

Conclusion

- Identification d'une nouvelle cause de bruit spatial
- Proposition de deux métriques pour le mesurer
- Développement d'une nouvelle technique pour réduire ce phénomène
- Maintenant intégré sur tous les périphériques Androïd