



AI based anomaly detection of Turn-by-turn Beam Position Monitors

Doctorant:

Quentin BRUANT

Sous la supervision de:

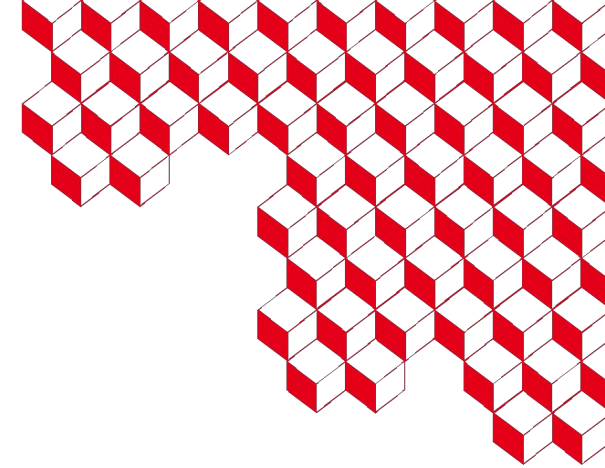
- Barbara DALENA (Dir)(CEA)
- Francesca BUGIOTTI (CNRS/CentraleSupélec)
- Valérie GAUTARD (CEA)



**FUTURE
CIRCULAR
COLLIDER**



EJADE
Europe-America-Japan Accelerator
Development Exchange Programme



Context

FCC collaboration:



**FSR published in European
Physical Journal C and ST**

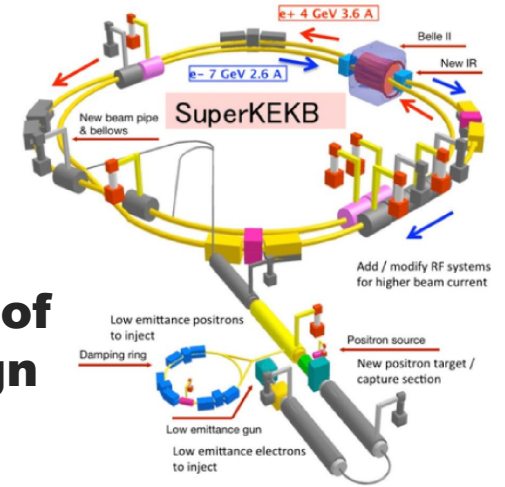
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<https://cds.cern.ch/record/2928793>

➤ **Largest existing e⁺/e⁻-collider**

○ **small-scale FCCee**

➤ **Provides proof of principle of
several concepts and design
choices.**



ADVANCED NUMERICAL TECHNIQUES AND AI TO MITIGATE IMPERFECTIONS IN FUTURE CIRCULAR COLLIDER

- **Optimisation** du design du booster haute énergie pour le FCCee
- **Étude et évaluation** des techniques d'IA pour améliorer les mesures d'optique par amélioration des rapports signal sur bruit des BPM tour-par-tour (TbT-BPMs)
- **Implémentation** de techniques IA pour la prédiction de l'ouverture dynamique des futurs collisionneurs.

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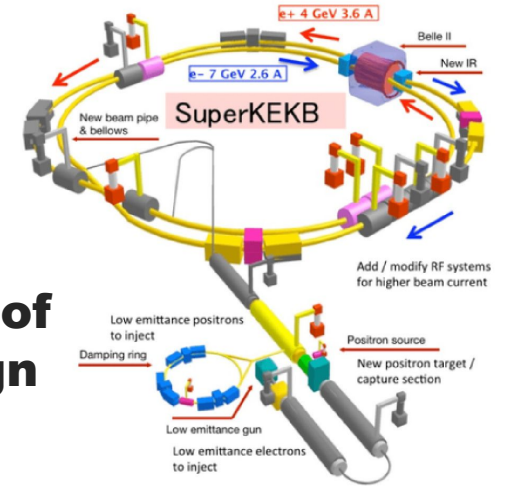
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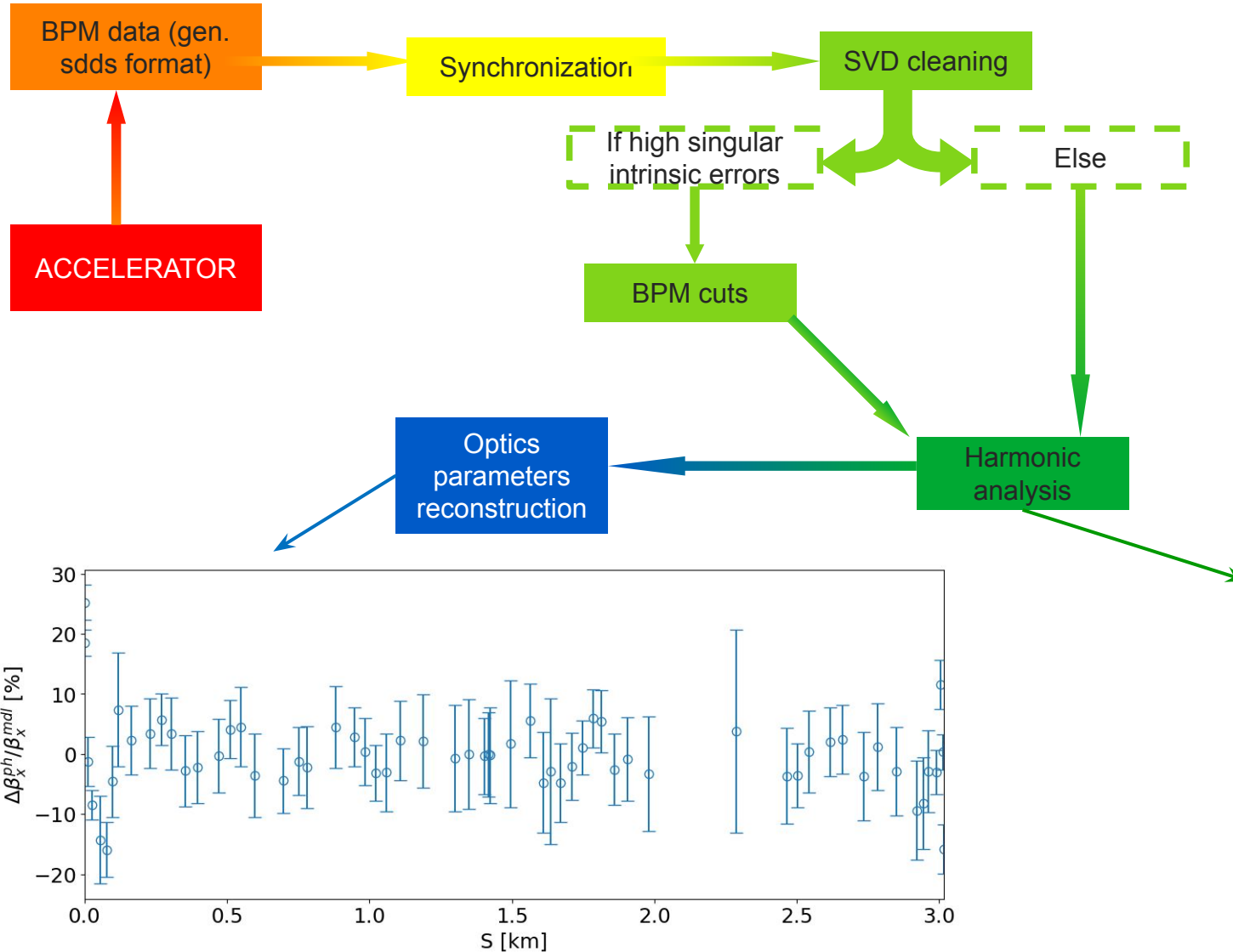
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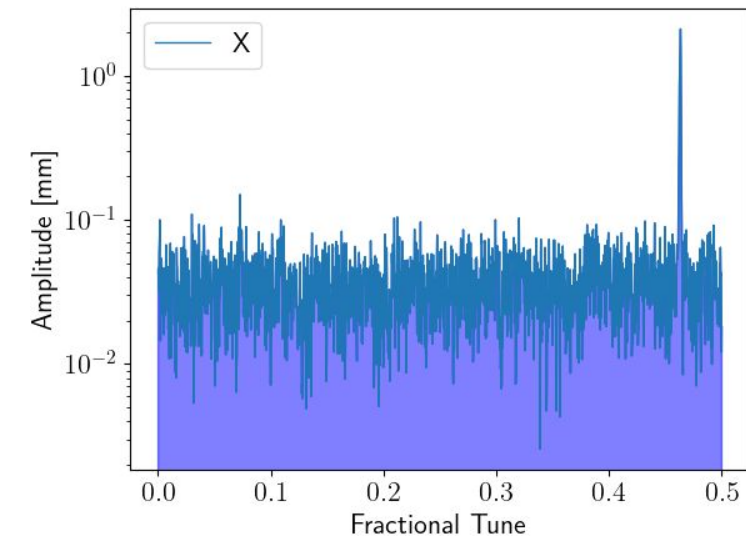
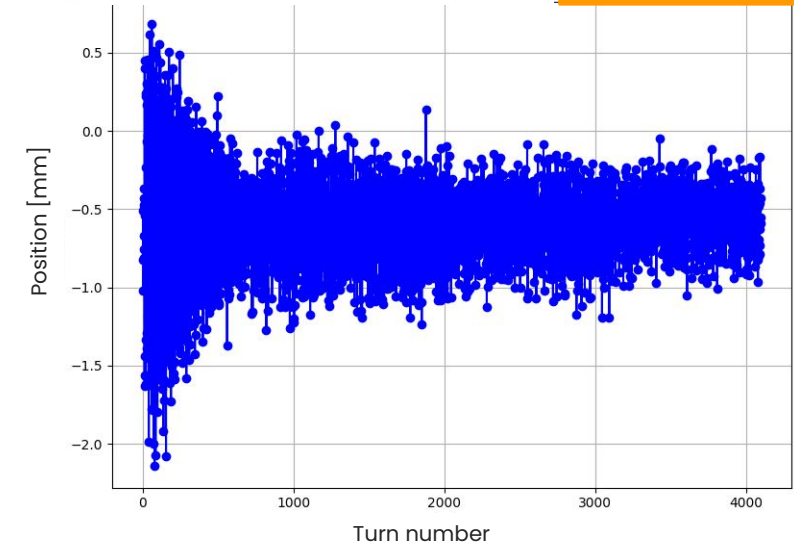
TbT BPM data



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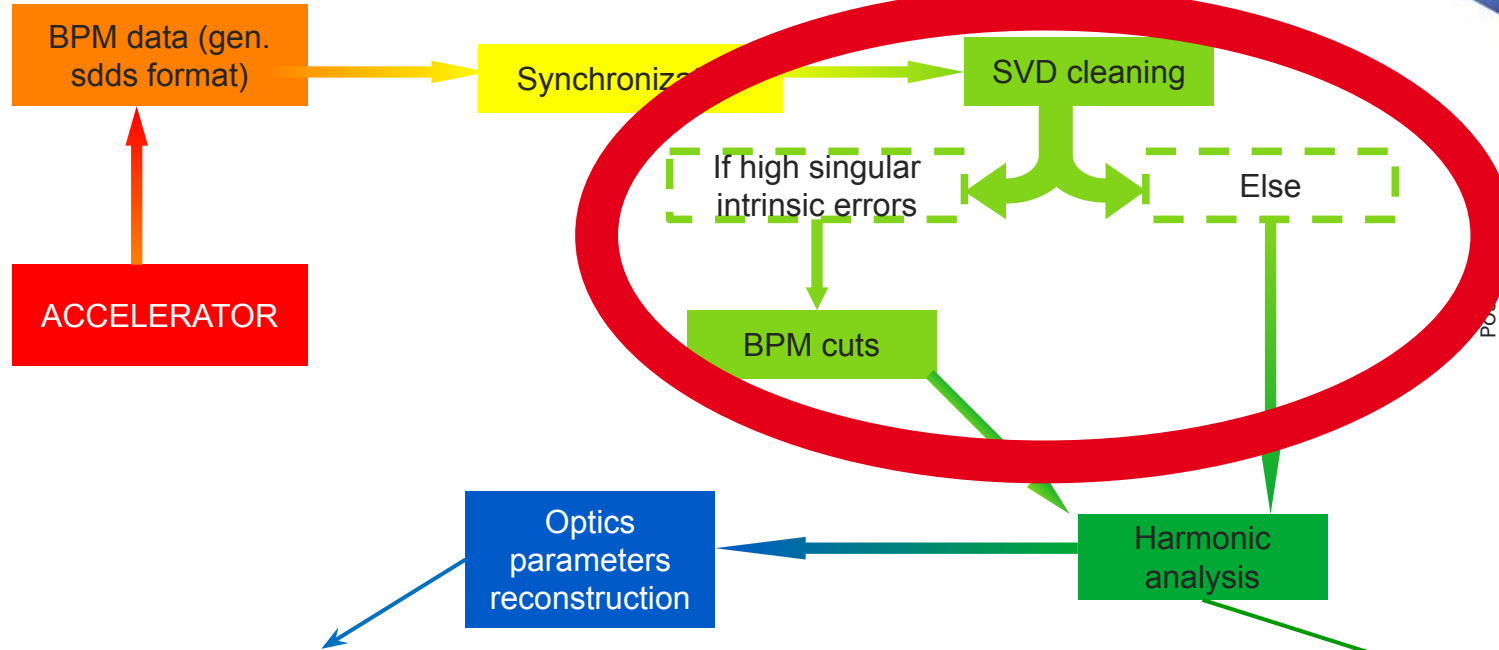
BPM data



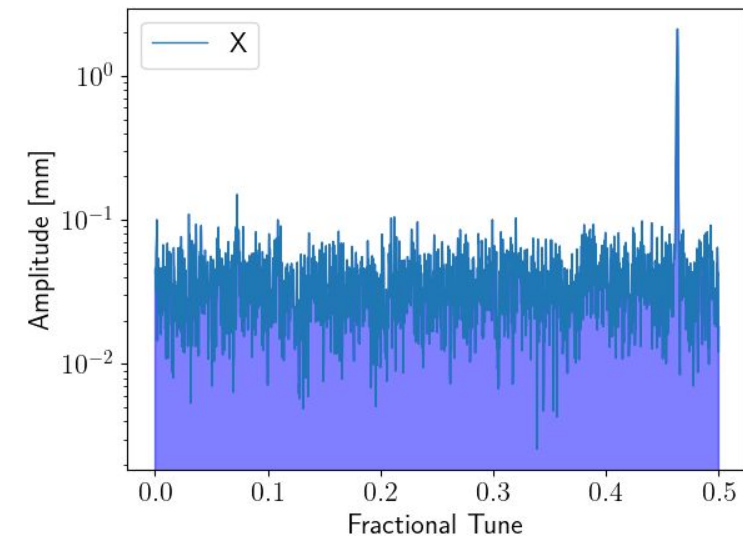
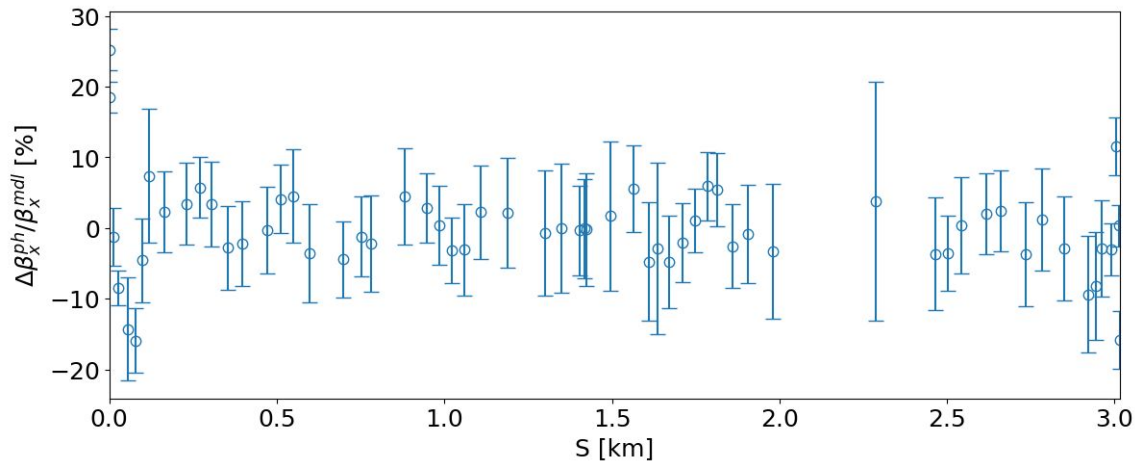
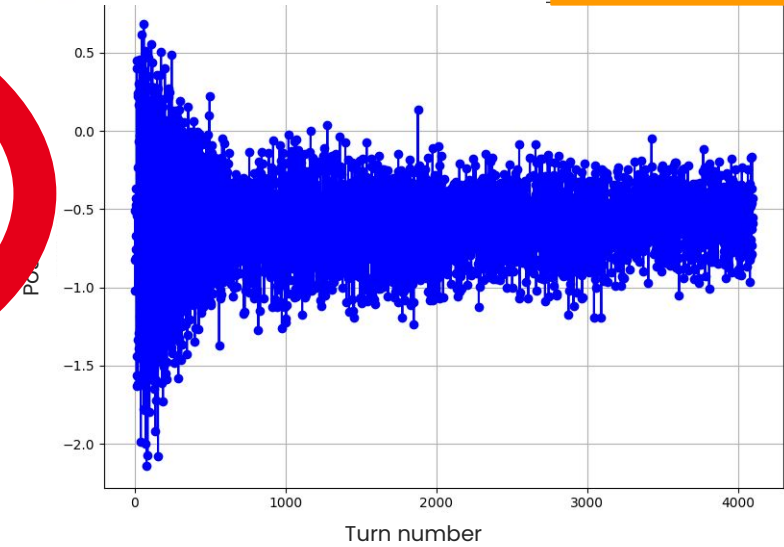
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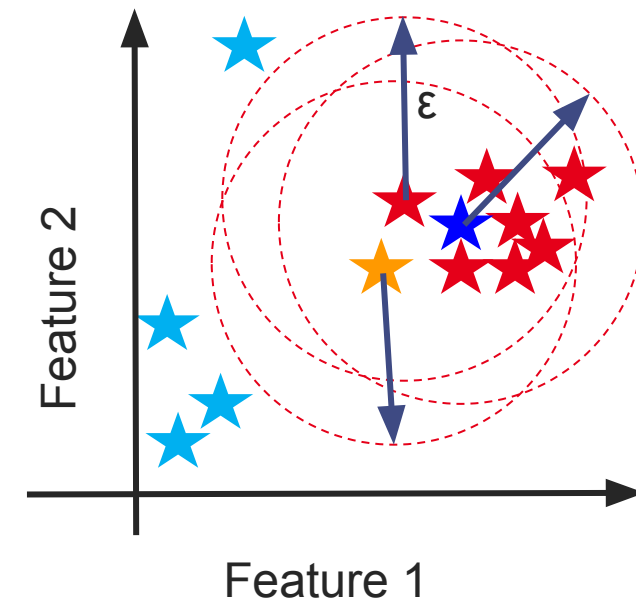
DBSCAN

- **Clustering algorithm : Density-Based Spectral Clustering Application w/ Noise**
 - Hyperspace of the statistical features from **Multivariate Time Series (MTS)**
- **1 vs All approach**
- ϵ **distance based algorithm**

Main approach:

- ❖ **One measurement, all tracks**

- ★ : outlier out of ϵ range from other points
- ★ : first point considered in the cluster
- ★ : point in the cluster
- ★ : point in the cluster w/ no neighbour



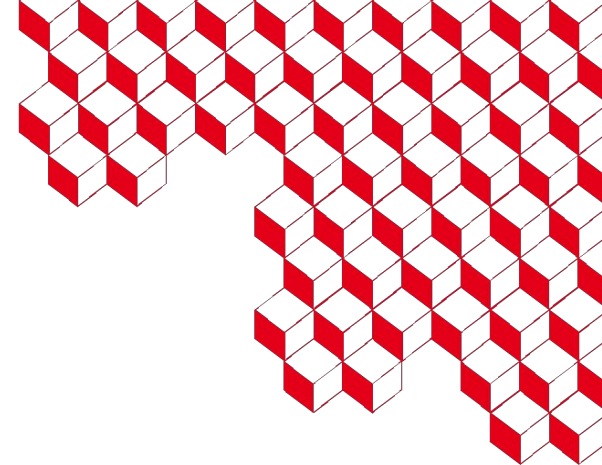
Main results

Faulty BPM HER (DBSCAN)	Expected faulty BPM HER	Faulty BPM LER (DBSCAN)	Expected faulty BPM LER
MQEAE35	MQEAE35		MQD3P23
MQD3E18	MQD3E18	MQEAP29	MQEAP29
MQR2ORE	MQR2ORE		MQD3P8
MQEAE20	MQEAE20		MQEAP10
MQEAE33		MQEAP35	MQEAP35
MQD3E29		MQW2ORP	MQW2ORP
	MQD3E23	MQEAP32	
MQEAE25		MQEAP33	
	MQD3E8	MQEAP44	
		MQD3P29	
		MQI6P	
		MQEAP38	

Résultats DBSCAN

Faulty BPM HER (DBSCAN)	Expected faulty BPM HER	Faulty BPM LER (DBSCAN)	Expected faulty BPM LER
MQEAE35	MQEAE35	MQD3P23	MQD3P23
MQD3E18	MQD3E18	MQEAP29	MQEAP29
MQR2ORE	MQR2ORE		MQD3P8
	MQD3E8		MQEAP10
MQD3E23	MQD3E23	MQEAP35	MQEAP35
	MQEAE20	MQW2ORP	MQW2ORP
MQC2RE			
MLB1LE			

Results of an SVD & Isolation Forest algorithm built by CentraleSupélec students co-supervised by B.Dalena and F.Bugiotti (CentraleSupélec)



Pour plus d'infos, venez voir le poster !!