

# Retour sur l'atelier GPU (3-5 avril)

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# Vue d'ensemble

- 60 participants
- 21 présentations
- ...dont 15 de retour d'expérience utilisateur
- ...et deux séances longues de travaux pratiques
- retour d'expérience orientés :
  - $\frac{3}{4}$  machine learning
  - $\frac{1}{8}$  calcul
  - $\frac{1}{8}$  stratégie
- thématiques scientifiques :
  - $\frac{1}{3}$  Astro
  - $\frac{1}{4}$  Hautes énergies
  - $\frac{1}{8}$  Biologie

# Présentations

## Titre

Présentation de la ferme GPU  
Abstraction logicielle pour la ferme GPU

Comment installer pytorch et tensorflow en python avec Cuda  
Une approche à base de Deep Learning pour la cosmologie observationnelle  
Reconnaissance individuelle de mammifères à partir de photos  
Deblending galaxies with Variational Autoencoder : a multi-bands, multi-instruments analysis  
LISA : Data analysis for observing gravitational wave sources from space  
GPUification avec OpenACC section efficace de capture d'électrons dans les supernovae  
Solving source separation problem for LISA data analysis with autoencoders  
Utilisation d'un réseau de neurones pour la discrimination gamma/neutron sur le détecteur NEDA

Usage of GPU for the ATLAS experiment  
ML/DL pour la physique des accélérateurs  
Inférence de réseaux de régulation de gènes à partir de données dynamiques multi-échelles/niveaux  
Généralités sur les réseaux de neurones

Experiences running Deep Reinforcement Learning on the IN2P3 GPU Cluster  
Applications multi-GPUs au CC-IN2P3 pour les analyses et simulations : apports, expériences  
Le service Data Analytics du projet PRACE  
Deep learning for inverse problems : Application to spectral CT

Soumission sur la ferme HPC  
TP : écriture d'un réseau de neurones avec numpy

## Speaker

Nicolas FOURNIALS  
Bertrand RIGAUD

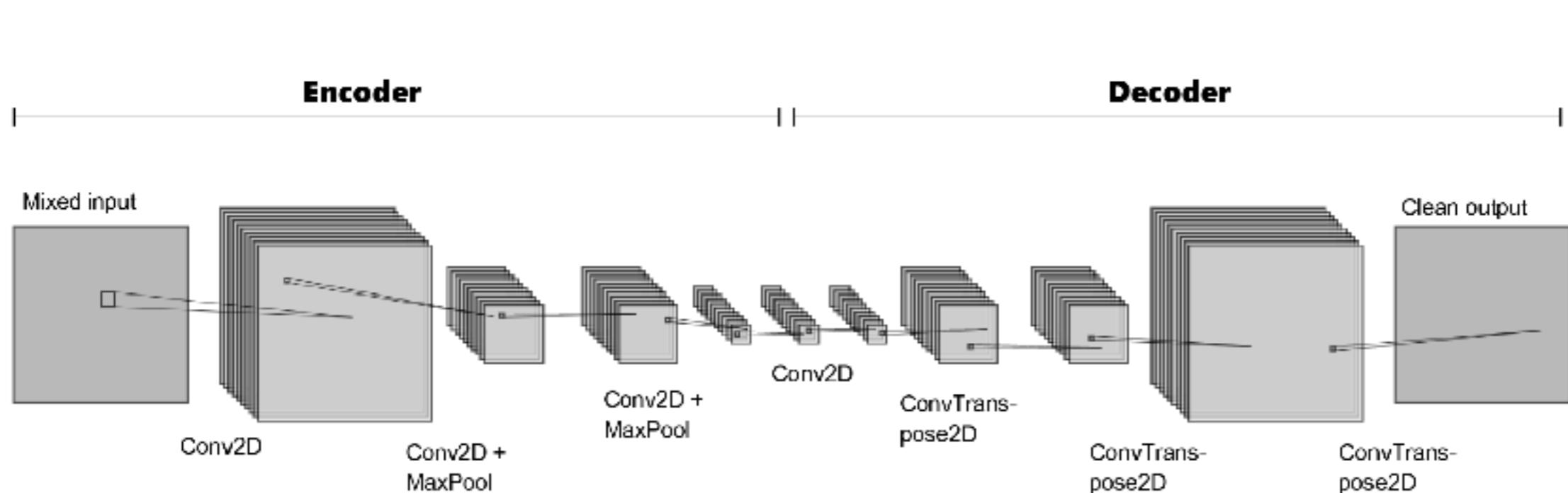
Thomas BAUDIER  
Johanna PASQUET  
Vincent MIELE  
Bastien ARCELIN  
Antoine PETITEAU  
Vincent LAFAGE  
Natalia KORSAKOVA  
Guillaume BAULIEU

Frederic DERUE  
Hayg GULER  
Arnaud BONNAFFOUX  
Alexandre BOUCAUD

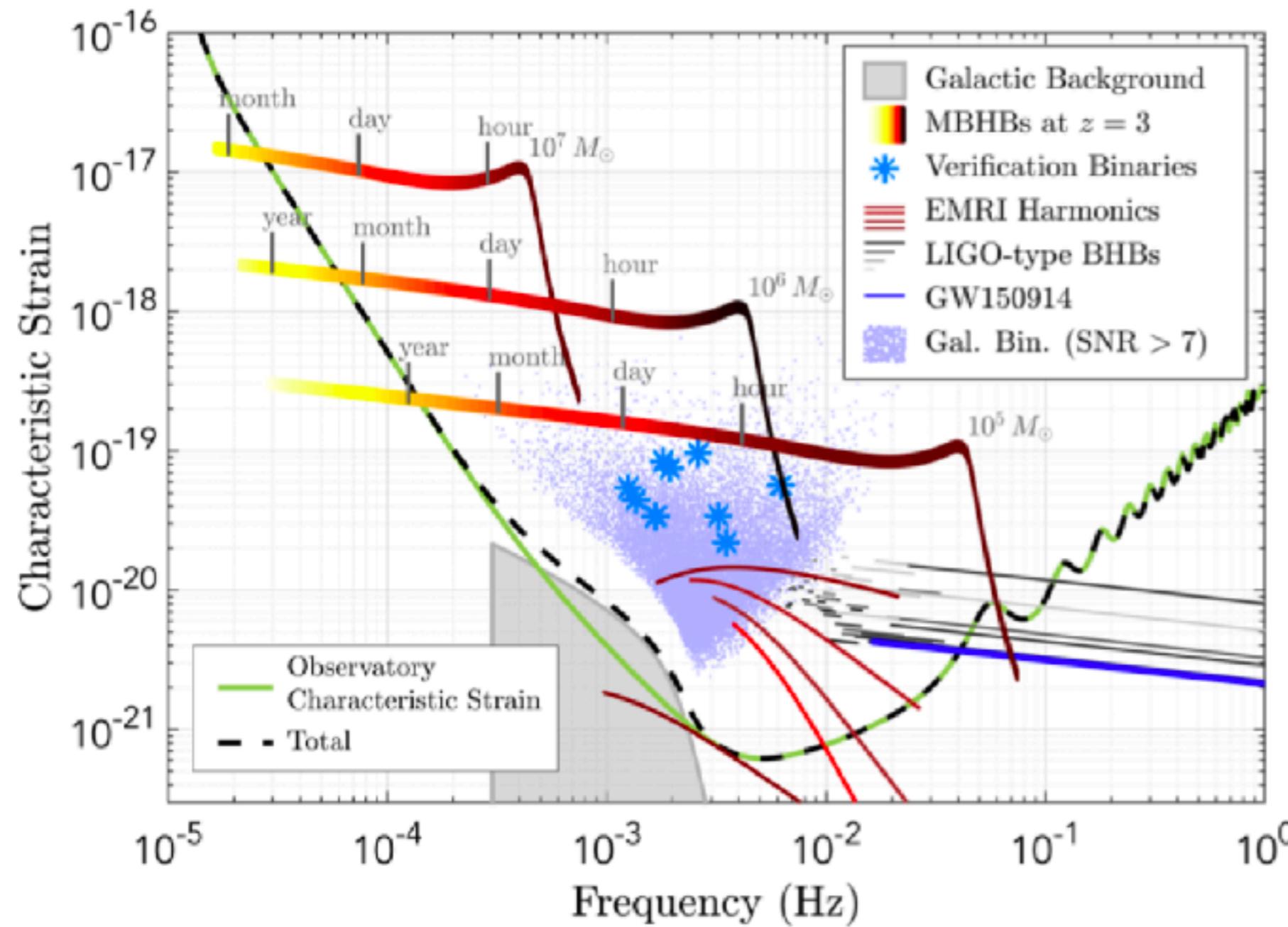
Edward BEECHING  
Gilles GRASSEAU  
Agnes ANSARI  
Juan Felipe Perez Justo

# DENOISING CONVOLUTIONAL AUTOENCODERS

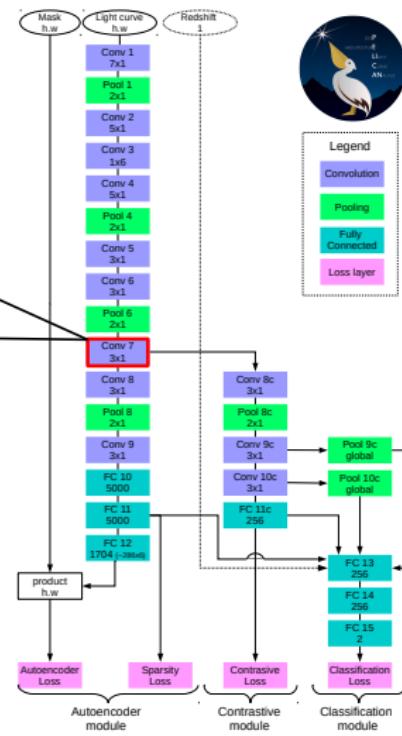
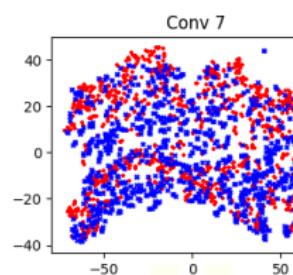
- Inspired by the paper Single Channel Audio Source Separation using Convolutional Denoising Autoencoders by Emad M. Grais and Mark D. Plumbley (GlobalSIP 2017 )



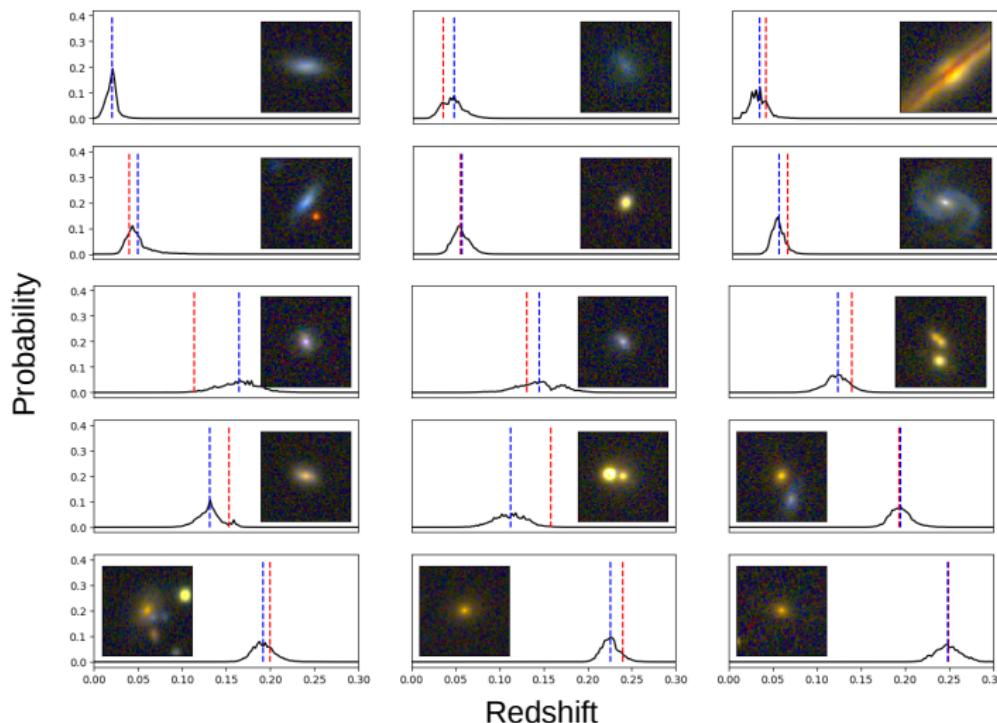
# LISA SOURCES



# Features visualization



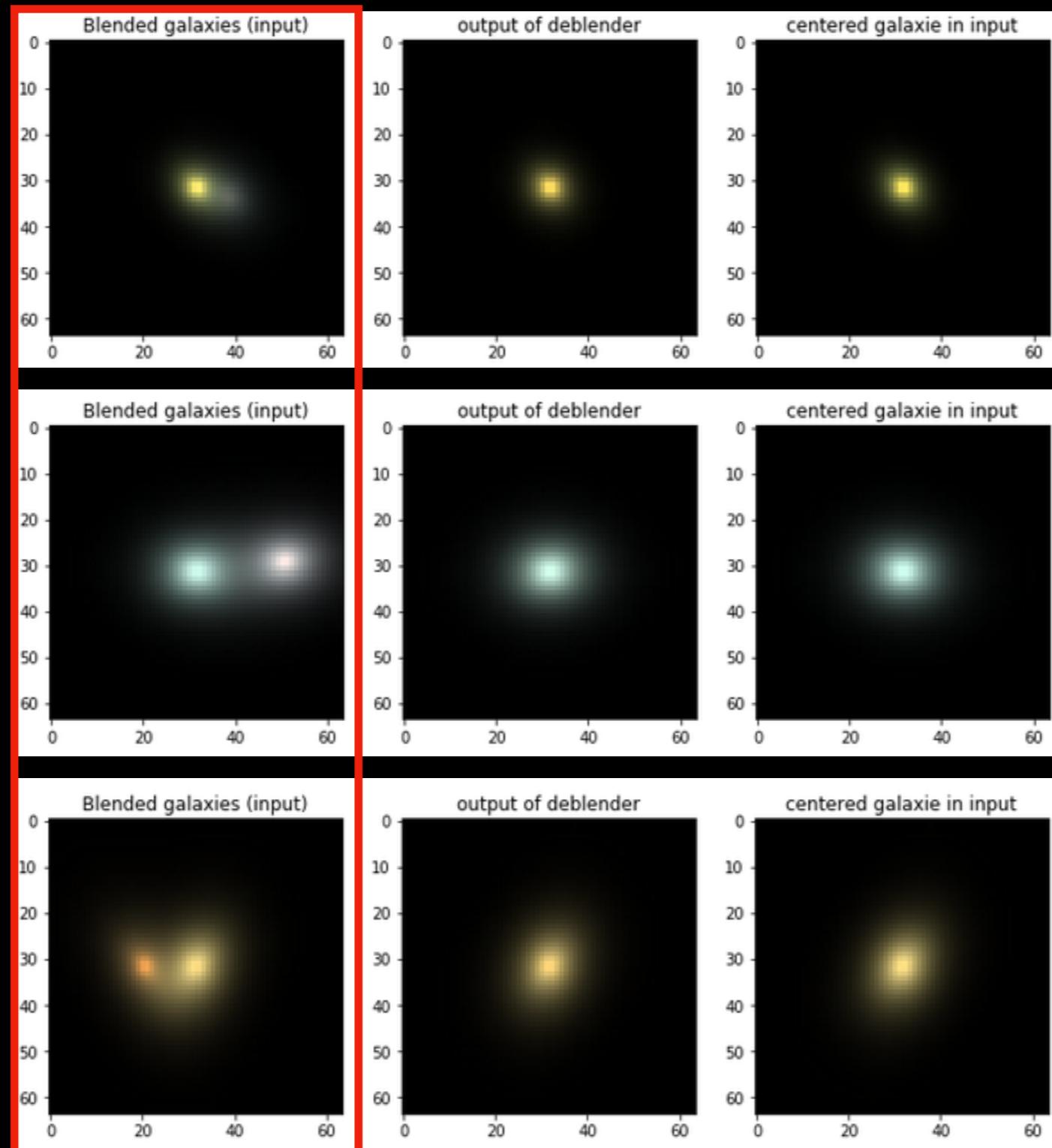
# Examples of PDFs



-- Spectroscopic redshift

-- Photometric redshift

# Deblender : results



# LSST+Euclid Data

- Why using Euclid data:
  - ✓ Adding infrared bands ( x3 )
  - ✓ Adding a visible band
  - ✓ Different PSF



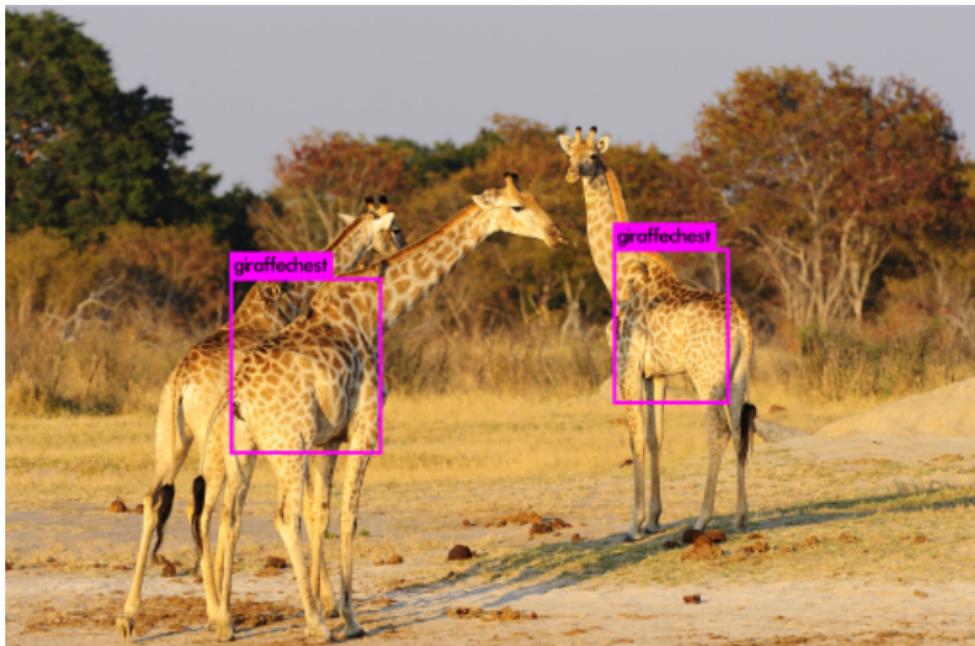
DES data - Peter Melchior's slides



CLASH WFC3/IR data - Peter Melchior's slides

# YOLO - Détection

\* Quelques secondes par image

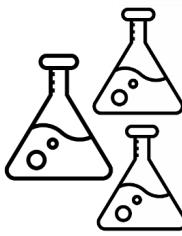


# YOLO - Détection

\* Quelques secondes par image

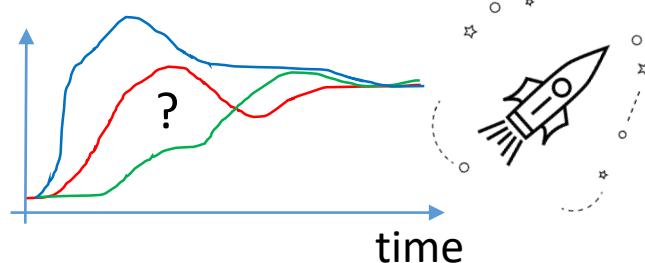


# WHY DYNAMIC MULTI-SCALE/LEVEL DATA?



## DYNAMIC :

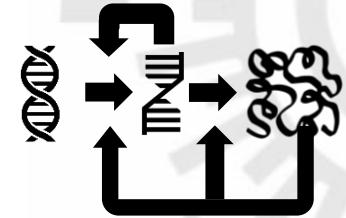
- Causality hides in transient



## MULTI-LEVEL :

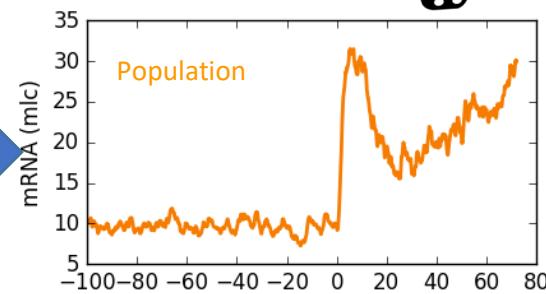
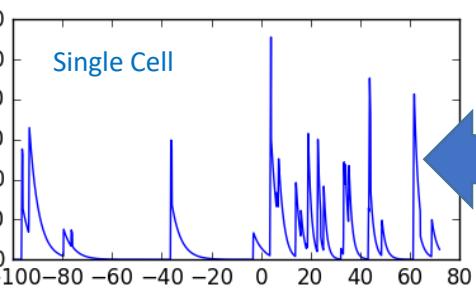
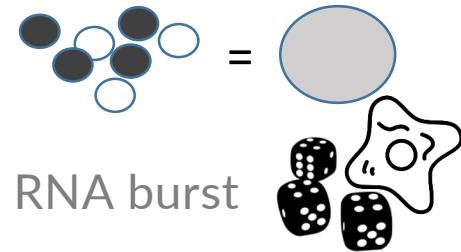
Promoter/RNA/Protein/Cell

- Multi-level Regulation
- Multi-omic data integration

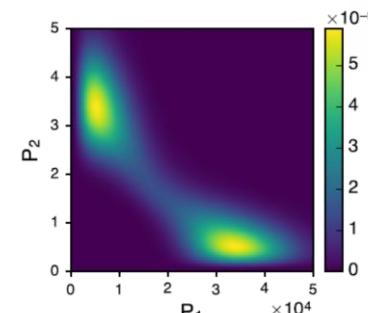


## MULTI-SCALE :

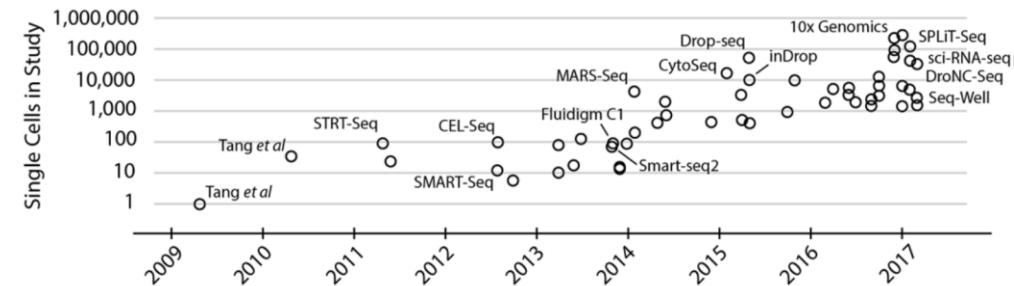
Single-cell VS population



- Joint distribution



- Statistical power > single-Cell Moore's law



# Use of GPU : mainly simulations

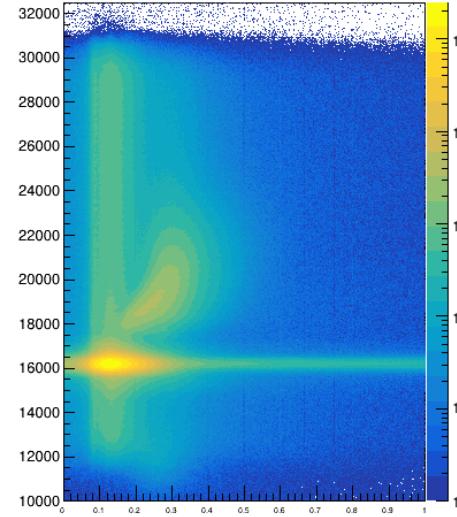
- Already in some proprietary codes (EM, beam transport codes)
  - Beam dynamics code : CST
  - Calculate multipactor : multiple electron generation from cavity surface
- 6D beam dynamics codes :
  - Code under MATLAB (Multi CPU)
- Particle tracking codes :
  - Elegant : GPU accelerated

# ML Program for our machines

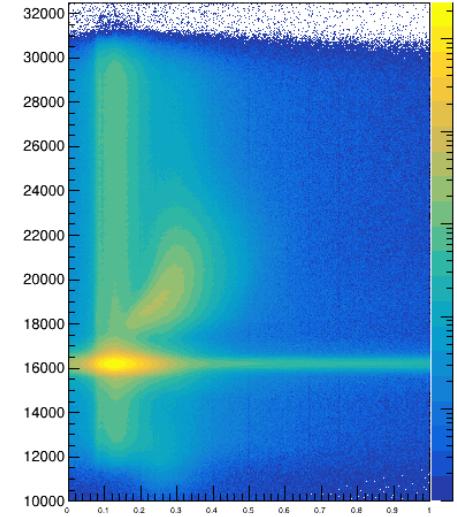
- Linac accelerator : PHIL, ThomX-Linac
  - Photo-injector type
    - Diagnostics : beam Images, BPM, charge monitor
  - Knobs : magnets, RF phase
  - Goal : transport beam, minimize emittance, ...
  - ML : training on images to make automatic tuning
    - Tests on simulation data with KERAS / Tensorflow
- Ring : ThomX, PERLE,
  - High level of collective effects
  - Complex tuning
  - Complex matching with linac side
- RF Conditioning process :
  - Use of ML could help us to optimize the conditioning and decrease the duration

→ Results on discrimination

MLP

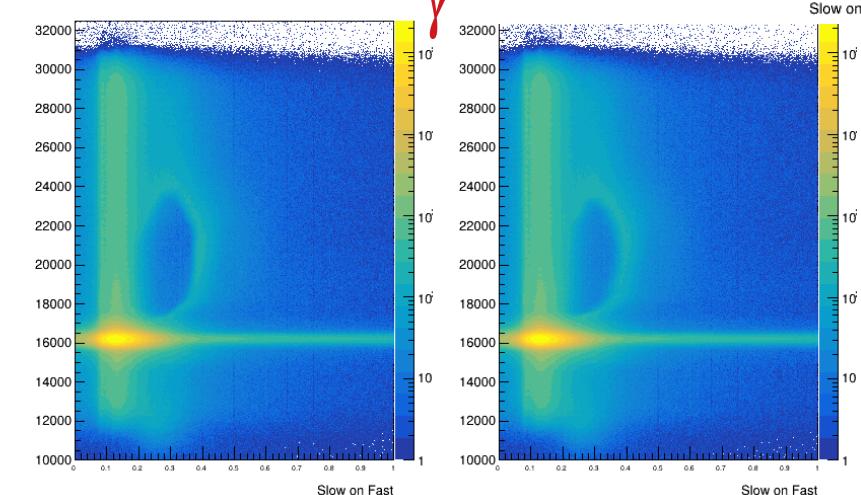


RNN



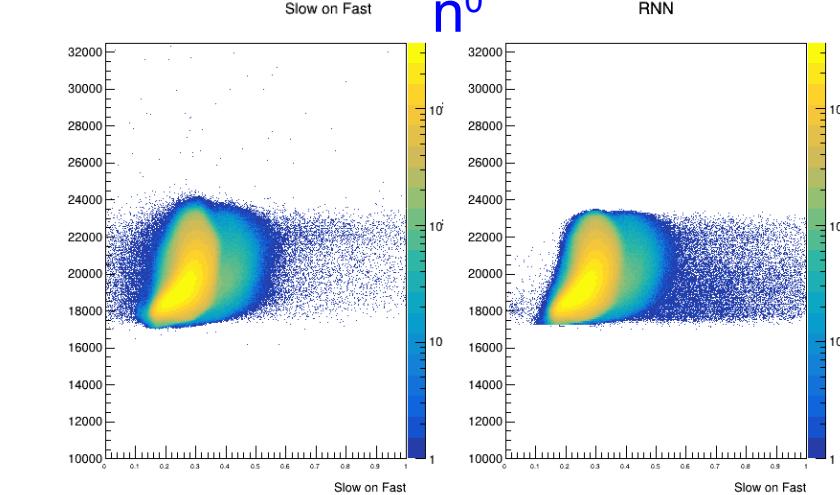
MLP

γ

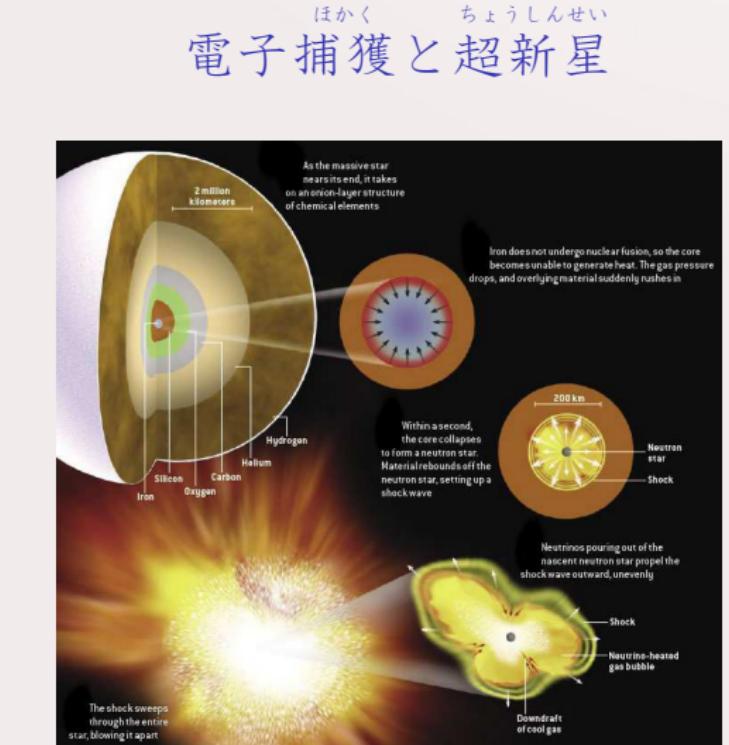


n<sup>0</sup>

RNN



IPNO の理論部  
 計算天体物理学  
 恒星内元素合成：  
 中性子星になるとき  
 $e^- + p \rightarrow n + \nu_e$  ?  
 ⇒  
 $e^- + \frac{A}{Z} \rightarrow \frac{A}{Z-1} + \nu_e$   
 千原子核の種類  
 温度 : [0.5, 5] MeV,  
 50 ステップ  
 ⇒ CPU 千年 !



⇒ スピードアップ > 55

⇒ 後で、CPU 20 年だけ  
 $\nu_e + \frac{A}{Z-1} \rightarrow \frac{A}{Z} + e^-$



## Performance

- ▶ Exploitation : 3<sup>rd</sup> PhD thesis (C. Martin-Perez ) -  $t\bar{t}H$
- ▶ Enabling these computations (MPI, GPU) help our physicists (LLR) to have an impact in this CMS collaboration analysis
- ▶ Improvements to do:
  - ▶ Performances
  - ▶ Code generation extension
- ▶ Ready for HL-LHC analysis

CC-IN2P3 – NVidia K80 platform

