Nikhef

Radboud University

BND School

Belgium Dutch German Graduate School in Particle Physics

Diana Pyatiizbyantseva

07 October 2022

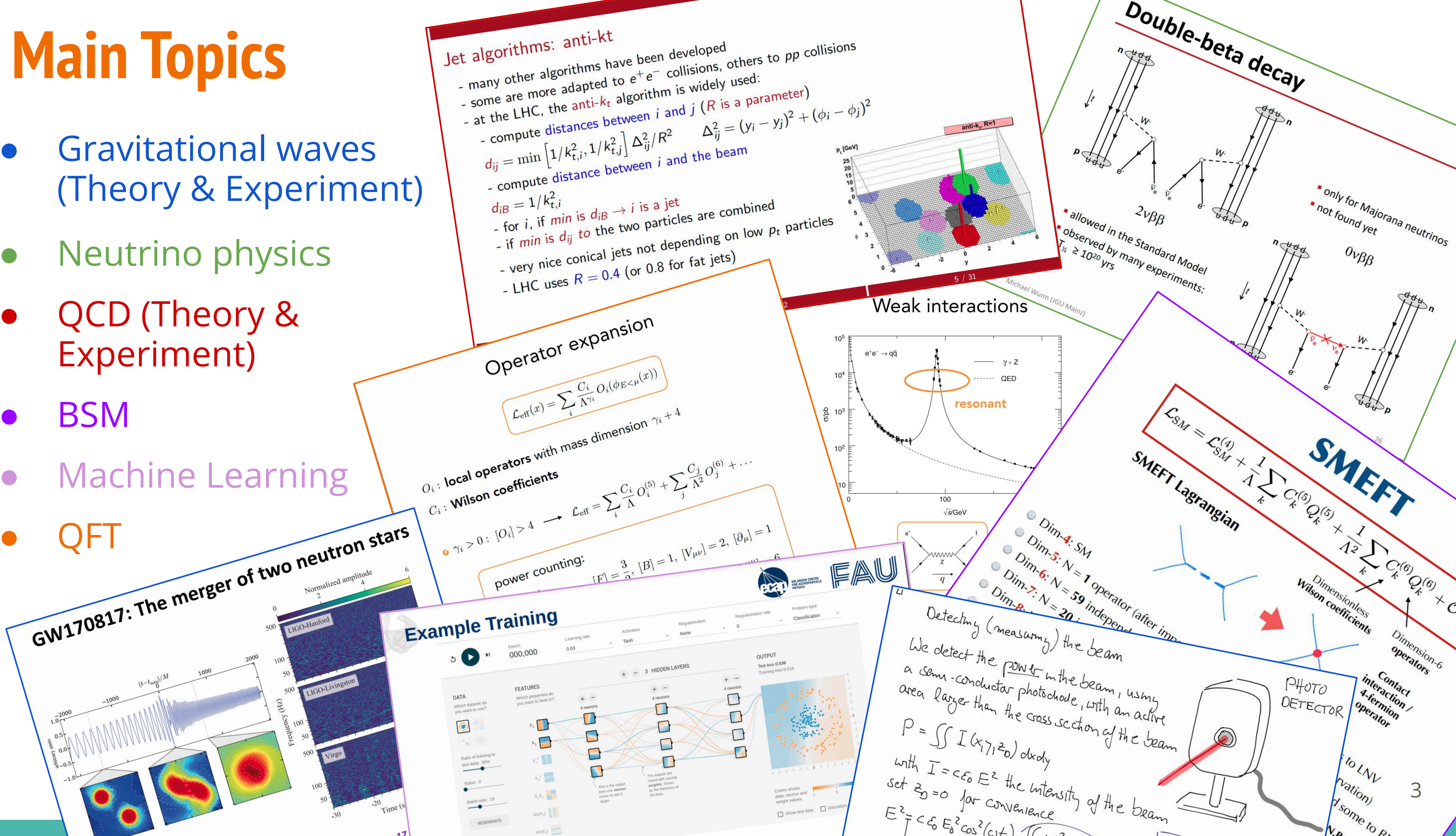
NORTH
SEA
Wadden
Texel
Den Burg
Noorderhaaks
Den Helder
Hollands Kustpad LAW 5-3
Callantsoog
Schagen
Noord-Hollandpad
IJsselmeer
Trekvogelpad LAW 2
Alkmaar
Egmond aan Zee
Heerhugowaard
Hoorn
Enkhuizen
Markermeer
Castricum
Heemskerk
Beverwijk
Velsen
Purmerend
Edam
Lelystad
IJmuiden
Zaanstad
AMSTERDAM
Almere
Haarlem
Zandvoort
Heemstede
Amstelveen
Hollands Kustpad LAW 5-2
Harlingen
Workum
Urk

General Info

- PhD students in particle and astroparticle physics
- Institutes in Belgium, Germany and the Netherlands
- 5–16 September 2022
- Callantsoog, the Netherlands
- A quiet sea-side resort with a sandy beach, approximately one hour travel north of Amsterdam
- Language: English

Main Topics

- Gravitational waves (Theory & Experiment)
- Neutrino physics
- QCD (Theory & Experiment)
- BSM
- Machine Learning
- QFT



Jet algorithms: anti-kt

- many other algorithms have been developed
- some are more adapted to e^+e^- collisions, others to pp collisions
- at the LHC, the anti-k_t algorithm is widely used:
  - compute distances between i and j (R is a parameter)

$$d_{ij} = \min\left[1/k_{t,i}^2, 1/k_{t,j}^2\right] \Delta_{ij}^2/R^2 \qquad \Delta_{ij}^2 = (y_i - y_j)^2 + (\phi_i - \phi_j)^2$$

  - compute distance between i and the beam

$$d_{iB} = 1/k_{t,i}^2$$

  - for i, if min is $d_{iB} \to i$ is a jet
  - if min is d_{ij} to the two particles are combined
- very nice conical jets not depending on low p_t particles
- LHC uses $R = 0.4$ (or 0.8 for fat jets)

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Double-beta decay

$2\nu\beta\beta$

- allowed in the Standard Model
- observed by many experiments: $T_{½} \geq 10^{20}$ yrs

$0\nu\beta\beta$

- only for Majorana neutrinos
- not found yet

Michael Wurm (JGU Mainz)

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Weak interactions

resonant

SMEFT

$$\mathcal{L}_{SM} = \mathcal{L}_{SM}^{(4)} + \frac{1}{\Lambda}\sum_k C_k^{(5)} Q_k^{(5)} + \frac{1}{\Lambda^2}\sum_k C_k^{(6)} Q_k^{(6)} + \ldots$$

SMEFT Lagrangian

- Dim-4: SM
- Dim-5: N = 1 operator (after imp…
- Dim-6: N = 59 independ…
- Dim-7: N = 20 …
- Dim-8: …

Dimensionless Wilson coefficients

Dimension-6 operators

Contact interaction / 4-fermion operator

…to LNV …rvation) …d some to B…

Operator expansion

$$\mathcal{L}_{\rm eff}(x) = \sum_i \frac{C_i}{\Lambda^{\gamma_i}} O_i(\phi_{E<\mu}(x))$$

O_i : local operators with mass dimension $\gamma_i + 4$

C_i : Wilson coefficients

- $\gamma_i > 0: \; [O_i] > 4 \longrightarrow \mathcal{L}_{\rm eff} = \sum_i \frac{C_i}{\Lambda} O_i^{(5)} + \sum_j \frac{C_j}{\Lambda^2} O_j^{(6)} + \ldots$

power counting: $[F] = \frac{3}{2}, \; [B] = 1, \; [V_{\mu\nu}] = 2, \; [\partial_\mu] = 1$

GW170817: The merger of two neutron stars

Example Training

Detecting (measuring) the beam

We detect the power in the beam, using a semi-conductor photodiode, with an active area larger than the cross section of the beam

$P = \iint I(x,y,z_0)\,dx\,dy$

with $I = c\varepsilon_0 E^2$ the intensity of the beam

set $z_0 = 0$ for convenience

$E^2 = c\varepsilon_0 E_0^2 \cos^2(\omega t)$

p_t [GeV]
anti-k_t, R=1
ϕ
y
n
p
u d d
d d u
u d u
W-
e-
$\bar{\nu}_e$
ν_e
t
$e^+e^- \to q\bar{q}$
γ + Z
QED
σ/pb
$\sqrt{s}$/GeV
z
q
Normalized amplitude
LIGO-Hanford
LIGO-Livingston
Virgo
Frequency (Hz)
Time (s)
$(t - t_{\rm merg})/M$
arbitrary units
ECAP
FAU
Epoch 000,000
Learning rate 0.03
Activation Tanh
Regularization None
Regularization rate 0
Problem type Classification
DATA
FEATURES
3 HIDDEN LAYERS
4 neurons
OUTPUT
Test loss 0.539
Training loss 0.514
REGENERATE
PHOTO DETECTOR

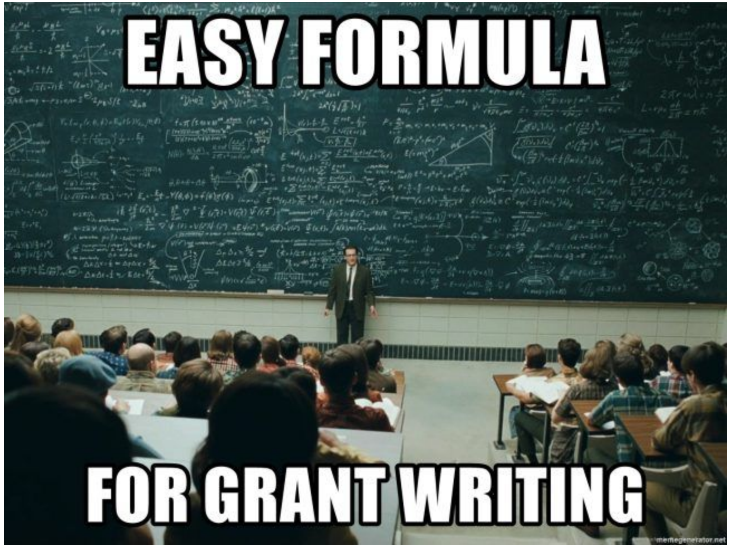
Project

What we ask you

- At the end of the school each group
  - Should have written a proposal:
    - Based on Green Science
    - Not longer than 1200 words and in any case no more than 3pages figure included and biography excluded
    - You ask for 800k euros … assume a PhD costs 240k just salary
    - Prepare 5 minutes movie pitch

Why green science?

- You have many different backgrounds at this school but "green science" is a common theme. Does not matter how you see that, you can pick up any aspect, computing, hardware, general running schedule, powering, efficient analyses ……



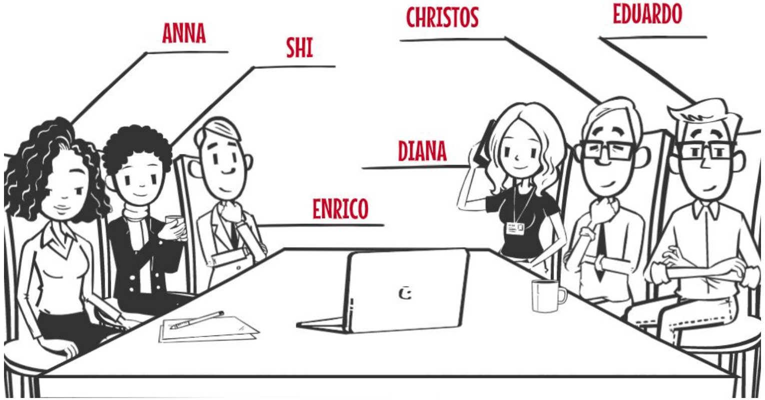
1. Abstract
2. Background and aim
3. Research plan
4. Knowledge utilisation

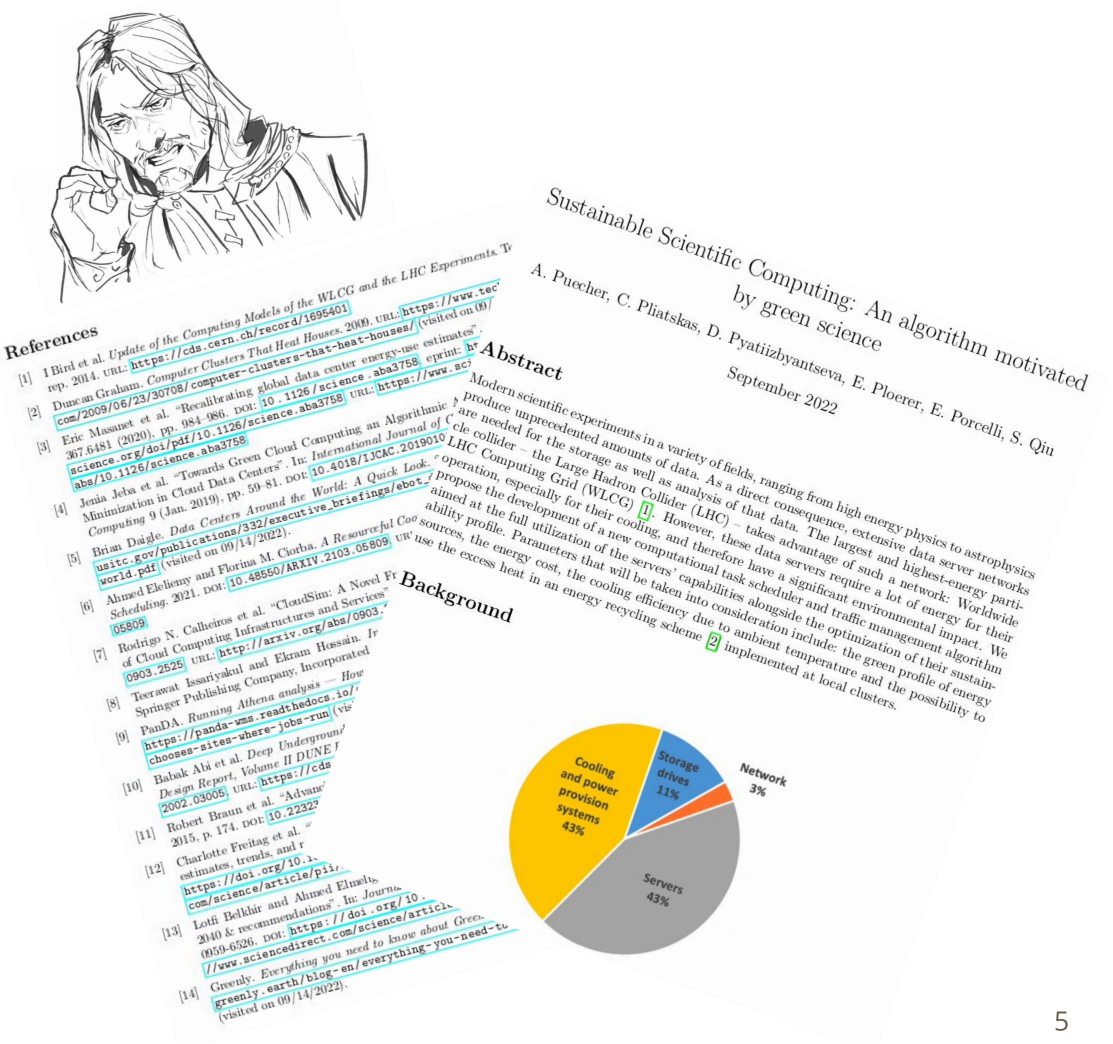
Each group has 6 persons, choosen randomly

Proposal + Video

Green Science

BND 2022 Proposal





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Sustainable Scientific Computing: An algorithm motivated by green science

A. Puecher, C. Pliatskas, D. Pyatiizbyantseva, E. Ploerer, E. Porcelli, S. Qiu

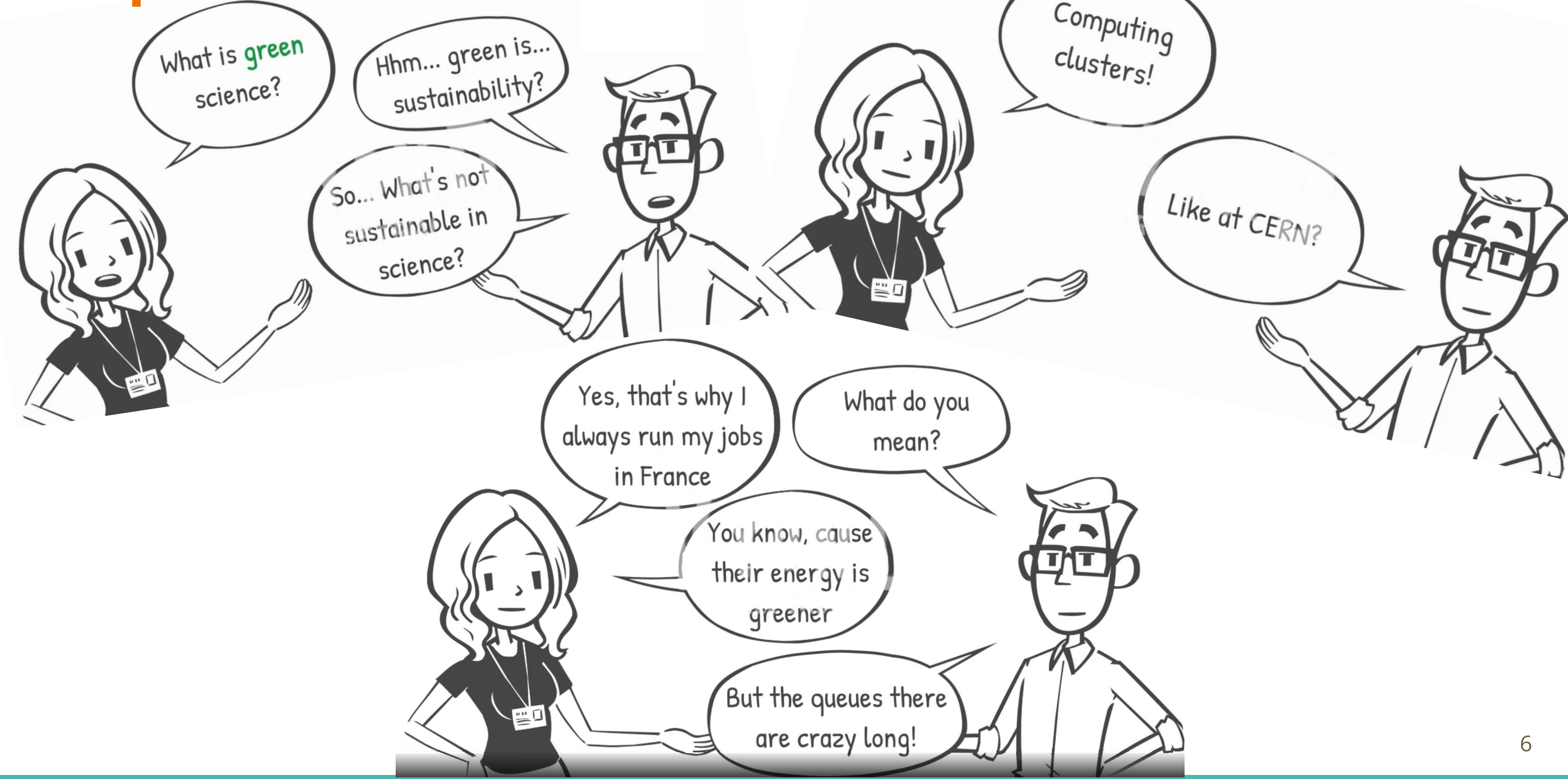
September 2022

Abstract

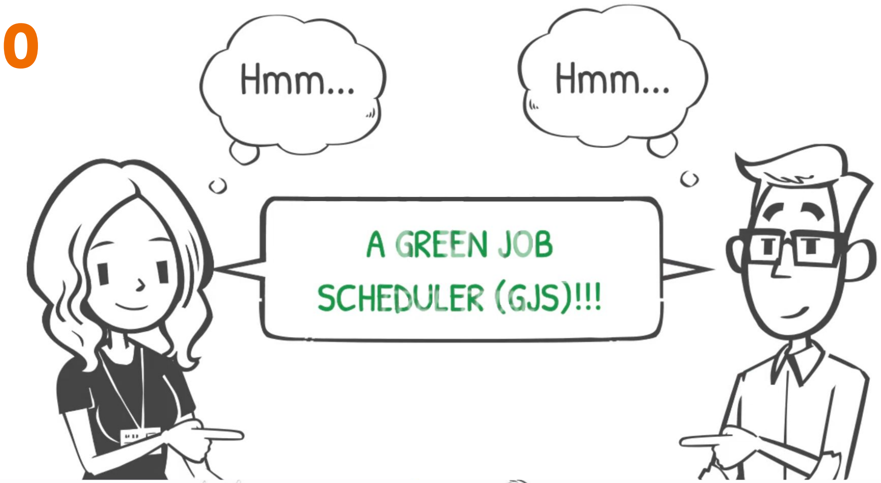
Modern scientific experiments in a variety of fields, ranging from high energy physics to astrophysics produce unprecedented amounts of data. As a direct consequence, extensive data server networks are needed for the storage as well as analysis of that data. The largest and highest-energy particle collider – the Large Hadron Collider (LHC) – takes advantage of such a network: Worldwide LHC Computing Grid (WLCG) [1]. However, these data servers require a lot of energy for their operation, especially for their cooling, and therefore have a significant environmental impact. We propose the development of a new computational task scheduler and traffic management algorithm aimed at the full utilization of the servers' capabilities alongside the optimization of their sustainability profile. Parameters that will be taken into consideration include: the green profile of energy sources, the energy cost, the cooling efficiency due to ambient temperature and the possibility to use the excess heat in an energy recycling scheme [2] implemented at local clusters.

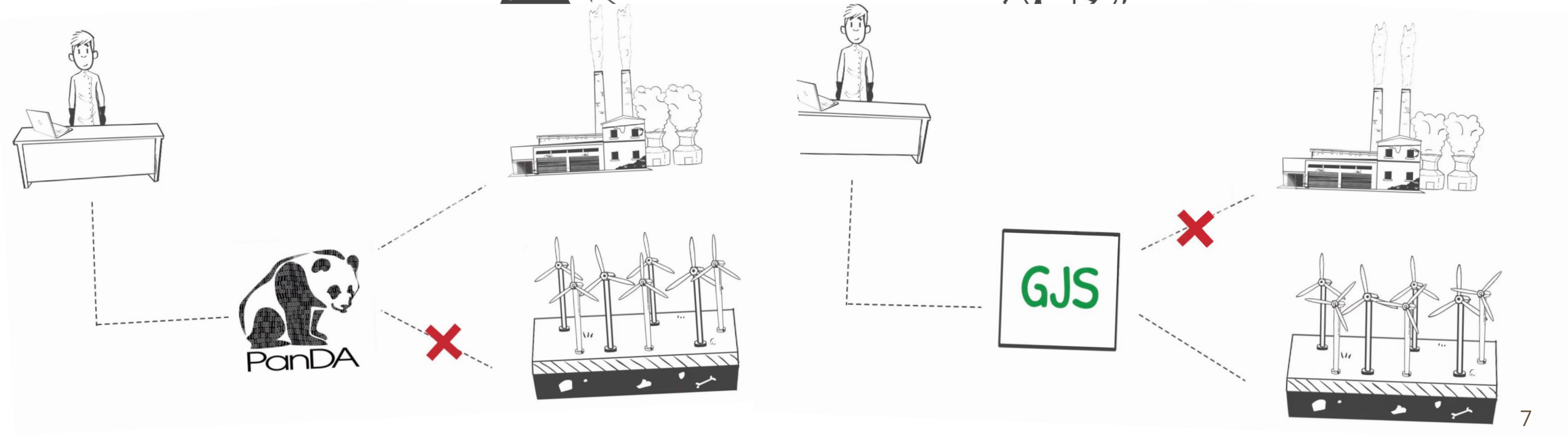
Background

Proposal + Video


What is green science?
Hhm... green is... sustainability?
So... What's not sustainable in science?
Computing clusters!
Like at CERN?
Yes, that's why I always run my jobs in France
What do you mean?
You know, cause their energy is greener
But the queues there are crazy long!

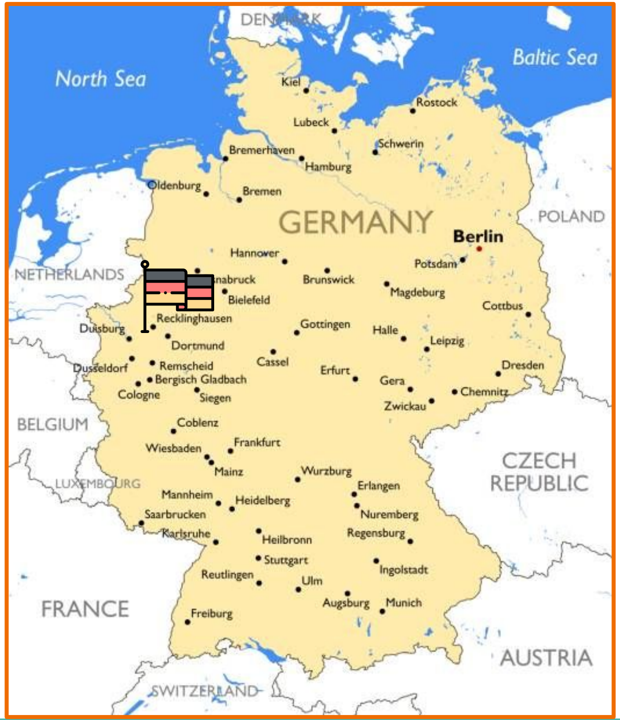
Proposal + Video


Hmm...
Hmm...
A GREEN JOB SCHEDULER (GJS)!!!



Next BND School

- Wuppertal, Germany
- 7–18 August 2023


DENMARK
Baltic Sea
North Sea
Kiel
Rostock
Lubeck
Schwerin
Bremerhaven
Hamburg
Oldenburg
Bremen
GERMANY
Berlin
POLAND
Hannover
Potsdam
NETHERLANDS
nabruck
Brunswick
Bielefeld
Magdeburg
Cottbus
Recklinghausen
Gottingen
Halle
Duisburg
Leipzig
Dortmund
Dusseldorf
Remscheid
Cassel
Erfurt
Dresden
Bergisch Gladbach
Gera
Cologne
Siegen
Chemnitz
Zwickau
BELGIUM
Coblenz
Frankfurt
Wiesbaden
Mainz
CZECH REPUBLIC
Wurzburg
LUXEMBOURG
Erlangen
Mannheim
Heidelberg
Saarbrucken
Nuremberg
Regensburg
Karlsruhe
Heilbronn
Stuttgart
Ingolstadt
Reutlingen
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Augsburg
Munich
Freiburg
AUSTRIA
SWITZERLAND

Thanks for your attention!