A MOOC on High-Energy Physics for French High-Schools

Journeys from the infinitely large to the infinitely small

ICHEP, Seoul – July 6, 2018

Sébastien Descotes-Genon (sebastien.descotes-genon@th.u-psud.fr)
Laboratoire de Physique Théorique (CNRS/INP & Université Paris-Sud)

Nicolas Arnaud (narnaud@lal.in2p3.fr)
Laboratoire de l'Accélérateur Linéaire (CNRS/IN2P3 & Université Paris-Sud)
European Gravitational Observatory (Consortium, CNRS & INFN)

Olivier Drapier (drapier@llr.in2p3.fr)
Laboratoire Leprince-Ringuet (CNRS/IN2P3 & École Polytechnique)

Philippe Schune (philippe.schune@cea.fr)
Institut de Recherche sur les lois Fondamentales de l'Univers
(Commissariat à l'Énergie Atomique et aux Énergies Alternatives)

Outline

- High-school teachers and students: a target audience
  - Educational and outreach projects
- The MOOC: « Voyages de l'infiniment grand à l'infiniment petit »
  - Structure and contents
  - Team
  - Diffusion
- Current status
- Prospects and outlook

High-school educational projects in France

- Interest from students for basic science
  - Intellectual curiosity, during high-school or even before
  - Notions part of the curricula: special relativity, radioactivity, quantum mechanics

- Teachers looking for resources
  - Not always familiar with our fields of research
    → Physics and chemistry teachers – plus occasionally mathematics
  - Activities welcome to liven teaching up
  - To provide examples/illustration of physics concepts, based on current research
  - Recent stress on team projects to be carried out and presented by pupils
    → Analysis of documents, etc.

- We need the next generation of scientists to be trained
  - And the general audience to understand better what we are doing – and why we are

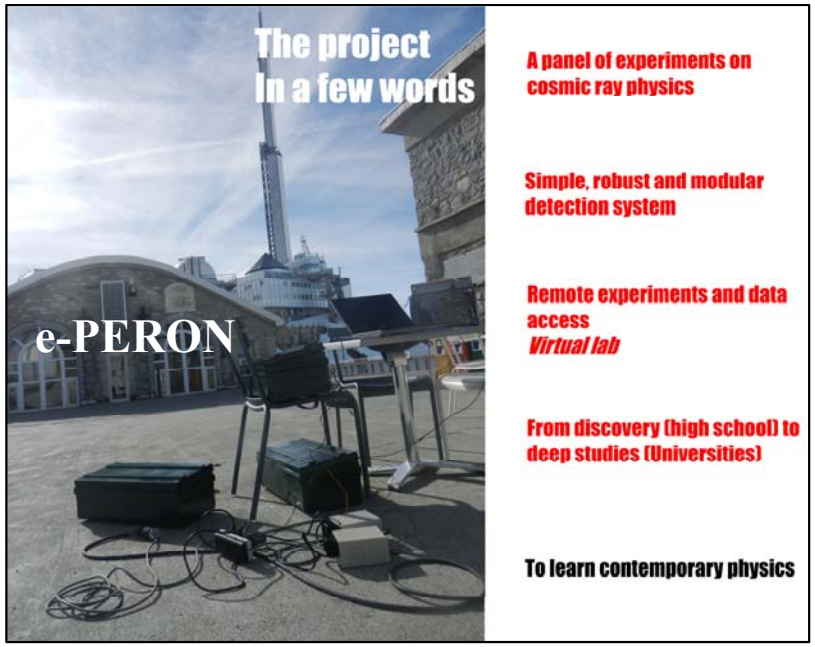
→ Mutual interest
  - Teachers act « Multiplication factors » (© CERN Teachers Programme)
    Teachers → Students → Families → General audience

High-school educational projects in France

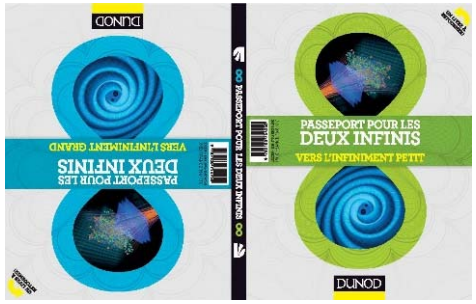
- Classic actions
  - Conferences
  - Laboratory visits
  - Educational documents
  - Teacher training sessions

- IPPOG's International Masterclasses

- Educational cosmic muon detectors
  - Cosmodétecteurs
  - Cosmix case
    → See talk at ICHEP 2014
  - e-PERON
    → New!



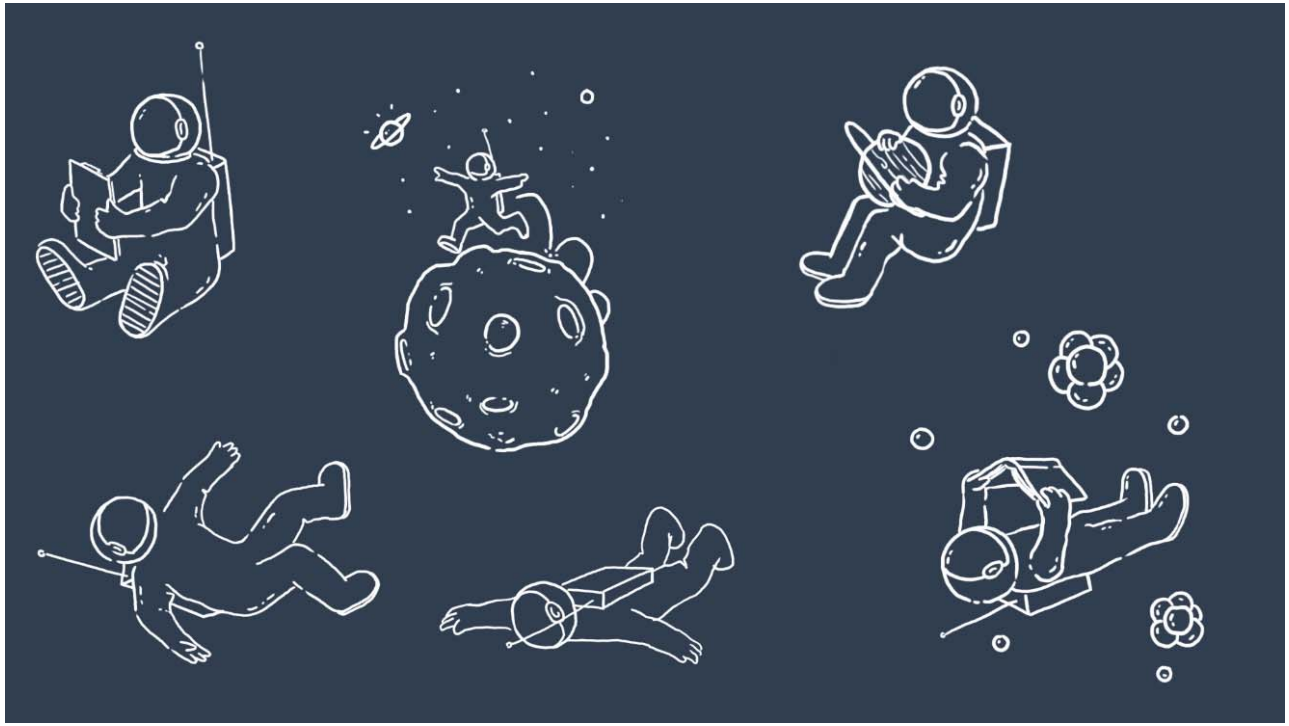
- Passeport pour les deux infinis
  - A book (2010) reprinted twice (2013 and 2016)
  - E-letter sent to 2,700+ teachers on a quartely basis



→ All under the common umbrella of the « physics of the two infinities »

Why a MOOC?

- Massive Open Online Course
- A more-modern media
- A wider audience to target
  - Not just teachers
    but also their students
    → Plus science hobbyists
  - Possibility of repetition
  - French-speaking countries
- Independent learning
  by the teachers
  - At their own pace
- Free (and validated)
  teaching material
  - Classes
  - Students bibliographic projets



Examples of existing MOOCs

- A (limited) digest for a French-speaking audience
  - Similar resources likely exist in other languages

- « From particles to stars »
  - Available on FUN(*)

  → Target audience: Master 1

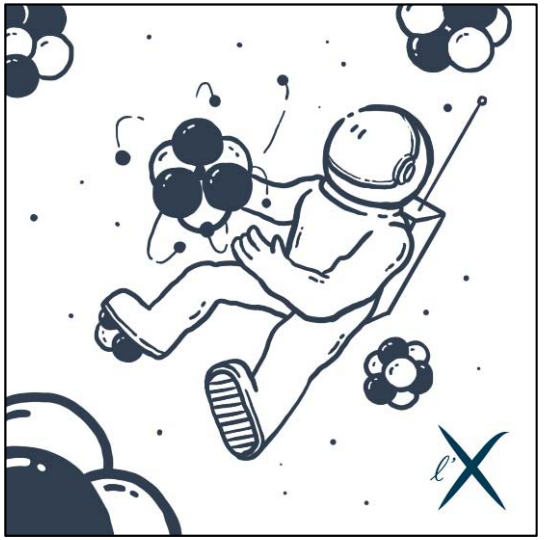
- « Gravity! From the Big-Bang to the black holes »

  → Gravity-centric
  - Available on FUN as well
  - For the general audience

(*) **« France University Numerical resources »)**

Voyages de l'Infiniment Grand à l'Infiniment Petit

- Each path of 10 modules is divided into four sets of two-three modules each
  - Guided progression
  - Each sub-path ends with a multi-choice quiz
    → For student self-evaluation

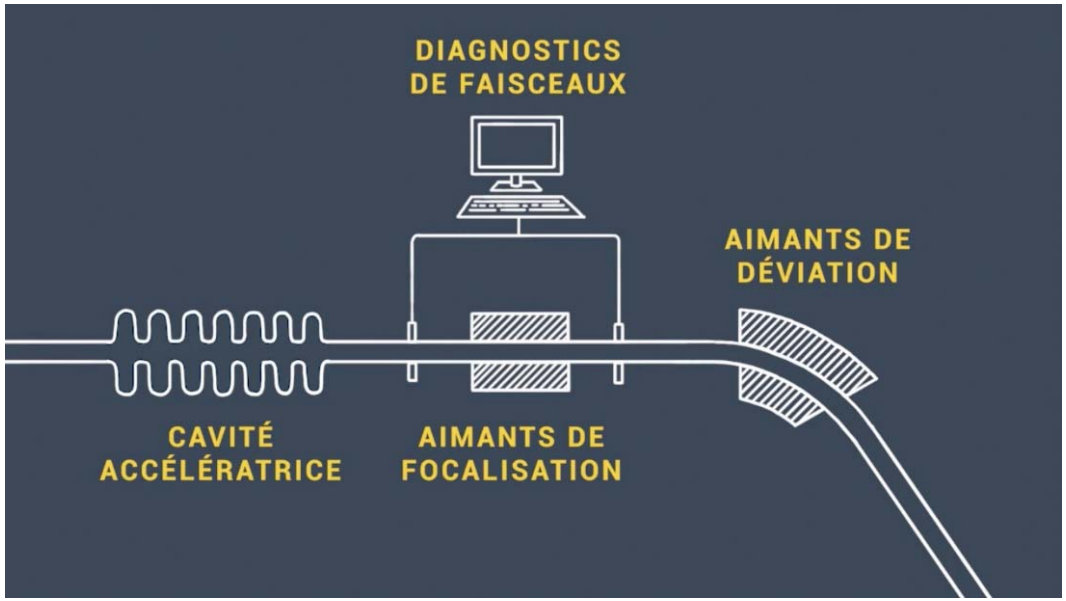


→ Example: the « infinitely small » path
  - Basics
    - On the road to the infinitely small
    - From the atomic nucleus to the quarks
    - $E=mc^2$ and its consequences
  - Fundamental constituents of matter
    - Fundamental interactions
    - The Standard Model
    - Looking for new particles
  - Studying elementary particles
    - Particle accelerators
    - Detecting particles
  - The LHC and beyond
    - The LHC
    - Future projects

Voyages de l'Infiniment Grand à l'Infiniment Petit

- A wide topic
  - Nuclear and particle physics
  - Astroparticle and cosmology
- Not just an introduction of the basic theoretical concepts
  - Detectors, experiments, international collaborations, prospects for the coming years
  - Applications to society
- Links between two research fields so widely apart on the length scale
  - From 10^{-18} m to 10^{26} m

→ Four main paths
  - Infinitely small
  - Infinitely large
  - Links between the two
  - Applications



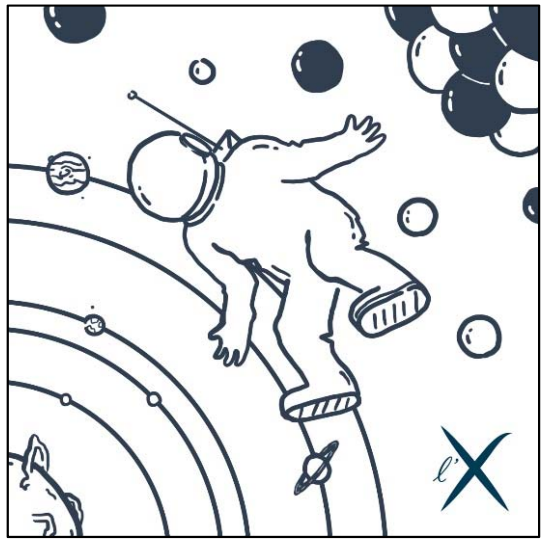
- 10 module-long each
  - 7-10 minutes video
  - Static shot, a single speaker per module facing the camera
  - Animations, pictures, schematics, etc. on the side

Voyages de l'Infiniment Grand à l'Infiniment Petit

- An ambitious project
  - Initial decision: make it local to the Orsay-Saclay area (southwest of Paris)
    → Ease management and communication between contributors
    → New clusters: network of labs, « Paris-Saclay University »

- Editorial board – four people, see cover slide

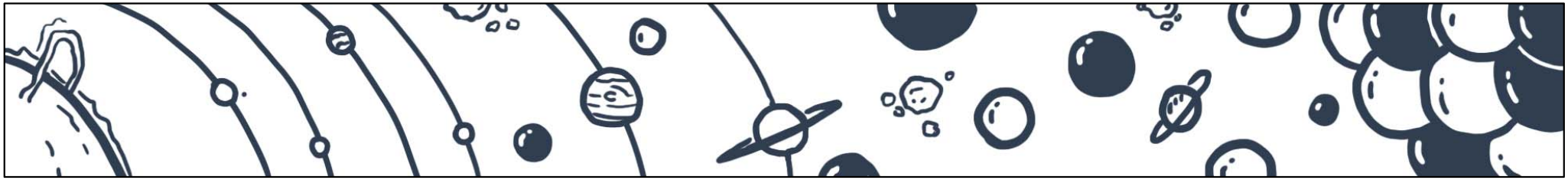
- Two partners
  - Ecole Polytechnique: film set & video editing, diffusion
  - The Paris-Saclay network of labs P2IO: funding support
    → « Physics of the 2 Infinities and of the Origins »
  - Support from the institutions
    of all the scientists involved:
    CNRS, CEA, Universities



- Technical team from Ecole Polytechnique
  - Eric Vantroeyen: e-learning officer
  - Latifa Berkous: engineer specialized in educational projects
  - Frédéric Picazo: video edition

Voyages de l'Infiniment Grand à l'Infiniment Petit

- A graphics designer: Loic Pauzié



- End-of-studies project from « Ecole Estienne »
  - Full name (translated):
    Graduate School of Arts and Printing Industry
    → Main trainings
    - Printing
    - Communication and design
      → Loic's topical section was scientific illustration
    - Artistic professions about books

- Loic kept on working on the MOOC as freelance after graduating

Voyages de l'Infiniment Grand à l'Infiniment Petit

- Support from high-school teachers
  - To link the MOOC contents with the curricula
  - To use as much as possible the same vocabulary than the teachers and students

→ Expect support from the Ministry of National Education for the MOOC diffusion
  - Already using associations of physics teachers to advertise the MOOC

- About 15 different speakers from various Orsay-Saclay labs
  - Two-three modules on close topics per speaker
    → Balance the load among many speakers
    → Speakers make their training profitable by recording more than one video
  - Gender balance
  - Physicists (both on the theory and experimental sides), engineers

- Audio in French
  - Automatically-generated subtitles
    → Then vetted by hand

Voyages de l'Infiniment Grand à l'Infiniment Petit

- MOOC plateform: Coursera
  - Paths available independently, as they get completed
  - Order of initial diffusion not necessarily optimal

    → Driven by organisational constraints: speaker availabilities, etc.
    - Infinitely small: online mid-February (2018)

      → More than 700 students
    - Applications: online mid-May

      → More than 200 students

    } Very positive feedback received from the students
    - Links: proofreading ongoing, online around the start of the next school year
    - Infinitely large: the last of the four paths, released shortly after the third one

      → All videos shot, editing work in progress

- The four paths will be replayed regularly on Coursera
  - In addition, they will all be available on a CNRS website
    - Currently under construction

    → With additional educational resources

- Transverse paths focusing on given topics

  → Example:

  Nuclear power, from the nucleus to the applications: medecine and energy

Outlook

- New MOOC about the physics of two infinites
  - Target audience: high-school teachers and students
  - Complement a wide set of educational and outreach resources already available
  - In French

- Half of the MOOC (2/4 paths) already online
  - The other half online by next Fall

- Long-term plans for diffusion
  - Standard MOOC + pool of educational resources
  - Four main paths + topical transverse paths

- Strong interest in broadening the diffusion to other French-speaking countries
  - Feel free to e-mail us!

  → See cover slide