

Highlights from France: The Antimatter Night Journey of a Cosmic Ray Detector

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The Antimatter Night



The Antimatter Night

- « **La Nuit de l'Antimatière** »
 - **13 participating cities**: Annecy, Bordeaux, Caen, Clermont-Ferrand, Dijon, Dunkerque, Grenoble, Limoges, Lyon, Orléans, Paris, Poitiers, Strasbourg
- Now a **French tradition**
 - **2010**: « **Nuit des Particules** » for **ICHEP 2010**
 - Then a few regional nights organized by the P2IO LabEx^(*)
 - **2017**: « **Nuit des Ondes Gravitationnelles** »
 - **2019**: « **Nuit de l'Antimatière** », Monday April 1st
 - **2021**: Topic tbd but a will to keep organizing such events every other year
- **Program well-established**
 - **Free local events**: outreach talks, exhibition, art performance, Q&A sessions, etc.
 - A **joint live session connecting the sites together** including a live **quiz**
 - **Contests** organized beforehand, results announced during the Night
- **Joint organization**
 - CNRS & CEA
 - SFP – French Physics Society

^(*) Laboratory of Excellence Physics of the 2 Infinities and of the Origins

The Antimatter Night

- **Antimatter**
 - Discovered almost a century ago
 - Many studies: **discoveries** / many **mysteries** remain
 - **Applications**→ **A good theme to federate enough cities / scientists**
- **Contests targetting students**
 - Short novel and comics
 - Pictures / images / paintings [!?] / videos
- **Typical agenda**
 - 18:30 – 20:00: local conferences
 - 20:00: all sites connected together
 - ◆ The tricky part – full dry session never possible!
 - 20:00 – 20:30: virtual visits of experimental sites
 - 20:30 – 21:10: Quiz
 - 21:10 – 21:2: Palmares of the contests
 - 21:20 – 22:30: Round table – for instance: « Science vs. science fiction »

The Antimatter Night

- **Media coverage**

- Partnership with a science divulgation magazine: « **Sciences et Avenir** »
 - ◆ Advertisement on website and social media
- Two **radio shows** on national stations the day of the event
- Unexpected: cover of the free daily newspaper « **20 minutes** »
 - ◆ Print rate: **900,000 copies**
 - ◆ Headline: « **Antimatière à réflexion** »
[In French: « Food for thought » ↔ « Matière à réflexion »]

- **Website:** <http://www.nuit-de-l-antimatiere.fr>

- **Contacts:** [Guy Wormser](#), [Céline Bézy](#)

- **Audience**

- ~4,000 spectators – 1,600 in Paris
 - **Social media**
 - ◆ **Facebook Live:** ~ 63 kPeople reached out / 15 kViews
 - ◆ **You Tube** webcast: ~ 23 kPeople / 2 kViews
- Audience main components: men, 25-34 years old



Journey of a Cosmic Ray Detector

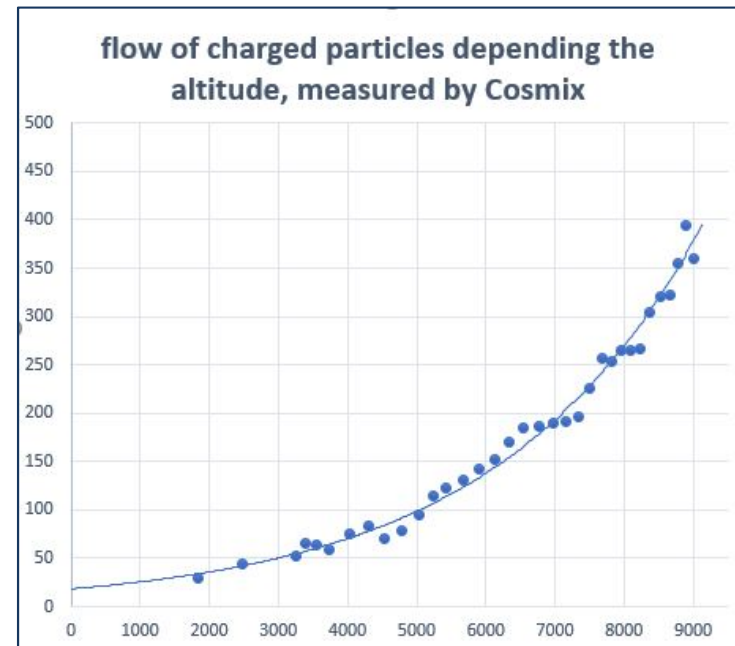
- France: mainland + **overseas!**
 - Extremely dynamic group of teachers at « La Réunion » Island
- **Fall 2013: start**
 - Gérard Cavalli gerard.cavalli@ac-reunion.fr took part in the **French Teacher Programme**
 - ◆ Since then: at least one teacher from La Réunion every year
- **2014: creation of the « Atelier des deux infinis »**
 - ~30 students / year
 - 3 teachers from 2 high-schools – FTP alumni
- **Main achievements**
 - National Science Festival
 - ◆ Regular visits from scientists
 - International Cosmics Day
 - Three science-driven school trips to France/Europe, internships in CNRS labs
 - **Two educational cosmic muon detectors**
- **HSSIP, SCool LAB Summer Camp, Nuit de l'Antimatière**



} Next step: **high-school specialization to open next September!**

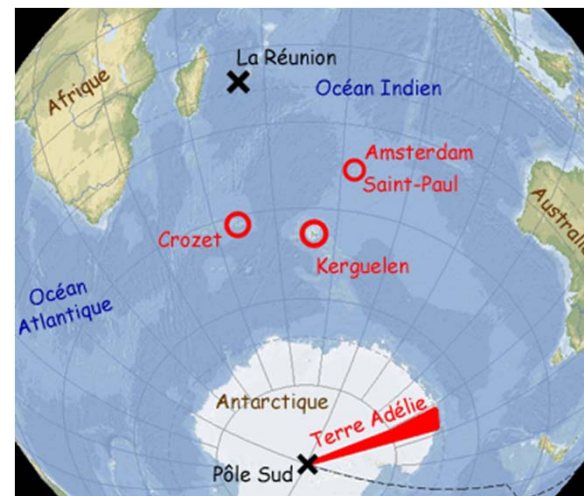
Journey of a Cosmic Ray Detector

- **Initial projects**
 - Cosmic muon angular distribution
 - Muon lifetime measurements
 - Muon rate as a function of altitude and at different places
- **Models and mock-ups**
 - Solar system at scale
 - Cosmic rays
 - Space-time
 - Supraconductivity
 - Polar aurorae
- **All projects involve students and teachers**
 - Students often bring new ideas!



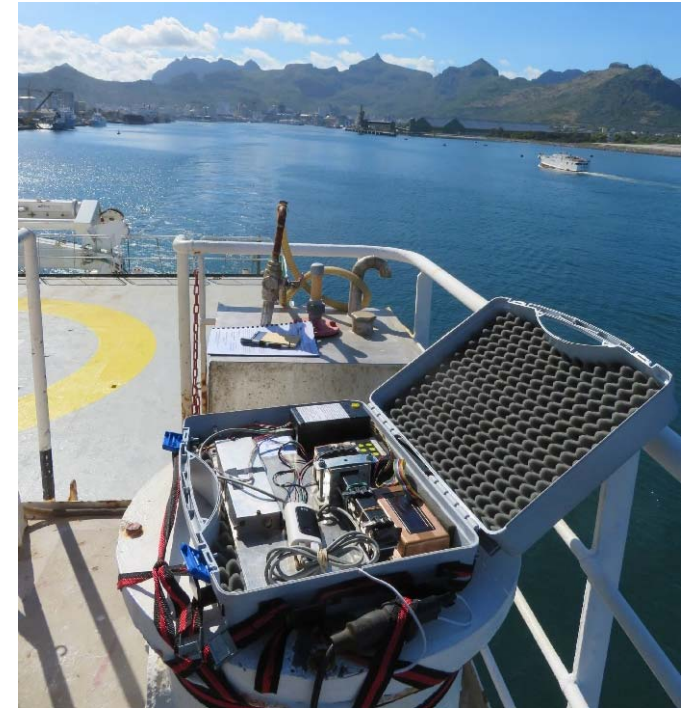
Journey of a Cosmic Ray Detector

- **Measuring the latitude effect on cosmic muons**
 - Earth magnetic field: rate increases with latitude – Compton, 1932
- Method: embark the **Cosmix educational detector** on the « **Marion Dufresne** »
 - Boat refueling the French Southern and Antarctic Lands
 - ♦ « Terres australes et antarctiques françaises » (TAAF)
 - 25-day journey: 4 → 29 December 2018
 - Latitude range: from 20°S to 50°S
- Goal: **continuous measurement of the muon rate**
 - Monitoring weather conditions as well
 - Collaboration with a scientist on board, in charge of the detector



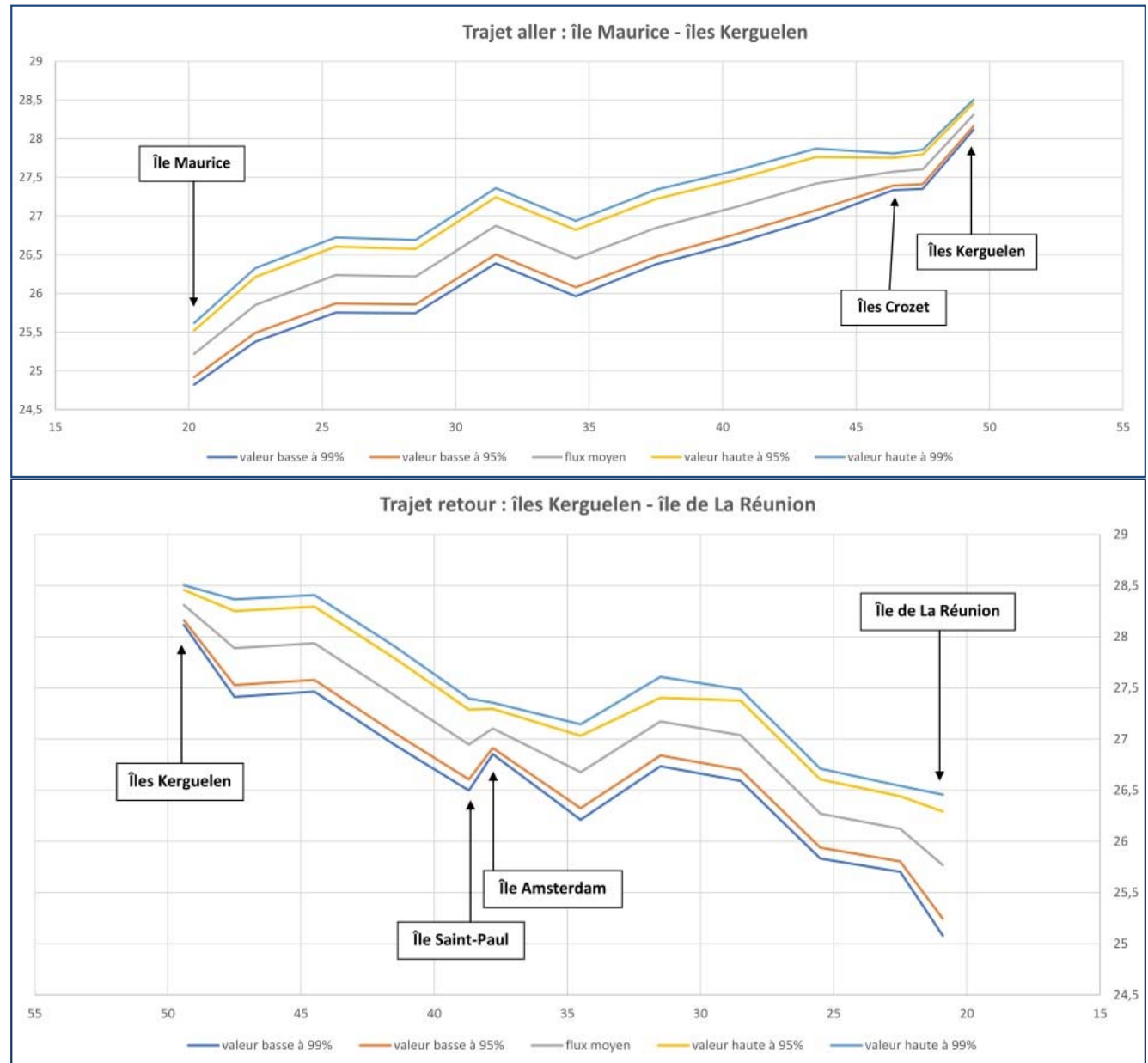
Journey of a Cosmic Ray Detector

- More pictures...



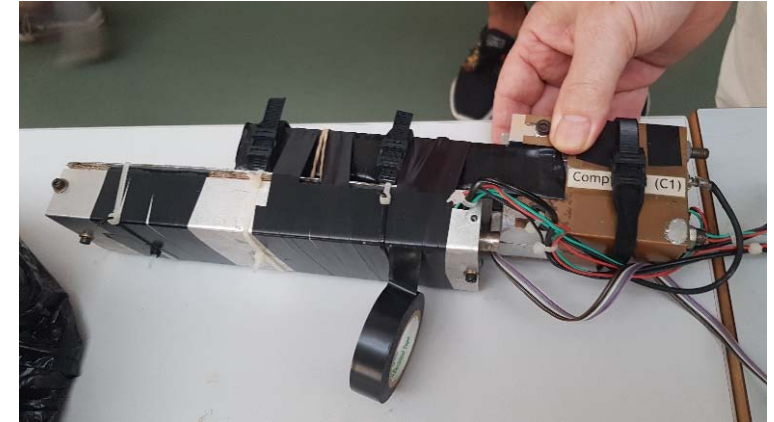
Journey of a Cosmic Ray Detector

- **Preliminary results**
 - 12% variation in the rate
- Still to be corrected for weather conditions



Journey of a Cosmic Ray Detector

- Variation of the muon rate as a function of depth in water
- Involve a team of divers
 - Goal is to reach **-50 meters**
- Dismantle and repack the Cosmix muon detector so that it fits in a cylindrical diving chamber
- Tests
 - Watertightness in a swimming pool
 - ◆ 3 tries needed
 - Resistance to pressure
 - ◆ 1 dive w/o the detector
- Procedure
 - Quick dive down
 - 3-minute stage on the way up every 10 meters
 - 2 scintillator bars superimposed
 - ◆ Coincidences
 - Dive watch to monitor depth



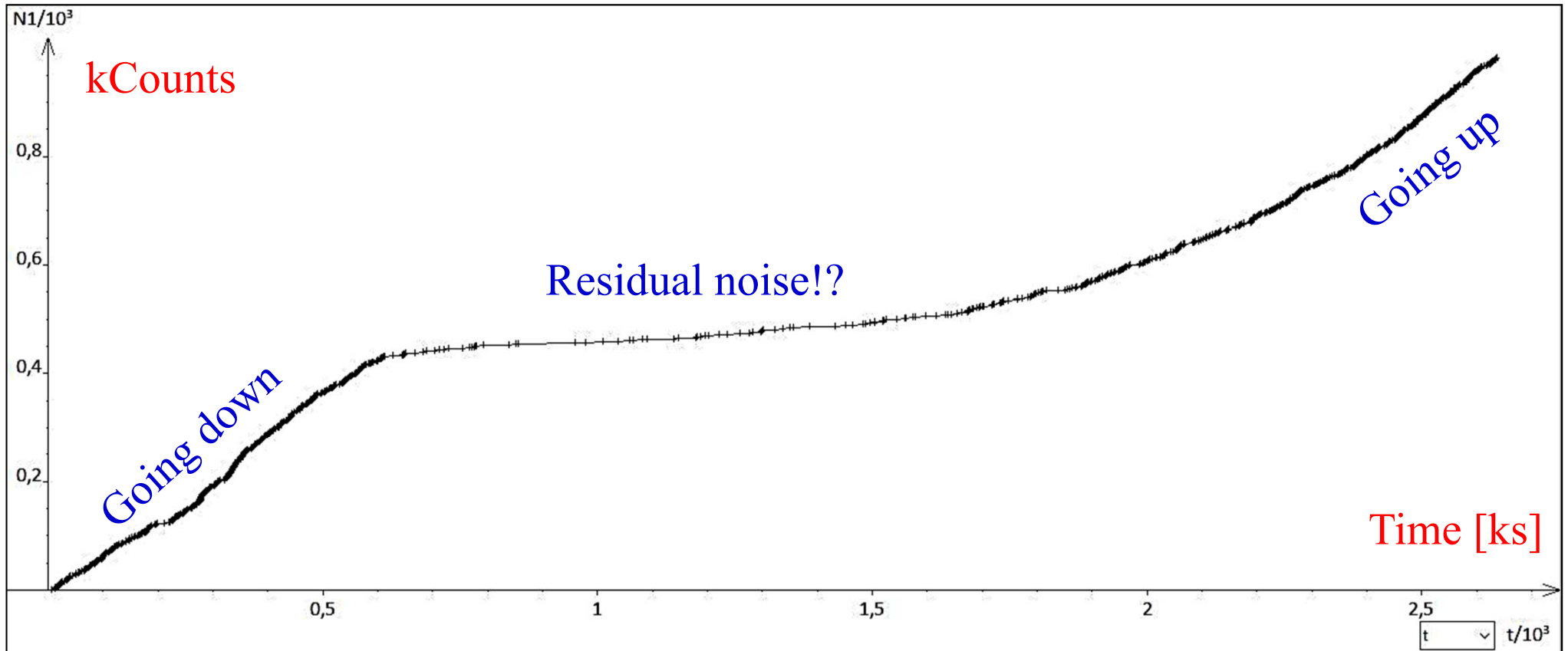
Journey of a Cosmic Ray Detector

- **Measurements**
 - First two dives did not produce any data!
 - ◆ Technical problems to be fixed
 - Then two successful dives
 - ◆ One from surface to -50 m
 - ◆ Another one with longer measurements at -10.40 and -16.20 m
- Container laying on the bottom



Journey of a Cosmic Ray Detector

- Preliminary results for the deep dive
 - Counts from one of the two counters



- Statistics too small at maximum depth to use coincidences
 - Both counters provide similar results
- Exponential decay of the rate: divided by 2 every ~ 6 meters
- Dive at two fixed depths gives ~ 7 meters instead

Brainstorming
ongoing to
improve procedure

Outlook

- **Two very different projects**

- One from **scientists**
- The other one from **teachers** and **students**

→ Both doing **outreach** in a complementary way

→ **Both benefiting from what we do and discuss in IPPOG**

- **Many other projects going on**

- **One example:** Virgo currently host of the stand « 1 Chercheur 1 Manip » (for two months) at the « Palais de la Découverte » science museum in Paris

