particle physics in a common language

12 years of CERN teachers training in Portuguese

Pedro Abreu, Sofia Andringa

many thanks to Nilson Garcia (SBF)
CERN

The largest research centre in the world

International collaboration model

Fundamental science

from $E=mc^2$ to the Higgs boson
Technology R&D

*from research to medicine*

Positron emission tomography detectors

Hadron therapy accelerators
Training, education and outreach

600 PhD theses / year

~100 internships for engineers

* 1000 teachers training / year *

the training in Portuguese was the first multi-national program

120 000 visitors / year

70 000 students

35 ministers

Sunday, 05 Sept 2010 – Friday, 10 Sept 2010

<table>
<thead>
<tr>
<th>Time</th>
<th>1st Year</th>
<th>2nd Year</th>
<th>3rd Year</th>
<th>4th Year</th>
<th>5th Year</th>
<th>6th Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>09:30</td>
<td>Particle Physics into 1</td>
<td>Particle Physics Basics</td>
<td>Particle Physics into 2</td>
<td>Particle Physics into 3</td>
<td>Particle Physics into 4</td>
<td>Particle Physics into 5</td>
</tr>
<tr>
<td>10:30</td>
<td>Particle Physics into 6</td>
<td>Particle Physics into 7</td>
<td>Particle Physics into 8</td>
<td>Particle Physics into 9</td>
<td>Particle Physics into 10</td>
<td>Particle Physics into 11</td>
</tr>
<tr>
<td>11:30</td>
<td>Statistics</td>
<td>The CMS Detector</td>
<td>Applied Physics</td>
<td>Q &amp; A</td>
<td>The ATLAS Detector</td>
<td>The ATLAS Detector</td>
</tr>
<tr>
<td>12:30</td>
<td>Lunch at CERN</td>
<td>Lunch at ATLAS, SHEP, LEPI</td>
<td>Lunch at CERN</td>
<td>Lunch at ATLAS, SHEP, LEPI</td>
<td>Lunch at CERN</td>
<td>Lunch at ATLAS, SHEP, LEPI</td>
</tr>
<tr>
<td>13:30</td>
<td>Visit to CERN</td>
<td>Visit to ATLAS, SHEP, LEPI</td>
<td>Visit to CERN</td>
<td>Visit to ATLAS, SHEP, LEPI</td>
<td>Visit to CERN</td>
<td>Visit to ATLAS, SHEP, LEPI</td>
</tr>
<tr>
<td>14:30</td>
<td>Visit to CAST, CERN, CERN Controls Center</td>
<td>Visit to CMS Electronics, CERN Controls Center</td>
<td>Visit to PS, LHC, CERN, CERN Controls Center</td>
<td>Visit to CMS Electronics, CERN Controls Center</td>
<td>Visit to PS, LHC, CERN, CERN Controls Center</td>
<td>Visit to CMS Electronics, CERN Controls Center</td>
</tr>
<tr>
<td>15:30</td>
<td>Group Discussion</td>
<td>Daily Discussion</td>
<td>Group Discussion</td>
<td>Daily Discussion</td>
<td>Group Discussion</td>
<td>Daily Discussion</td>
</tr>
</tbody>
</table>

Updated modern physics training for teachers

Focus on experimental particle physics (much helped by visits!)

Underline connections to applications in medicine and elsewhere

Lectures and visits by Portuguese and Brazilian researchers
Portugal (406)
10 Million people
age < 15 yrs: 14%
Literacy: 96%

Brazil (225)
208 Million people
age < 15 yrs: 22%
Literacy: 93%

Cape Verde (5)
0.6 Million people
age < 15 yrs: 29%
Literacy: 77%

S.Tomé & Príncipe (7)
0.2 Million people
age < 15 yrs: 41%
Literacy: 75%

Guiné Bissau (1)
1.8 Million people
age < 15 yrs: 44%
Literacy: 60%

Angola (4)
30 Million people
age < 15 yrs: 48%
Literacy: 71%

Mozambique (25)
27 Million people
age < 15 yrs: 45%
Literacy: 56%

East Timor (7)
1.2 Million people
age < 15 yrs: 41%
Literacy: 68%

680 teachers x 120 students x 6 years ~ half a million students!
### CERN teachers training in Portuguese

<table>
<thead>
<tr>
<th>Year</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>member state national languages</td>
</tr>
<tr>
<td>2007</td>
<td>1st CERN program for Portugal</td>
</tr>
<tr>
<td>2009</td>
<td>extended to Brazil &amp; Mozambique</td>
</tr>
<tr>
<td>2011</td>
<td>all Portuguese-speaking countries (74)</td>
</tr>
<tr>
<td>2016</td>
<td>Pt(20)+Br(20)+Mz(1)+STP(1)</td>
</tr>
<tr>
<td>2018</td>
<td>minimal version Pt (20) + Br (20)</td>
</tr>
</tbody>
</table>

### what happened in 2008-2010?

- Proposal from Portuguese and Brazilian researchers
- CERN visit by Mozambique authorities
- LIP researchers in São Tomé e Príncipe
- Contacts with Education Ministries in other countries
- Support from Ciência Viva Portuguese outreach agency
what happened in 2014-2018?

East Timor added nuclear physics in curriculum

Boost in Masterclasses and CERN (virtual) visits

São Tomé e Príncipe active in IPPOG Masterclasses

Feedback for small adjustments:

- more classroom proposals
- more teacher exchanges
- but not more “free time”
- a global survey in 2019

Angola and Guiné Bissau did not come back

Reduced funding in Brazil and Portugal
Who are these teachers?

Selection by LIP / Ciência Viva (Pt), Physics Society (Br), University (STP), Education Ministries

Criteria: gender, age and regional balance, high-school physics teachers, extra class activities (bonus if particle physics related)

Answers in 2019 survey:

Portugal: 153/406 (38%)
Brazil: 90/225 (40%)
Mozambique: 12/25 (48%)
S. Tomé Príncipe: 2/7 (29%)
Angola: 1/4 (25%)
Timor Leste: 1/7 (14%)
Cape Verde + GB: 0/6

Active in urban public high school (with more accumulation in Brazil)

Years of experience:

Evaluation (1-5) of the contacts at CERN reflects in present contact None / Sporadic / Frequent

2016: most teachers in Facebook group
2018: all teachers in WhatsApp group
researchers less present in social media
Modern Physics Update 4.53
New teaching materials 4.08

Larger asymmetries in importance of:
visiting CERN experiments
talks on Technology and Applications
the examples of International Collaboration
**Direct impacts in the classroom**

bringing in particle physics (and present day research)

fostering (physics? technology?) curiosity in students

*can we help improve experimental physics in schools?*

**Very different student / teacher ratio:**

- Portugal: 2-4 classes x 20-30 students
- Brazil: 4-10 classes x 30-45 students
- Mozamb: 10-15 classes x 50-60 students

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**Modern Physics Update**
- Portugal: Very Good (4.53)
- Brasil: Very Good (4.54)
- Moçambique: Very Good (4.50)

**CERN/ experiments**
- Portugal: Very Good (4.54)
- Brasil: Very Good (4.63)
- Moçambique: Very Good (4.33)

**Technology/applications**
- Portugal: Medium (4.63)
- Brasil: Medium (4.56)
- Moçambique: Medium (4.33)

**International collaborat.**
- Portugal: Medium (4.47)
- Brasil: Medium (4.47)
- Moçambique: Medium (4.33)

**Teaching materials**
- Portugal: Very Good (4.08)
- Brasil: Medium (4.12)
- Moçambique: Very Good (4.08)

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**Particle Physics**
- Portugal: Medium (4.23)
- Brasil: Medium (4.18)
- Moçambique: Medium (4.00)

**Experimental Physics**
- Portugal: Medium (3.59)
- Brasil: Medium (3.68)
- Moçambique: Medium (3.33)

**Current Research**
- Portugal: Medium (4.10)
- Brasil: Medium (4.12)
- Moçambique: Medium (3.58)

**Technological applic.**
- Portugal: Medium (3.65)
- Brasil: Medium (3.64)
- Moçambique: Medium (3.42)

**Curiosity**
- Portugal: Very Large (4.59)
- Brasil: Very Large (4.62)
- Moçambique: Very Large (4.42)
Impact outside the classroom
more demanding on teachers
more dependent on their career

On students, school and community:

- many public talks by Brazilian teachers
- boost in Masterclasses and CERN (virtual) visits
- participation in other programs directed to schools

<table>
<thead>
<tr>
<th>None</th>
<th>Medium</th>
<th>Very Large</th>
</tr>
</thead>
<tbody>
<tr>
<td>Portugal</td>
<td>Brasil</td>
<td>Moçambique</td>
</tr>
<tr>
<td>Public talks</td>
<td>3.81</td>
<td>3.68</td>
</tr>
<tr>
<td>CERN visits</td>
<td>3.25</td>
<td>3.37</td>
</tr>
<tr>
<td>Masterclasses</td>
<td>3.18</td>
<td>3.79</td>
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<tr>
<td>Science Clubs</td>
<td>3.14</td>
<td>3.18</td>
</tr>
<tr>
<td>+ Particle Phys.</td>
<td>4.42</td>
<td>4.50</td>
</tr>
<tr>
<td>+ Training</td>
<td>3.98</td>
<td>4.00</td>
</tr>
</tbody>
</table>

On the teachers themselves:

- following research updates
- attending new courses
- post-graduate studies

Similar teacher training at the National Synchrotron Lab, Brazil
**Strengths**

- bringing particle physics to different classrooms
- increasing number of science and physics students

**Opportunities**

- Union of Physicists in Portuguese Speaking Countries
- direct contacts with (teacher training) Universities
- internalization of CERN and Astroparticle projects

**Weaknesses (challenges!)**

- teachers would like increased follow up
- may be better tuned to different realities?

**Threats**

- funding problems...
  (hopefully solvable)