

# particle physics in a common language

12 years of CERN teachers training in Portuguese

Pedro Abreu, Sofia Andringa



many thanks to Nilson Garcia (SBF)

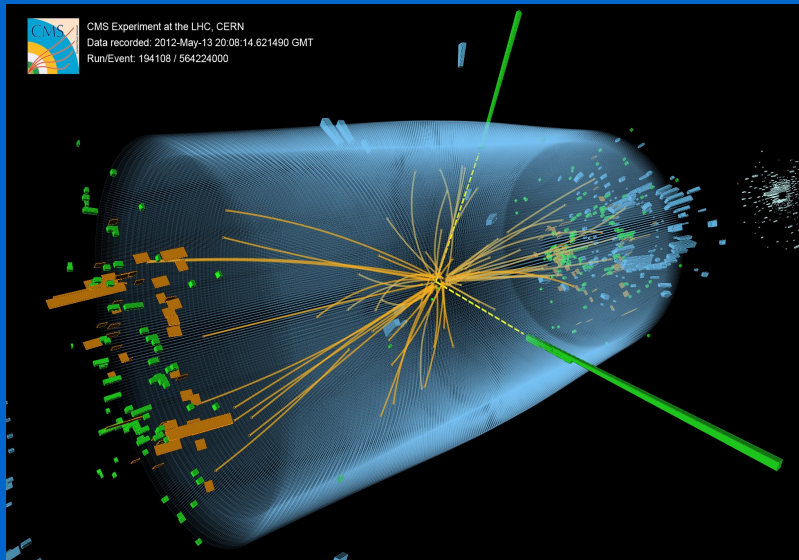
# CERN

*The largest research centre in the world*

*International collaboration model*

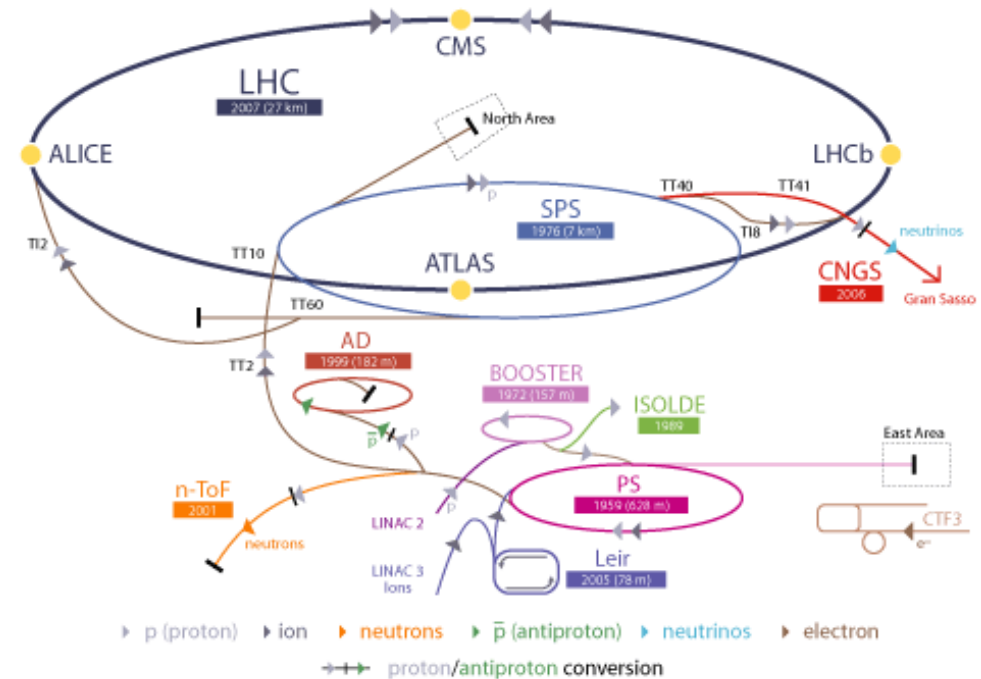
*Fundamental science*

from  $E=mc^2$  to the Higgs boson



CMS Experiment at the LHC, CERN  
Data recorded: 2012-May-13 20:08:14.621490 GMT  
Run/Event: 194108 / 564224000

## CERN Accelerator Complex



LHC Large Hadron Collider SPS Super Proton Synchrotron PS Proton Synchrotron  
AD Antiproton Decelerator CTF3 Clic Test Facility  
CNGS Cern Neutrinos to Gran Sasso ISOLDE Isotope Separator OnLine DEvice  
LEIR Low Energy Ion Ring LINAC LINear ACcelerator n-ToF Neutrons Time Of Flight

Web@  
30  
1989 - 2019

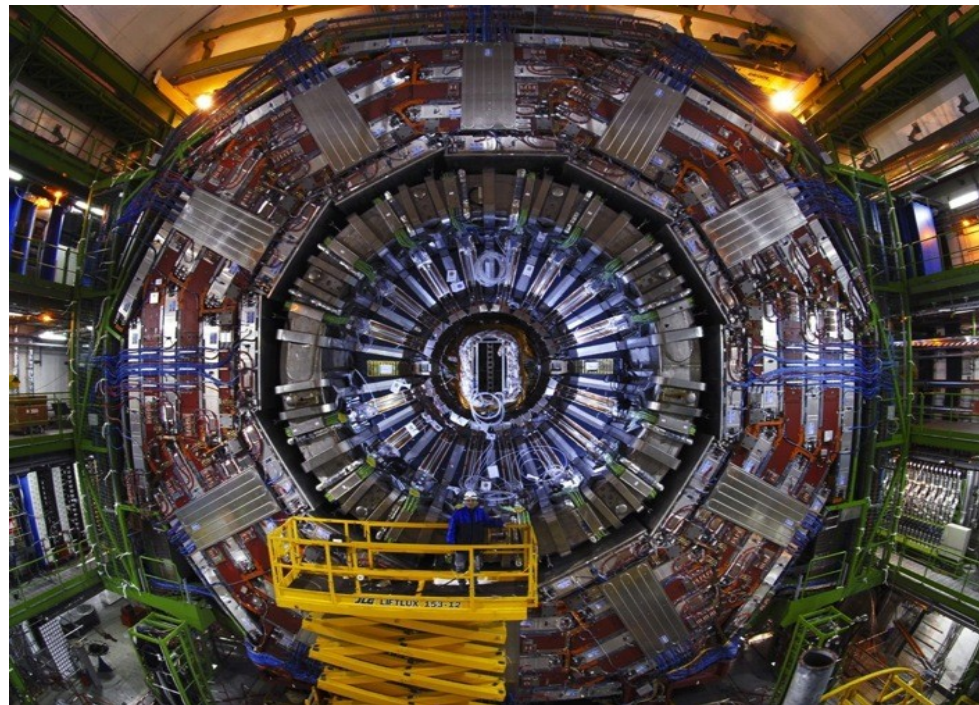


## Technology R&D

*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

	Dom.	2ª feira	3ª feira	4ª feira	5ª feira	6ª feira
09:00		Particle physics Intro 1	Particle Detection Basics	Particle physics Intro 3	Particle physics spin-offs	Particle physics without accelerators
10:00						
10:30		Particle physics & the Universe	Particle physics Intro 2	Data acquisition systems	Why an LHC?	Preparing an accelerator
11:30		Statistics	The CMS detector	Applied physics @ ISOLDE	Q & A session	The ATLAS detector
12:30						
14:00	Intro to CERN + Visit to ATLAS, SM-18	Visit to CAST, LHCb, Globe, Microcosmos	Visit to CMS Electronics, CERN Control Center	Visit to PS, LINAC, Computer Center / Cloud Chamber hands-on	Discover Geneva	Open questions on particles & the Universe
18:30	Groups	Daily Revision	Daily Revision	Churrasco Dinner	Geneva Dinner	

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



680 teachers x 120 students x 6 years ~ half a million students !



**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%

**Portugal (406)**

10 Million people  
age < 15 yrs: 14%  
Literacy: 96%

**East Timor (7)**

1.2 Million people  
age < 15 yrs: 41%  
Literacy: 68%

# CERN teachers training in Portuguese

2006...member state national languages

2007...1st CERN program for Portugal

2009...extended to Brazil & Mozambique

2011...all Portuguese-speaking countries (74)

2016...Pt(20)+Br(20)+Mz(1)+STP(1)

2018...minimal version Pt (20) + Br (20)

## 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

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## 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



SBF 2015

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

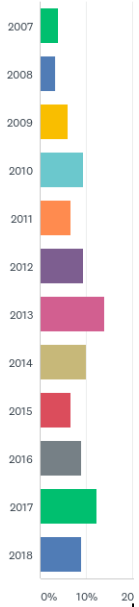
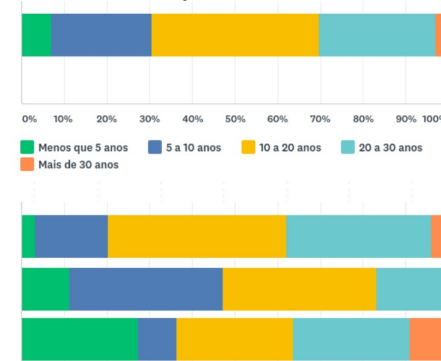
Criteria: gender, age and regional balance,  
high-school physics teachers, extra class  
activities (bonus if particle physics related)

## Answers in 2019 survey:

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

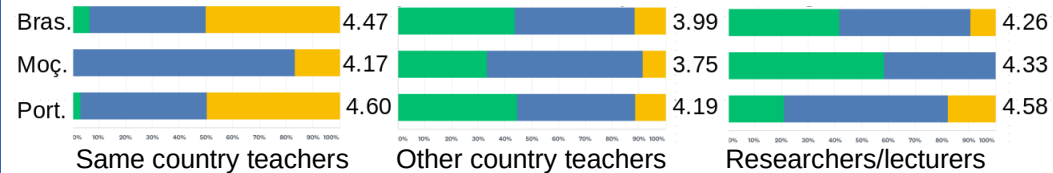
Active in urban public high school  
(with more accumulation in Brazil)

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*



Sunday, 05 Sept 2010 – Friday, 10 Sept 2010

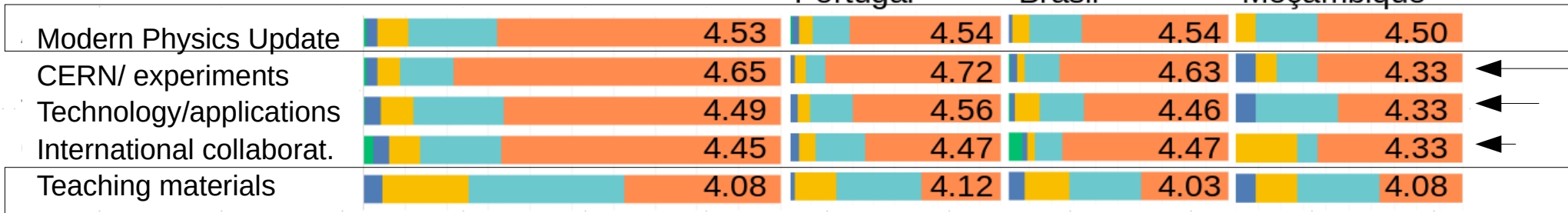
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Rating from very bad (1) to very good (5)

Modern Physics Update 4.53

New teaching materials 4.08

(Very Bad) Medium Very Good



Sunday, 02 Sept 2018 – Friday, 10 Sept 2018

	Dom.	2ª feira	3ª feira	4ª feira	5ª feira	6ª feira
09:00		Particle Detection Basics	Particle physics Intro 1	AMS POOC & CERN control center	Particle physics Intro 3	ECO @ CERN
10:00						
10:30		Data acquisition systems	Particle physics Intro 2	CMS cavern	Particle physics Intro 4	Controlling cool accelerators
11:30		CMS physics	Cosmic Rays	School activities	Impact of the program	Particle Physics and the Universe
12:30						
14:00 To 18:30	Intro to CERN + Error and uncertainty	Visit to SM18, Anti-matter, Data center, LEIR	ATLAS control room, Globe, microcosmos / Cloud Chamber hands-on	Discover Geneva	ATLAS + Masterclasses	Open questions on particles & the Universe
18:30		ATLAS virt. visit, Particle Fever, Q&A		Churrasco Dinner	Geneva Dinner	

Larger asymmetries in importance of:

visiting CERN experiments

talks on Technology and Applications

the examples of International Collaboration

## Very different student / teacher ratio:

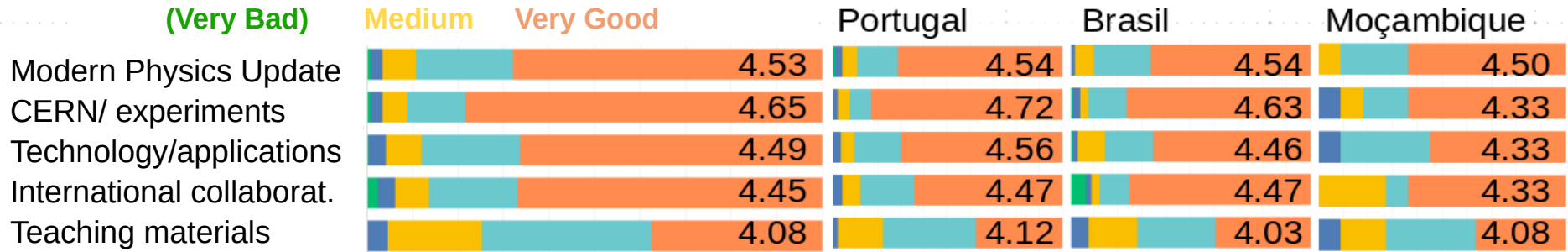
Portugal: 2-4 classes x 20-30 students  
 Brazil: 4-10 classes x 30-45 students  
 Mozamb: 10-15 classes x 50-60 students

## Direct impacts in the classroom

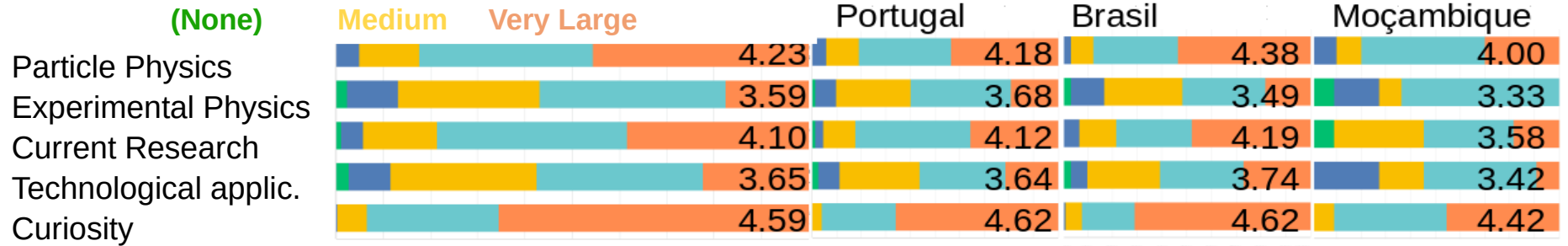
bringing in particle physics (and present day research)

fostering (physics? technology?) curiosity in students

*can we help improve experimental physics in schools?*



\* bad to medium / large



\*

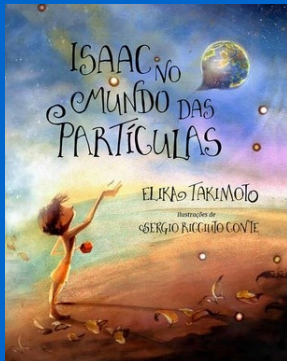
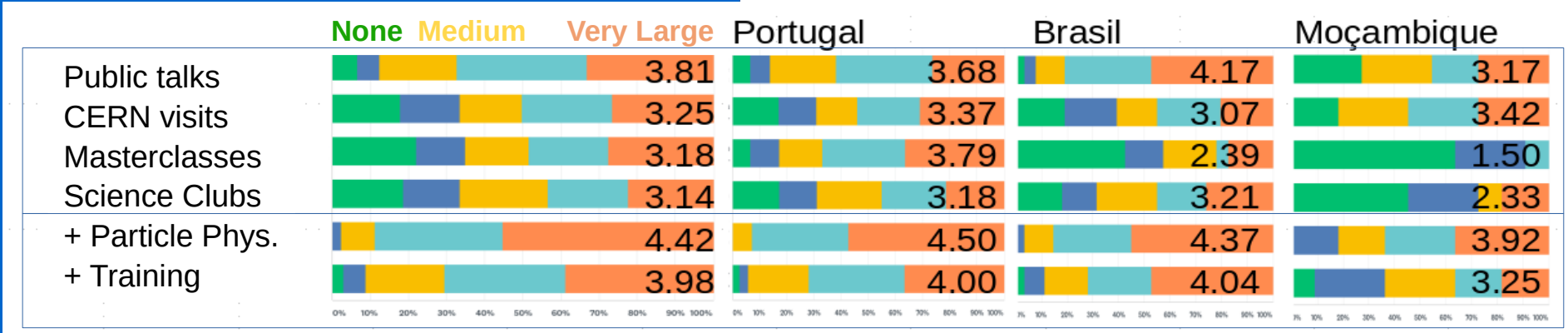


# Impact outside the classroom

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



14 a 18 de janeiro de 2019 no Laboratório Nacional de Luz Síncrotron, Campinas, SP



Bem vindo! Esta é a página da primeira edição da Escola de Síncrotron para Professores do Ensino Médio LNS-SBF que acontecerá entre 14 e 18 de Janeiro de 2019 no Laboratório Nacional de Luz Síncrotron (LNS), em Campinas, SP. A SBF e o LNS oferecem a você a oportunidade de participar de um programa especialmente voltado para professores, no qual você encontrará novas idéias para levar a física moderna para a sala de aula, através da interação com cientistas e imersão na atmosfera de pesquisa de fronteira do LNS. Com duração de 5 dias, a escola terá aulas expositivas, demonstrações computacionais e experimentais, visitas à fonte de luz síncrotron e laboratórios associados, além de discussões com os cientistas. Você também terá oportunidade de fazer contato e trocar experiências com outros colegas professores de todo o Brasil.

# On the teachers themselves:

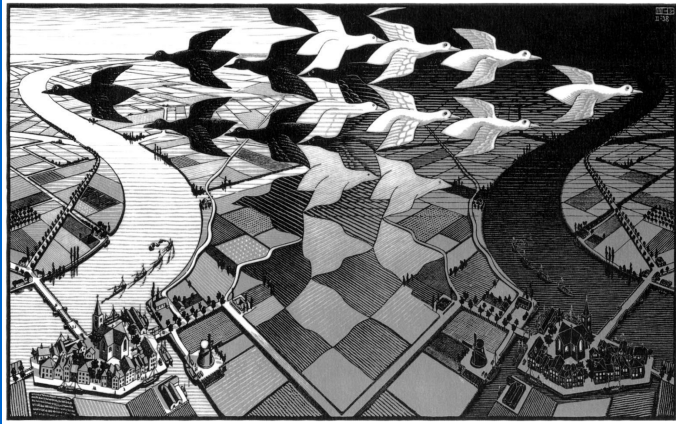
following research updates  
attending new courses  
post-graduate studies

*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

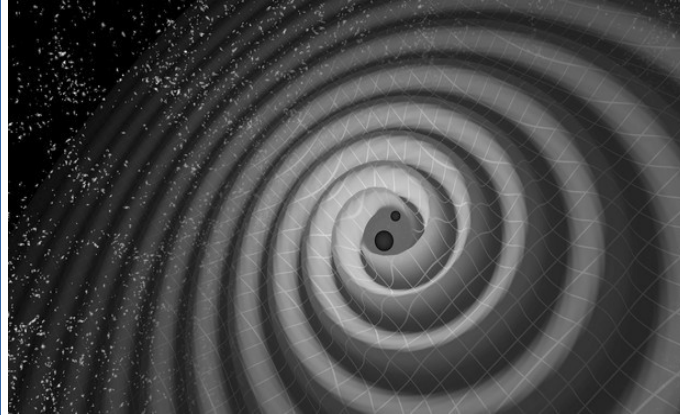
direct contacts with (teacher training) Universities

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)