

TOWARD AN INTEGRATED MUSEUM OF PHYSICS IN PIEDMONT:

**developing the relationship between the Museum of Physics of
the University of Turin and the old Cabinets of Physics of
secondary schools in Turin and Cuneo provinces**

PhD Progress Report

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1.1 History of physics: going back to the (primary) sources

- Historians of physics use a combination of sources for information. However, “*at all stages of their research, primary sources are the most important*” (Duff et al 2004).

Primary source: “a source that stems from the time about which it discloses information and as such has a direct connection with the historical reality” (Kragh 1987)

- Main primary sources addressed in this project are:
 - **archival documents** (e.g. scientific and administrative correspondence, inventories, payment orders, etc.)
 - **printed sources** (e.g. scientific papers, yearbooks)
 - **collections of scientific instruments** (former Physics Cabinets)

1.2 History of physics as a tool for teaching

Relevant research on physics education evidence following reasons
(Matthews 1994,2015, Irzik 2015, Teixeira et al. 2009) :

- promote the **better comprehension** of scientific concepts and methods
- connect the development of individual thinking with the development of scientific ideas
- necessary to understand the nature of science
- by examining the life of scientists and their mistakes, **make physics less abstract and more engaging for students**
- allow **connections with other disciplines**

1.3 Scientific collections and their educational value

- ❖ The collections preserved by University-based physics museums are usually made of instruments originally acquired **for teaching and research.**
- ❖ Yet, the sad state of affairs of most of these collections is that these instruments are by and large unused *neither* in research *nor* in teaching.
- ❖ The science education community is aware of the **educational value of science museums as well as of the advantages of introducing history of science topics into the teaching of science** (Matthews 2015, Bernarduzzi 2014, Filippoupoliti 2014).

**Transform a scientific collection from a tool of research
to a tool of education**

2.1 Museum of Physics



Wataghin Hall

Partially, restyling of the exhibits
in a “didactic point of view”



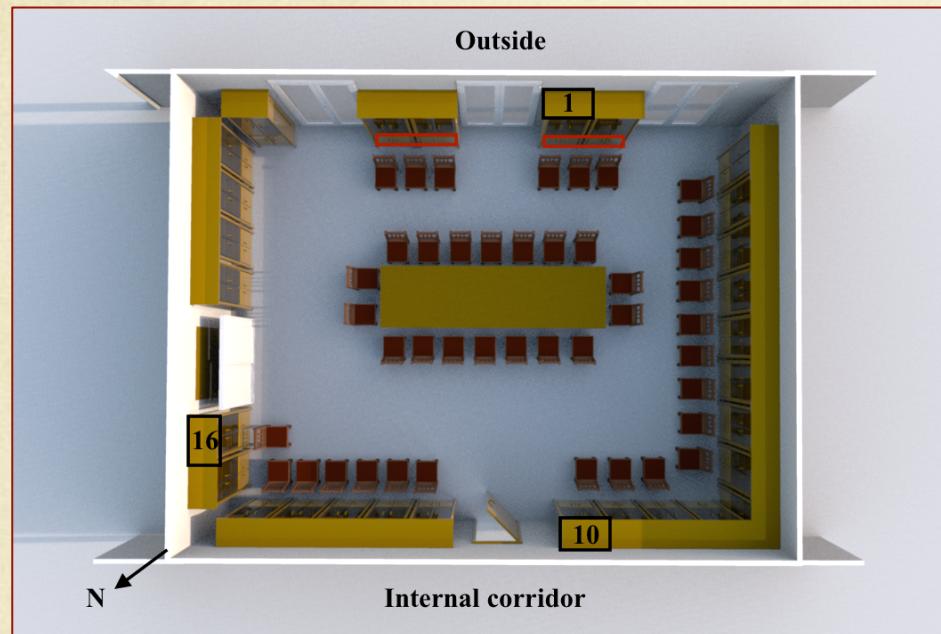
Hallway of the old Institute of Physics

about 1300 instruments

about 45% of them (the most relevant ones) displayed in 23 showcases in the hallways of the **old Institute of Physics** and in 23 showcases in the **Wataghin Hall**

Microclimatic analysis in the Museum of Physics, University of Turin: a case-study , EPJ PLUS, submitted

Ferrarese S., Bertoni D., Dentis V., Gena L., Leone M., and Rinaudo M.



- ✓ Analysis on showcases 1, 10, 16
- ✓ 11 thermo-hygrometers
- ✓ 13 months inside and outside showcases



Historical research

WHAT?

Informations about instruments of museum and reconstruction of the history of Department in XIX century.

WHERE ?

Archive of University of Turin
Archive of city of Turin
Library of Dep. of Physics
Historical library “Grosso”

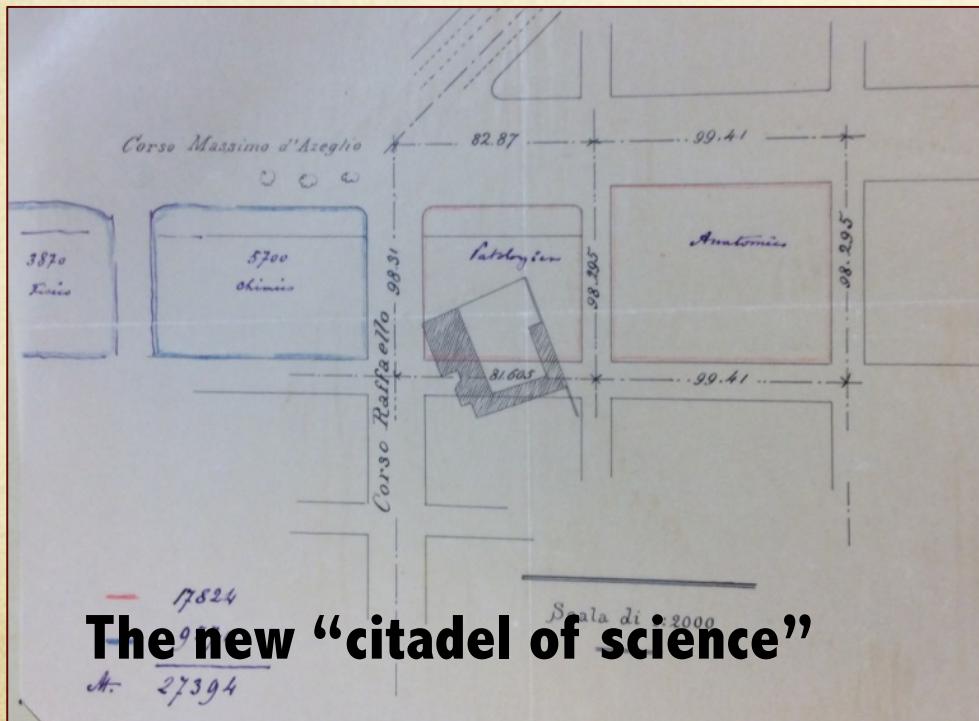
DOCUMENTS

- ✓ About 1200 pages of archival documents gathered
- ✓ About 10^4 archival documents checked
- ✓ Analysis of “yearbooks” of University
- ✓ Inventories of Department of Physics

History of Institute of Physics

1720-1899 : site of the old Cabinet of Physics at Rettorato, street Po

1899-oggi: new site in street Giuria,
before called street Esposizione



Informations about museum instruments

3

Machine Fisiche dell' Abb^o. Nollet
ed altre fatte dal Machinista Francalancia
le quali si trovano nella prima Camera secon
l'ordine delle Scienze.

Inventario delle Machine
di Fisica, di Matematica,
di diverse armi antiche
e di preparazioni
di Miologia.
di fatti esecuti, modelli anatomici
e de cinque Sentimenti
del corpo.

<p style="text-align: center;">96.</p> <p>el S. Francalancia</p>	<p>L. M. Agosto 1758.</p> <p>Sped. mandato al S. Giuseppe Francalancia d' lire trecento - ottantaquattro, e soldi dodici, le quali sono in rimborso d' alzettature da lui spese per uso delle spettacole fisiche fatta dal P. Beccaria pendente l' ora scorsa anno scolastico, come risulta dall' asseatura sua Lira sotto scritta dello stesso D. Beccaria, avviata dall' 1. Marzo.</p> <p>2. Prospettiva Riformata</p> <p>Chemod. Gen. 2. Lira (-)</p>
	<p>388.12.</p> <p> Listo delle Spese e Lavori fatti per uso dell' Esperienze fisiche nel corso dell' anno 1757 e 1758. D'ordine del P. Beccaria Professore di tal Cattedra e come segue. P: per i Cabasini per far girar la ruota della Machina Elletrica per tre mattinate nel teatro notomico in tempo delle Esperienze L. 1: 10: Per aver fatto una Chiave di ferro per formar le viti delle collette della ruota di d' st: macchina, e fatto due tute quadrate alle suet viti L. 2: 10: Per sforzare coiana ader L. = 6: Per sali diversi buono = 10: Salvi diversi buono 5: </p>

“....d'ordine del P. Beccaria Professore di tal cattedra e,
come segue, P : per i Cabasini per far girar la ruota
della Machina Elletrica per tre mattinate nel teatro
Notomico in tempo delle Esperienze” (1758)

2.2 Census of the historical scientific collections of schools in Piedmont

Collaborative effort between **Museum of Physics** of the University of Turin and the **old Cabinets of Physics** of a significant sample of secondary schools in Turin and Cuneo provinces



We hope that this effort will serve as a catalyst to the rescue, preservation and diffusion of the scientific heritage and can play a seminal role in **transforming dusty scientific instruments into tools of education**

- **Seventeen** 19th century **classical lyceums** and **gymnasiums** preserving significant collections of scientific instruments that were formerly part of the *old Cabinets of Physics*
- Classical lyceums are the oldest schools, so we have more probability to find significant scientific collections

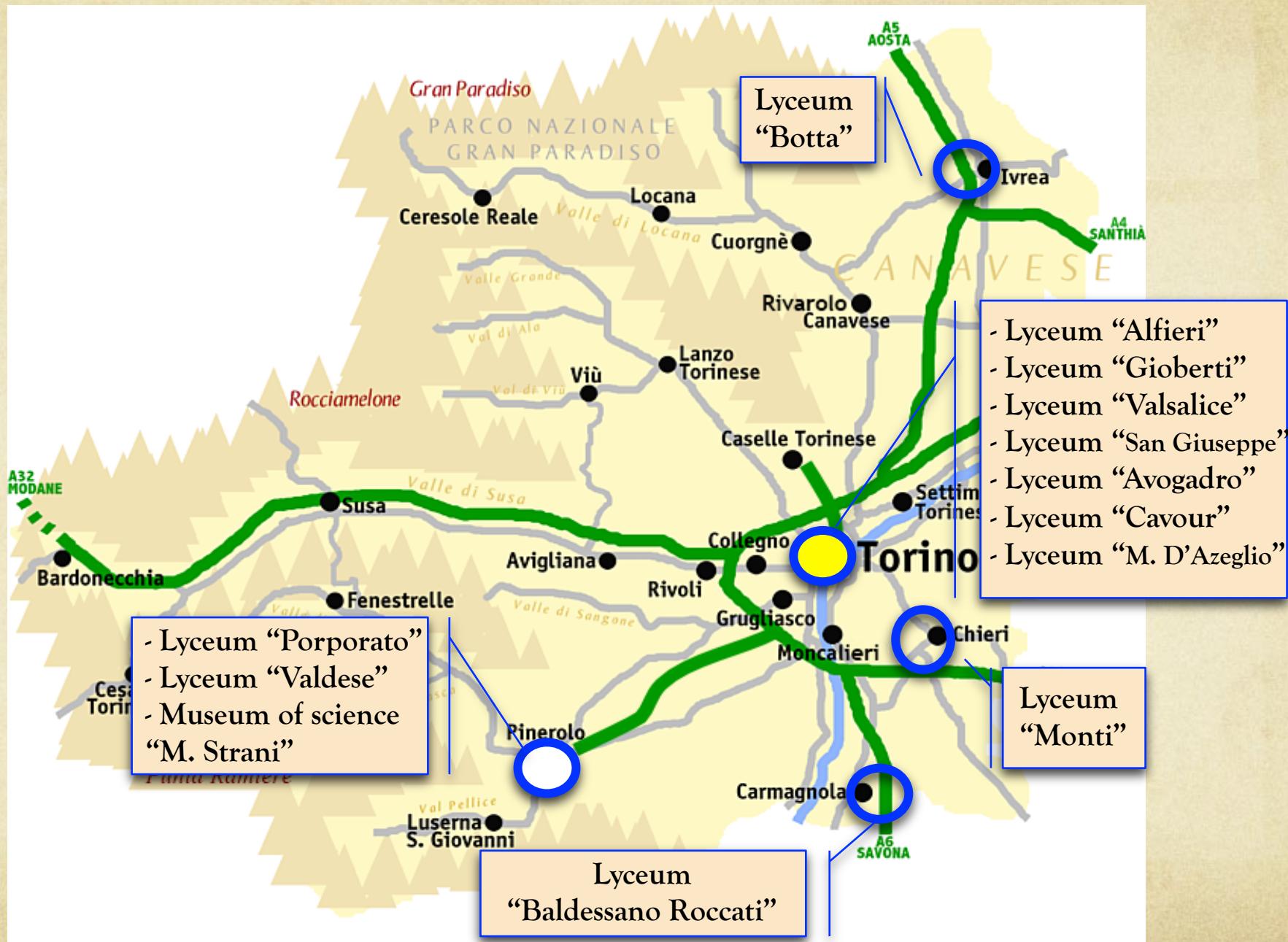
Schools already visited : 12

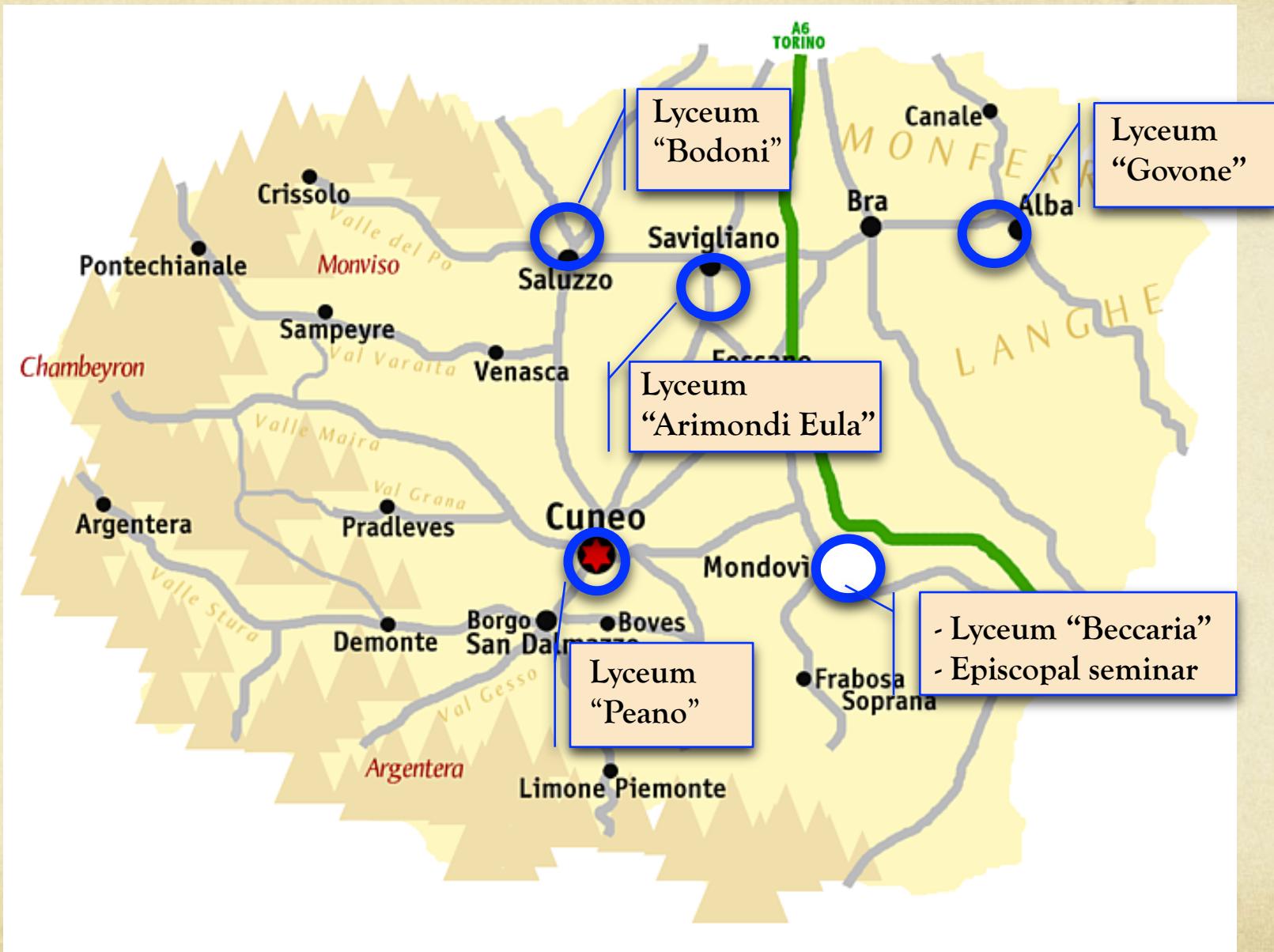
Schools missing : 5

Teachers involved : 20



Museum of the Lyceum "Vasco-Govone-Beccaria" in Mondovì



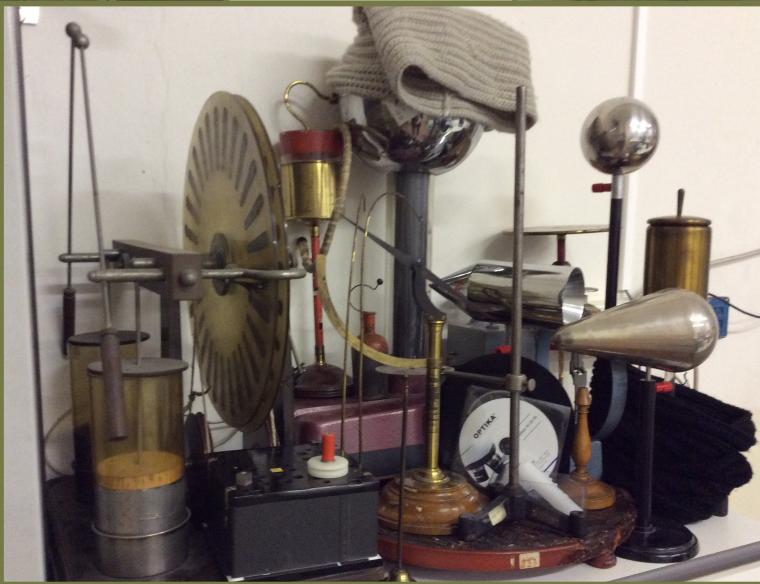


State of the art of school scientific collections: a varied landscape

Until now, we have found the following types of schools' collections:

1. Instruments **stored in boxes** in school closets and no longer used
2. Instruments stacked in furniture or shelves in the laboratory,
without cataloging or paying attention to the exhibition
3. Instruments **in part exposed** in showcases and sometimes shown during lessons
4. **Real school museum**, open to visitors, at fixed times

STATUS OF RESEARCH



After the first contact with the school, we propose the collaboration:

- for educational activities in their laboratory or at Museum of Physics
- and / or historical research on their instruments.

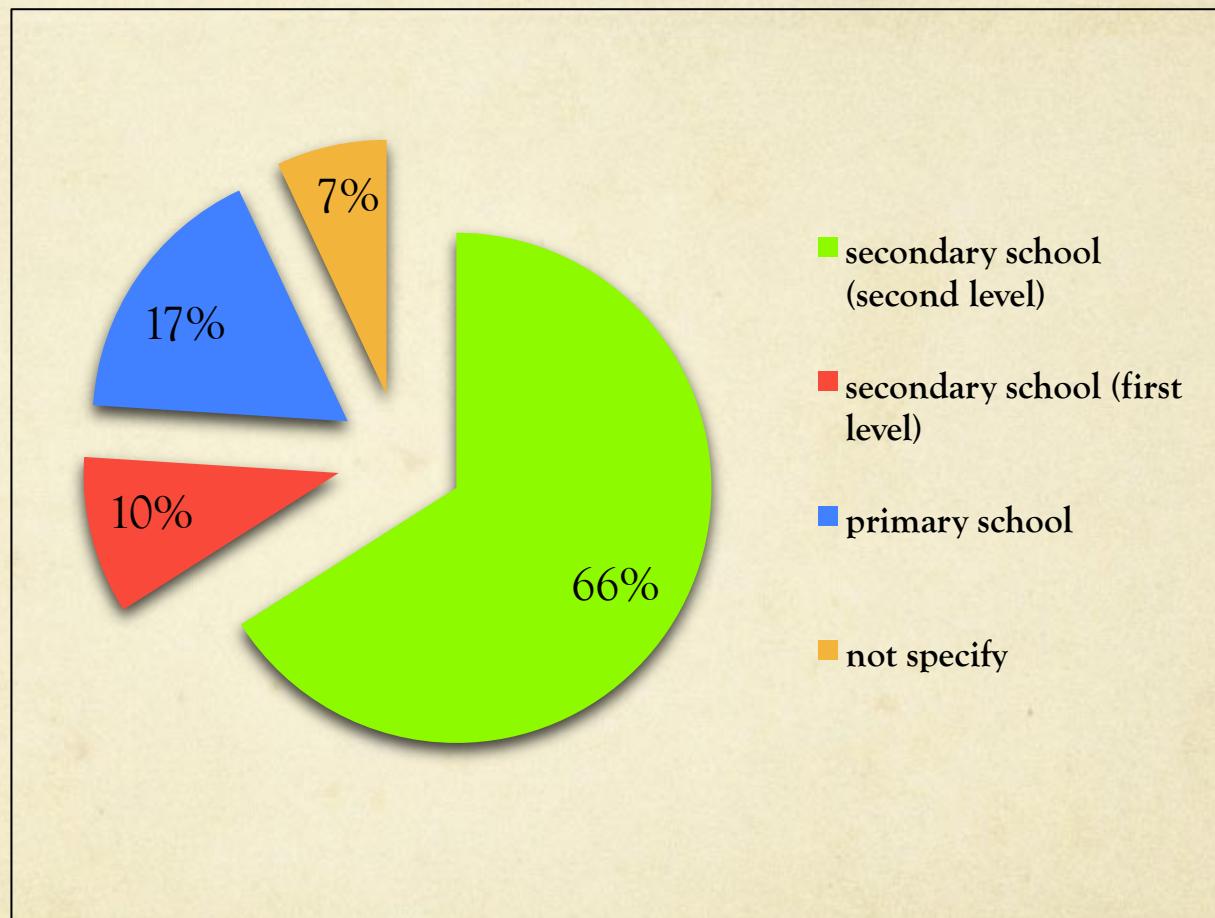
2.3 Designing and testing educational activities based on the historical scientific collections

- **questionnaire on the historical approach** administered to the (mainly) secondary school in-service teachers participating to training seminars in physics education organized by the Univ. Turin
- **training seminars for teachers** with design of *hands-on* activities with *low-cost* materials *inspired* on the *historical instruments displayed* in the Museum of Physics
- **educational activities for classes** (mainly secondary school level): *hands-on* activities + *guided tour* of the Museum

Questionnaire on the historical approach

Objective: investigate the motivations that drive (or discourage) the choice to use the historical approach to introducing scientific themes and concepts

Sample:
160 TEACHERS



“It is helpful to bring a historical approach to normal disciplinary teaching because ...”

- ✓ Contextualize discoveries and scientific evolution (42)
- ✓ Motivate students (6)
- ✓ Show wrong theory and mistakes (5)
- ✓ Links with other subjects (5)
- ✓ Link between history and human tought development (2)
- ✓ Link between theory and practice (1)

“It is NOT helpful to bring a historical approach to normal disciplinary teaching because ...”

1	2	3	4	5
Complete disagreement	disagreement	Indefinite	agreement	Perfect agreement

	Mean value
Because I do not have the preparation	2,1
Because I do not consider it to be a significant factor	1,7
Because it would take time	2,3
Because some of the reasons given in the past are complex and contorted, risking complicating the understanding of the phenomenon	2,6

Training seminars for teachers

After the analysis of the questionnaires and the dialogue with some teachers we have proposed training seminars.

Storia della Física e allestimento del museo scolastico

Matteo Leone

Dipartimento di Filosofia e Scienze dell'Educazione, Università di Torino

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Dipartimento di Fisica, Università di Torino

UTILIZZO DELLA STORIA DELLA FÍSICA IN DIDATTICA

Matteo Leone

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- ✓ Set up and organization of a school museum

- ✓ How to prepare a didactic activity using an historical approach

- ✓ Analysis of students' prior knowledge

Educational activities

In recent years, attempts at reversing this state of affairs carried out at the Department of Physics of the University of Turin as a part of the orientation initiatives for high school students.

- ✓ **HANDS-ON ACTIVITIES** using artifacts inspired on historical devices (electrostatics, optics)
- ✓ **GUIDED TOUR** of Physics Museum where the original instruments are displayed
- ✓ The active learning activities and guided tours are designed to provide us a **better insight** into student's prior knowledge and to promote a better understanding of physical sciences

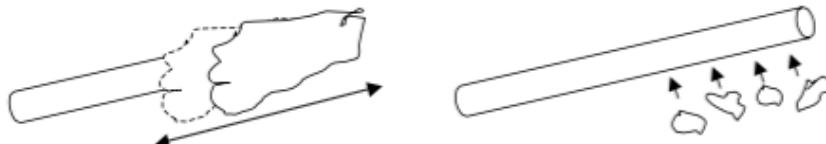
Example of student's mental representations

A look at the evidence provided by a pre-test submitted to upper secondary school students and partly designed on the basis of the historical evolution of electrostatics

Data di nascita Scuola

Museo di Fisica – Università di Torino

1. Una barretta di plastica viene strofinata ripetutamente con un panno di lana. Dopo aver avvicinato la penna a dei pezzettini di carta osserviamo che i pezzettini vanno ad attaccarsi alla penna.



Cosa pensi delle seguenti affermazioni? Ognuna di esse può essere vera o falsa.

I pezzettini di carta esercitano un'attrazione nei confronti della barra

Motivazione:

.....

L'attrazione della carta è causata dal riscaldamento prodotto con lo strofinio

Motivazione:

.....

Dopo lo strofinio ai lati estremi della barretta ci sono cariche elettriche di segno opposto

Motivazione:

.....

Dopo lo strofinio su barretta e panno ci sono cariche elettriche di segno opposto

Motivazione:

.....

Publications

- Rinaudo M., Biglio A., Borello L., *Percorso didattico sui fluidi: esperienze in laboratorio*, Atti del convegno Di.Fi.Ma. 2017, ISBN 978-88-99781-37-8
- Rinaudo M., Leone M., Amoroso A., Marocchi D., *Il Museo: strumento di didattica della Fisica?*, Atti del convegno Di.Fi.Ma. 2017, ISBN 978-88-99781-37-8
- Marocchi D., Serio M., Rinaudo M., *Best practices for a good laboratory experience*, Conference proceeding GIREP 2016, ISBN 978-83-945937-4-2
- Amoroso A., Rinaudo M., *Study of oscillatory motion using smartphone and Tracker software*, Conference proceeding GIREP 2016, ISBN 978-83-945937-4-2
- Rinaudo M., Leone M., Amoroso A., Marocchi D., *The dust catcher: discovering the educational value of the historical-scientific heritage*, GIREP 2017 selected paper for Springer, submitted
- Ferrarese S., Bertoni D., Dentis V., Gena L., Leone M., Rinaudo M., Microclimatic analysis in the Museum of Physics, University of Turin: a case-study, EPJ PLUS, submitted

Talks and poster

- July 2018: talk in **GIREP 2018** (Groupe International de Recherche sur l'Enseignement de la Physique) title: “The educational role of a scientific museum: a case study”
- February 2018: talk in **AIAR** (Associazione Italiana di Archeometria) title: “Microclimate analysis in a scientific museum:the case study of the Physics Museum of Turin University”
- October 2017: talk in **DIFIMA 2017** (title: “Il museo: strumento di didattica della Fisica?”)
- October 2017: poster in **ANMS** (National Association of Scientific Museums) title: «Verso un museo diffuso di Fisica in Piemonte»
- July 2017: talk in **GIREP 2017** (title: “The dust catcher: discovering the educational value of the historical-scientific heritage»)
- October 2016: poster in **YRM** (7th Young Researcher Meeting) title: “Learning from experimental activities (for secondary level school)”

3.1 Future work

- ✓ **Complete the historical analysis of primary sources** about history of Institute and of instruments of the Museum
- ✓ **Surveying the collection of the Museum of Physics** and restyling of the exhibits in a “didactic point of view”
- ✓ **Complete the census** of historical scientific collections of schools in Piedmont (5 schools missing)
- ✓ **Prepare educational courses in collaboration with the teachers**

Prepare educational courses in collaboration with the teachers based on the equipment present in the school:

- Preparation of pre-test
- Analysis of students' prior knowledge on the concept/theory chosen
- Experimental activity in groups to understand the evolution of instrument or theory, taking into account mistakes
- Valorize schools' collections and, if it is possible, cataloguing and making historical research

Planned activities

To evaluate the educational value of an historical approach, different schools and different types and ages of students have been involved.

- ❖ Lyceum Gioberti : 11 classes of 4° and 5° years with activities about electrostatic and fluids (7 teachers involved)
- ❖ Lyceum San Giuseppe : 1 class of 3° year and peer education activities for secondary school (first level) students
- ❖ Lyceum Valsalice : planning activities with 2 teachers
- ❖ Lyceum Alfieri : 1 class with activities about mechanics

*Thank you
for
your attention !!!!!*