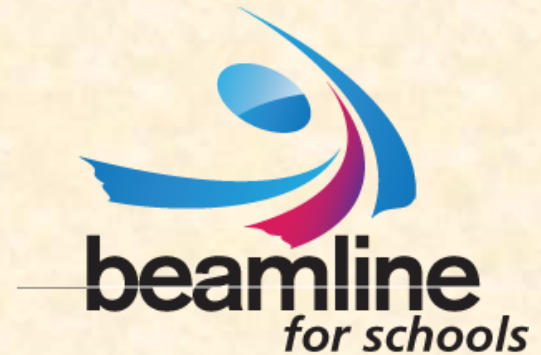


Beamline for Schools

an global competition to win beam time at CERN



Motivation



The best way of **learning** is to involve **experience**

Idea of the Beamline for Schools competition: **pupils become scientists**

Idea

- **Worldwide competition** among schools for beam time at CERN
- Teams phrase **scientific question** for an **experiment** which uses a **particle beam**
 - Written proposal (max. **1000 words**)
 - 1 minute video
- **Students** should “**drive**” the team
 - **Teachers** and external **experts** may give **guidance**
- A scientific committee at CERN selects two proposals
 - **Feasibility** of the proposal is important
- Student teams come to CERN to do their experiment
- Teams **write up results** (if possible results are published)



As close as possible
to real science life

Supported by CERN

- CERN **management** supports the project
- Many people at CERN are **enthusiastic** to help
- Boundary conditions:
 - Experimental areas and beam time at CERN extremely precious
 - The PS and its T9 experimental area is the only viable option

Supported by donators

- **2014**
 - Danfysik (constructor of accelerators)
 - National Instruments (Electronics)
- **2015**
 - Motorola Solutions Foundation
 - National Instruments (Electronics)
 - Ernest Solvay fund, managed by the King Baudouin Foundation
- **2016**
 - Alcoa foundation
 - Motorola Solutions Foundation
 - National Instruments (Electronics)
 - Ernest Solvay fund, managed by the King Baudouin Foundation
- **2017**
 - Alcoa foundation

Success factors

- **Motivated teachers**
 - Yes, it takes time on top of the their teaching duties.....
 - The teacher (team coach) may have to educate himself
- Good **documentation**
 - Complete and comprehensible but not too long
- **Publicity**
 - World wide there are 480 million students of the right age.....
- Good **communication**
 - **BL4S** is not for privileged schools but **for everyone**
- Attractive **prizes**
 - Invitation to CERN
 - Particle detectors for the school (<http://cosmicpi.org>)



Statistics

	2014	2015	2016
Full proposals	292 from 50 countries	119 from 28 countries	151 from 37 countries

- In total ~5500 students have participated since 2014
- 2/3 boys, 1/3 girls
- 1/3 from non member states
- Teams spend on average 25 hours on making their proposal
 - Short listed teams spend 40-50 hours (effort pays out)

T9 Beam line @ PS East Area



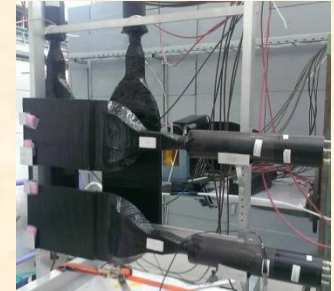
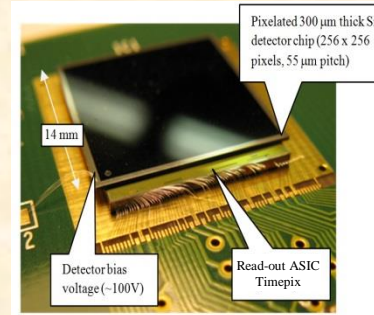
PS East Area

- typical CERN beam line
- excellent experimental conditions and reliable performance

The building blocks: Detectors, magnets, DAQ system

Detectors:

- **Scintillator**
 - 6 available (more if needed)
 - Trigger
 - Halo detector
- **Cherenkov**
 - Particle identification
- **Delay wire chamber**
 - Tracking
- **Timepix**
 - Small (2x2 cm), high resolution tracking and energy measurement
- **Lead Crystal Calorimeter**
 - 20 elements
- **Multi-gap Resistive Plate Chamber**
 - Precise time of flight measurement



Data Acquisition:

- Based on the S/W used by ATLAS
- Capable of recording 1000-5000 events per second
- On-line monitoring and histograms

Magnets:

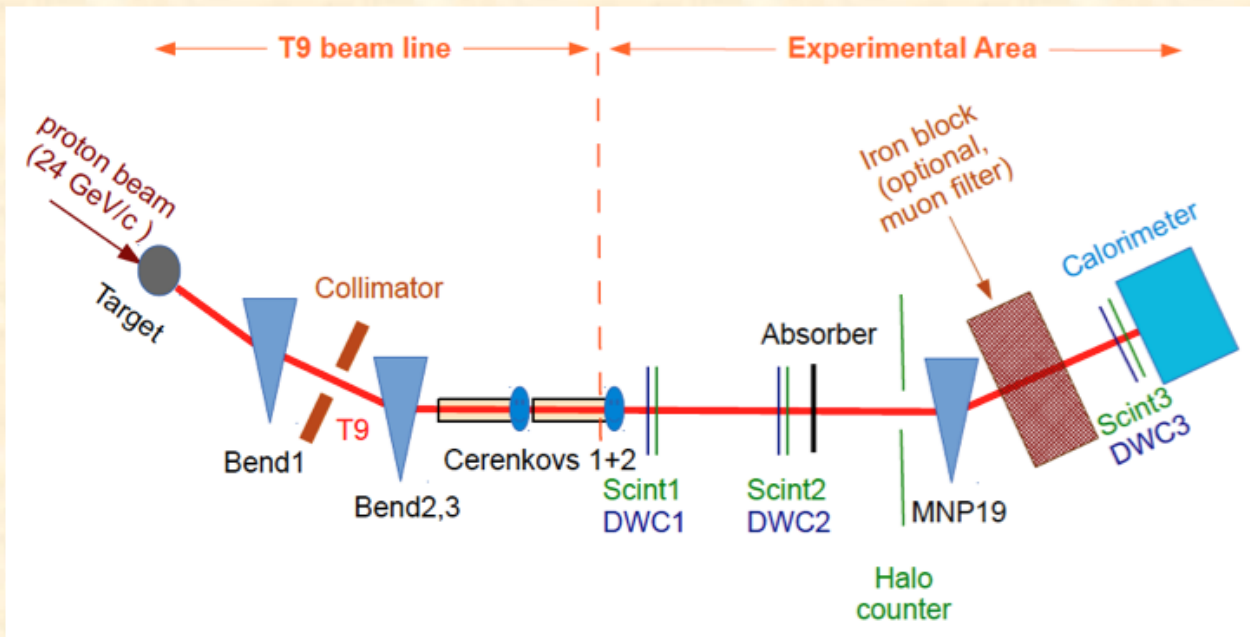
- Several types of magnets available for separating particles

Absorbers:

- Iron blocks to absorb all particles but muons

An example experiment

Experiment to determine particle composition of the beam before and after an absorber (e.g. to study impact of particles on body tissue/materials...)



All equipment shown including data acquisition system is available for the teams!

- Changes of the setup allow for many other experiments
- Example experiment should be used to explain available beam line, detectors and instrumentation

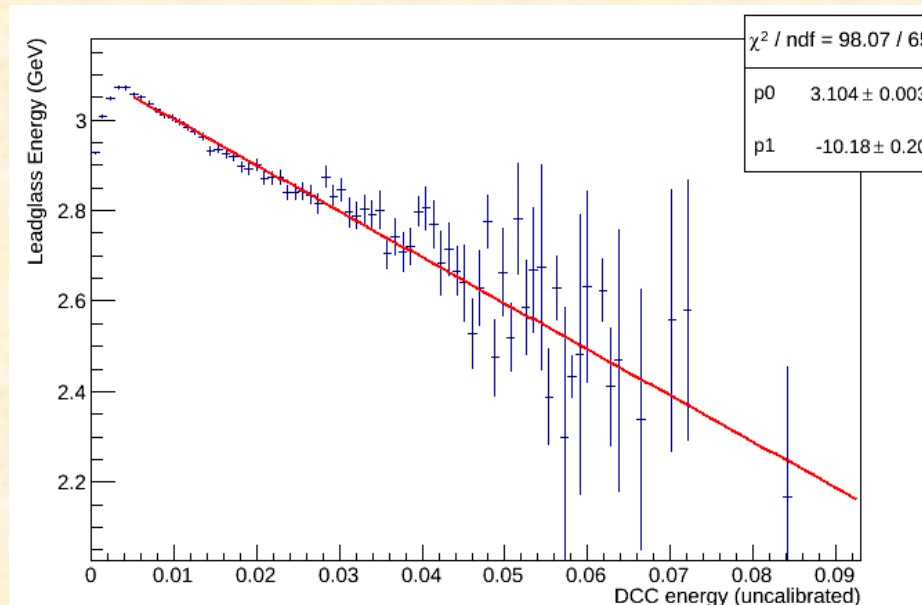
BL4S behind the scenes

- A large number of CERN **volunteers** are helping at different levels
 - **Two full-time support scientists** (PhD / postdoc) are paid from February to October
 - ~40 experts for the pre-evaluation of the proposals
 - ~5 scientists from the SPSC committee for the selection of the winners
 - 2 people for administrative help (part time)
 - ~10 colleagues are organizing a full day **safety training**
 - Lots of other volunteers
- BL4S is one of the main projects of the **CERN & Society foundation**
 - Mission: Education and outreach, innovation and knowledge exchange, culture and creativity
 - <https://giving.web.cern.ch/content/cern-society-foundation>

BL4S - Impact

Difficult to quantify but we know that:

- Teams spent **several 10 hours** on making the proposal (and they do this **self motivated**)
 - Many teams contact us with partially **sophisticated questions**
- Many schools are **participating every year**
- Teachers tell us that BL4S nicely **complements the curriculum**
- One winner team from 2014 has worked on a **scientific paper** for almost 2 years
- One winner team spent their summer vacation learning C and root
- Winner teams make it to the local news (newspapers, regional TV)
- INFN (Italy) provides **additional opportunities** to their short listed teams



Compared: the energy deposited in the BL4S lead-glass calorimeter (vertical) to the DCC energy (horizontal).

Thank you for your attention



...any questions??

Bonus slides

Documentation and support

The students teams get several **documents**:

- A **description** of the beam and the detectors (12 pages)
- 8 – 10 **example experiments**
- The **winner proposals** of the previous years

The teams can get in touch with **professional physicists**:

- Members of **IPPOG**
- Members of **the BL4S team**
- Additional **volunteers**

<http://beamline-for-schools.web.cern.ch/useful-documents>

<http://beamline-for-schools.web.cern.ch/contact>

BL4S in 2014: The winners

**“Odysseus’ Comrades” from Greece and
“Dominicuscollege” from the Netherlands**

A BEAM LINE FOR SCHOOLS AND A NATURE'S PREFERENCE



0:00 / 0:59

YouTube



CERN competition: a beam line for schools Domin...



0:00 / 1:00

YouTube



http://www.youtube.com/watch?feature=player_embedded&v=ula_s1fsB7oext

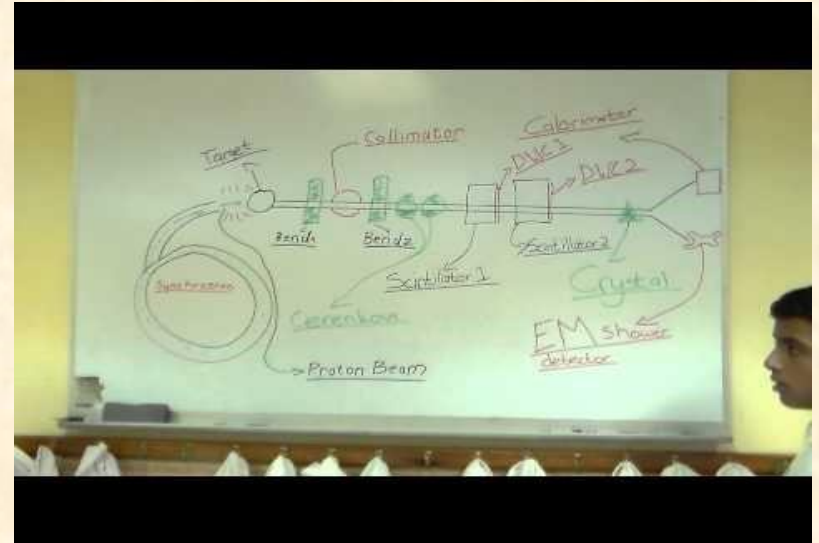
https://www.youtube.com/watch?feature=player_embedded&v=GvDOxH18wNM

The winners of 2015

“Leo4G” from Italy and
“Accelerating Africa” from South Africa



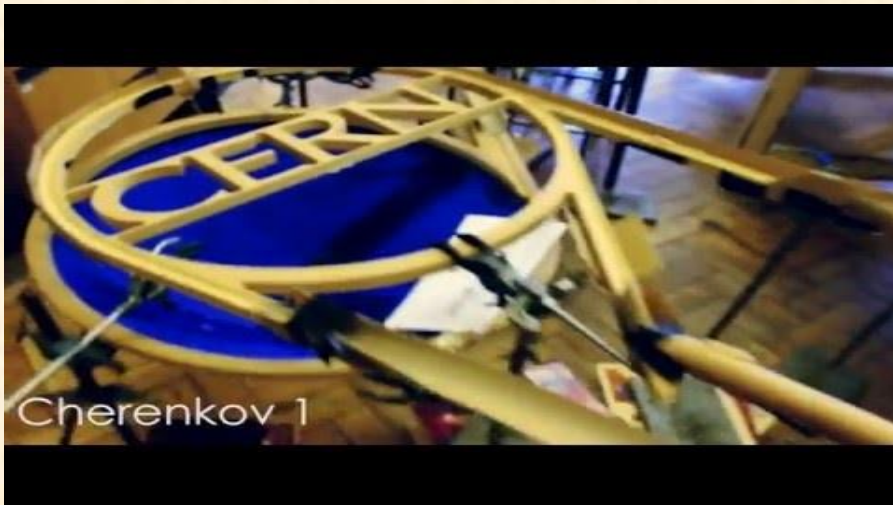
<http://youtu.be/46b3eMB274U>



<http://youtu.be/1bRnuciYZU>

The winners of 2016

**“Pyramid hunters” from Poland and
“Relatively special” from the UK**



<https://www.youtube.com/watch?v=fIKV8dvIM10>

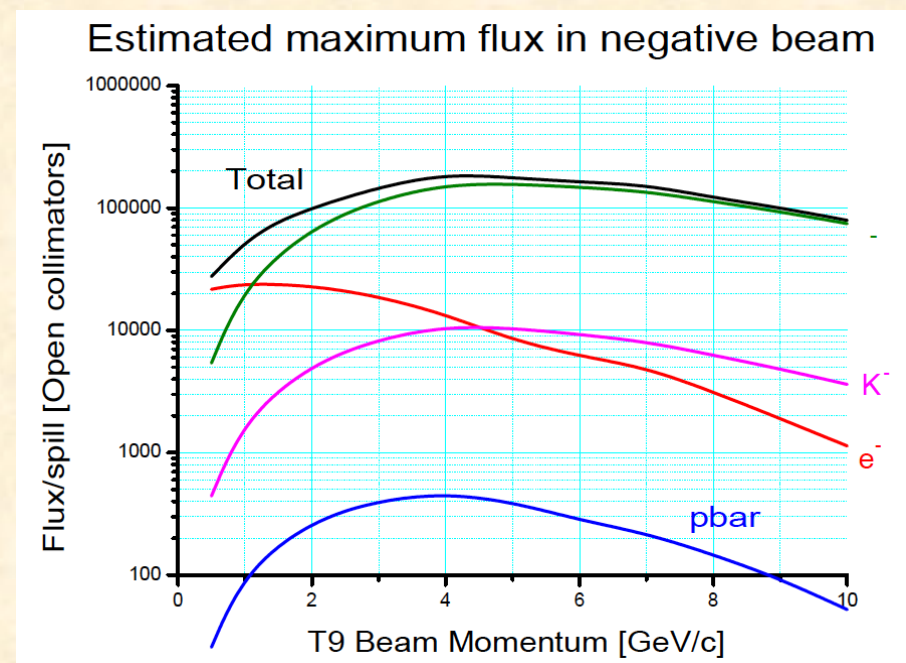
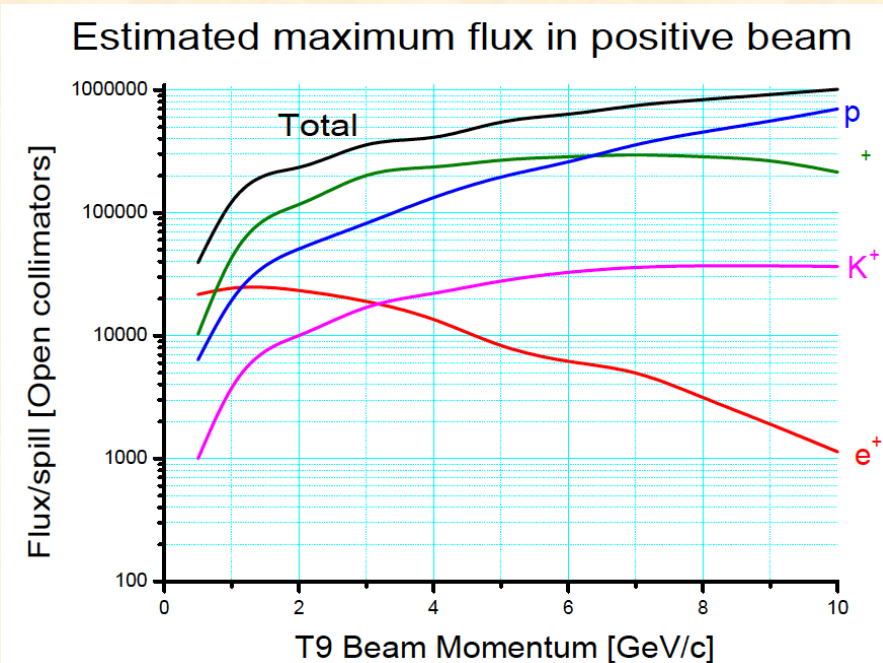
<https://youtu.be/fp4FOYXjsUs>

T9 Beam parameters

Particle **momentum**: 0.5 - 10 GeV/c

Main **Target**: Made of 20 cm beryllium, followed by 3 mm of tungsten
(target composition has only a small effect on the beam composition)

Particles: protons, electrons, (decay) muons, pions, kaons (as well as their anti particles)



One spill of 0.4 ms every ~20 seconds