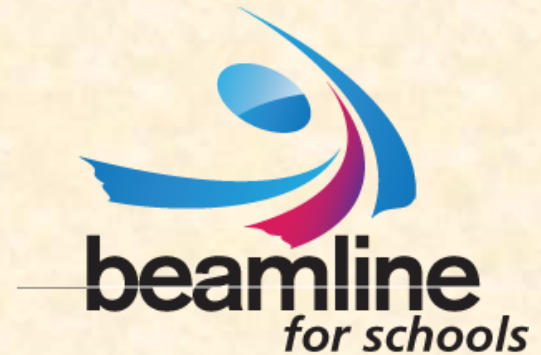


BeamLine for Schools

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: **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** and write a proposal
 - Step 1: “Letter of Intend” (=registration of team)
 - Step 2: “Proposal” (**1000 words** plus **1 minute video**)
- **Students** should “**drive**” the team
 - **Teachers** and external **experts** should give **guidance**
- A scientific committee selects best proposals
 - SPS and PS experiment committee (SPSC) decides which experiment(s) win(s) one week of beam time at the CERN PS accelerator
 - **Feasibility** of the proposal is important
- Student team(s) come(s) to CERN to do their experiment
 - Preparation and execution in close collaboration with **CERN scientists**
- Team(s) **write(s) up results** (if possible results are published)

As close as possible
to real science life

Supported by CERN

- CERN management and departments in favour...
- ...all people at CERN enthusiastic to help...
- Boundary conditions:
 - Experimental areas and beam time at CERN extremely precious
 - PS and its T9 experimental area is the only viable option

Supported by donators

- 2014
 - Danfysik (constructor of accelerators)
 - National Instruments (Electronics)
- 2015
 - Ernest Solvay fund, managed by the King Baudouin Foundation
 - Motorola Solutions Foundation
 - Maybe more....
- 2016++
 - In discussions with several companies & foundations

T9 Beam line @ PS East Area



PS East Area

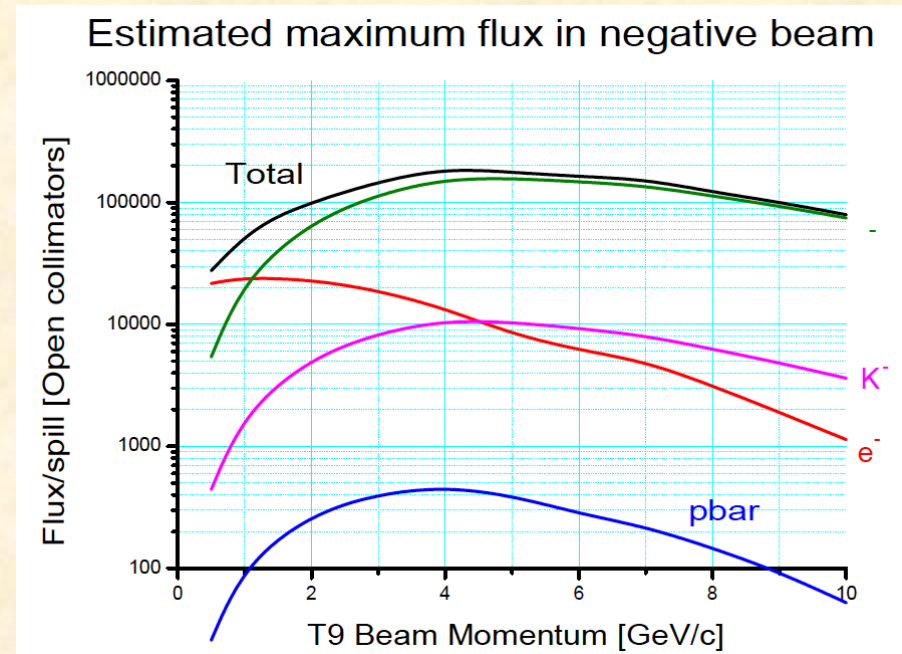
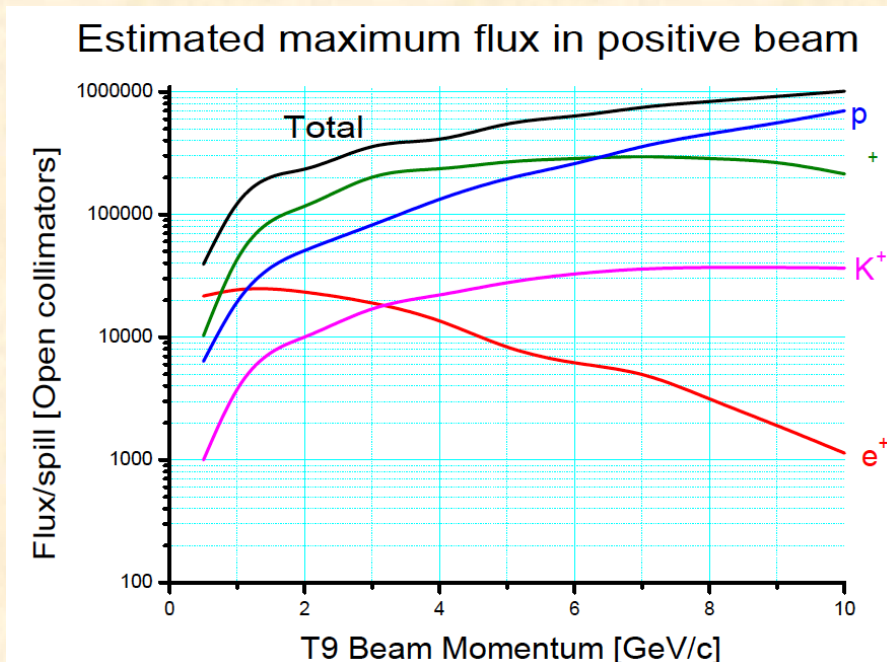
- typical CERN beam line
- easy access (and close to Restaurant 1)
- excellent experimental conditions and reliable performance

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)

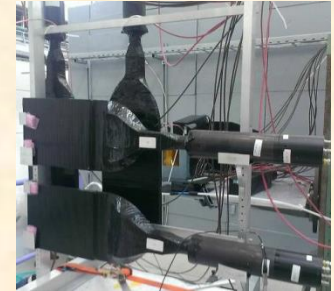
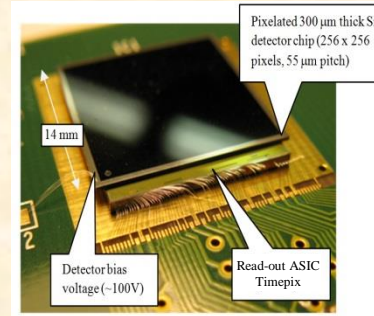
Particles: protons, electrons, muons, pions, kaons (as well as anti particles)



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
- **Straw detector**
 - Large area (1x1 m) tracking
- **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:

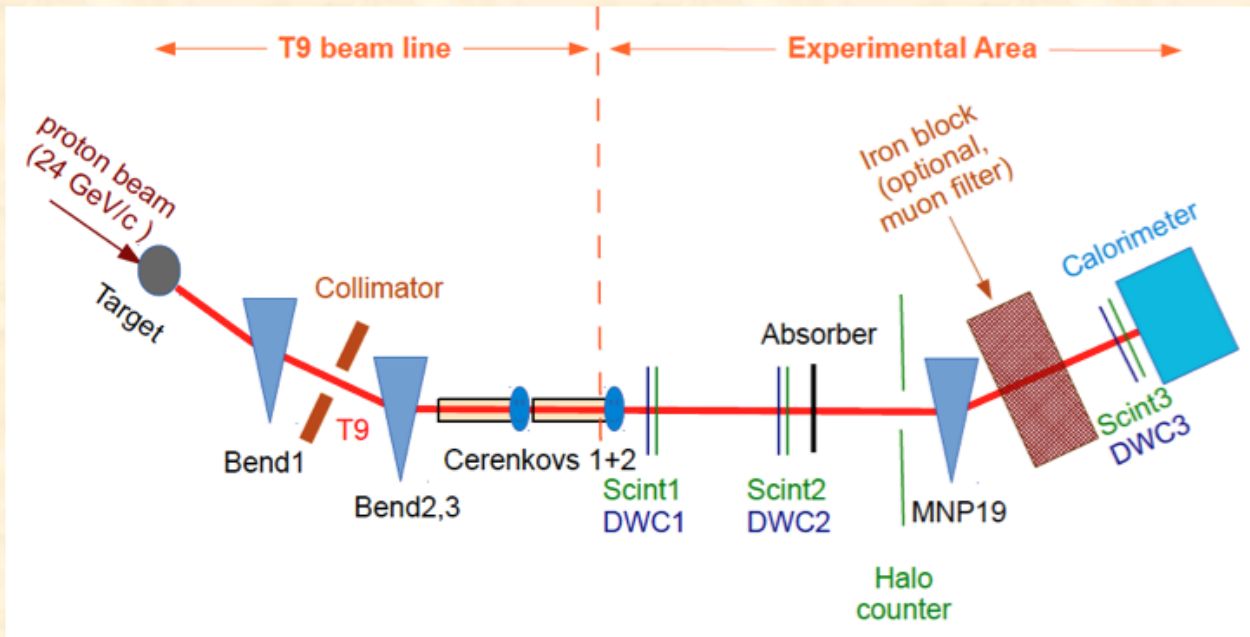
- Several types of magnets available for separating particles

Absorbers:

- Concrete block 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 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

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

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



0:00 / 1:00

YouTube

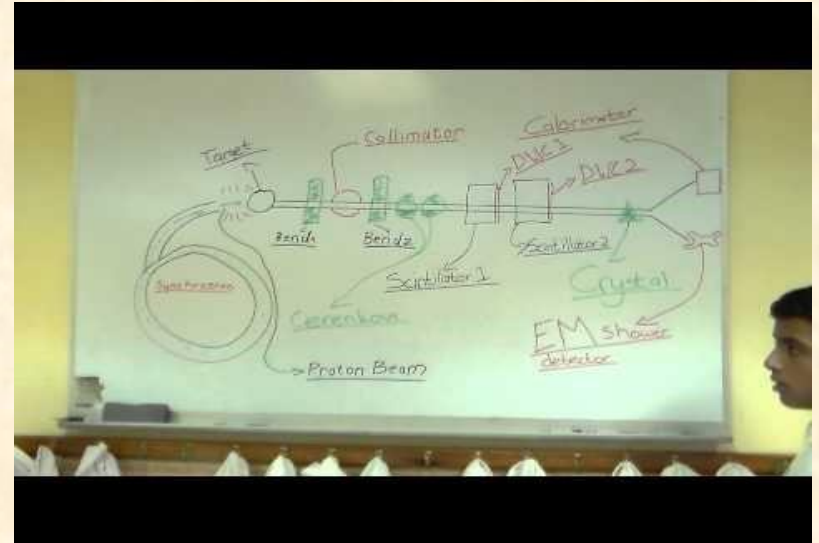
https://www.youtube.com/watch?feature=player_embedded&v=GvDOxH18wNM

The winners of 2015

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



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



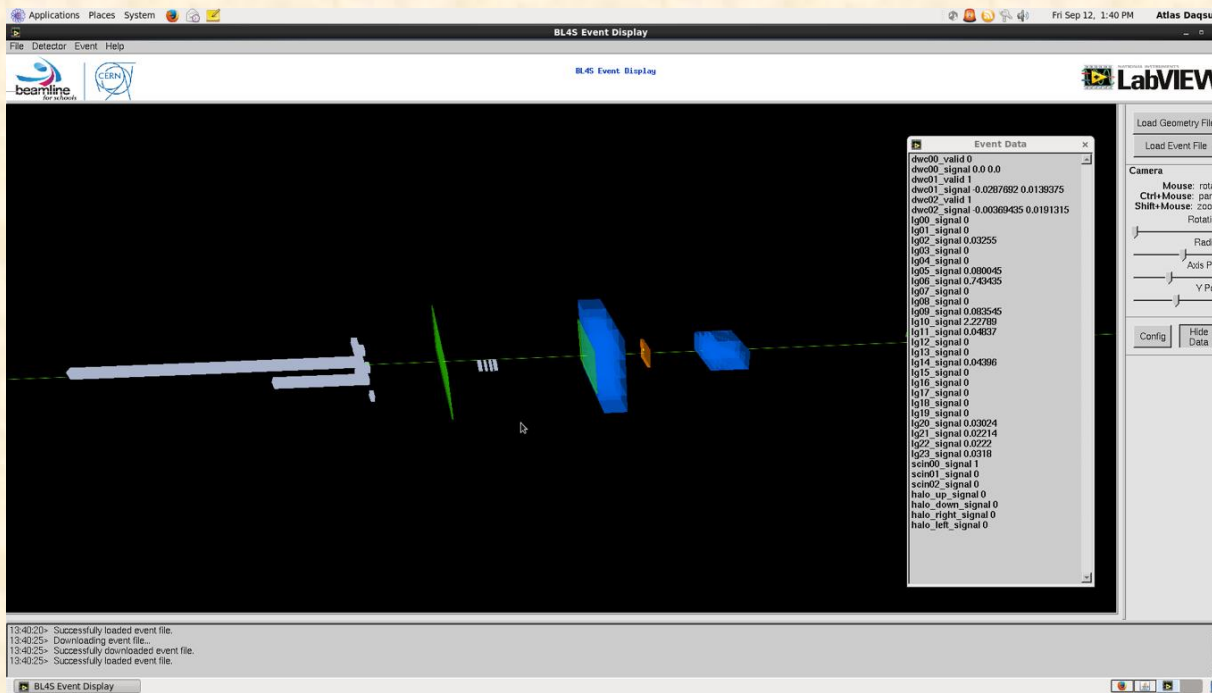
<http://youtu.be/1bRnuciYZU>

Teams at CERN, 7.9.-17.9.2014



BL4S in 2014: Excellent preparation

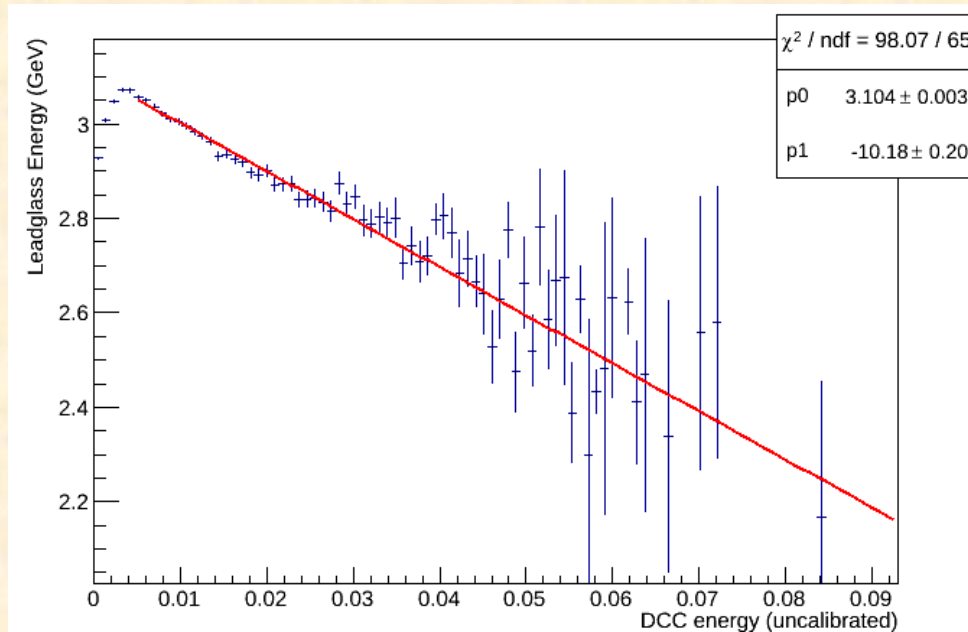
- **Two full-time support scientists** (PhD / postdoc) were hired from February to October
- **15-20 volunteers** (mostly CERN staff) provided their help



Event display: Signal in the Dominicuscollege Calorimeter

BL4S in 2014: Calorimeter works very well!

Tested: the home-made Dominicanus College Calorimeters (DCC) in front of the OPAL lead-glass calorimeters. The DCC consists of KDP crystals that the students were able to grow themselves. A total of 8 such crystals are placed in 2 rows of 4, one of such rows directly in the beam. The example plot shows that the calorimeters are able to measure energy and distinguish electrons from MIPS.



Compared: the energy deposited in the OPAL lead-glass calorimeter (vertical) to the DCC energy (horizontal). When there is energy deposited in the DCC there should be less energy in the LGC. This is indeed the case for 4 GeV electrons as shown. The plot is actually used to get the proper calibration for the DCC.

Statistics

	2014	2015
Letters of intent	455 from 60 countries	215 from 40 countries
Full proposals	292 from 50 countries	119 from 28 countries

- 2014: Very high participation due to
 - Novelty of the competition
 - Link to “CERN 60” celebrations
- 2015
 - 54 (of 119) proposals from schools that have participated in 2014

In total ~4000 students have participated in 2014 & 2015

More statistics

Country	Submissions 2014 + 2015
E.g.: Japan, Pakistan, Nigeria, Bangladesh	0
Australia, Austria, Bahrain, Bangladesh, Belgium, Bulgaria, Chile, Czech Republic, Estonia, Ethiopia, Indonesia, Jordan, Kenya, Lebanon, Malaysia, Malta, Mauritius, New Zealand, Oman, Philippines, Qatar, Sri Lanka, Sweden, Tunisia, United Arab Emirates	1
Brazil, China, Finland, Ireland, Israel, Norway, Slovenia	2
Colombia, Mexico, Russia, South Africa, Thailand	3
France, Hungary, Iran, Slovakia, Switzerland	4
Singapore	5
Serbia	8
Romania, Turkey	9
Netherlands	10
India	11
Canada	12
Poland	13
Greece, Portugal	14
Germany	16
United States	33
United Kingdom	43
Spain	59
Italy	81

BL4S – How to improve

How can we:

- **Attract more teams?**
- **Make BL4S known** with students and teachers?
- **Motivate** teachers to spend some of their (free) time on coaching teams?

Our ideas:

- **Announce** the competition (much) **earlier**
- **Provide** the teachers with more written **documentation and background material**
- Provide **extra prizes**
- **Advertise** competition via additional communication channels
- BL4S @ “other lab”

Now its your turn.....