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Fermilab, October 7, 2010

Reflections on Understanding Detectors and Instrumentation

Some (Obvious) Observations

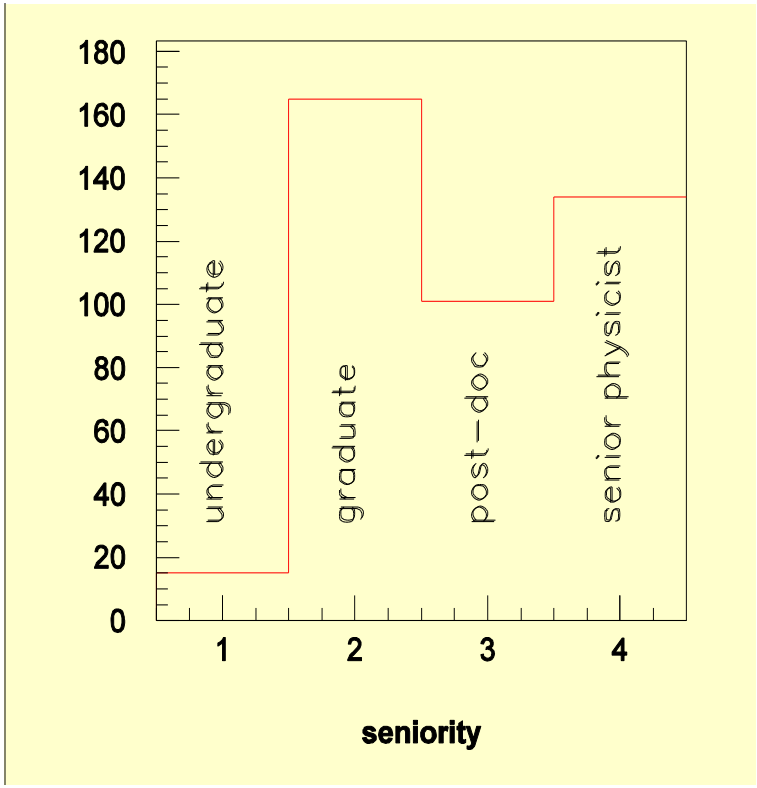
- HEP experiments are:
  - Becoming larger and larger, approaching the industrial scale
  - Taking longer and longer (~10-20 years from the design to the commissioning)
  - Involving O(~1000) of people, with most of them involved in a very narrow aspects of the detector design/construction/commissioning/operation
  - Etc.. Etc..
- What effects do these factors have on the professional development of our younger colleagues? Is the art of detector/experiment design still alive and prospering (LHC upgrades, ILC, CLIC, Muon Colliders, huge neutrino experiments, intensity frontier experiments)

How Serious is the Situation? Is there some Action Needed?

- Opinions vary, and they tend to be very strong, reflecting personal experience, and local conditions.
- ICFA Instrumentation Panel is running a bi-annual 'Instrumentation School', usually highly praised. The last school in Bariloche, Argentina, January 2010. This school is primarily aimed at the technology transfer to 'third world' countries.
- Perhaps there is a need for a structured and organized education program allowing young experimentalists to acquire practical experience with various detector techniques? What are the areas where the nees are most acute?
- Opinions vary, and they tend to be very strong, reflecting personal experience, and local conditions.
- Need broader perspective: conduct a survey

Survey: Spring 2010

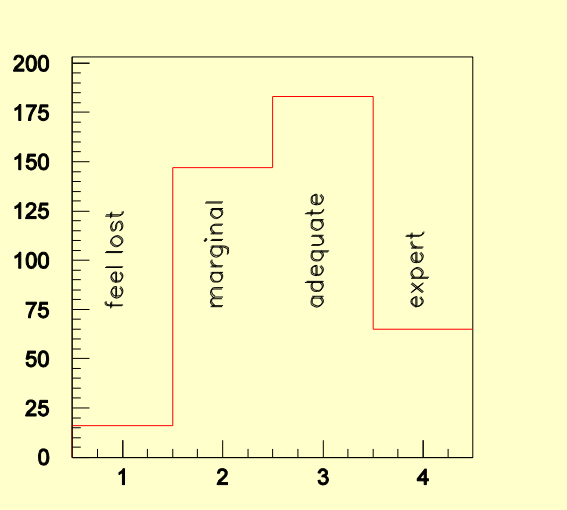
- Over 630 responses to the survey (over 100 responses within the first 24 hours)
- (for the observant) Some of the results will be shown for a sample of ~450 responses
- about equal representation of graduate students, post-docs and senior physicists
- Scale of the response indicates that the problem is perceived as a serious one.
- Bias: Survey was structured primarily to identify a possible need for new series of schools for young physicists



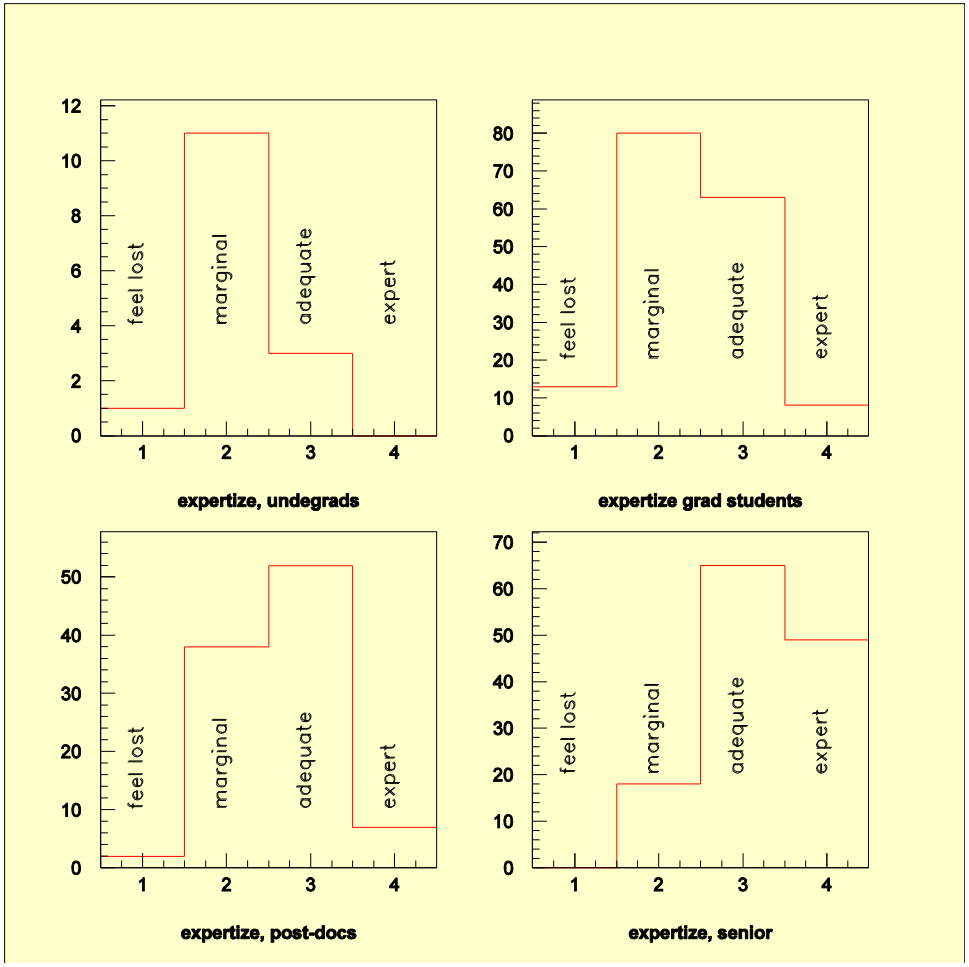
Perceived Level of Expertise

Do you consider that your current knowledge and understanding of the detector aspects of your experiment is:

- Exceeding your real needs, can even help your colleagues
- **Just adequate**
- Marginal, usually manage, but need help from others
- Feel totally lost and need a lot of help



Expertise Level at Different Seniority Levels



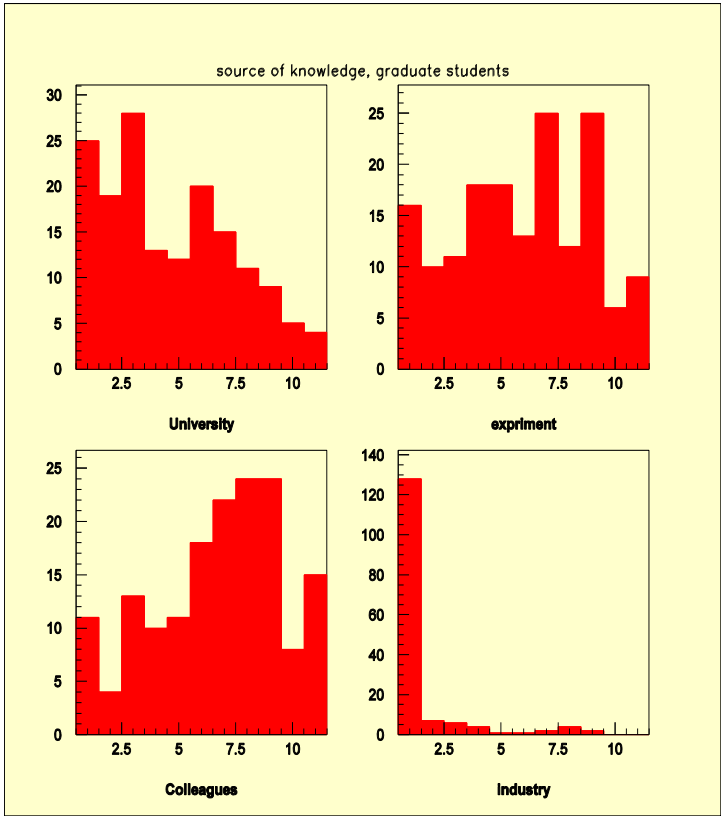
Warning: These, and all other, results need to be taken with a lot of grains of salt and cannot be taken too literally.
Sample is likely to be biased, interpretations and standards are likely to vary between respondents.
But they may serve as indicators of the perceptions in the community.

Sources of Knowledge

Did you receive any training in the detector/instrumentation area? Please indicate the extent/depth of the training in a scale from 0 (none) to 10 (expert):

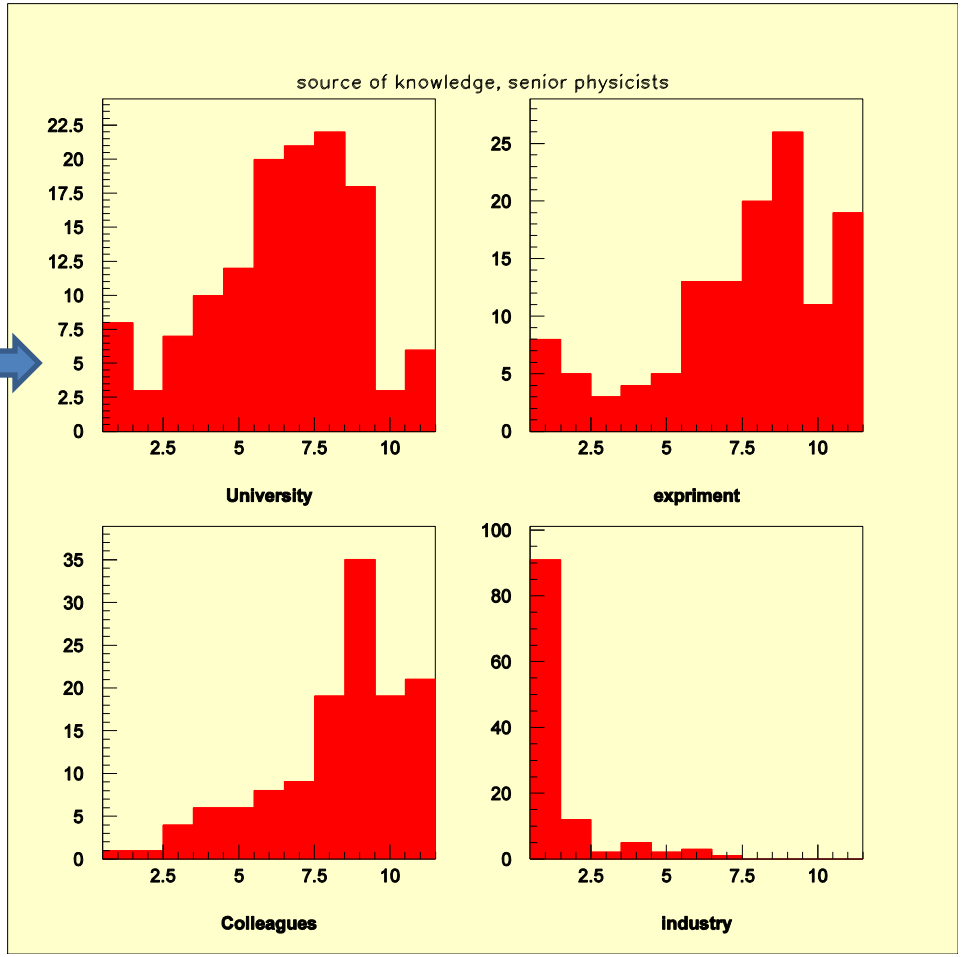
- Informal training from your colleagues/peers
- At your university
- In your collaboration/experiment
- In industrial courses

‘On the job’ training is the primary form education.

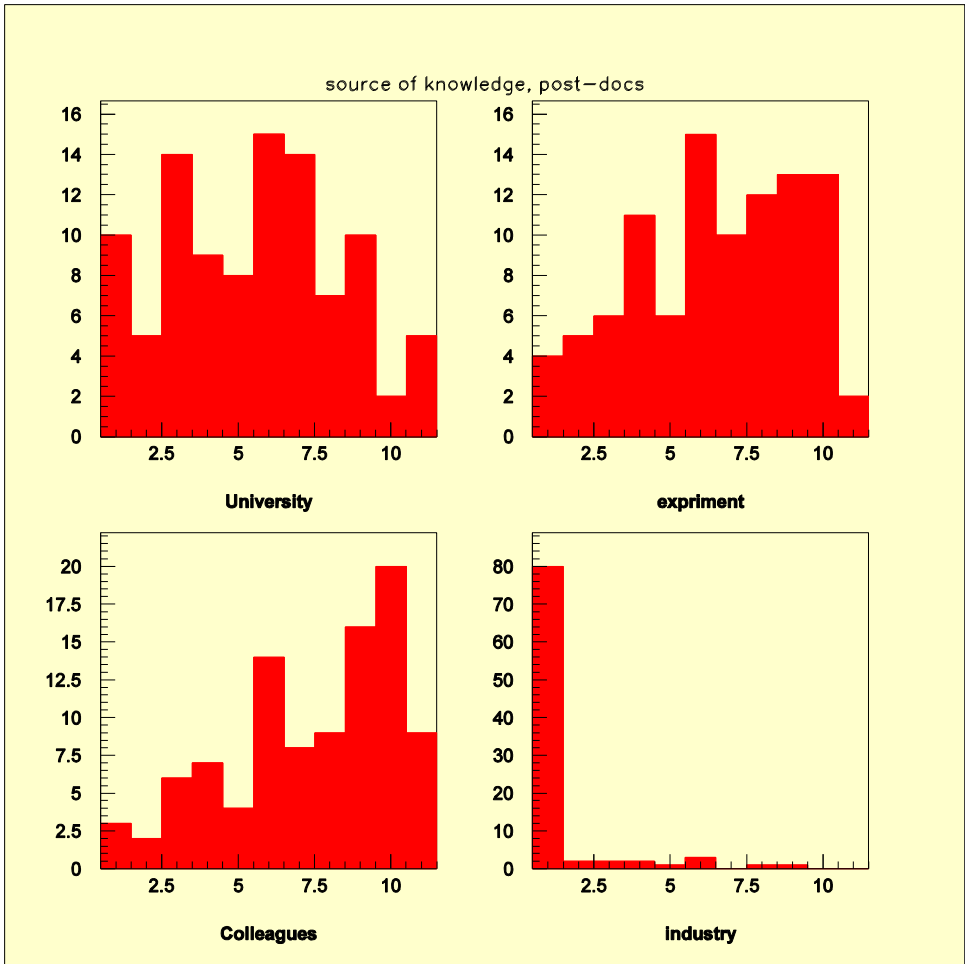


Sources of Knowledge, Senior Physicists

We used to learn quite a lot at school.

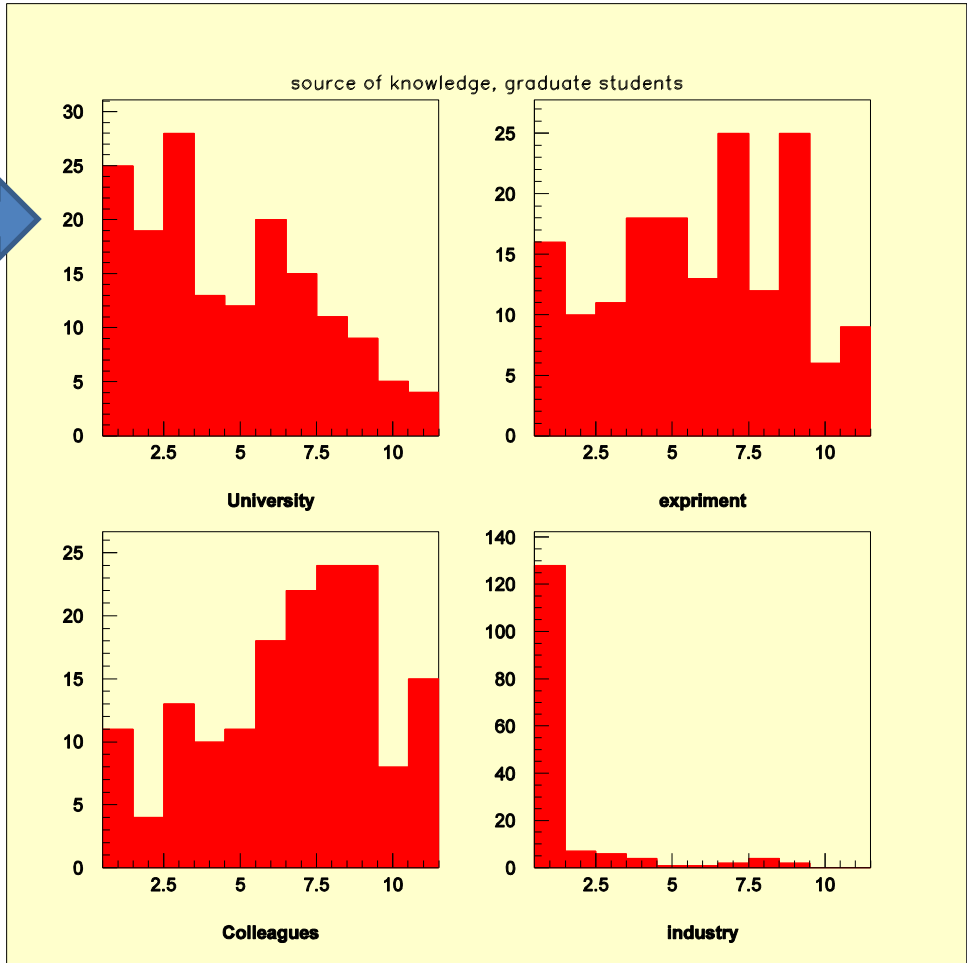


Sources of Knowledge, Post-docs



Sources of Knowledge, Grad Students

Nowadays, the level of the education at universities in detector aspects seems to rather insufficient.



Need an Instrumentation School?

How useful, in your opinion, would a dedicated school for the detector and instrumentation aspects be? From 0 (not at all) to 5 (very badly needed):

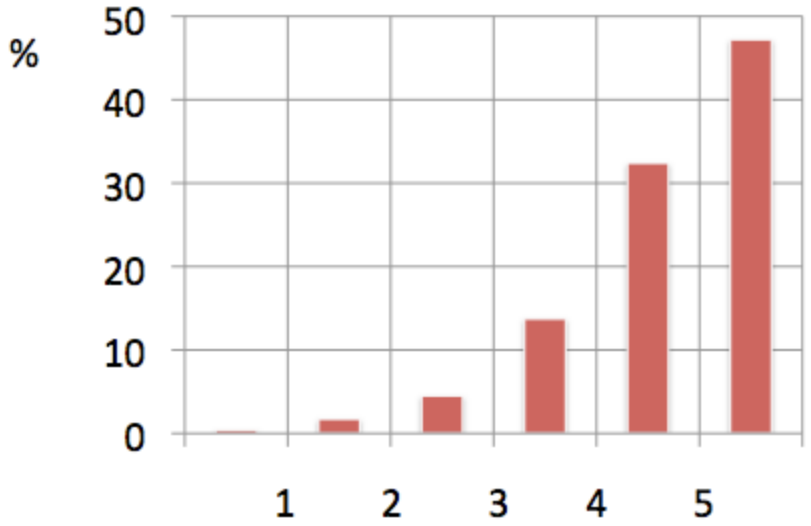
- 5 44.5%
- 4 40.2%

What would be the most appropriate division between lectures and lab courses:

- courses only 1.6%
- 75% courses 25% labs 18.1%
- 50% courses 50% labs 55.5%
- 25% courses 75% labs 24.4%

On the Importance of Lab Courses

- How important do you consider to include in the school practical laboratories on different detectors technologies?" (first bin means no useful at all - last bin means of fundamental importance)



What Lectures?

Here are some examples of possible courses (long, quasi-random list follows). Please rate them on a scale from 0 (useless) to 5 (extremely interesting or useful). Fraction of responses of 4 or 5:

- Fundamentals of silicon detectors (74%)
- Interactions of particles with matter (71.6%)
- Pixel detectors and vertex detectors (65.5%)
- Signal acquisition and processing (63.7%)
- Silicon strip detectors (63.1%)
- Fundamentals of electronics (62.5%)
- Front-end electronics (61.7%)
- Noise, grounding, etc (60.8%)
- Photodetectors (59.6%)
- Signal shaping and conditioning (56.8%)
- Electromagnetic calorimetry (59.9%)
- Hadron calorimetry (58.2%)
- Energy resolution of calorimeters: the practical limitations(54.8%)

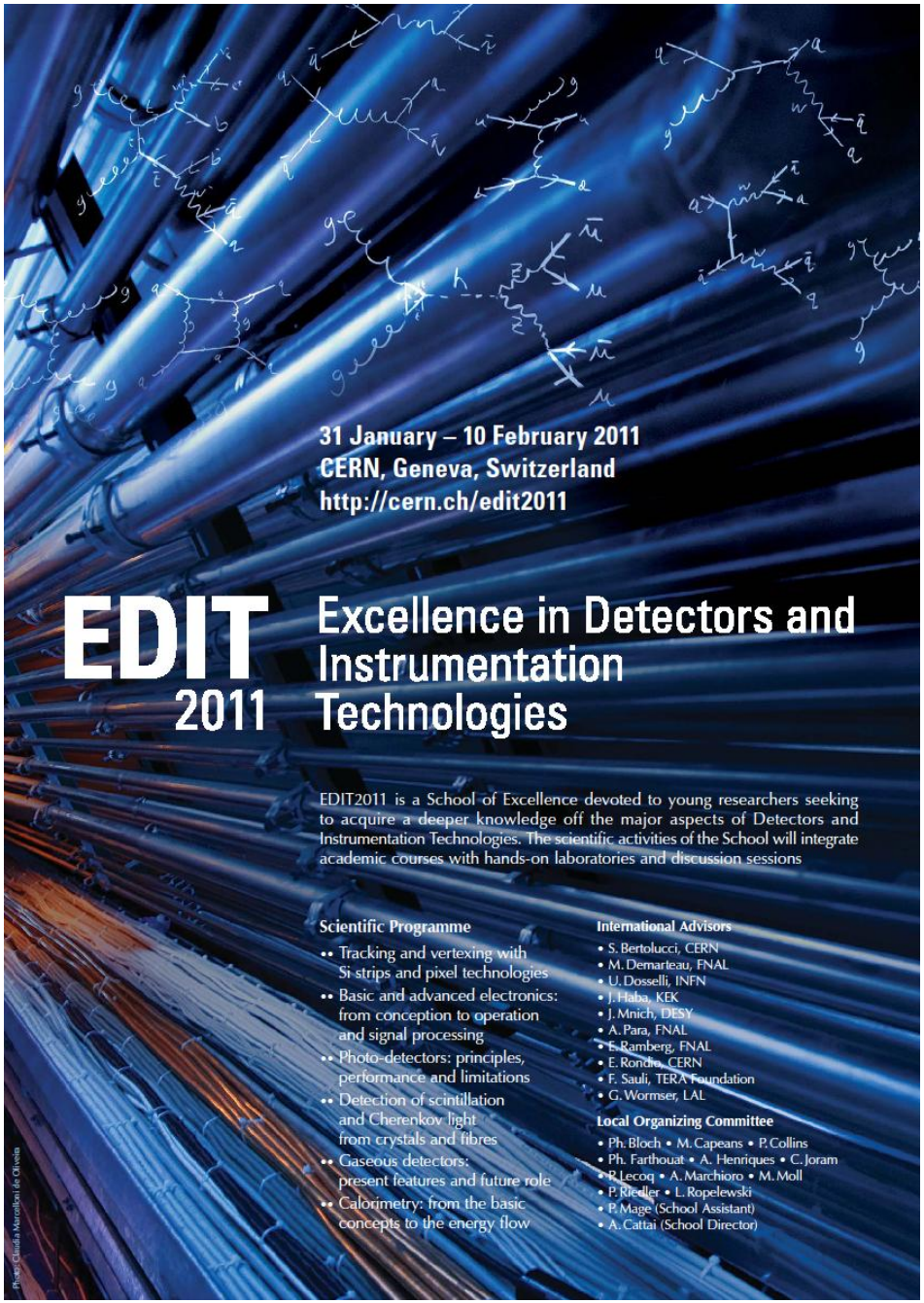
What Labs?

- Here are some examples of possible lab courses, please indicate your opinion/interest on a scale from 0 (useless) to 5 (extremely interesting or useful):

- Testing detectors in a test beam (69.9%)
- Basic Electronics (64.5%)
- Silicon pixel detectors (61.8%)
- Silicon strip detectors (59.8%)
- Time of flight measurements (50.1%)
- On-line experience with digital oscilloscopes (49.2%)

Some General Conclusions

- There is a widely perceived need to improve the level of education/training in the area of instrumentation.
- There is a great demand for a systematic courses of fundamentals of the experimental techniques
- There is a huge need for opportunities for practical experience: lab courses, test beam experience..



- First step: Instrumentation School for Young Researchers. Complement of the HEP Physics Schools, HEP Computing School.
- First edition: CERN, January/February 2011. Registration still open. Encourage your advanced grad students, young post-docs to apply.
- Ambitious format: parallel courses/lab experiments for small groups of ~10 people..

Instead of Conclusions: a Bunch of Opinions as an Invitation for Discussion

- These matters deserve broader discussion
- 'Doing physics' must not be limited to running ROOT or GEANT. Instrumentation/detector technology must gain the recognition as a scientific activity.
- A 'detector school' is a good thing, but it will not solve the problem
  - Too few people can participate in periodic schools
  - You cannot acquire much of the practical experience in a very short lab exercise
- Universities must be the primary place for systematic education. But they tend to lack the infrastructure for a comprehensive instrumentation training
- National Labs should be a major resource. Perhaps a dedicated test beam area with all possible and some impossible detectors?
- Perhaps an academically recognized school like USPAS school, with formal curriculum, credits, etc..
- Specialized schools? Silicon detectors, calorimetry, electronics for HEP?
- Closer collaboration of NSF – DOE (detector R&D effort)
- Collect the successful Instrumentation courses, create a 'template', customizable instrumentation course?
- This is a tip of the iceberg… A lot of ideas out there..