What does it mean to be an experimental/instrumentation physicist?

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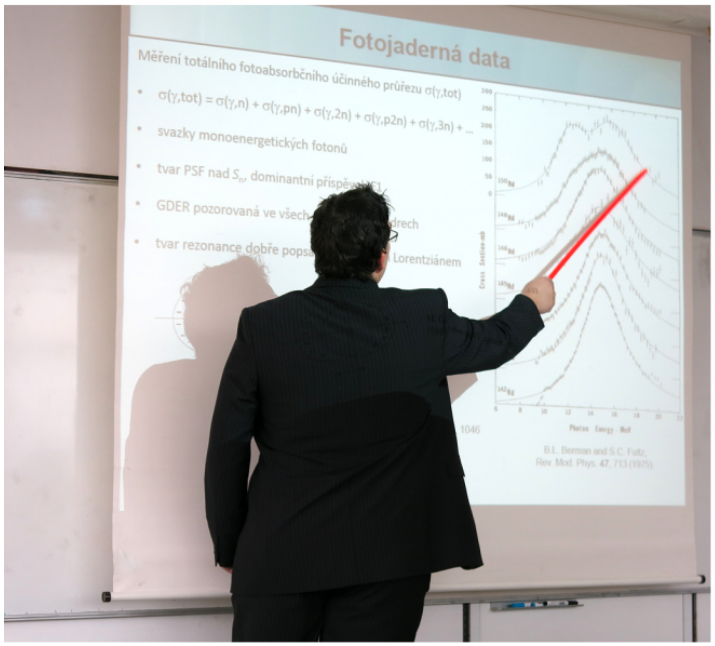
Just to get these slides a bit into context

- I studied General Physics (Bc., 2007), Particle and Nuclear Physics (Mgr., 2009), and Nuclear Physics (Ph.D., 2013) at MFF UK, especially at the Institute of Particle and Nuclear Physics
  - so most of the present colleagues know me quite well (not sure if they appreciate it on the same level as me)
- After Ph.D. I spent 1 year in Los Alamos National Lab., officially as a PostDoc at North Carolina State University (2014)



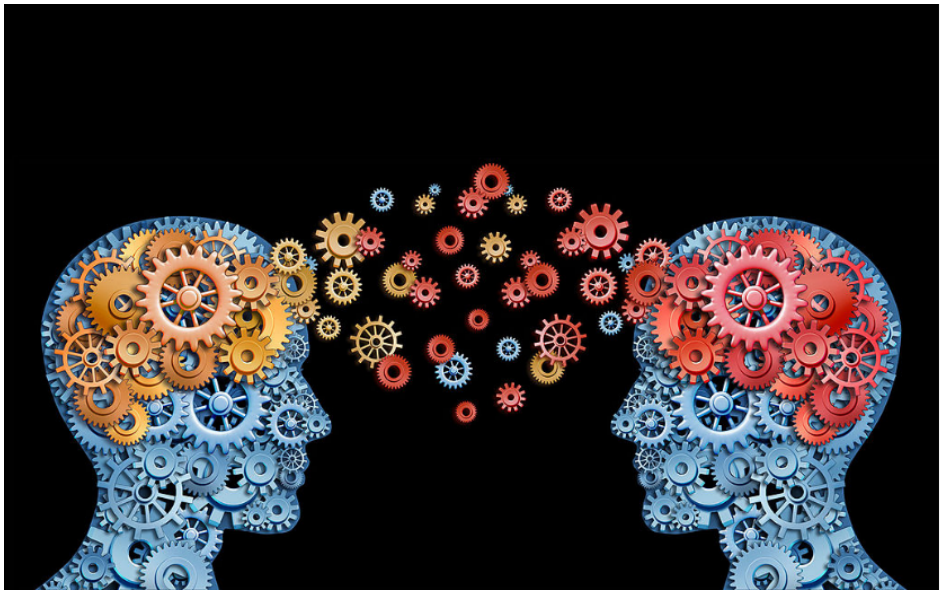
Just to get these slides a bit into context

- Mainly due to family I had to return back to Prague and I have found a position at the Institute of Physics of the Czech Academy of Sciences (2015)
  - together with Ing. Marcela Mikestikova, Ph.D. we started building the Research group for development and testing of semiconductor detectors
- The primary project in which we are involved is the ATLAS Inner Tracker - new all-silicon tracking detector of the ATLAS experiment, which will be able to detect tracks of charged particles produced by the HL-LHC
  - R&D work is currently realized dominantly within RD50 (DRD3)
- Our research is mostly done in the clean laboratory we have built at FZU, but also at various testbeam and irradiation facilities installed all over the world (DESY, CERN, FNAL, Prague, ...)



Original goal of this talk

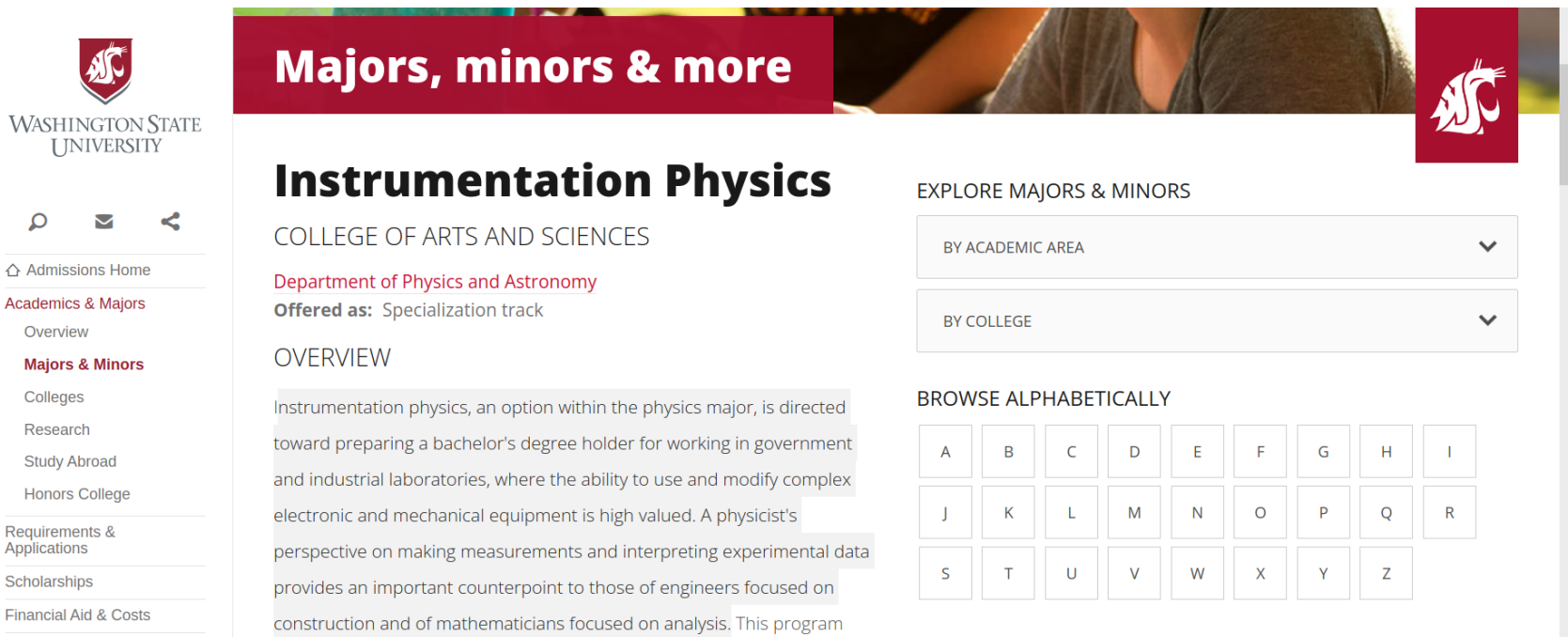
- The topic suggested by Prof. Pavel Cejnar: "One day in life of the experimental physicist" presented in very informal way
  - but I have realized that the only people who really cares about one day of my fuc... life are actually my wife and my four kids (and only when I come home too late as usually)
- I have decided to slightly modify the topic and share with you some of the findings I made in my profesional life during the last years
  - may be you will find some of them useful



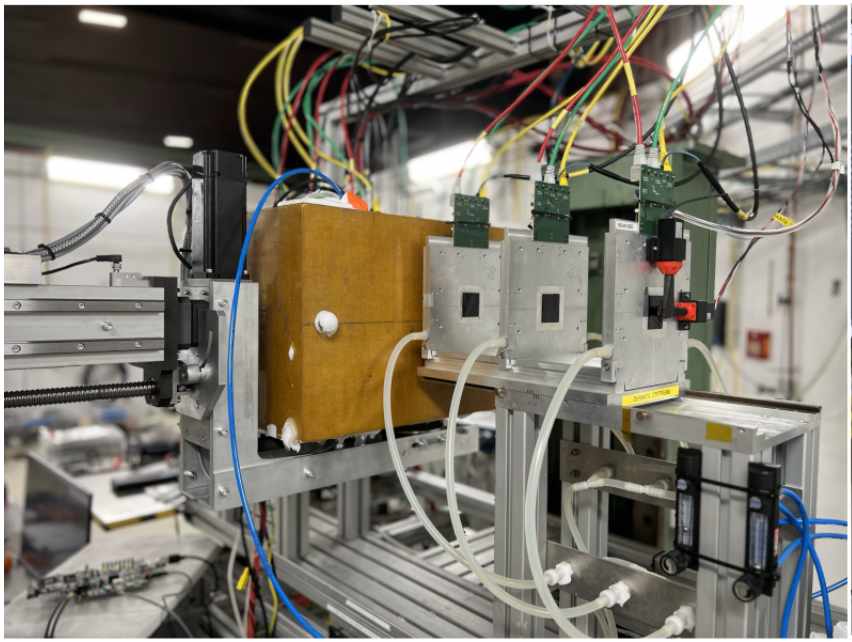
When people try to belittle your project and your work, just show them your results.
It always helps ;-)

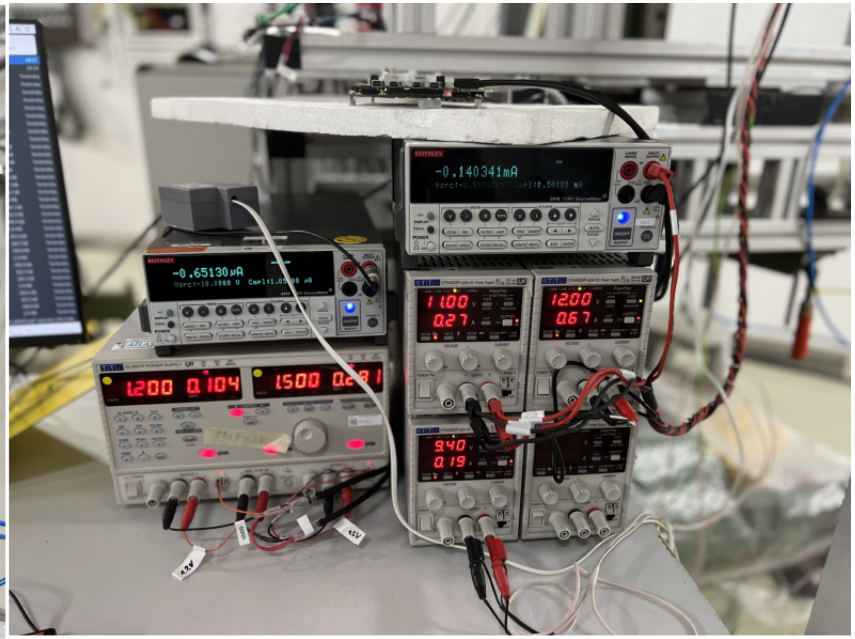
Experimental/instrumentation physics - definition

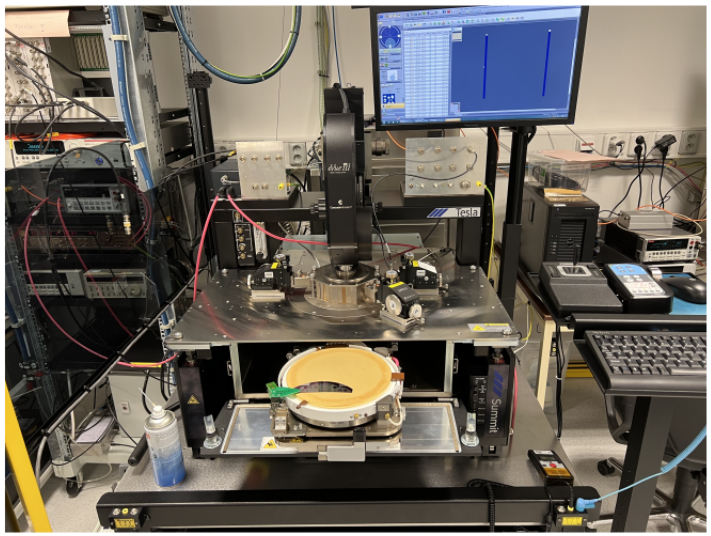
- *Instrumentation physics ... is directed toward preparing a bachelor's degree holder for working in government and industrial laboratories, where the ability to use and modify complex electronic and mechanical equipment is high valued. A physicist's perspective on making measurements and interpreting experimental data provides an important counterpoint to those of engineers focused on construction and of mathematicians focused on analysis.*

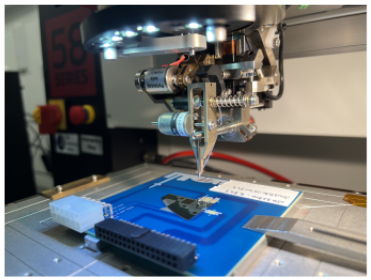


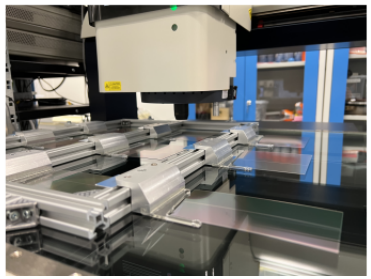
Experimental/instrumentation physics - reality



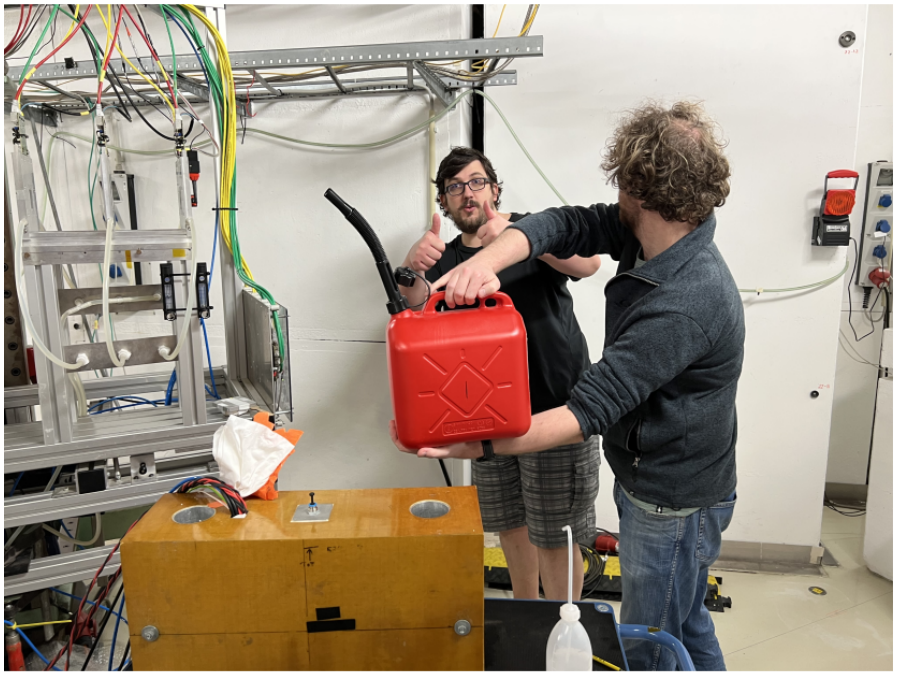








Experimental/instrumentation physics - also reality

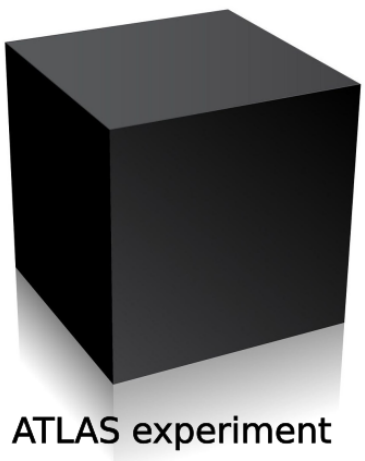


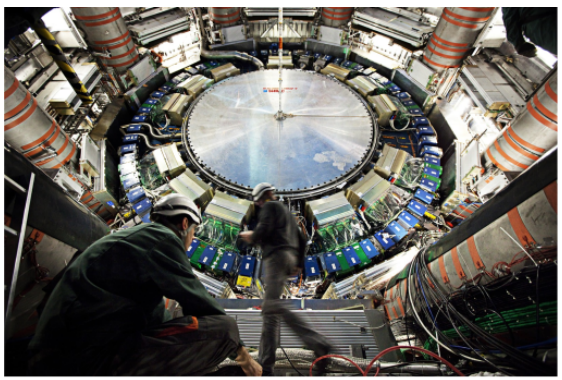
When you should think about experimental physics

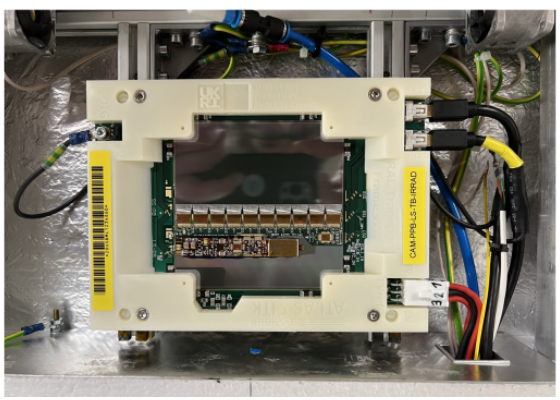
- Your relation to theoretical physics is following
  - you are fine with theory but you also realize that somebody else will probably do it better than you,
  - you really like theory but touching data and instruments is more exciting,
  - the last time you got the correct result of the typical example from the textbook was before you were 18.

When you should think about experimental physics

- You like experimental physics and experimental physicists (Marie Curie, ...) but analysing data produced by the big experiments is too “impersonal”
  - you want to be able to play with your setup and study all its aspects,
  - and have its complete functionality under your control,
  - and most importantly: This is not how Marie Currie was doing the science.

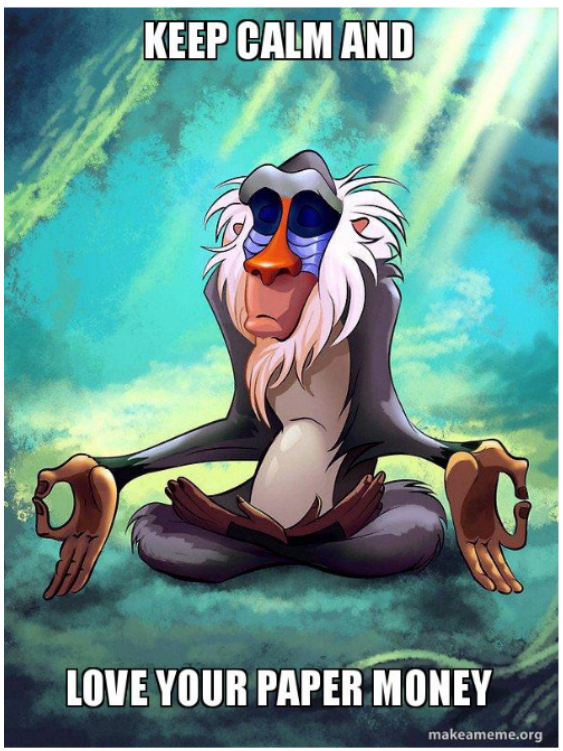






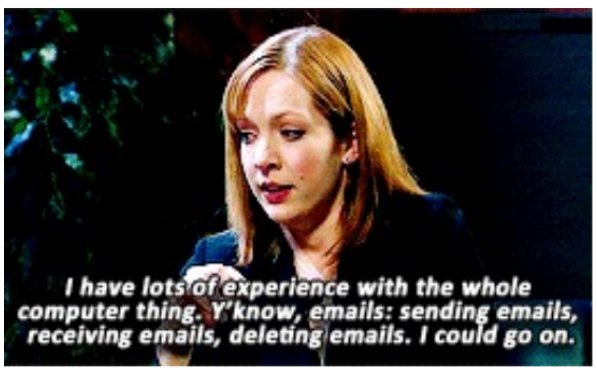
When you should "forget" about experimental physics

- You want to have a calm and non-stressful life,
- you have a partner (and kids), who would like to see you at home (at least time to time), or even want to plan some activities in which you are supposed to be participating
- you like sleeping and related activities,
- you plan to be rich or something like that.



What skills you will very probably use

- Standard programming is definitely important (C/C++, Python, ...)
- Hardware programming is very useful (C/C++, Python, NI LabVIEW)
- Being expert is some specific simulation/designing tools is extremely valuable (CAD, TCAD, Geant4/Allpix-Squared, Corryvreckan, ...)
- Effective work with tons of emails is more important than you think
- You need to be open to learn completely new things - operation of various more or less complicated instruments
- You should not be worried of radioactivity (working in irradiation and testbeam facilities) + more you know about the radiation effects on materials (also biological) and related topics the better for you and the team

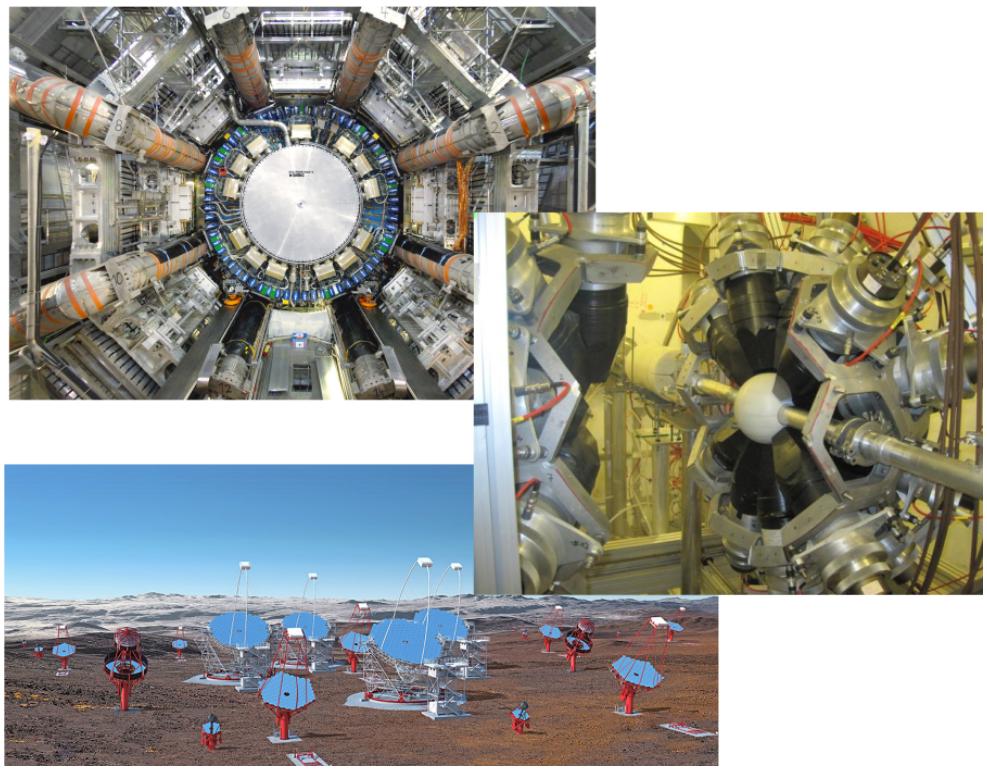


... and if you would like to lead the team?

- Communication with people on various levels - you need to communicate with your bosses, your team members, your friends, your wife (be careful), with your kids (be extremely careful), ...
- You should be able to accept responsibility and make decisions (even when they are wrong)
- Try to create and attractive working conditions - so people will enjoy working in your team even when you have no effect on their incomes (international teams)
- Writing grant applications is a skill which can be trained (don't get frustrated)
- Be familiar with basic cleaning procedures (sweeping, wiping, vacuuming, use of different cleaning agents) - quite a rare skill these days
- If you really need to sleep, then sleep faster

Still on board? What you would like to work on?

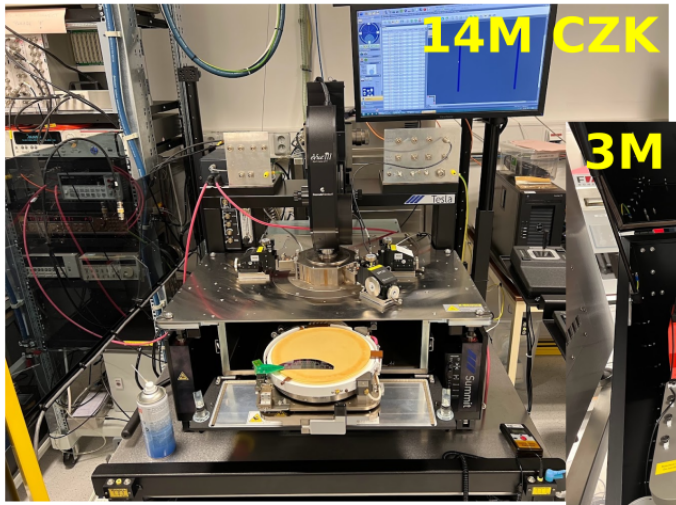
- It is necessary to have some idea on what you would like to investigate, ... but just the idea will very probably not bring you the needed resources
  - you will have to be a part of the project critical for your institute,
  - or you can build such a project from scratch and defend it at yout institute among the already running projects (then you have my respect)

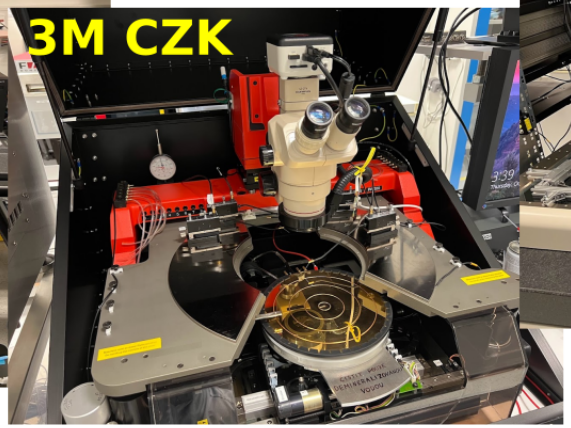


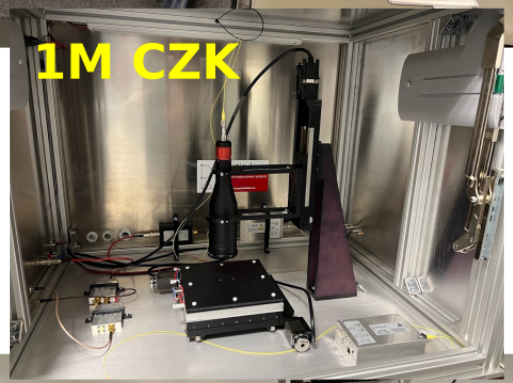
Where you would like to do your experiments?

- Typically you need some laboratory - in some cases it is even required to have a clean laboratory, with a defined level of cleanliness
  - depending on the required level of cleanliness and a necessary area this can cost you from a few millions of CZK to ... (significantly more)

... and what instruments you will need?





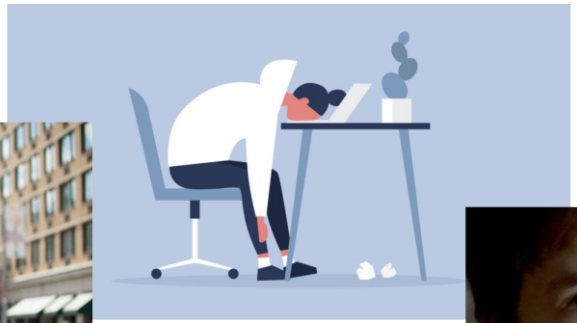


Who will pay your laboratory and necessary equipment?

- You can try the bank robbery
  - not considered to be a sustainable approach and typically not supported by your institute
- You can ask private companies if they would provide you some resources
  - you should have really (but **really**) good justification - why they would support your lab, administratively complicated
- You will apply for resources in a standard "institute-like" way - submitting grant applications and applications for financing of this a that
  - it is quite slow iterative process - if you will be really lucky, you will be able to purchase one bigger investment per 1-2 years
  - advantage: you will buy the instruments that you really need (and not the machines you only think you need)

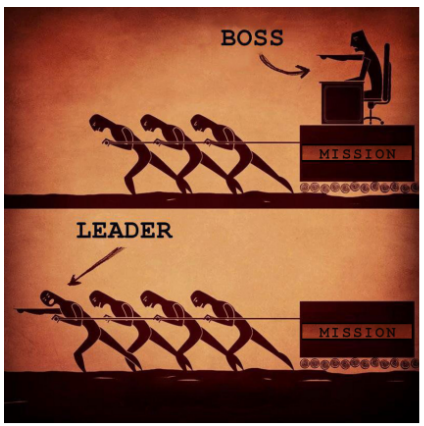
Who will work in your laboratory - team

- Identifying the right people into your team is the most critical and also most complicated problem of this business
  - one “incompatible” member can easily destroy the whole team
- What people you will need
  - Physicists - should have the overall idea on what to do, when, and mainly why (physics + instrumentation + project management)
  - Experts in electronics, mechanics, design/simulations + corresponding workshops (it is not important what these people studied but what they really know - practice and contacts to technological companies is critical)
  - **Students** with enthusiasm and fresh ideas
- Considering the resources you have, people with skills you need for the team must be crazy to accept such a position (and they typically really are)



Are you able to manage your team?

- As a team leader, you should be working really hard to show your team that the project is important and worth of effort (working hard on something else doesn't really count)
- all team members need to have well defined tasks and you should give them a feeling that they are critical for these tasks and a success of the whole project
- you should be an expert in several project fields but also know at least something about the other aspects
- try to provide some benefits to your team members if they work hard (even when you don't hold the budget, you should fight for your people)
- organize regular team beer/wine/whatever meetings to sit with your colleagues and discuss on the same level

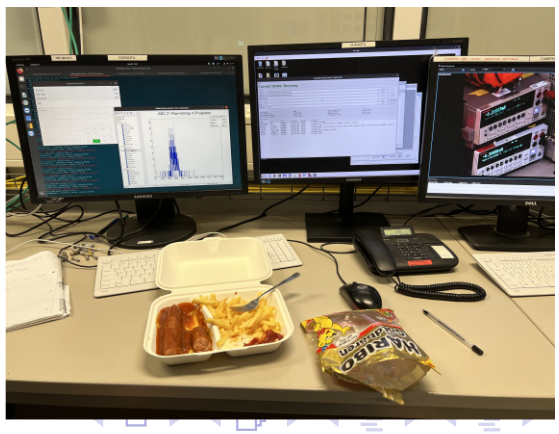


Be very careful with selection of new team members

- You should be really very careful when choosing new team member, as the overall harmony in the team is essential.
- Some of the fundamental advices would be
  - HR department can be very helpful to organize the interviews, but will certainly not help you with right choice
  - You can basically ignore recommendation or motivation letters - they are typically bullshits
  - In reality, there is almost no way to recognize if the new member is compatible with your team and your strategy during the interview time
- You have 3 months (testing time) to find out if the new member is fine for you and your team
  - prepare the tasks in a way that the new member can get into "all possible" situations, including increased stress, willingness to do extra things, learn new things, etc.
- If you will not recognize the problem within the first 3 months, and the critical problems will eventually appear, you are basically fuc...
  - either you will lose your team, non-trivial portion of resources, or your mind

Leading the CERN group is a completely different story

- I am leading the ATLAS ITk strip testbeam and irradiation group since 2016
  - several of your colleagues from IPNP were/are conveners of their groups, so they can share their experience
- Why the people from institutes all over the world should work in your activity/group?
  - It includes core components listed in MoU - money invested by the institute are counted as an official contribution of CERN (No)
  - Activity is an important part of the big project and its outputs are required for various project reviews (Yes)
  - Activity is atractive especially for students as it produces a lot of valuable data to be analyzed, interpreted, presented and published (Yes)
  - People are able to somehow enjoy the time invested into the activity (Probably yes)

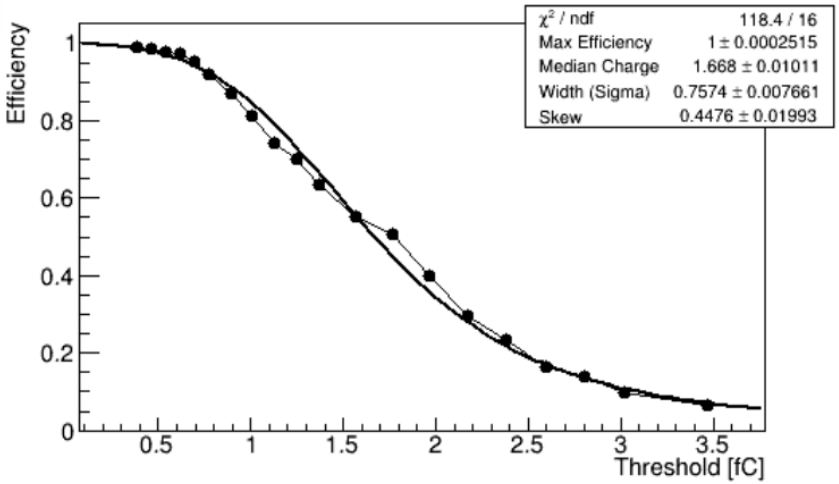
But what happends when you don't have people available

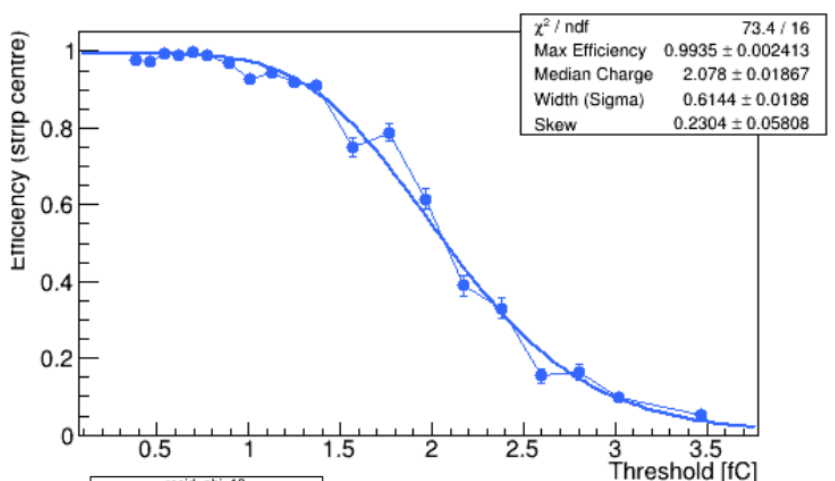
- ... then you need to run 24 hours per day for 14 days with only two shift crews and you will get really tired (picture below was produced by Midjourney AI according to our description of the testbeam status)

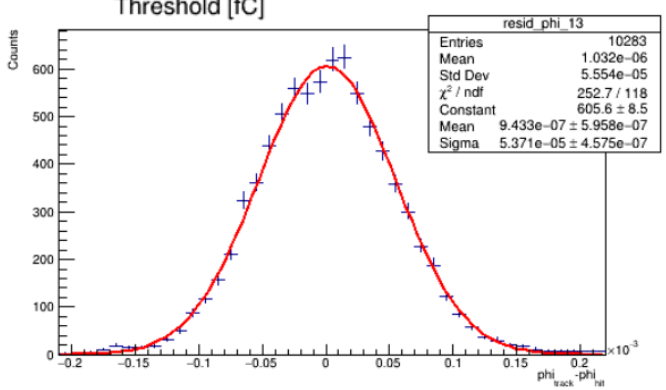
But what happends when you don't have people available

- and your official slides with results can looks like this



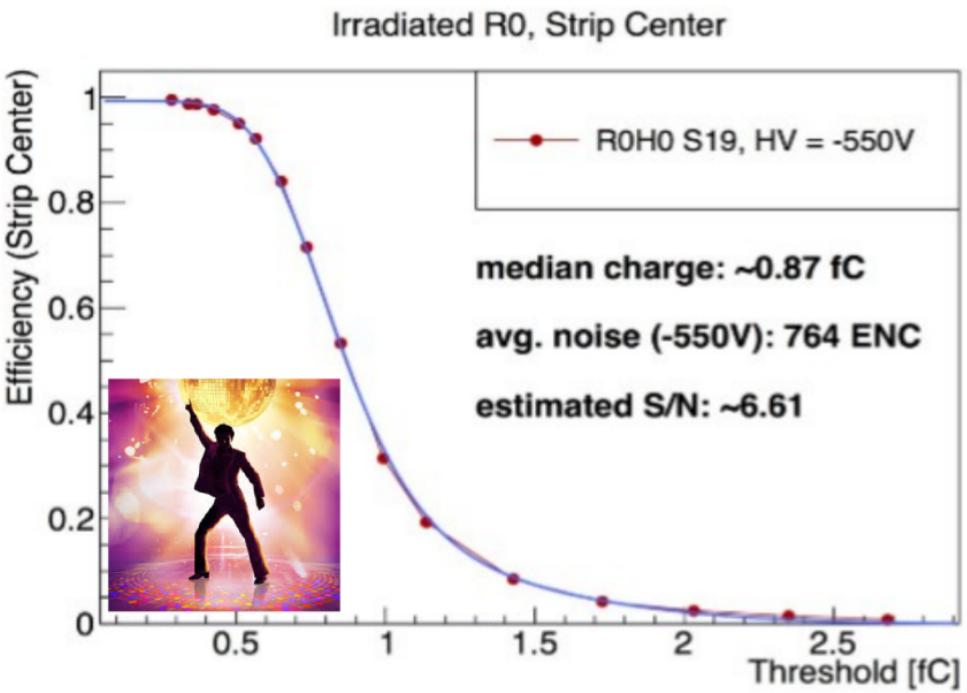






But what happends when you don't have people available

- or like this



The requirement is to have a S/N of 10:1

We are happy to welcome you in our lab and in our team

- If you would be interested in working with us, please just catch me here or call/email me anytime