

The COSY–11 collaboration

Walter Oelert¹

Institut für Kernphysik, Forschungszentrum Jülich, D–52425 Jülich, Germany

Abstract. A very personal view of the COSY–11 collaboration is given and thanks are expressed to all those people who helped and supported the work of COSY–11 over the years.

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DEAR FRIENDS, CO-WORKERS AND COLLEAGUES

How justified and wrong at the same time is Friedrich Schiller, when starting his play Don Carlos with the words:

*Die schönen Tage in Aranjuez
Sind nun zu Ende. Eure königliche Hoheit
Verlassen es nicht heiter. Wir sind
Vergebens hier gewesen. Brechen Sie
Dies räthselhafte Schweigen. Öffnen Sie
Ihr Herz dem Vaterherzen, Prinz. Zu theuer
Kann der Monarch die Ruhe seines Sohnes -
Des einz'gen Sohns - zu theuer nie erkaufen.*

*Minęły oto piękne dni pobytu
W Aranjuezie. Lecz Wasza Wysokość
Wraca do domu wcale nie weselszy.
Daremna była zatem ta wyprawa.
Porzuć milczenie zagadkowe, książę,
Otwórz swe serce ojcowskiemu sercu.
Wszak dla monarchy nie ma takiej ceny,
Której by nie mógł zapłacić za spokój
Swojego syna - jedyne go syna.*

*The pleasant days in Aranjuez are over.
Your Royal Majesty will leave this place
No happier than when he came. Our stay
Has been a waste of time, but why? Explain*

*The riddle of your silence to us, Prince,
Lay your heart open to your father's heart.
To buy contentment in his only son
There is no price the monarch would not pay.*

Yes, the pleasant days of the COSY–11 experiments are over. Yes, we do not leave this experiment happily. But, it has not been a waste of time, we have used the time successfully. We did not keep a mysterious silence; we published a lot and we educated ourselves and many students. We did open our hearts to our monarchs, the Board of Directors, the Rectors, the Directors of the individual institutions and agencies. Though we were and are not their only son, there was no price our monarchs would not pay. We were supported, not for contentment, not for calmness – not for being cosy – but rather for exciting, interesting and basic physics at COSY.

Back on the 9th of May 1989 there was the first meeting of the Program Advisory Committee (PAC) of COSY. The judgment of this very first PAC on the “**Proposal**

¹ Email: w.oelert@fz-juelich.de

No. 11: Threshold Meson Production at the Internal COSY-Beam in the Range of Scalar Mesons Involving Strangeness” was: *“The physics is highly recommended and interesting. Technical problems have to be solved”*.

This was no wonder, given the quality of drawings presented and the many technical questions that were really not answered. But, with the help of the Central Technology Division (ZAT) of the Research Center Jülich, and with the cooperation of all the participating institutions of the newly-created COSY-11 collaboration, we managed to create a functional experimental facility that met all expectations.

We are here to thank all those people who supported us so enthusiastically and to celebrate the achievements of the COSY-11 experiment, which has been called by several people “THE SUCCESS STORY of COSY”.

Here we are, celebrating a good day at the marvelous library of the Copernicus museum, in the impressive rooms of the Jagellonian University, in the unique city of Cracow and in the admirable country Poland, in a steadily uniting Europe. Here we are among colleagues and friends, and with friends, and we are happy again to be here again.

Is it a good reason to come together to celebrate the end of an experiment, in particular of the COSY-11 experiment? Certainly it is and I will tell you why. The main reason is that we are not here for a final end, or even for a funeral, since things will continue. I am convinced that there is a good and exciting future for us. Things are changing, and that is how it should be, and we have to admit that all the indicators are positive. We have no reason whatsoever to complain, though I have to confess that the development into the exciting future is going very slowly, too slowly for my liking. Still, as long as we stay together and really want what we want, we will succeed.

Yes, we agreed to stop our experiments at the unique facility COSY-11. Yes, we did have an incredibly good and exciting time. Yes, we measured a lot, we worked a lot, we learned a lot, we created relations between us and it is good the way that it is. But we are by no means at the end and therefore we do not have to be sad. We can and should be proud having the opportunity to be here.

Would it not be good if we could say: *Yes, – hurrah – the problems, questions and challenges are solved, we did it all and therefore we can stop now?*

Everybody who knows science is well aware that this is almost never the case. It is the nature of science that with one basic experiment some questions are answered – if you had asked the right question to Nature in your experiment in the first place. And I think indeed that we did so. But by learning more, getting deeper inside, you open the door to still deeper questions – which could not even have been asked before – and this leads to deeper thoughts. Therefore it is only logical to state: That was not the end, we will continue to work with our data, we will continue to contribute to science, we will continue to publish and share our knowledge with others, and we will continue to be a community with a unique well-defined aim.

We did participate in providing fundamental contributions to further exciting physics to come, for further developments and for new things to be done. We did educate ourselves, we did learn a lot, we contributed our share. Many colleagues within the COSY-11 collaboration advanced their careers through our joint work. And this effect just multiplies, since four of us are on their way to become professors, thirteen got their doctor’s degree, additionally seven are close to finishing their dissertations, twenty three

did their diploma work, and an honorary member of COSY-11 was chosen to become a Dr. h.c. of the Jagellonian University.

Now, what did we do during the last decade? To judge this, we will leave the floor to our good, critical and sometimes friendly collaborator of some other experiments, who is well known to speak out if he does not like something and, most important for now, knows how to celebrate “End of an Era” parties. Besides other shutdowns, he was the one who had the final say when SATURNE stopped, he was present when CELSIUS finished, and he is present here today. Colin; I am curious to learn what you will tell us about ourselves.

As you all know from reading our papers or listening to our talks, we studied hadronic systems and the strong interaction and I will not contribute to this science here or even discuss it. We just did it carefully and precisely. We received international recognition but other people will judge our work and I am by no means afraid of their judgment.

We built one of the most simple experiments – small and beautiful – from all those experiments which were invented at COSY. It was a typical first generation experiment and, despite that, we were really rather long online. Though it was a small experiment, which benefited from earlier experiments at CERN, which were stopped by the time that we started, the investment was still as large as about 2.3 million Deutschmarks. However, we have to admit that COSY-11 was much more expensive, since we used 608 days or 1.666 years of beam time which must have cost something like 10 Million Euro. Also, on average 11 people had to be paid by somebody over the period that we were active. This adds up to more than 11 years’ time, *i.e.* more than 121 man-years.

We have here to thank many people and agencies and directors and managers for their generous support. We could not have done all this without the help of the Board of Directors of the Research Center Jülich, without the help of the Jagellonian University, without the help of the IKP in Jülich, without the help of the Physics Institute of Cracow, without the help of the Institute of Nuclear Physics in Cracow, without the help of the Institute of Physics at the Silesian University, without the help of the Physik Institute at the Westfälische Wilhelms University in Münster, without the help of the Verbundforschung, without the help of the Polish Science foundation, without the help of the Internationale Büro, without the help of the DAAD, without the help of the DFG, without the help of the Eta-Meson-Net of the EU, without the help of all those people administering the grants, without the help of the secretaries in the individual institutions, without the help of the safety control regulators. And who else is there to name? There are so many enthusiastic people that are needed to achieve the success that we had. And we should not forget those who took care of whatever we left behind after long days or nights of working, who cleaned up behind us without our acknowledging even their existence.

Let us come back to COSY-11, the team of eleven players and more – you always have to exchange some players and keep some in reserve, as in any good soccer team. Just as for a soccer team, a good team needs defenders and strikers and that was all of us, some more on the right side, some more on the left, some more aggressive, some more passive, but they were all needed and had their own specialties.

A good soccer league gains creativity by exchanging players. Now, I have to admit that in our scientific league the transfer money is orders of magnitude below the one in the professional soccer game. Still, we made quite some profit from the exchange

program between the Jagellonian University and the Research Center Jülich. It is clear that we do need this program, for continuing to play in the Champions' League, and we would like to plead for a justified and merited continuation.

Just as in a soccer team, COSY-11 needed to have and had a goalkeeper. You can make up your own mind who that was, but I think in most cases it was Thomas Sefzick, who took care that not too many faults happened during our operations.

The team needs an improviser, or otherwise things get dull and here I could name Dieter Grzonka, who frequently comes up with new ideas which, to realize take only a few days – in his opinion, and sometimes he was even right.

A very important aspect is the continuity that a team needs in order to win. One of the unbelievable continuities of our team was the continuous reliability of the drift-chambers. In all the experiments that I have collaborated with which were using drift-chambers, a frequent repair was necessary. This was not so with the drift-chambers from Jerzy Smyrski and his group. Believe it or not, it is a fact that these chambers were installed in 1994 and never ever had to be repaired up to our last beam time in late 2006. This is a world record as far as I can judge and that is why future experiments demand Jurek's expertise. Congratulations to the detector laboratory of the Physics Institute at the Jagellonian University, and all those technicians working so successfully at this laboratory for us and for other experiments. This unbelievable success is even more remarkable when one realizes that there was no experience whatsoever at the Physics Institute, but Jurek and his group developed it and they were an absolutely winning formation.

A soccer team needs a continuous flow of beverages to satisfy its thirst. Though the Münster crew, coached first by Rainer Santo and thereafter by Alfons Khoukaz, did not provide the refreshment drinks, they continuously provided a flow of hydrogen clusters used by us as the proton target. And even more, on request, they gave us heavy hydrogen. Thank you so much; it was essential for us and our experiments. Again, that is why future experiments demand your and the COSY-11 expertise.

Even a very good soccer team needs to go through continuous training and has to repeat frequently certain exercises and practices. You can imagine how helpful Kurt Kilian was with his continuous education in relativistic kinematics and continuous replay of kinematical fitting and optimization of procedures. Still, boring as training lessons are, it was perfect or nearly perfect most of the time, at least in the result of forming a winning team.

Sometimes a soccer team needs fresh blood and brilliant supplements, which was given to us frequently by new enthusiastic students but, unfortunately, I cannot name all of them here, though I would very much like so to do.

A particular historical supplement of one player was Joachim Treusch, here not as the Director of the Research Center Jülich but rather as a theoretical physicist taking part in one night shift of an experiment when we were measuring the analyzing power of the η -meson in the proton-proton collision. Thank you for this contribution as well. The data really were published!

And how about the team leaders? Magnus Wolke and Paweł Moskal have successfully led us through the last eight years. It was the first time that you had acted as team leaders and you had to learn how to do this job. It is evident that both of you did a great job, which is why the community still asks for your advice and leadership.

You can not play a game without a ball, without the correct and professionally made tools. Here we would like express our appreciation of the work of the workshops of the two Institutes in Cracow, and the ones in Katowice, Jülich and in Münster. I cannot name all those persons who were working for us and conjured their magic creations. But insiders know all of them and are very thankful. What we got delivered from the designer offices, the mechanical and electrical workshops and those people who finally did the work, was exceedingly good, precise and functional. It cannot be acknowledged enough what this support meant and still means to our work, to the work of science.

Finally, no team can work without a brilliant coach. And here we had quite some from the different institutions. Adam Strzałkowski, Lucjan Jarczyk, Andrzej Budzanowski, Kurt Kilian, Rainer Santo, Wiktor Zipper all trained their special sub-team to form a unique group of players at COSY-11.

No game will take place without a referee, and I have to admit that we were only very occasionally angry with one referee or the other. It seems that the referees of the program advisory committees have always been on our side, or at least fair. Thank you to all referees and the chairpersons of the COSY-PAC: Erwin Rössle, Ulrich Mosel, Sven Kullander, Muhsin Harakeh, and Wim van Oers. Only seldom did we get to see a red card from you. Believe me, please, that it was not necessary, but after all it educated us.

Before and after a game, and sometimes even in between, players need a good massage to renew their strength, concentration and power, to be ready for new, significant and thrilling games or experiments. Who else could have been our masseur than the theory department of the institute, namely Josef Speth and his group. Some of them are giving us the honor of being with us today; thank you for being here and for the massage that we needed, and needed so urgently.

Naturally, a team can only play its games if there is a really well prepared sports field, first to be built, second to be operated, and finally to be maintained. All this was taken care of again by the board of Directors of the Research Center Jülich. However, it never would have worked out if there had not been a group with spirit and enthusiasm that is really doing the work and performing the job in a professional way. We must pay homage to the COSY accelerator team under the leadership of Rudolf Maier and Dieter Prasuhn. The formula is very simple: no beam \Rightarrow no experiment. But, thanks to you and all the supervisors and operators, we had lots of beam.

Apart from playing their games as professionals, each soccer player does have a private life – and this is true also for the COSY-11 team members and the members of the operating staff. At the very least, I would like to mention that very often the families had to suffer from long hours of training and working of the COSY-11 team. I would like to apologize for how it was and is and thank you for your understanding.

Some members of the COSY-11 team and the operating staff had to experience dreadful incidences of sickness, death and losses of partners, we all feel with you and hope that you find enough strength for the life to come.

There is something special in the Premiership of Science. Whereas in the world-championships of both soccer and handball, Germany beat Poland over the last year, here at the COSY-11 team we were and are on one side – at least for most of the time! We were fighting together for good experiments and good results, and we both were winning together – many congratulations to all of you participating in one way or the other. I think that this part is really a very important aspect, that we both were and are on one side,

working, running, suffering and celebrating together, hand in hand. This was not always the case between our nations, as most of us know from history only, though some of us still remember vigorously from the own experience. Let us hope that we always can do science and sports together and never ever again return to former experiences. We are now here together in Europe and we should continue what we started already back in the early 80s as part of a large community.

Thus, what I am saying here totally echoes what Prof. Treusch said during his first opening of the academic year at the Bremen International University (now: Jacobs University Bremen), that the opening of the national boundaries is nowadays an obligation. Members of COSY-11, as well as others, fulfilled this long before we started COSY-11 and continued throughout. We, in fact, practiced globalization though, necessarily and naturally, on a limited small scale. But we should and can be proud that we contributed with our little stones to the large mosaic, which is now Europe for all of us.

I know that Professor Musioł shares these sentiments. I know this from his openings of conferences here in Cracow, from joint visits to the concert hall in Cracow, from his continuous pledges, wishes and dreams for a united Europe on a fair basis, with Poland and Germany playing a significant role in this complicated but exciting and enjoyable interaction between the nations. These interactions appear to be much more complicated than our scientific strong, weak, electromagnetic, and gravitational interactions. Thank you Karol for all what you and your team are doing for us and our nations.

I can not resist comparing COSY-11 to another object, an object we all know very well and each of us has a few 2.5×10^{28} of them in their own body. COSY-11 is like a neutron. The neutron is the essential hadron of the material world. Or is the proton, which is effectively the same particle only with charge, more important? In any case, we would not exist if one of them – neutron or proton – were missing.

I will tell you why COSY-11 is a neutron rather than a proton. Inside both of them there is much going on with valence quarks, sea quarks, gluons and the interaction between them. Inside the neutron and proton there is a frequent coming and going, exchange and interaction, annihilation and creation, turning and twisting. There is high life in the neutron and proton; nothing is quiet, calm or cosy. There is competition between the constituents but finally they are all needed to form the hadron. Just as we all are at COSY and COSY-11.

But, to the outside world, the neutron and the proton looks like a well behaved, solid and well organized object (just as we are at COSY and COSY-11) with a definite mass, a definite spin and a well measurable magnetic moment. I will leave it to your imagination to decide who, from COSY-11 and the teams supporting COSY-11, is which species, which constituent, and takes which part in the neutron equivalent of COSY-11. We might argue about this during wine or beer later today.

However, I promised to tell you, why COSY-11 is not a proton but rather a neutron. This distinction might surprise you, especially since I said that they are almost the same and are treated in the same manner by our theoreticians. The different charge is one thing and is certainly important to form atomic structures, of this there is no doubt. But there is another difference, which is only on the order of a few tenths of a percent, but which is essential and is one of the main research fields in these years. It is the mass: the neutron has a per-mille larger mass than the proton. We do not understand the difference in the masses of the two hadrons but, even more, we do not really understand

the origin of mass at all. Here physics might be at the doorway for great new findings when the present theoretical framework will be proved or disproved, whether the Higgs particle will be observed or not-observed, whether it exists or not. In this context we do not understand the inequality between matter and antimatter in our Universe. How was matter created and where is the antimatter if they were both created in the same amount, as mirror images one to one. Though this is an extremely interesting topic, I will not comment further. I just would like to state that at COSY:

- *We are not searching for the Higgs particle – for that the COSY beam energy is too low, and*
- *We are not inventing a possible difference between matter and antimatter – for that we do not have the right particle types in sufficient quantity.*

At COSY we are contributing to the determination of masses and widths of particles, we are contributing to the matter-antimatter interference, we are – in the medium energy regime – at the frontiers of modern sciences.

Now, why is COSY-11 a neutron and not a proton? The neutron is slightly heavier, and therefore dominant but, because it is heavier, the neutron decays through $n \rightarrow p e^- \bar{\nu}$. In our symbolism, the neutron disappears and turns into a proton and something else. The COSY-11 neutron will stop existing as such, but will survive in other important activities. And the newly born proton, which was formerly the neutron, will live for ever, at least as long as the World and the Universe will exist. COSY-11 decays and turns in into WASA at COSY, at least its major parts will, and into PANDA on a longer term.

But parts of the neutron turn into the electron and the neutrino, $e^- \bar{\nu}$. We all know how important these secondary particles are, coming from the decaying neutron or COSY-11. The electron is essential for atoms and binds them to molecules, which form matter and us. The neutrino cannot be prevented from passing through just about everything. It is small, tiny, fast and not to be stopped once it exists. I am sure that you will see what happens with the decaying COSY-11 team; it multiplies itself to very important new sources of new activities.

Here we are gathered in the Copernicus museum and we are really privileged to be allowed to do so. We are here among valuable and unique experimental equipment. We admire the way and style those tools for studying nature have been invented and are presented here. We are jealously seeing with what kind of accuracy they have been made, serving the precision needed but still being ornamented with beautiful decorations, illuminations and symbols. Our equipment is much more dry and sober.

Still we allow ourselves to present one of our detectors to the museum for whatever use by generations to follow. We appreciate the courtesy, generousness and liberality of the museum to take it into their collection. This detector was built as a joint effort by COSY-11 with essential contributions from the Research Center Jülich and the Institute of Physics at the Jagellonian University under the leadership of Jerzy Smyrski.

We are privileged to work in our field and to be here, to work as scientists in the fantastic community, to be members of this exciting community in a unique Europe among many nations coming together. Let us try to continue on this advantageous way, together.

Many thank to all of you and good luck for your and our futures.