

61st Meeting of the LHC Collimation Working Group, July 08, 2005

Present: Oliver Aberle, Ralph Assmann (chairman), Cristina Biino (INFN-Torino), Markus Brugger, Ilias Efthymiopoulos, Brennan Goddard, Gianluca Guaglio, Vincenzo Guidi (INFN-Ferrara), Massimiliano Fiorini (INFN-Ferrara), Roberto Losito, Manfred Mayer, Stefano Redaelli (scientific secretary), Walter Scandale.

1 Crystal experiment at the SPS

This special collimation working group meeting was devoted to a discussion on a possible crystal experiment to be carried out at the SPS. The goal of this meeting was to assess the scientific interest of the crystal experiment and to bring together the people from various CERN groups that would possibly be involved. This is required to estimate in detail the required manpower.

Overviews of past and recent crystal experiments and latest information on the state-of-the-art crystal technology can be found in the proceedings of the recently held Care-HHH workshop on “Crystal Collimation in Hadron Storage Rings”:

<http://care-hhh.web.cern.ch/CARE%2DHHH/CrystalCollimation/>

1.1 Goals and deliverables of a crystal experiment at the SPS (W. Scandale)

See slides at http://www.cern.ch/lhc-collimation/files/WScandale_1_2005-07-08.pdf

Walter Scandale (WS) gave a general introduction on the crystal experiments to put in perspective the proposed crystal experiment at the SPS. Details can be found in his slides. It is well known that crystal experiments with stored beam were already carried out at the SPS starting from the early nineties (**RD22** experiment). There, channeling efficiencies of the order of **10 %** were achieved. The **main motivation to repeat crystal experiments now** is that in the recent years the crystal production and bending technologies have considerably improved. Simulations and experimental results promise that multi-turn channeling **efficiency up to 90 %** can be achieved with state-of-the-art crystal, as they can be produced for instance in Russia or in the INFN section of Ferrara (I). However, these claimed performances are not yet supported by solid experimental results and the community calls for an experimental verification with beam. A reasonable **goal** is to achieve **multi-turn channeling efficiencies $\geq 90 %$** .

On paper, these new results make the crystal technology very attractive for various applications at the LHC. Notably, **the LHC collimation** could be improved by using small bent crystals as primary collimators. The crystal extraction could be very useful also for **LHC ion collimation** (which is still an open point for the LHC). Another possible use of crystal could be an efficient reduction of the **background in the detectors**.

WS stresses that there is a wide interest from Italian and Russian institutes to contribute to a crystal experiment at the SPS. Contributions include crystal production (from Russia and Italy), detection systems, manpower and money. Upon a CERN commitment on the realization of the SPS crystal experiment, the various resources will be made available to deliver the various components within 2006.

1.2 Possible installation layouts at the SPS (W. Scandale)

See slides at http://www.cern.ch/lhc-collimation/files/WScandale_2_2005-07-08.pdf

On behalf of Gianluigi Arduini, who could not attend this meeting, WS presented a possible layout of the crystal installation at the SPS. As a baseline, it is assumed that **two different crystals** will be tested, with bending angles of ≈ 4 mrad and **0.2 mrad**. The goals would be (1) to experimentally assess the multi-turn channeling efficiency with different bending angles and (2) to investigate the efficiency of a crystal-based, two-stage collimation system. For the goal (2), it is foreseen to make use of existing scrapers and collimators that will be already installed in the SPS. Notably, the LHC secondary collimator prototype will also be used (the same used for the 2004 tests with beam).

Installations in **four locations** are required for the experiment:

- **two locations** are needed to install the crystals (different vacuum tanks must be used);
- **one location** is needed to install the **detection arm** of the large bending angle experiment
- **one location** is required for the installation of a **roman pot**.

Preliminary studies by Gianluigi Arduini have shown that there is enough space for all these installation in the **straight section 5 of the SPS**. Some further iterations would be required to finalize the layout. WS commented that the proposed layout is not optimum for the crystal experiments, in particular there is some concern for the low-angle extraction, but it should be good enough to successfully achieve the experiment goals.

WS commented that it is not easy to estimate in detail how much material of the old RD22 test could be re-used for the new crystal experiment. It seems clear that the **vacuum tanks** must **re-designed** and **re-built** from scratch because the old one is too long. For other components such as motors, cables, tank windows, etc. the availability is difficult to estimate without help/suggestions from the experts. Therefore, **WS proposed that the people involved take some time to figure out what is available** and can be re-used and what needs to be re-built. This step is mandatory to have reliable estimated of costs and required man power.

1.3 External contributions from Italy and Russia (C. Biino)

See slides at http://www.cern.ch/lhc-collimation/files/CBiino_2005-07-08.pdf

Cristina Biino (CB) discussed possible contributions to the SPS crystal experiment from Russian and Italian institutes. Details of the foreseen contributions are listed in CR's slides. It is noted that there is a certain interest from the TOTEM people to contribute to the experiment with a Roman Pot detector to measure the fluxes of channeled particles. This could have the advantage of using some equipment that was installed for the SPS test with the roman pots on 2004. Several equipment will only be available in 2007.

1.4 Discussion

There was a general agreement that, even if additional studies are certainly required, the promises of crystal applications are interesting and potentially useful for the LHC. There were no principle objections to carrying out a crystal test at the SPS even if there were several concerns about the required manpower (see below). The presentation triggered several questions.

- Ilias Efthymiopoulos said that, even if the promised channeling efficiencies will be achieved, the channeled halo particles must be collimated somewhere. WS replied

that the **crystals** are meant to be used **instead of the primary collimators**. A dedicated system of secondary collimators must be in place to absorb the channeled particles. The advantage of a crystal-based collimation is that one can in principle get larger scatter angles than with the amorphous primary collimators. This should ensure a better halo cleaning. RA commented that having a highly channeled beam of halo particles could cause problems of collimator survival in case of low beam lifetimes. This should be investigated,

- Ilias Efthymiopoulos also asked what happens to the un-channeled particles that hit the crystal. There was a general concern about the crystal survival. Brennan Goddard asked what happens in case of even slight heating of the crystal. Can deformations spoil the channeling performance? WS replied that the crystal is **almost transparent** to the beam. Particles that are not channeled interact very poorly with the crystal. Therefore, that should be no survival issues for the crystal. In addition, WS believes that, even if the channeling performance might be changed by tiny crystal deformations, it cannot be made worse than for an amorphous material as the Carbon LHC primary collimators. Available experimental results from transfer line tests suggest that there should be no problem for the crystal survival at low energy densities (Cristina Biino). Nevertheless, WS agrees that it would be **useful** to systematically study the effect of high intensity, high energy beams on the crystal.
- Manfred Mayer stressed that, with the presently available manpower at the design office, it will **not be possible to design and build at CERN the required vacuum tanks to house the crystals**. WS is aware of this problem and believes that a possible way out is to ask **help from the Russian collaborators** or from the **INFN-Legnaro collaborators**. This requires follow-up.
- RA asked about possible **deadlines** for the external contributions to be made available for the experiment. WS has had commitments that the required equipment (crystal, detectors, man power, ...) will be **available within 2006** for full beam experiment in 2007. Partial experiments could be done already in 2006. But WS stressed that a CERN commitment on the realization of the SPS experiments is required to start the procedures.
- RA also asked how many FTE's from other institutions are involved. WS replied that at least **15-20 FTE's per year from Italian and Russian institutes** are committed to contribute to the SPS crystal experiment.
- Stefano Redaelli asked how much beam time should be asked for the experiment. WS replied that probably **5 shifts of 8 hours each** should be sufficient. RA had some concern whether this was enough and proposed to ask suggestion to Gianluigi Arduini.

1.5 Conclusion

The collimation working group **endorses the idea of a crystal experiment at the SPS** for its possible applications for LHC collimation. It was agreed that the details of the experiment (involved resources, time line) must be worked out in detail and then proposed to the LTC once there is agreement between the various involved groups. In particular, **a detailed written proposal** should be prepared as soon as possible and before going to the LTC. The proposal should in particular indicate the required resources.

From the discussions it appeared clear that the crystal experiment cannot be carried out during the 2006 SPS run but must be foreseen for the **2007** run. Nevertheless, in 2006 there could be tests of some crucial components like for instance the detectors. The startup of the collaboration with the partner institutes from Italy and Russia requires a CERN

Stefano Redaelli, 09-07-2005

commitment on the SPS crystal experiment. In order to make sure that all the equipment will be available in time, a final CERN commitment should be taken in **September 2005**.

The next meeting will be announced.