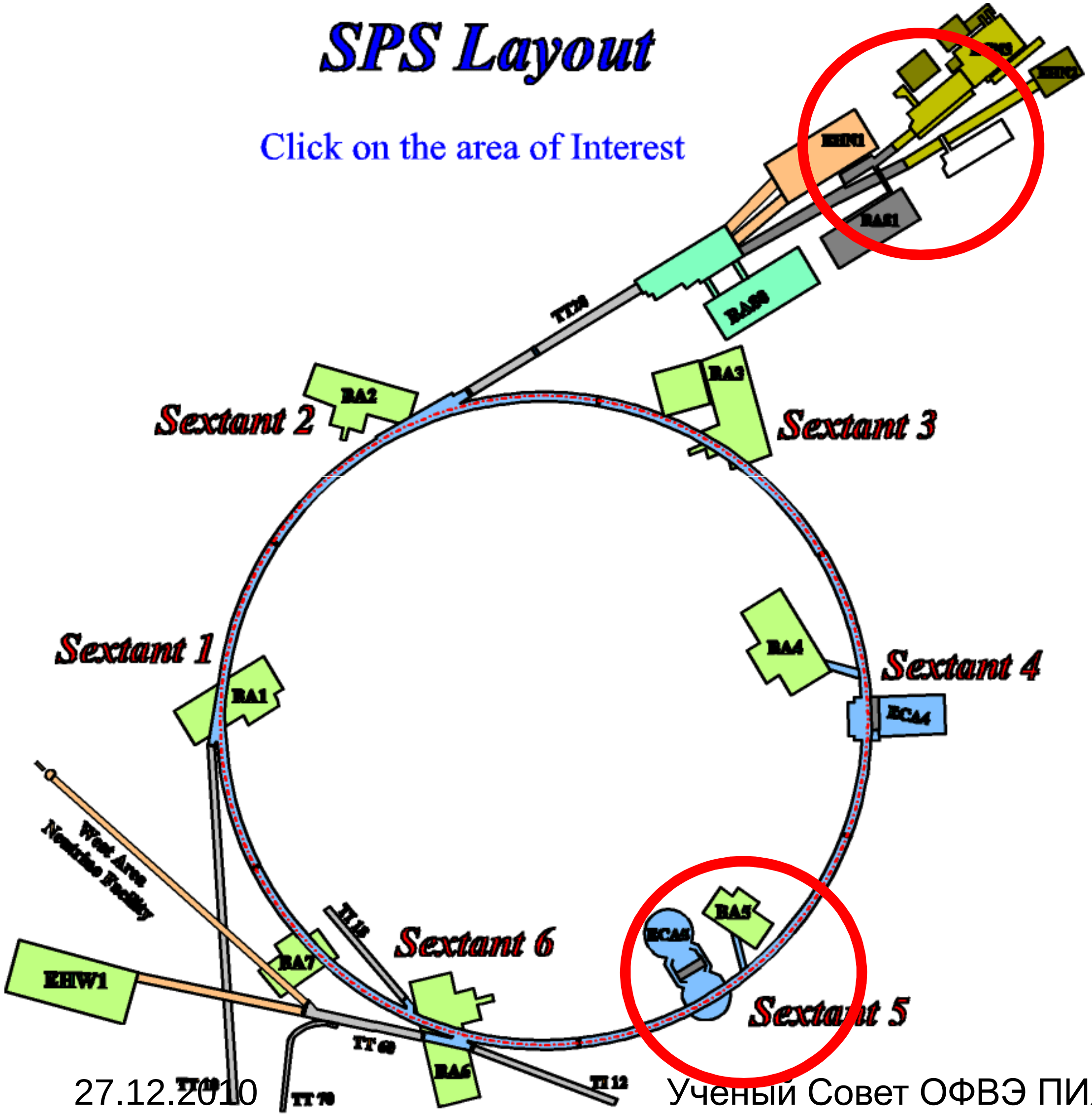
Эксперимент UA9

Ю.М.Иванов

UA9 в CERN


SPS Layout
Click on the area of Interest
Sextant 1
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BA1
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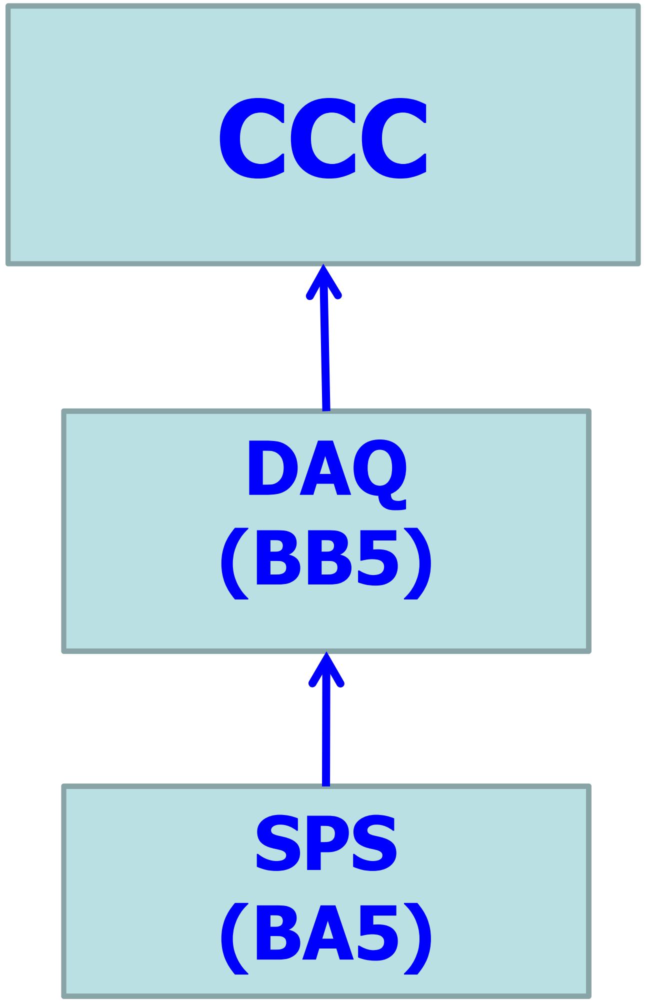
EHW1
West Area Neutrino Facility
TT 60
TT 70
TT 12


CCC
DAQ
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SPS
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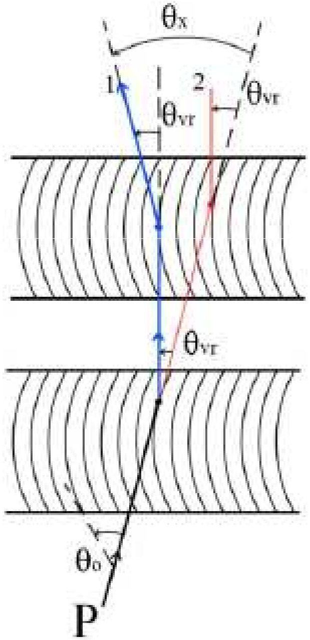
Публикации 2010 г.

- *Multiple volume reflections of high-energy protons in a sequence of bent silicon crystals assisted by volume capture,* **Physics Letters B 688 (2010) 284–288**
- *Observation of multiple volume reflection by different planes in one bent silicon crystal for high-energy negative particles,* **submitted to Europhysical Letters**
- *Deflection of high-energy negative particles in a bent crystal through axial channeling and multiple volume reflection stimulated by doughnut scattering,* **Physics Letters B 693 (2010) 545–550**
- *Probability of inelastic nuclear interactions of high-energy protons in a bent crystal,* **Nuclear Instruments and Methods in Physics Research B 268 (2010) 2655–2659**
- *First results on the SPS beam collimation with bent crystals,* **Physics Letters B 692 (2010) 78–82**

Multiple volume reflections of high-energy protons in a sequence of bent silicon crystals assisted by volume capture

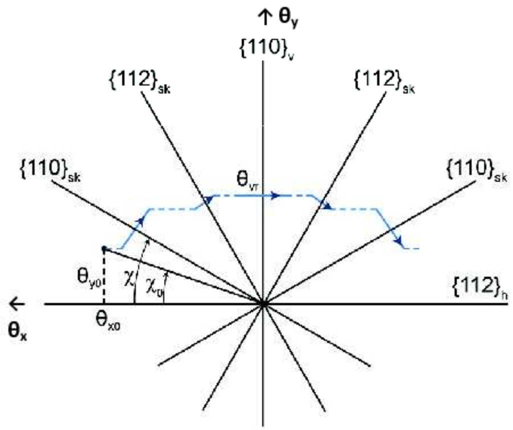


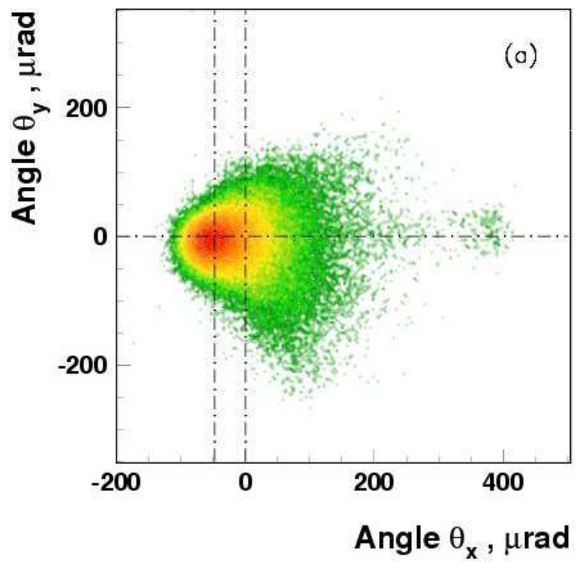
Multiple volume reflections of the 400 GeV/*c proton beam by the sequence of fourteen bent silicon* strips has been studied at the CERN SPS. The sequence is close to be parallel that is the spread of the strip orientation angles is much smaller than their bend angle and eleven strips working coherently in the regime of volume reflections deflected the beam by 110 μrad with the efficiency 88%, which is significantly larger than the estimation based on independent reflections. The mechanism giving the efficiency increase has been studied by simulation. It appears that many particles volume captured in one of the strips take part in volume reflections in the subsequent ones.

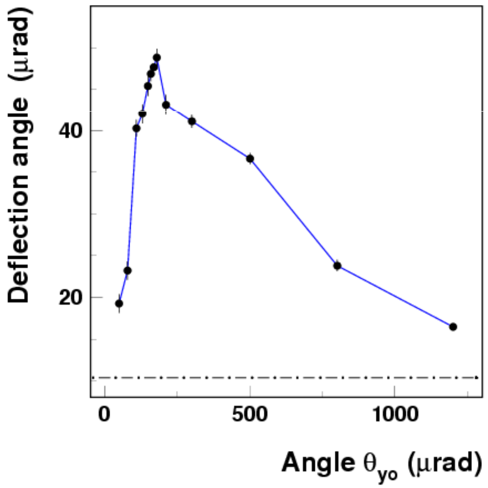
Observation of multiple volume reflection by different planes in one bent silicon crystal for high-energy negative particles

θm=(47.65±0.31) μrad

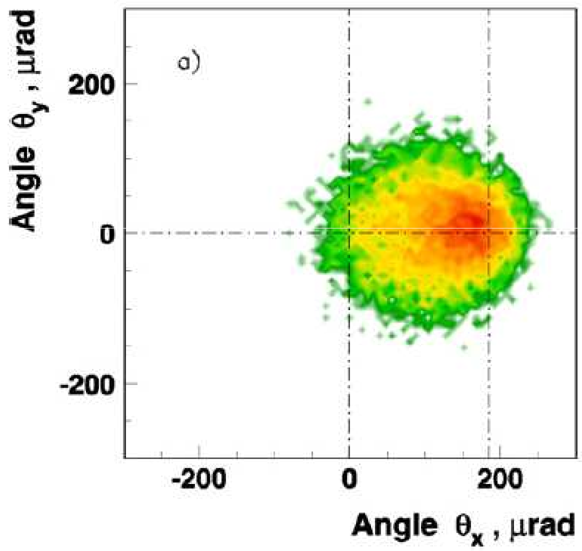
Pd(θx < 0) = (64.73 ± 0.31)%





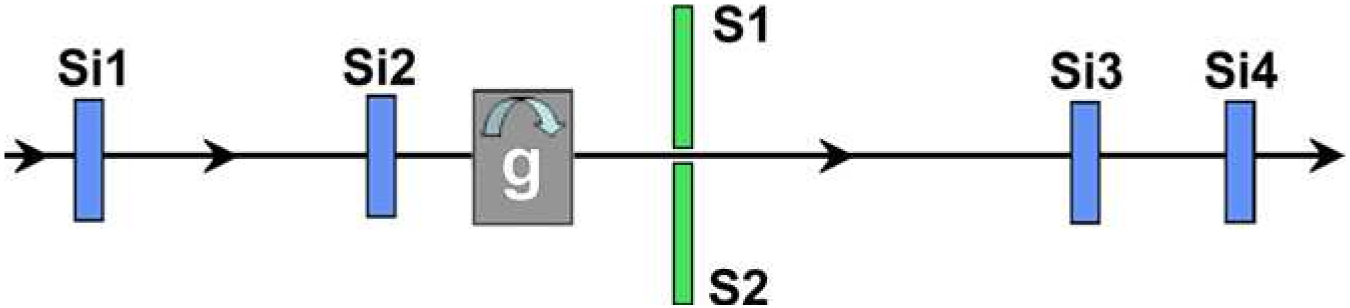


Deflection of high-energy negative particles in a bent crystal through axial channeling and multiple volume reflection stimulated by doughnut scattering



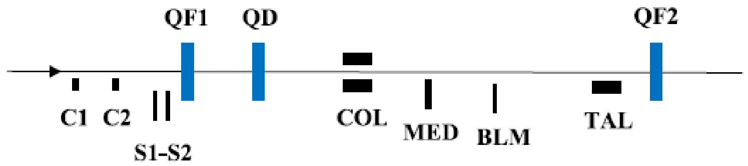
Different kinds of deflection in a silicon crystal bent along the 111 axis was observed for 150 GeV/*c* negative particles, mainly *π*− *mesons, at one of the secondary beams of the CERN SPS.* *The whole beam* was deflected to one side in quasi-bound states of doughnut scattering (DSB) by atomic strings with the efficiency (95.4 ± 0.2)% and with the peak position close to the bend crystal angle, *α =185 µrad. It was* observed volume capture of *π*− *mesons into the DSB states with a probability higher than 7%. A beam* deflection opposite to the crystal bend was observed for some orientations of the crystal axis due to doughnut scattering and subsequent multiple volume reflections of *π*− *mesons by different bent planes* crossing the axis.

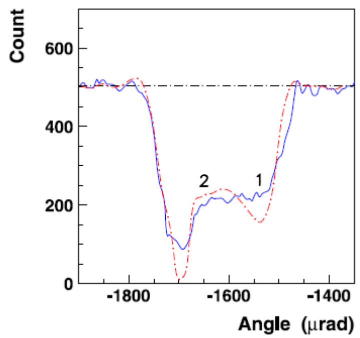
Probability of inelastic nuclear interactions of high-energy protons in a bent crystal

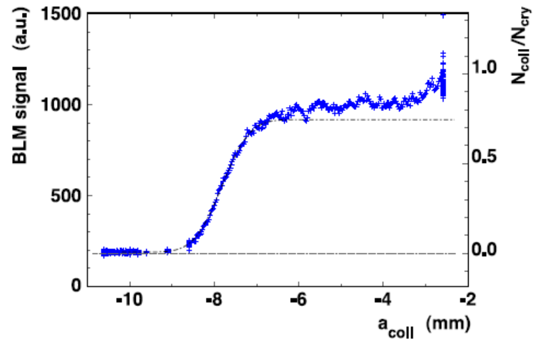


Probability of inelastic nuclear interactions in a short bent silicon crystal for its orientations optimal for channeling and volume reflection was investigated using 400 GeV/c protons of the CERN SPS. The contribution of nuclear interactions from channeled protons was observed to be about 3–4% of the probability for the amorphous orientation. For the crystal orientation optimal for volume reflection the nuclear interaction probability of protons was a few percents larger than in the amorphous case. It was shown that in the limiting case of a quasi parallel beam realizing for the collider beam halo the inelastic nuclear losses should decrease by more than five times, which is an additional advantage of a crystal as a primary collimator for the LHC collimation system.

First results on the SPS beam collimation with bent crystals

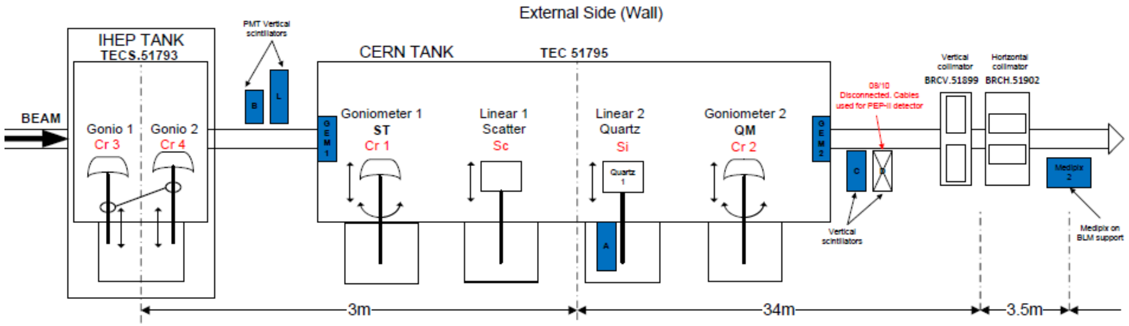


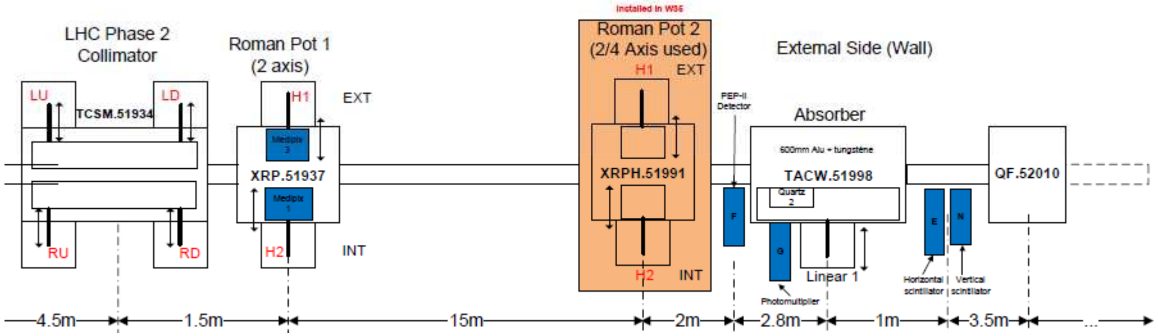


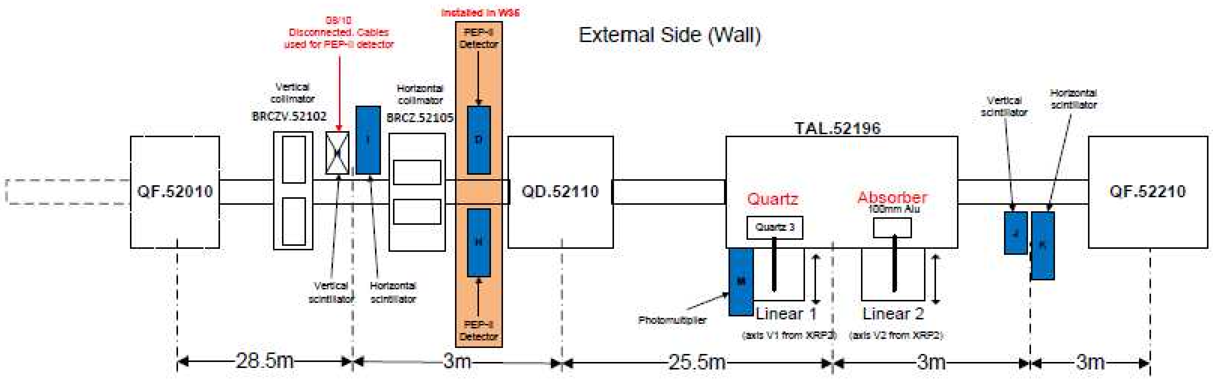


Experiments were performed at the CERN SPS with 120 GeV/*c stored proton beams to assess the possibility* of beam halo collimation assisted by bent crystals. A bent crystal was used to deflect horizontally by an angle of about 170 μrad the beam halo protons in channeling states directing them into a 60 cm long tungsten absorber. The halo loss rate due to nuclear inelastic interactions of protons in the aligned crystal was up to five times smaller than for its amorphous orientation. Channeled fractions, *(75 ± 4)%* and *(85±5)% for the two tested silicon crystals, were measured by intercepting the deflected beam with* another collimator located between the crystals and the absorber. The pixel detector (MEDIPIX) installed in a Roman pot inside the beam pipe was used to obtain visual images of the deflected beam.

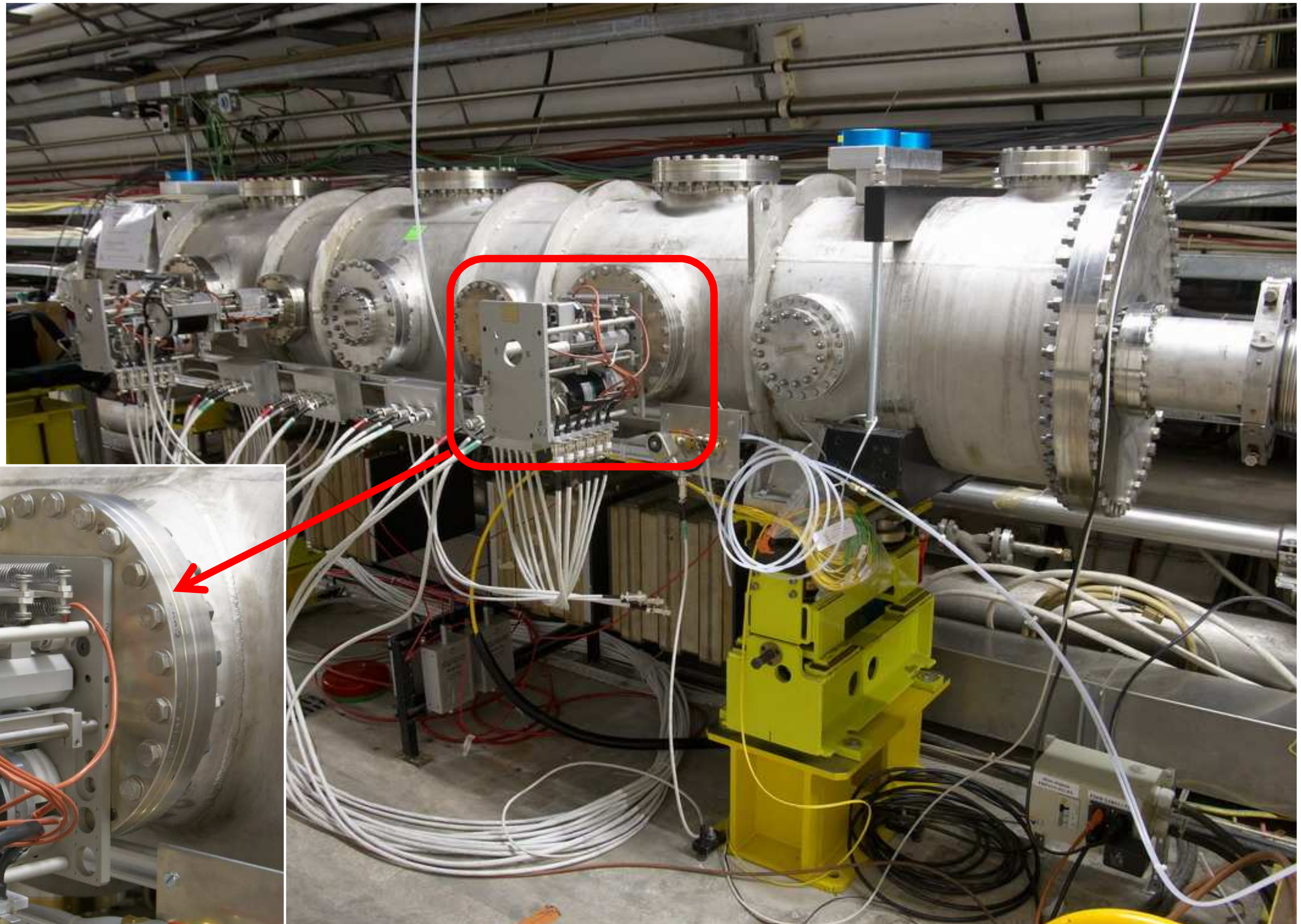
Расположение установки UA9 на кольце SPS



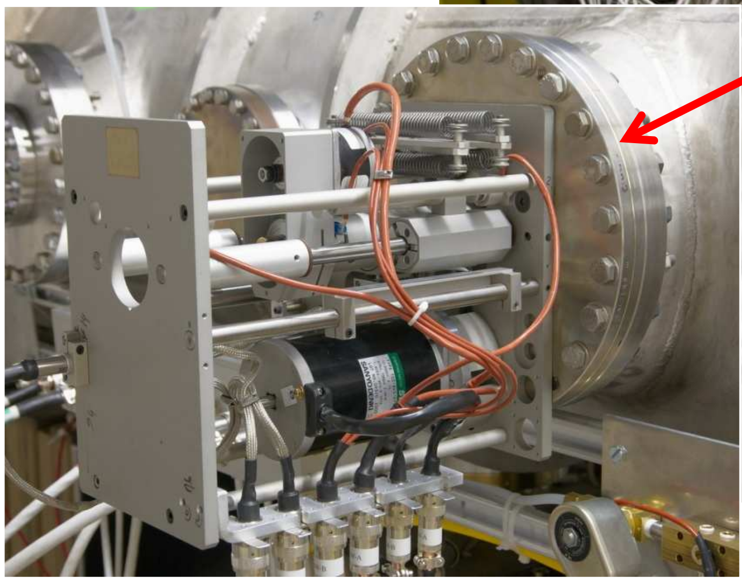




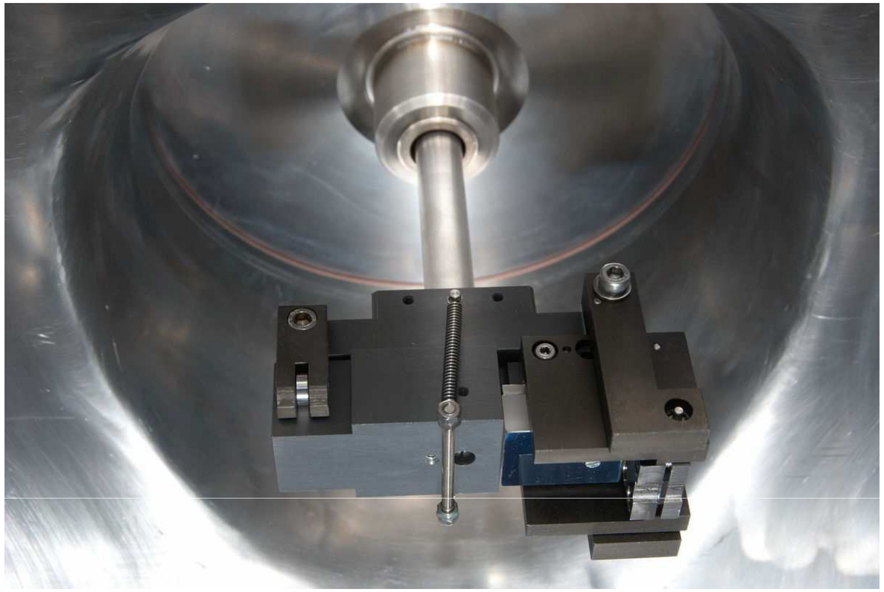
Вакуумный танк с гониометрами для двух кристаллов

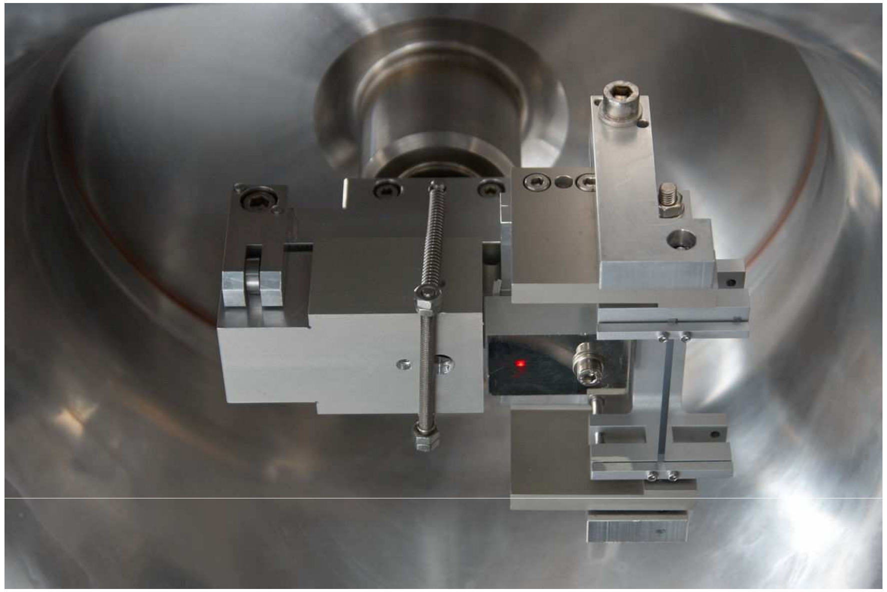


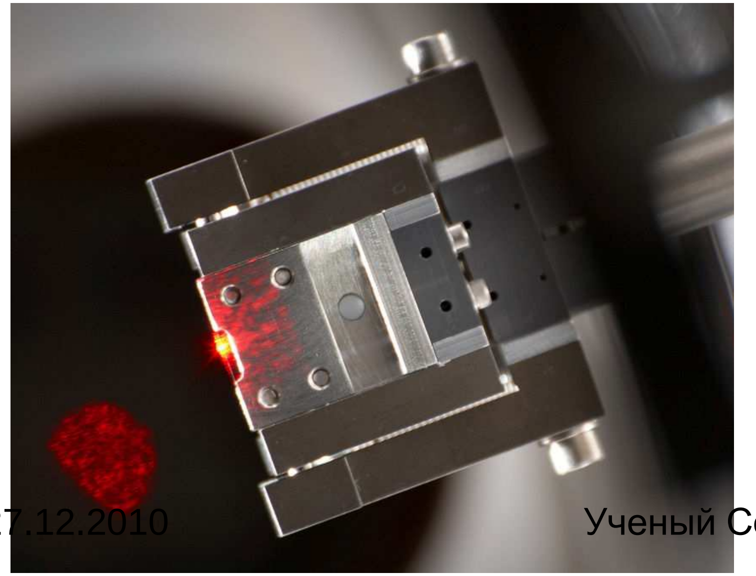
Гониометр

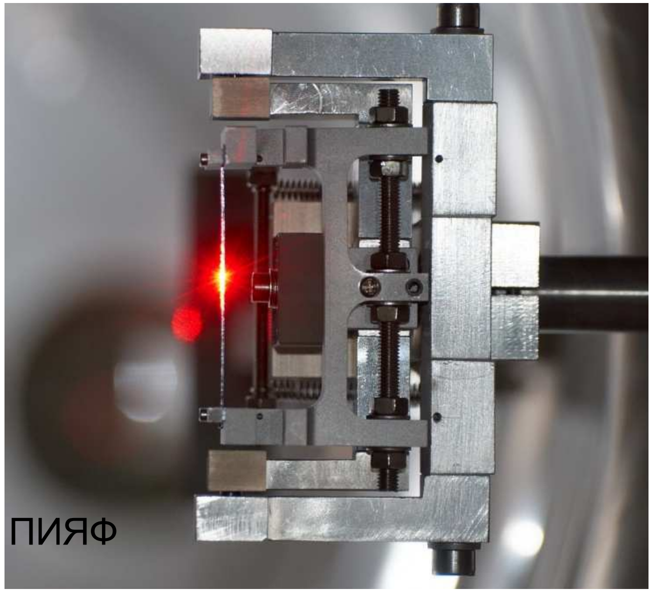


Установленные на гониометры кристаллы



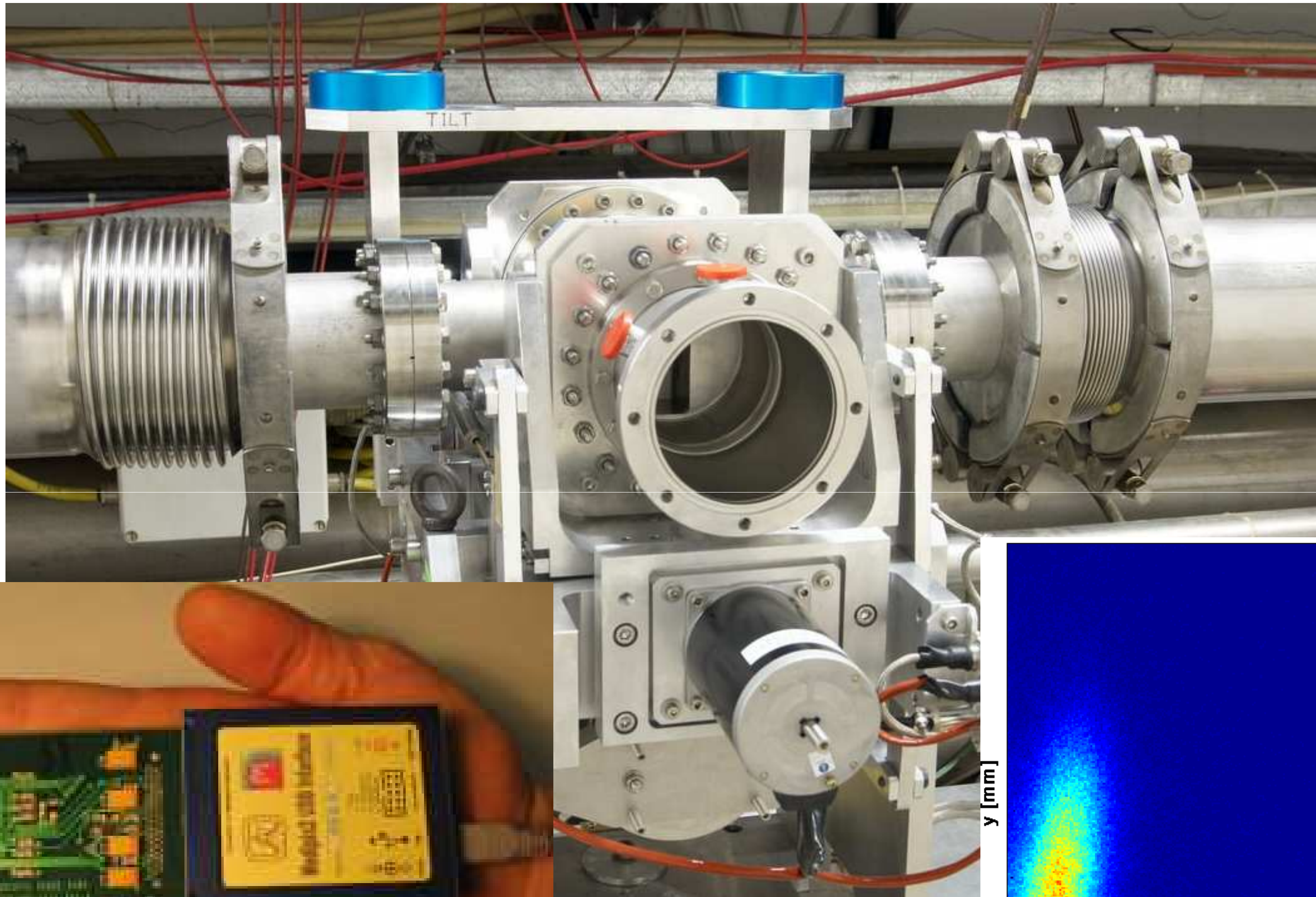


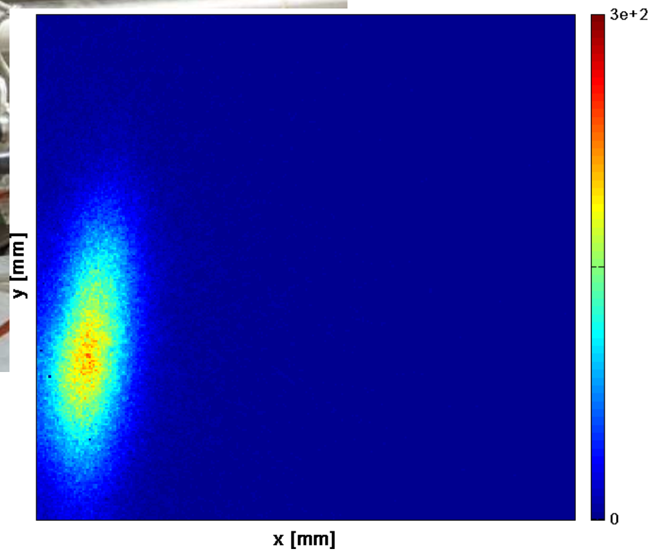




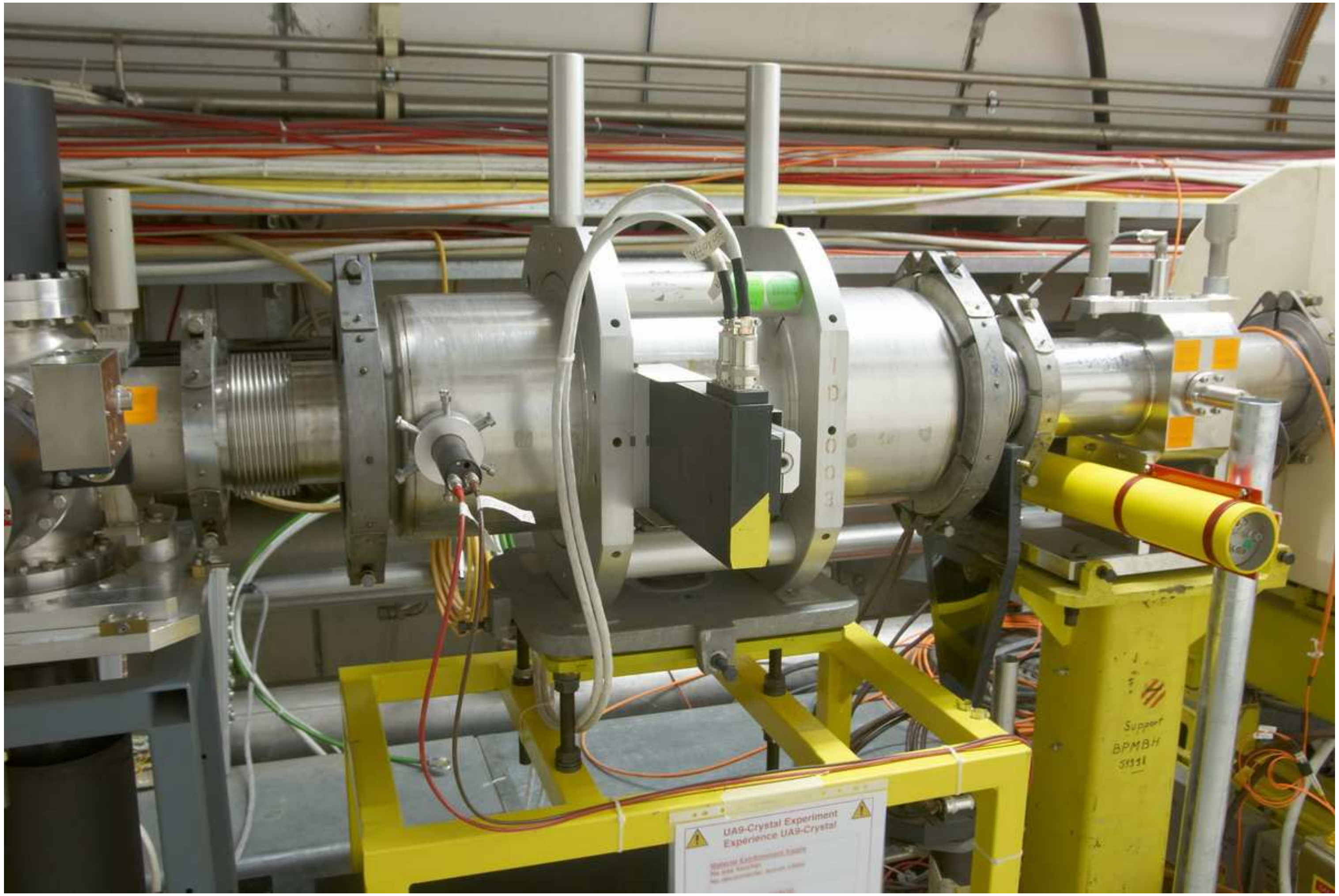
LHC коллиматор

Пиксельный детектор MediPix

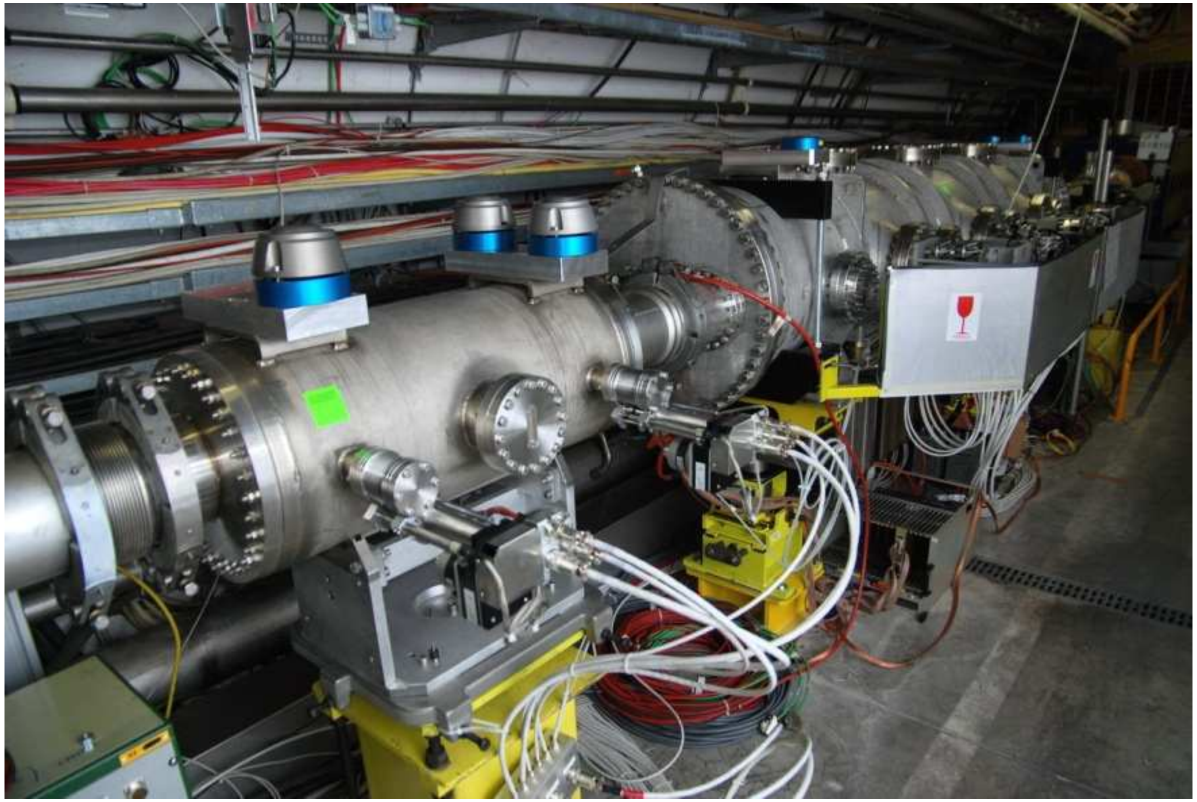




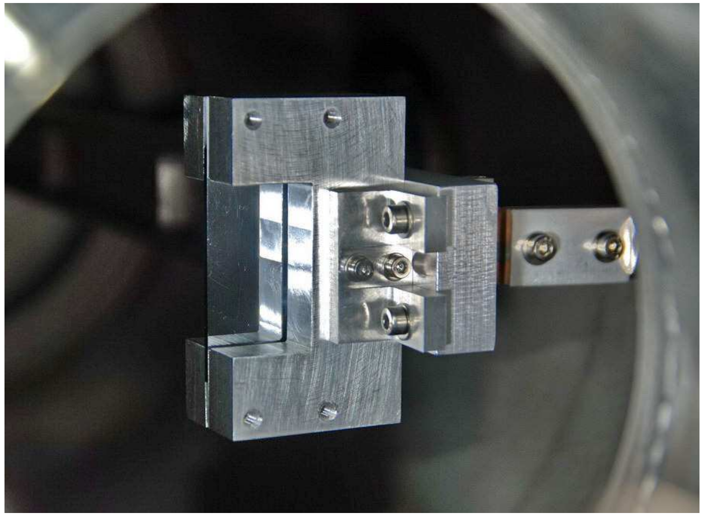
Коллиматор отклоненного пучка



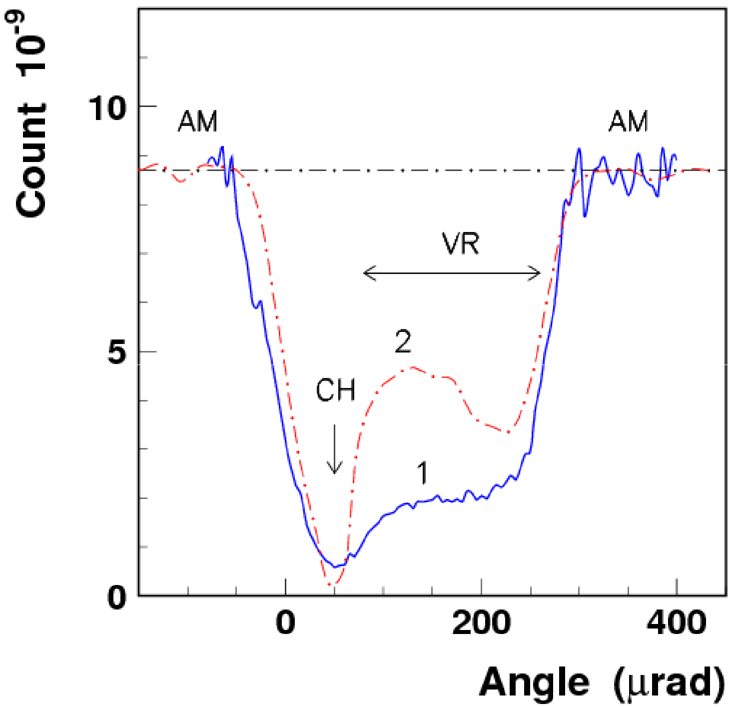
Новый танк с гониометрами для двух кристаллов



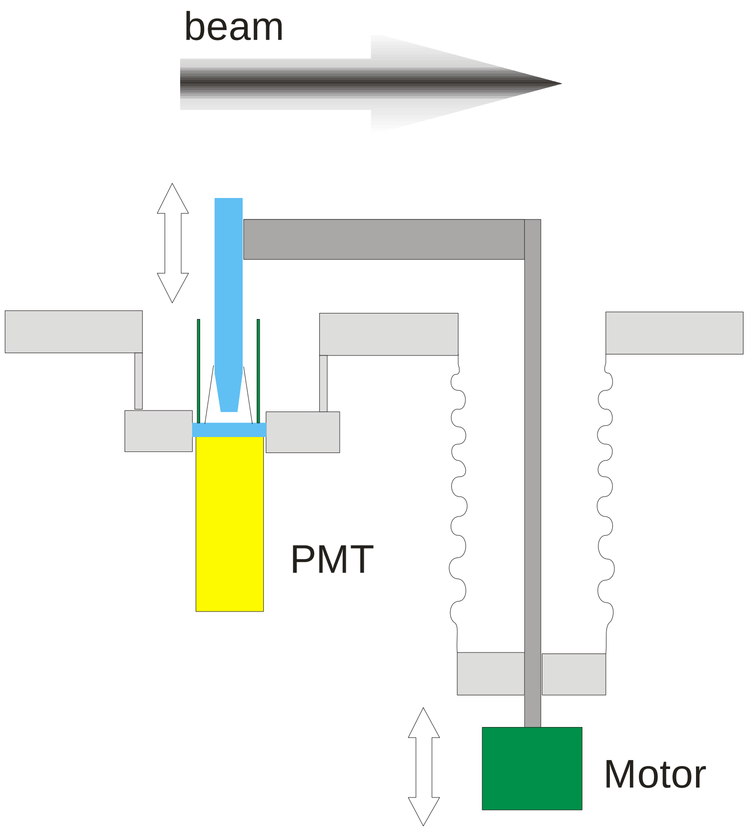
Кристалл



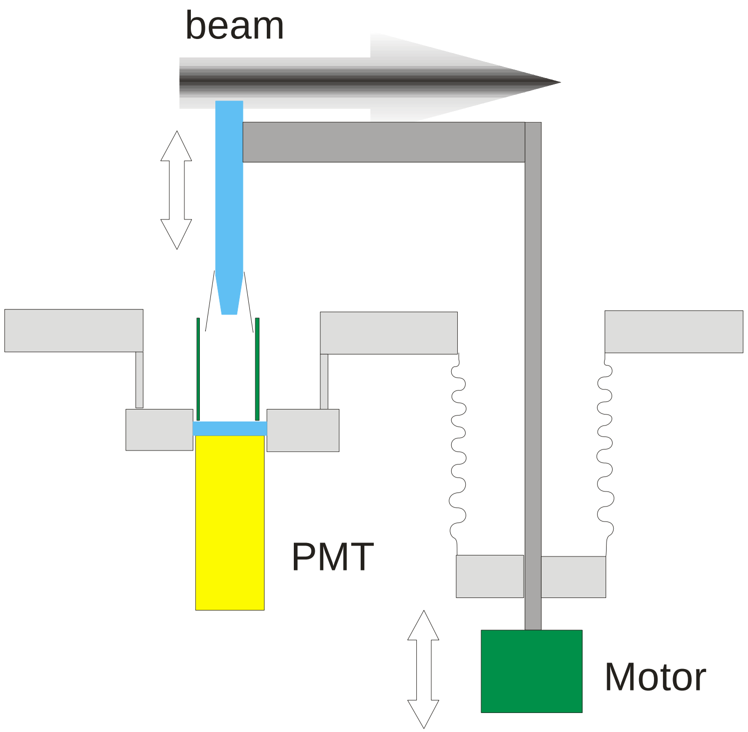
Угловой скан с новым кристаллом



Cherenkov detector for SPS

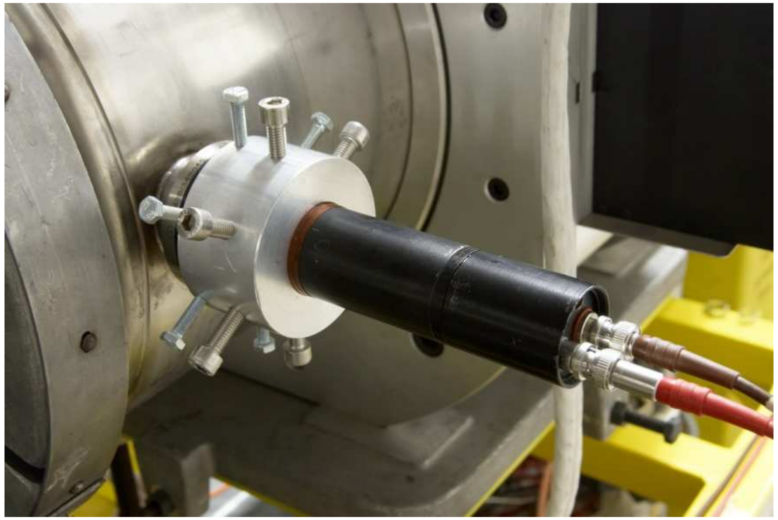


OUT position

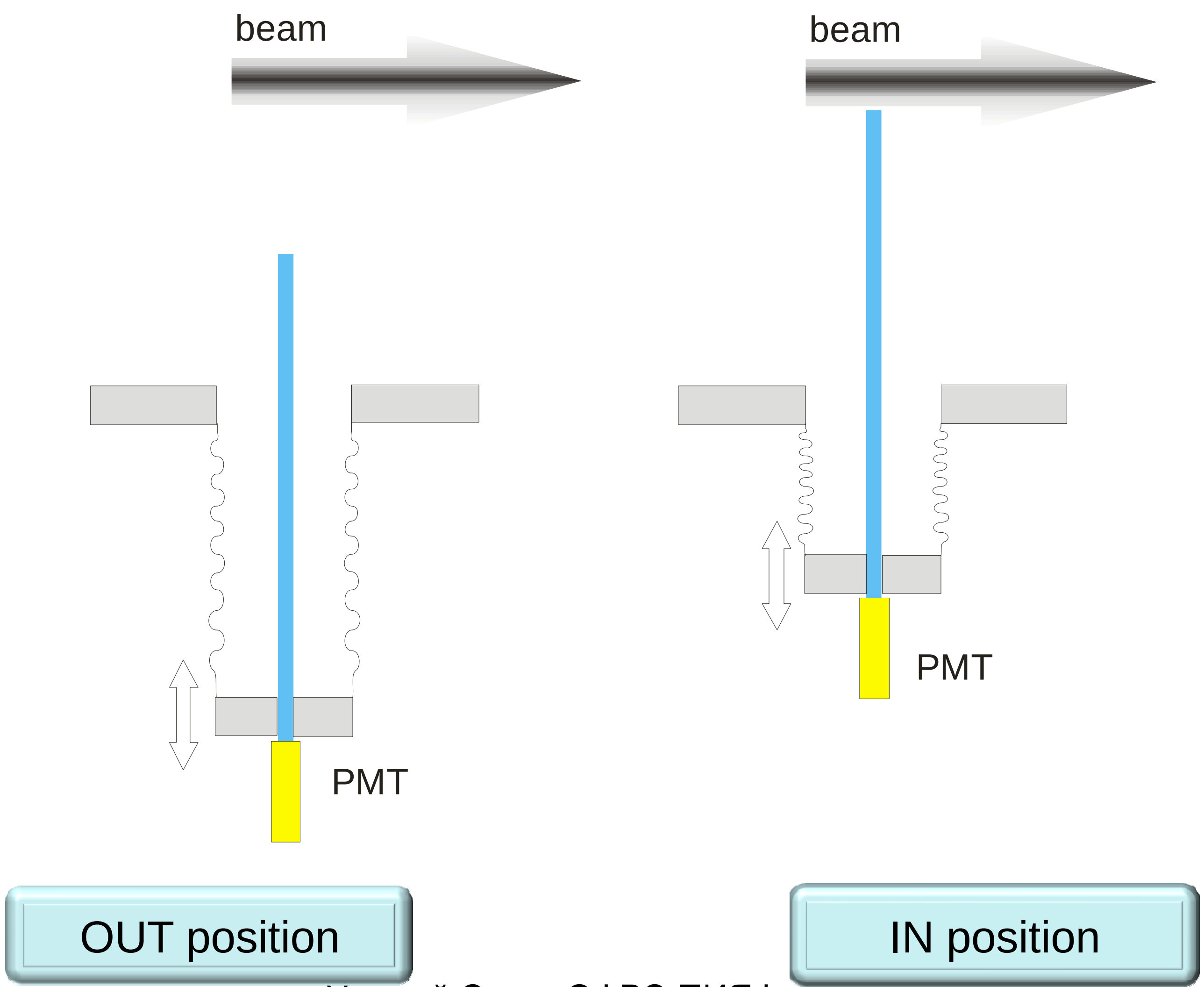


IN position

Черенковский детектор перед коллиматором отклоненного пучка



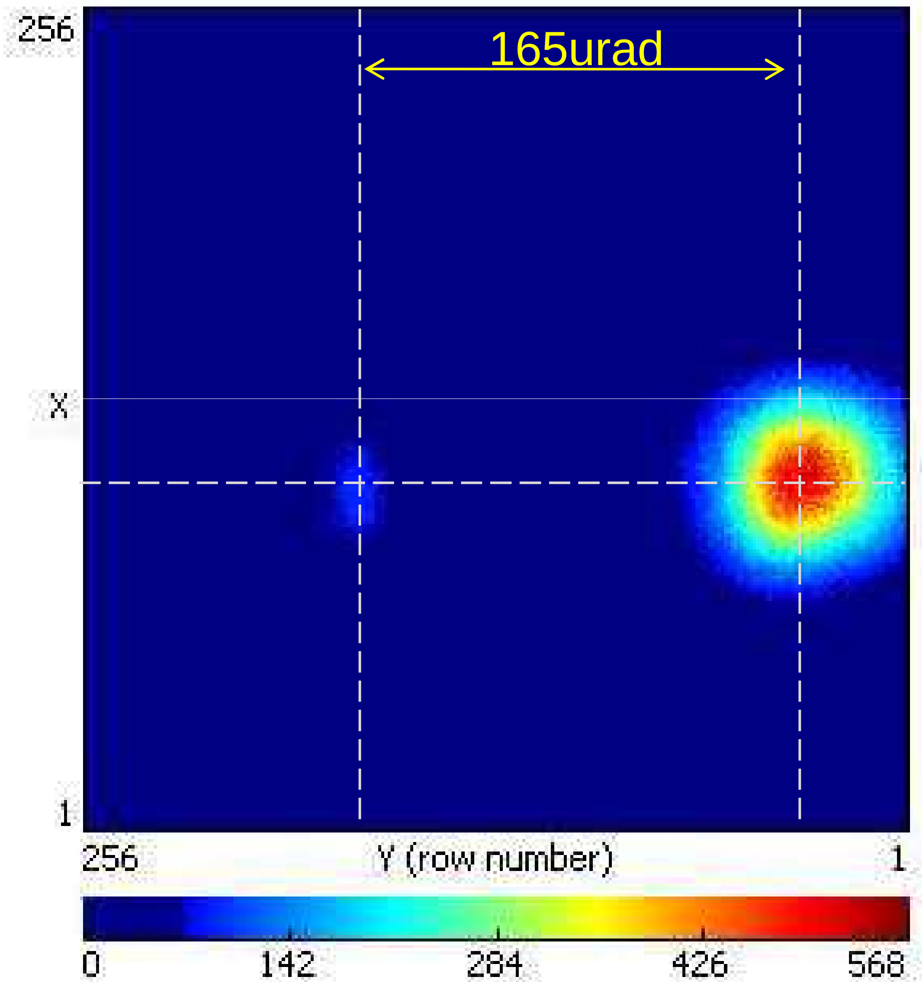
Improved Cherenkov detector for SPS



H8

Observation with Medipix

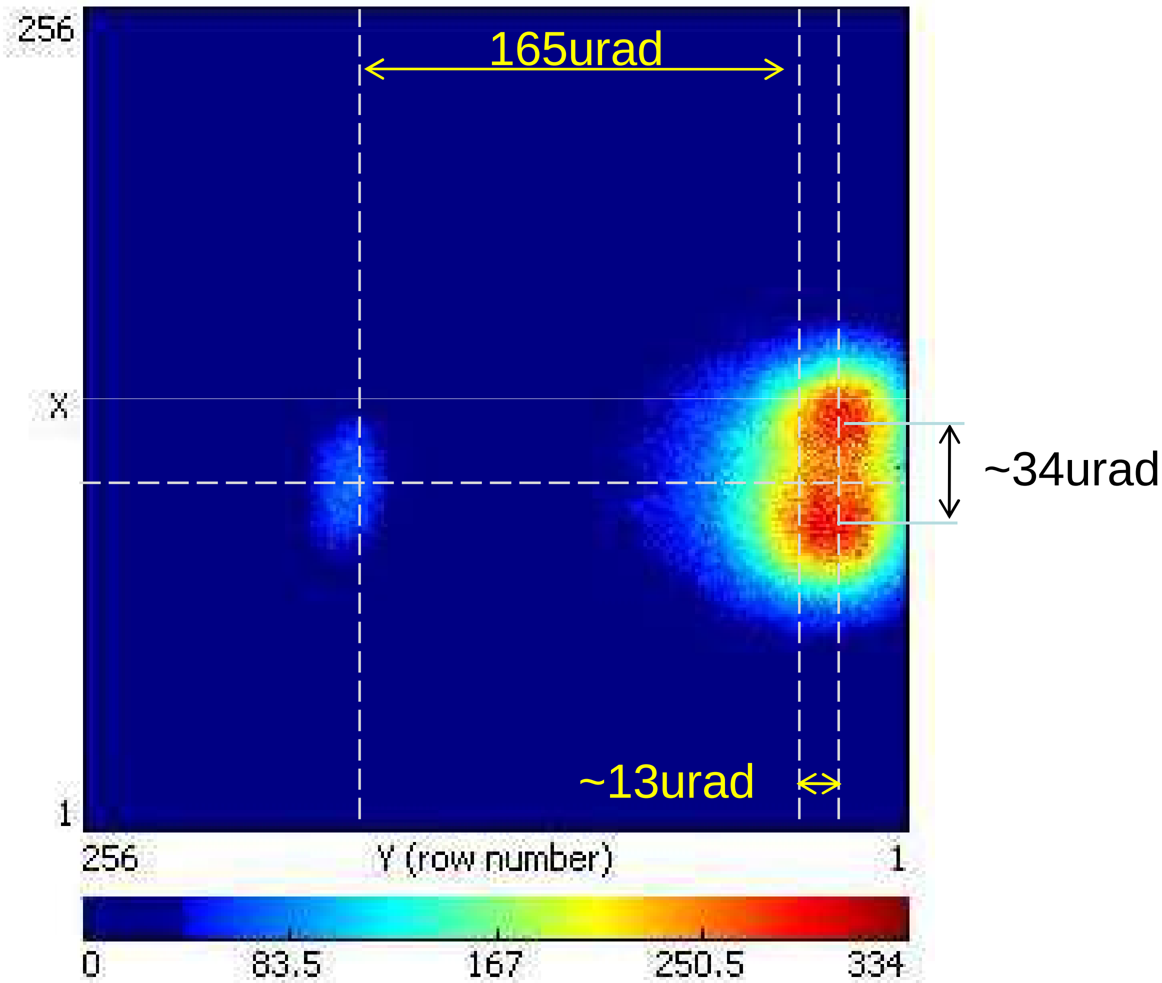
Crystal QM25SPS in channeling



H8

Observation with Medipix

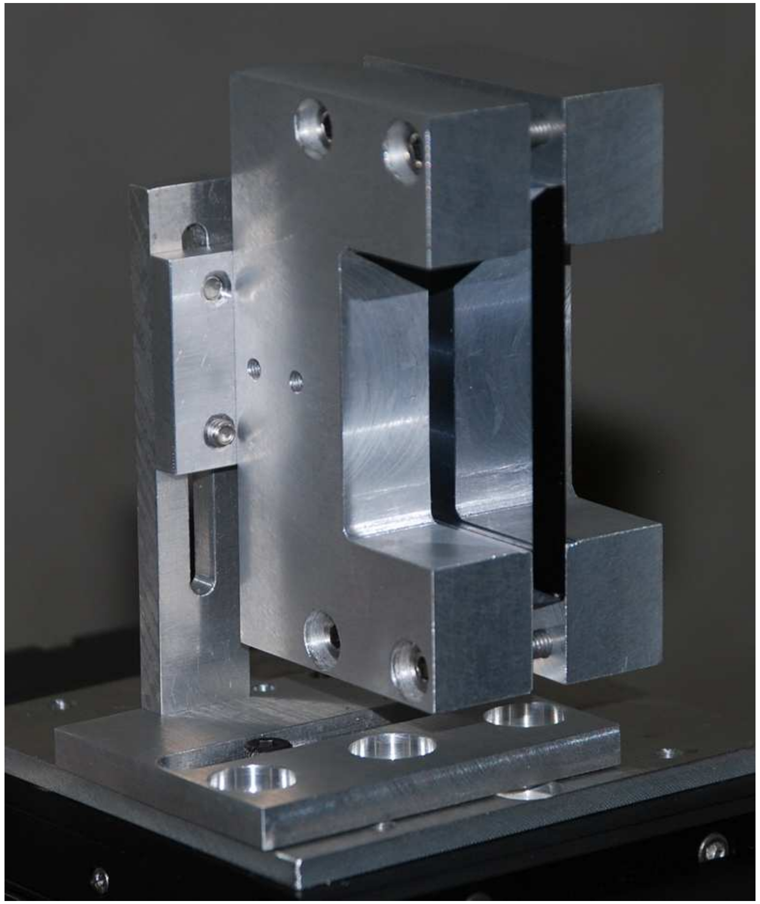
Crystal QM25SPS in channeling + optimized vertical angle



H8

QM28-QM29

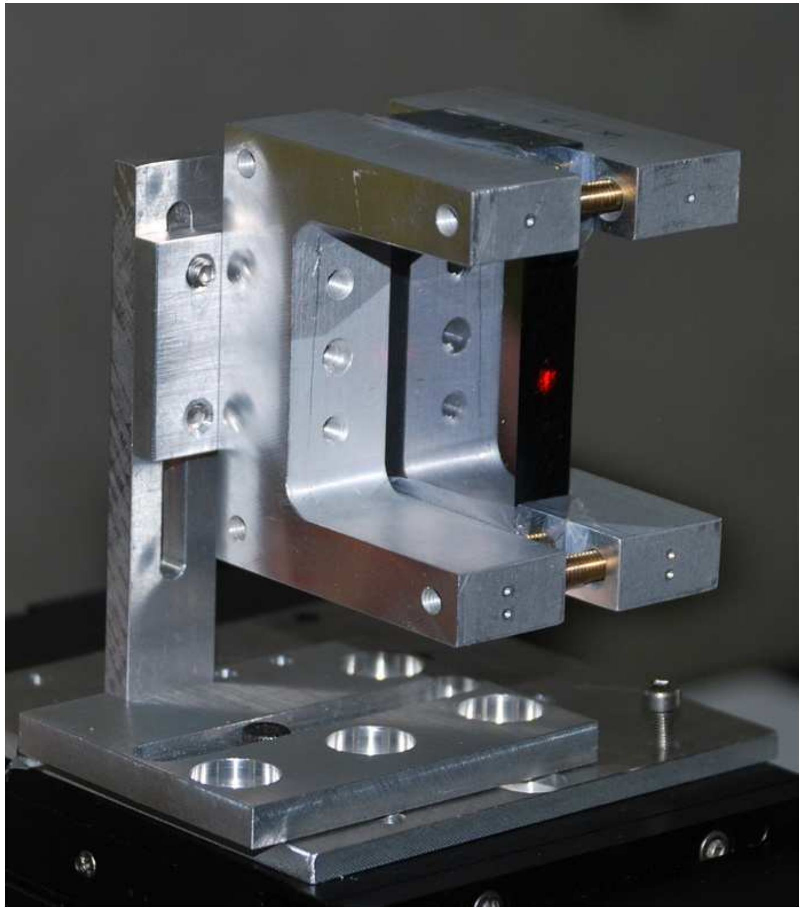
- Thickness 6mm
- Data has to be analyzed



H8

QM30-QM31

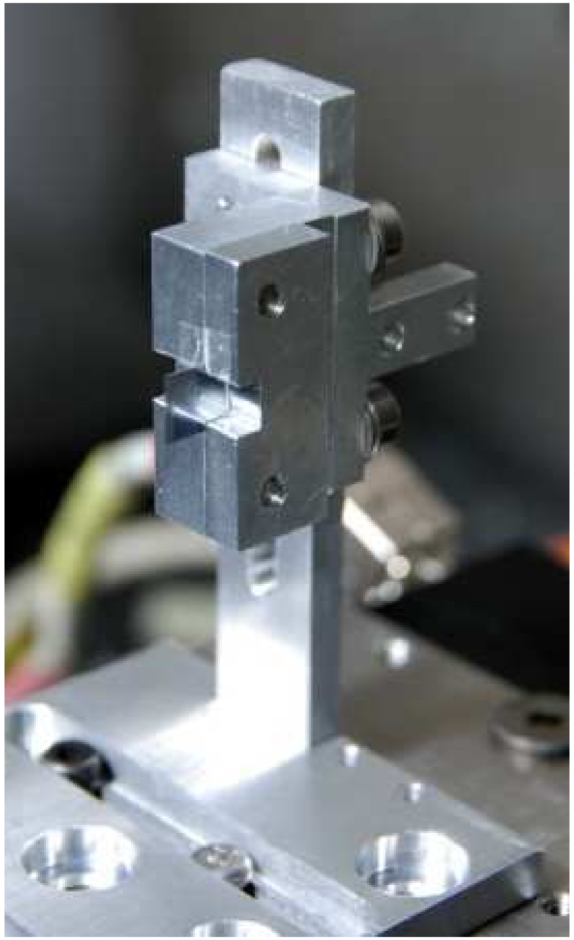
- Thickness 10mm
- Data has to be analyzed



H8

TFP1 (25 um) “mirror”

- No observation of “mirror” effect online
- Collected data has to be analyzed



Планы LHC

1. CERN management very clearly expressed the wish to install a crystal in the LHC.

2. Operation of devices installed into the LHC during experiment data taking will be under the responsibility of experts in LHC operation.

3. The UA9 collaboration will propose the experimental layout, based on the information provided by the Collimation project, and will take care of proposing the experimental procedures: it will elaborate on the parameters that should be measured and on the measurement techniques. The UA9 collaboration will also be in charge of data analysis and evaluation of the results in order to prove the feasibility of crystal collimation in the LHC.

4. Once the principle is considered sufficiently assessed, the design and installation of an eventual operational collimation system for the LHC will fall under the responsibility of the Collimation Project.

5. The schedule of the experiment will be the following:

1. The crystal collimation concept will be tested initially at 450 GeV, such that accidental effects will not be destructive for the machine. It is important to notice that at higher energies (already at 3.5 TeV) even the lowest possible available intensity (2 109) risks to melt the vacuum chamber if lost accidentally and is therefore considered an “unsafe” beam.

2. The crystal will be tested at the higher possible energy, to prove the effectiveness of crystal collimation concept in the LHC case.

6. Given the current schedule of the LHC, we expect to have a full demonstration of the crystal collimation principle at nominal energy and intensity in the LHC during 2016/2017, even if significant results can be expected before.