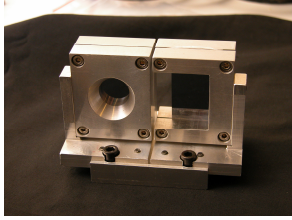


Status of UA9

Walter Scandale *CERN*

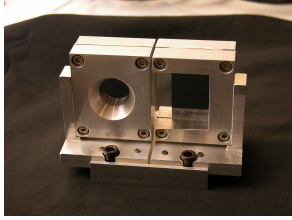
For the UA9 collaboration

(CERN, INFN, IHEP, PNPI JINR, SLAC, LBNL, FNAL)

LMC36

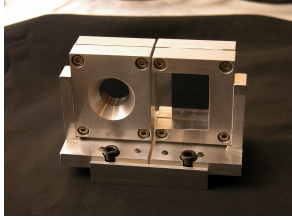
11 November 2009

UA9 summary results of the 2009 MDs



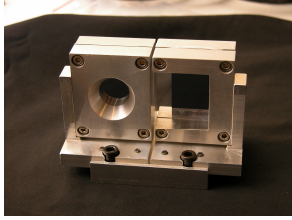
- Crystal collimation works very well based on *channeling process*
  - Optimal crystal alignment easily detected and achieved
  - Steady operation for many hours – even in presence of large CO glitches (as in last MD)
- *Collimation leakage* hardly measurable -> *inefficiency* compatible with 0
  - *Diffractive* and *betatronic* loss rate negligible at the TIDP location
- Multi-pass *channeling efficiency* very large -> compatible with 100%
  - Clearance area between the deflected and the circulating beams almost empty
  - About 20 % uncertainty due to BCT and MEDIPIX calibration
  - Loss profile in the close-to-collimation area as expected from simulations
- *Nuclear loss rate* (including diffractive) strongly depressed
  - In channeling versus amorphous mode : × 5 in multi-turn (SPS) and × 3 in single-pass (NA)
  - Effect of the target length to be checked (crystal is a few mm long - LHC-collimator is 1 m)

outlook



- Many positive indications in the SPS data
  - Easy operation of the crystal in the SPS in collider mode
  - Large collimation efficiency up to 85 % for 92 % expected from simulations
  - Strong reduction of the nuclear rate in channeling
  - No leakage of the collimation system (but this is an expected result in a quasi-linear machine)
- Some points need clarifications
  - more reproducible gonioneter,
  - crystals in planar mode instead of quasi-axial mode
  - More instrumentation and collimators to observe the far-from-collimation area
  - More stable accelerator
  - We need an improved hardware and more running time in the SPS at least for one more year
  - The available results are so encouraging that it is wise and starting the preparatory work for a test LHC

The SPS beam

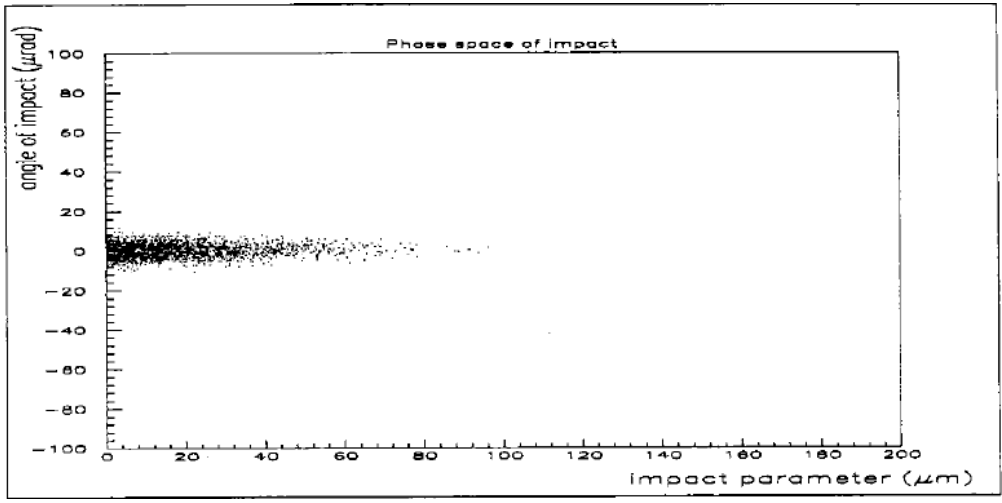


- **Initial beam intensity:** single bunch of a few 10^9 up to a few 10^{12}.
- **Initial beam lifetime:** larger than 80 h, determined by the SPS vacuum.
- **Lifetime with the crystal at 6σ:** 10 h (down to 15' with the shaker on)
- **Halo flux in the crystal:** a few 10 to a few 10^3 particles per SPS turn

Nominal beam parameters

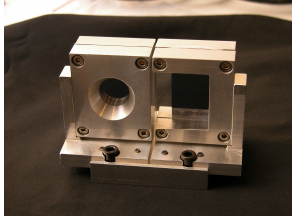
RF Voltage [MV]	1.5
Momentum P [GeV/c]	120
Tune Qx	26.13
Tune Qy	26.18
Tune Qs	0.004
normalized emittance (at 1 σ) [mm mrad]	1.5
transverse radius (RMS) [mm]	1
momentum spread (RMS) Δp/p	4×10^{-4}
Longitudinal emittance [eV-s]	0.4

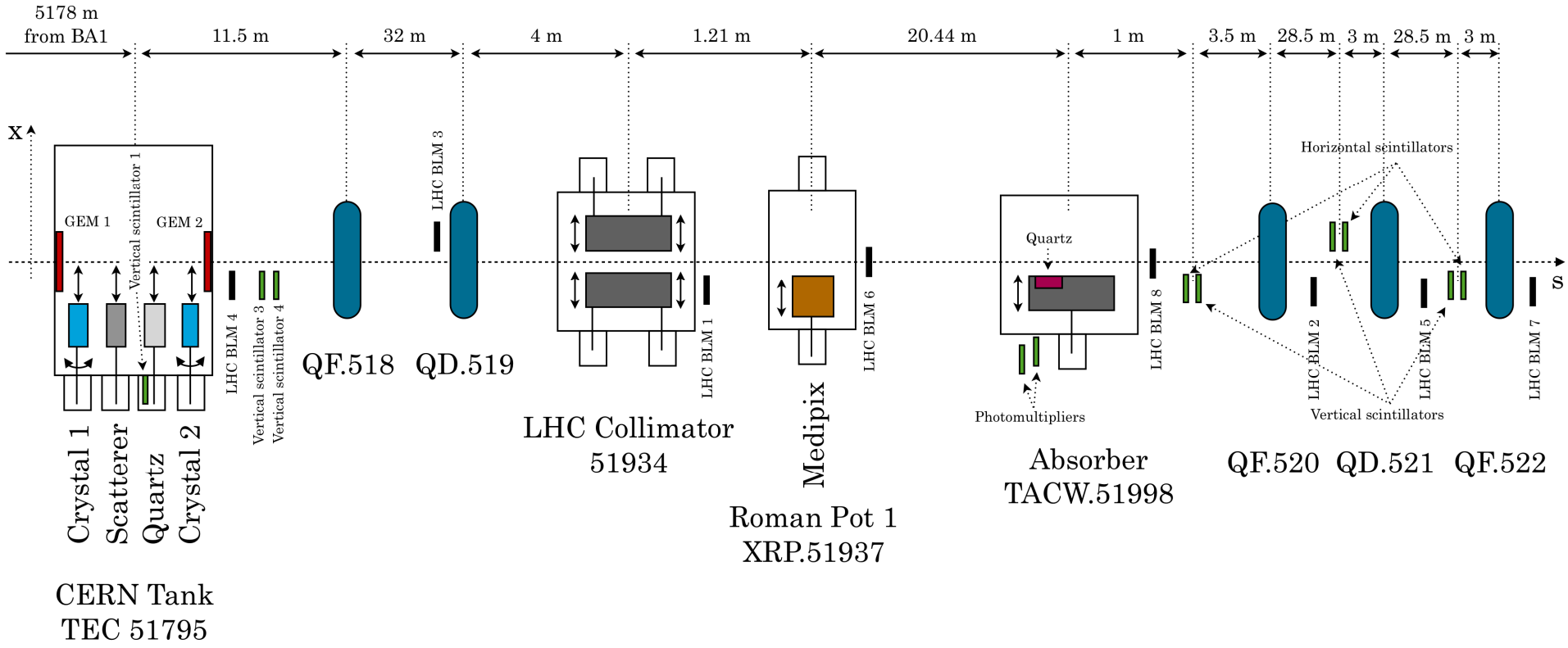
First hit footprint of the halo into the crystal for a lifetime of the of 10 h.



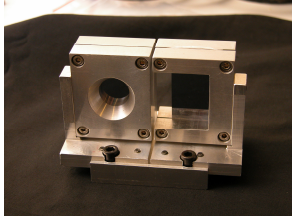
Impact paramenter up to 0.1 mm
impact angle ±10 μrad

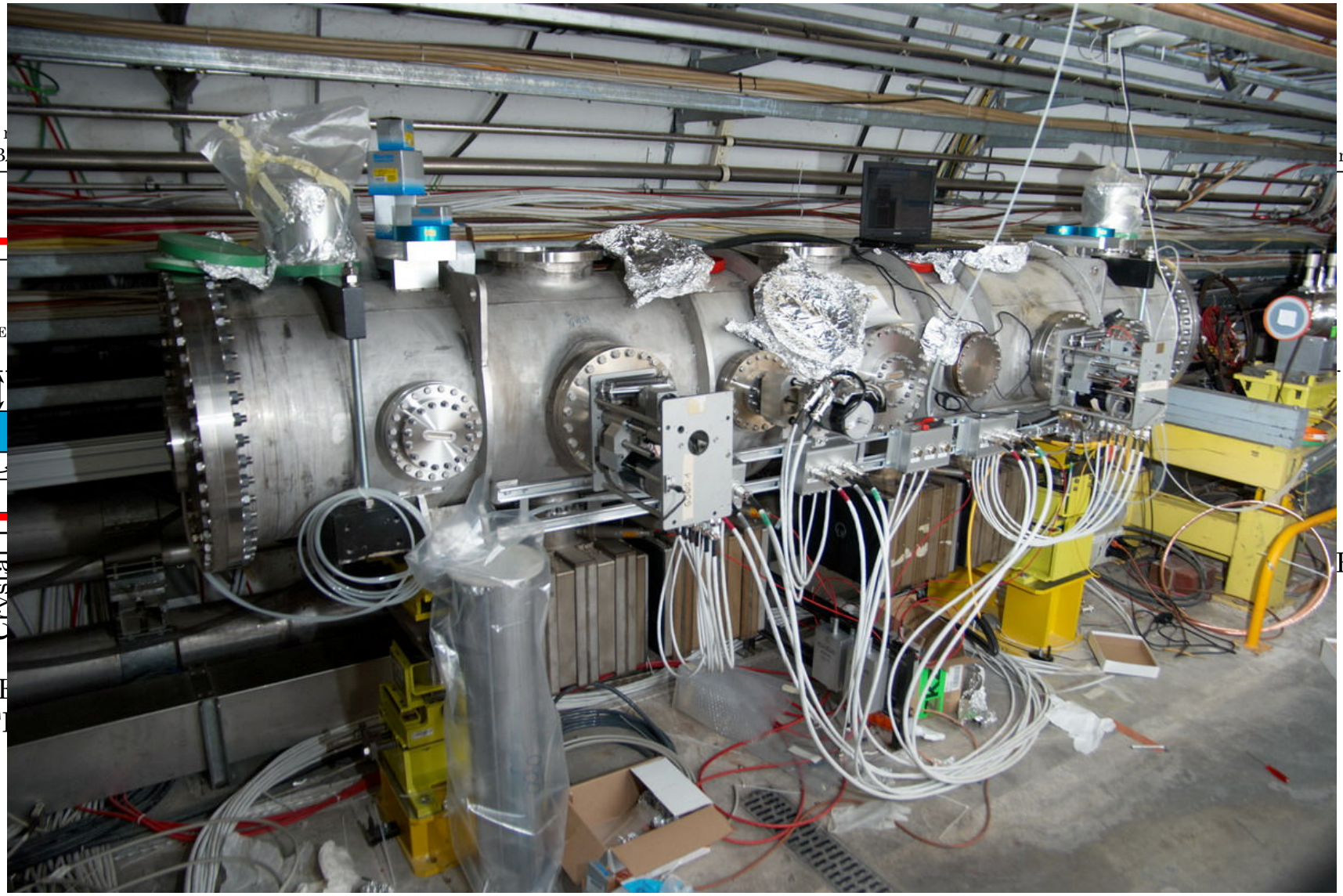
UA9 layout




5178 m
from BA1
11.5 m
32 m
4 m
1.21 m
20.44 m
1 m
3.5 m
28.5 m
3 m
28.5 m
3 m
x
s
GEM 1
GEM 2
Vertical scintillator 1
LHC BLM 4
Vertical scintillator 3
Vertical scintillator 4
LHC BLM 3
QF.518
QD.519
LHC BLM 1
LHC BLM 6
Quartz
LHC BLM 8
Photomultipliers
Horizontal scintillators
LHC BLM 2
LHC BLM 5
LHC BLM 7
Vertical scintillators
Crystal 1
Scatterer
Quartz
Crystal 2
LHC Collimator
51934
Medipix
Absorber
TACW.51998
QF.520
QD.521
QF.522
Roman Pot 1
XRP.51937
CERN Tank
TEC 51795

UA9 layout





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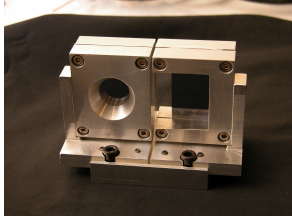
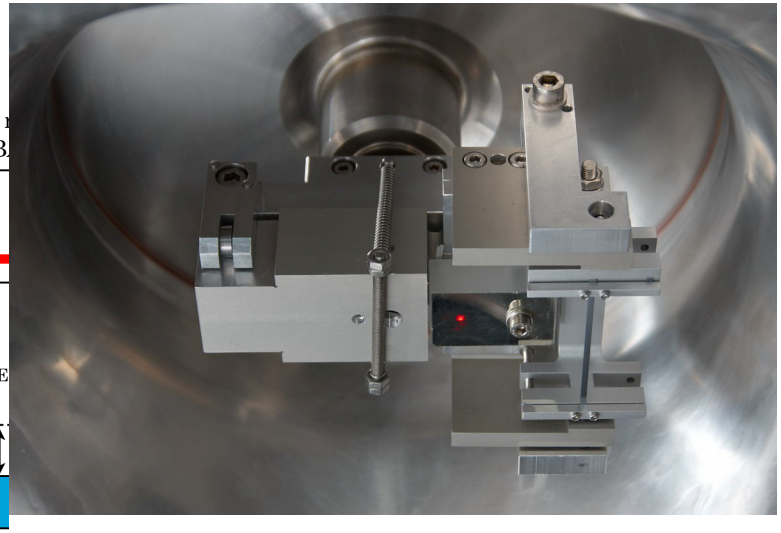
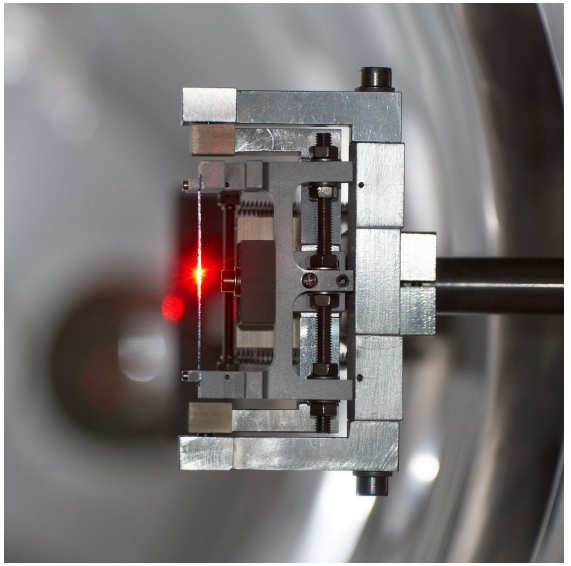
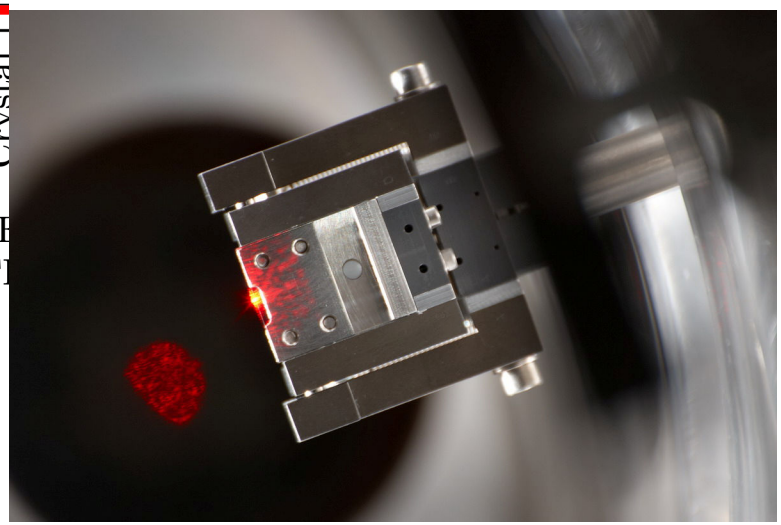
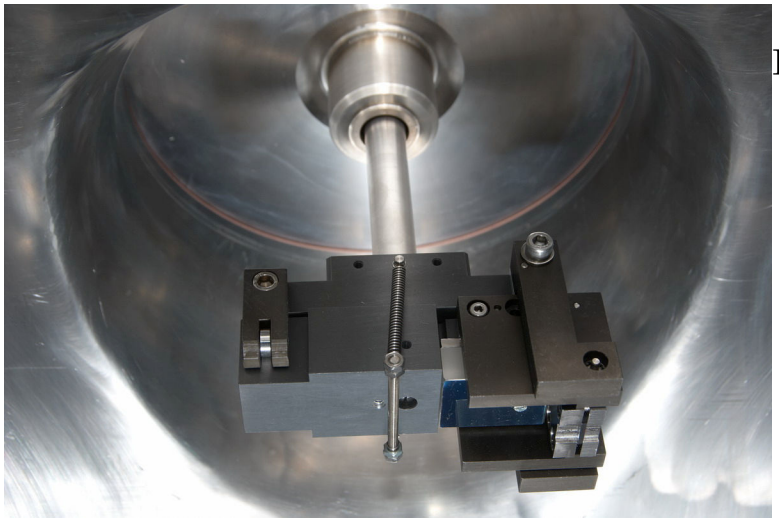


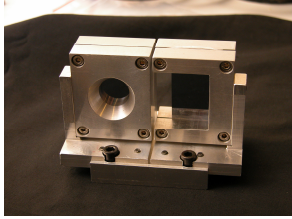


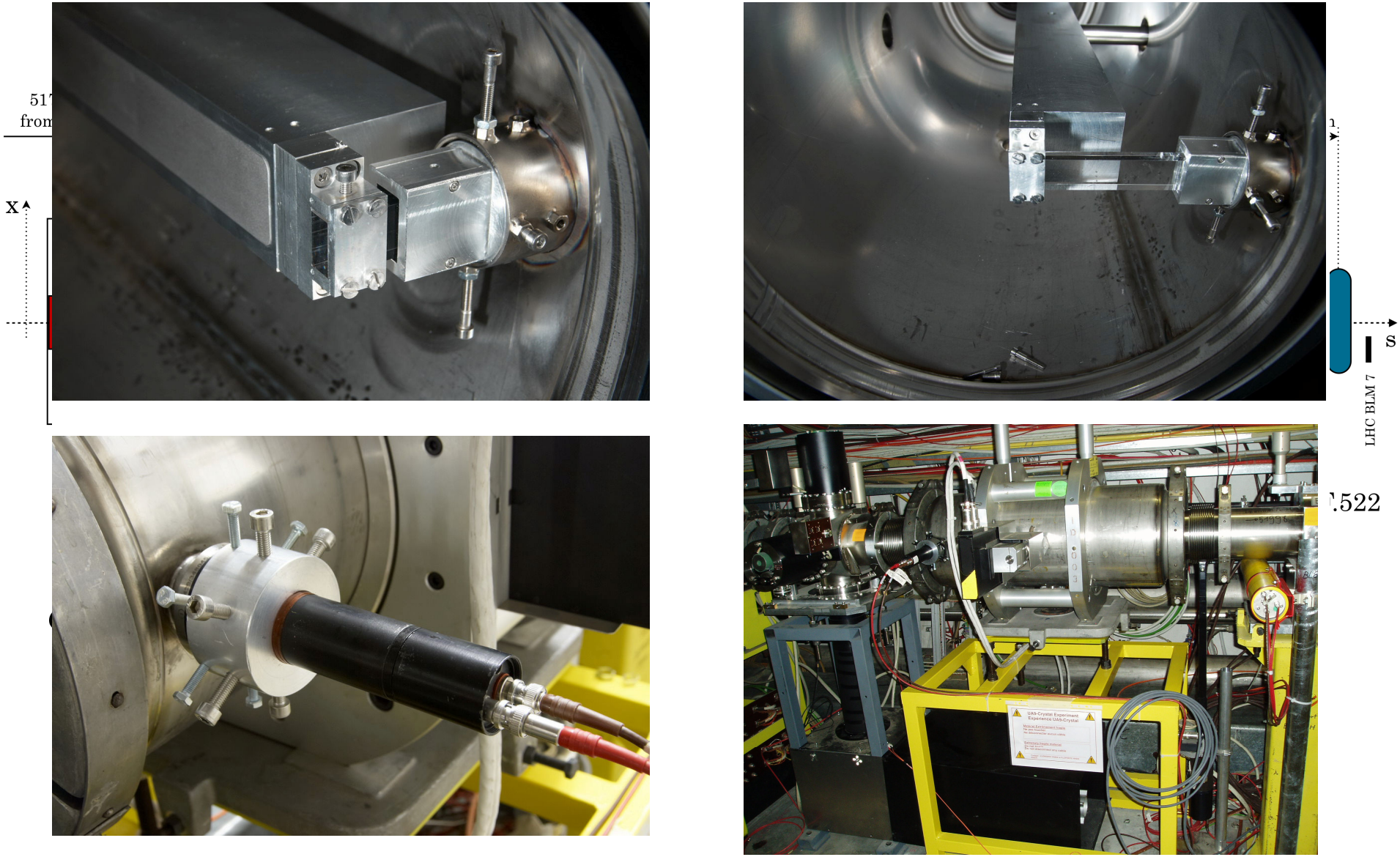






UA9 layout





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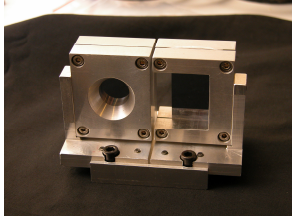
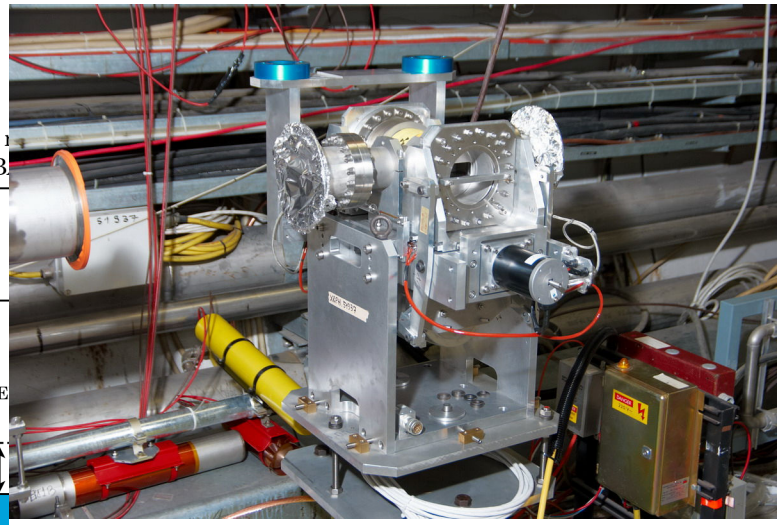
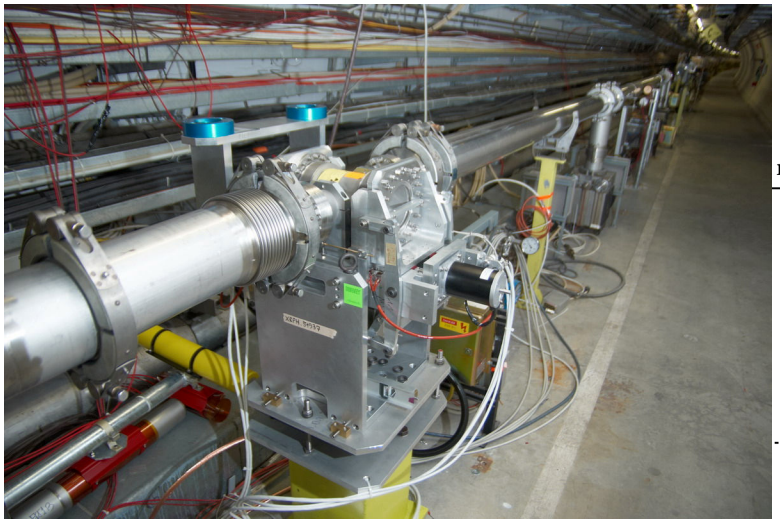
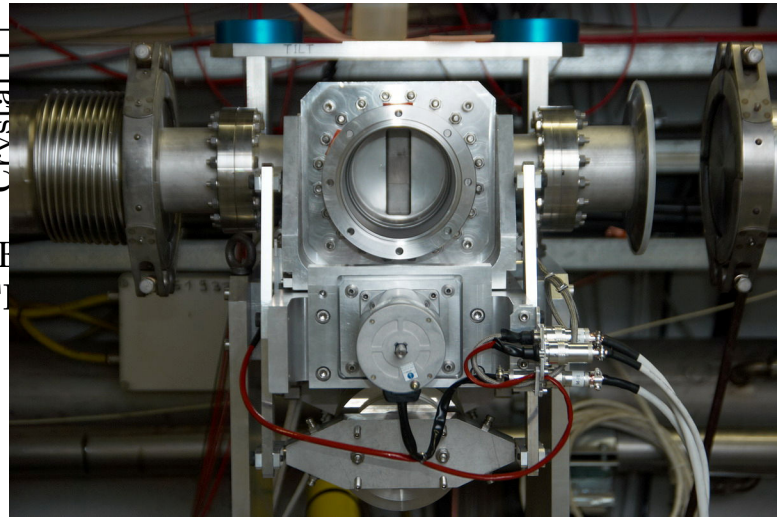
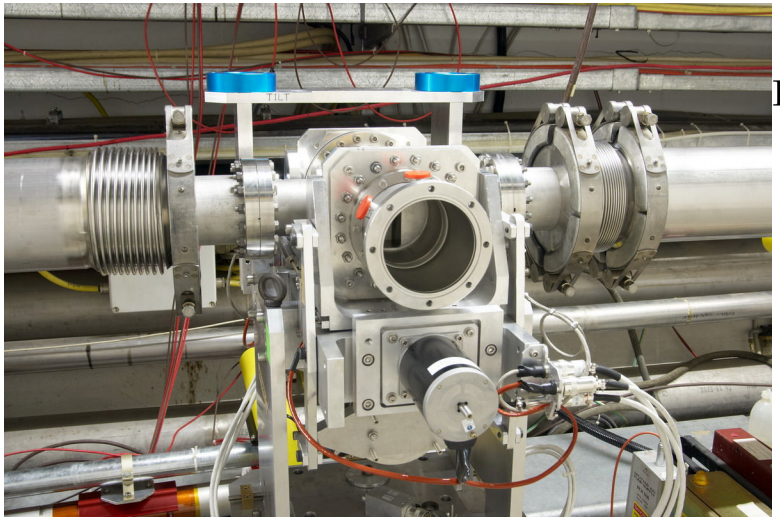


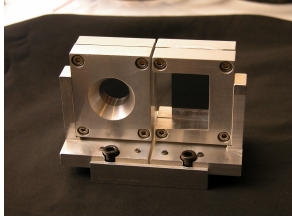




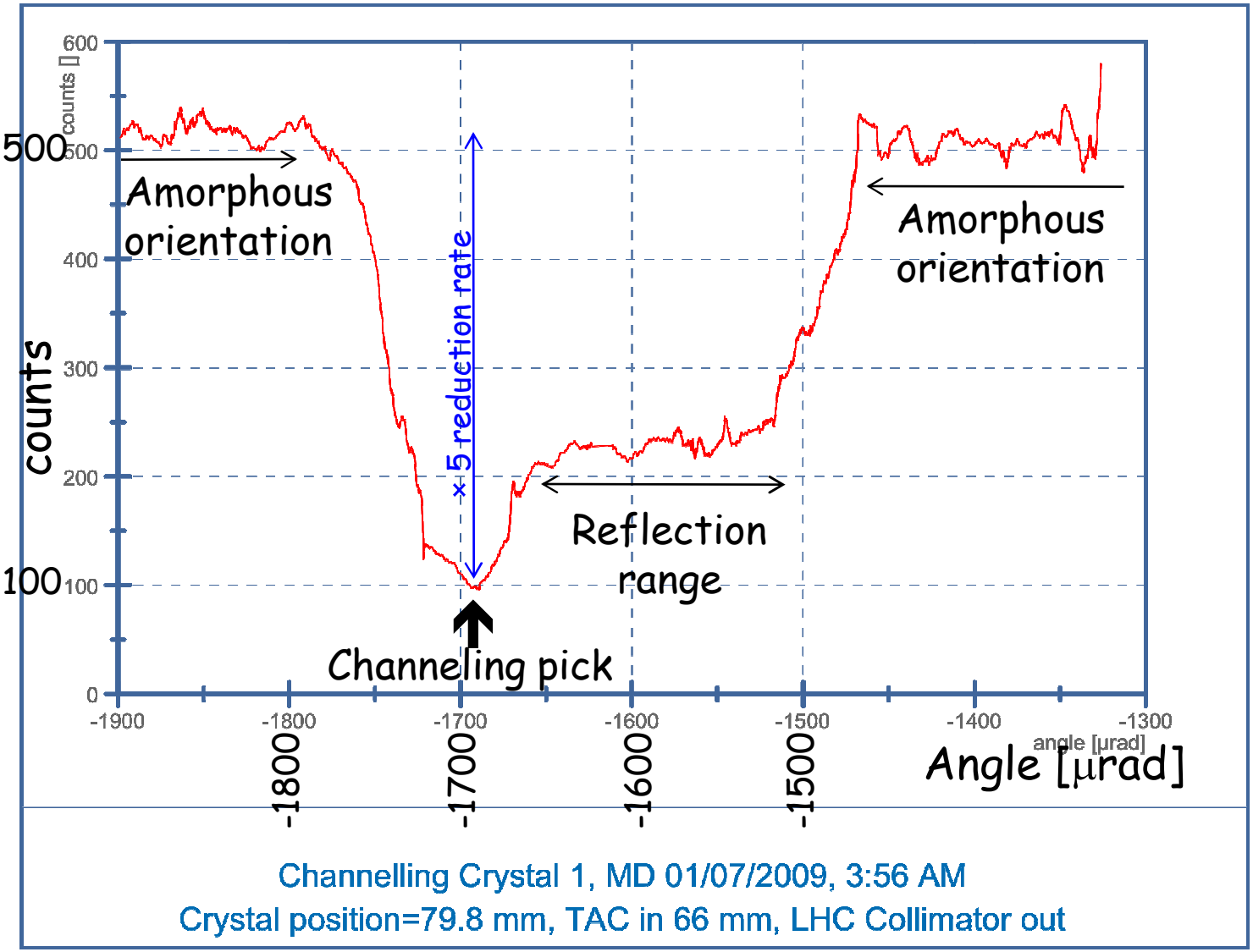




Beam deflection based on channeling process

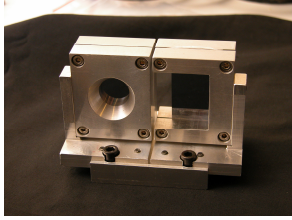


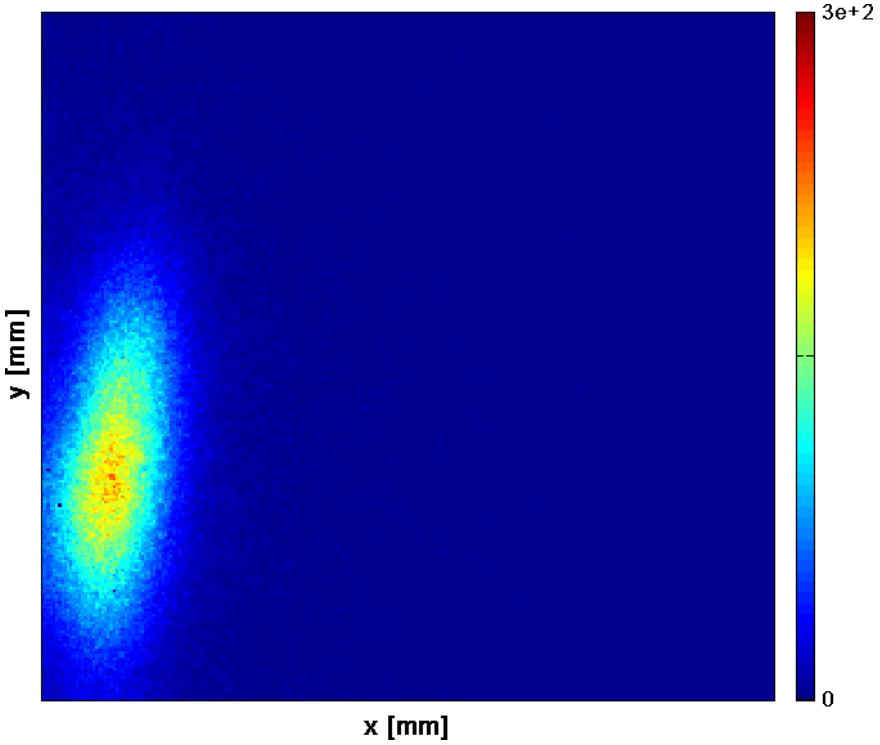
Nuclear loss rate seen by a scintillator telescope downstream the crystal 1

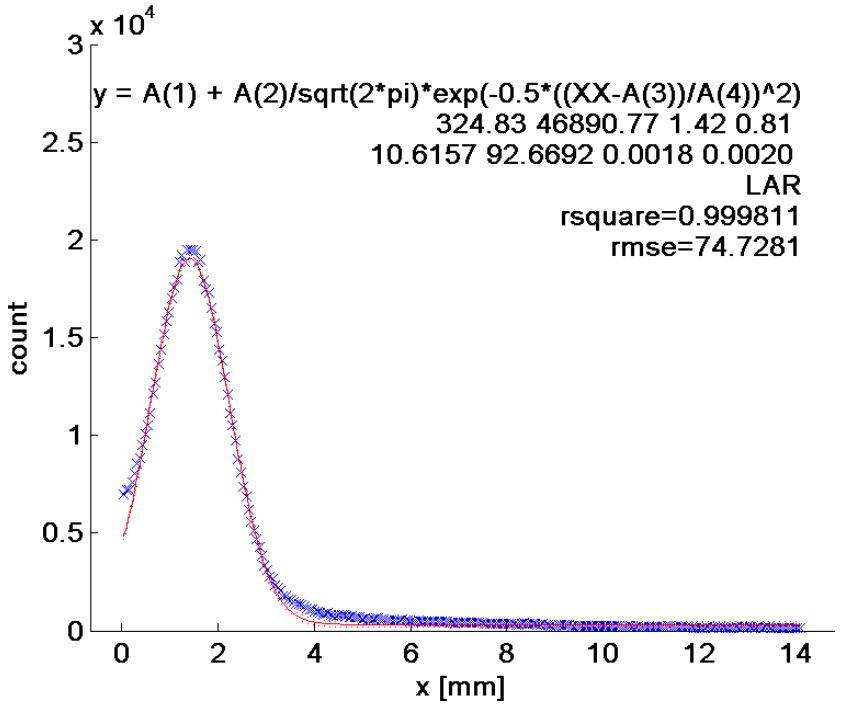


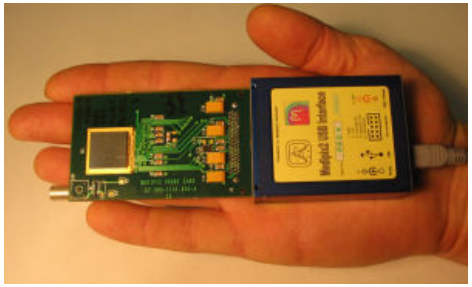
- *Nuclear loss rate* (including diffractive) strongly depressed

Extracted beam profiles with medipix – crystal 2



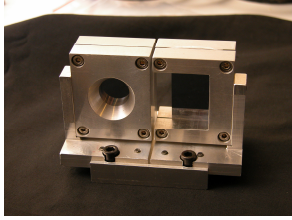


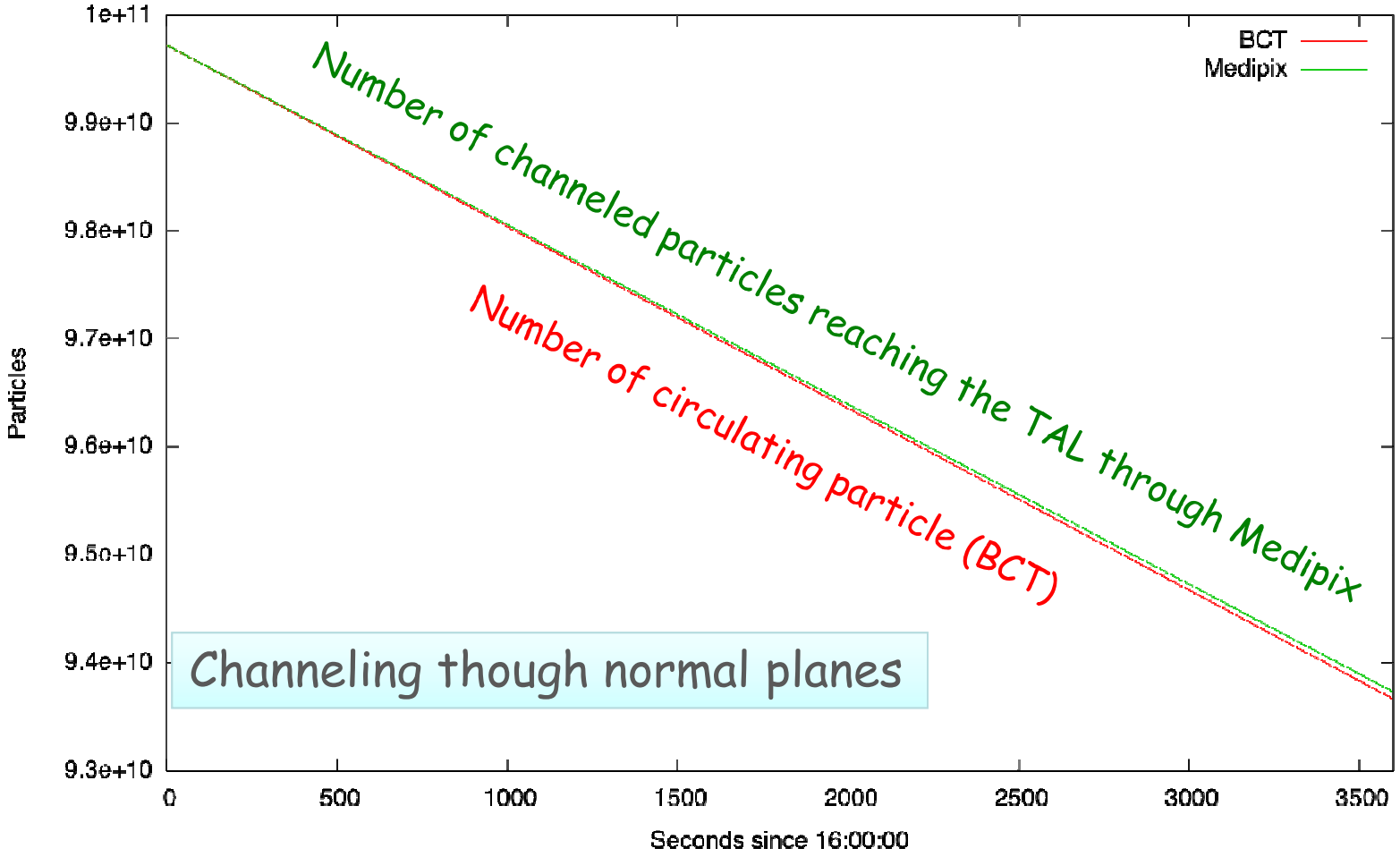




Medipix sensor of the type inserted in the UA9 roman pot, **provided by L. Tlustos (PH/ESE)**

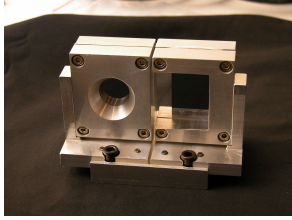
Crystal 1 collimation efficiency using medipix

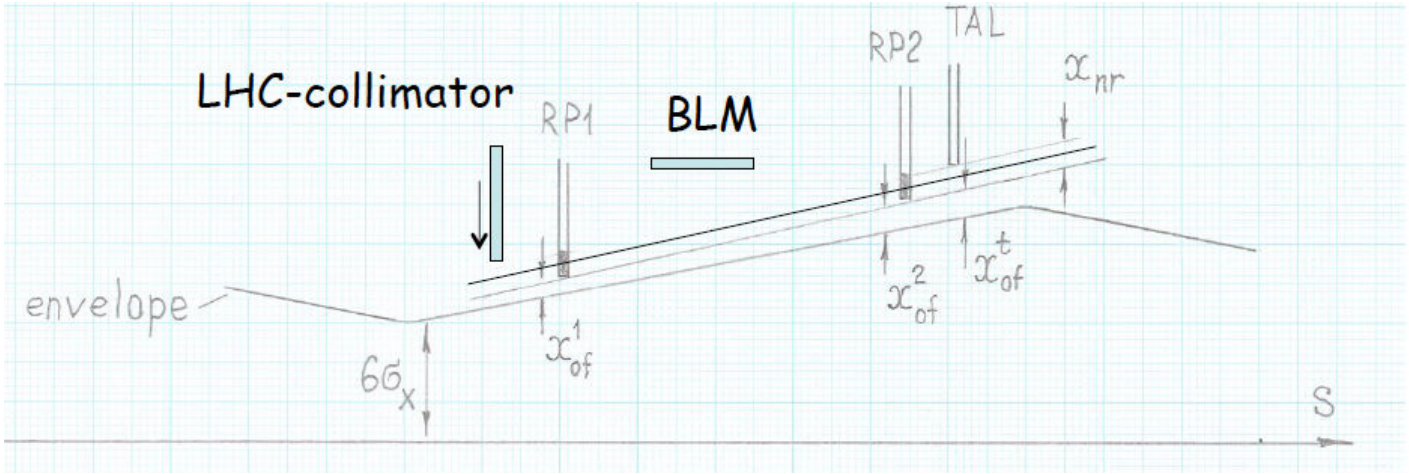


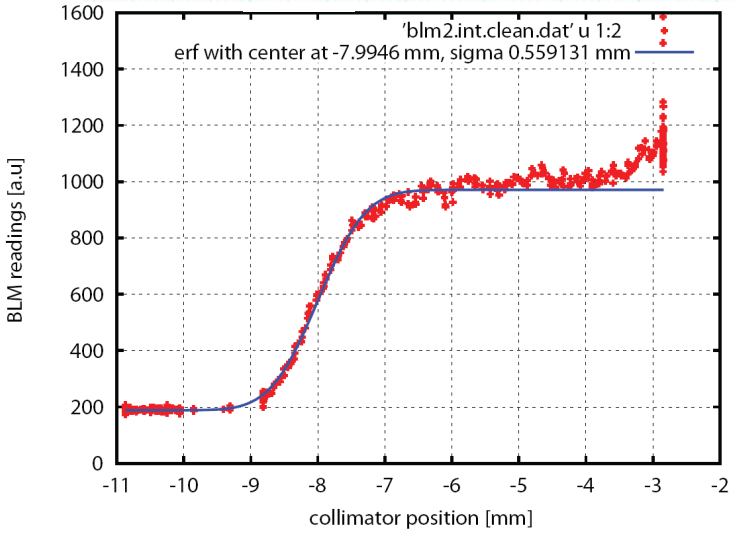


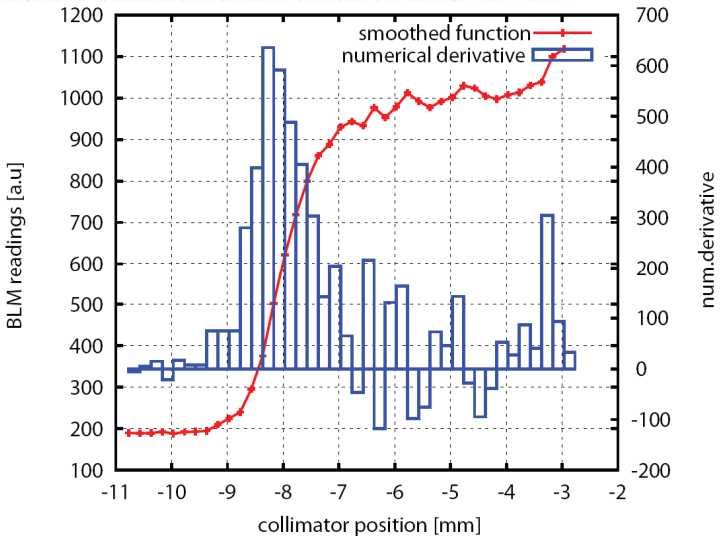
- Multi-pass *channeling efficiency* very large -> compatible with 100%
  - Measured efficiency ≥ 86 %
  - 20 % uncertainty due to BCT and MEDIPIX calibration (corrected with the data of the NA)
  - large CO glitches ≥ 200 μm every a few tenth of seconds during the data taking

crystal collimation efficiency using the LHC-collimator

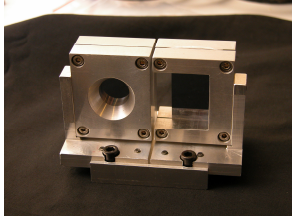








crystal collimation efficiency using the LHC-collimator

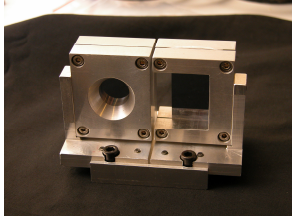


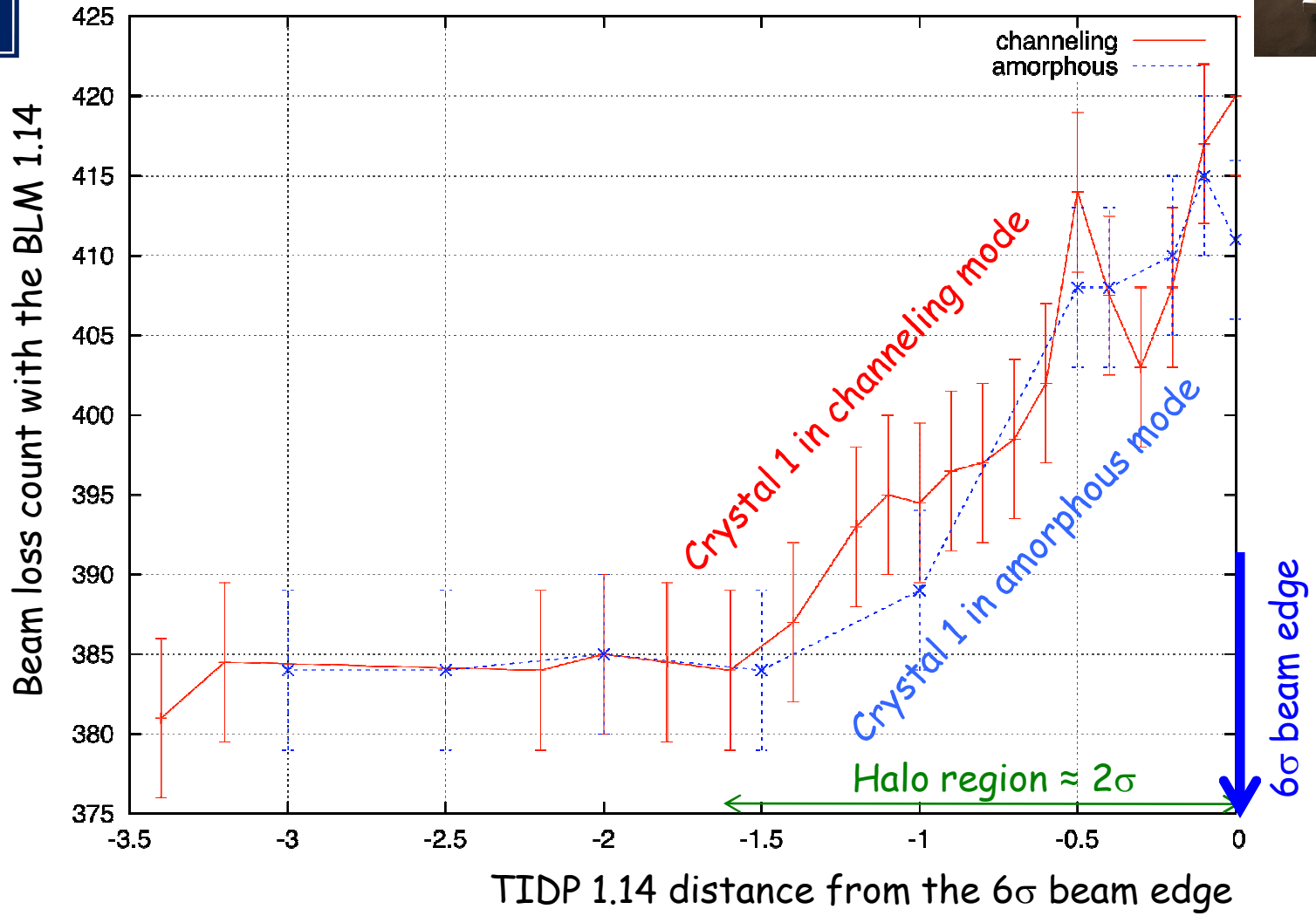
PRELIMINARY

V. Previtali & R. Assmann

Scan	Date	Intensity	Efficiency measured	Efficiency simulated	Efficiency meas/sim	Width measured	Width simulated	Width meas/sim	Angle measured	Angle expected	Angle meas/exp
		[p]				urad			urad		
SPS crystal 1	1.7.09	2.00E+10	74.00%	91.40%	0.81	16.6	13.2	1.26	172.8	170	1.02
SPS crystal 1	22.9.09	1.00E+10	58.80%	92.50%	0.64	35.3	13.5	2.61	200.6	170	1.18
SPS crystal 1	23.9.09	1.00E+10	55.60%	92.50%	0.60	35.3	13.5	2.61	201.6	170	1.19
SPS crystal 2	23.9.09	2.00E+12	77.40%	91.60%	0.84	19.5	14.1	1.38	180.9	150	1.21
Tevatron	20.11.08	???	66.60%			13.3			296	410	0.72

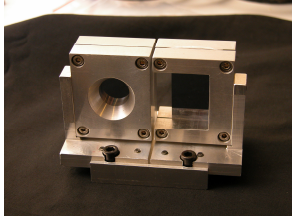
Halo detection by a TIDP scan

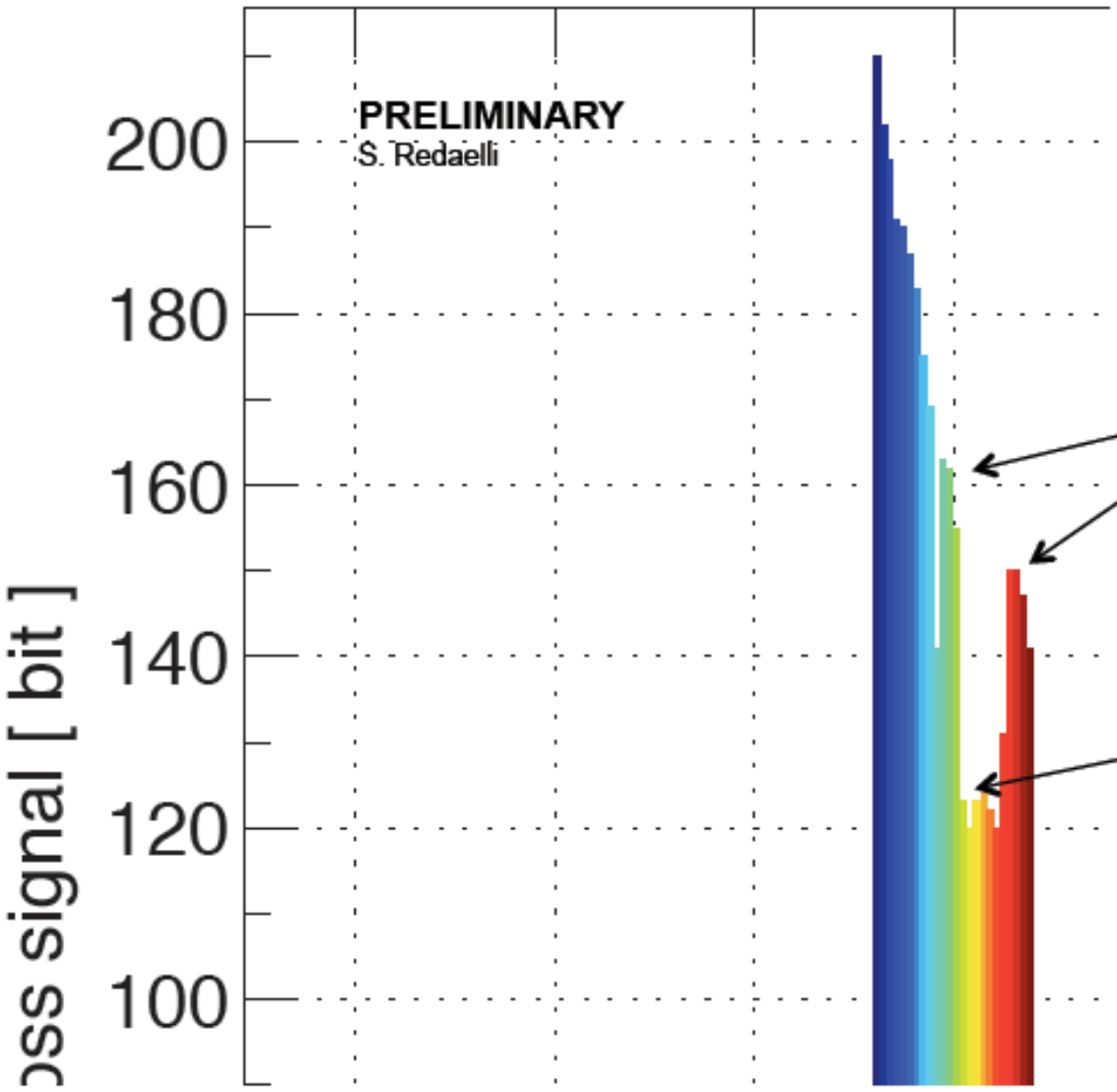




- *Collimation leakage* hardly measurable -> *inefficiency* close to 0
  - *Diffractive* and *betatronic* loss rate negligible above 8σ at the TIDP location
  - Loss in the region from 6 to 8 σ compatible with the multiple scattering in the crystal

Halo detection in LSS6 BLM



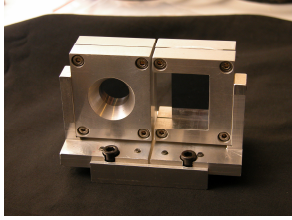


Note: Exponential decay of beam intensity when crystal was placed in beam core.

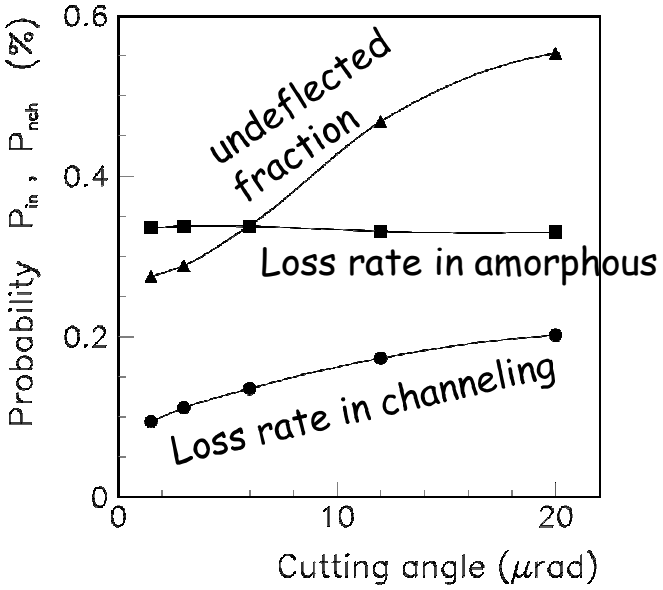
No channeling

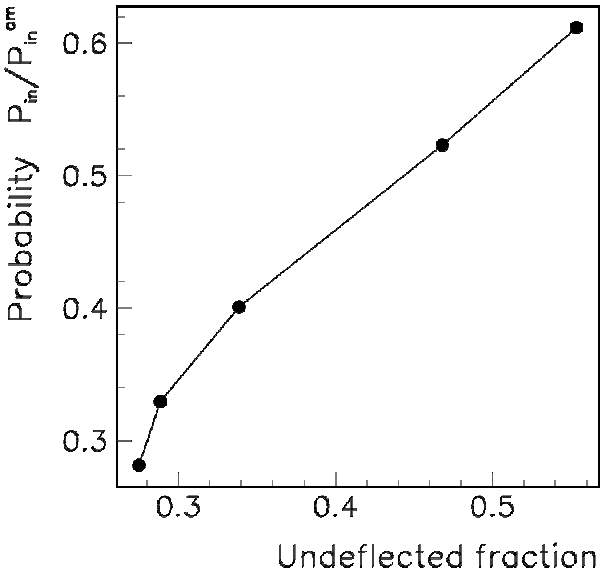
Channeling

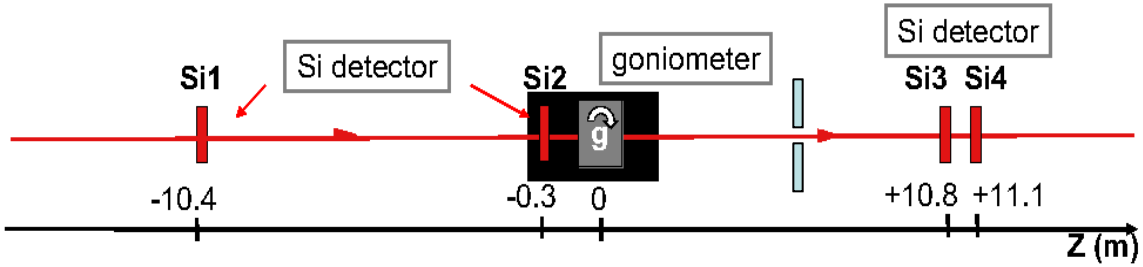
nuclear rate in H8



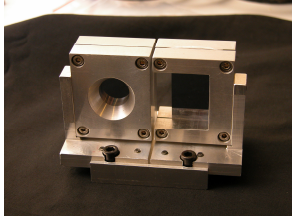
- *Nuclear loss rate* (including diffractive) strongly depressed
  - In channeling versus amorphous mode : × 5 in multi-turn (SPS) and × 3 in single-pass (NA)





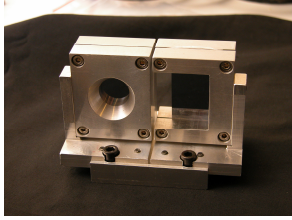


Future plans



- Install the IHEP gonioneter with two new crystals
- New station in the dispersive area of the SPS after the crystal-collimation set (upstream of QF5-22) containing
  - stopper
  - Cherencov in vacuum
  - Roman pot 2 with medipix
  - The aim is to detect the collimation leakage and the diffractive events
- Two crystals in the LHC
- The activity in NA (H8/H4) and in the SPS will be focused on the specific need of the test in LHC
  - Studies in the NA devoted to develop and investigate exotic new crystal will be followed with interest but will not longer engage CERN staff

Details for LHC proposal

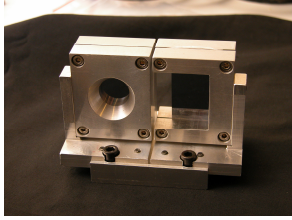


- 2 crystals installed in LHC IR7 during the shutdown 2010/2011.

- Main goals
  - estimate of the collimation efficiency
  - detect the loss maps induced in the LHC ring.
  - confirm that crystal channeling can be exploited reliably also at energies higher than 120 and 400 GeV (and 1 TeV in the Tevatron).

- New features
  - Crystal collimation in a cryogenic environment (as in the Tevatron)
  - Halo control below the quench threshold of the LHC superconducting magnets,
  - Also in presence of a large halo flux induced by fast diffusive particle dynamics.

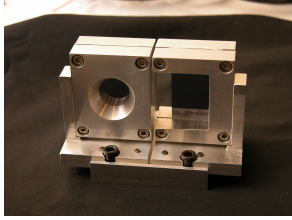
Budget for LHC proposal



- Decision to be taken before the end of the year '09
- Discussion on the manpower required for hardware (EN/STI), Accelerator physics (BE/ABP and OP) and instrumentation (BE/BI)
- Support the EU request of a Marie-Curie fellowship programme on UA9
- Additional roman pot eventually provided by SLAC/LARP

		2010	2011	2012
Material	Vacuum Vessel (and integration)	200		
	2 Goniometers	200		
	Instrumentation (scintillators, Medipix etc..) with DAQs	250		
	Control system, Cables etc…	200		
	Operation		100	100
Total Material		**850**	**100**	**100**
Personnel	1 Fellow	120	120	120
	2 PhD	100	100	100
	1 Project Associate	60	60	60
	Technical students	75	75	50
Total Personnel		**355**	**355**	**330**
TOTAL		**1205**	**455**	**430**

acknowledgments



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