UA9 Status & Plans

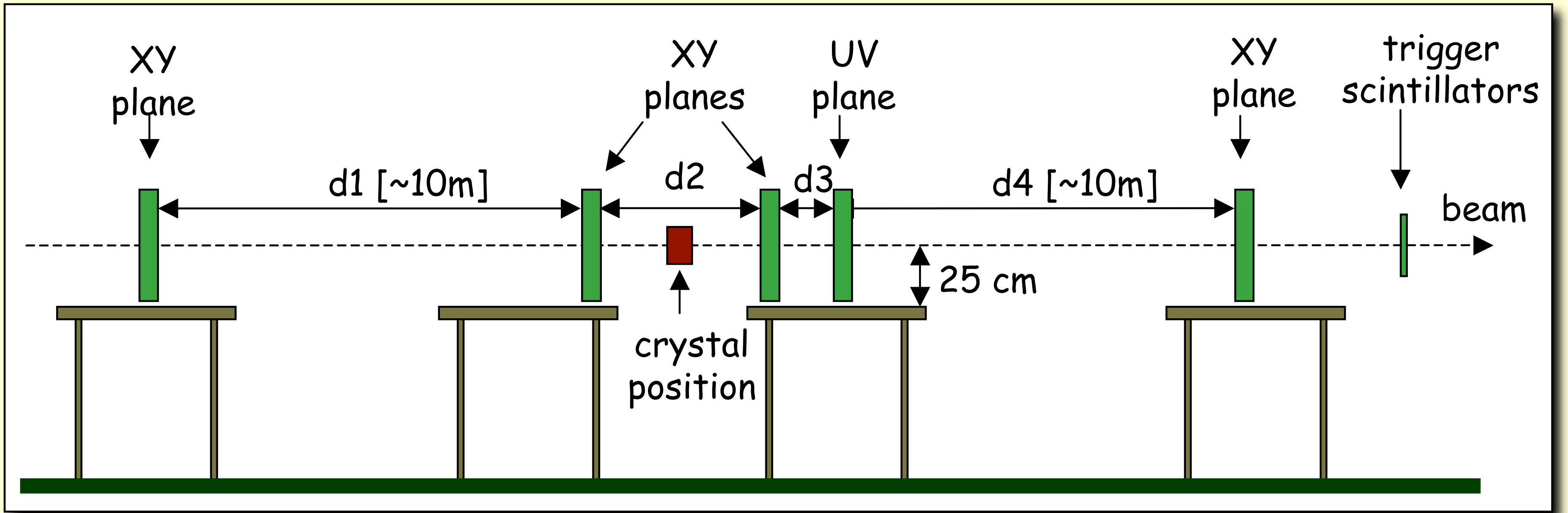
U. Wienands, SLAC
LARP LTV @ CERN

Acknowledgment to W. Scandale, Spokesperson of UA9, for providing me with most of the material.

UA9 Goals

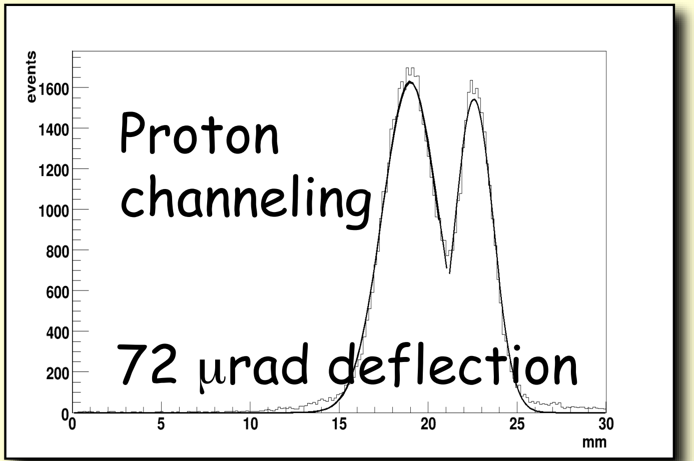
- UA9 is a rather large multi-lab collaboration:
  - CERN, BNL, INFN(4 labs), IHEP, Imperial, JINR, PNPI, SLAC
- Its goals are to:
  - Characterize crystals suitable for beam collimation in the SPS and, ultimately, the LHC
  - Proof of principle and demonstration of collimation efficiency in the SPS
  - Pending results, extension to mount a beam-collimation experiment with crystals in the LHC.

Sep 2010 H8 telescopes



- 5 planes altogether (10 silicon strip sensors) each plane provides 2 co-ordinates: XY or UV
- UV plane = XY plane rotated through 45⁰ (resolves ambiguities for multiple hits / trigger)
- 65 m downstream: TPC- GEM and Medipix (fast scan) + Planar GEM

Image with the TPC-GEM
June 2010



Si Strip Detector

» CMS LHC Si strip readout system

» Provided by Imperial College group

» DAQ, calibration, raw data and recorded

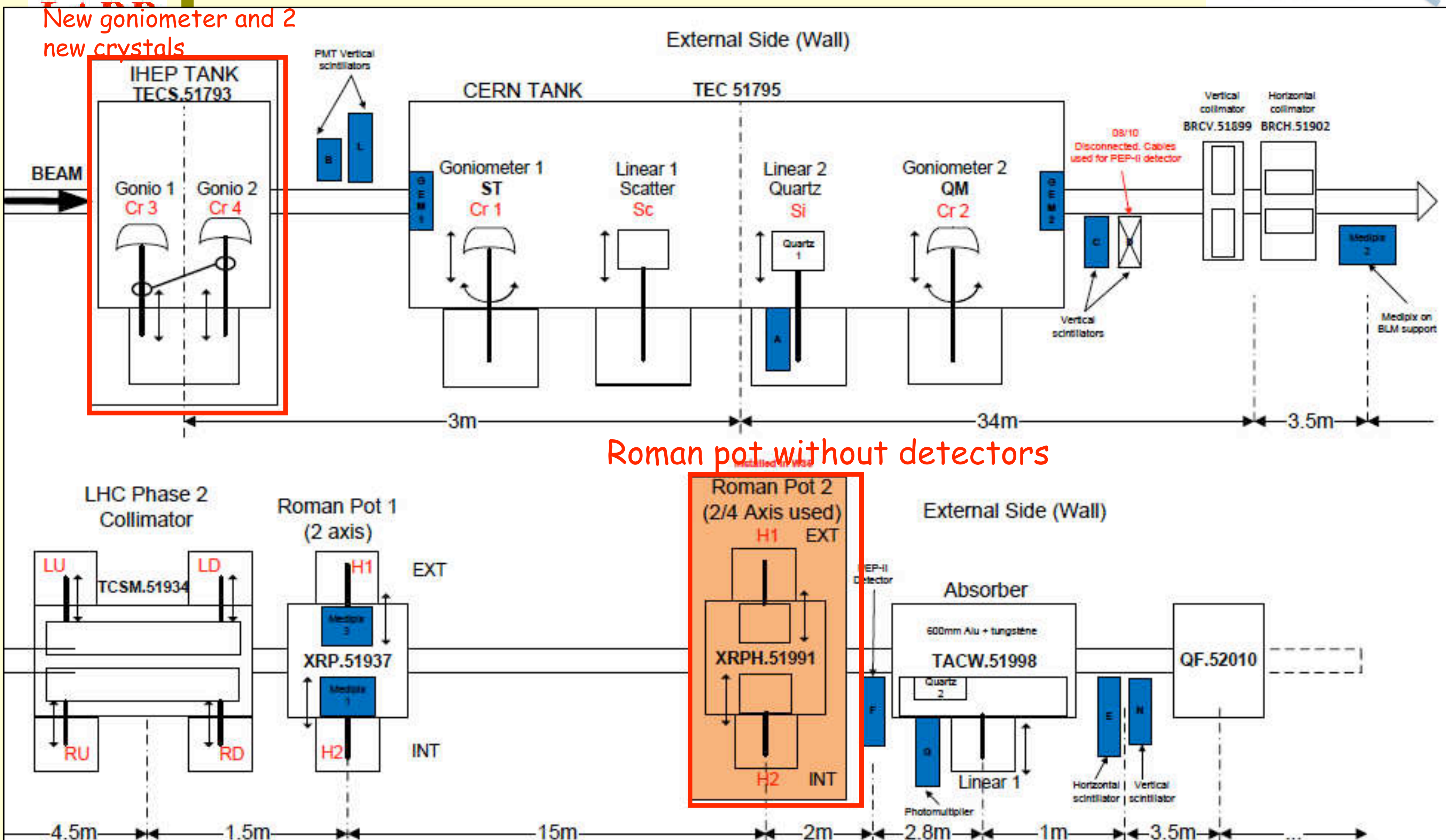
» Tested in H8 in June one telescope working suitable for UA9 physics investigation

H8 Results

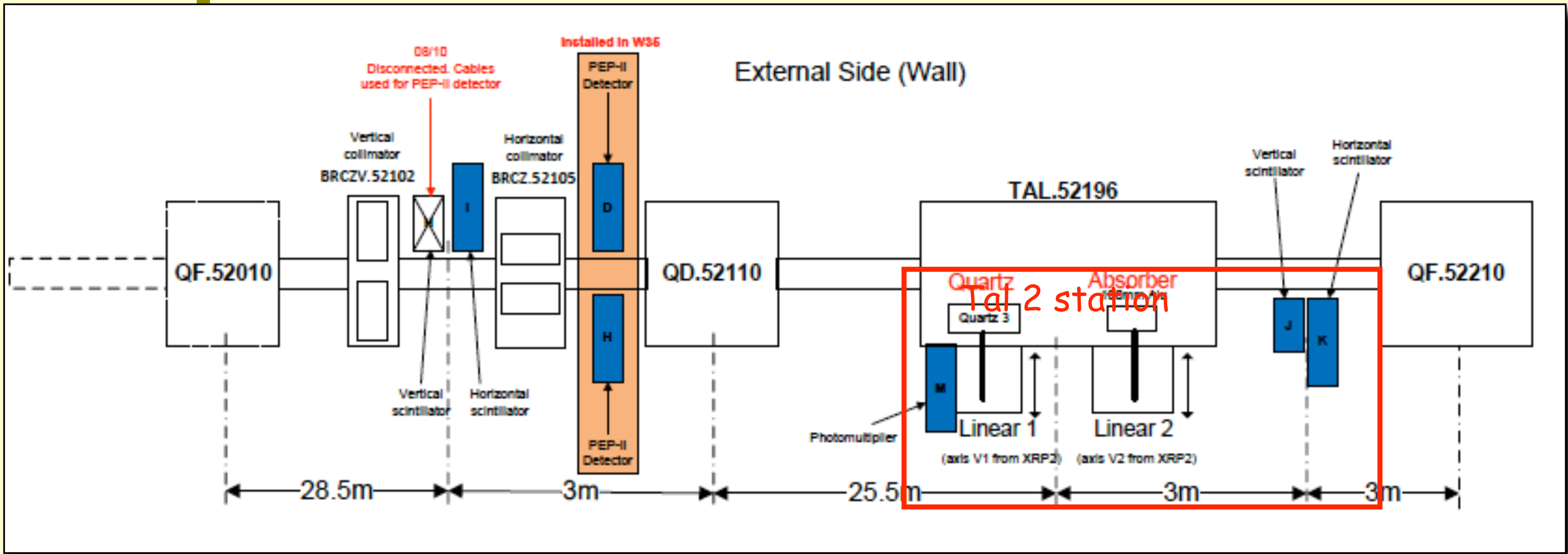
S. Montesano

Crystal name	Provider	Description	Measurements done in H8	Run numbers
QM2	PNPI		angular scan (no channeling found)	?? (22 sep - 16:42)
ST21	FERRARA	5 mm strip crystal	channeling from skew planes, angular scan, craddle scan, PXR (several conditions)	??? (22 sep - 00:51), 292, 299, 300, 301, 307, 309, 310, 311,312
QM24SPS	PNPI	SPS, 11 mm	tail of channeling on medipix, angular scan	317, 318, 319
QM27	PNPI	1.7 mm	angular scan, PXR in amorphous and channeling, fine angular scan	321-->325; 344; 348
TFP1	PNPI	25 um flat crystal	manual scan	378, 379, 547-->552
ST40A	FERRARA	Crystal suitable for LHC Channeling planes: (110) Channeling axis: <111> Thickness along the beam: 5mm bending angle: 100urad torsion: < 1 urad/mm	angular scan, channeling statistics, PXR in channeling	381-->386
ST45A	FERRARA	Crystal suitable for SPS Channeling planes: (110) Channeling axis: <111> Thickness along the beam: 2mm bending angle: 150urad torsion: 0.7 urad/mm	angular scan, torsion adjustment, statistic in channeling, channeling efficiency	391-->415 ; 434-->450
QM28	PNPI	6 mm	fine angular scan at different lateral positions	416-->424
QM29	PNPI		fine angular scan at different lateral positions	425-->433
QM30	PNPI	10 mm	lateral scan + angular scan	453 --> 456
QM31	PNPI	10 mm	fine angular scan at different lateral positions	457-->464
TFI1	FERRARA	Unbent crystal having thickness λ/2 would be an efficient beam mirror. Realized crystal consists of a silicon membrane of lateral size 5x5 mm2 and thickness in the range 28-29 μm surrounded by a rigid frame of thickness 300 μm. Thickness was measured by means of white light and infra-red interferometry.	gem	469-->484
ST38-A	Ferrara	Crystal for SPS, 2mm thick, (110) ch plane, (110) ch axis	angular scan	545, 546
TFP2	PNPI	Unbent flat crystal, thickness ??? Channeling planes ???		

UA9 (SPS) Setup in 2010



UA9 Setup (cont'd)



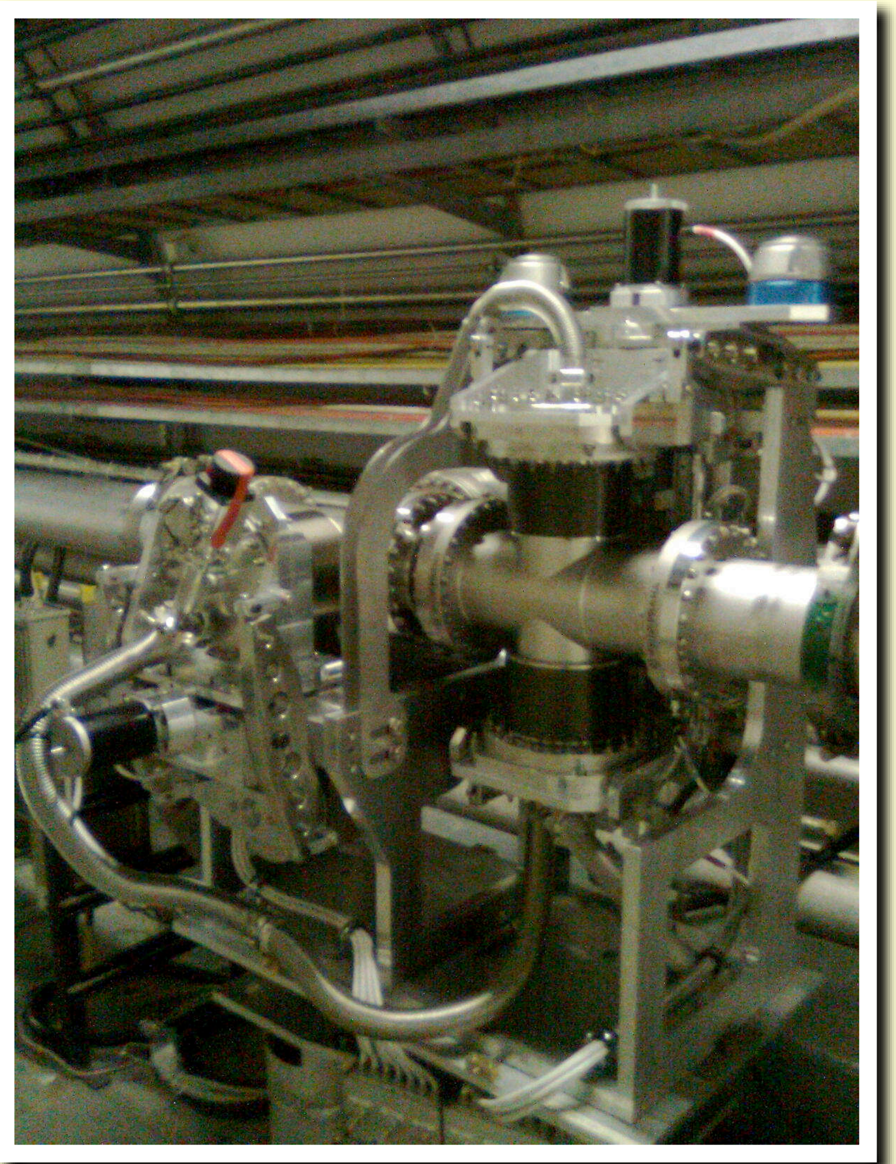
Roman Pot #2

Very close to TAL, better position to see channeled beam!

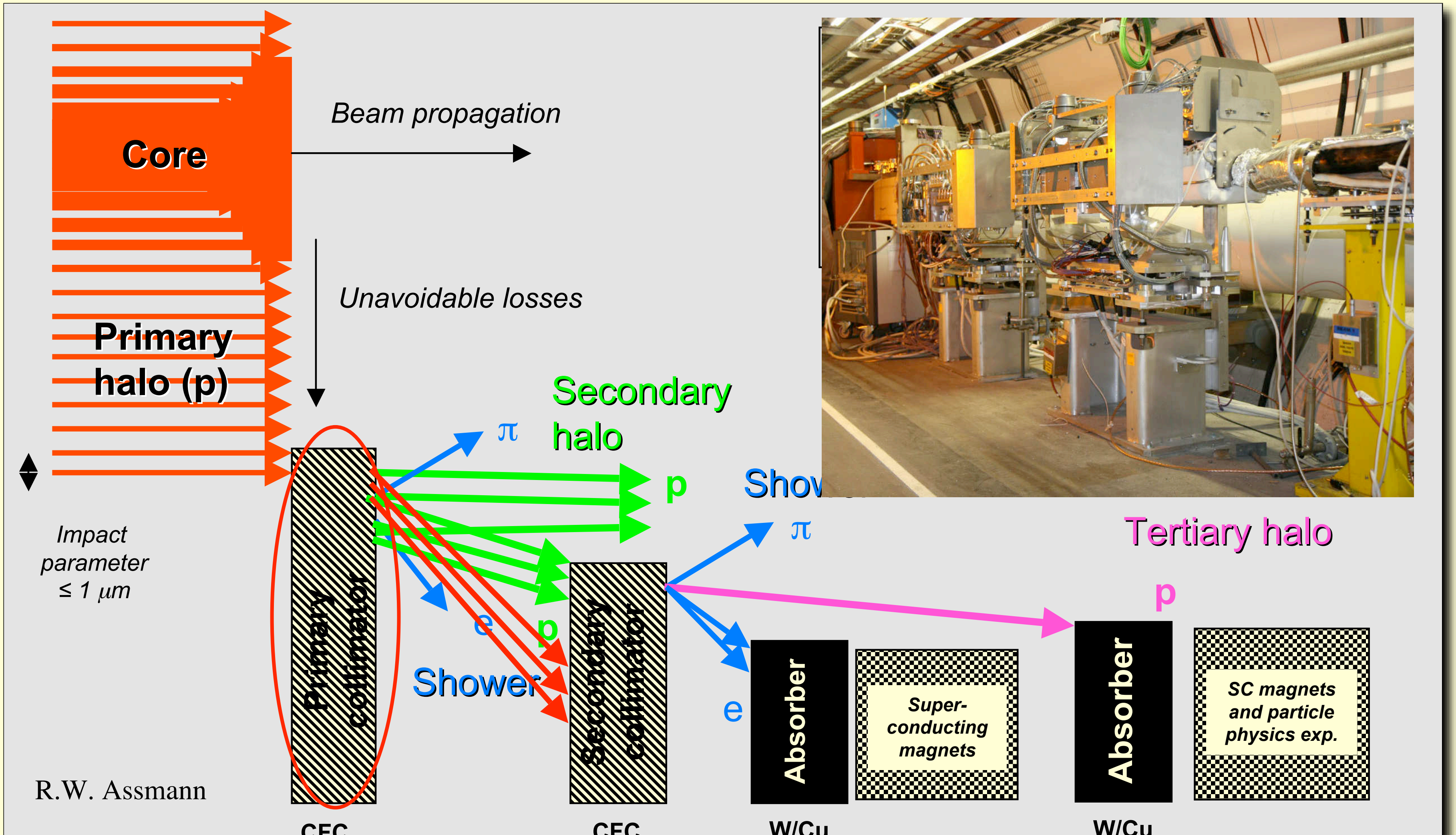
No detectors yet

Place to install 4 Medipix (2 Horiz and 2 Vert.)

Relevant to measure channeled beam direction in conjunction with the RP1 (from centroids)

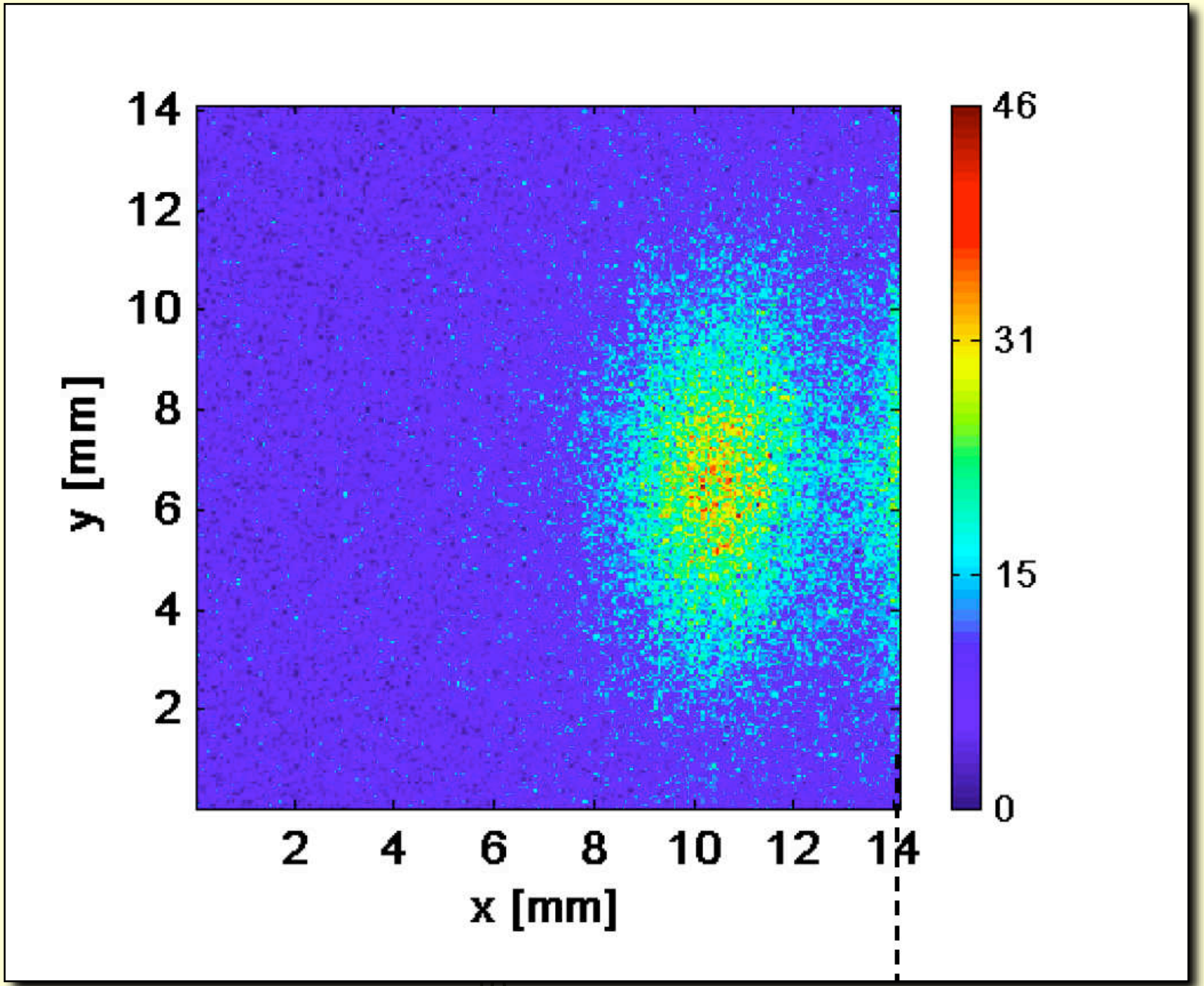


Beam Collimation



replace by crystal

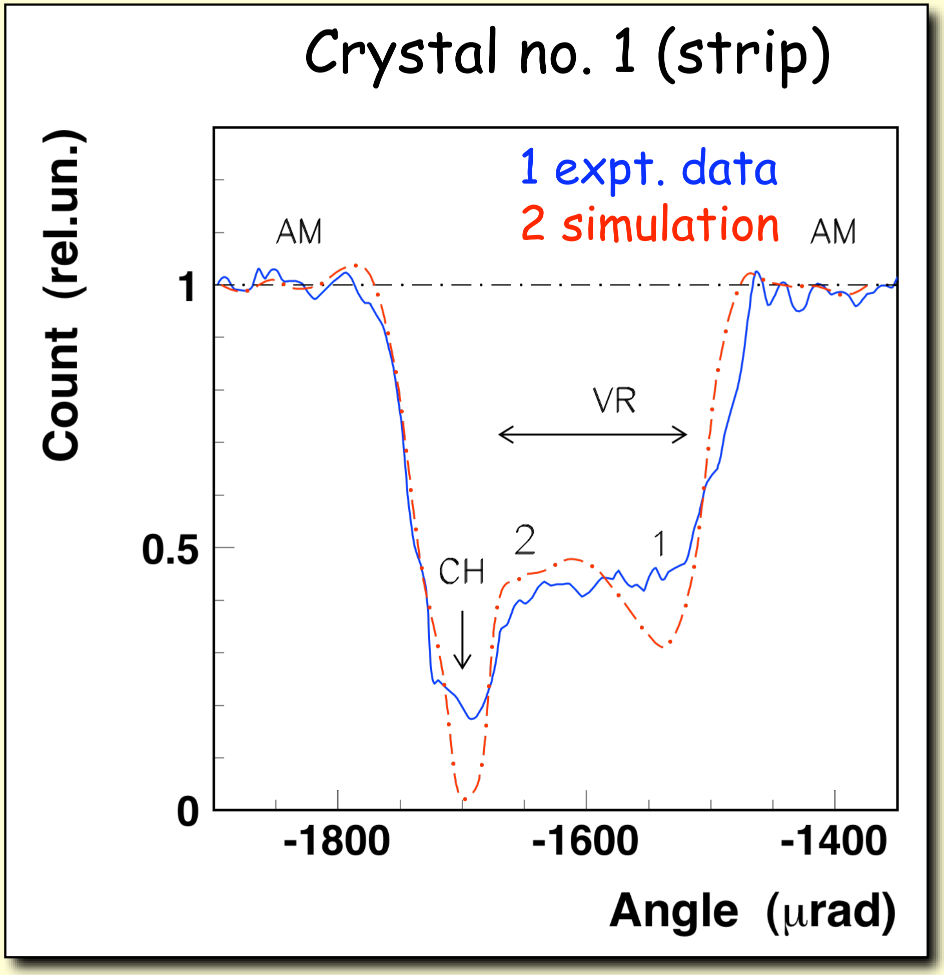
Channeled Beam on MediPix



2009 Result (Crystal #1)

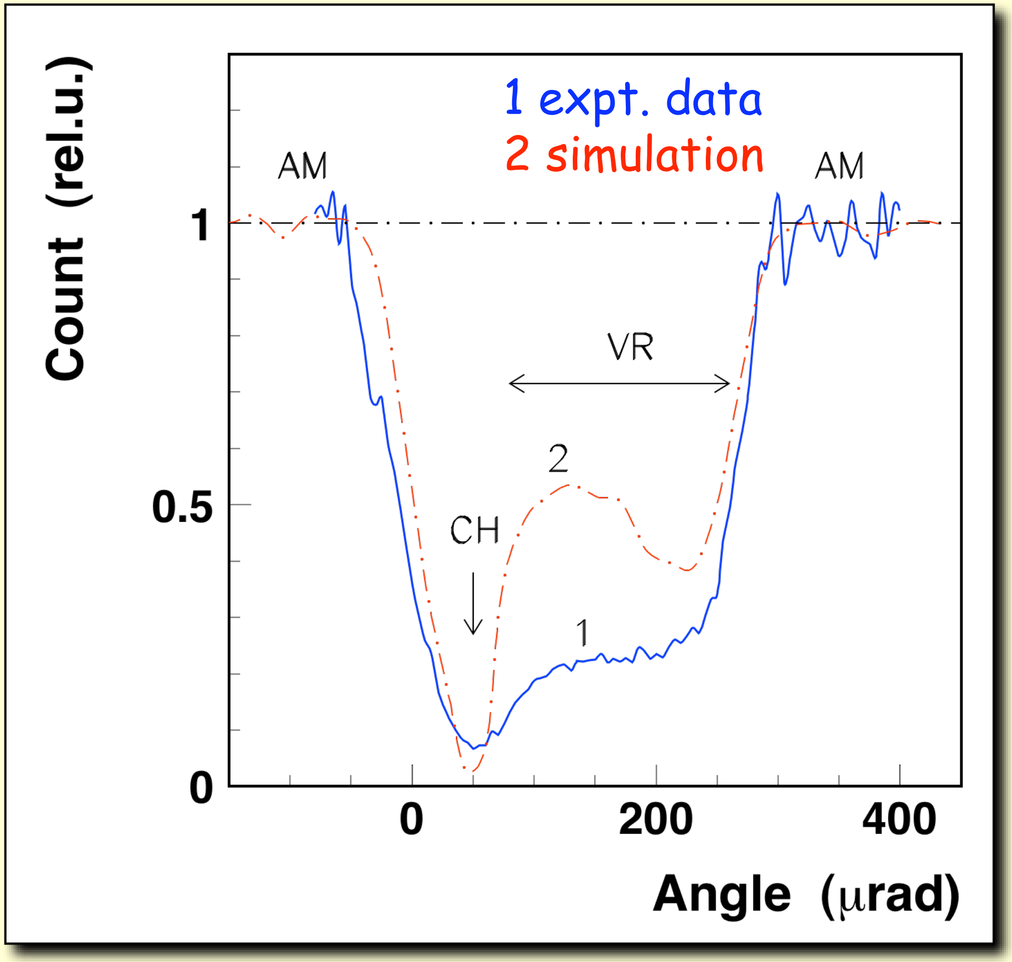
W. Scandale et al. / PLB 692 (2010)

- Rotate crystal, detect (nuclear-) scattering
- Loss reduction in channeling mode (× 5)
  - smaller than in MonteCarlo simulation (× 36)
- Alignment errors induced by
  - vertical torsion of the crystal
  - inaccuracy of the Goniometer
- Deflection efficiency for crystal 1 and 2 : (75±4)% and (85±5)%



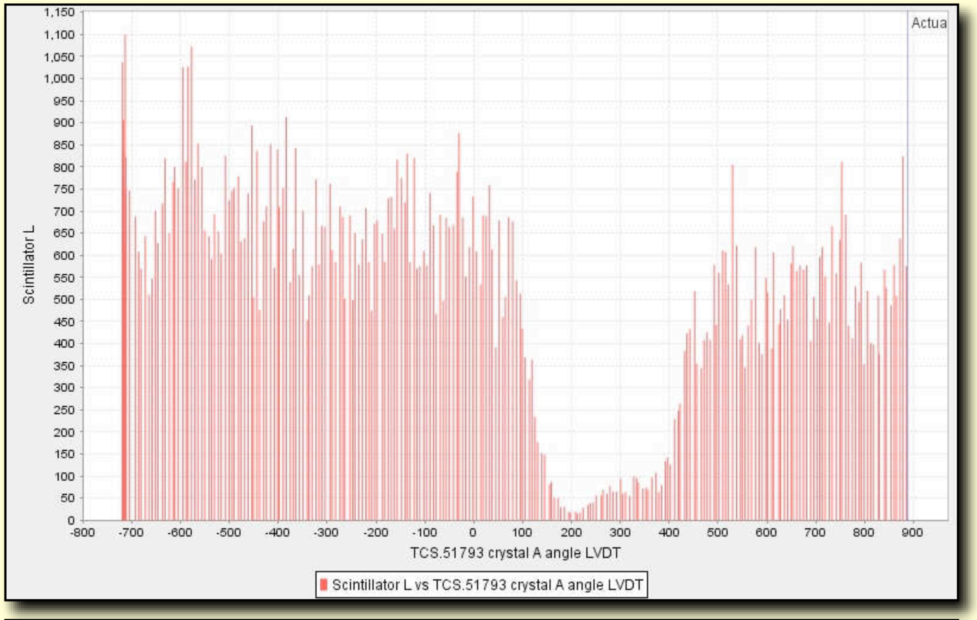
2010 Result: Crystal #3

- Loss reduction in channeling mode (× 16)
  - smaller than in MonteCarlo simulation (× 33)
  - larger than in crystal 1 (× 5)
- Small variations of the deflection angle in different scans
  - [better control of the alignment errors]

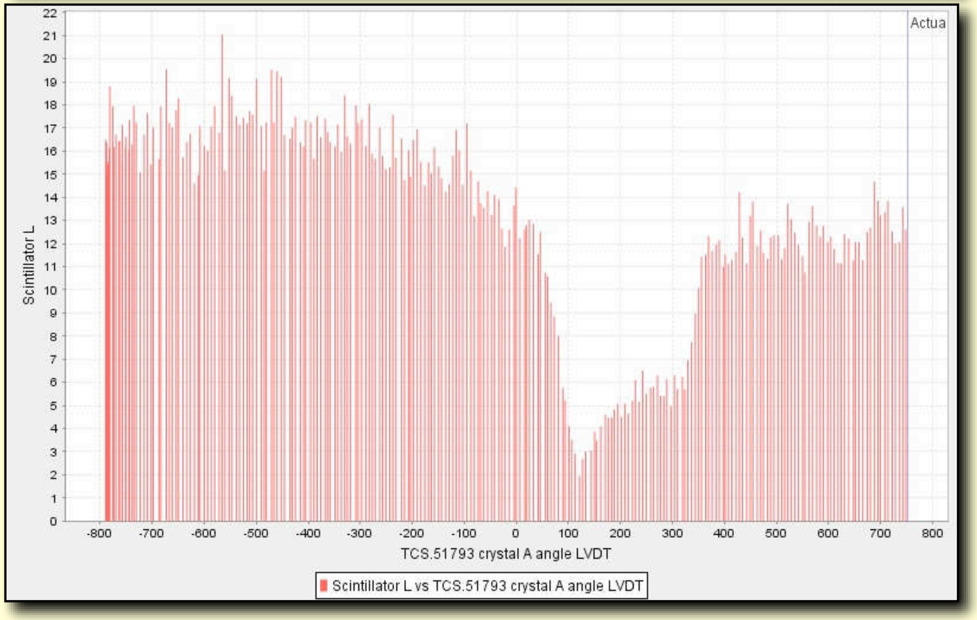


Angular Scan of Crystal #3

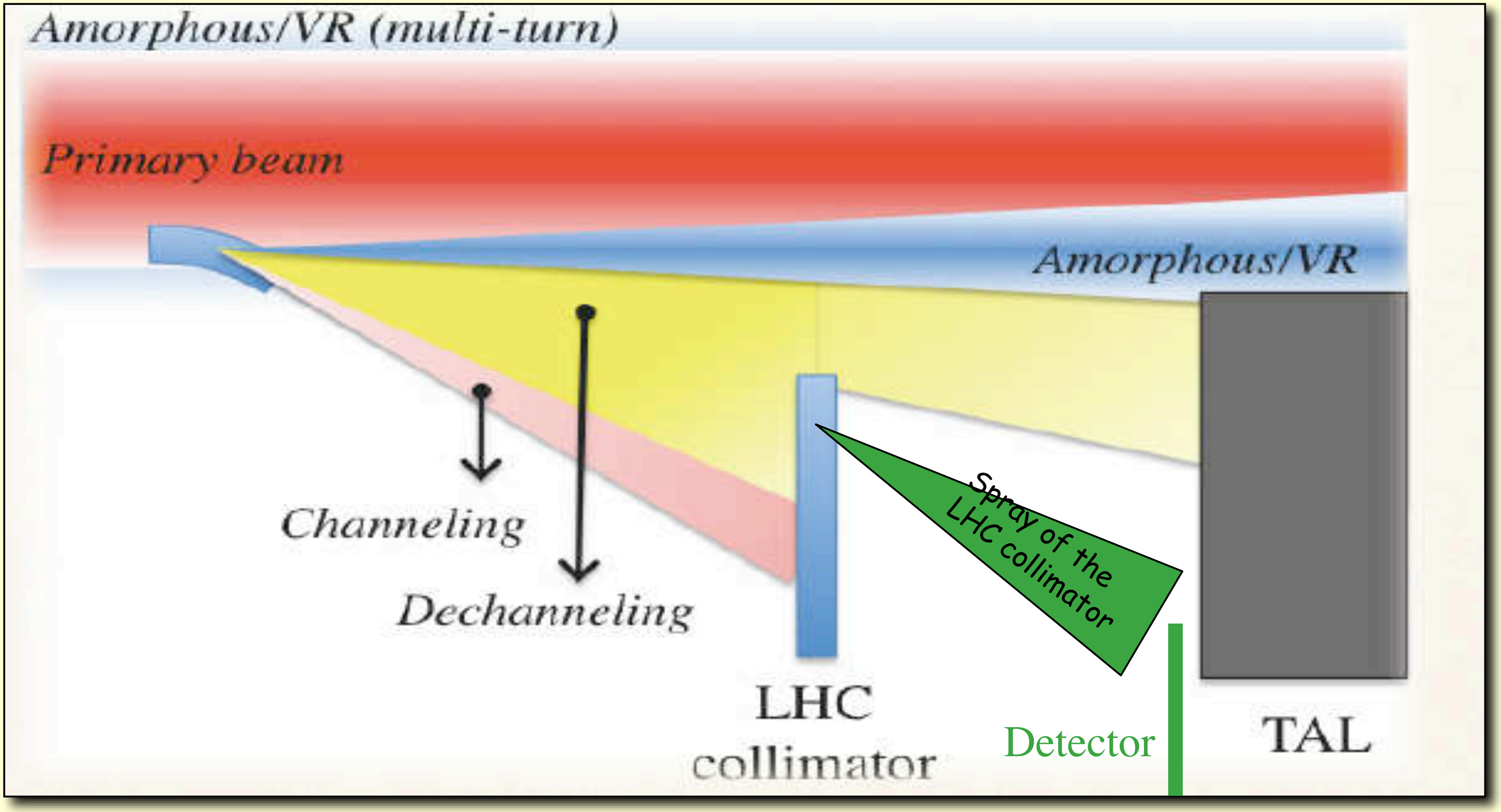
- Crystal at 4.5 σ
  - Nuclear loss ratio × 35
  - Channeling at 100 μrad



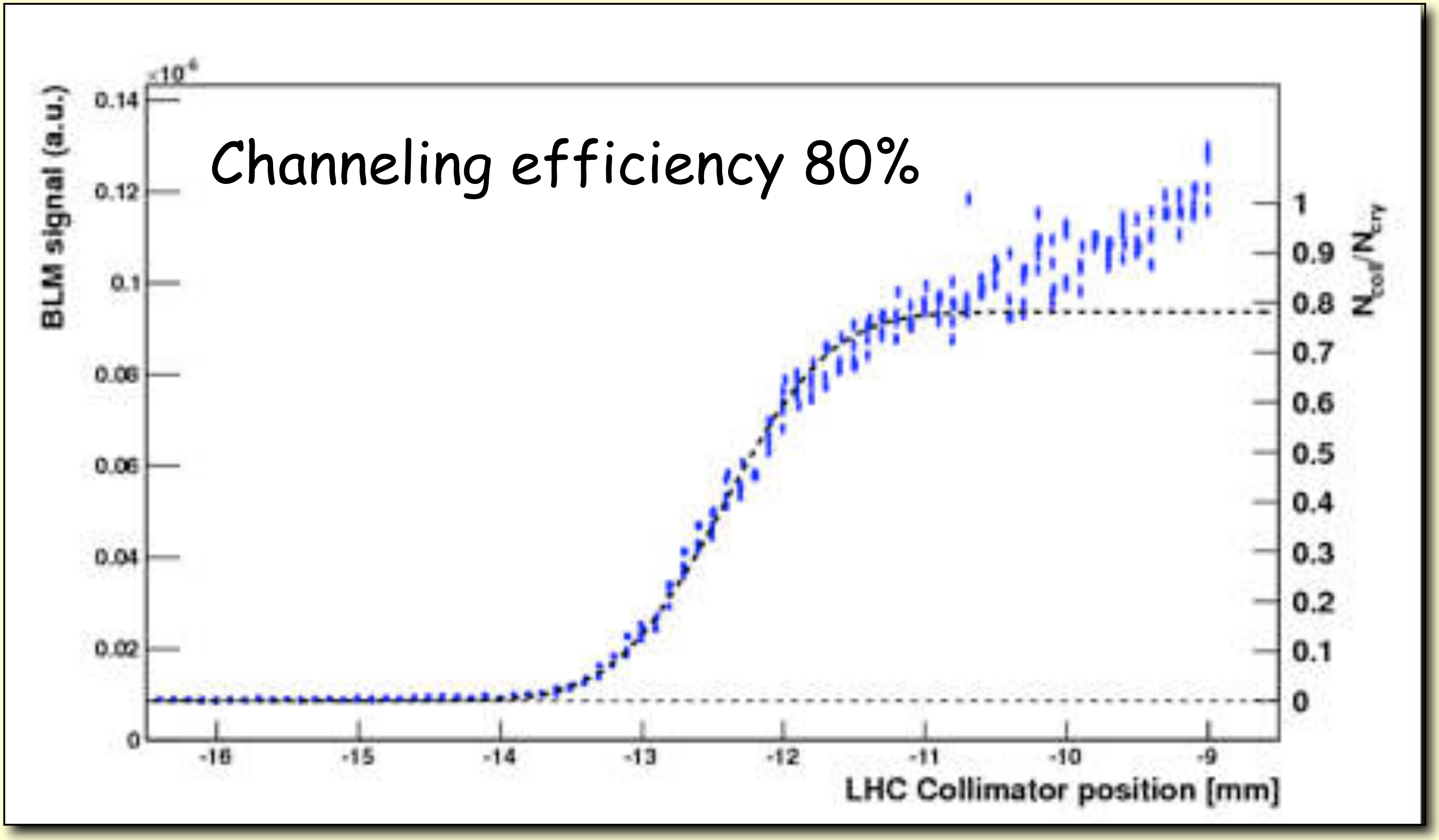
- Crystal at 6 σ
  - Nuclear loss ratio × 8
  - Channeling at 60 μrad



Collimator Scans

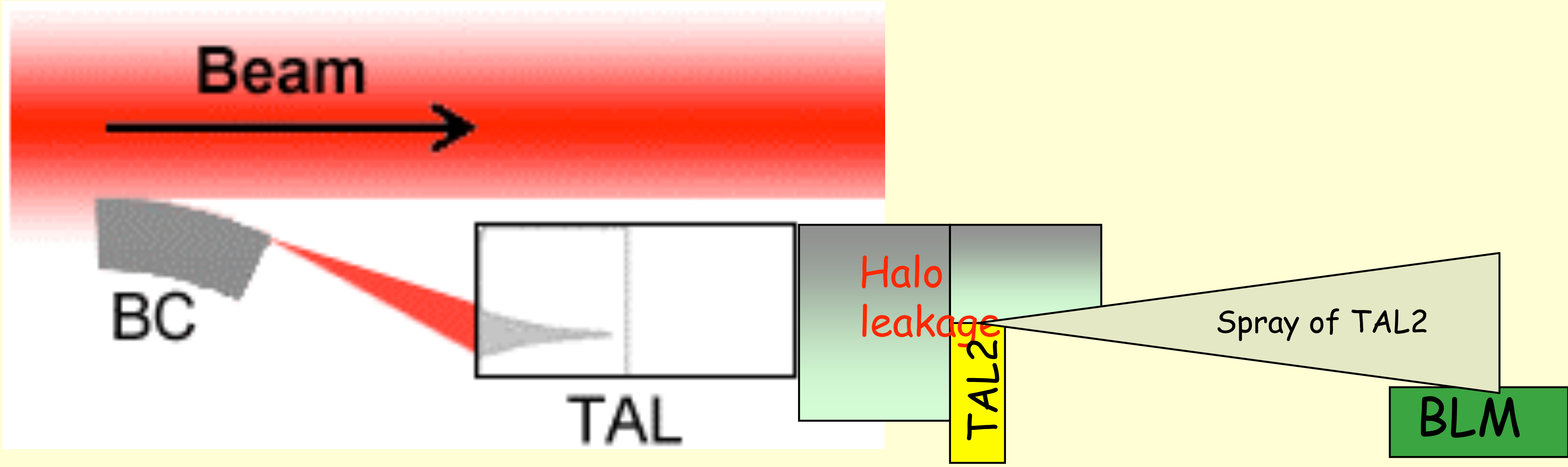


LHC Collimator Scan of Crystal 3

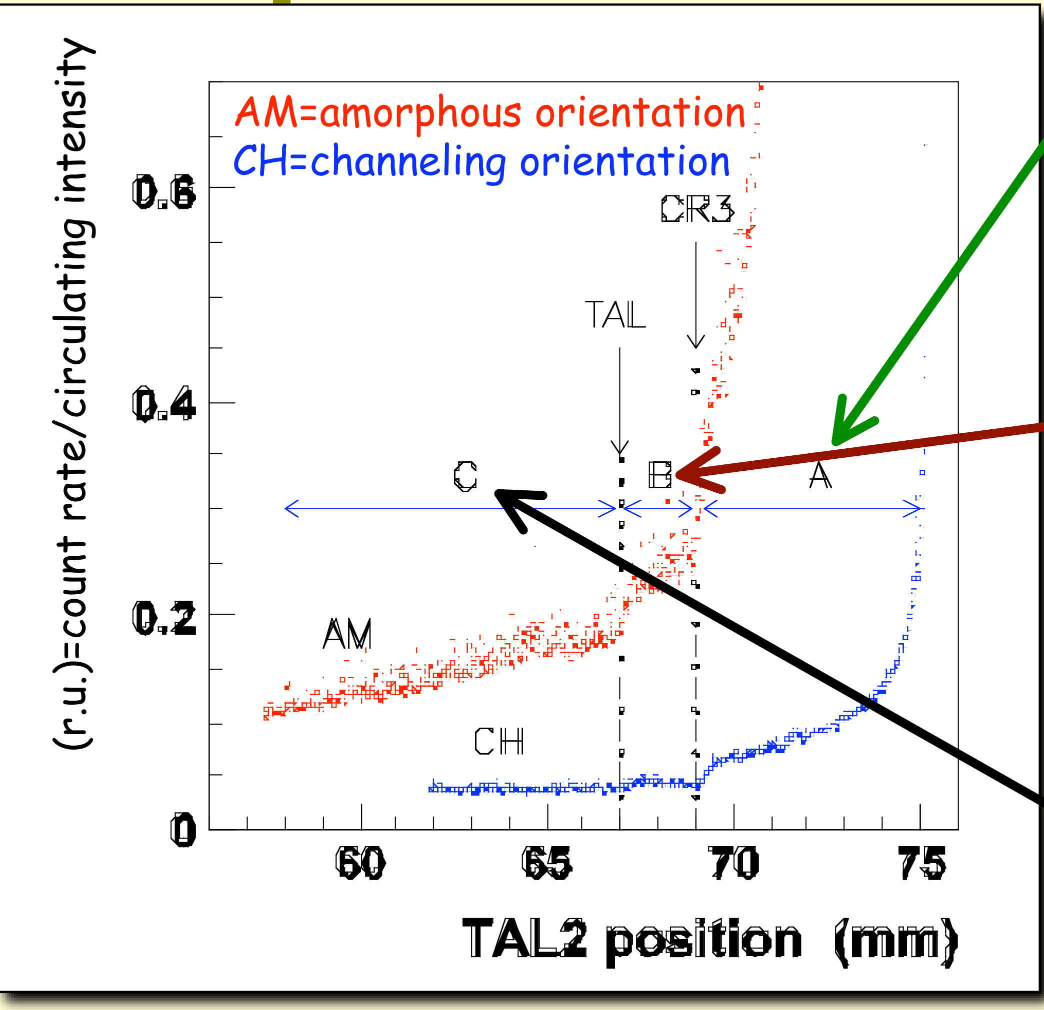


TAL 2 Scans

- Dispersive area of the SPS sensitive to diffractive events
  - channeled particles don't hit TAL2 (on 1st path)



Collimation leakage in a high-dispersive area



- A) tail of the circulating beam
  - fast depletion in channeling mode
  - linear descent of the population in amorphous orientation (or with the tungsten scatterer)
- B) multiple Coulomb scattering
  - fast depletion by high probability of prompt channeling at the first crystal hit
  - slow depletion due to multi-turn hits of the amorphous primary (very slow extraction)
- C) shadow of the absorber
  - low population due to low probability of nuclear interaction in channeling mode
  - off-momentum halo due to diffractive hits with the amorphous primary and TAL

UA9 Main Results

- Crystal collimation works very well based on channeling process
  - Optimal crystal alignment easily detected and achieved
  - Collimation leakage in amorphous orientation larger than in channeling
- Collimation leakage rate reduced by more than a factor of 5 at the TAL2 in the dispersive location (sextant 5, position 22)
  - Nuclear loss rate (including diffractive) strongly depressed
  - In channeling versus amorphous mode : × 16 in multi-turn (SPS)

UA9 Plans

- Complete the runs in 2010
  - (pending request of one additional shift of 8 h to partly compensate the two UA9 shifts used to fill LHC)
  - Main goals
    - Improve the estimate of the collimation efficiency
    - Improve loss map detection in the dispersive area
    - Test the remaining crystals
    - Add one or two Medipix in the Roman pot 2 (–> 2011)
    - Test with IONS Pb82
- Extension of the UA9 apparatus in the 2011 winter shutdown
  - Replace gonios 1 and 2 with more accurate short goniometers (suited for LHC)
  - Complete the beam loss detectors (a coincidence telescope everywhere)
  - Fill the RP2 with 4 medipix and 2 fiber hodoscopes
  - Add SPS collimators and loss detectors in 2 more areas to introduce betatronic aperture restrictions.
- Request submitted for similar run time in SPS and H8 next year.
  - endorsed by the CERN SPSC

SPS Results *vs* LHC Requirements

Parameters	Obtained in 2009	Obtained in 2010	Required for LHC
Channeling efficiency, %	75	80	90-95
Nuclear loss reduction	5	16 - 20	20 - 30
Goniometer angular accuracy, μrad	30 - 40	10	1 - 2
Crystal bend angle, μrad	140 – 150	150 – 170	50 - 100
Crystal torsion, μrad	20 - 30	5 - 10	0.5 - 1
Amorphous layer on crystal	About zero	About zero	About zero
Collimation leakage reduction	-	5	Should be analysed

Road Map towards an LHC Expt.

- Crystals in preparation at PNPI and INFN-Ferrara to be tested in H8
- Goniometer in preparation with and industrial partnership with CINEL, to be tested in H8
  - IHEP also proposed to build new goniometers for SPS, should fit LHC also
- Special instrumentation [loss detectors and mini-Roman pots] in preparation at CERN with the help of INFN and Imperial College to be tested at the SPS
- Simulation!
  - Simulation working group to be formed (CERN, INFN, IHEP, …)
  - important for both the SPS expts as well as any planning for LHC
- Layout of a possible installation at the LHC
  - There are flanges in the LHC available, details to be worked out, close coordination with LHC ops and LHC collimation group needed.

Summary

- The UA9 collaboration is alive and well
- Most recent data from the SPS look quite convincing re. channeling efficiency in the ring
- Improvements to the experimental setup will increase data quality and quantity in 2011.
  - better understand the details
- Discussions about a possible experiment in the LHC are now beginning in earnest.