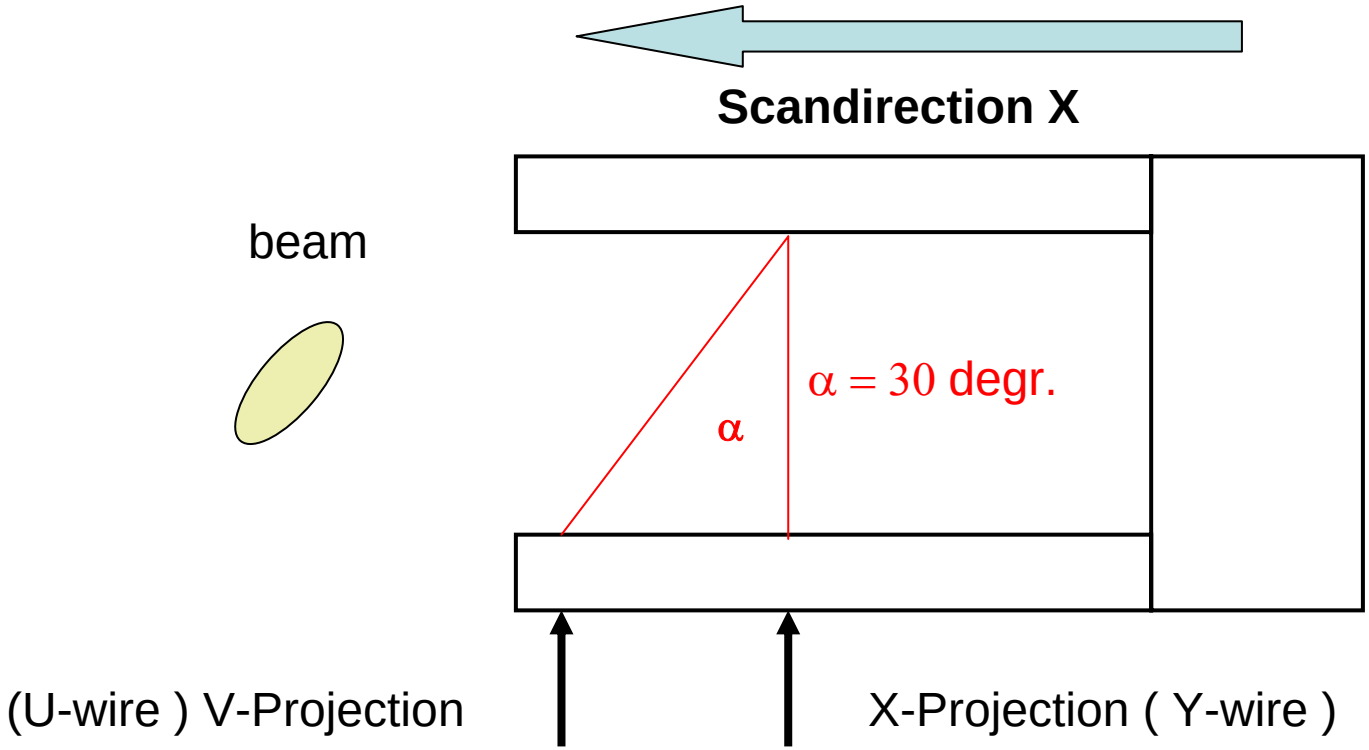
WS study (MC) with tilted wires

- **Summary (Last Summer)**

- **WS are integrated into PITZ-DOOCs.**
- **Can be used by everybody.**
- **First measurements show promising results.**
- **Upgrades/improvements are planned**
  e.g. fork 45 ^{o} wire (to resolve x-y coupling).
- **Proposals for improvements are welcome.**

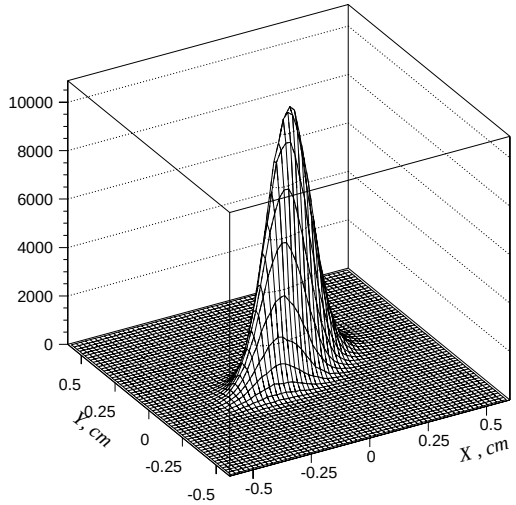
WS study (MC) with tilted wires



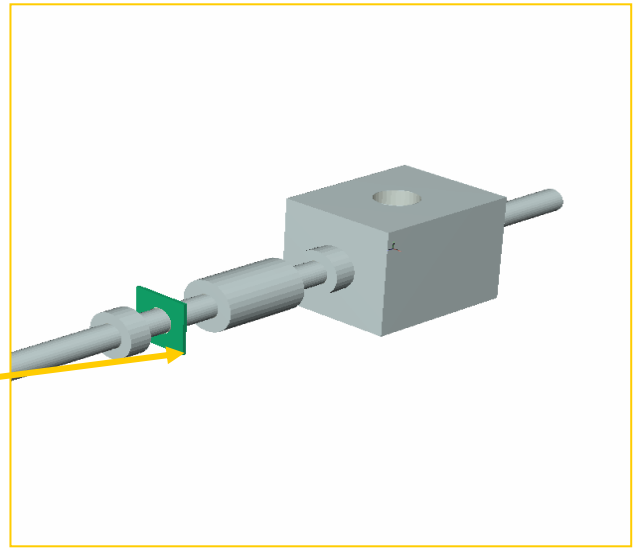
45 ^{0} <u>not possible</u> without serious change in WS construction, but 30 ^{0} can be easily realized (needs only new forks).

WS study (MC) with tilted wires

PITZ beam tilt study



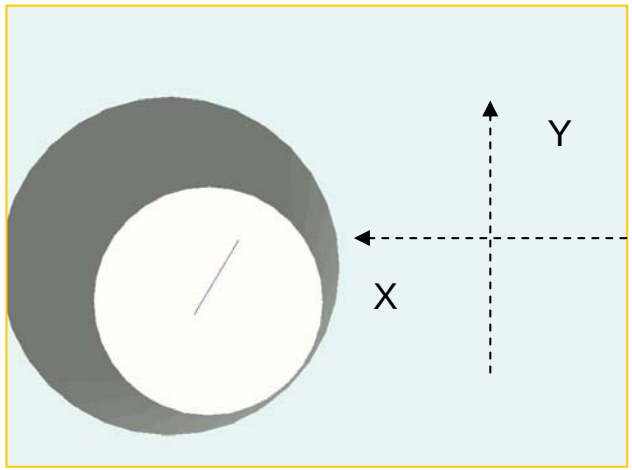
wire moved (in steps) through the beam, energy deposition in scintillator counted.



Beam 30 MeV e-

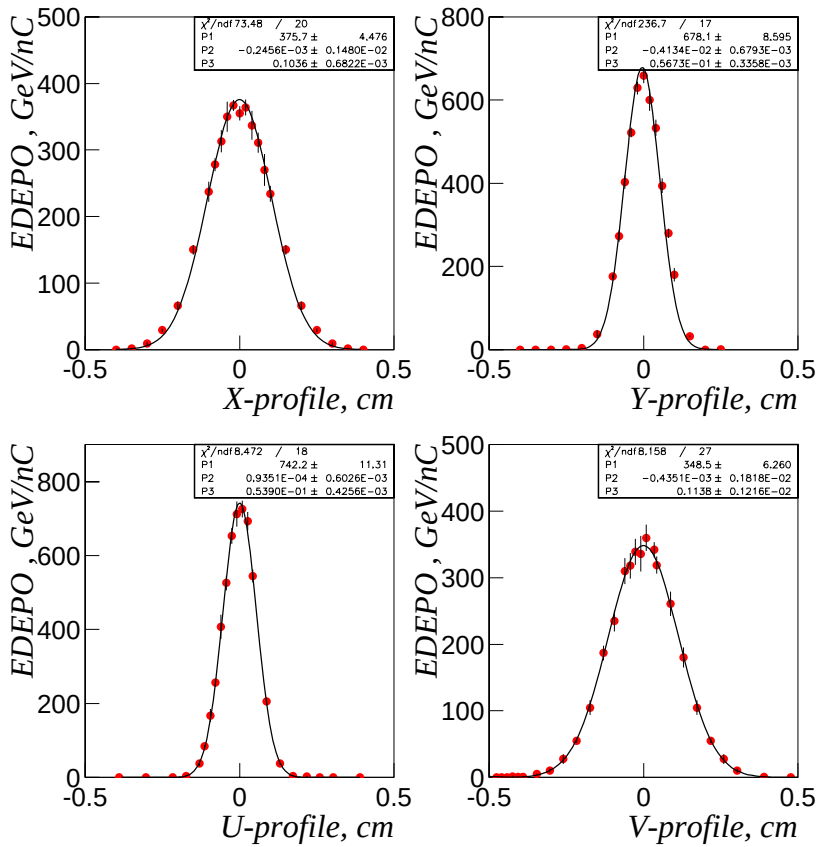
σ_X = 1.114 mm , σ_Y = 0.5 mm

20 ^{0} beam tilt, 10 μm wire



WS study (MC) with tilted wires

PITZ tilted beam study



Each red data point correspond to 5x10000000 trigger, the error bars are the STDEV of the 5 independent MC-runs.

The values are scaled to 1 nC bunch charge.

Important are only the σ values of a Gauss fit:

σ_X = 0.104 +/- 0.7E-3 cm

σ_Y = 0.057 +/- 0.3E-3 cm

σ_U = 0.054 +/- 0.4E-3 cm

σ_V = 0.114 +/- 0.1E-2 cm

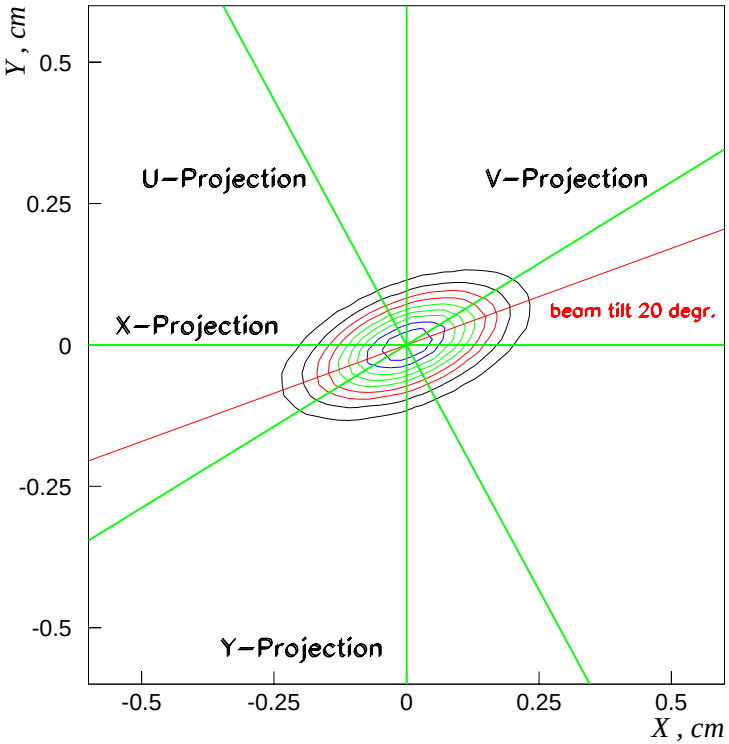
WS study (MC) with tilted wires

4 profiles with the rotation matrix:

$$\begin{pmatrix} U \\ V \end{pmatrix} = \begin{pmatrix} \cos\Theta & \sin\Theta \\ -\sin\Theta & \cos\Theta \end{pmatrix} \begin{pmatrix} X \\ Y \end{pmatrix}$$

Θ = roll angle of wire

PITZ beam tilt study



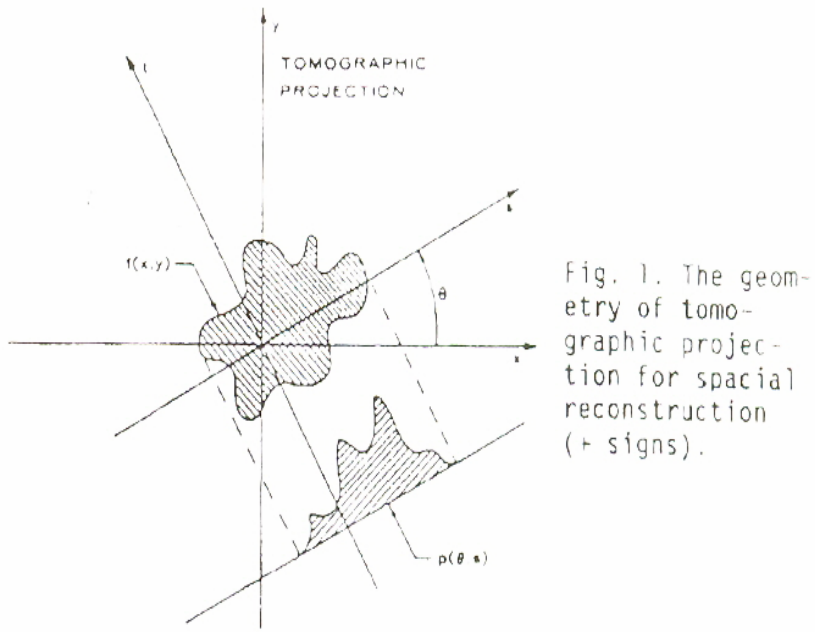


Fig. 1. The geometry of tomographic projection for spacial reconstruction (+ signs).

C.T.Mottershead: Max.Entropy for Beam Diagnostics,1985

WS study (MC) with tilted wires

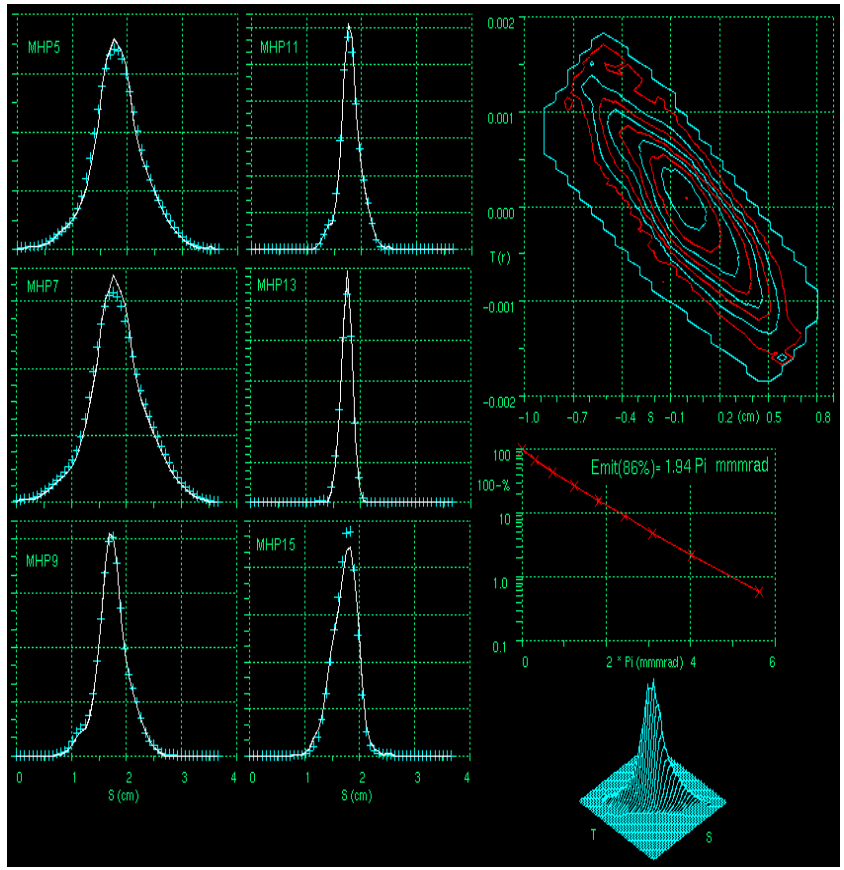
INTRODUCTION OF TWO-DIMENSIONAL TOMOGRAPHY FOR MONITORING THE TRANSVERSE BEAM EMITTANCES AT SIN

Urs Rohrer and Werner Joho, SIN

http://pc532.psi.ch/ment.htm

Tomography is a method for reconstructing a multidimensional source from a number of selected projections. Its initial and best known applications today are in medical radiology. The goal of two-dimensional beam tomography is the reconstruction of the probability distribution in two-dimensional phase space from a few (at least three, one near a waist) measured profiles. The reconstruction is done using the computer programme MENT2A …., which we received from Los Alamos. …
The way this beam tomography code is adjusted today, the only restriction is the span of the measured beam profile data to not be less than about one mm. The beam profiles may be measured with different devices such as wire scanners, harps, strip detectors or photographic (CCD) cameras. Instead of gathering profile information at different locations along the beam line it may also be preferable to measure only at one location and getting the multitude of information for doing beam tomography through the variation of the optics (by controlled modification of the settings of some) between the source and the location of the beam profile observation device…..

The code is also capable of reconstructing 2D-x/y-sources from different angle projections at one location (at least 3) if the rotation matrices {Rij} for each projection are properly given in the input.



HJG, 2.3.10

WS study (MC) with tilted wires

The program is :

-**Old:** **G. MINERBO, "MENT: A MAXIMUM ENTROPY ALGORITHM FOR RECONSTRUCTING A SOURCE FROM PROJECTION DATA," COMPUTER GRAPHICS AND IMAGE PROCESSING 10, 48-68 (1979).**

-**Was developed to calculate X(Y) and X' (Y') in phase space.**

-**Is written in F77 for VAX and DEC computer, ported to Linux and Windows.**

-**Uses X11- Window server.**

-The code to produce any graphical output is much longer than the MENT code.

-**The code is restricted to > = 1 mm beam span.**

-**The code needs an equidistance binning wit 51 data points/profile. Maximal 21 profiles.**

-**Accepts only values > = 1**

Did only marginal modifications to use it.

WS study (MC) with tilted wires

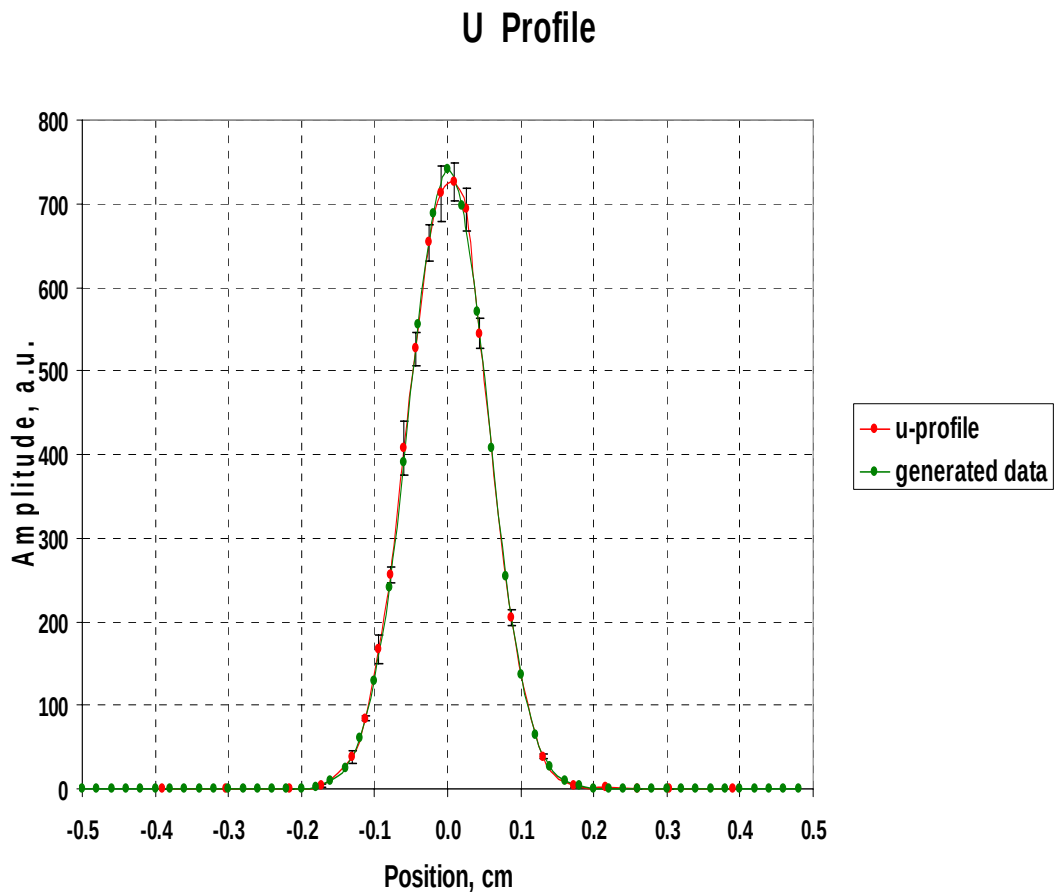
To fulfill the input conditions of the MENT program:

DATA

FIT

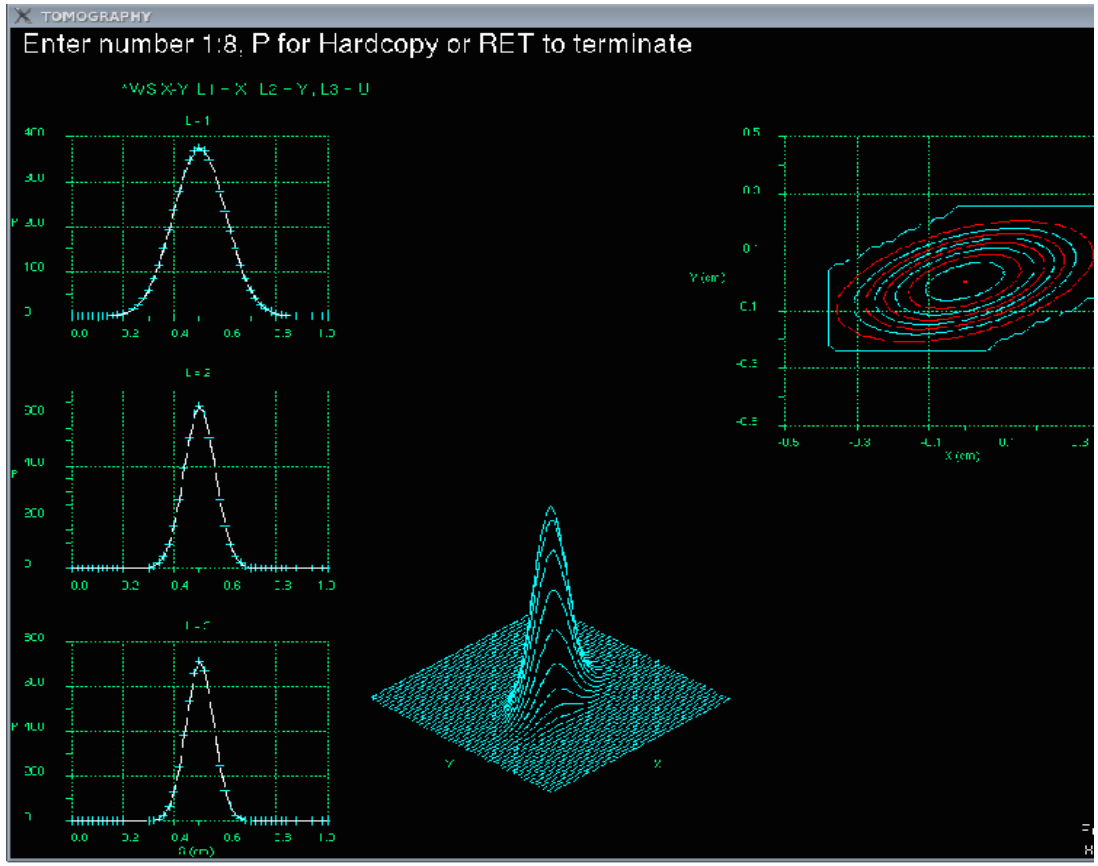
NEW INPUT DATA

(equidistant binnig, 1 cm span)



WS study (MC) with tilted wires

X , Y and U Profiles

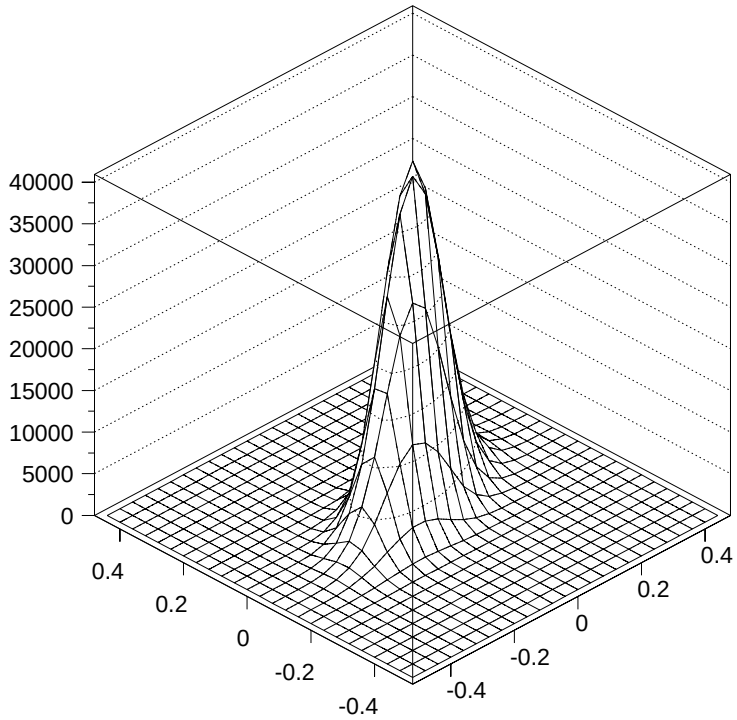


QMAX (largest relative error in matching the data) = 8.6 E-4

HJG, 2.3.10

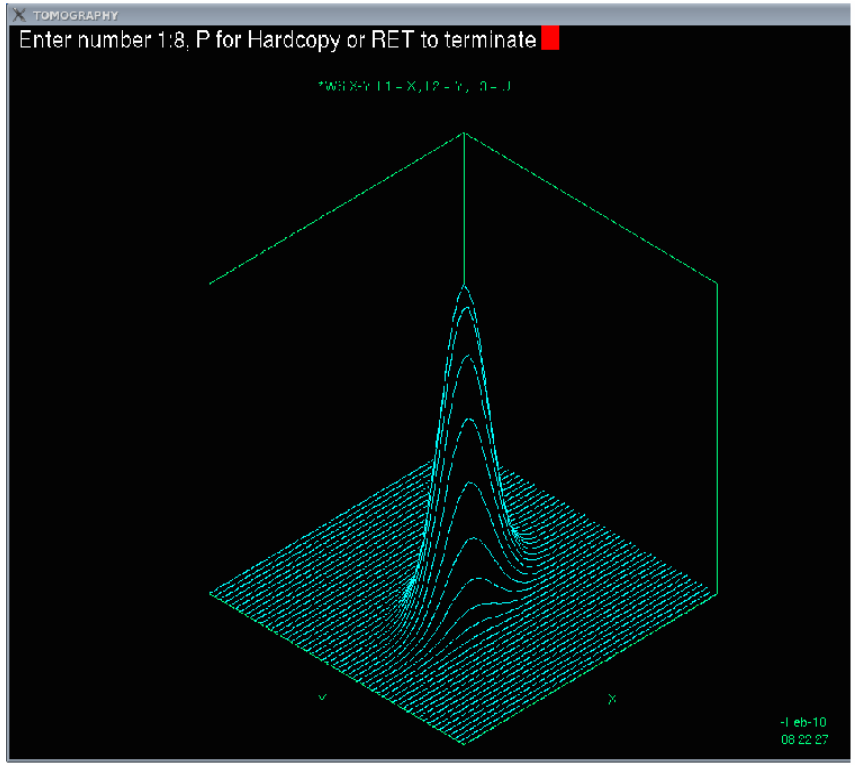
WS study (MC) with tilted wires

PITZ tilted beam study



original

200 μm grid

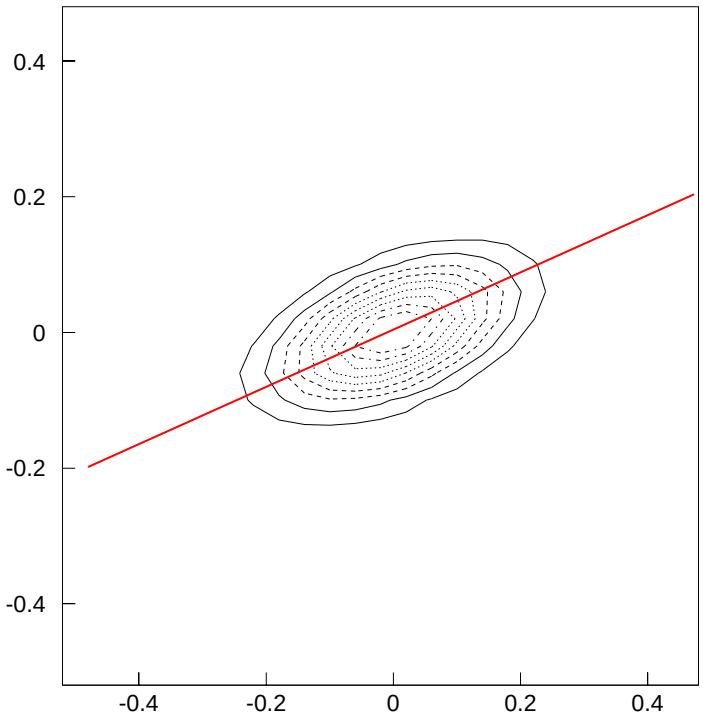


reconstructed

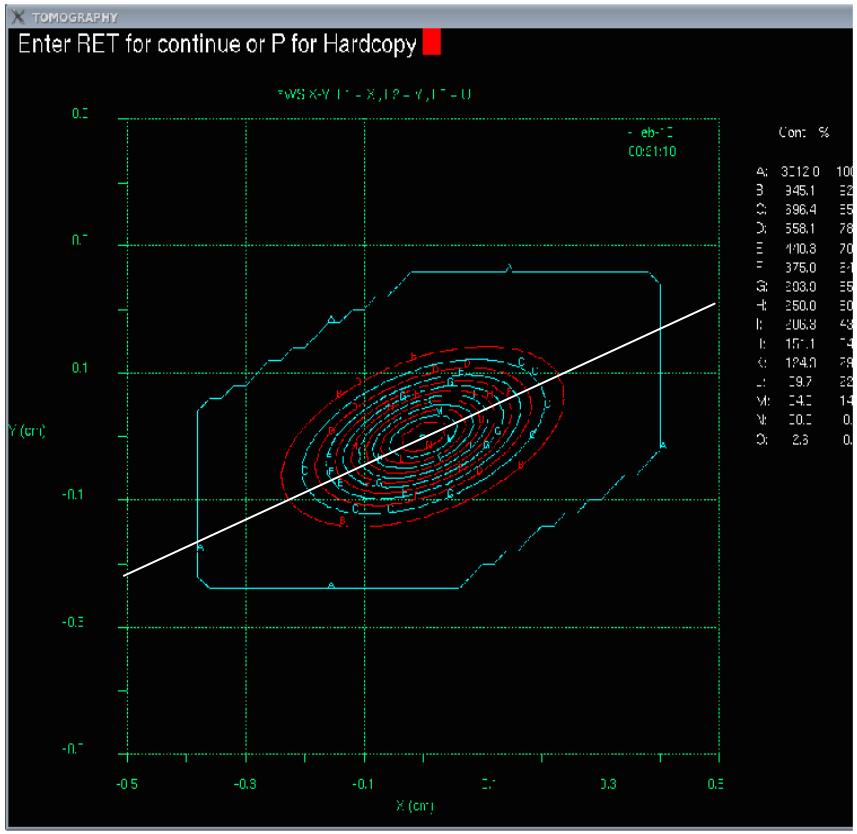
HJG, 2.3.10

WS study (MC) with tilted wires

PITZ tilted beam study



original

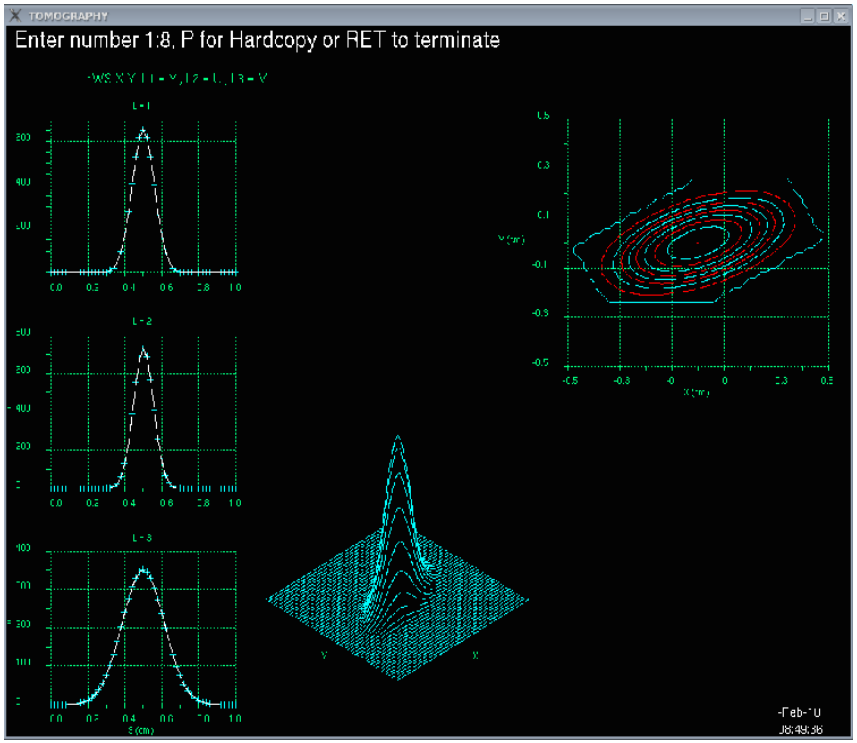


reconstructed

HJG, 2.3.10

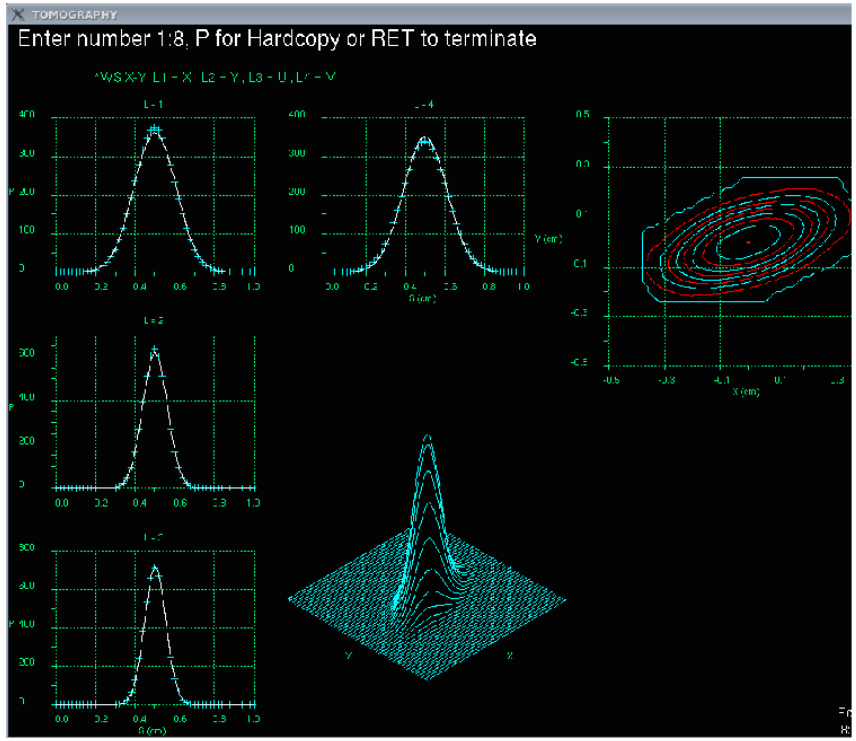
WS study (MC) with tilted wires

Y , U and V profiles



QMAX = 9.7E-4

all 4 profiles

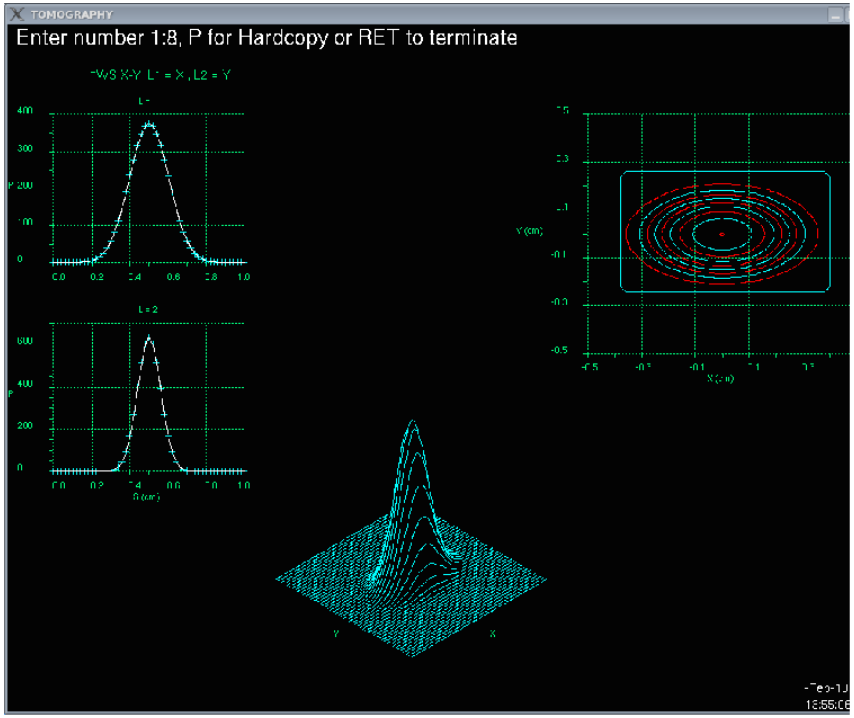


QMAX = 8.9E-2

HJG, 2.3.10

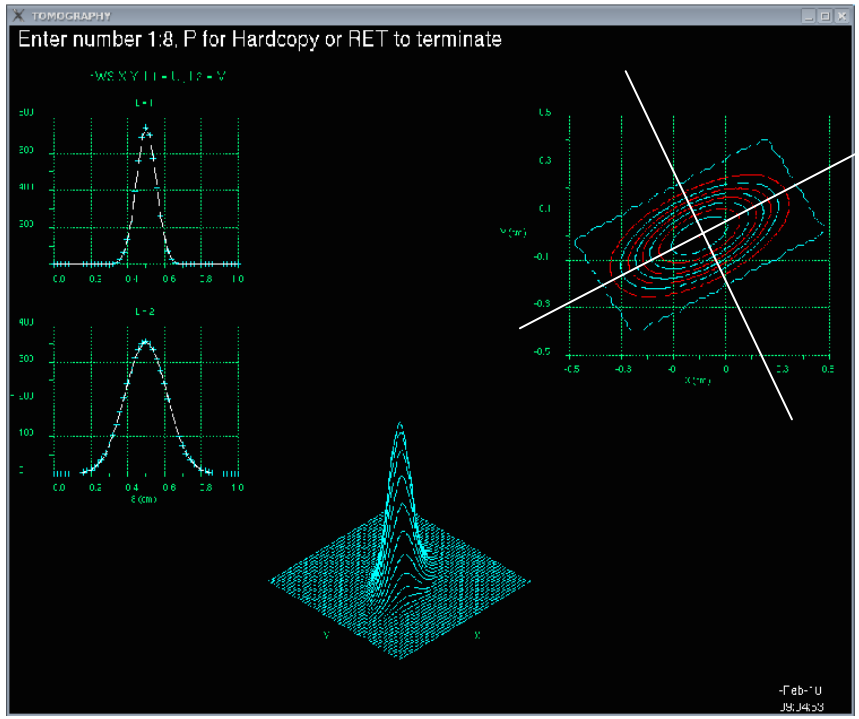
WS study (MC) with tilted wires

only X and Y Profiles



QMAX = 9.0E-4

only U and V profiles, reconstruction in U-V-system (30 ^{0} rotation of X and Y)

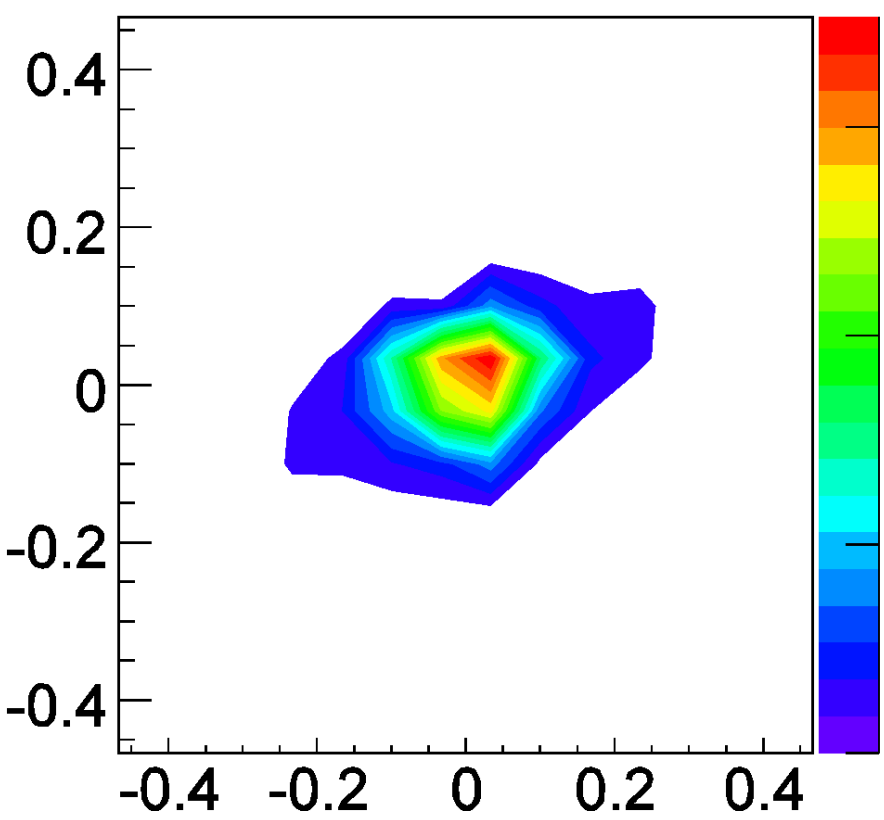


QMAX = 9.2E-4

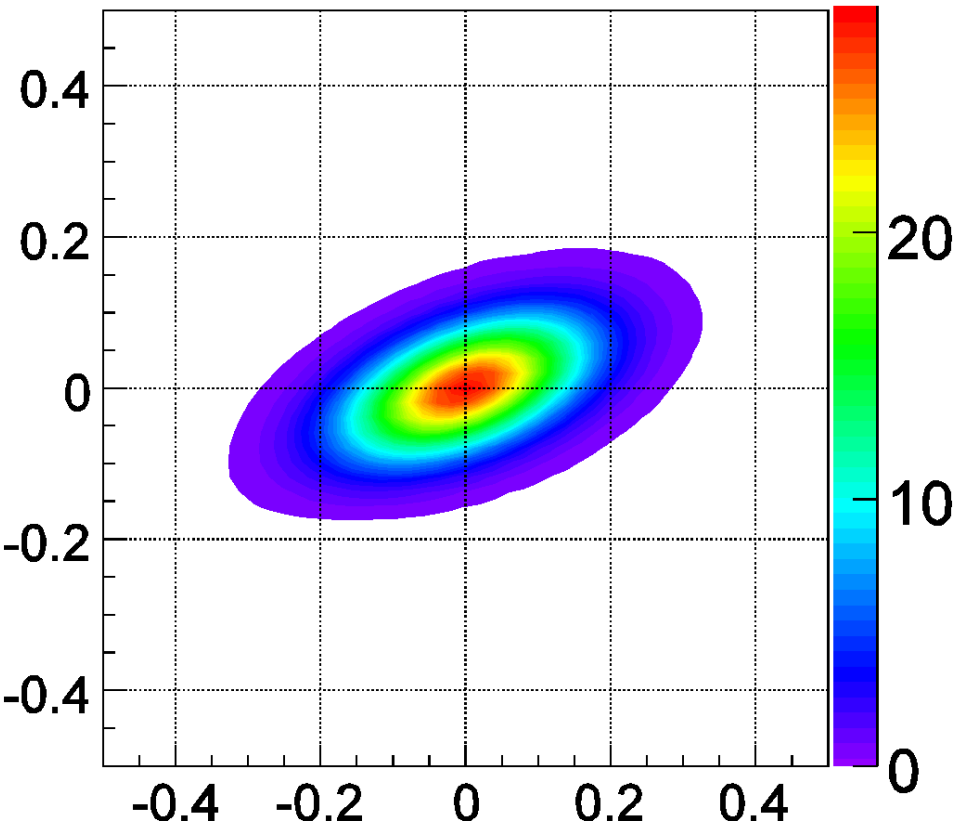
HJG, 2.3.10

WS study (MC) with tilted wires

From Galina, MENT reconstruction with:

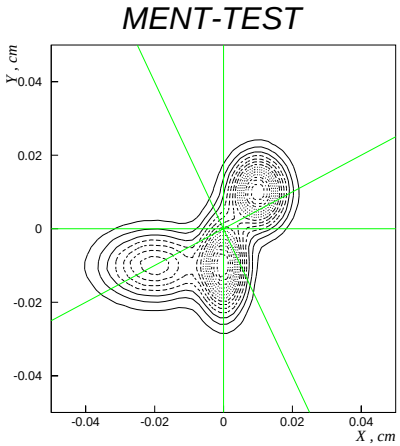


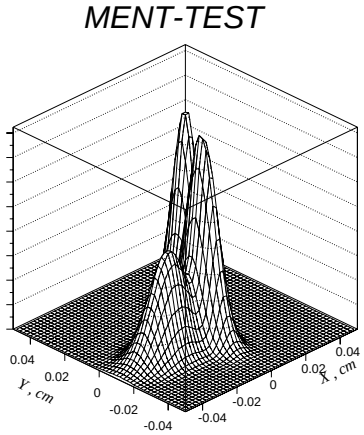
orginal binning



rebinning (equidistant 200 μm)

WS study (MC) with tilted wires

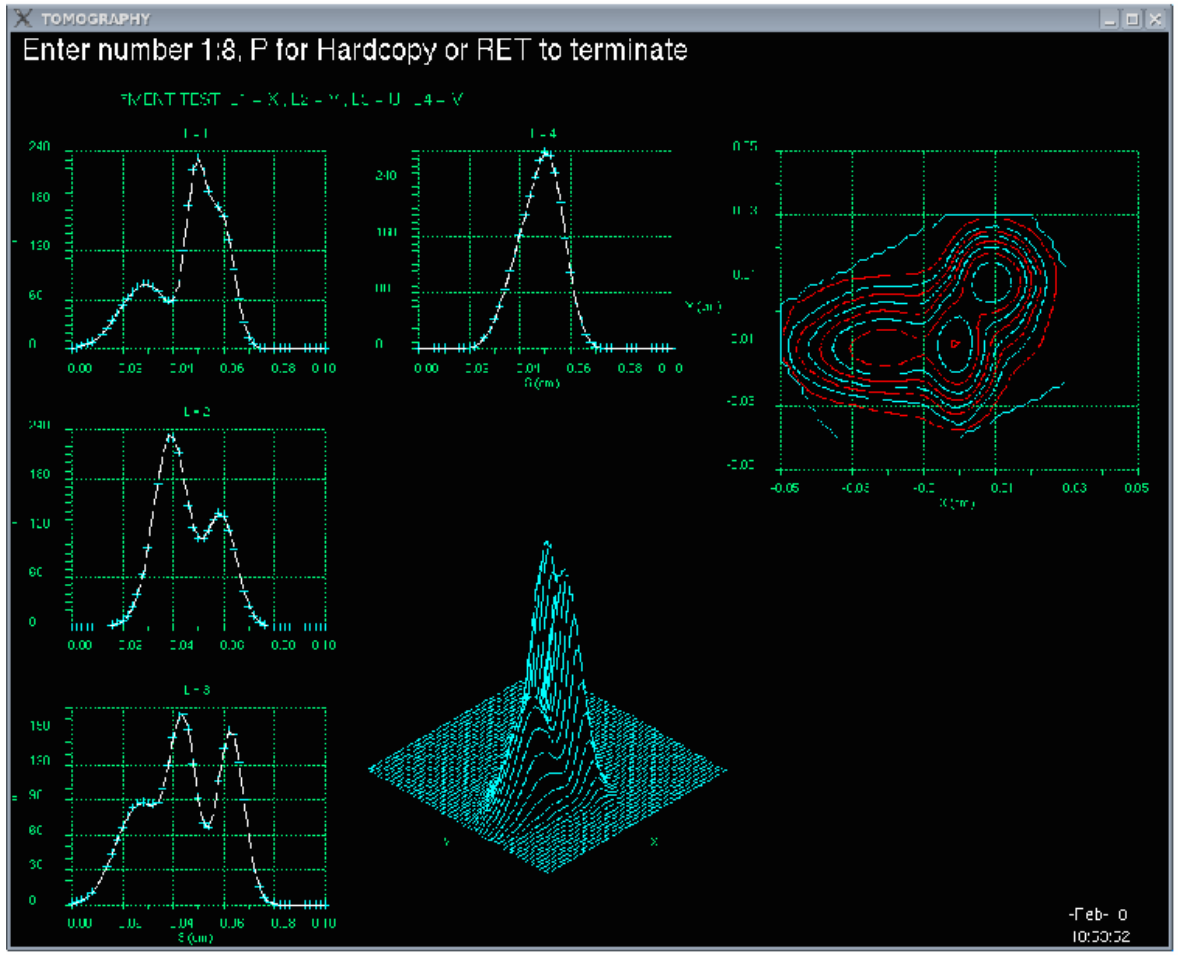




structure with 20 μm grid generated,

WS resolution !!

TEST of capability of the MENT-code



QMAX = 5.2 E-3

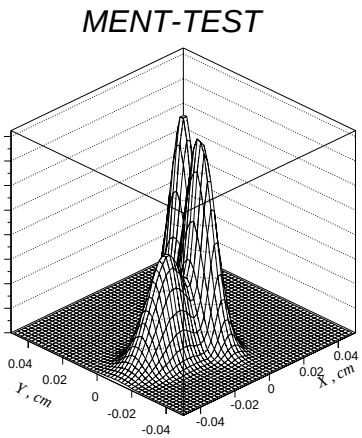
HJG, 2.3.10

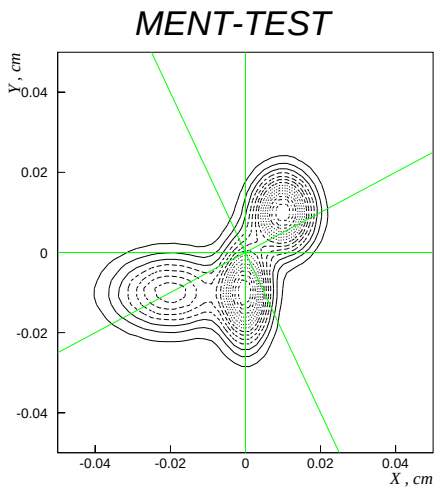
WS study (MC) with tilted wires

more details

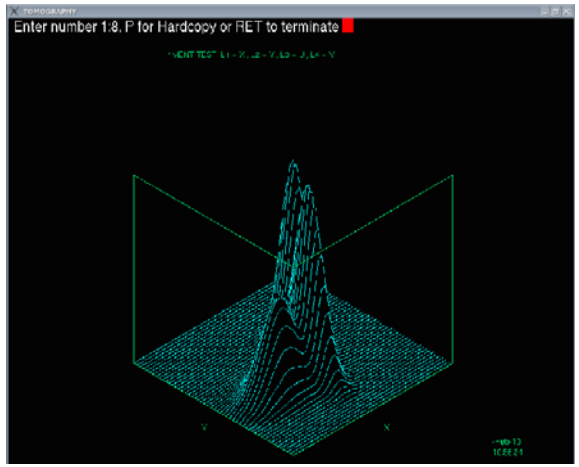
initial structure

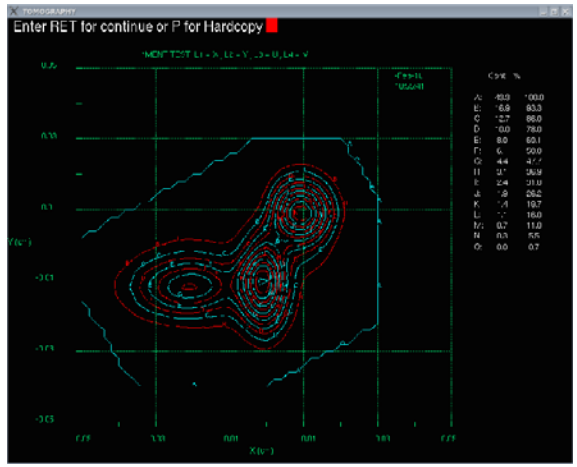
(20 μm grid)





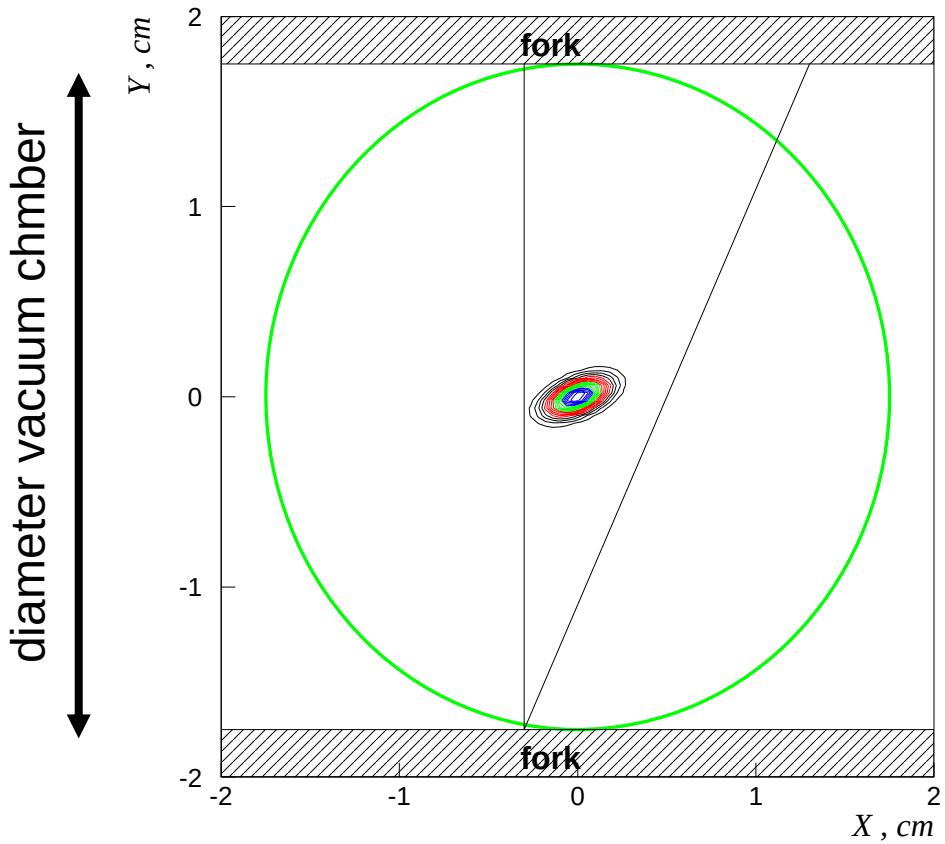
reconstructed
from 4 projections





WS study (MC) with tilted wires

PITZ tilted beam study



Problems:

Large beam sizes at high charge or significant beam halo can lead to an overlap of the signal from standard wire and tilted wire.

Solution:

-direct wire readout

-an other wire arrangement

-restriction to small beam sizes

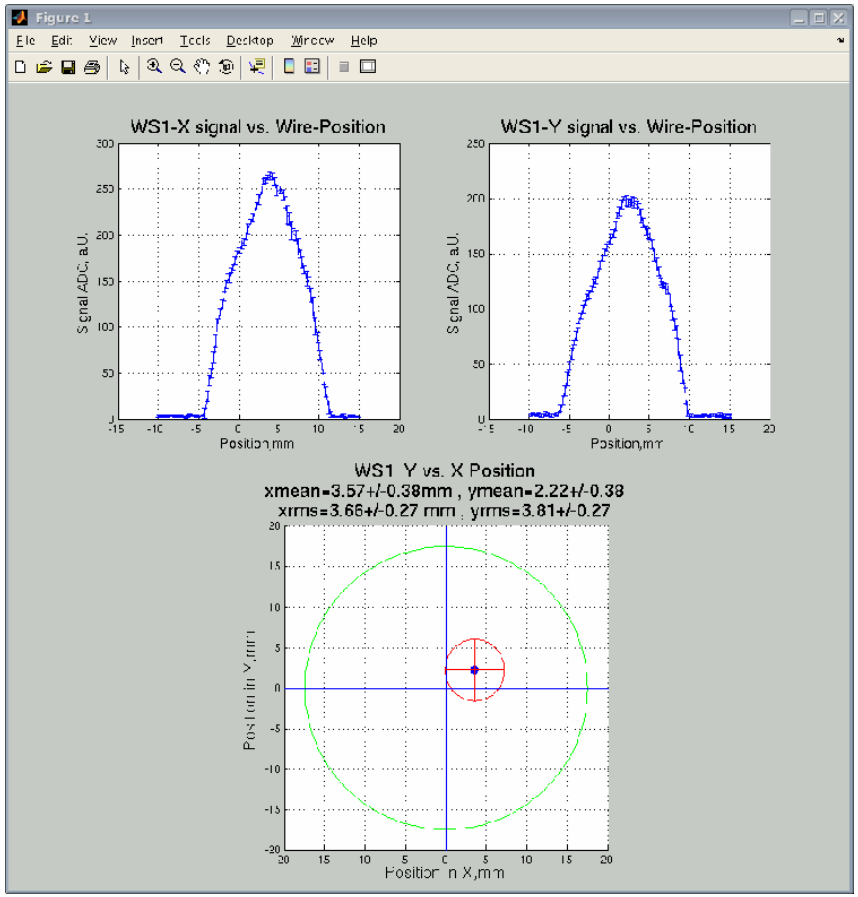
-halo subtraction (BG)

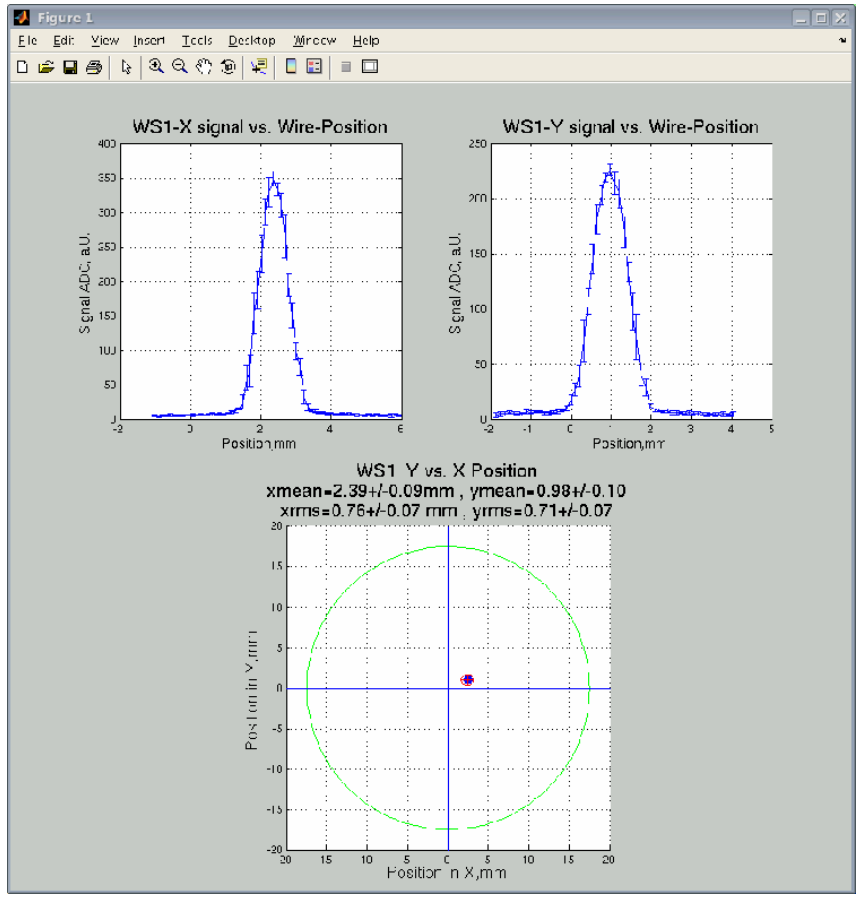
If the wire is tiltet by more than 30 ^{0} it extend into the beam pipe at rest !

WS study (MC) with tilted wires

measurement from last year

Q- scan: 1 nC, 500pC, 200pC, 100pC, 50pC, 10pC , Imain = 340 A





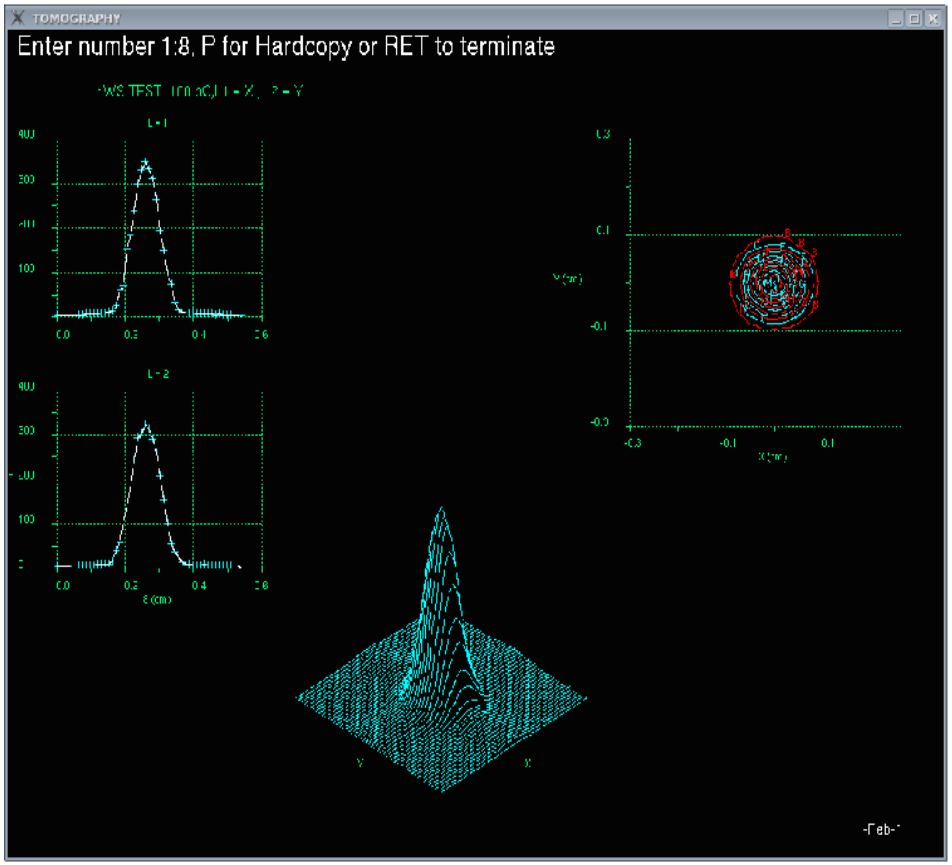
HJG,07.07.09

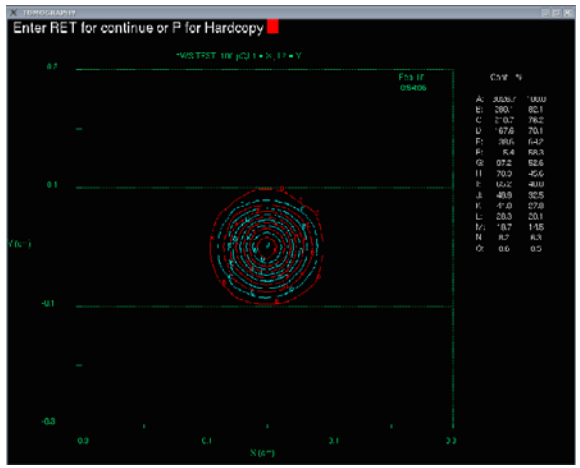
Q = 1 nC

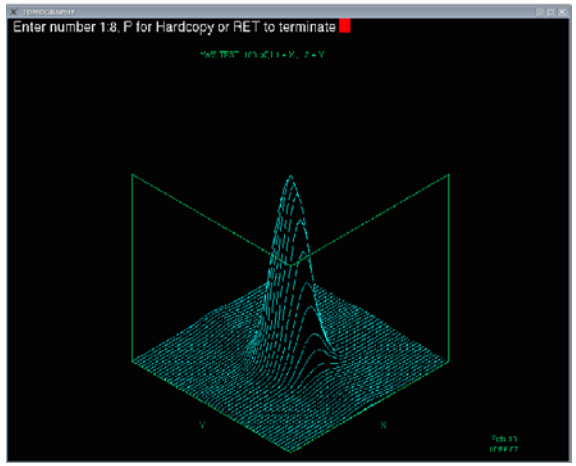
Q = 100 pC

WS study (MC) with tilted wires

reconstruction with two profiles





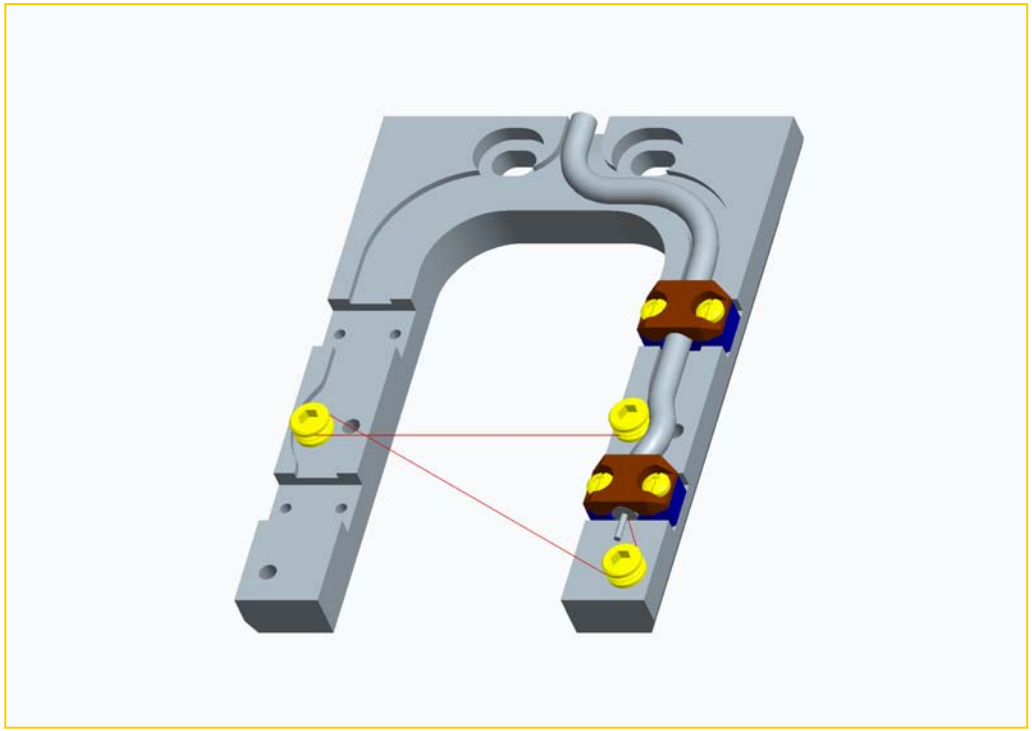


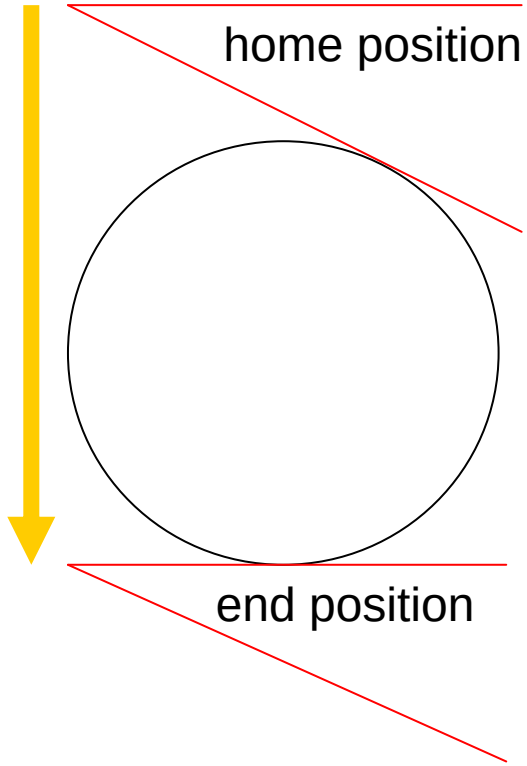
Ws1 data (logbook 2009 : 1906_a

only X and Y profile , ~ 100 μm grid

WS study (MC) with tilted wires

For the next running period (2010) :

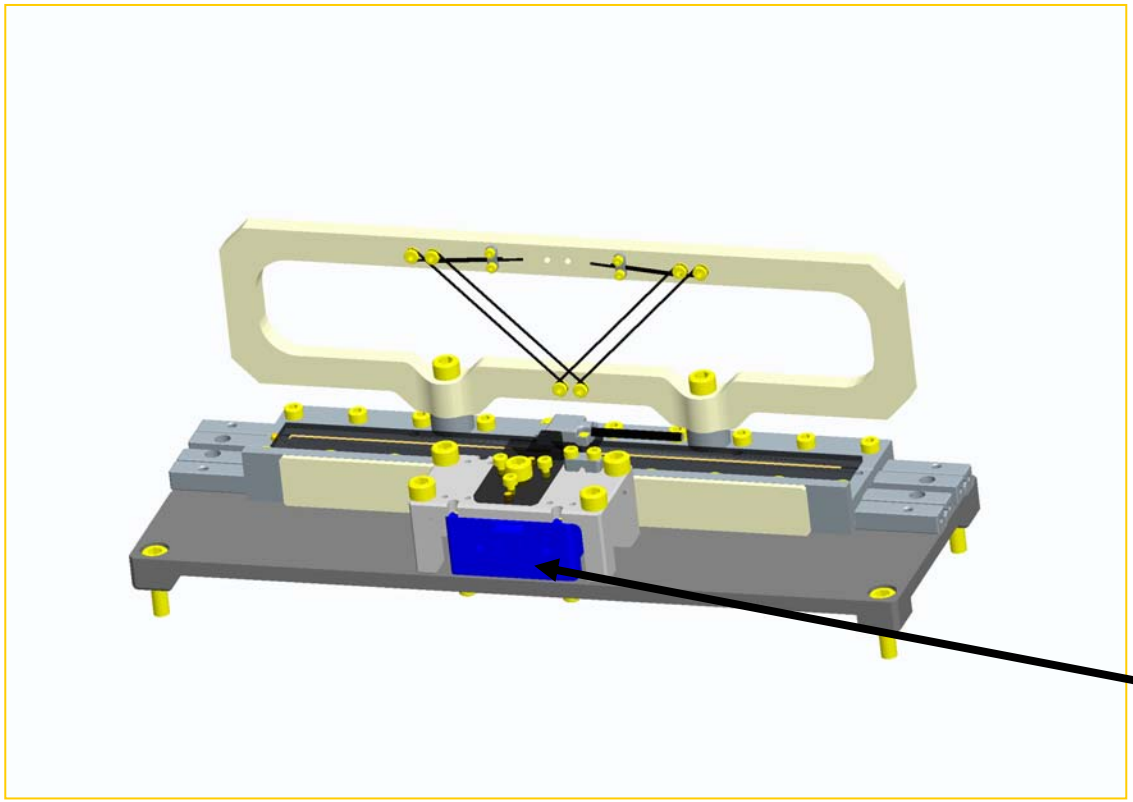




30 ^{0} can be easily realized , new forks in preparation, test in WS1 , if successful ➔ implementation in WS2 during a weekly shutdown.

HJG, 2.3.10

WS study (MC) with tilted wires



speed = 250 mm/s

position error: 2 - 6 μm

stroke : theo. unlimited

force: ~ 30 N

UHV motor

for e.g. 45 ^{0} wires a new construction is needed , study with a UHV motor in vacuum successfully , Diplomwork J. Nagler. It overcome all difficulties of the old WS (bellows, no stepping...), allows to mount any kind of wire to measure any profile. All components in Zeuthen, only workshop needed for prototype and a place to test it.

WS study (MC) with tilted wires

Summary

- **30 ^{0} wires can be realised**
- **Local tomographie in the WS plane using MENT is possible**
- **Phase space tomographie can be done by:**
  - **Measurement different profiles with several devices (CCDs,WS)**
  - **Measurement in one location and manipulate the phase space by e.g. quadrupoles**