Proton beam for UCN

UCN TAC-Meeting, May 12-13, 2005

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PSI Accelerator Division

Department of Large Research Facilities

Introduction

Important parameters of the PSI proton beam for UCN:

Beam energy: 590 MeV

Beam intensity: > 1.8 mA

Beam power: > 1 MW

Duty factor: 1% (8 s of beam every 800 s)

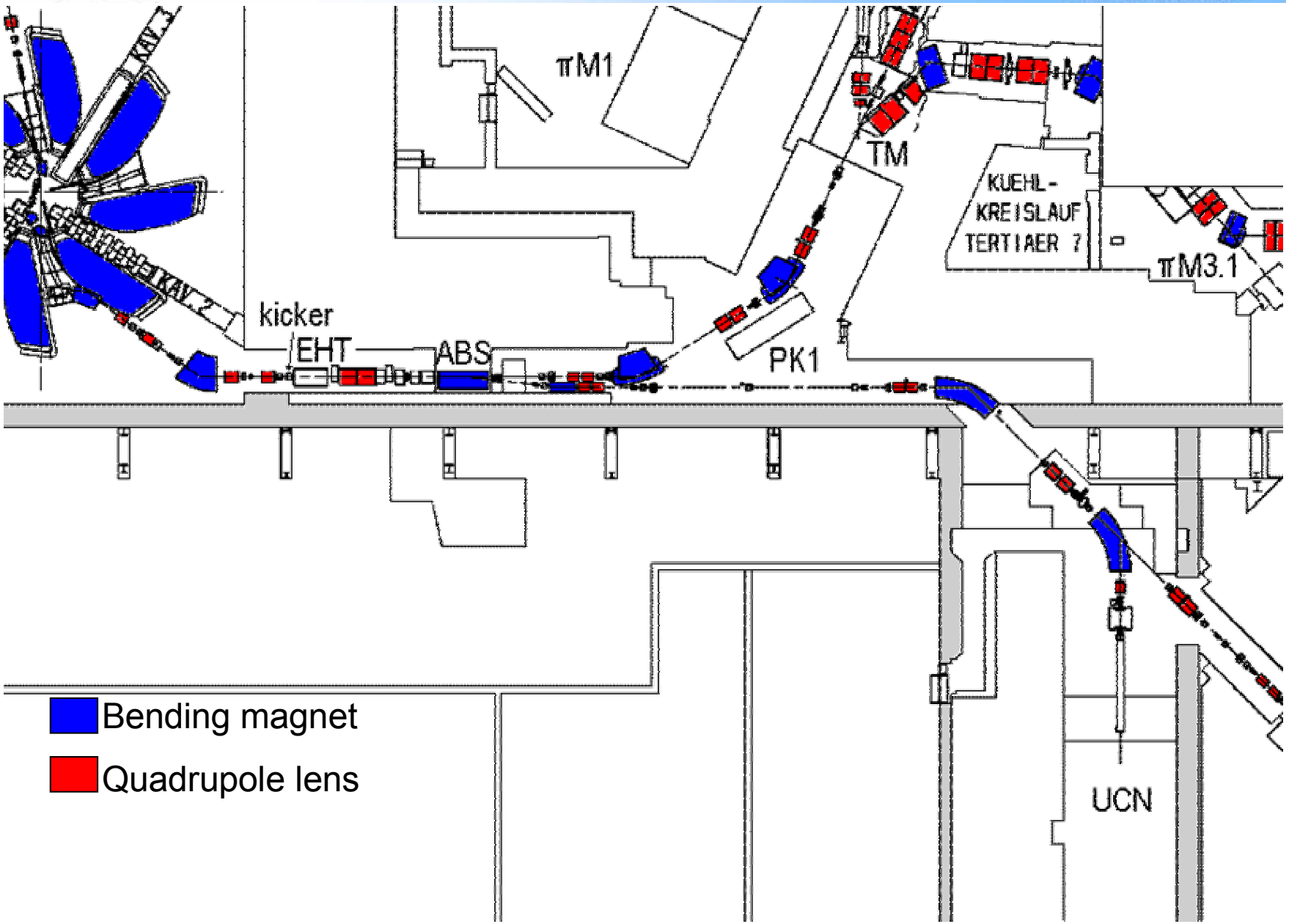
Pulse length: 5 ms to 8 s

Switching time: < 1 ms ($\Rightarrow$low losses, ~2 ppm)

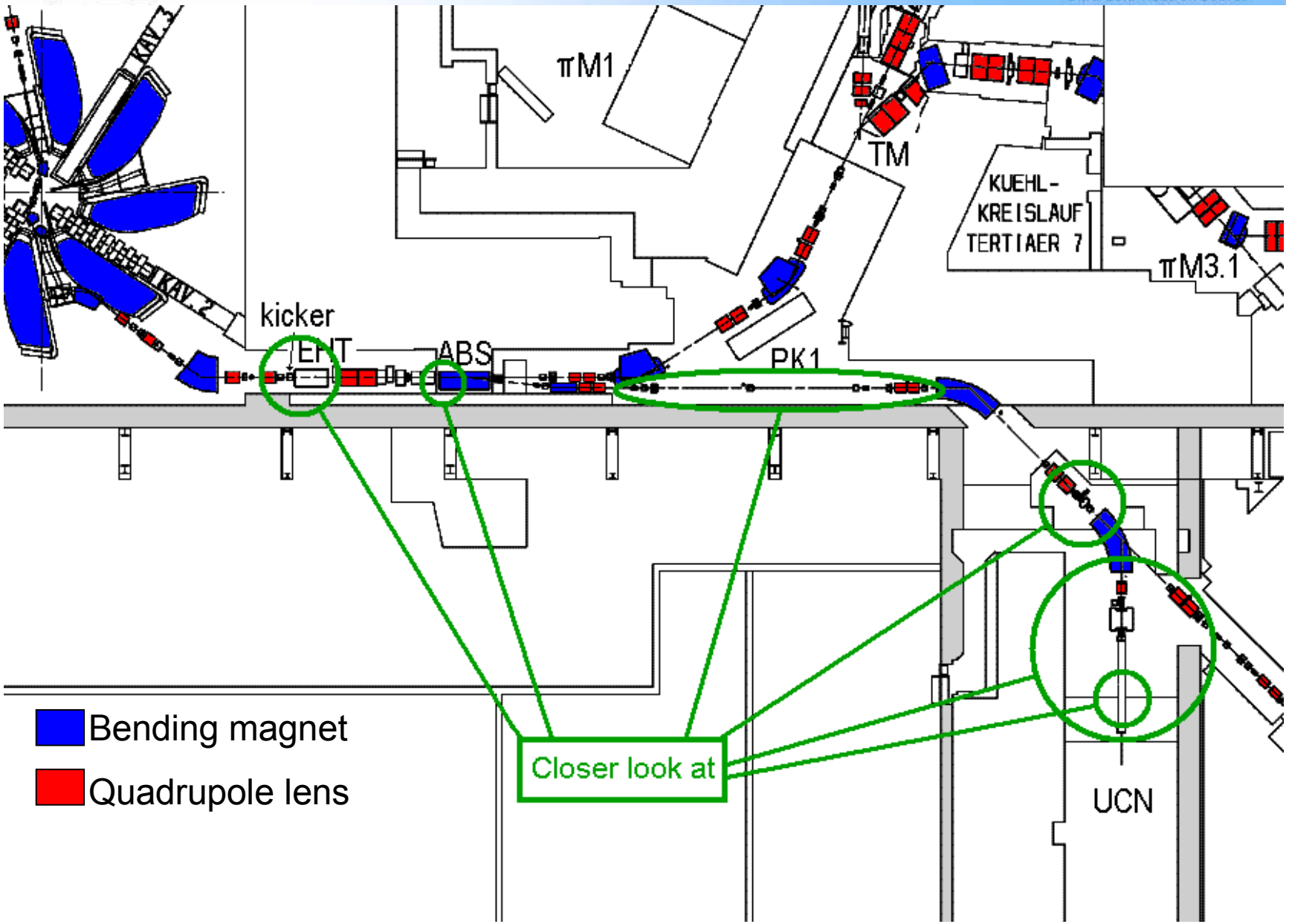
Sigma(waists): 1 mm (like a welding torch, $t_{melt} \approx 10$ ms)

Sigma(UCN): 40 mm (beam-diameter = 200 mm)

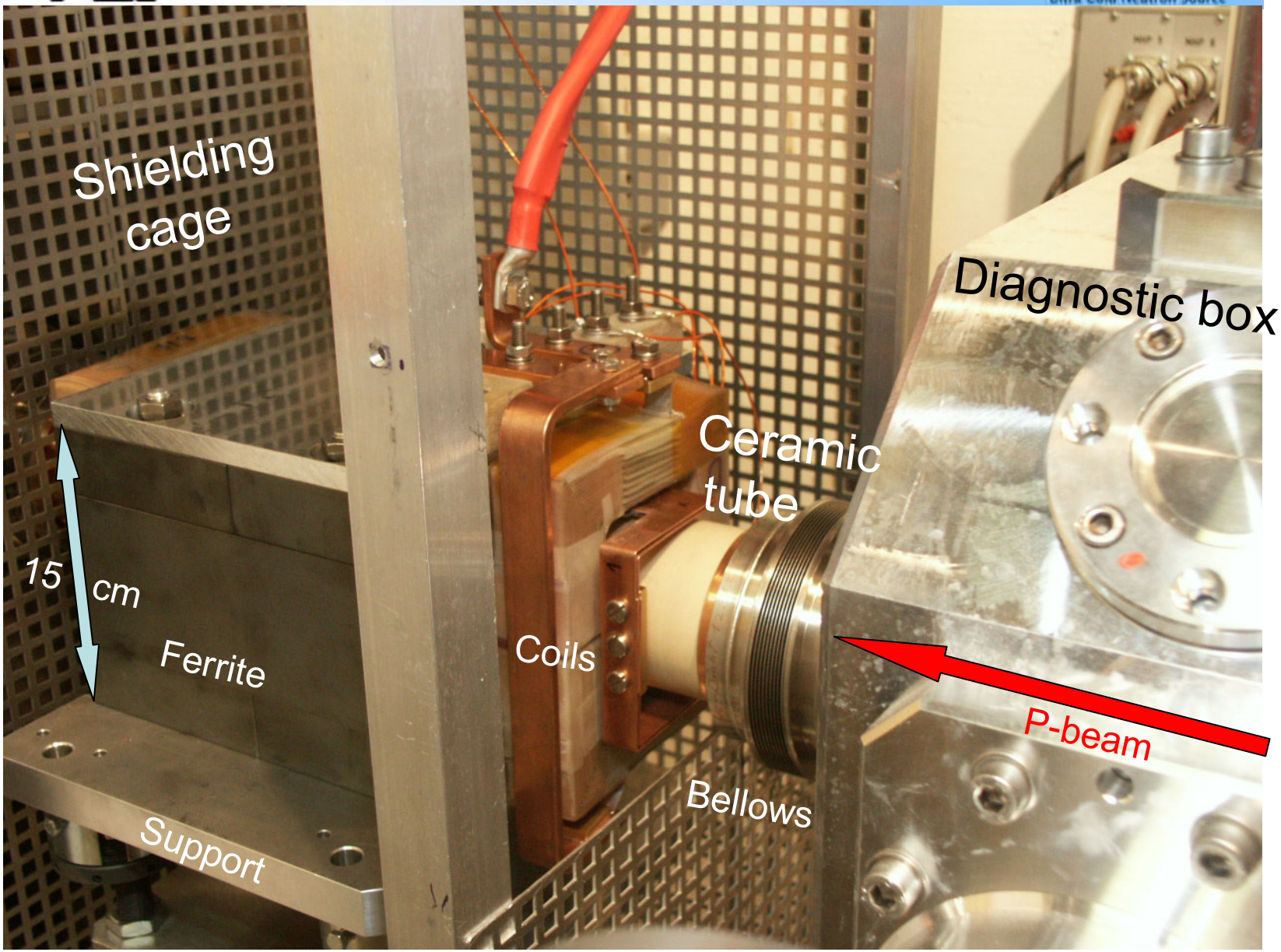
Partial top view of the experimental hall



Partial top view of the experimental hall



Kicker magnet installed in the p-channel



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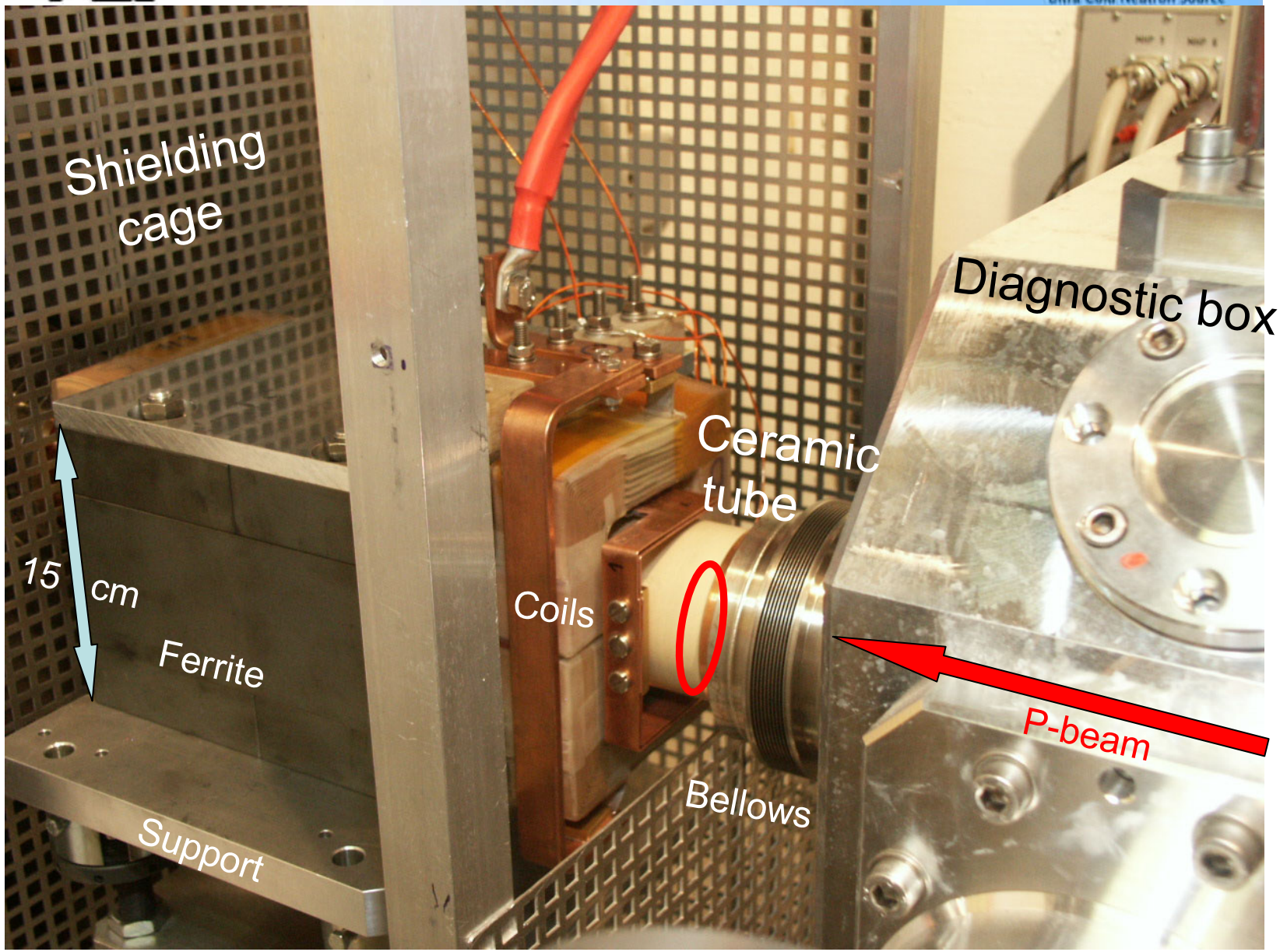
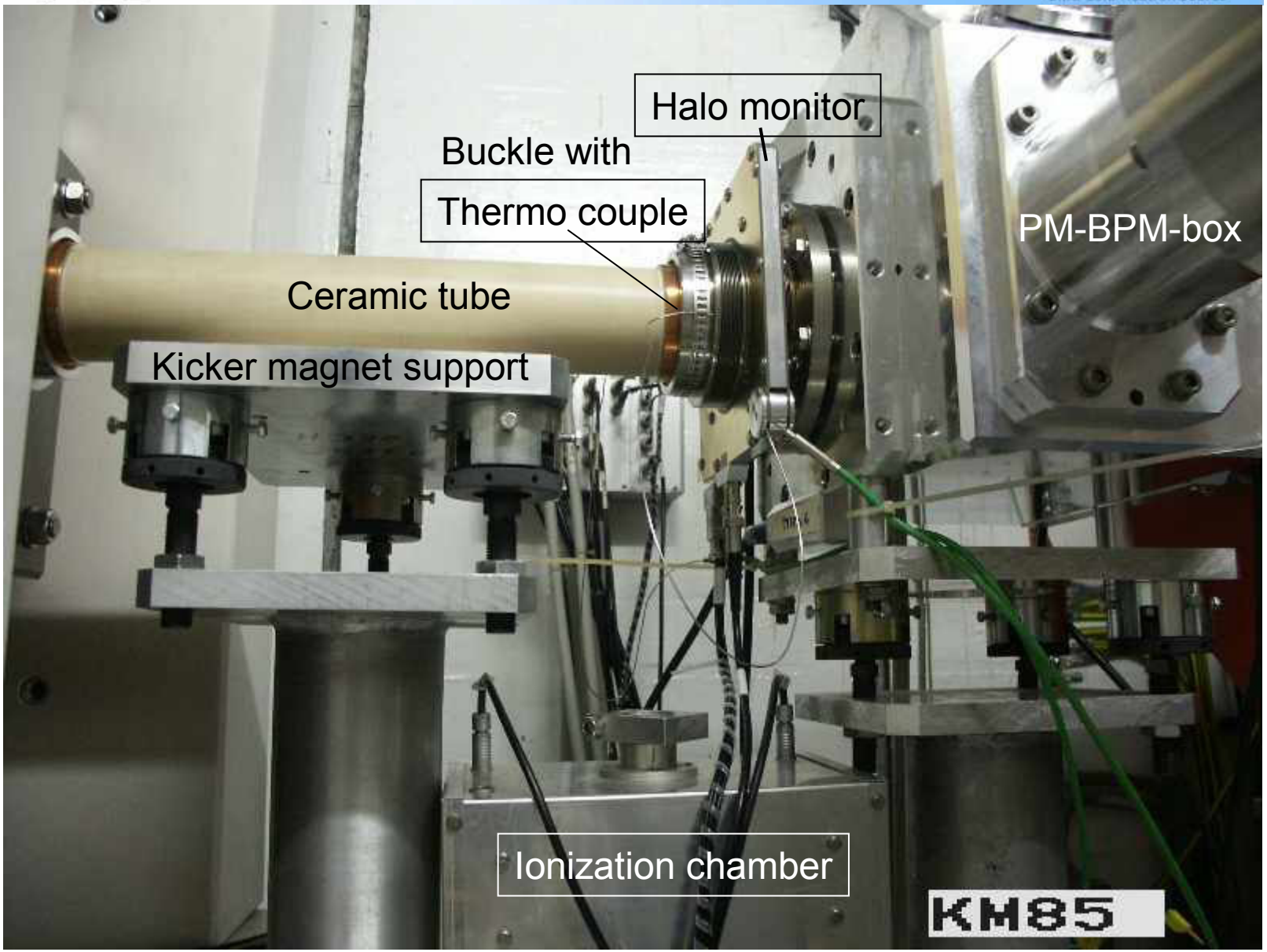
Vacuum leak from mis-steered beam

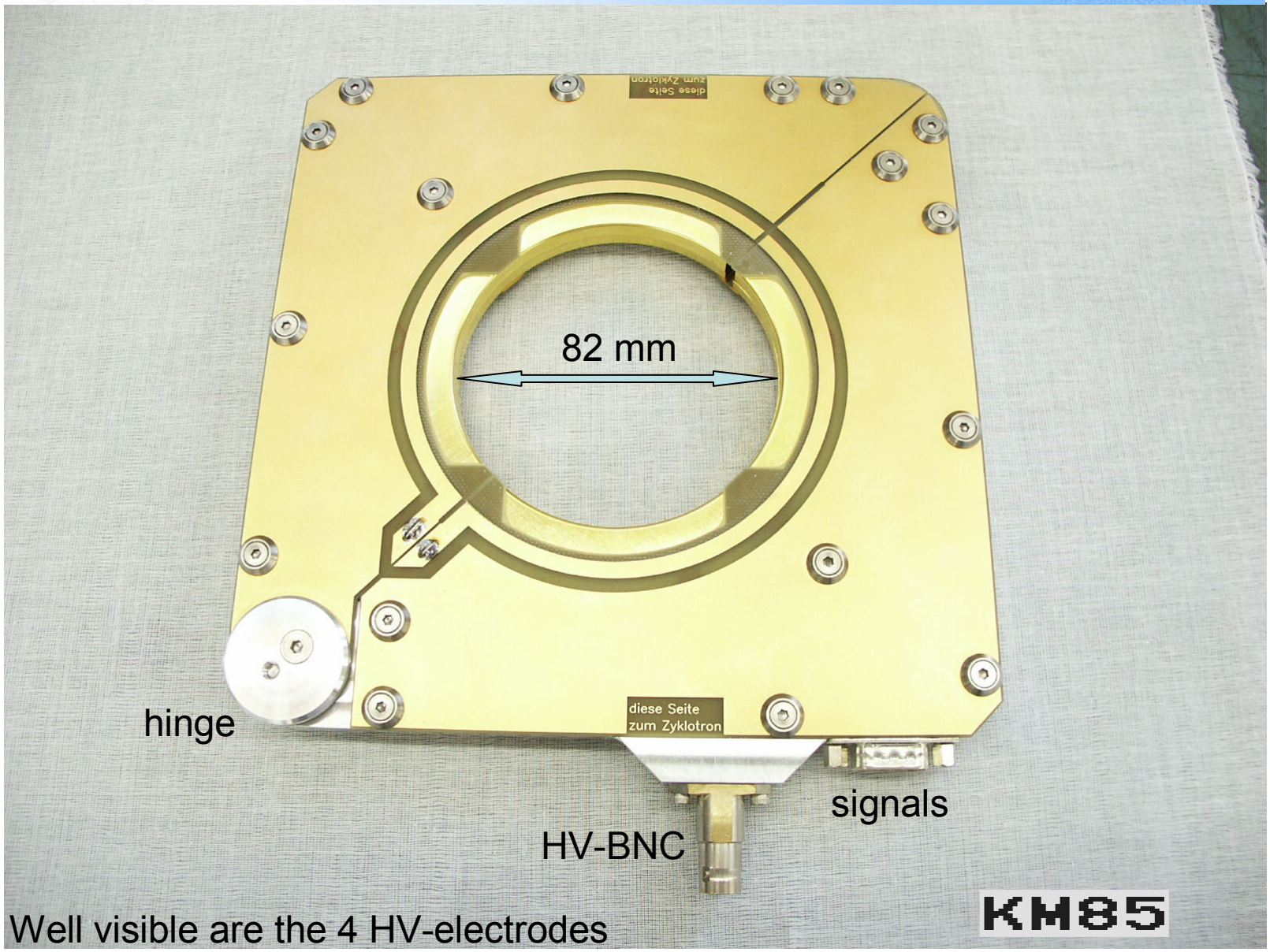
Ultra Cold Neutron Source



Safety environment for the UCN kicker magnet



New 4-segment beam halo monitor



Well visible are the 4 HV-electrodes

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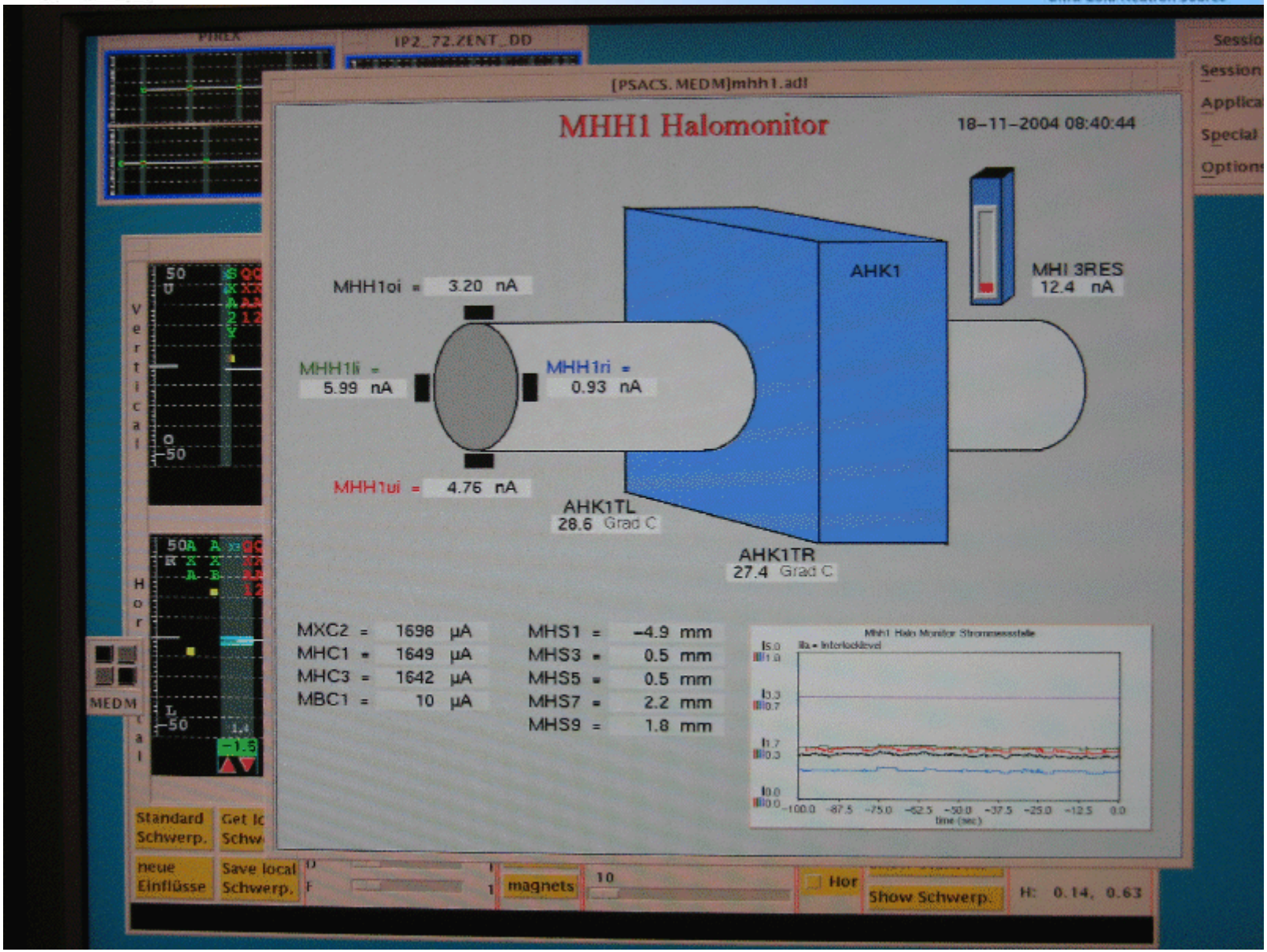
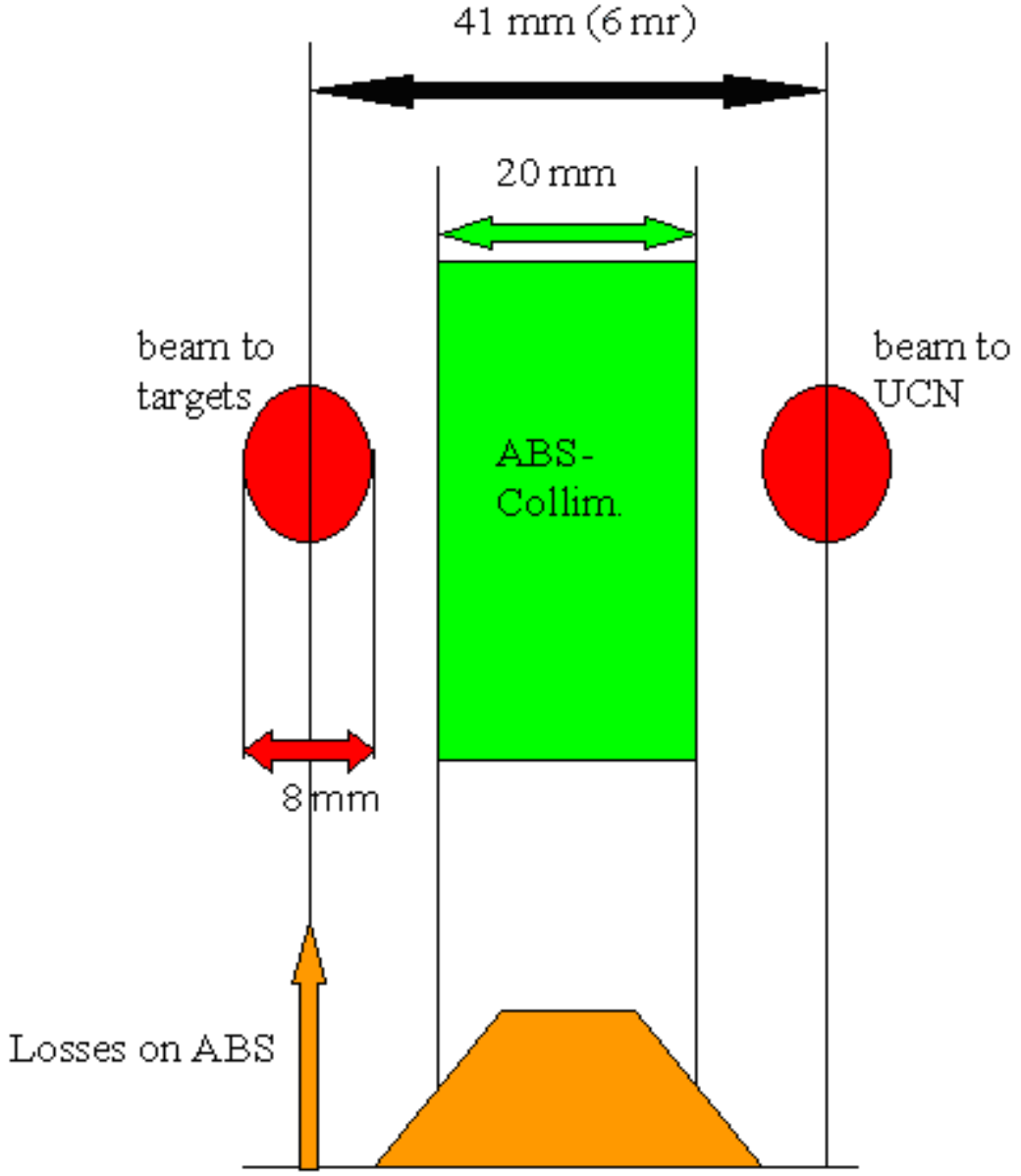
Computer tool for tuning the losses at the kicker

Ultra Cold Neutron Source

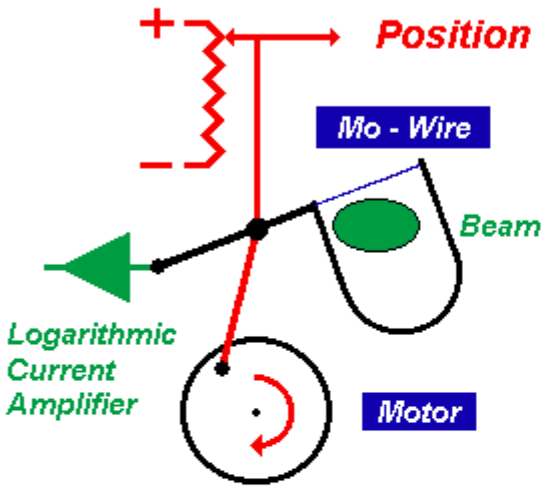


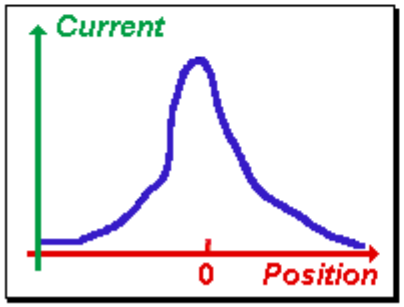
Beam separation at the magnetic septum (ABS)



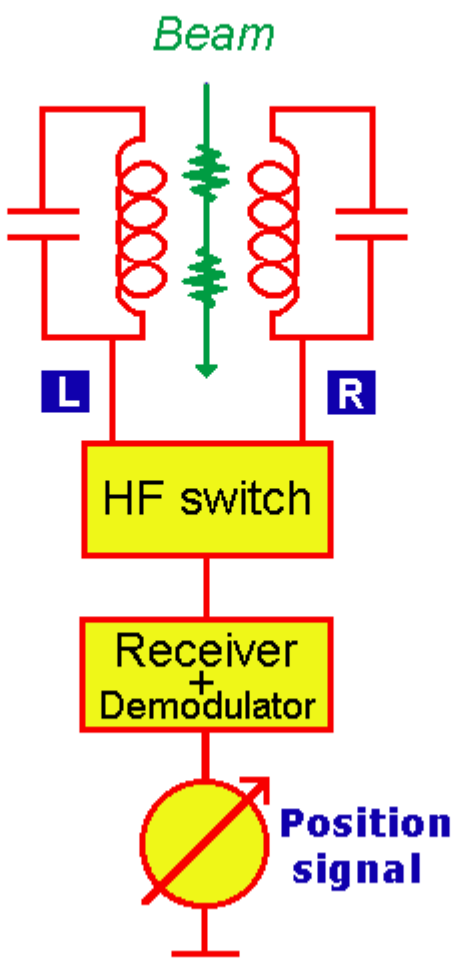
Proton beam diagnostic elements

Profile Monitor

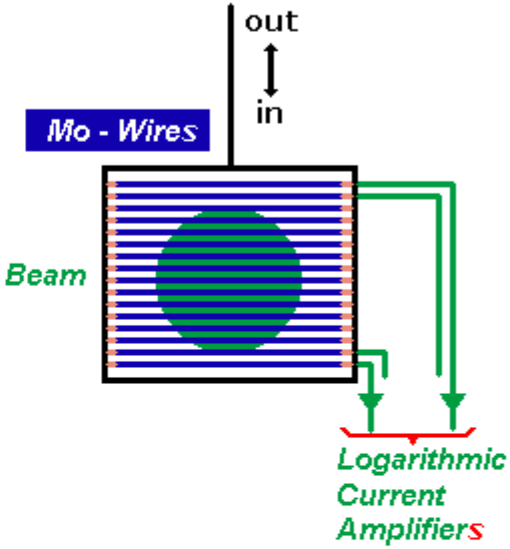


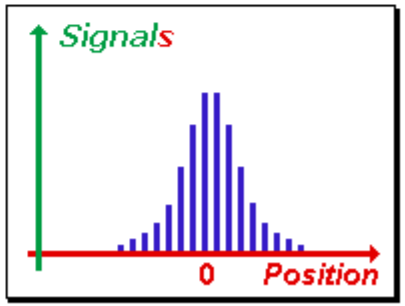


Beam Position Monitor



Harp Monitor





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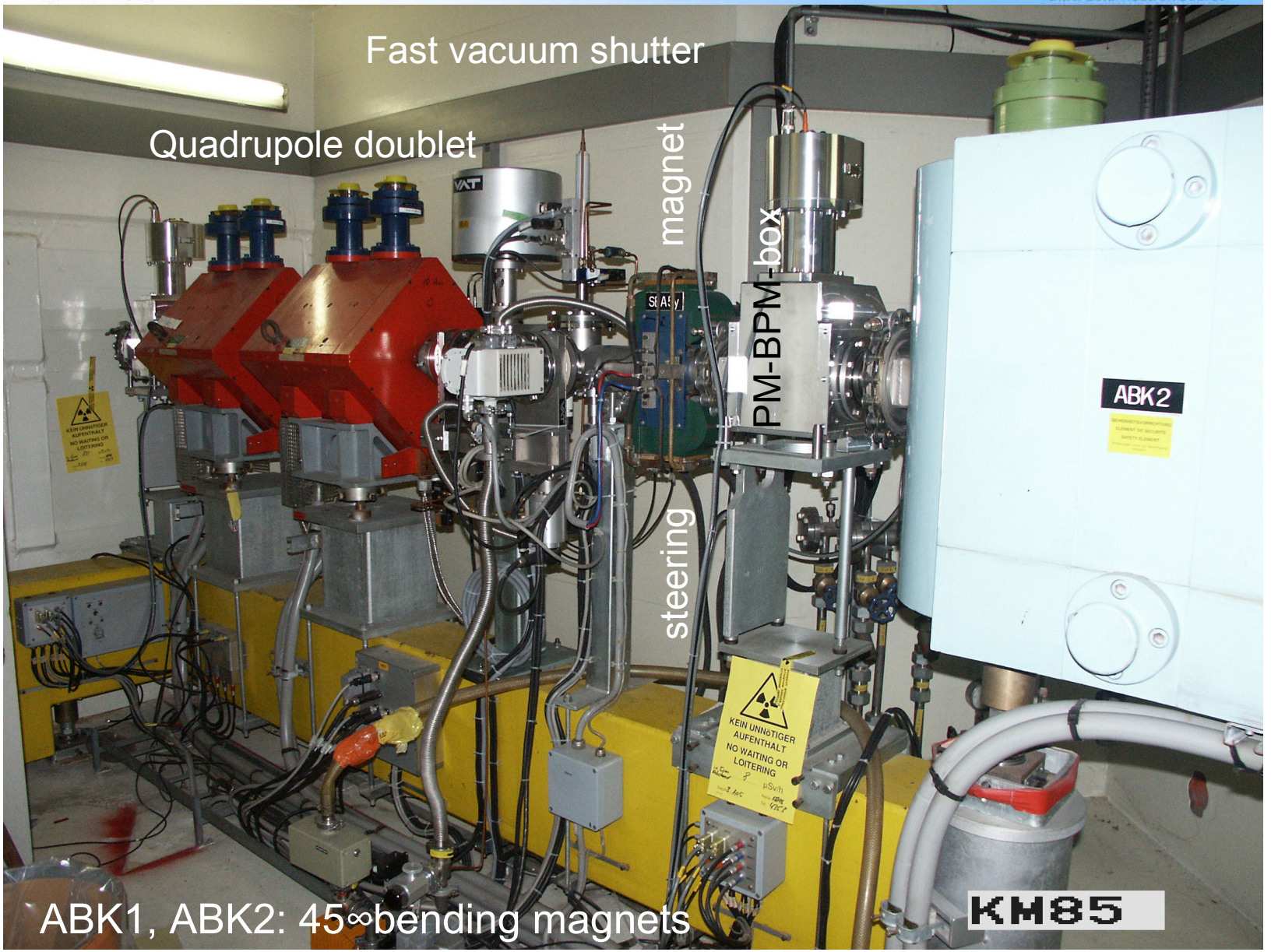
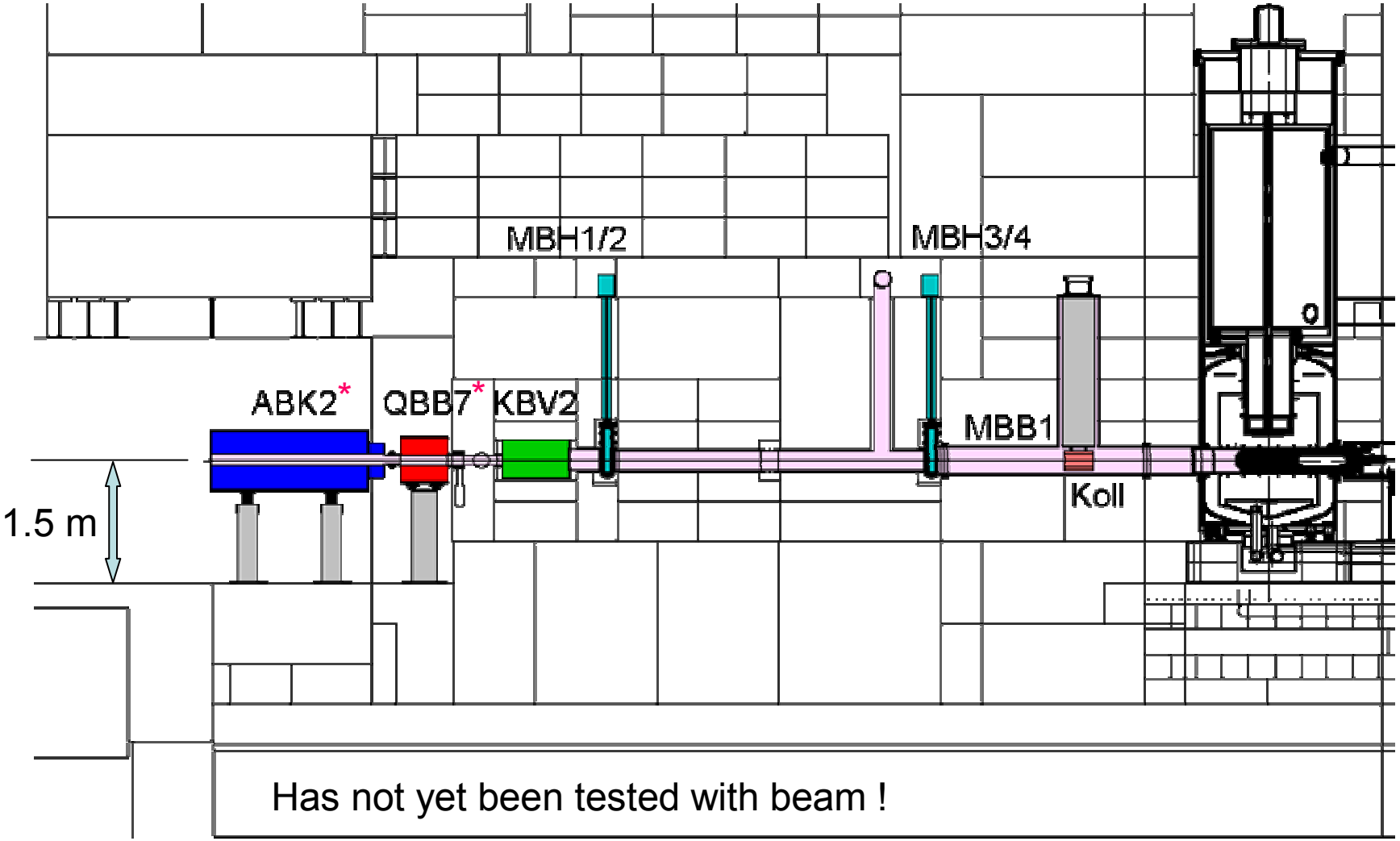
P-channel, ABK1 to ABK2 with new devices

Ultra Cold Neutron Source

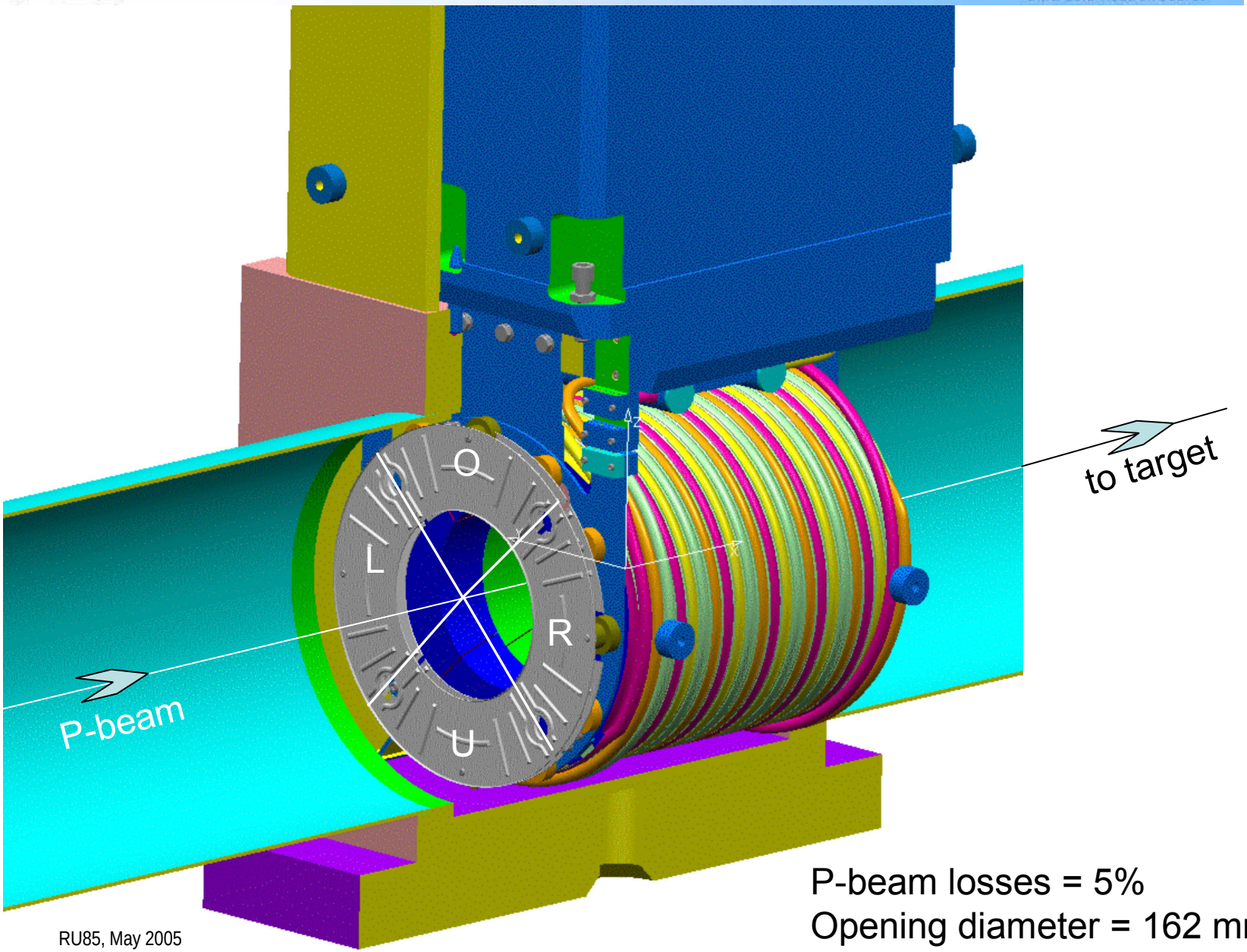


Side view of the beam line section to UCN



* Recycled from previous user

4-segment halo-monitor and collimator



P-beam losses = 5%
Opening diameter = 162 mm

Virtual beam tuning and centering for a pulsed beam

- No `real continuous` beam tuning possible because of the 20 µA limit.

--- Beam envelope ---

- Compute initial beam condition with envelope fit to target M.
  (back-projection with measured full intensity beam profile data)
- Forward fit for quadrupole settings of beam line to UCN target.

--- Beam centers ---

- Short (5 ms) test beam pulses with full intensity to UCN target.
  (During this time collect BPM and harp data along beam line to UCN)
- Extract beam centers and compute corrections for steering magnets.
- Set new values of steering and bending magnets.
- Second short (5 ms) test beam pulse with full intensity to UCN target.
- If beam is centered and no interlock from loss monitors: ***Beam ready.***

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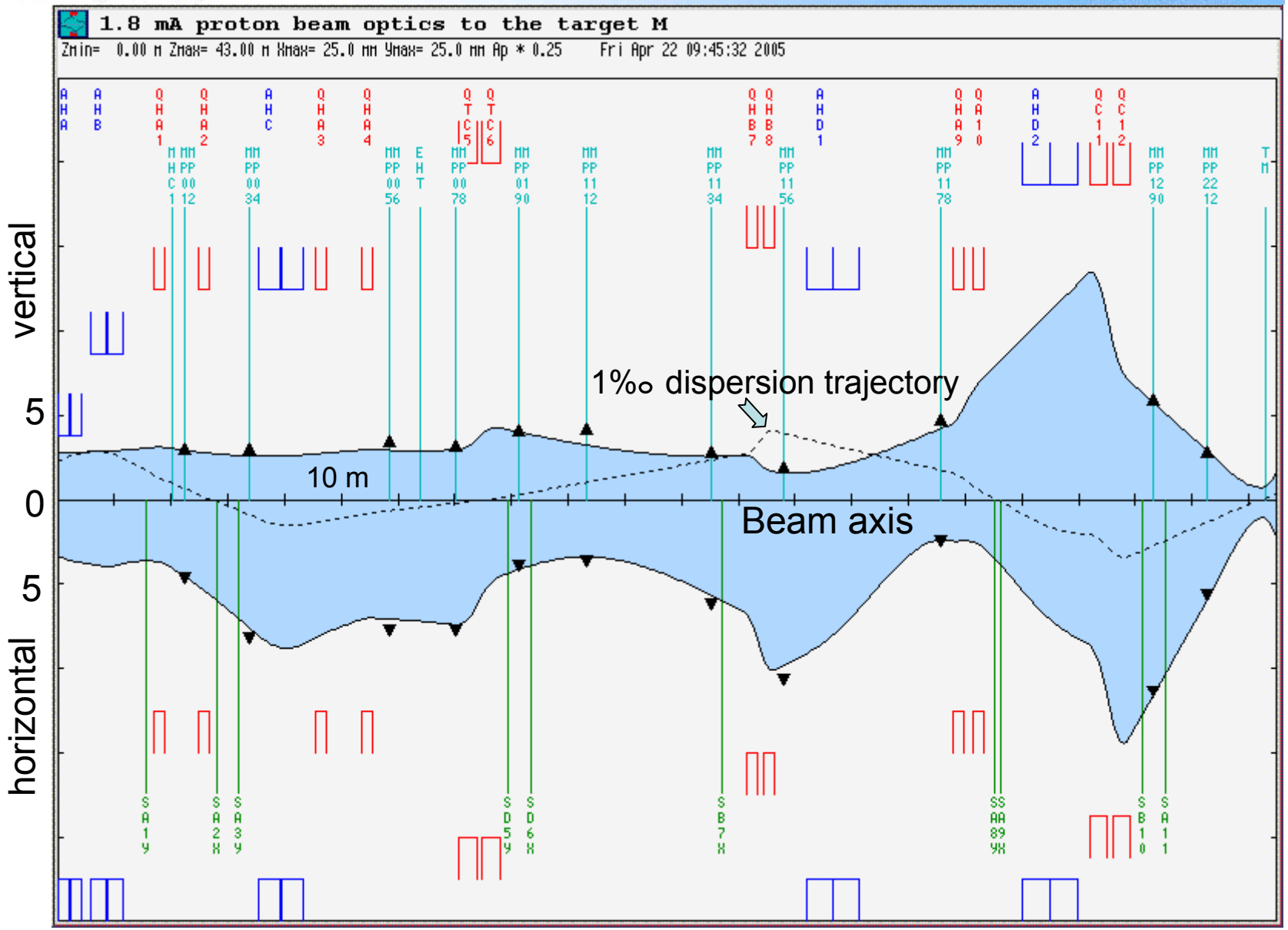
Transport envelope fit of the p-beam to target M

Ultra Cold Neutron Source



▲ vertical ▼ horizontal measured beam profile widths (2σ)

RU85, May 2005

Initial beam conditions

z	0.000	m
x	2.515	mm (2σ)
x'	1.247	mr (2σ)
r12	-0.051	
epsx	3.1329	mmmr (86%)
y	2.903	mm (2σ)
y'	0.426	mr (2σ)
r34	-0.058	
epsy	1.2337	mmmr (86%)
R16	-2.328	mm/%o
R26	-0.963	mr/%o
p	1.20480	GeV/c
dp/p	0.976	%o

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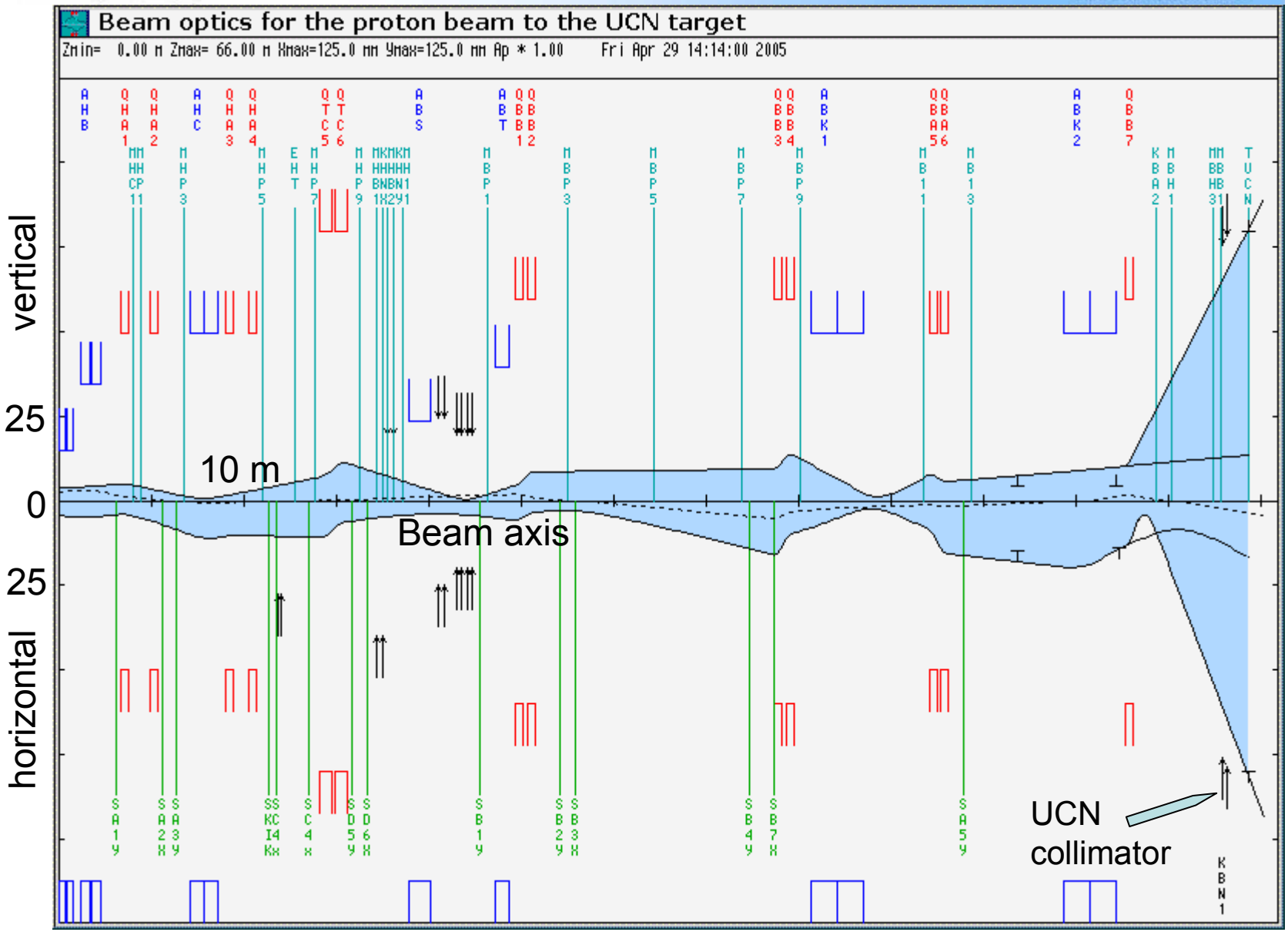
Transport envelopes of the future p-beam to UCN

Ultra Cold Neutron Source



RU85, May 2005

Virtual beam centering for a pulsed beam

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- Set new values of steering and bending magnets.
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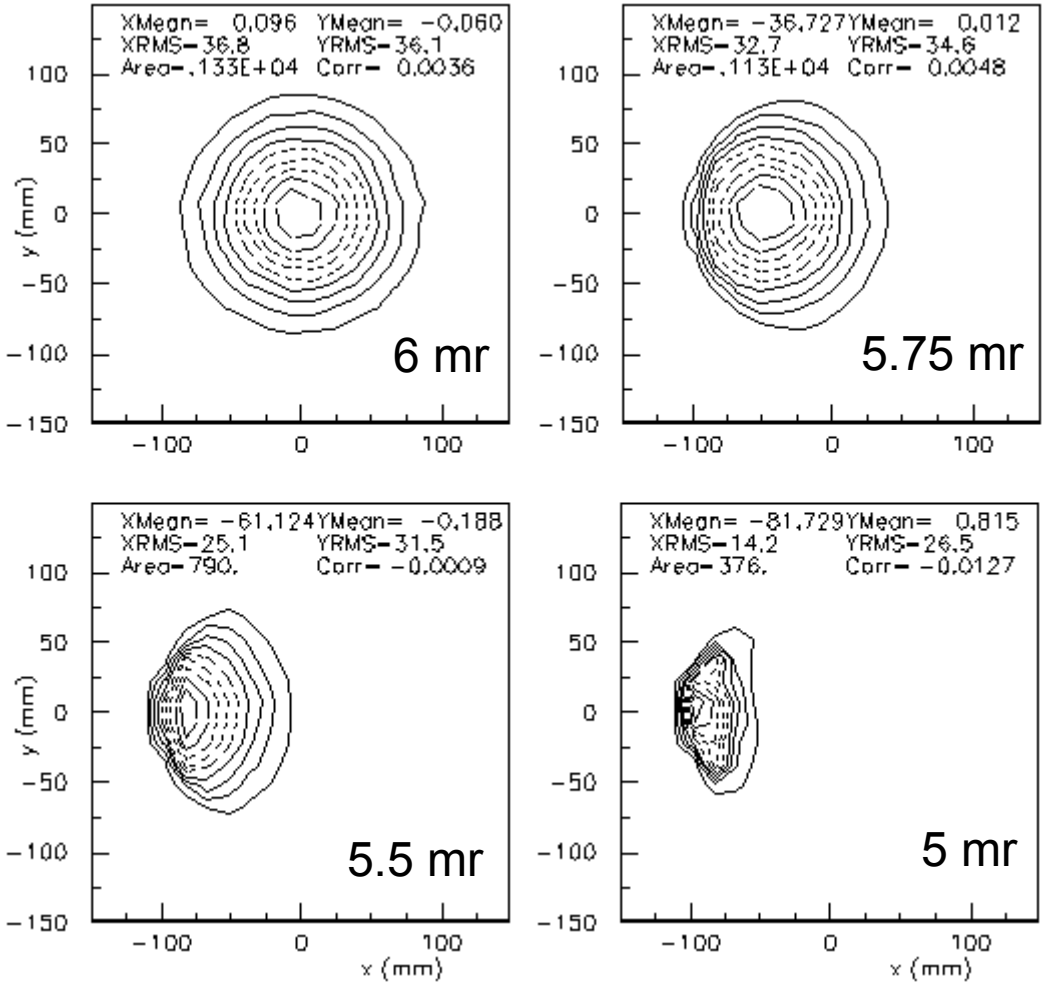
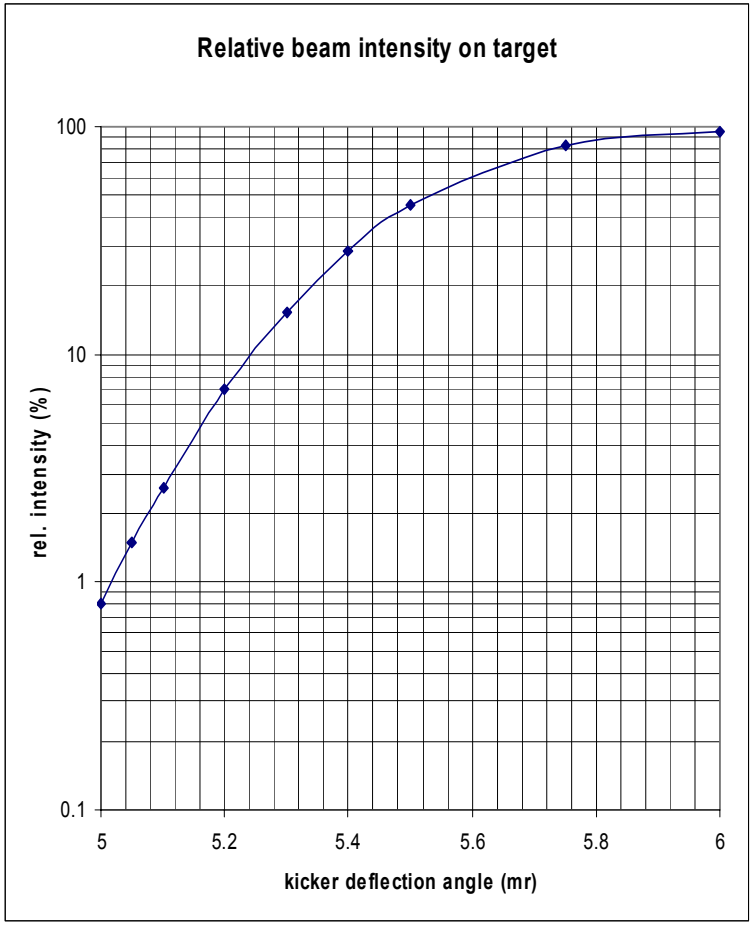
Monte Carlo computation of target beam spot

Location, shape and intensity of the swept-in proton beam on UCN target





2 ms, non-linear

Not shown at the TUC meeting, RU85, May 2005

Some final remarks

- Handling of MW-beam is well established at PSI
- But experience with pulsed beam is not yet present
- Redundancy of machine safety system is well developed
- Backbone of this system are ionization chambers
- Halo monitors at crucial locations are also important

PSI proton accelerator facility will be unique with

two concurrently running spallation sources:

SINQ is continuous and UCN is macro-pulsed.