PITZ
Photo Injector Test Facility Zeuthen

Design consideration of the RF deflector to optimize the photo injector at PITZ

S.Korepanov

The prospect diagnostic complex for the beam phase analysis

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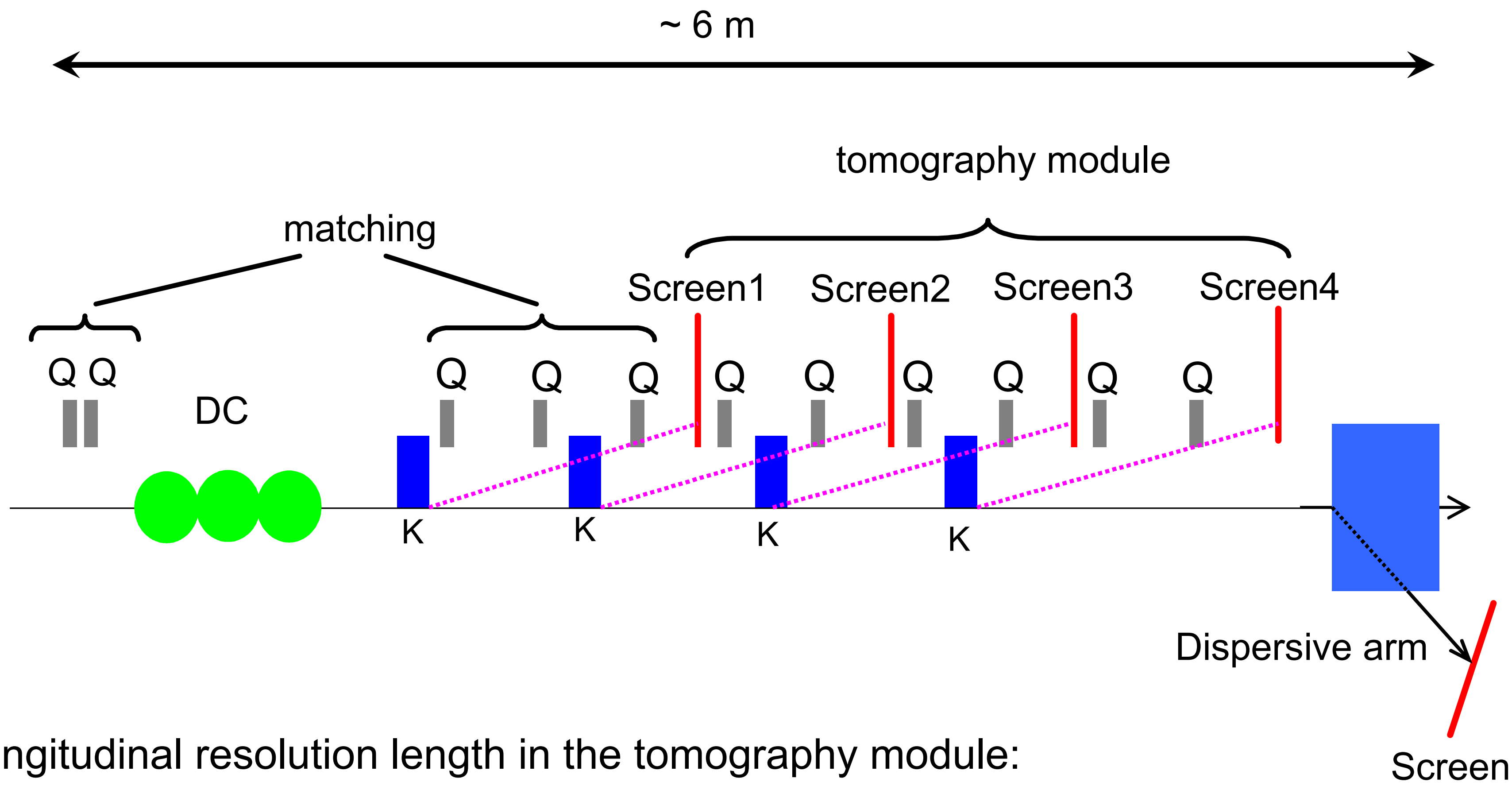
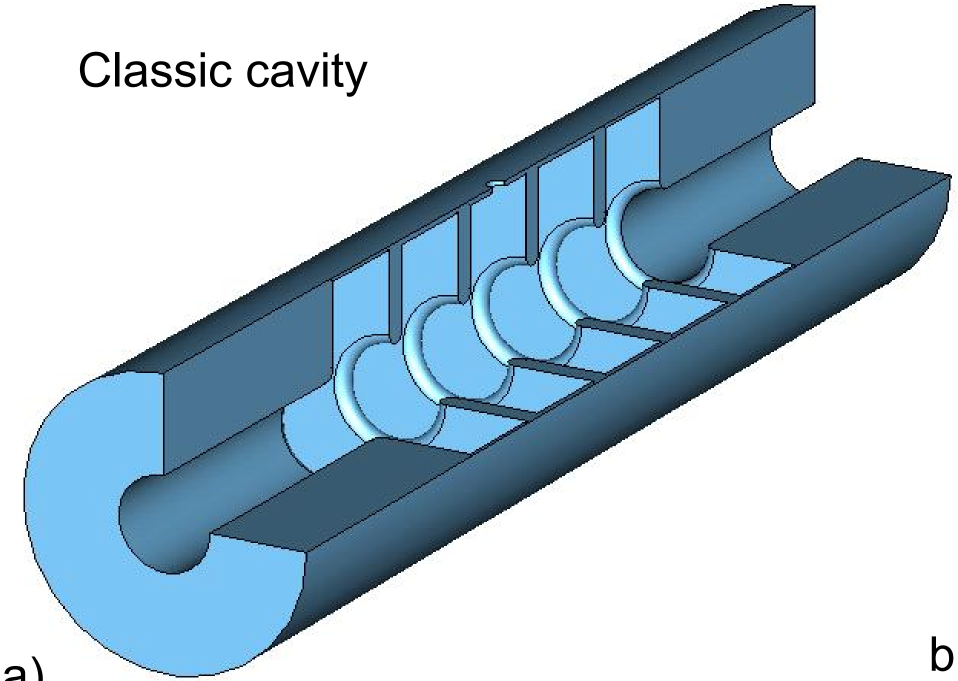


Longitudinal resolution length in the tomography module:
At the Screen4 ~ 0.15 mm (0.5 ps) – 55 slices
At the Screen1 ~ 0.35 mm (1.1 ps) – 23 slices

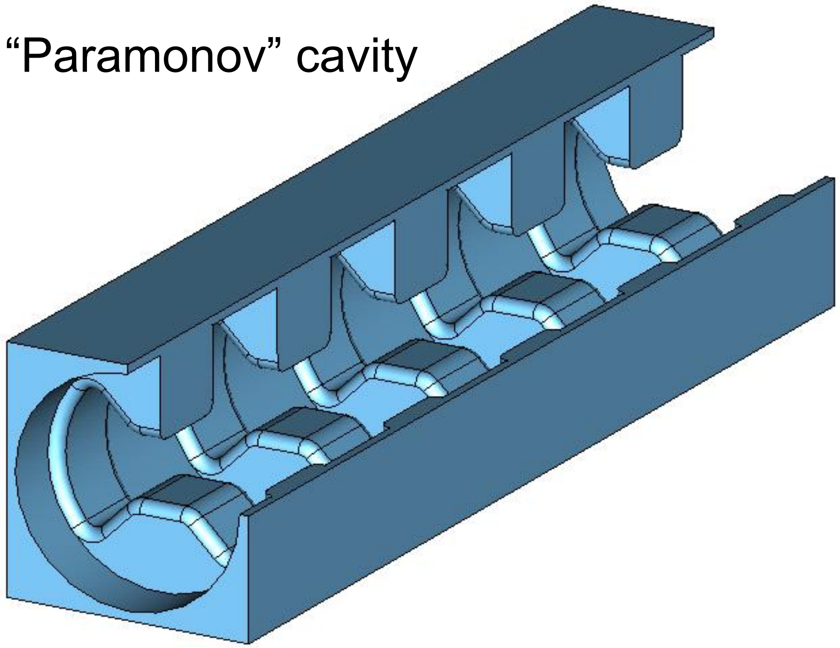
Vertical screen size ~ 30 mm

Classic cavity



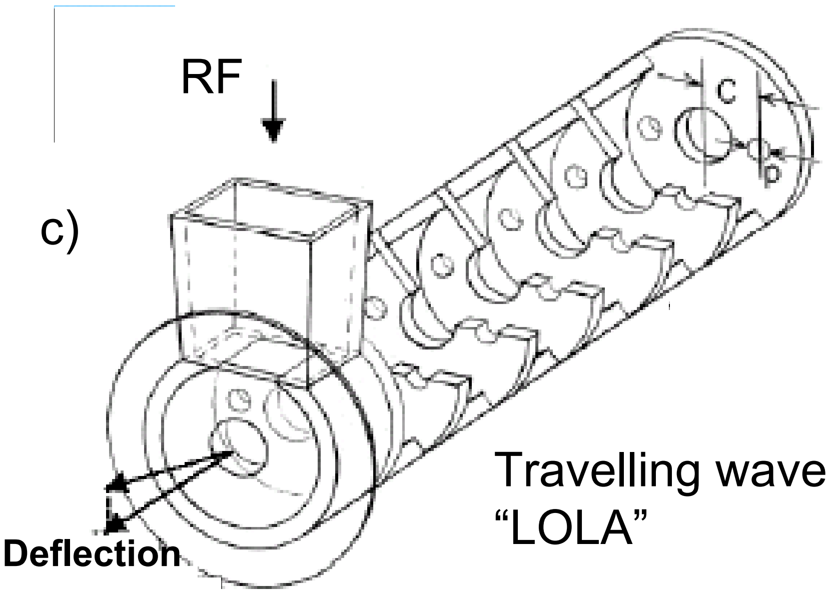
a)

"Paramonov" cavity



b)

Length ~ 0.7 m
f = 1.3 GHz



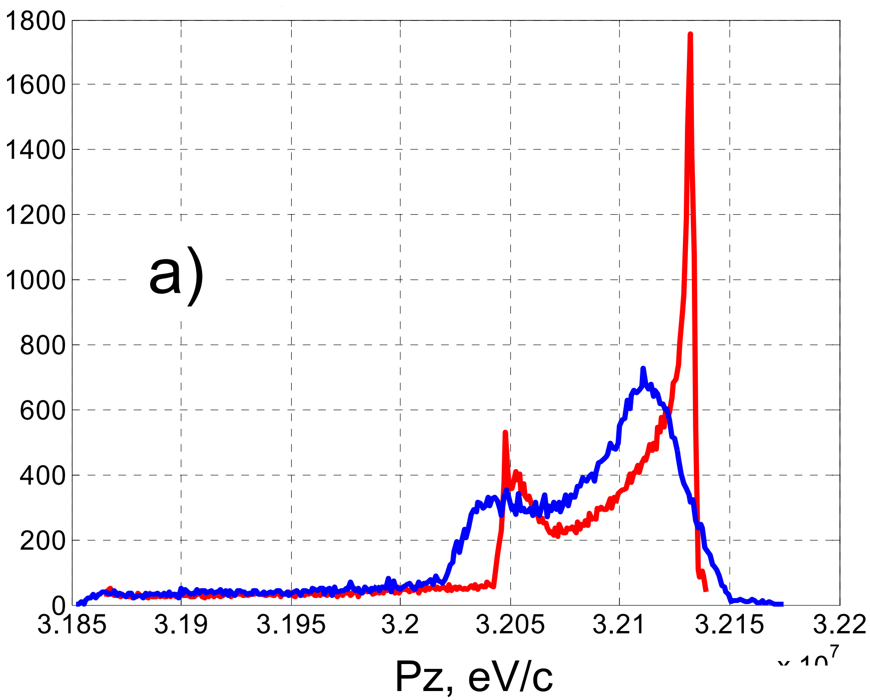
c)

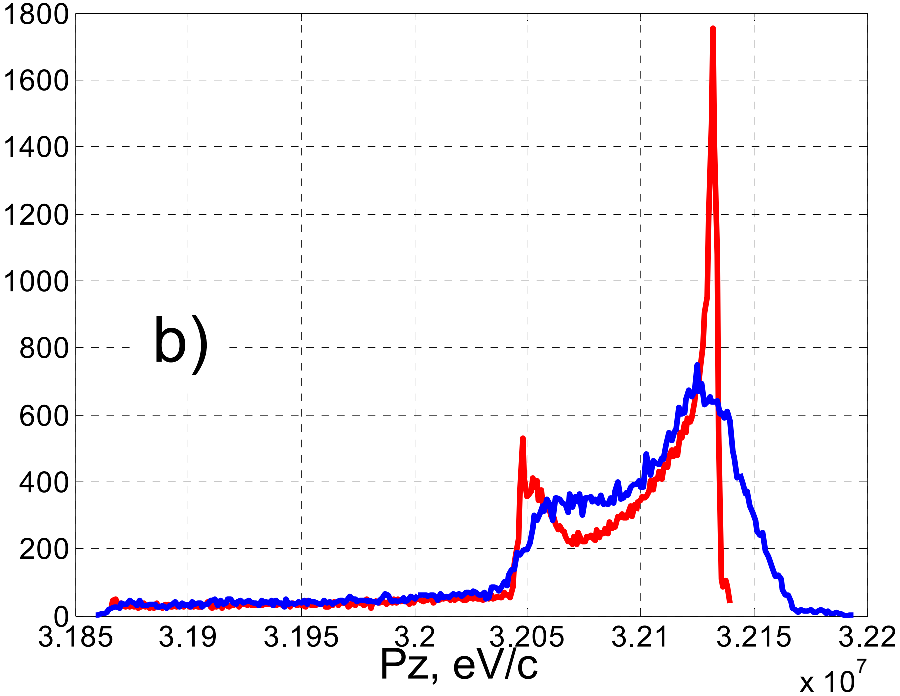
Travelling wave cavity
"LOLA"

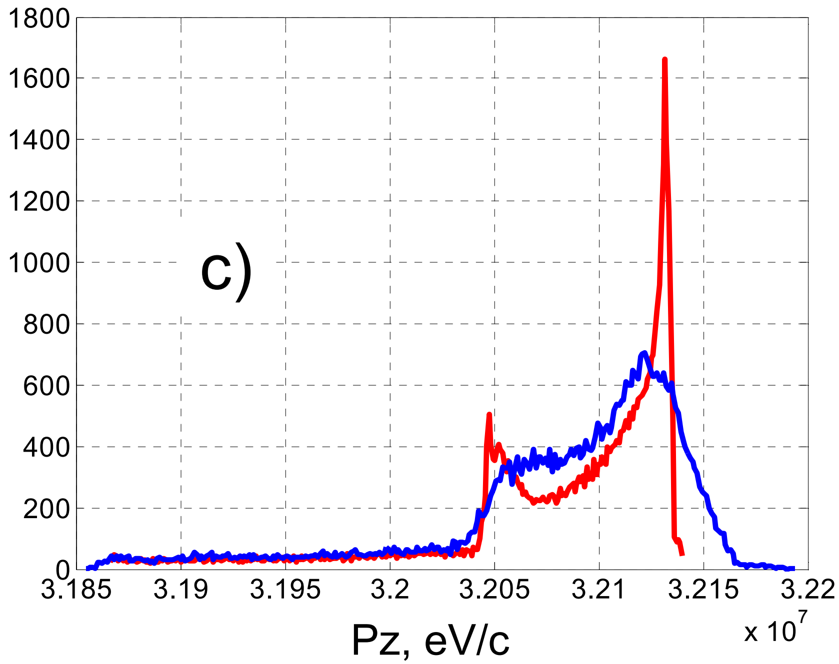
a) D.Alesini, C.Vaccarezza, "Longitudinal and transverse phase space characterization", SPARC-RF-03/003, INFN/LNF, Frascati, 2003

b) V.Paramonov, et. al. "Effrctive standing-wave RF structure for charged-particle deflector", LINAC, 2006

c) O.H.Altenmueller, et.al., "Investigations of traveling – wave separator s for the Stanford two-mile linear accelerator", The rev. of Sci. instr., Vol.35(4), 1964







$\langle Pz \rangle \cong 32$ MeV/c

Red line – initial distribution

Blue line – distribution after:

- Classic cavity
- "Paramonov" cavity
- Traveling wave cavity (LOLA)

Maximum resolution ~ 25 keV/c (~10^{-3})

HELMHOLTZ GEMEINSCHAFT DESY

Results of the simulations:

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- For the all kind of the cavities the beam emittance has changed from 0.96 mm mrad to ~1.02 mm mrad
- Steady wave cavity requires less RF power.
- Travelling wave cavity has small field filling time. => Possibility to analyze a single bunch in the train.

	Classic cavity		"Paramonov" cavity		Travelling wave cavity	
	Tomography	**Dispersive**	**Tomography**	**Dispersive**	**Tomography**	**Dispersive**
Distance, m	2-4.2	6	2-4.2	6	2-4.2	6
$V_{\perp}$, MV	0.85-1.8	0.6	0.85-1.8	0.6	0.85-1.8	0.6
Q	21000	21000	15000	15000	19000	19000
P_{RF}, MW	up to 1	0.12	up to 0.17	0.02	up to 9.1	1.01
Field build up, μs	~20	~20	~20	~20	~0.2	~0.2

Summary:

- The three different deflector were analyzed in complex with the tomography module and the dispersive section.
- The longitudinal resolution length for the beam analysis in the tomography module is 0.35mm (0.5 ps).
- Resolution of the dispersive section is limited by 25 keV
- Transverse emittance distortion by the deflector and the kicker is about a few %.

To do:

- Try to reduce the longitudinal momentum distortion in the deflector (D.Alesini).
- More detail cavity analysis. Design the real geometry (coupler, load). (D.Alesini)

The prospect diagnostic complex for the beam phase analysis

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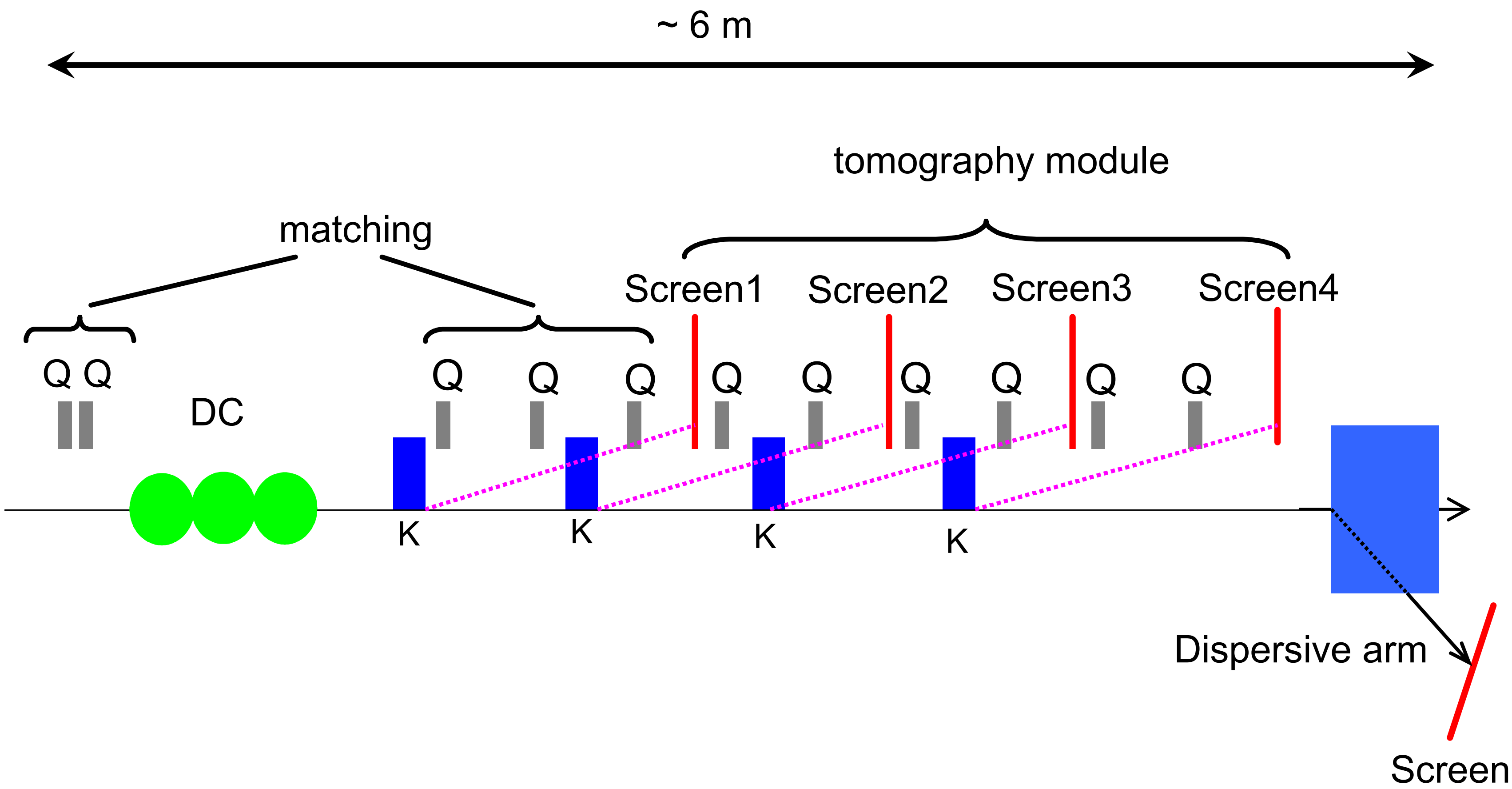


Longitudinal resolution length in the tomography module:
At the Screen4 ~ 0.15 mm (0.5 ps) – 55 slices
At the Screen1 ~ 0.35 mm (1.1 ps) – 23 slices

Kicker (TESLA damping ring kicker)

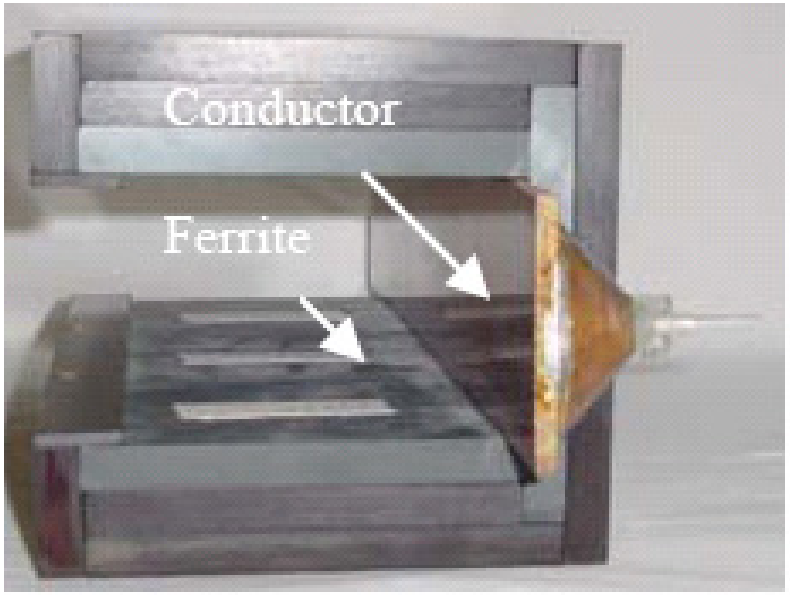
- Free aperture 50mm x 50 mm
- Length 300 mm
- Field rise/fall (10%-90%) ~5 ns
- Pulse length 30 ns
- Repetition rate 2 MHz (~100 pulses), 5 Hz
- Deflection for 30 MeV up to 6.6 mrad

Frank Obier (DESY -MIN-)

For PITZ2 beam:
L =1m – distance between kicker and the screen
Deflection angle ~2 mrad
Off axis ~ 2 mm

$\Delta Pz \sim 1\% \, Pz$
$\Rightarrow \Delta x_{rms} \sim 10\ \mu m$

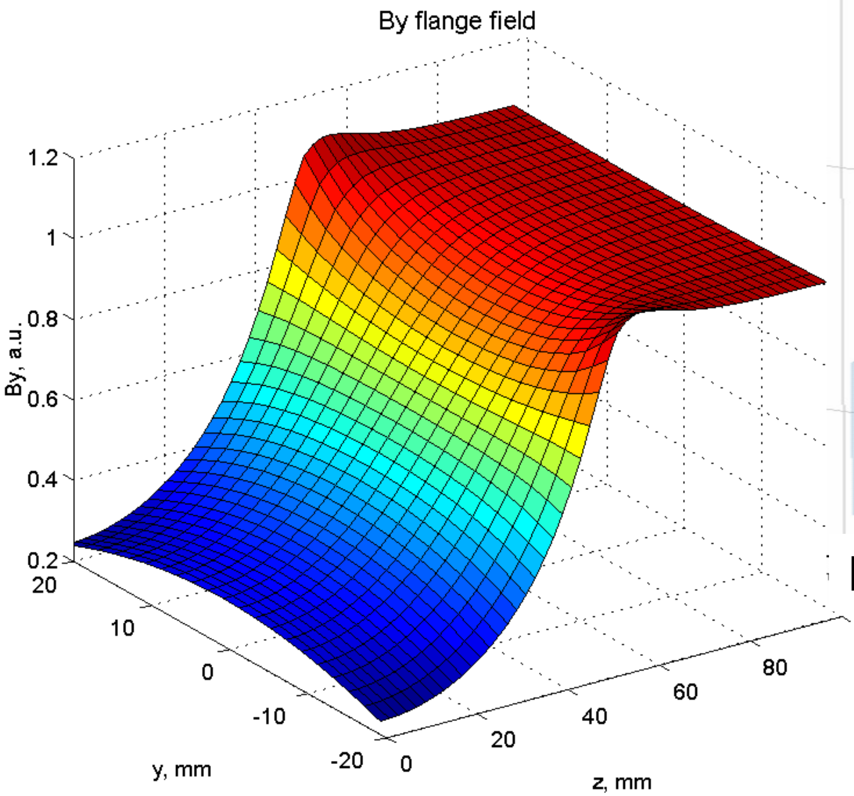
$X_{rms} \sim 120\ \mu m$

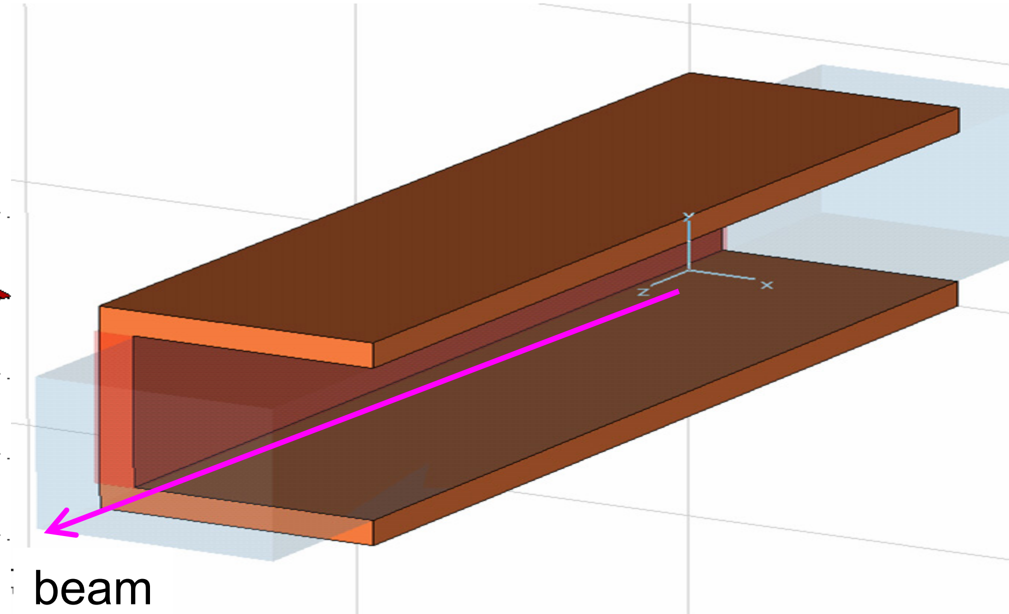


Flange fields effect (estimation)

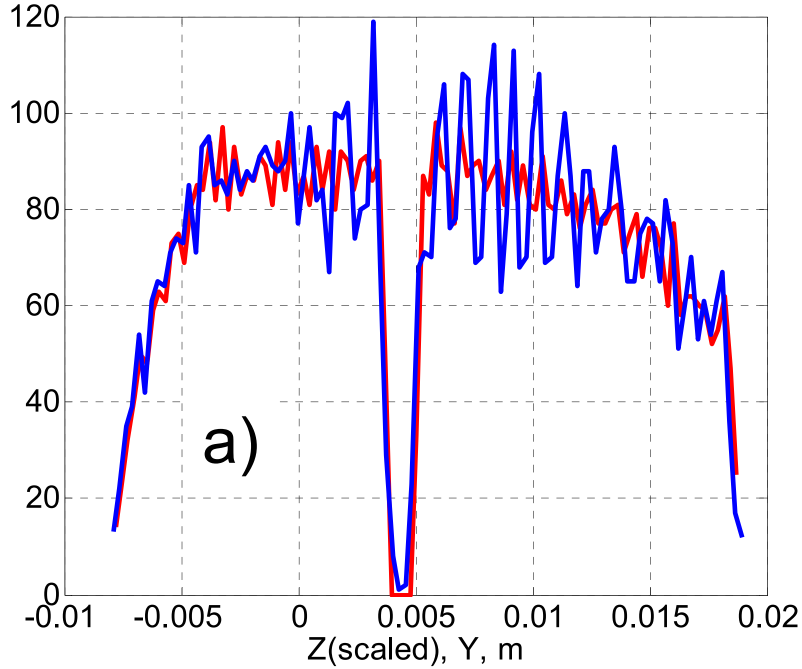
The beam is deflected by By.

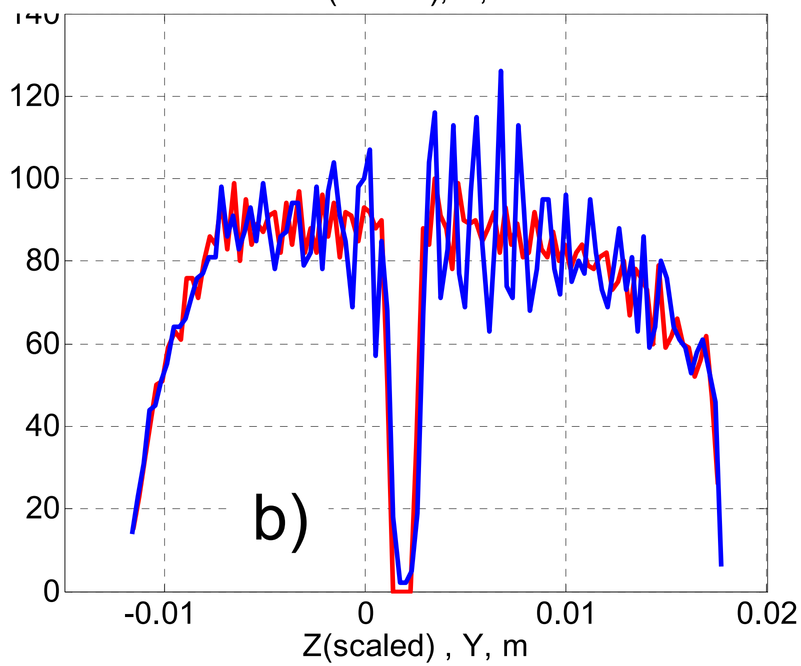
By(x=0,y,z)

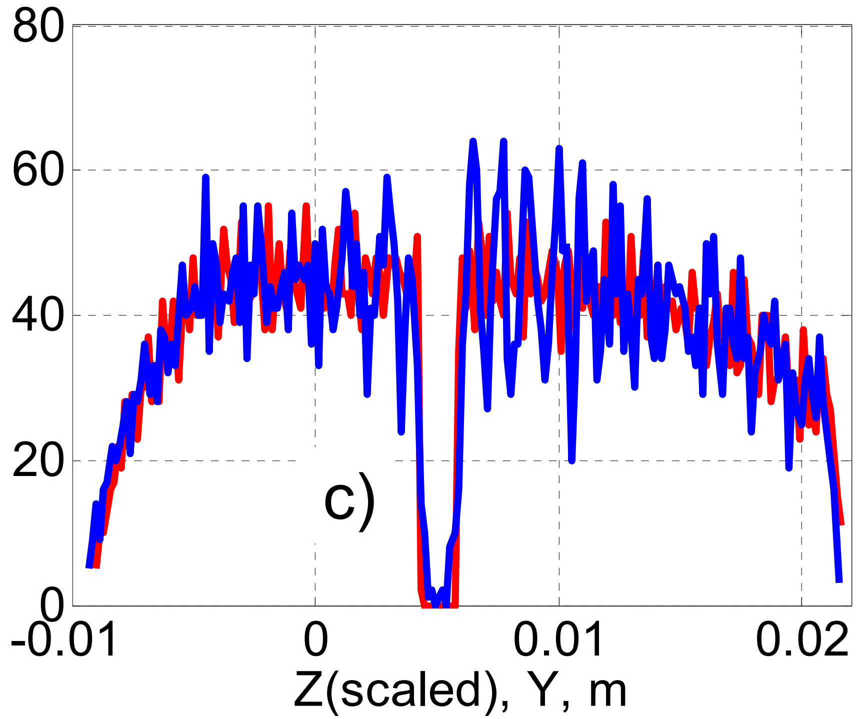




Inhomogeneity ~ 0.4%





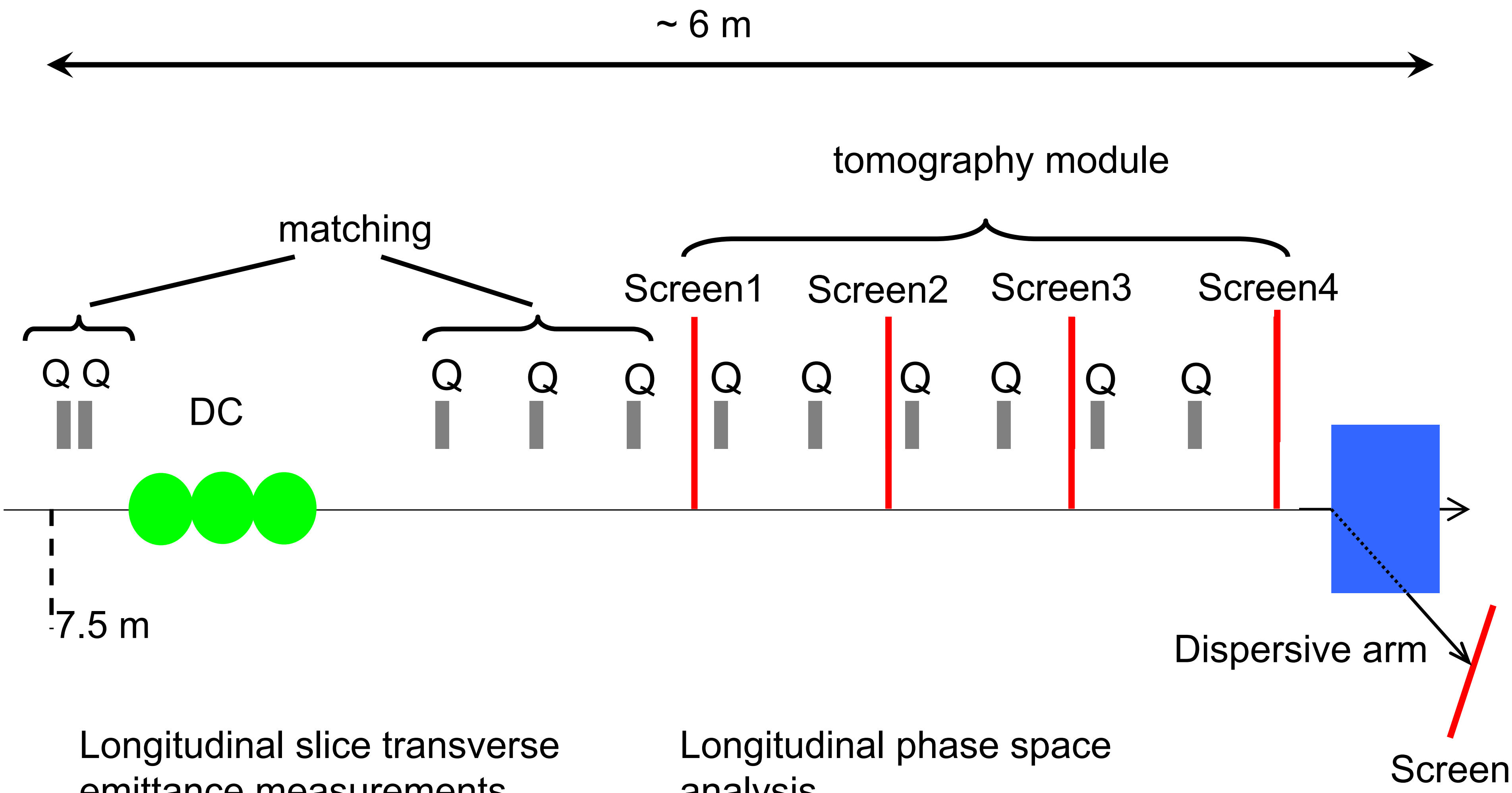


Red line – initial distribution
Blue line – distribution after:

- Classic cavity
- "Paramonov" cavity
- Traveling wave cavity (LOLA)

The gap in the initial distribution - 0.15 mm

Diagnostic complex for beam phase space analysis



Longitudinal slice transverse emittance measurements

DC + Tomography module

Longitudinal phase space analysis

DC + Dispersive arm

D.J.Holder, et. al., “A phase space tomography diagnostic for PITZ”, EPAC2006, Edinburgh, UK

Beam parameters for the simulations:

average long. momentum	32 MeV/c
min. norm. emittance (rms)	~ 1 π mm mrad
transverse beam size on the screen in the tomography module, rms (full)	~ 0.12 (0.7) mm
full longitudinal beam size	8 mm (27 ps)
pulse frequency	1-9 MHz
repetition rate	10 Hz