

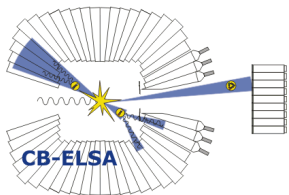
# The Bonn Electron-Stretcher Accelerator



*Status 02/2010*

Wolfgang Hillert

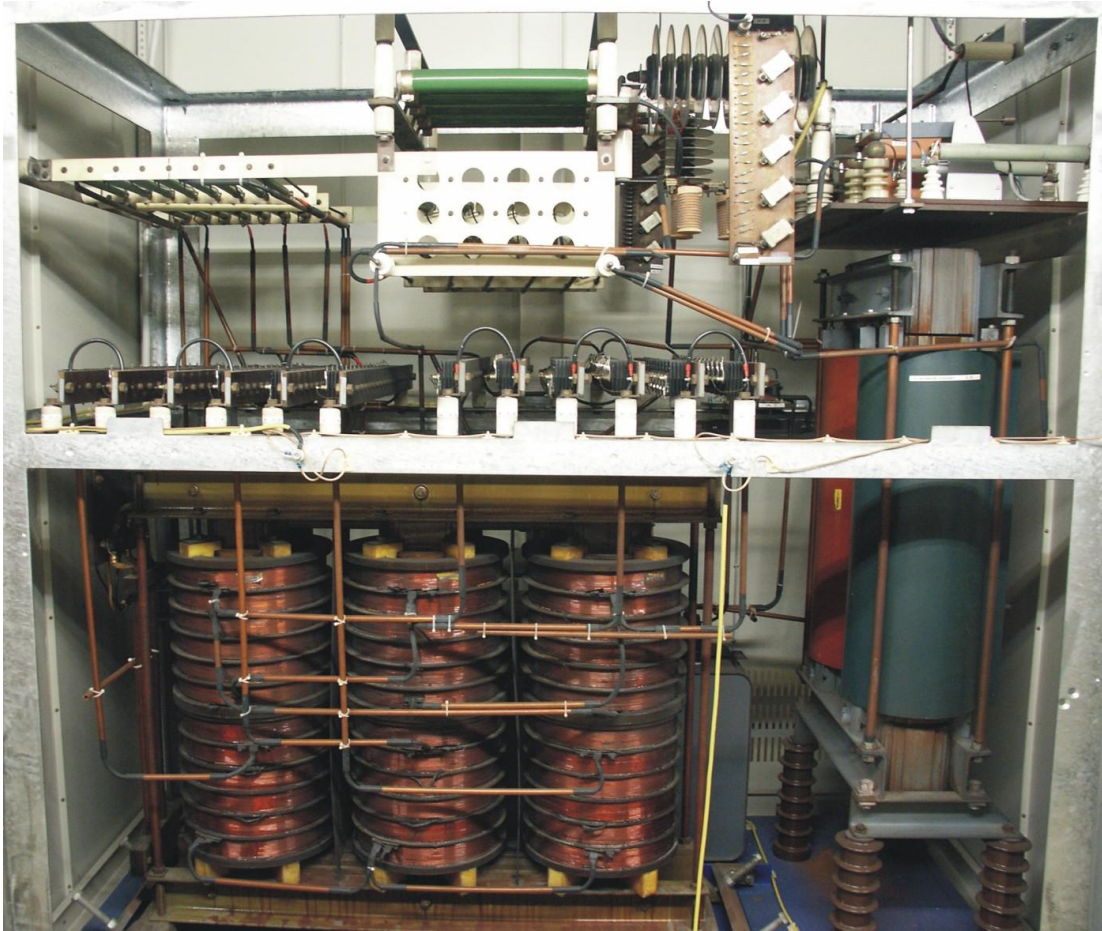
*Physics Institute of Bonn University*





**Improvements  
2009**

# HVPS Linac 2

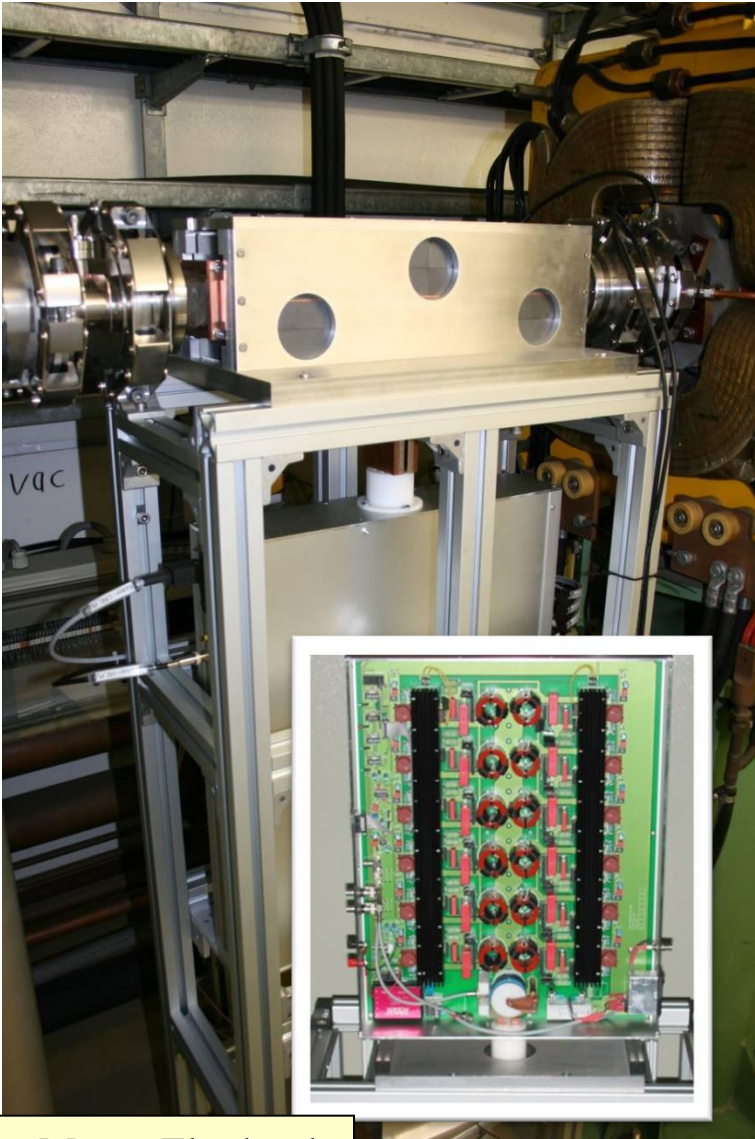


**old**

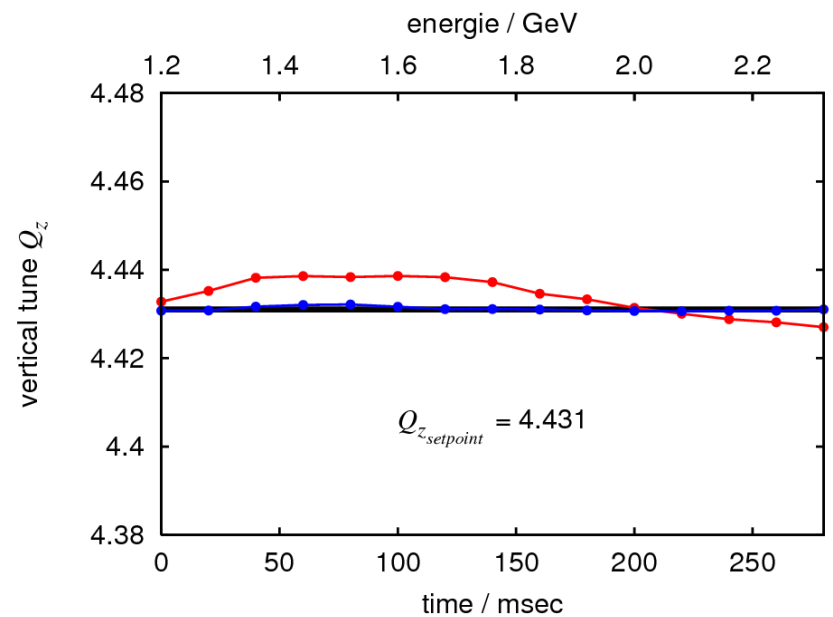
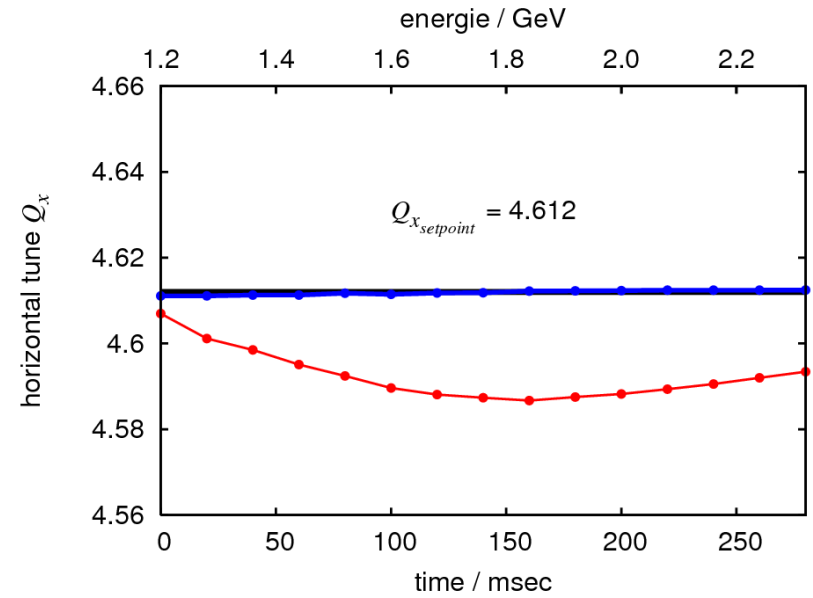


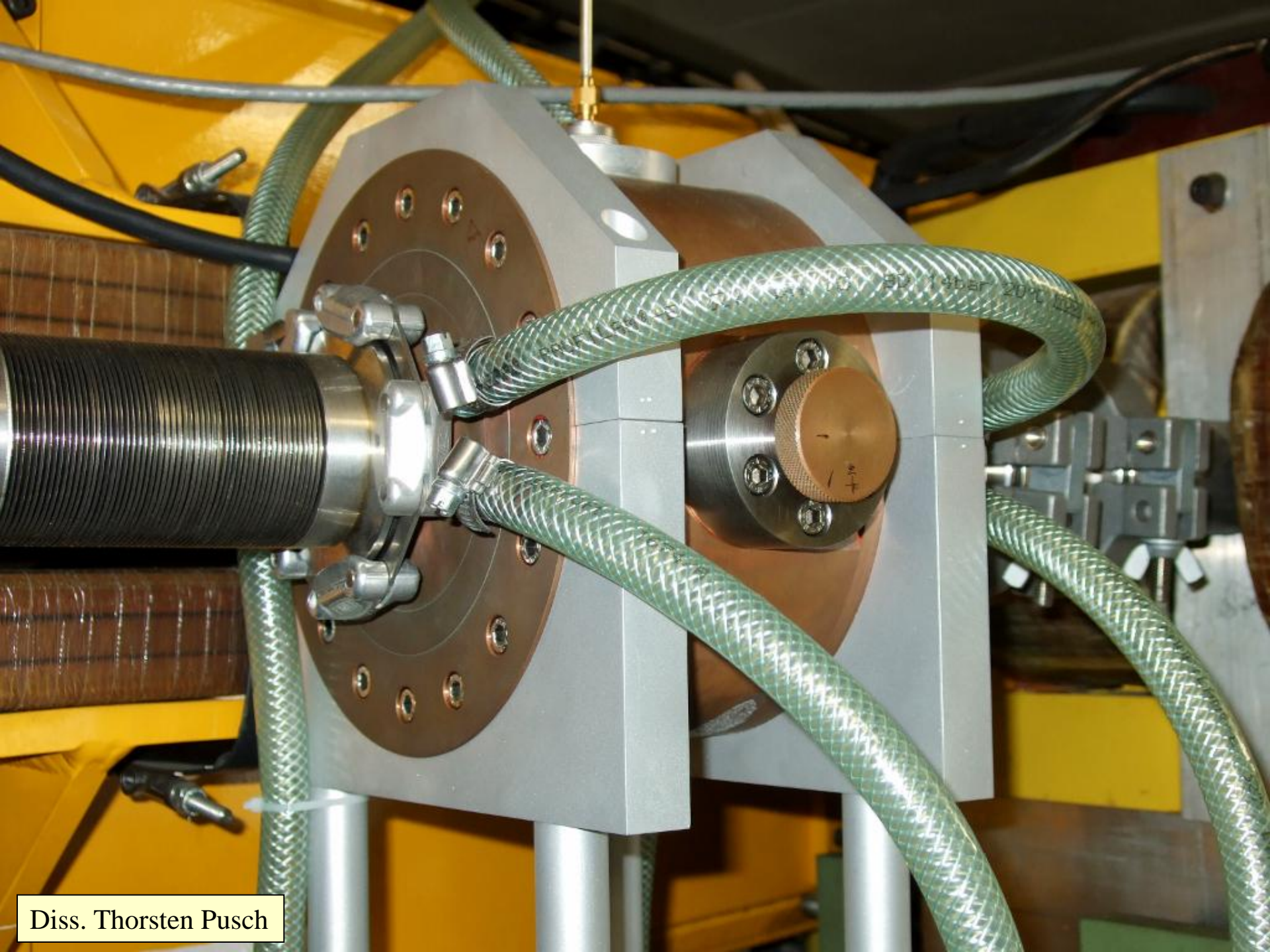
**new**

# Tune Measurements



Diss. Maren Eberhardt

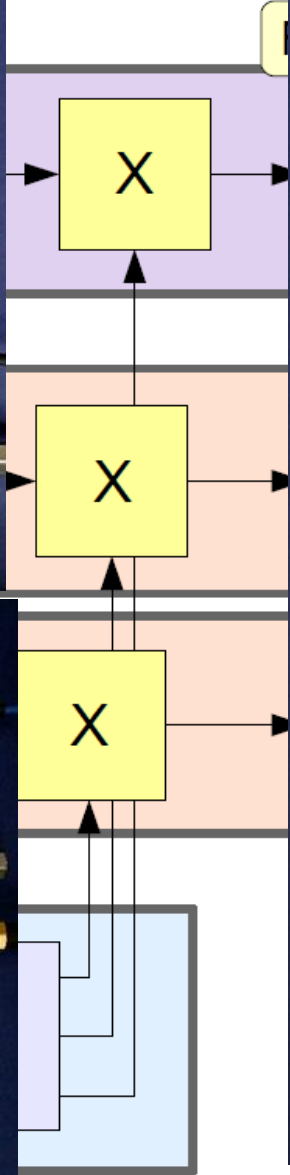




Diss. Thorsten Pusch

# RF Electronics

gener



st  
tu

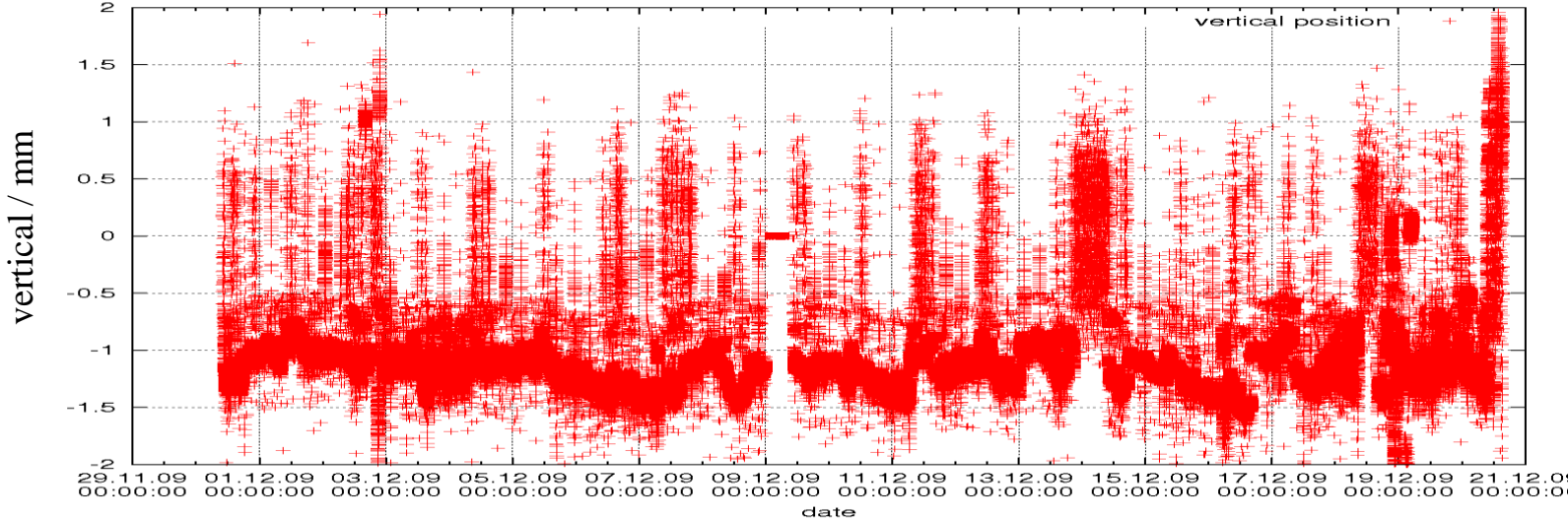
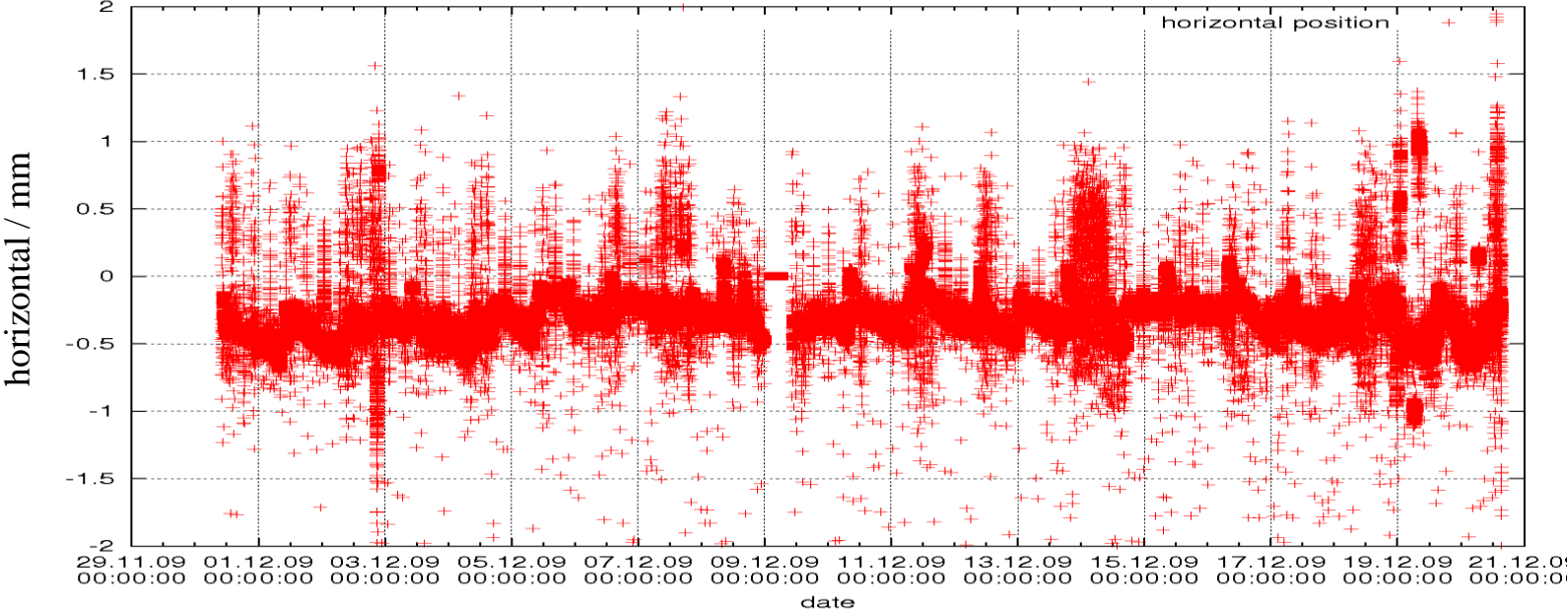


x

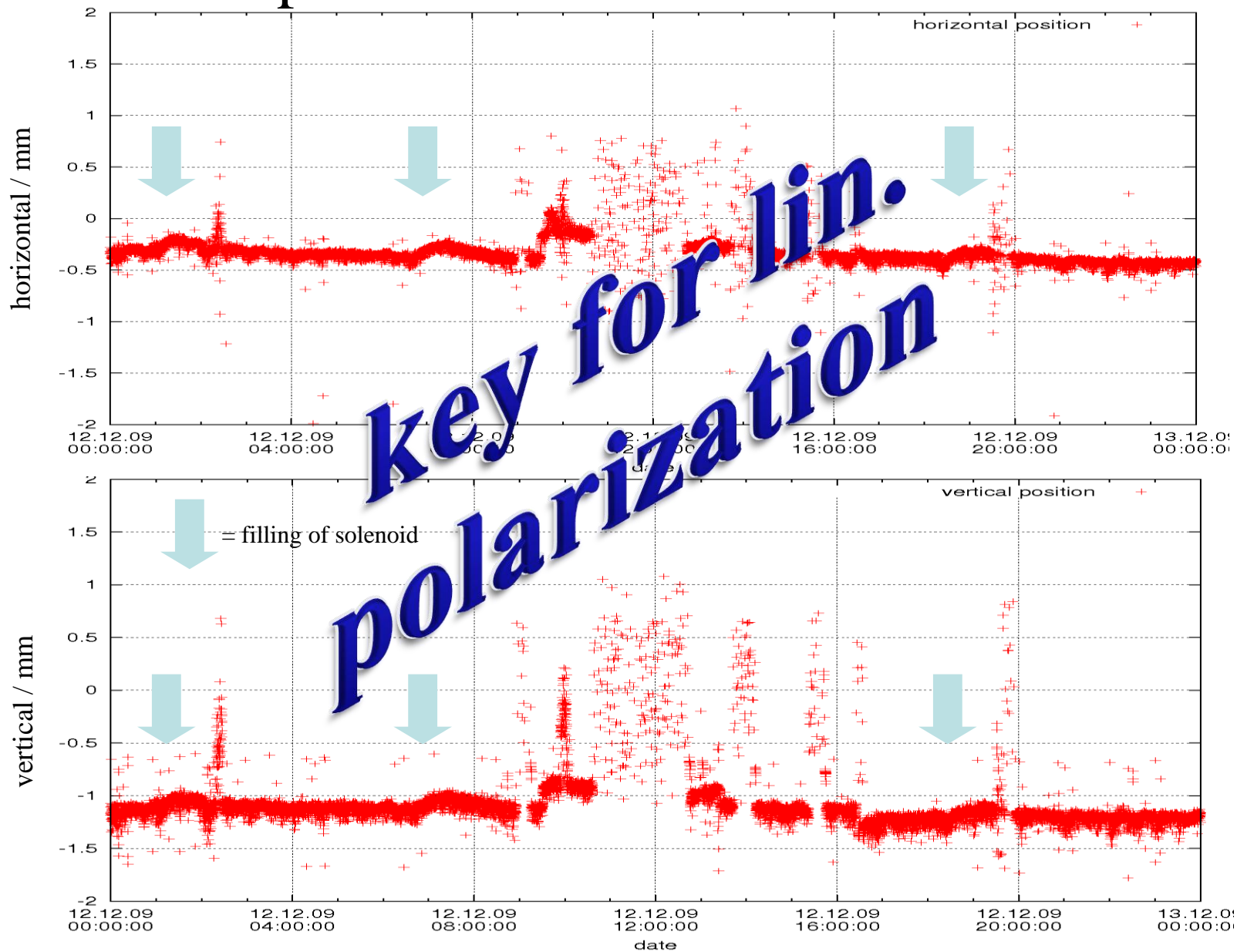
y

Diss. Thorsten Pusch

# Beam position measured with rf cavities

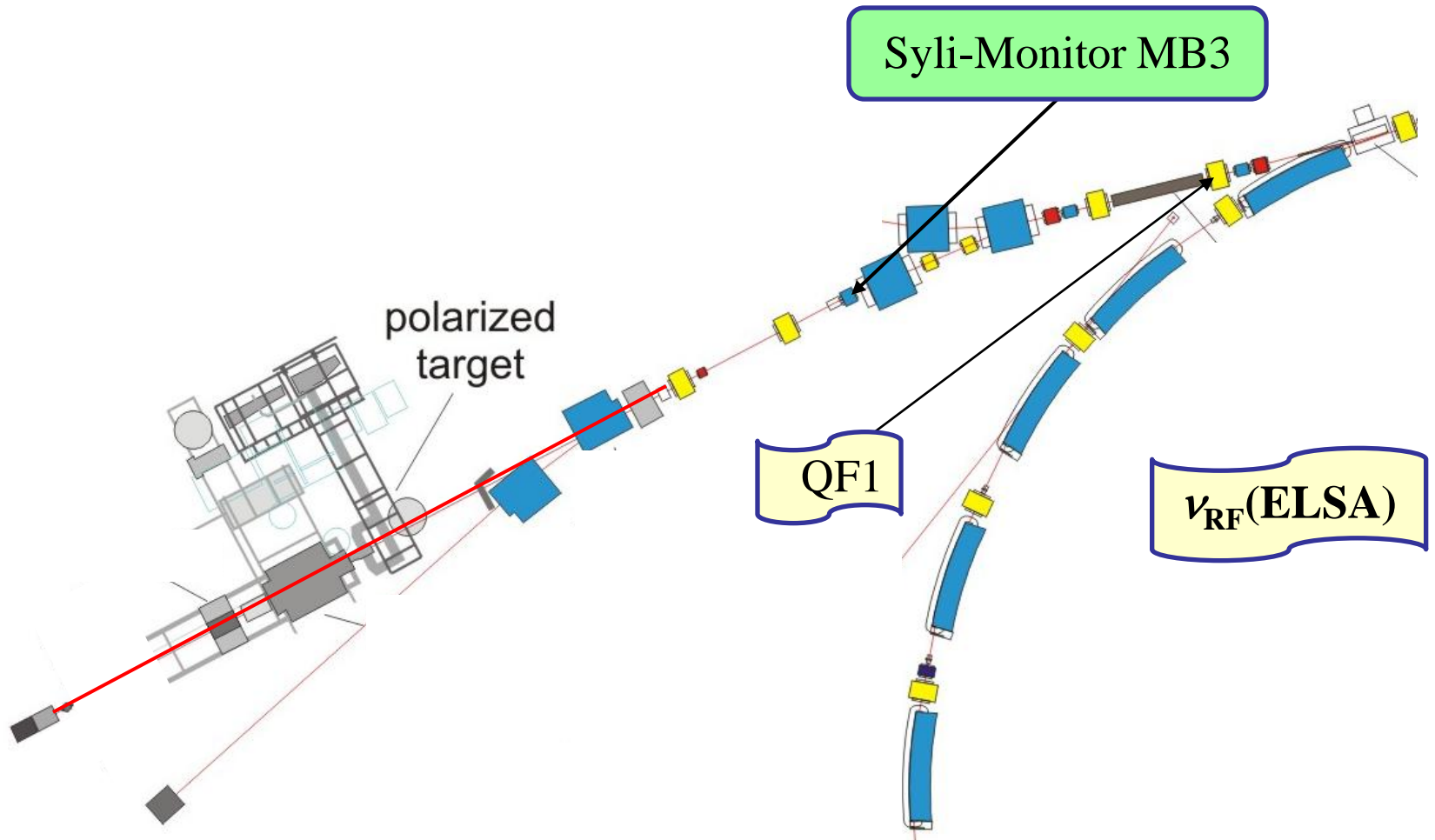


# Beam position measured with rf cavities

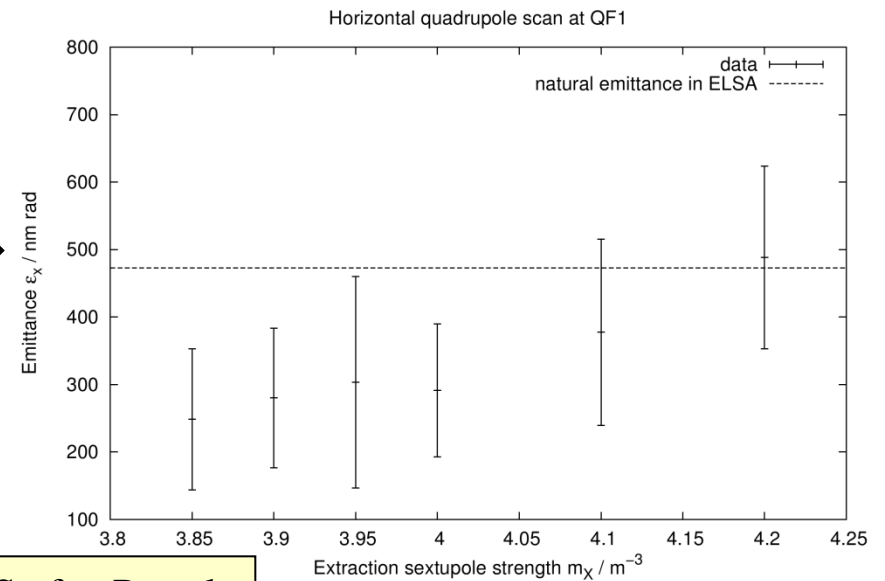
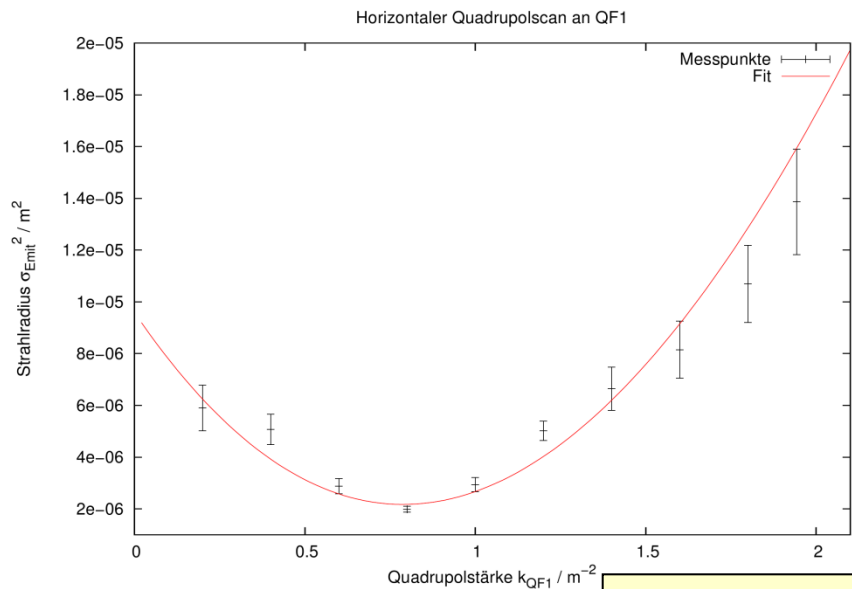
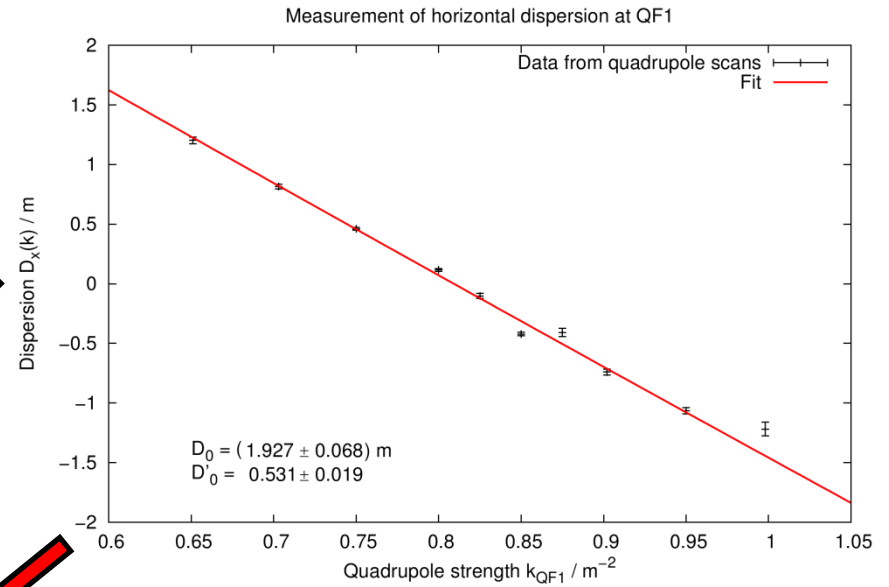
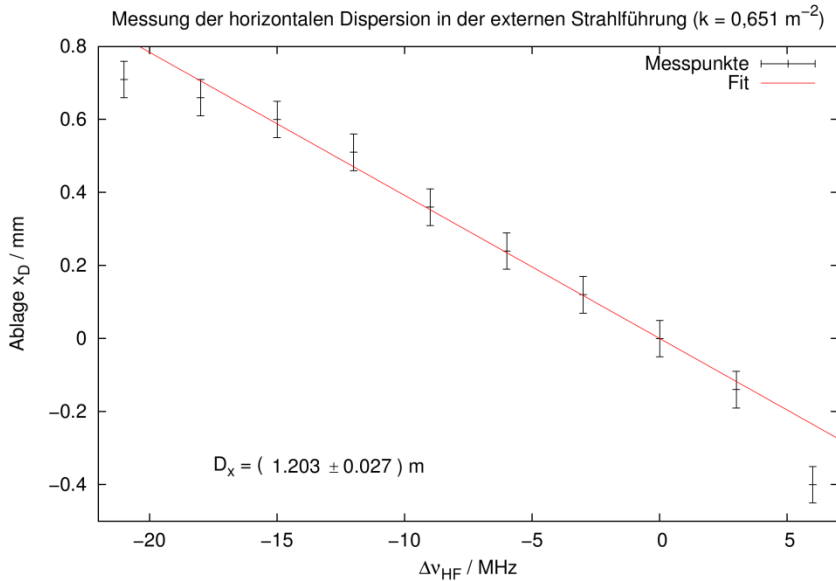




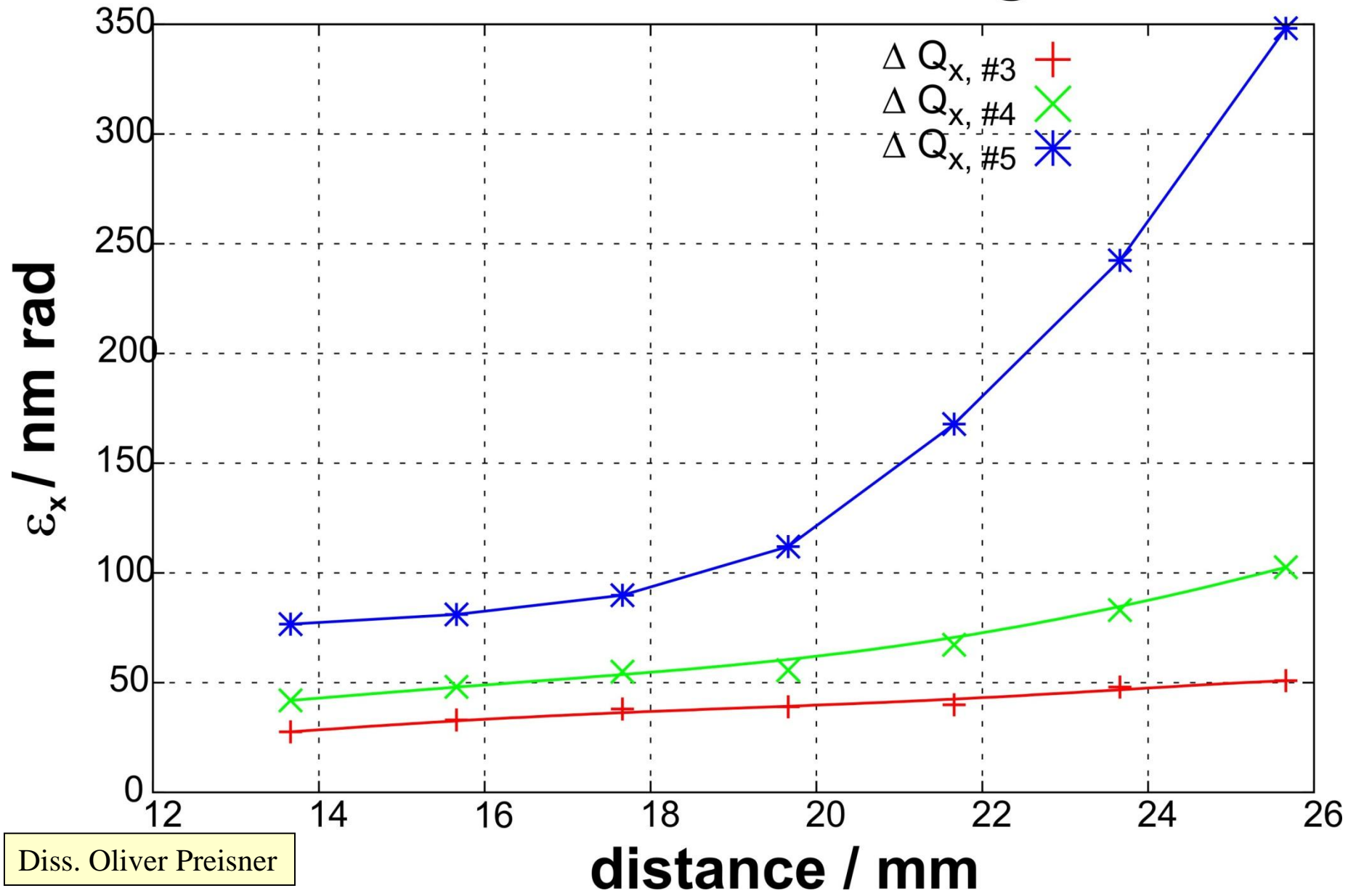
# Emittance Measurements @ CB



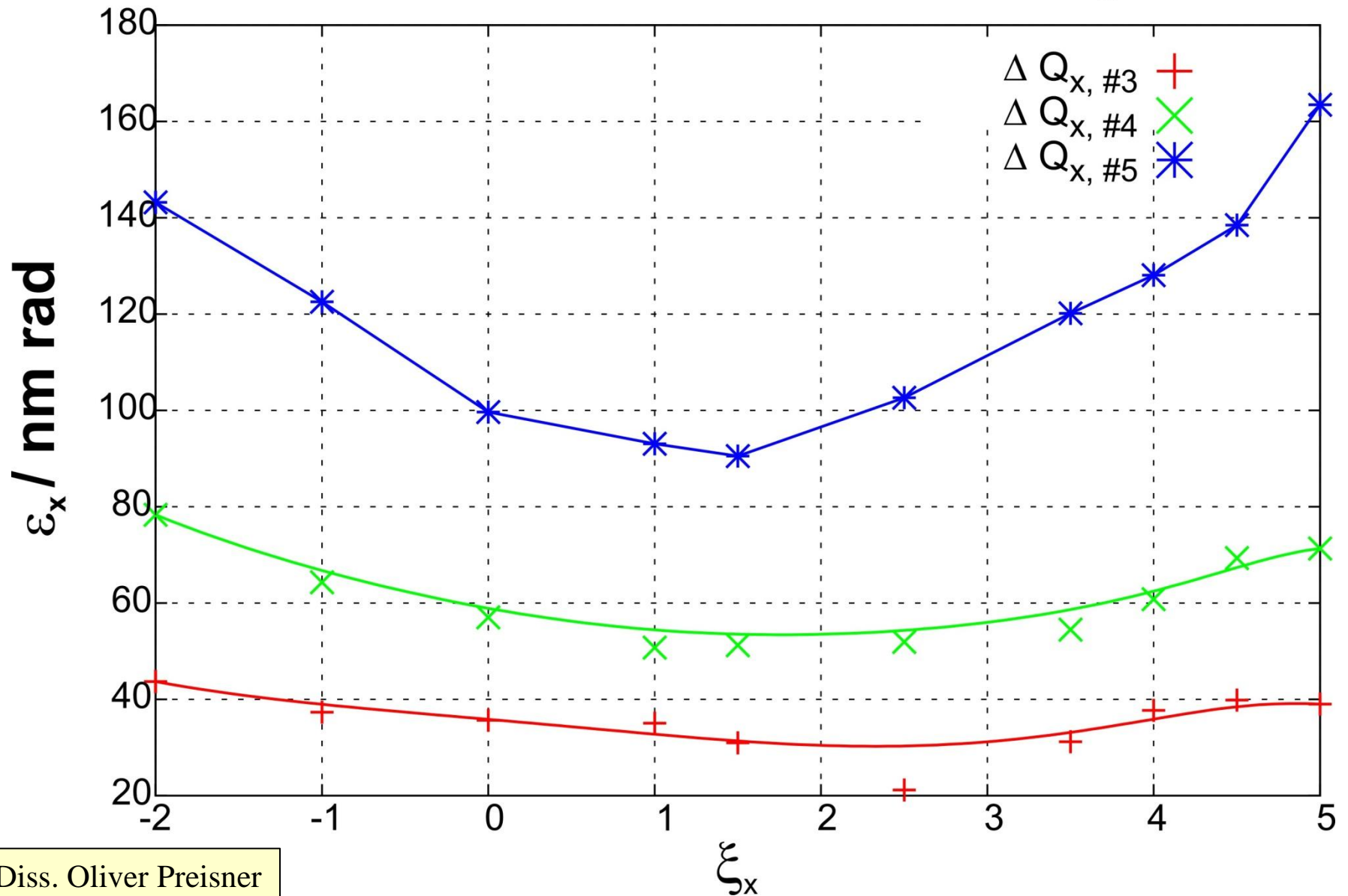
# Emittance Measurements



# Emittance depending on distance of MSE22 to design orbit



# Emittance depending on the horizontal chromaticity

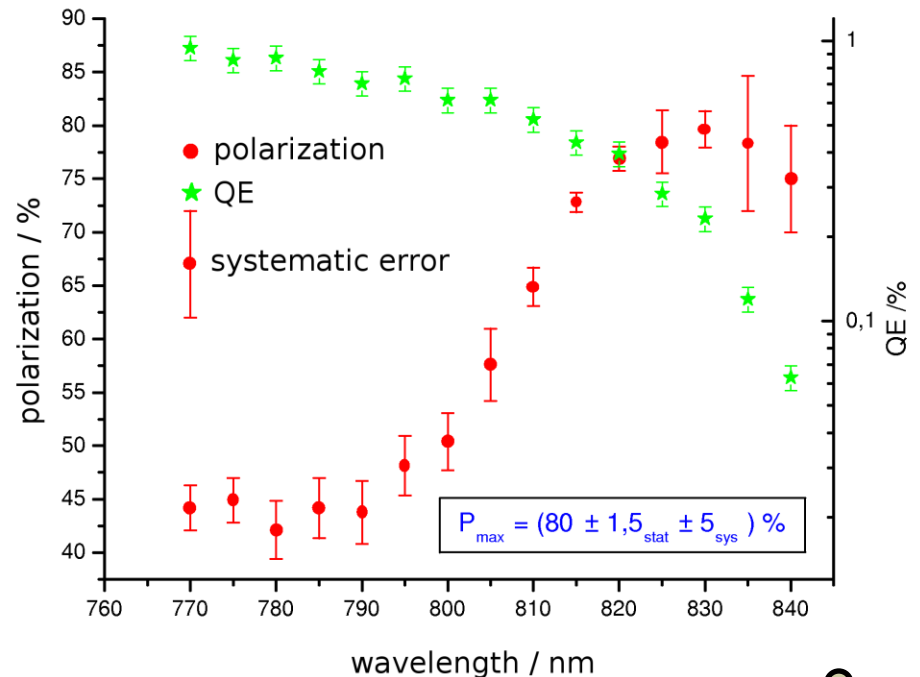


# Source of Polarized Electrons

old strained layer superlattice  
photocathode

As (protective coating)
Be – InGaAs $8 \times 10^{19} \text{ cm}^{-3}$
Be – AlGaAs $4.75 \times 10^{17} \text{ cm}^{-3}$
Be – InGaAs $5.39 \times 10^{17} \text{ cm}^{-3}$
⋮
Be – AlGaAs $4.75 \times 10^{17} \text{ cm}^{-3}$
Be – InGaAs $5.39 \times 10^{17} \text{ cm}^{-3}$
Be – AlGaAs $5 \times 10^{18} \text{ cm}^{-3}$
Be - GaAs buffer
Zn - GaAs substrate

measured performance:



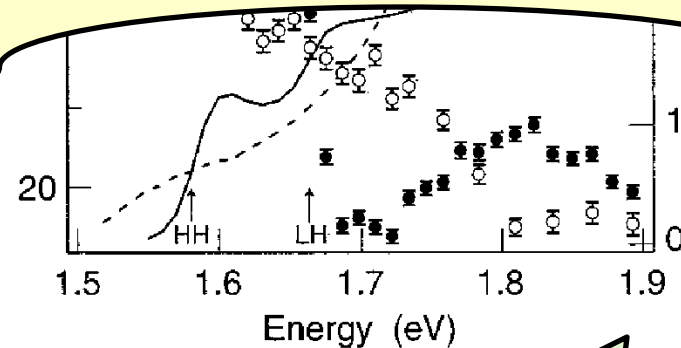
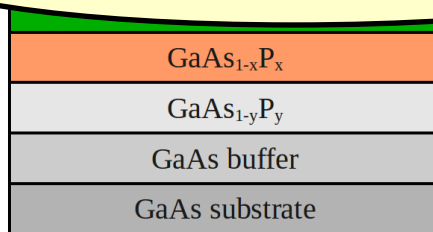
In operation until Sep-09,  $P > 80\%$ ,  $QE_{\text{typ}} \approx 0.2\%$

# Source of Polarized Electrons

new strained layer superlattice  
photocathode

Larger Emission Area ( $\varnothing 8\text{mm} \rightarrow \varnothing 9\text{mm}$ )

→ Intensity Increase of 20%

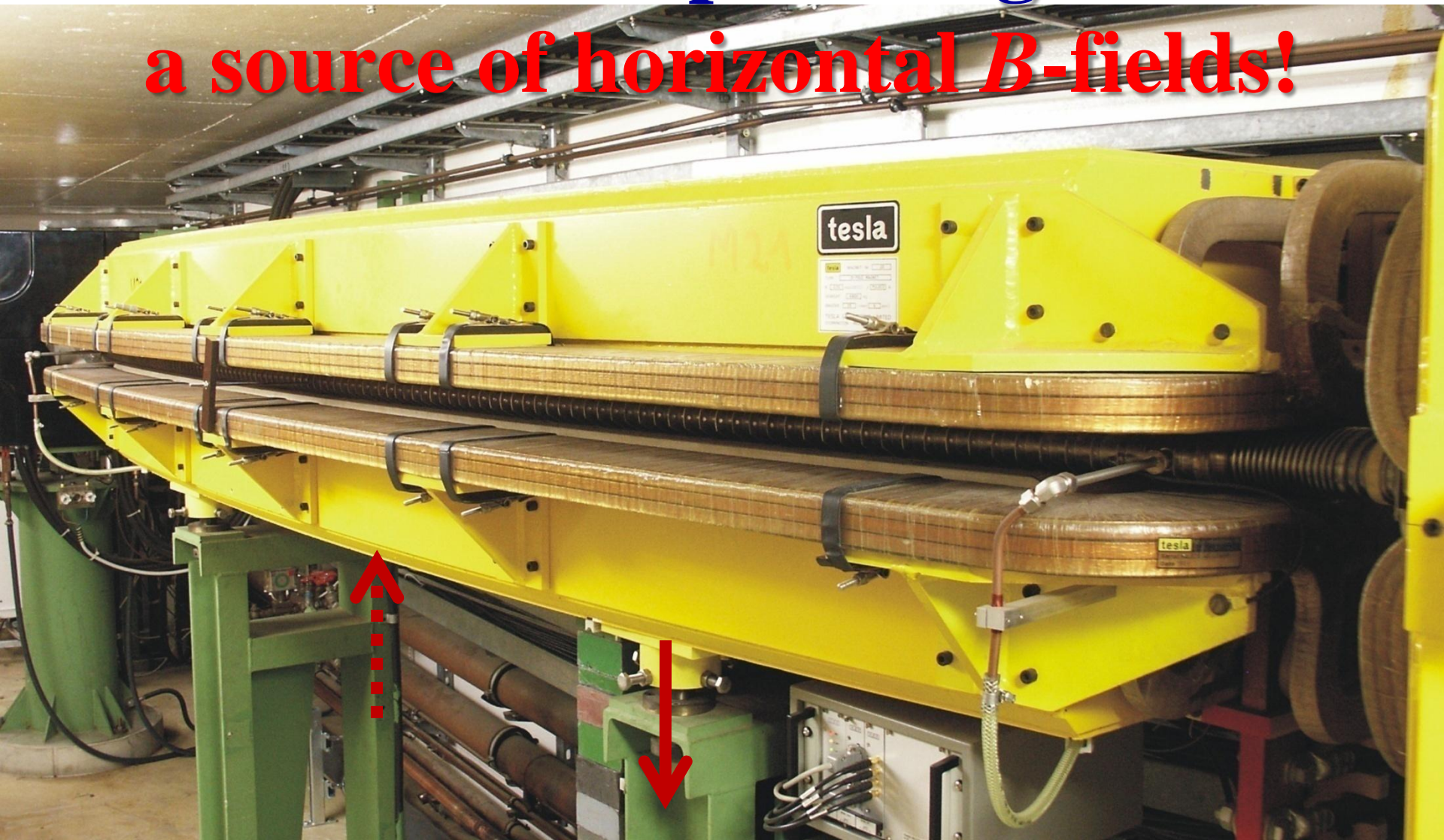


In operation since Sep-09,  $P > 80\%$ ,

$QE_{\text{typ}} \approx 1.4\%$

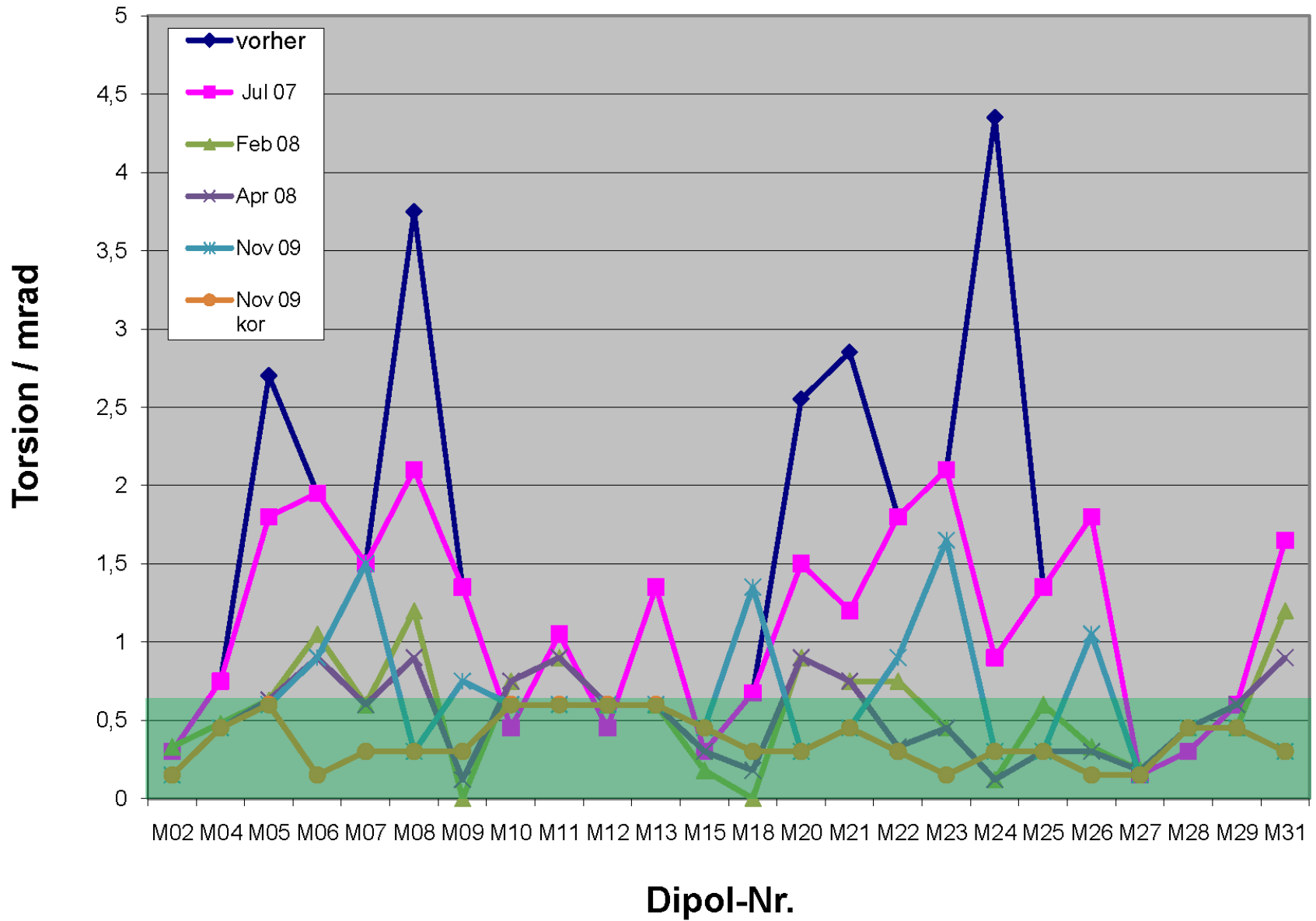
# Distorted Dipole Magnets:

a source of horizontal  $B$ -fields!



a “simple” and meanwhile well proven technique!!

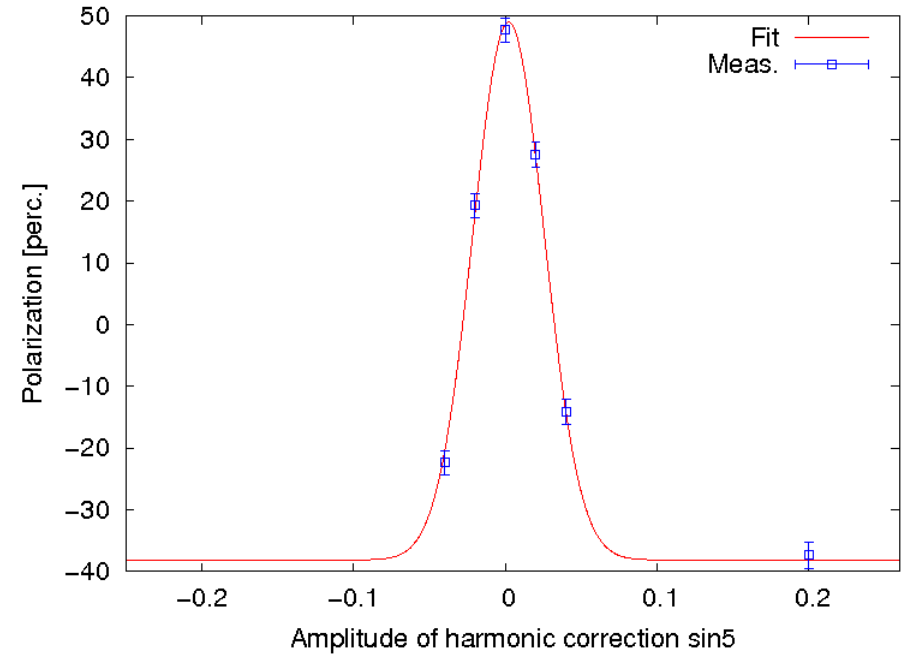
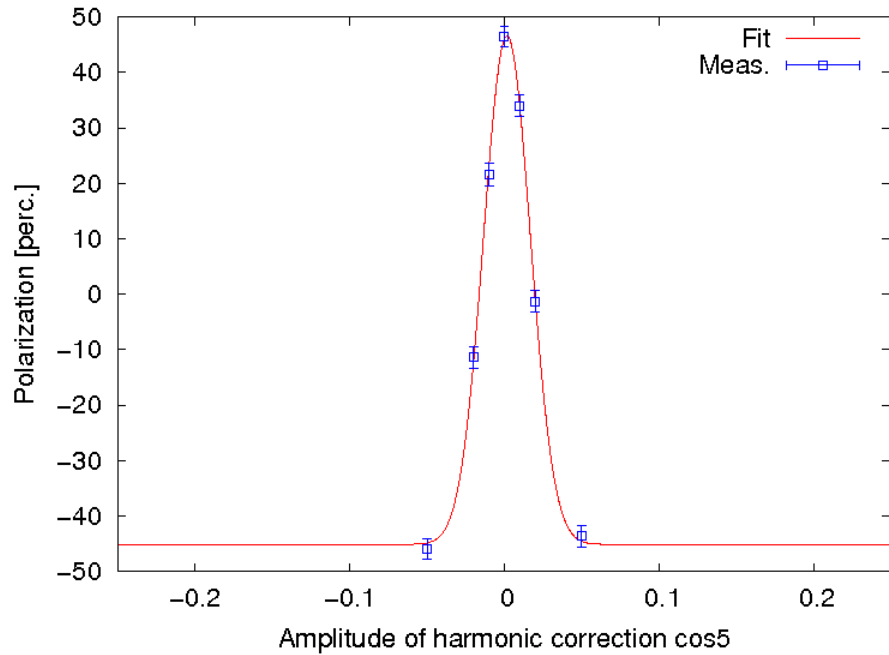
# Dipol-Justierung 11/2009





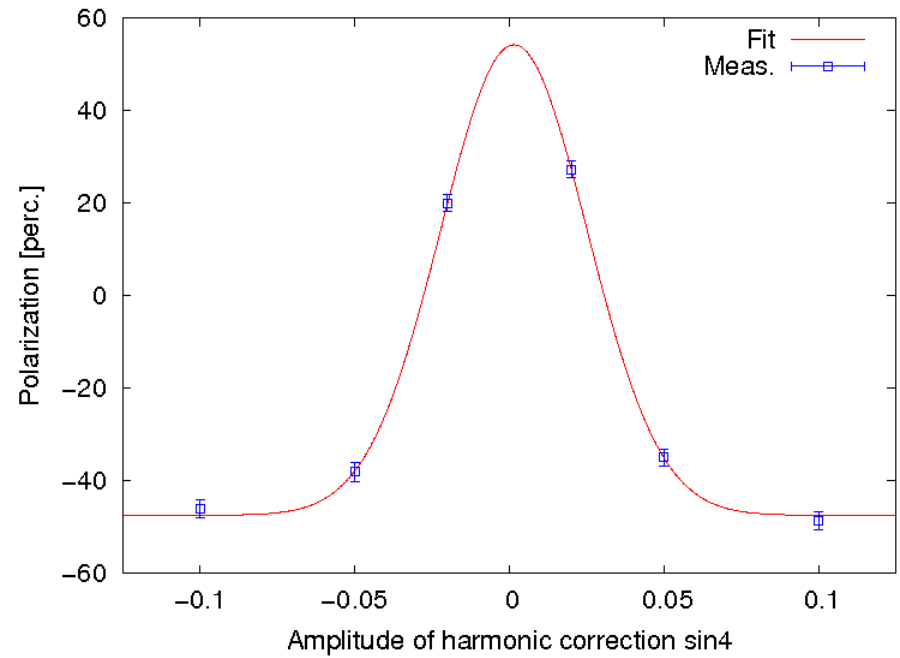
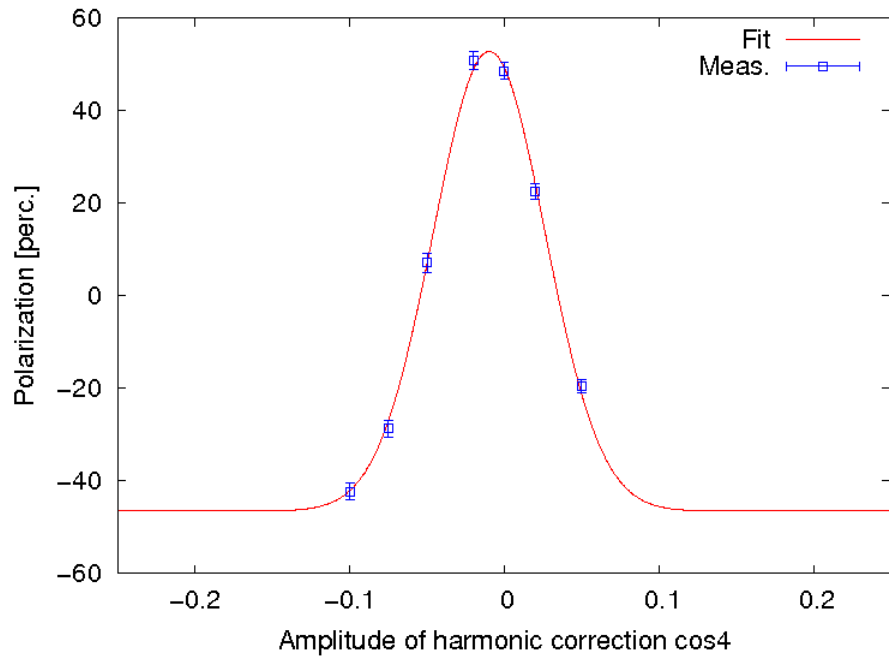
# Correction of 5th imperfection resonance

## $E = 2.203 \text{ GeV}$



# Correction of 4th imperfection resonance

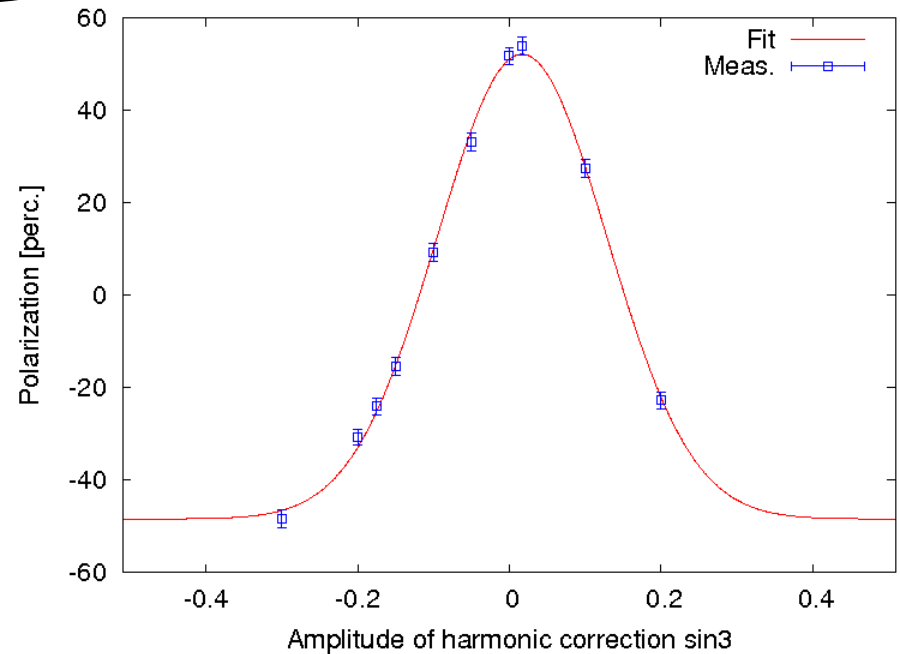
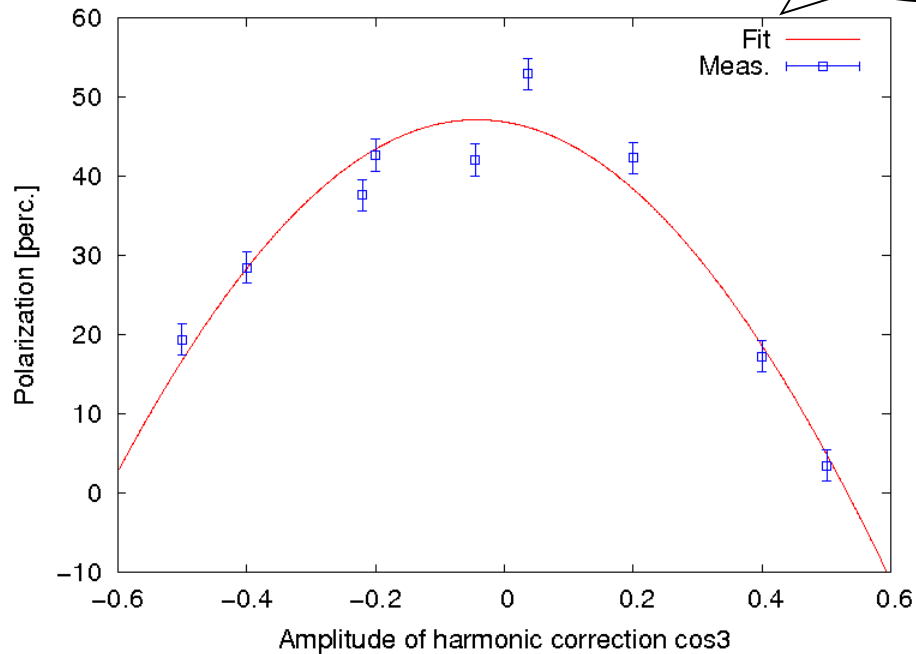
## $E = 1.763 \text{ GeV}$



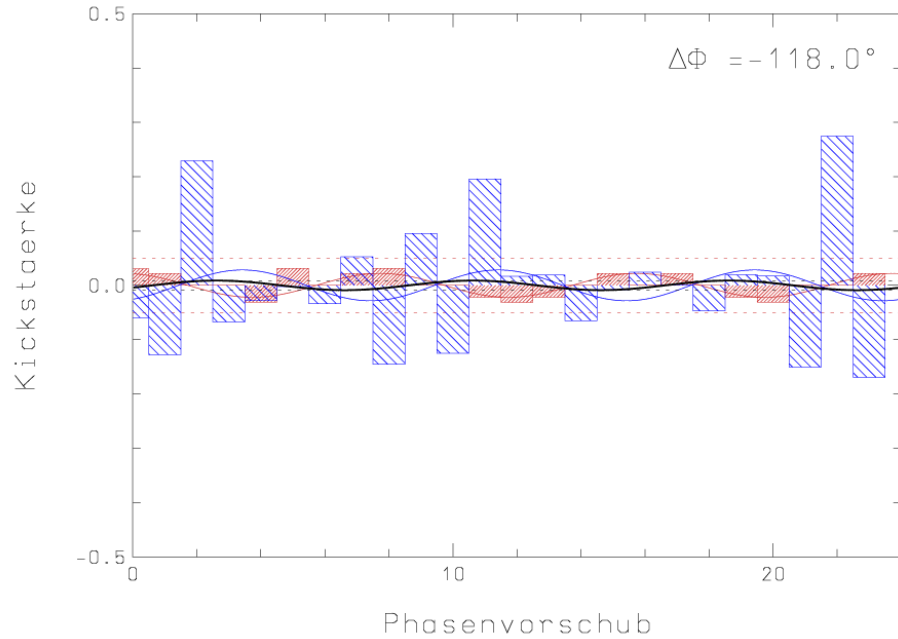
# Correction of 3rd imperfection resonance

## $E = 1.322 \text{ GeV}$

measured in  
Sept. 2009

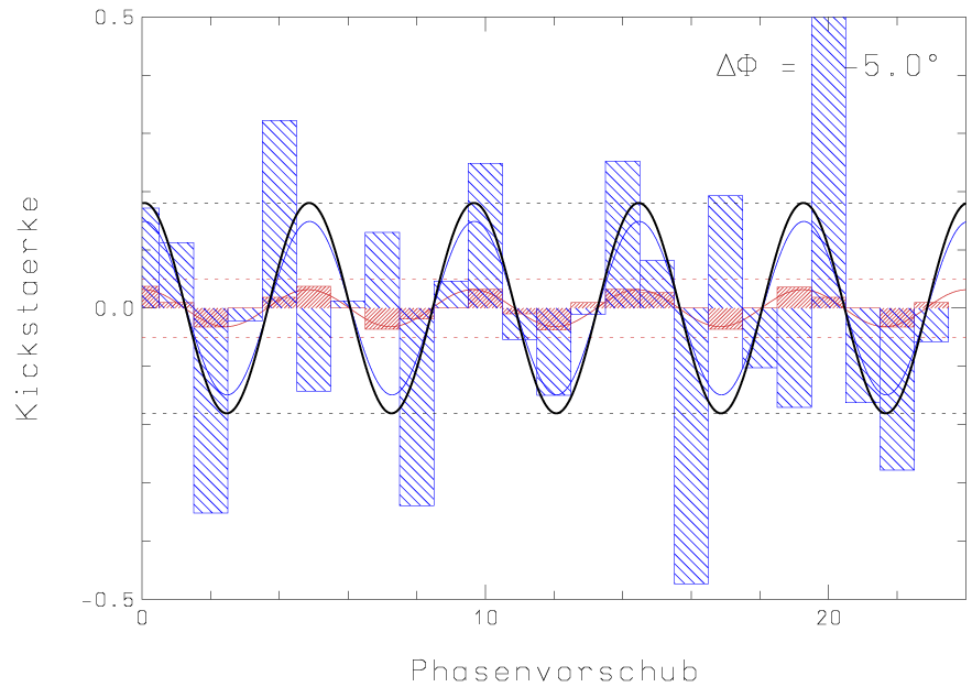


# Harmonic Correction

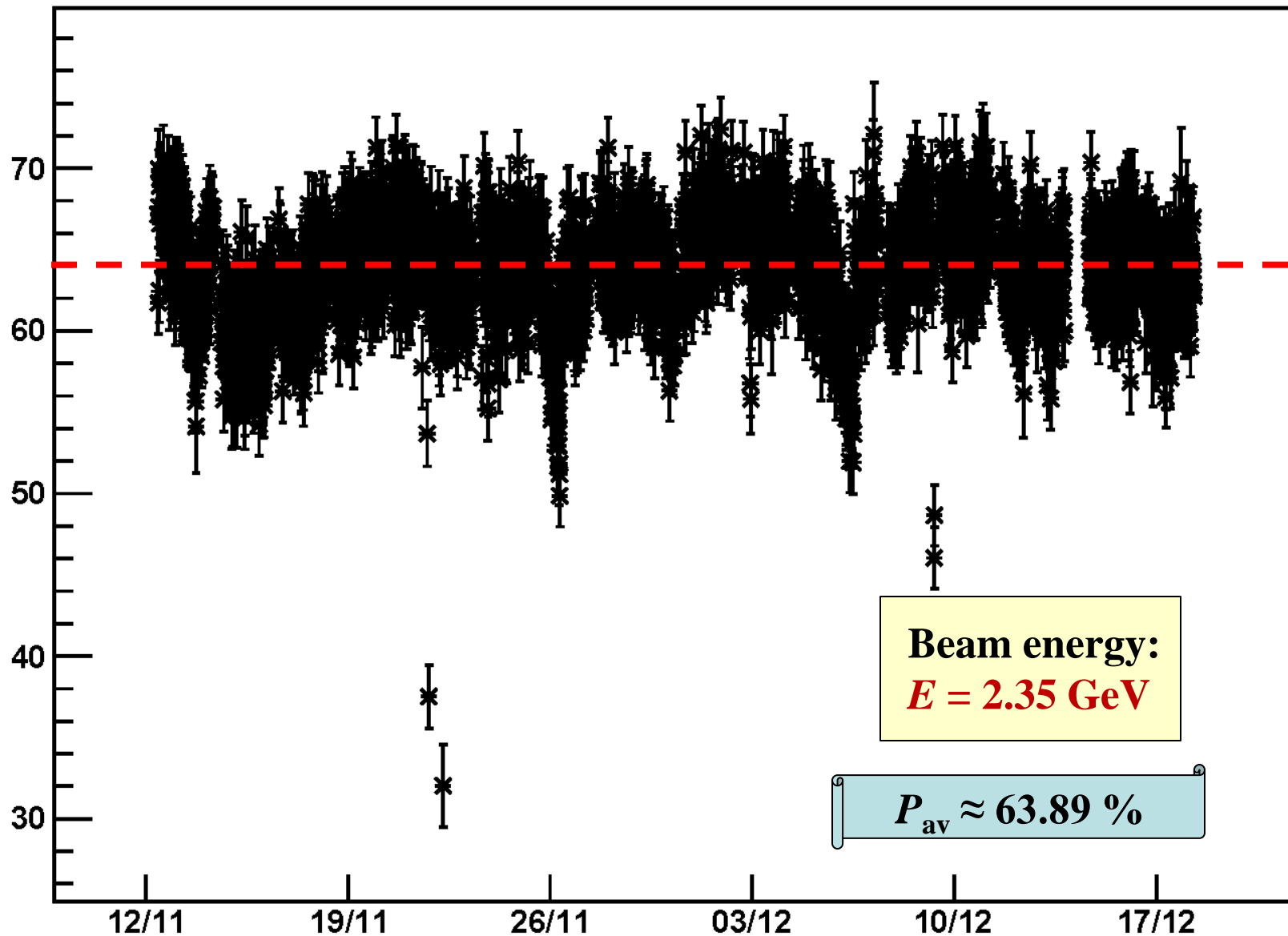


←  $\cos 3\phi$

$\cos 5\phi$  →



Polarisation @ 2350MeV, 12.11.2009, 10:54 - 18.12.2009, 8:49





**Operating Statistics  
2009**

# ELSA Operation 2009

## 3 CB/TAPS Runs with extended Data-Taking

26.01. – 04.03.	<b>888 hours @ 3.2 GeV</b>	(no Pol.)
17.08. – 09.10.	<b>1012 hours @ 2.35 GeV</b>	(cir. Pol.)
10.11. – 20.12.	<b>976 hours @ 2.35 GeV</b>	(cir. Pol.)

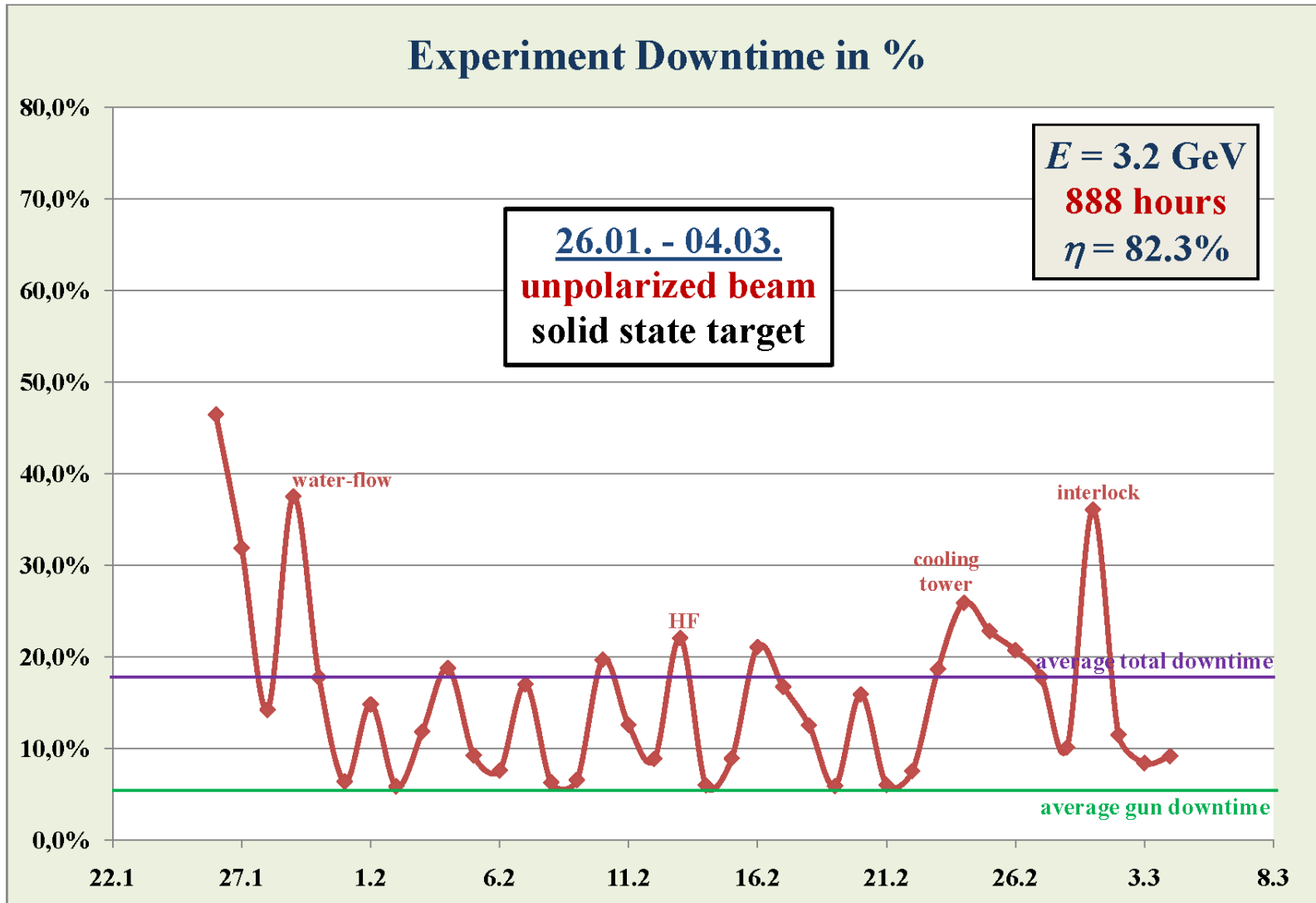
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**$\Sigma = 2876$  hours**

Tests in CB-Area:	<b>160 hours</b>
Ilcpol in B1-Area:	<b>200 hours</b>
Students Experiment:	<b>70 hours</b>
ELSA Tests:	<b>75 hours</b>

**approx. 3380 operating hours in 2009**

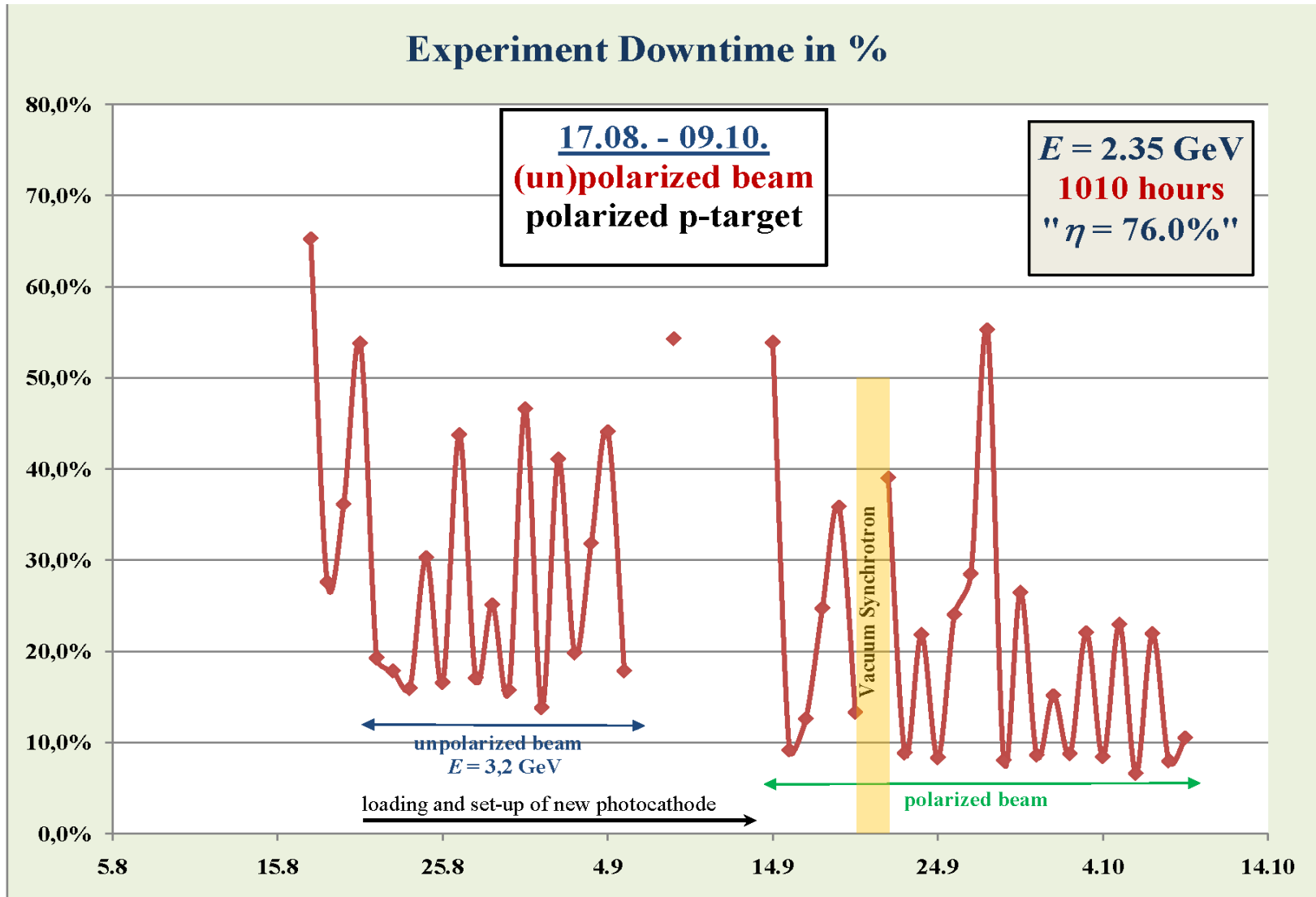
# Performance Jan - Mar



**Considered: beam in experimental area ( $I_{FC} > 10\text{pA}$ ) !**

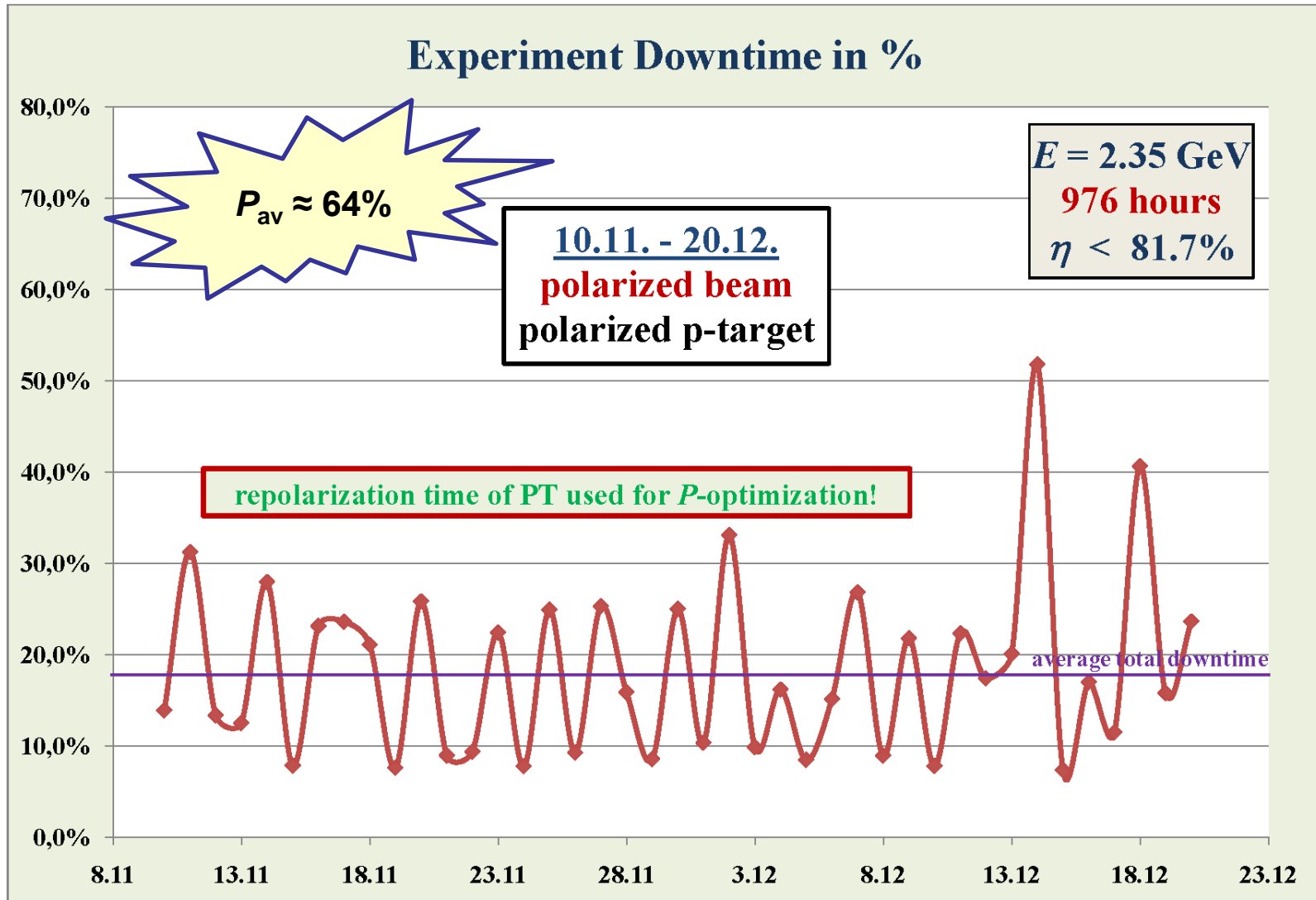


# Performance Aug - Oct



**Considered: beam in experimental area ( $I_{FC} > 10\text{pA}$ ) !**

# Performance Nov / Dec



Considered: beam in experimental area ( $I_{FC} > 10\text{pA}$ ) !

# **Planned Activities Spring / Summer 2010**

**Polarized Electrons @ 3.2 GeV**

**Commissioning of LINAC I**

**Set up of new Test-Beamline**

**Bunch by Bunch Feedback**



## New Correction-System:

24 correction coils  
(main dipoles)

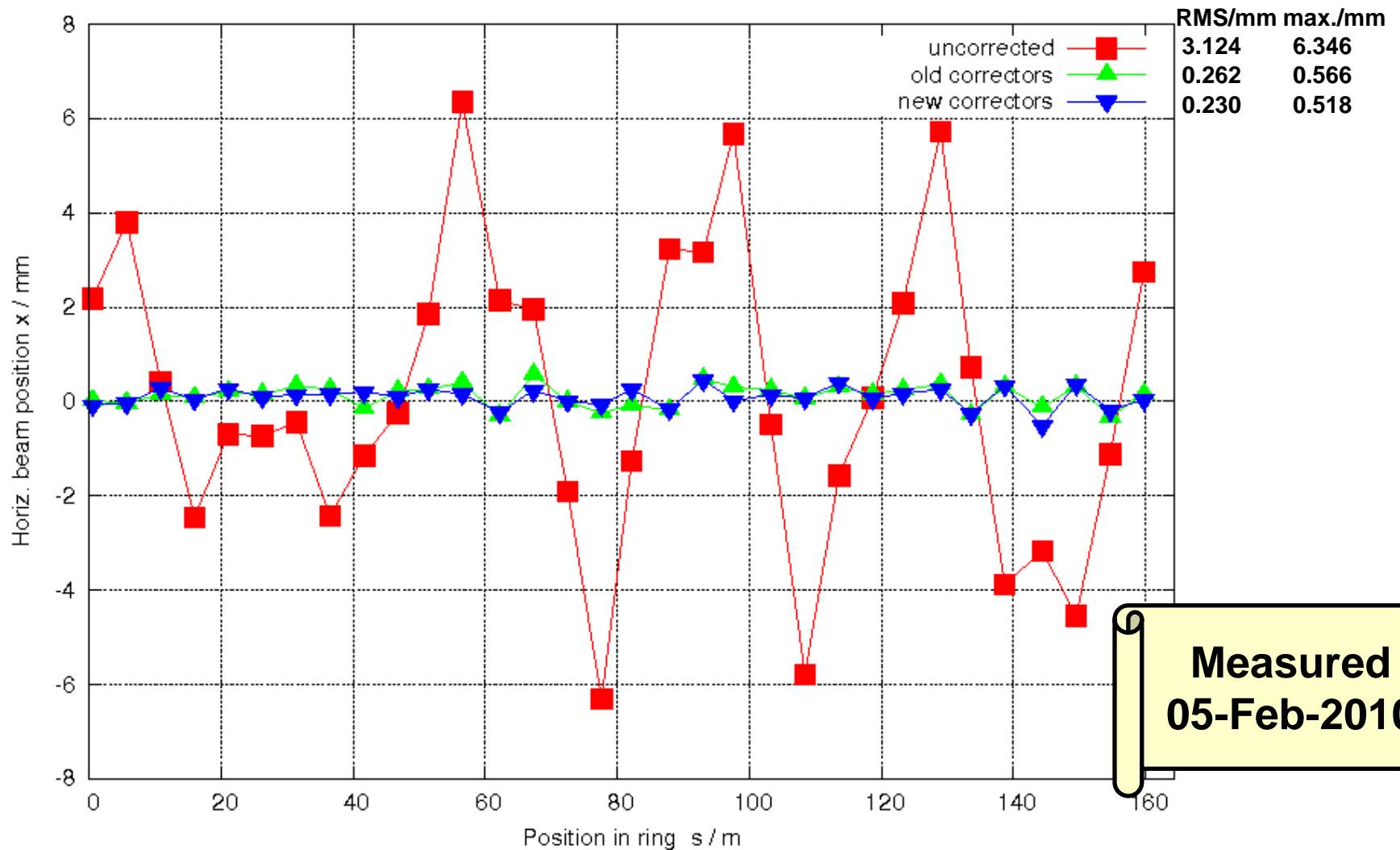
30 new vert.  
dipole  
correctors

54 new  
“pulsed”  
power supplies



Diss. Andreas Balling

# Correction of horizontal beam position with new correctors (E = 2.35 GeV)



# Linac 1

## Operating Modes:

- Long pulse:

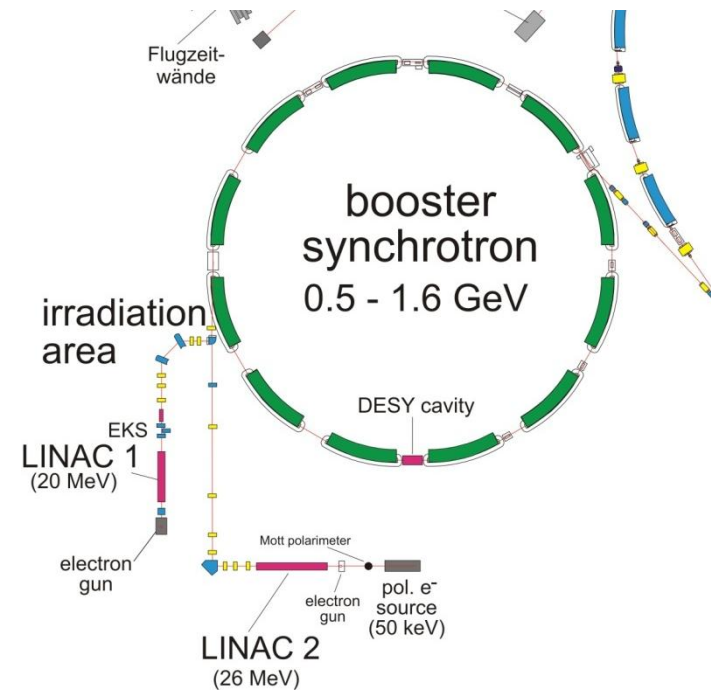
- energy range  $10 \text{ MeV} < E < 20 \text{ MeV}$
- pulse length  $t^3 \ 2\mu\text{s}$
- pulse charge  $q \ \approx 0,5 \ \mu\text{C}$
- repetition rate  $n \ \approx 50 \text{ Hz}$

used for: **high current operation**  
irradiation operation

- Short pulse

- Pulse length  $t^3 \ 100 \text{ ps}$
- Pulse charge  $q \ \approx 40 \text{ pC}$
- Repetition rate  $n \ \approx 50 \text{ Hz}$

used for: **low current high energy test beam** (detector testing @ ELSA)  
investigation of single bunch beam instabilities



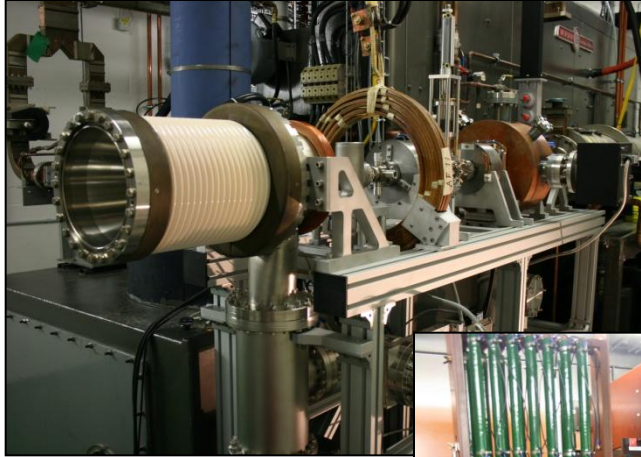
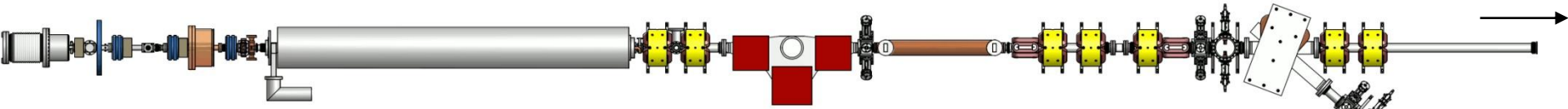
**polarized not electrons available with LINAC I !**

**Injector**

**LINAC 1**

**Transfer line**

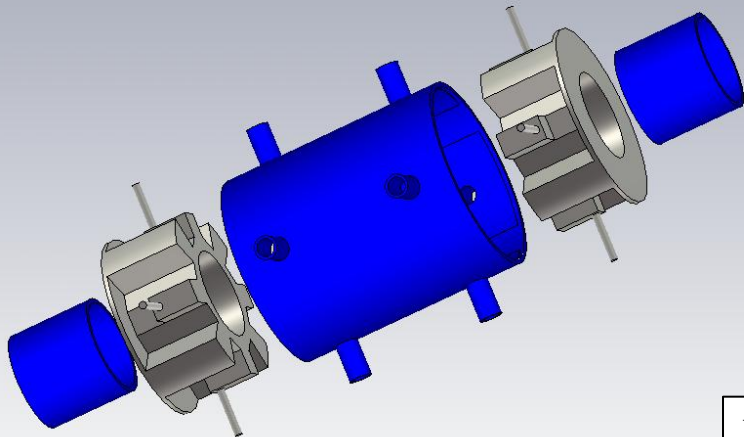
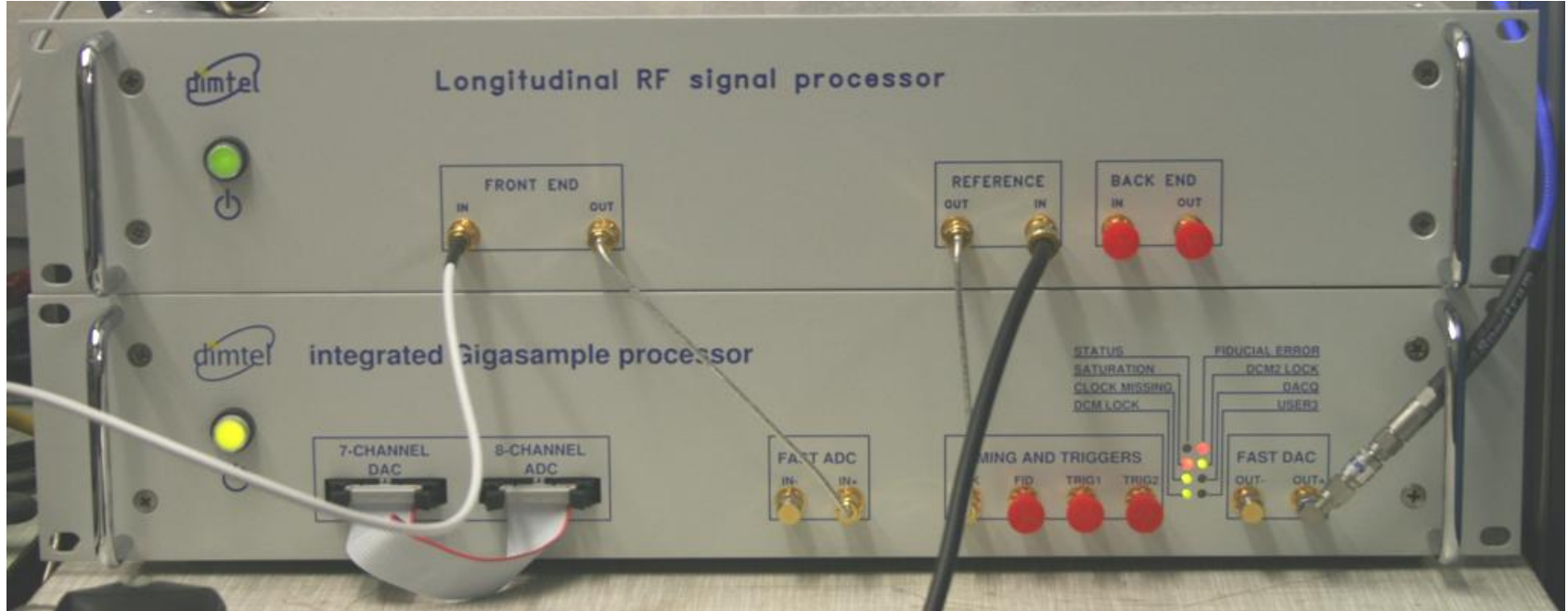
**Irradiation chamber**







# Bunch by Bunch Feed-Back System

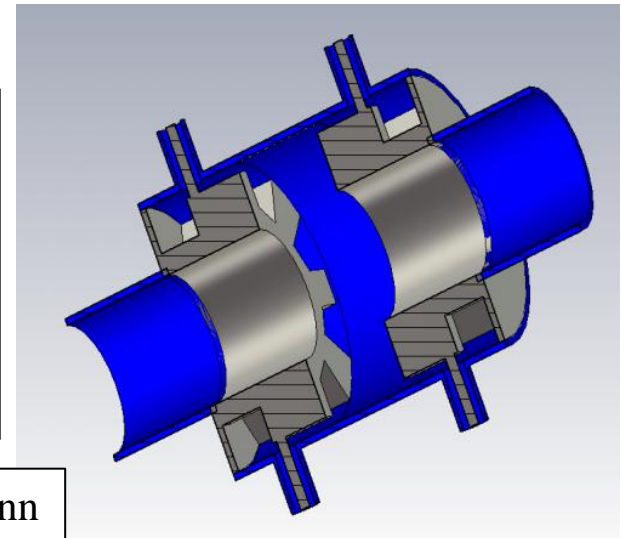


$$f_c = 1,125 \text{ GHz}$$

$$BW = 250 \text{ MHz}$$

$$Q_L = 4,5$$

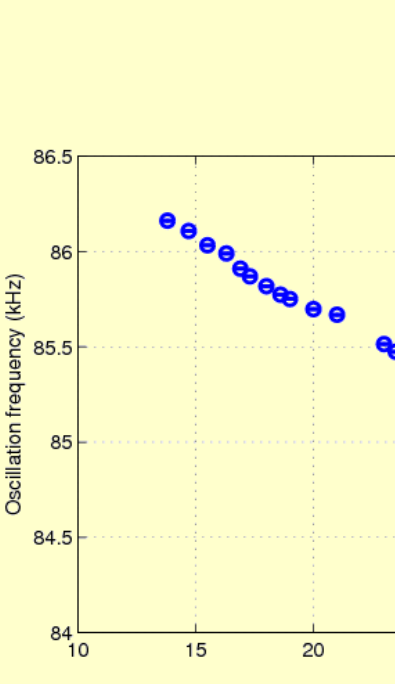
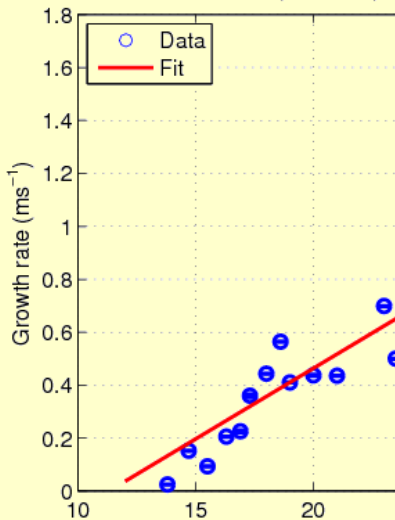
$$R_s \approx 450 \Omega$$



Dipl. Rebecca Zimmermann

# Bunch by Bunch Feed-Back System

ELSA, feb0710, lo



SYSTEM: IGPF DEVICE: TEST HELP EXIT

**Mean**

Plot of Mean versus Bunch number. The y-axis is labeled C N T and ranges from 6 to 13. The x-axis is Bunch number, ranging from 0 to 300. The data (red circles) shows a peak around bunch 150.

**Max RMS channel (filtered)**

Plot of Max RMS channel (filtered) versus Time (ms). The y-axis is labeled C N T and ranges from -10 to 15. The x-axis is Time (ms), ranging from 0 to 4. The data (blue circles) shows a diamond-shaped distribution centered at 2 ms.

**RMS**

Plot of RMS versus Bunch number. The y-axis is labeled C N T and ranges from 0.5 to 3.5. The x-axis is Bunch number, ranging from 0 to 300. The data (green circles) shows a peak around bunch 150.

**Averaged spectrum**

Plot of Averaged spectrum versus Frequency (kHz). The y-axis is labeled dB and ranges from -60 to 60. The x-axis is Frequency (kHz), ranging from 0 to 1000. A sharp peak is visible at approximately 708 kHz, marked with a red circle.

ACQUISITION CONTROL MEAN 9.2 AMP P-P 3.9 MARKER SPAN (kHz)   MARKER 42.0 dB

RMS 1.5 MAX RMS 3.2   AVG  FREQ 708.03 kHz

SPECTRUM AVERAGING PATTERN

# Conclusions

## **ELSA-Operation:**

- Excellent beam pointing stability  
(measured by RF cavity and  $\gamma$ -camera)
- Standard and reliable operation with lin. pol.  $\gamma$ 's
- Polarization close to 65% at CB-Tagger (2.35 GeV)

**ELSA-crew is continuing intensive accelerator R&D**

## **Maintenance periods required for:**

- Set up and commissioning of LINAC I
- Set up and commissioning of new ext. beamline