

Application of Libera Brilliance Single Pass at HLS LINAC

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Outline

- Hefei Light Source and its upgrade project
- Off-line Test of Libera Brilliance Single Pass
- Calibration of eight-striplines BESM with Libera Single Pass
- Beam position measurement with Libera Brilliance Single Pass at HLS Linac

Hefei Light Source

- Dedicated second generation VUV light source
- 800MeV electron storage ring, 200MeV linac and transfer line
- Large beam emittance and less number of straight sections

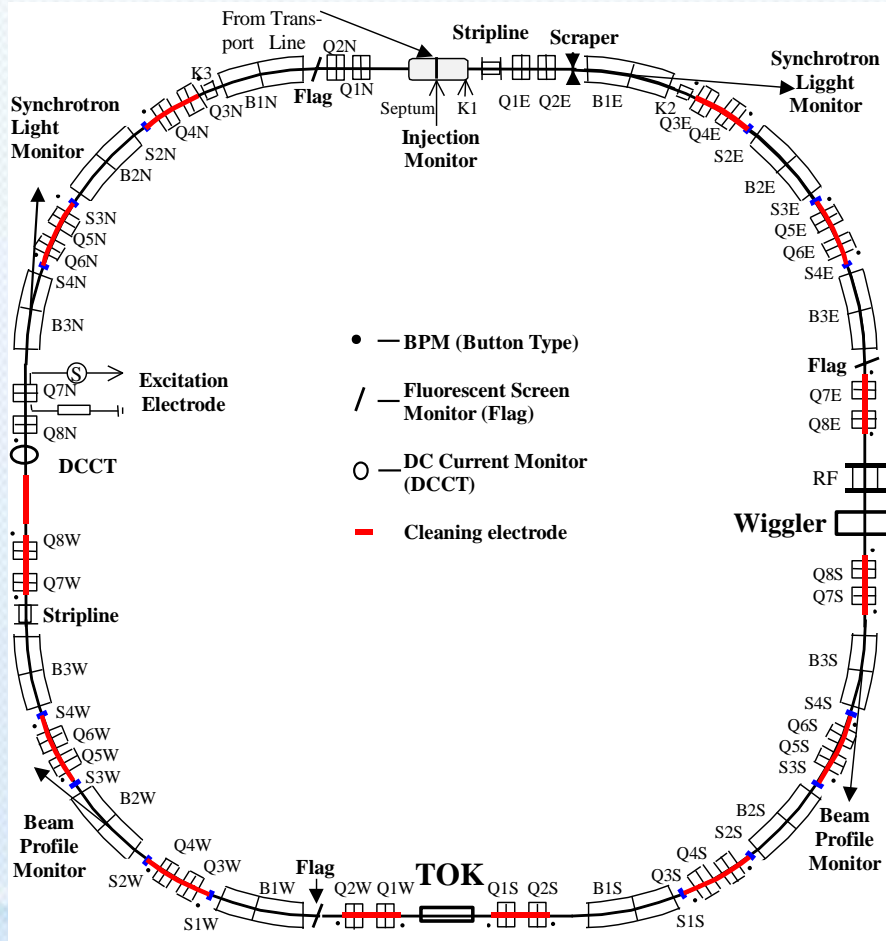


**HLS
storage
ring**

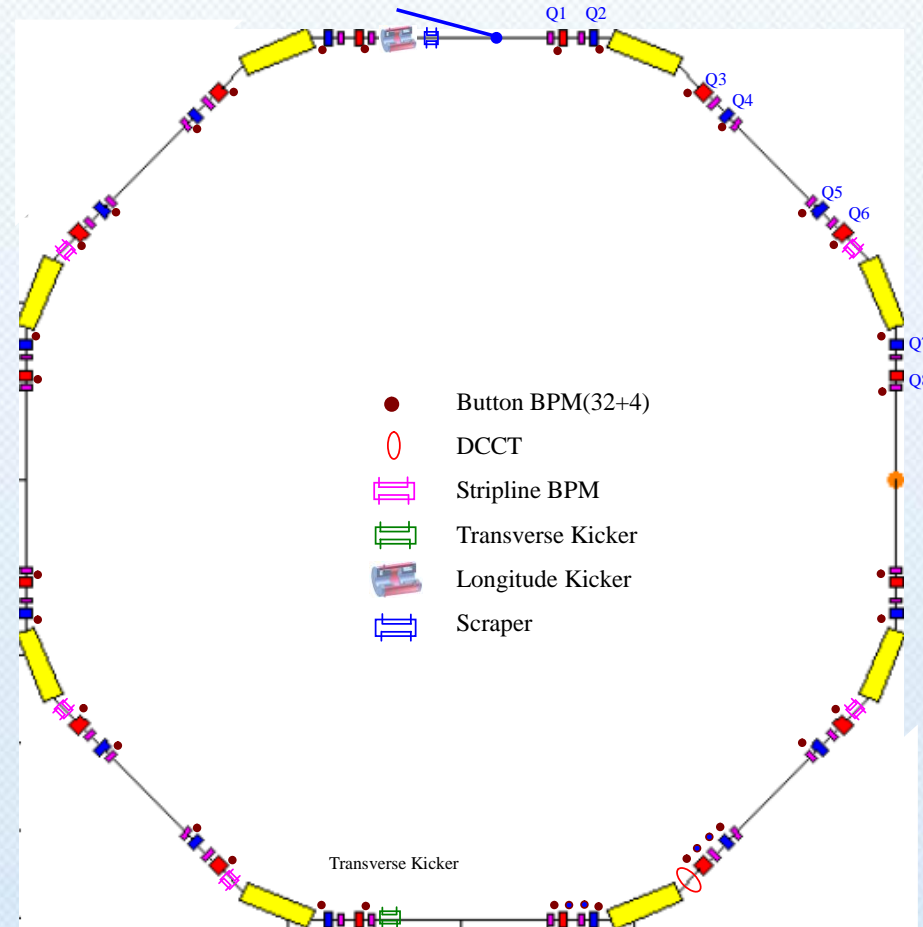
Main parameters of HLS and HLS II

	HLS II		HLS
	Mode A	Mode B	
Operation energy	800 MeV		800 MeV
Circumference	66.13m		66.13m
RF Frequency	204MHz		204MHz
Transverse tunes	4.41/3.21	4.44/3.20	3.54/2.60
Momentum compaction	0.0205	0.0183	0.048
Beam Emittance	36nm.rad	20nm.rad	~160nm.rad
Beam intensity	> 300mA		250~300mA
Radiation loss	16.74keV/turn		16.3keV/turn
Parameters of straight section	(4m + 2.3m)×4 = 25.2m		3.36m×4 = 13.4m

Beam measurement system of HLS and HLS II storage ring



HLS

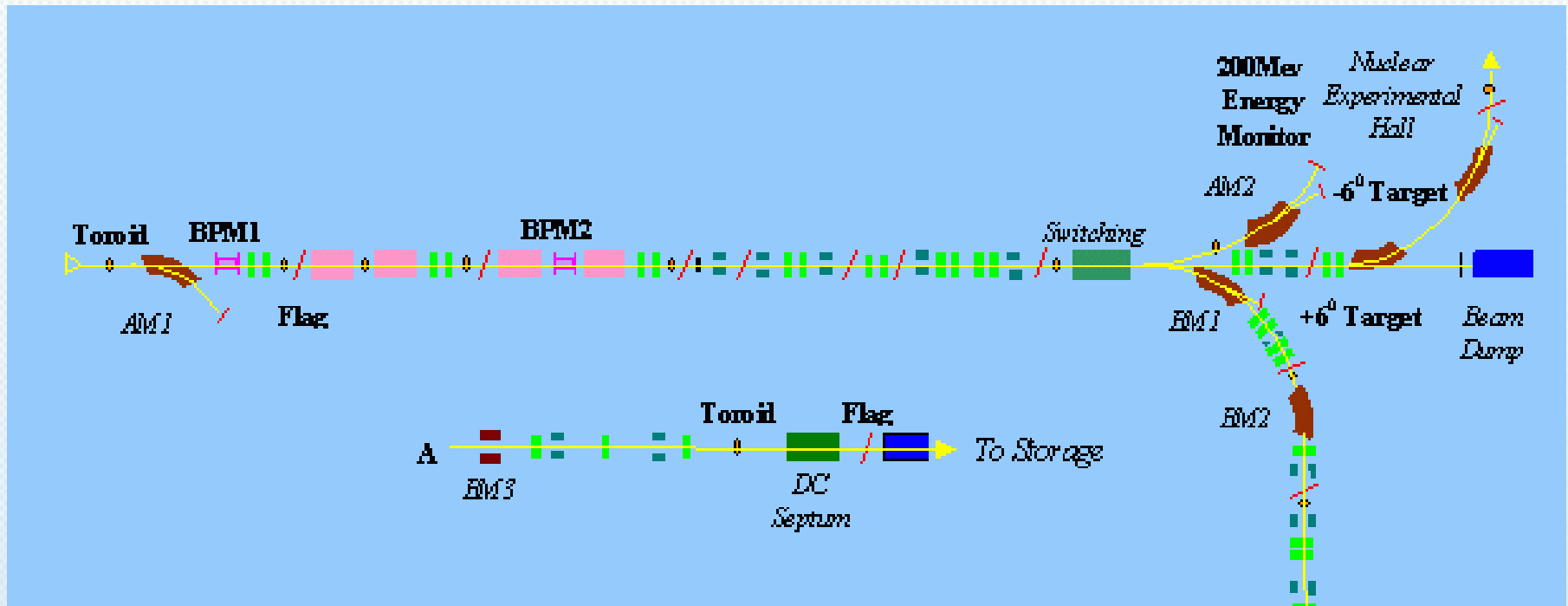


HLS II

Parameters of the Injector before and after be upgraded

Parameter	After be upgraded	Now
Electron Energy	800 MeV	200 MeV
Macro-pulse Length	1ns	1 μ s
Micro-pulse Length	~10ps	~10ps
Charge	1nC	50mA
Energy Spread(rms)	<0.5%	<0.8%
Energy Stability(rms)	<0.5%	<1.0%
Normalization Emittance in Horizontal(rms)	<60mm•mrad	<200mm•mrad
Normalization Emittance in Vertical(rms)	<60mm•mrad	<200mm•mrad
Pulse Repeat Frequency	1Hz	1~50Hz
Accelerator Structure Working Frequency	2856MHz	2856MHz
Positional Deviation at injection points (rms)	<0.2mm	
Angle Deviation at injection points (rms)	<0.2mrad	

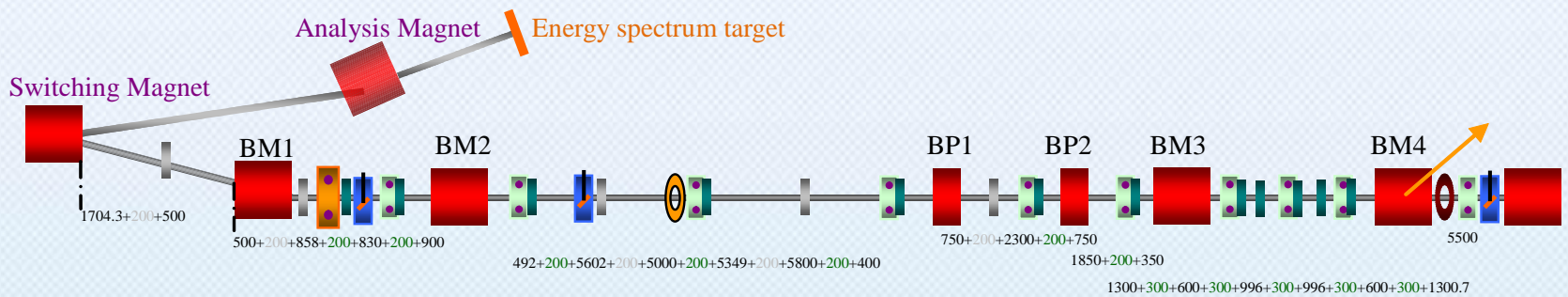
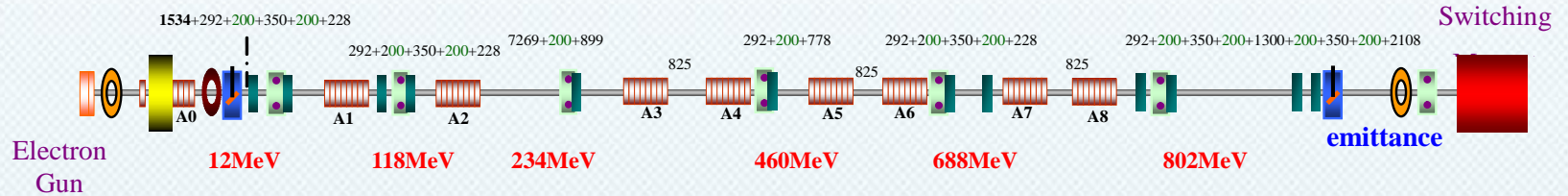
Beam measurement system of HLS linac and transfer lines



**Stripline
BPM**



Beam measurement system of HLSII Injector



Beam Measurement System of HLSII Injector

Beam Parameter	Measurement Method	Number	Main Indicator		
			Parameter	Value	
Beam Position	Stripline BPM +Libera	16~18	Beam Position Resolution		50 μm
			Dynamic Range		>40db
			Linear Range		> 5mm
Beam Section	YAG crystal/OTR +Motor Driver	5	Space Resolution		50 μm
			Position Repeat Accuracy		50 μm
Beam Emittance	Quadrupole Magnet Scan+ Beam Spot Monitor/BPM	2	Normalization Emittance (rms)	Range	20~50 mm·mrad
				Accuracy	10%
Beam Current	FCT	3	Rise Time		<350ps
			Accuracy		1 %
	ICT	2	Measurement Range		10~1000pC
			Accuracy		1%
Beam Energy and Energy Spread	Energy Spectrum Analysis System	1	Energy		800MeV
			Energy Spread Range		0.1%~1%
			Energy Spread Resolution		5×10^{-4}
	Eight-stripline Energy Spread Monitor	1	Energy Spread Range		0.1%~1%
			Energy Spread Resolution		1×10^{-3}



Used BPM signal
acquisition system



21 Libera
Brilliance
Single Pass



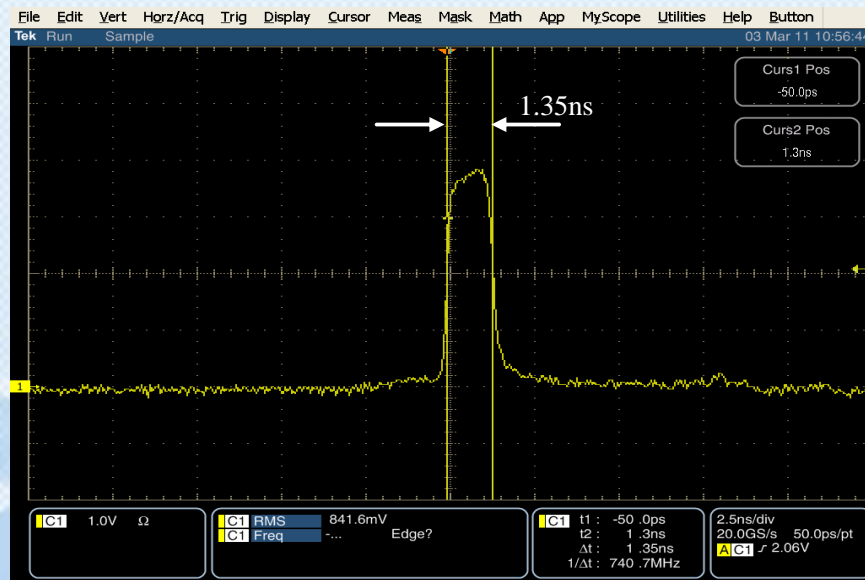
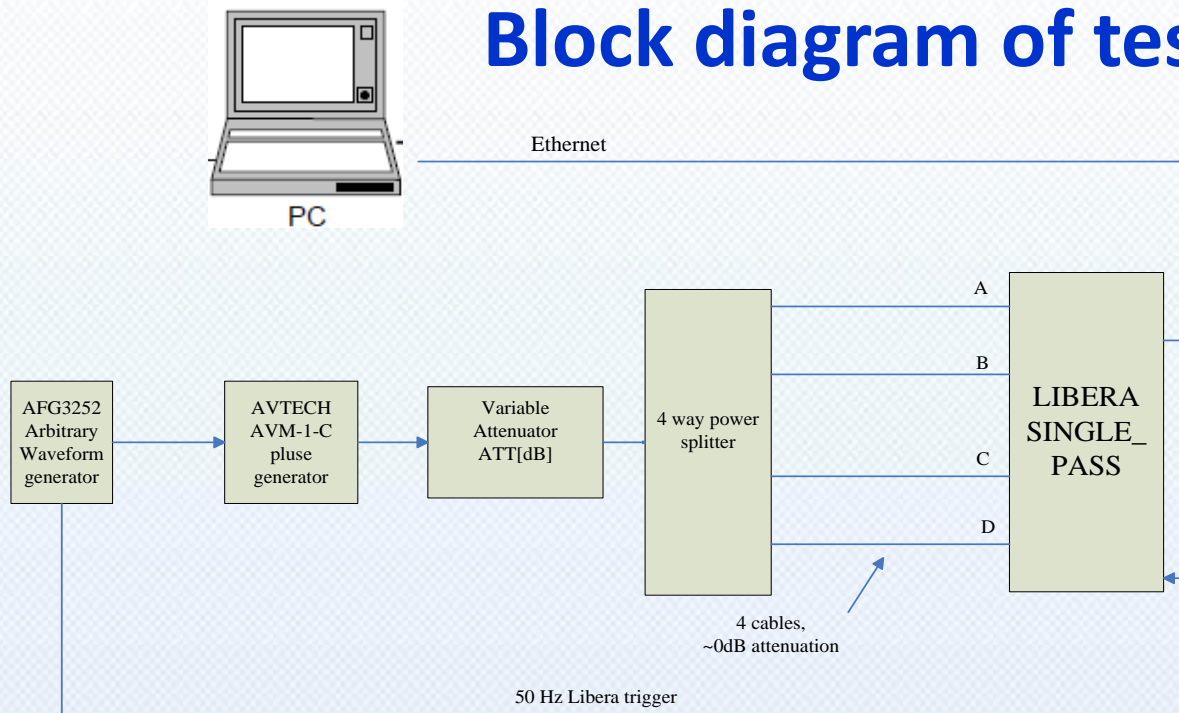
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Off-line test of Libera Brilliance Single Pass



Block diagram of test system



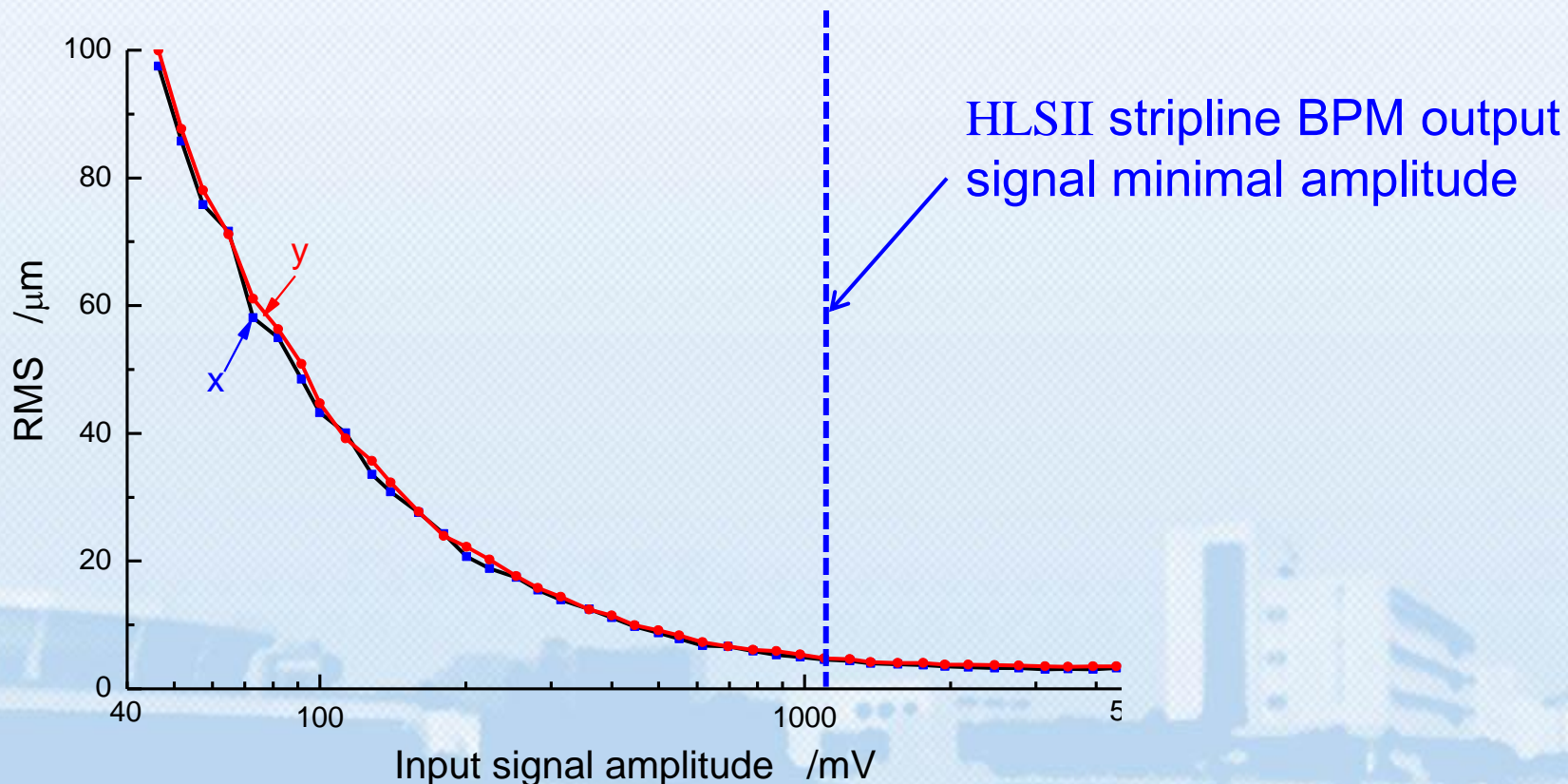
Simulated signal seen on an oscilloscope

Off-line test results

X, Y position calculation formulas of stripline BPM

$$\begin{cases} X = K_x \frac{V_A - V_C}{V_A + V_C} - X_{offset} \\ Y = K_y \frac{V_B - V_D}{V_B + V_D} - Y_{offset} \end{cases}$$

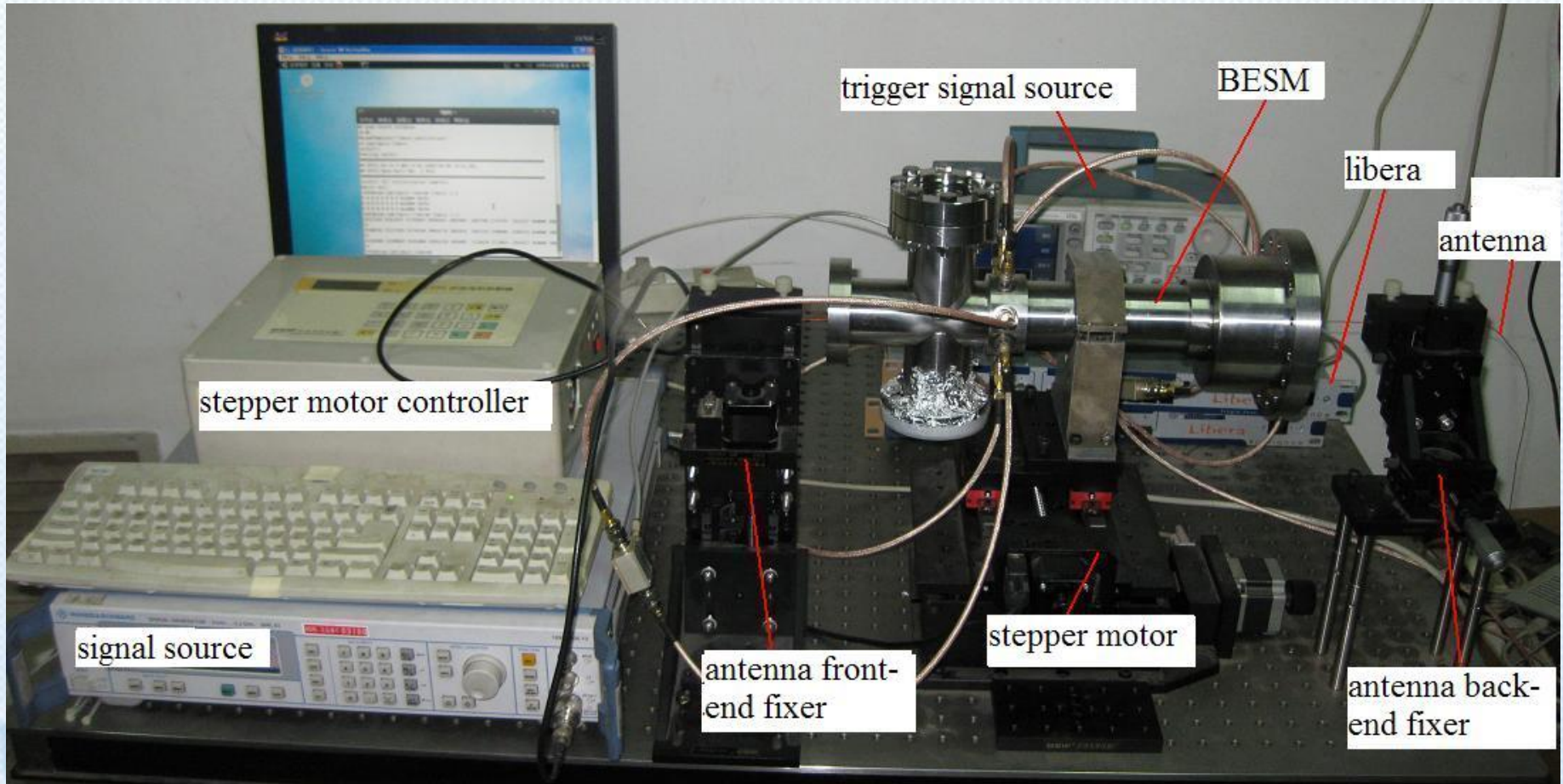
X, Y position RMS resolution results



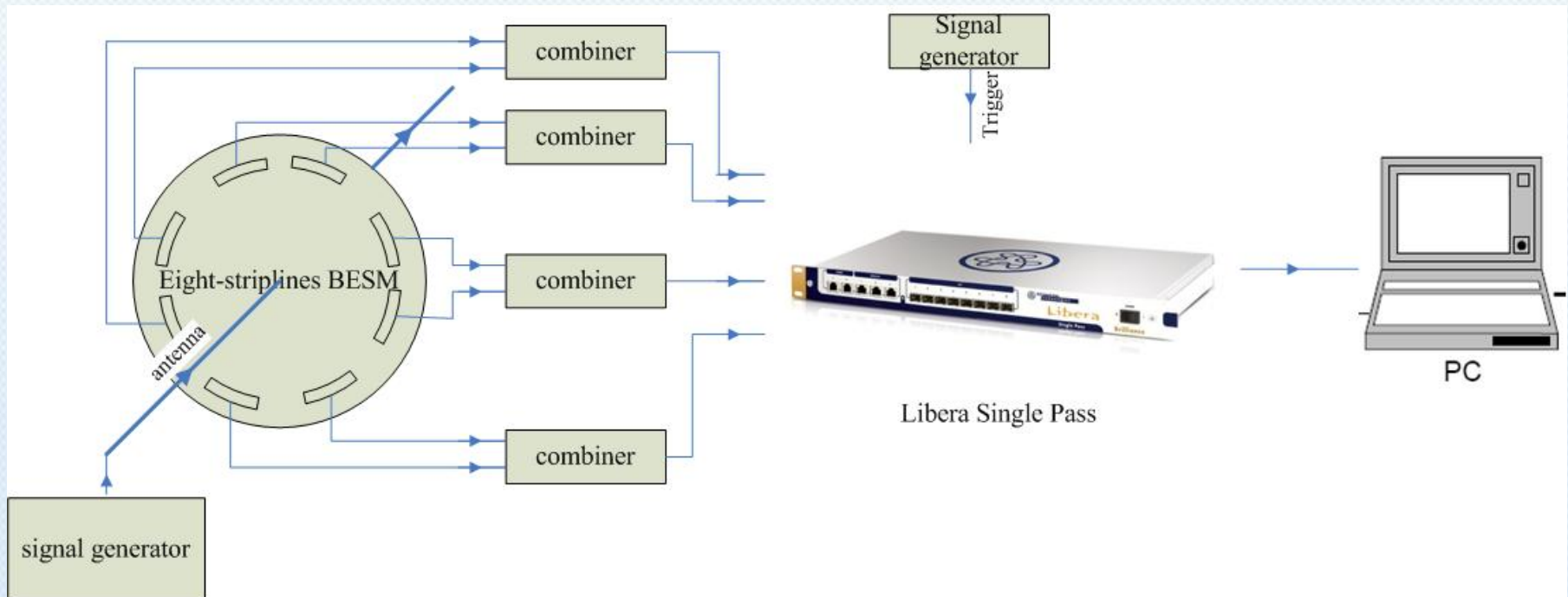
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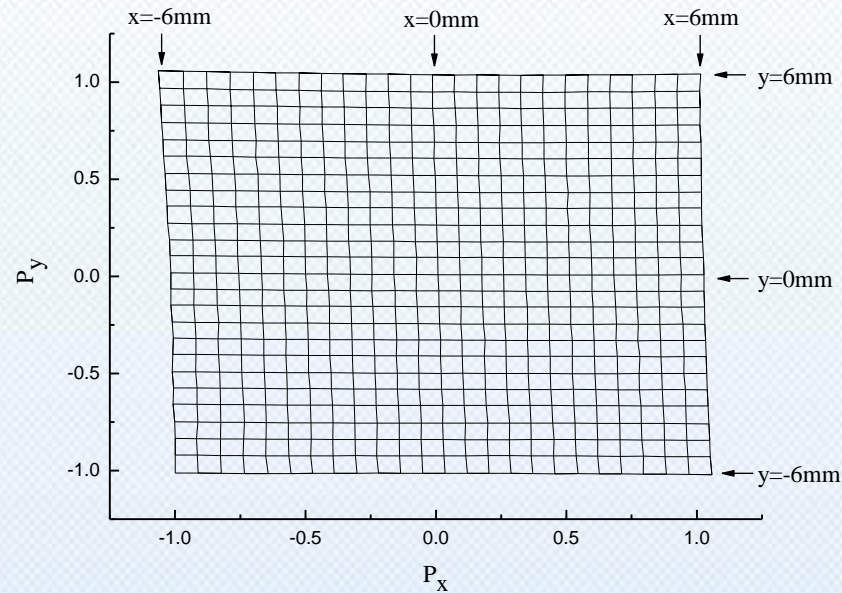
Calibration System of Eight-striplines BESM with Libera Single Pass



Block diagram of Calibration



Calibration Results



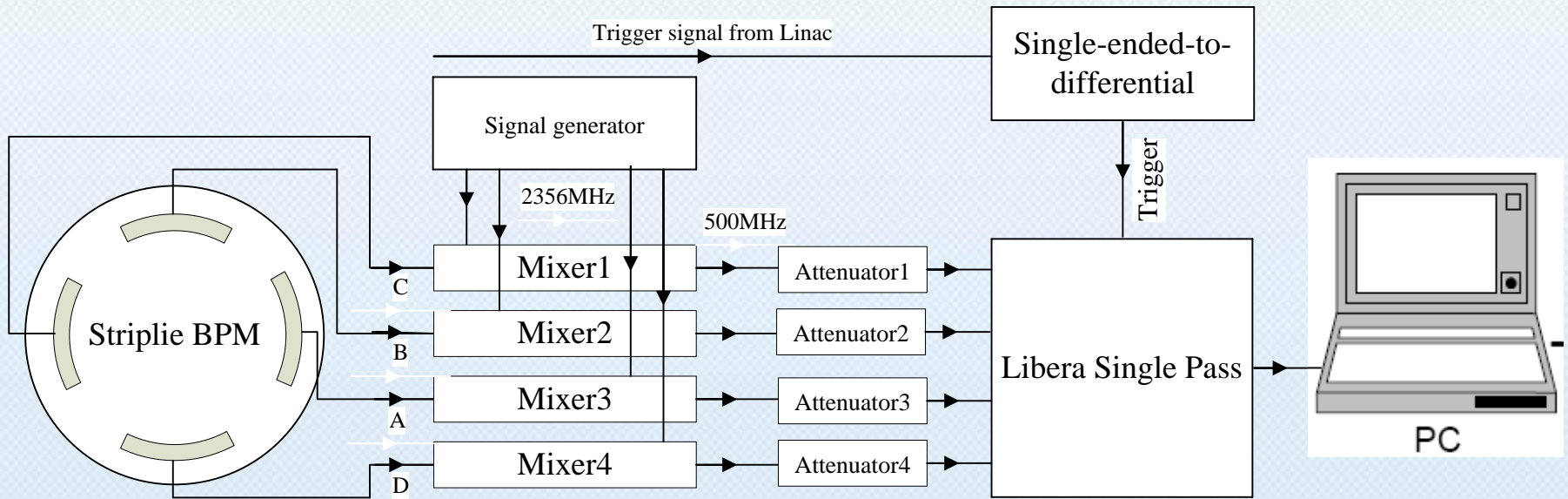
Fitting formulas of real position and calculated position by libera single pass:

$$\begin{cases} x \approx -0.062 + 5.773P_x + 0.151P_y - 0.032P_xP_y + 0.035P_x^2 + 0.018P_y^2 \\ y \approx -0.064 + 0.032P_x + 5.857P_y - 0.0064P_xP_y - 0.025P_x^2 - 0.014P_y^2 \\ P_x = \frac{V_A - V_C}{V_A + V_C}, P_y = \frac{V_B - V_D}{V_B + V_D} \end{cases}$$

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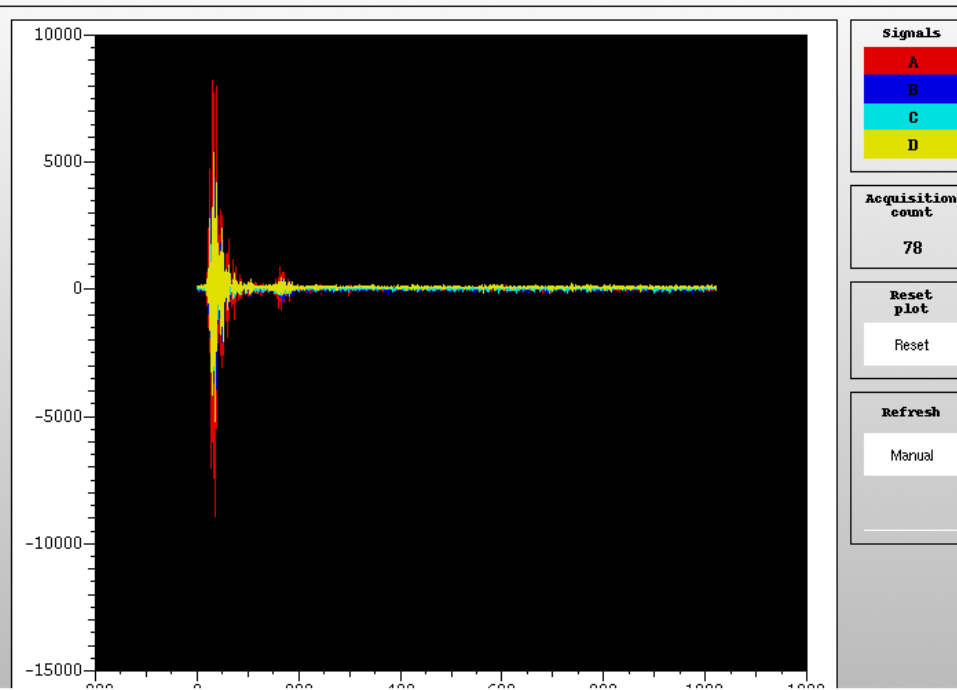
Block diagram of measurement



ADC raw acquisition from Libera Single Pass when eletrode output signal be mixed or no

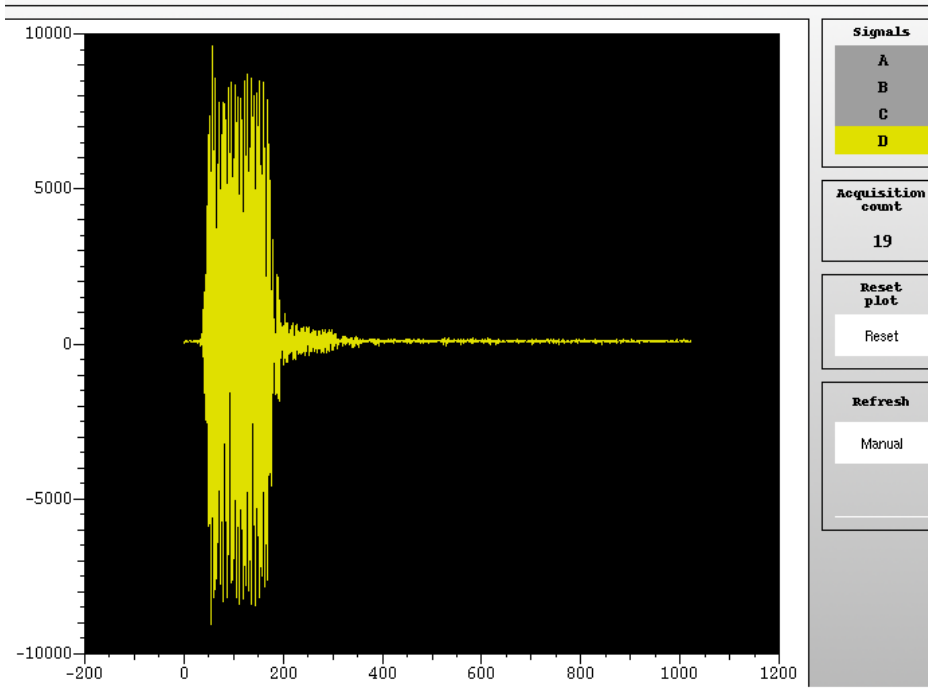
No mix

ADC Raw Acquisition

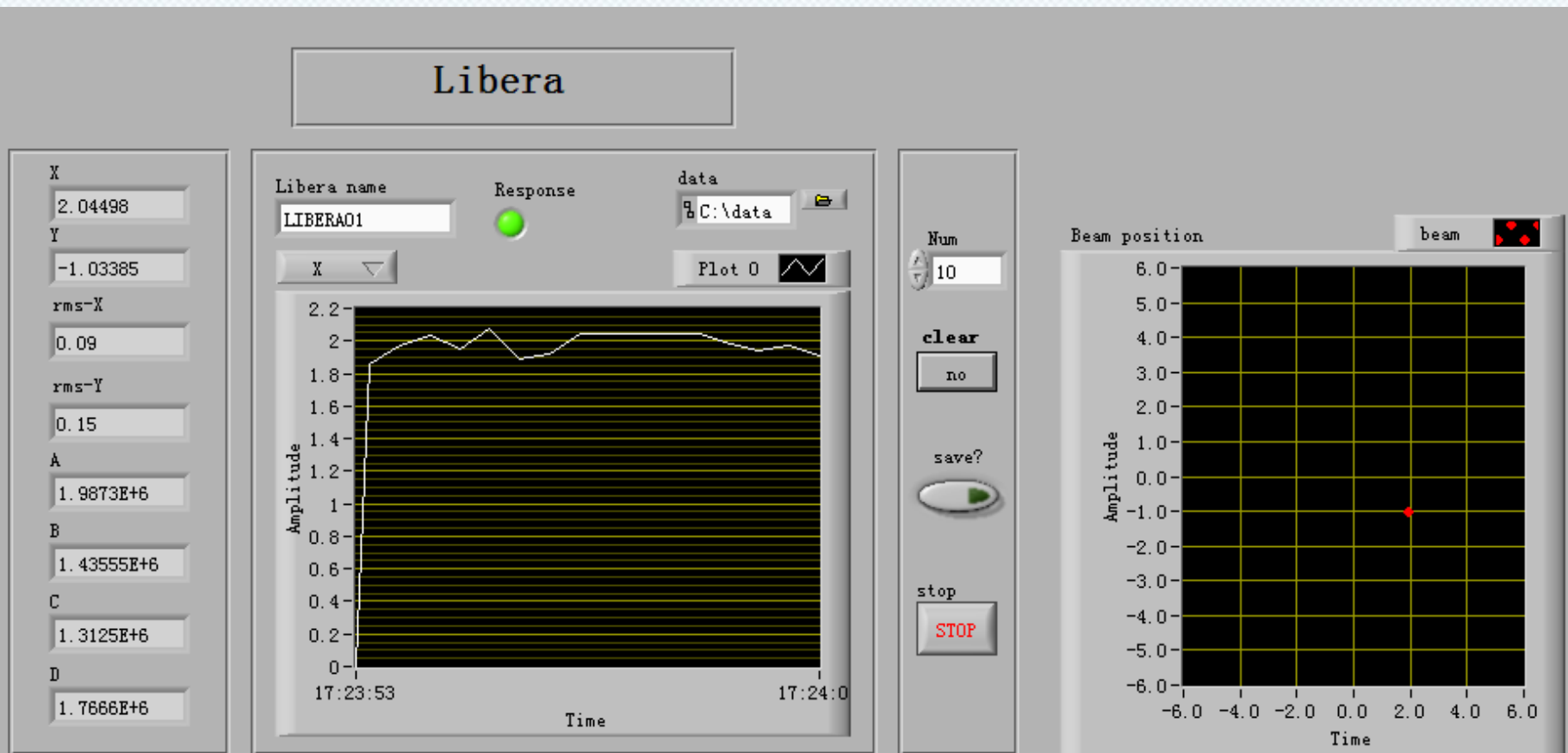


Be mixed

ADC Raw Acquisition

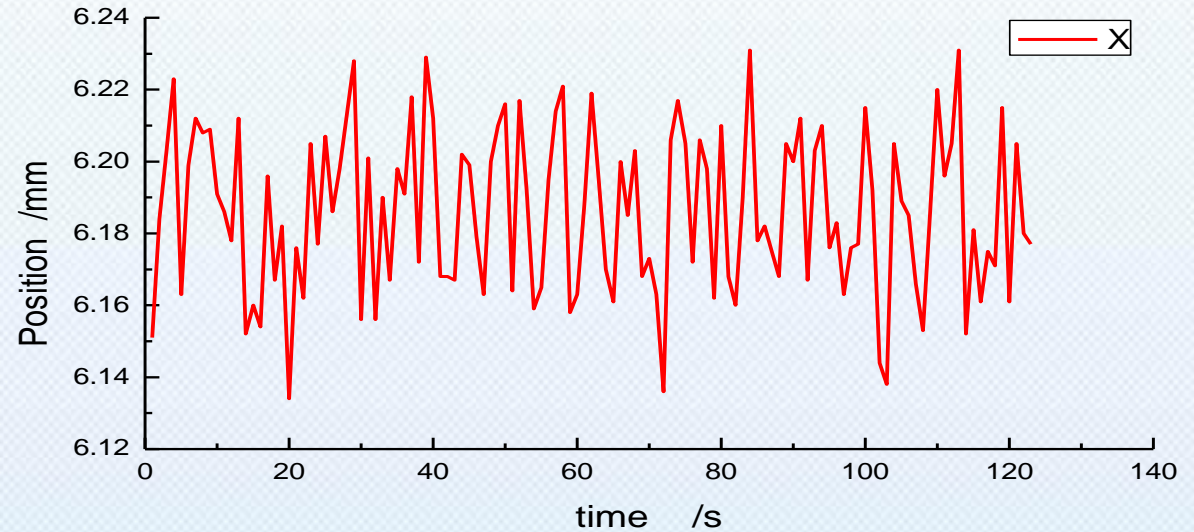


Interface of measurement system based on Labview

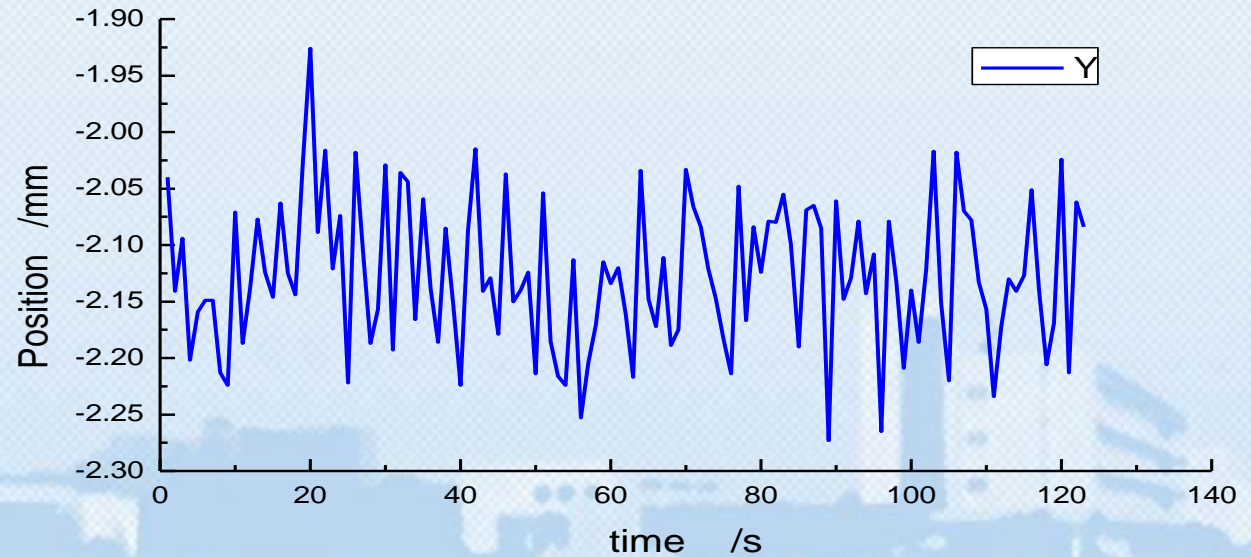


Beam position measurement results

Horizontal
position
resolution
 $20\mu\text{m}$



Vertical
position
resolution
 $50\mu\text{m}$



Thank you!