MOP34

Injector Linac Upgrade for the BEPCII Project

(Beijing Electron Positrn Collider, BEPC)

Shu-Hong Wang

for the BEPCII-Linac Group

Institute of High Energy Physics (IHEP), Beijing , China

1. Upgrade Goal

	BEPC	BEPCII
Collider Luminosity	1×10^{31} $cm^{-2}s^{-1}$	1×10^{33} $cm^{-2}s^{-1}$
Injection Energy	1.30 GeV	1.89 GeV
Beam Current (e+)	4.0 mA	40 mA
Energy Spread (e+)	$\pm$0.8 %	$\pm$0.5 %
Emittance (e+)	1.70 mm-mrad	1.60 mm-mrad
(e-)	0.58 mm-mrad	0.20 mm-mrad
Pulse Repe. Rate	12.5 Hz	50 Hz
Injection Rate (e+)	3 mA/min	50 mA/min

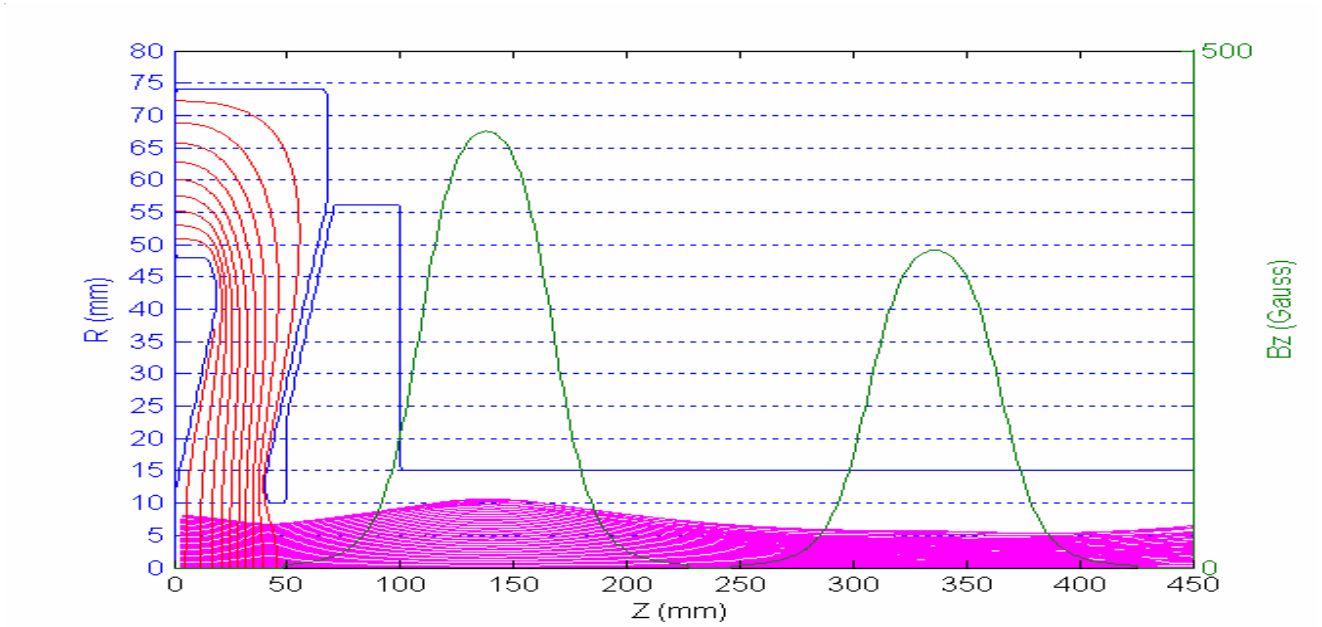
2. Measures to Reach the Goal

1) New e- Gun	High e- intensity; Complete tuning devices
2) New e+ Source	High e+ yield; Large capture acceptance
3) New RF System	High RF power output; Stable phasing loops
4) New Beam Tuning Devices	Orbit correction; Optics tuning
5) Other System Upgrade	Vacuum, Instrumentation, RF Transmission, Control.

3. New Electron Gun

1) A thermionic triode gun, cathode- grid Y796, emission density 10 A/cm^2: 10 A, 1 ns, 50 Hz.

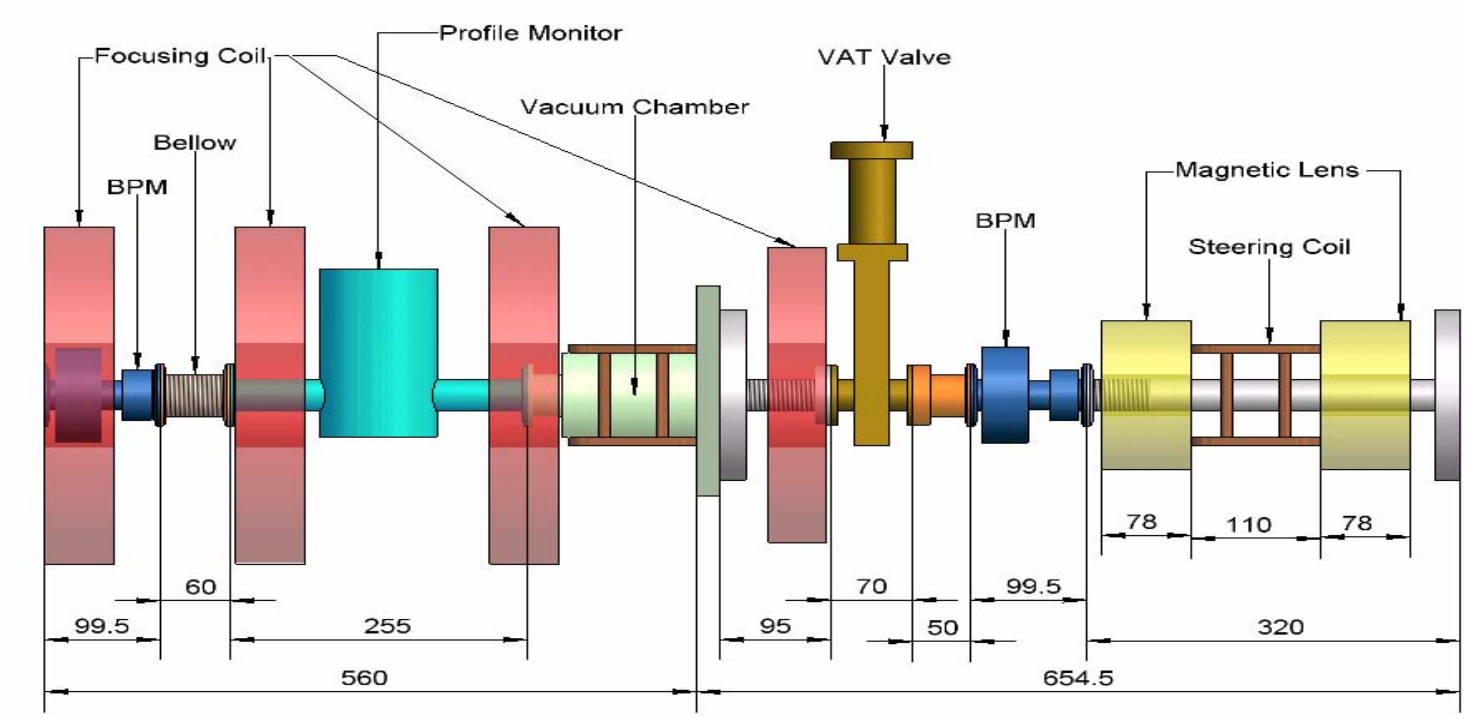
2) Optimize the beam optics and emittance



3. New Electron Gun (Cont.)

3) A complete beam tuning devices:

Focusing lens; BPMs; Correctors; BCMs ; Profile.



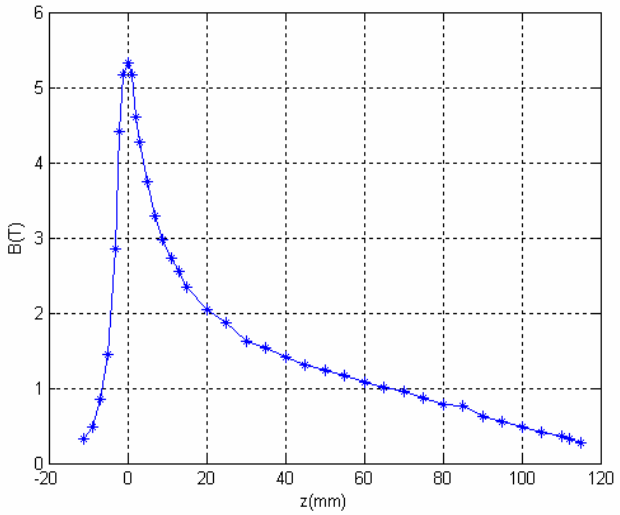
4. New Positron Source

1) A Flux Concentrator is employed:

L = 10 cm , B = 5.3 T ↘0.50 T, Φ = 7 mm →52 mm.

12 turns by wire cutting with gap thickness 0.2 mm.
Powered by 12 kA, 5 μ s, 50 Hz.

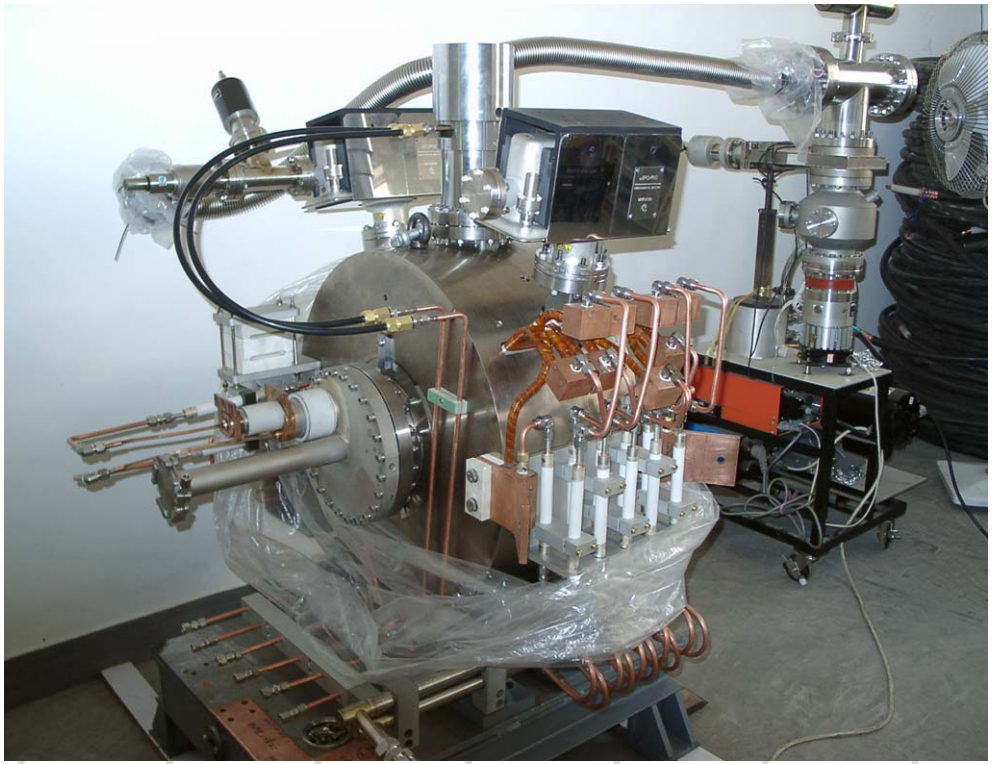
Flux



Measured B-field

4. New Positron Source (Cont.)

2) New e+ target chamber in testing

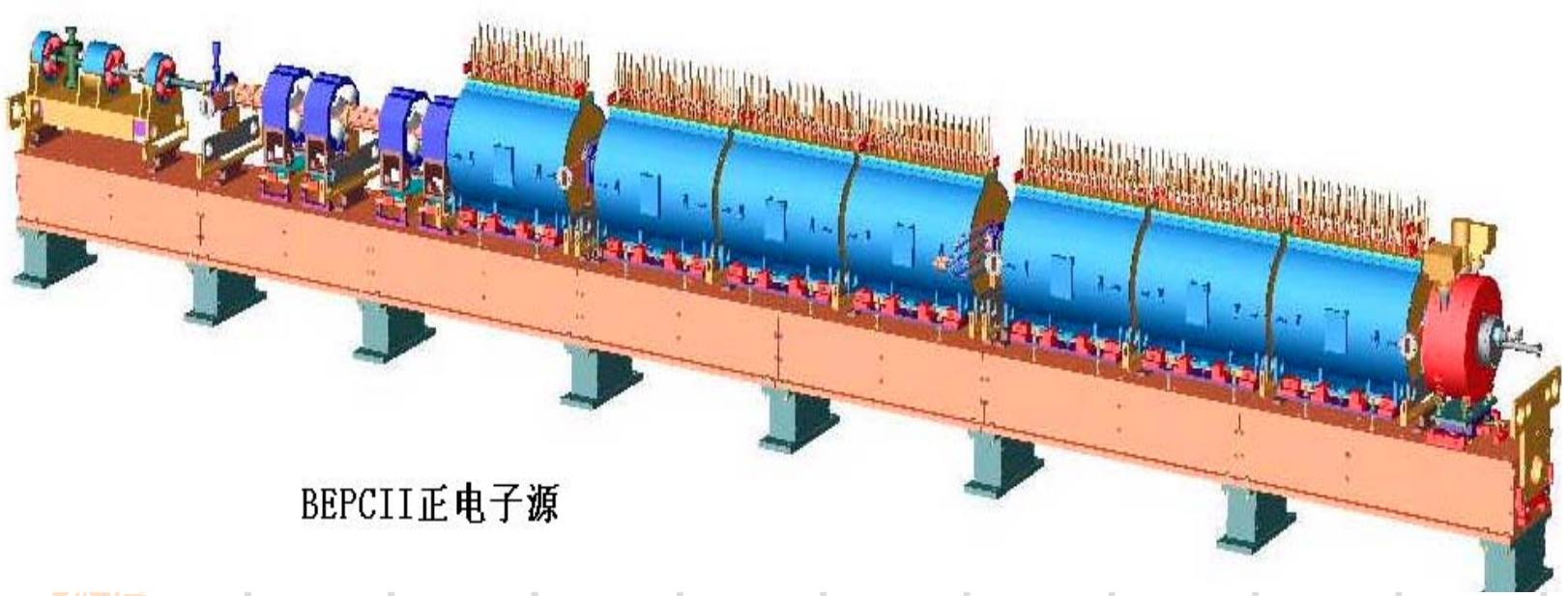


- Vacuum: 7.5 $\times 10^{-9}$ Torr;
- Target moving-positioning 7000 times safely

4. New Positron Source (Cont.)

3) New DC solenoid: 7.5 m long, 0.5 Tesla.

e+ decelerated in the 1st –m, then bunched and accelerated. At solenoid exit: e+/e-=1.95%.



5. New RF Power Sourse

1) Higher power Klystrons (50 MW - 65 MW) to replace the old ones (30 MW) for energy upgrade to 1.89 GeV

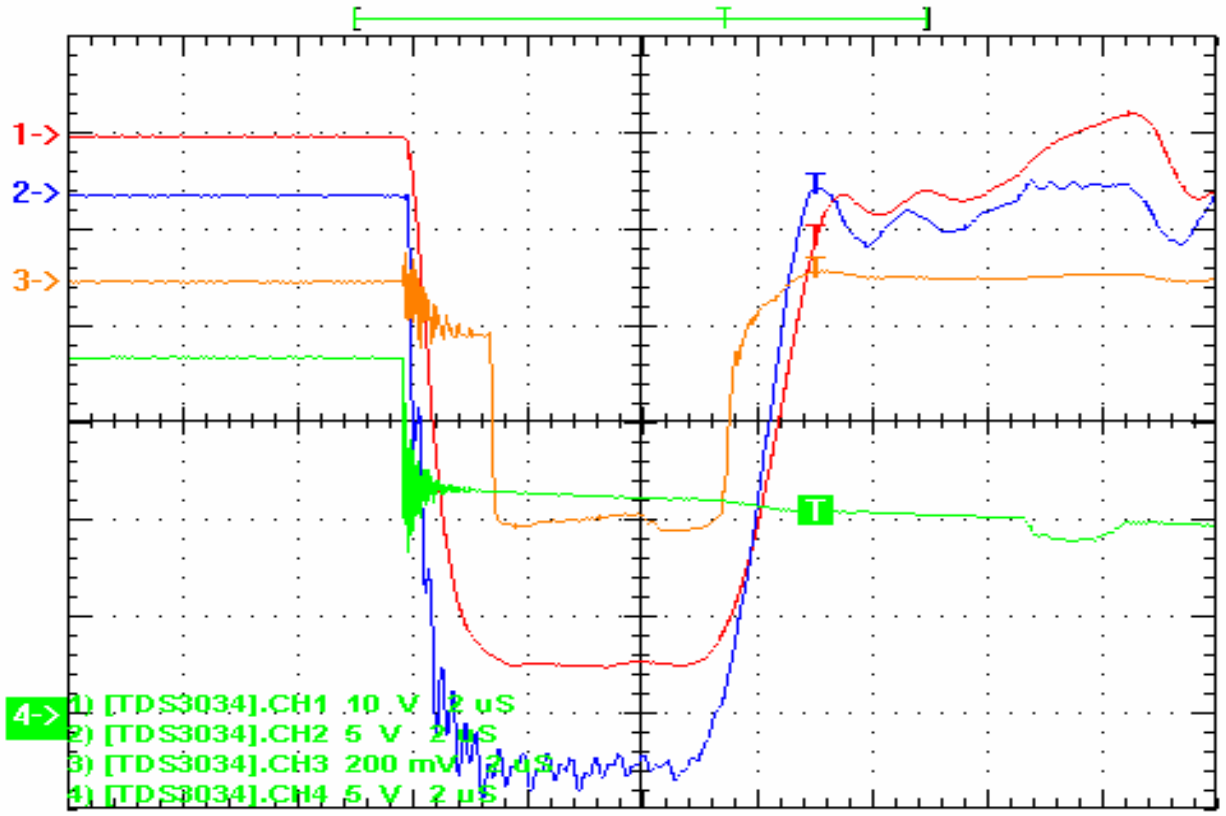
E3730A（50MW）

TH2128C (45MW)

SLAC 5045 (65 MW)

5. New RF Power Sourse (Cont.)

2) New modulators with high power 320 kV × 360 A.



5. New RF Power Sourse (Cont.)

3) Phase control system with following measures:

(1) Use of the maximum energy method to define the optimum phase;

(2) A PAD system of I/Q demodulator type is used to monitor the phase with accuracy of 0.2° and amplitude.

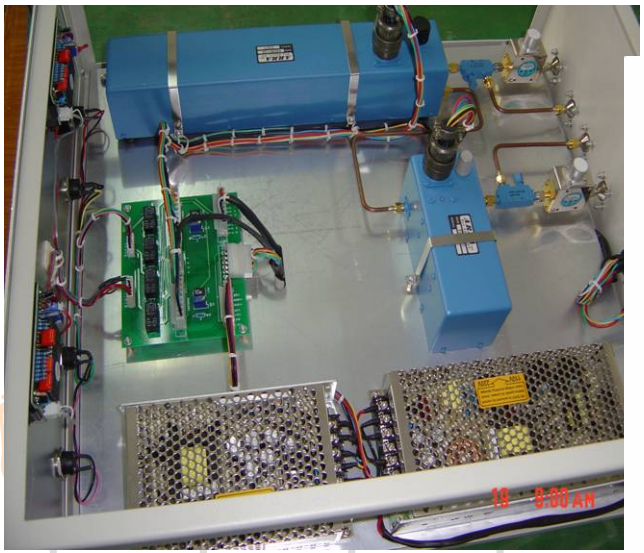
(3) The new IϕA units have been developed with its minimum insertion loss of 2 dB, maximum decay of 20 dB and phasing range of > 360°.

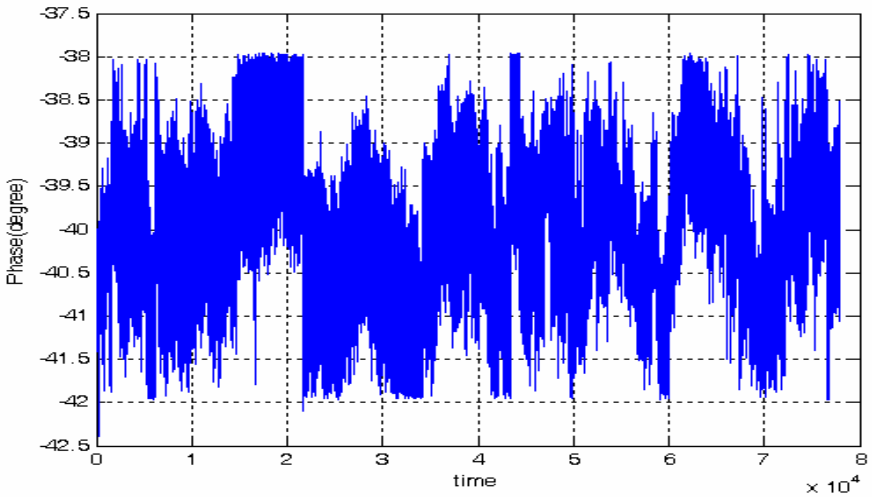
(4) A reference line of the phase stabilized co-axial type is employed for its easy maintenance and cheaper than the optical type.

(5) A prototype of phasing loop was made for the 1st RF unit, and a very good experimental result has been obtained within ±2°.

5. New RF Power Sourse (Cont.)

3) Phase control system (Cont.)





A new IΦA unit

Mini. insertion loss 2 dB,

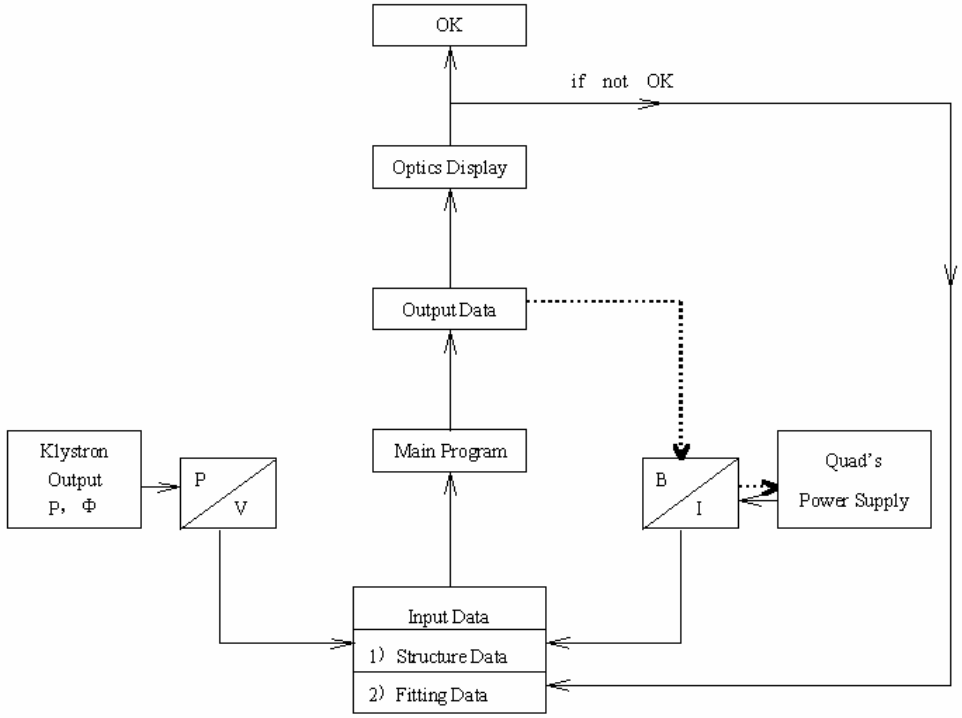
Maxi. decay of 20 dB.

phasing range of > 360°.

Test results: $\Delta\phi \leqslant \pm 2^{\circ}$

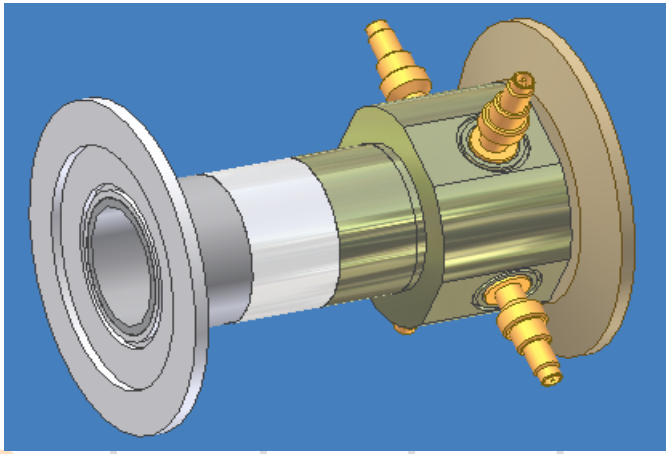
6. Optics and Orbit Correction

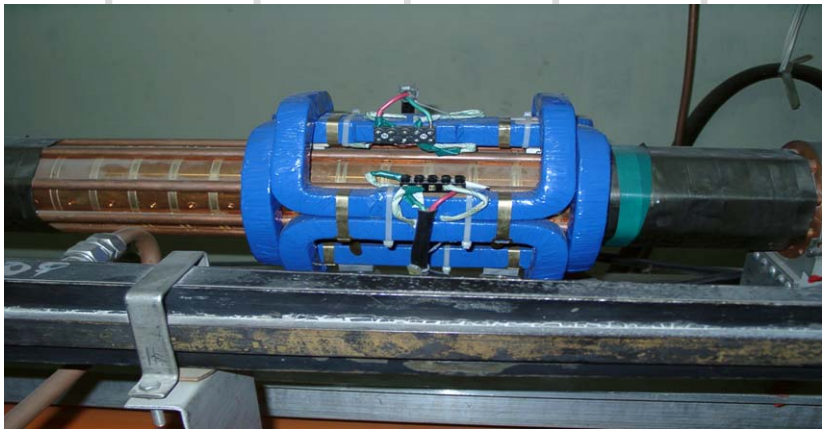
1) Optics correction



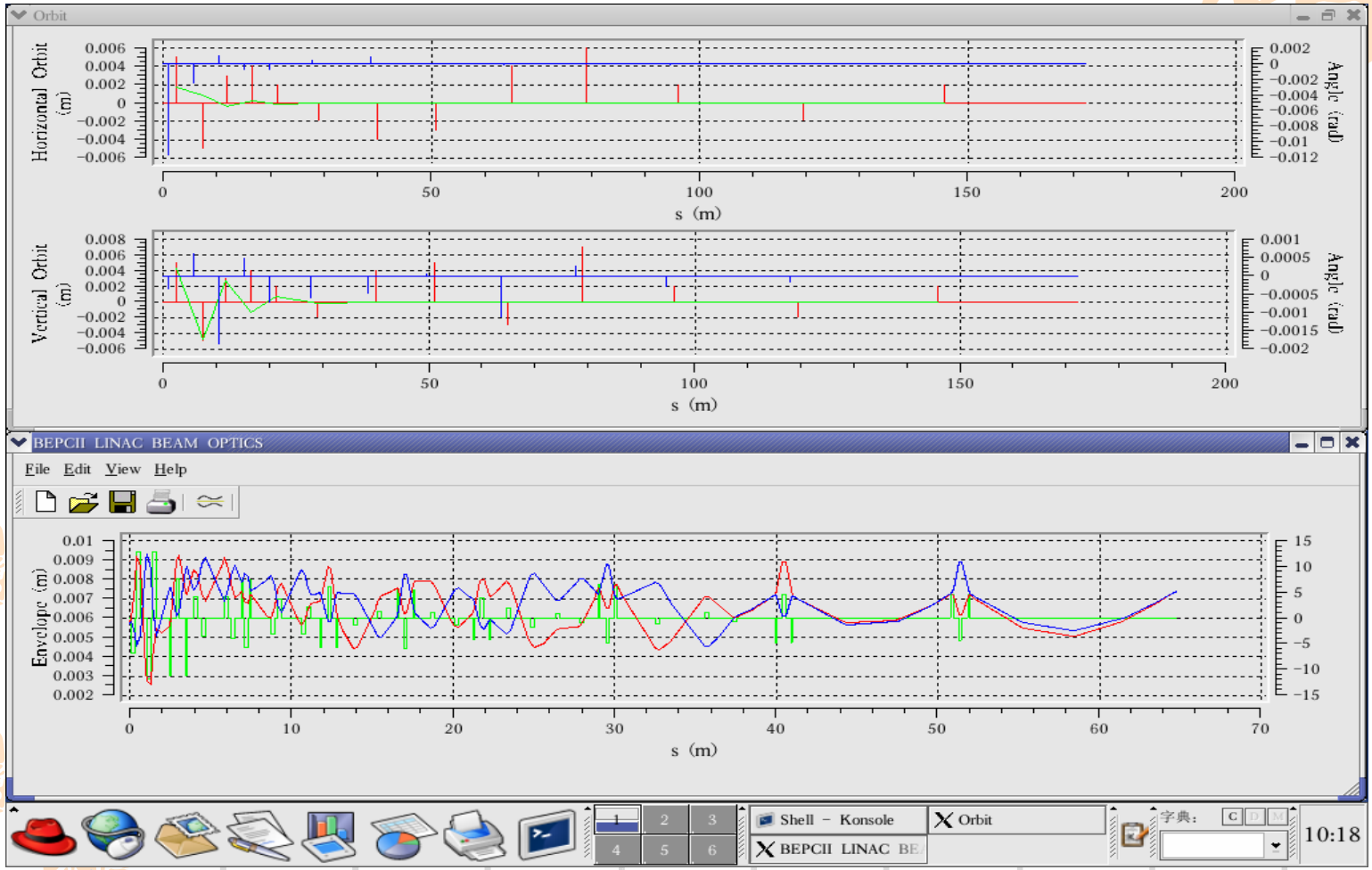
6. Optics and Orbit Correction (Cont.)

2) Orbit correction with Strip-line BPMs and Correctors





6. Optics and Orbit Correction (Cont.)



7. Beam Modeling

1) Positron beam modeling

With TRASPORT、EGS4、PARMELA and LIAR – codes, with optimum beam optics and orbit correction system, and with

the initial beam offset ≤±0.3 mm,
Structure, Quads, BPMs offset ≤±0.2 mm,
Phasing error ≤±2^0,
Modulator's instability ≤±0.1%,

Positron beam's modeling results

Location	Energy (MeV)	Current (mA)	Emittance (mm-mrad)	ΔE/E (%)	Δφ (o)	e+ yield (e^+/e^-.GeV)
e+ Target exit	1 -14	80	3080	---	---	5.58%
DC Solen. exit	89.45	53	29.2	±8.0	±16	3.67%
Linac exit	1890	42	1.42	±0.5	±5.0	2.92%
Design goal	1890	37	1.60	±0.5	±5.0	2.57%

7. Beam Modeling (Cont.)

2) e- beam modeling

With EGUN , TRASPORT, PARMELA and LIAR – codes, with optimum beam optics and orbit correction system, and with

the initial beam offset ≤±0.3 mm,
Structure, Quads, BPMs offset ≤±0.2 mm,
Phasing error ≤±2^0,
Modulator's instability ≤±0.1%,

Electron beam for injection into ring

Location	Energy (MeV)	Current (mA)	Emittance (mm-mrad)	ΔE/E (%)	Δφ (o)
Gun exit	0.150	1.5	42.5	---	±180
Linac exit	1890	0.6	0.18	±0.5	±5

Primary e- beam for the e+ production

Location	Energy (MeV)	Current (mA)	Emittance (mm-mrad)	Spot size (mm)
Gun exit	0.150	10.0	17.1	6.0
@ target	250	6.0	0.75	1.0 – 1.5

8.Summary

- **A new e- gun, a new e+ source, an upgraded RF power system with phasing loops, and many other modified components for upgrading the BEPCII injector linac have been designed, fabricated, tested and being installed in their final positions.**

A new e- and e+ beam from this linac is expected soon.

- **By controlling the phasing error within ±2°, machine alignment error within ±0.2 mm, and modulator's voltage error within ±0.1%, the linac beam qualities are expected to meet the design goal with the aid of orbit correction system.**

Thank You !