Beam-based alignment measurements at the ATF in 2008 April

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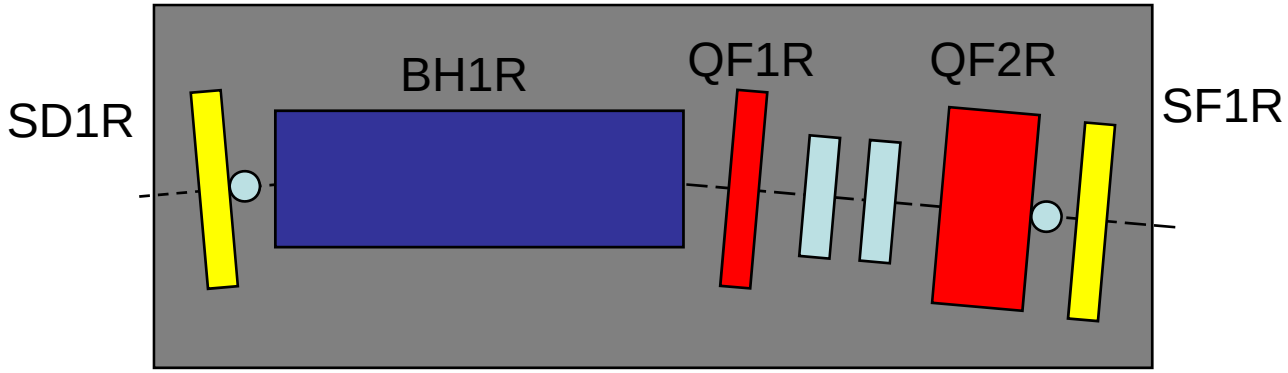
ATF Normal Cell

ATF normal cell consists of

- *1 combined function bending magnets*
- *2 quadrupole magnets*
- *2 sextupole magnets*
- *2 correctors*
- *2 BPMs*



1 BPM is located near to the quadrupole magnet (QF2R).

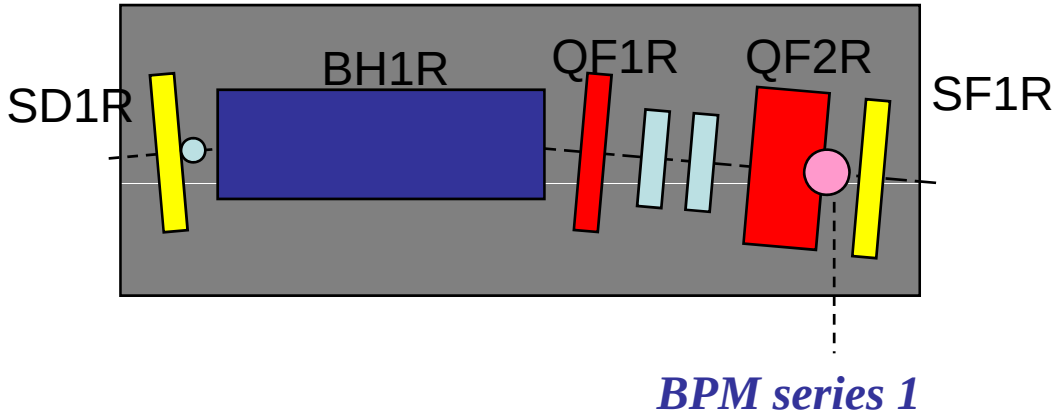
1 BPM is located near to the sextupole magnet (SD1R).

Vertical BPM offset measurement with respect to QF2R.

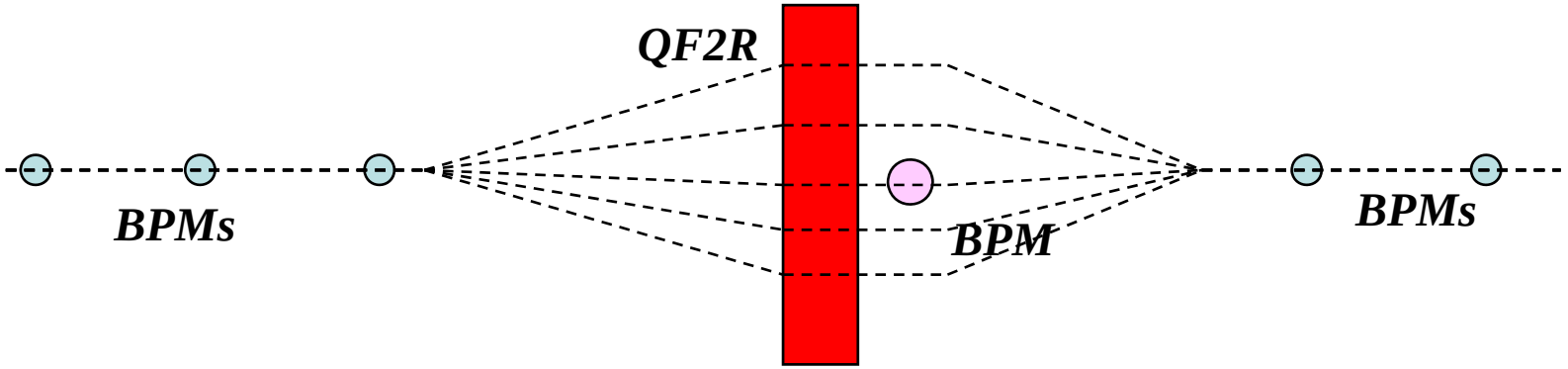
- Since the vertical beam offset at the sextupoles makes the betatron coupling, it is important to reduce the vertical orbit at the sextupole, and it is important to know the BPM center position with respect to magnets.

-Since the accuracy of the mechanical alignment of QF2R to SF1R was within 100μm, we tried to measure the BPM offset with respect to QF2R.

-The BBA measurement was done by SLAC collaborators in 2007 Dec.



Procedures



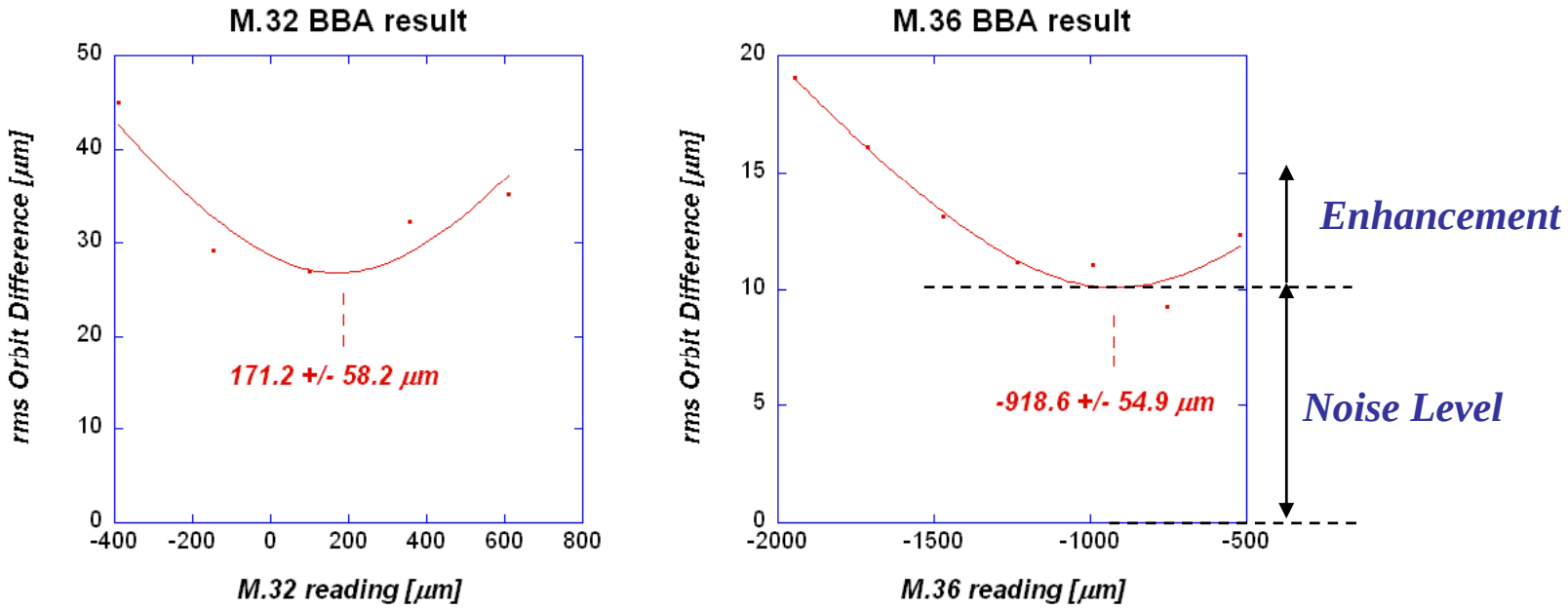
1. *Make a vertical local bump at the BPMs.*

2. *Change the QF2R strength by +/-0.4A (ΔK_1 = +/- 0.0036 /m).*
   - Almost limit to be the tune resonance.

3. *Measure the vertical orbit difference for all the BPMs.*

4. *Estimate the minimum orbit difference point by parabolic fitting.*

Example of BBA measurement



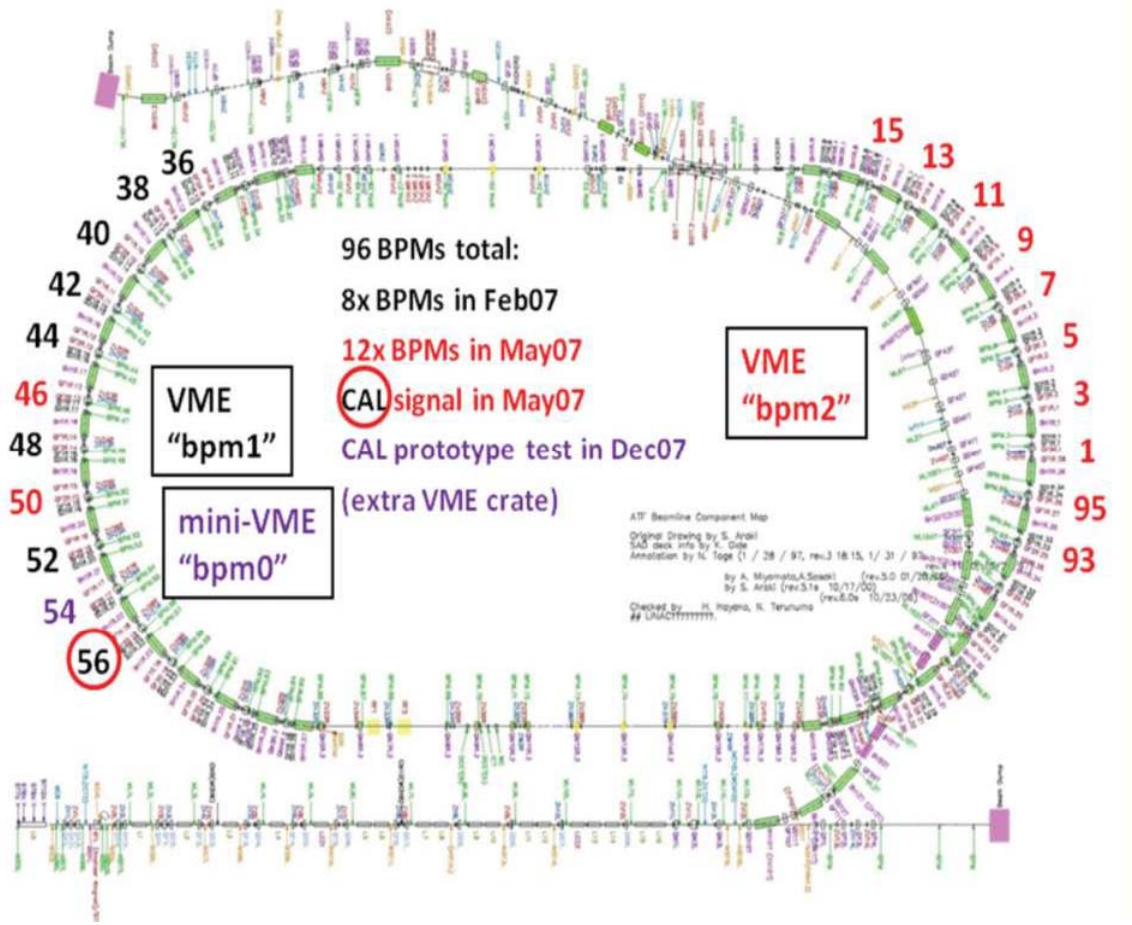
We can observed some resonance, but it was difficult to measure the clear dependence, because the orbit change was close to the BPM resolution (around a few 10mm).

ATF DR BPM system

ATF DR has 96 BPMs.

- 74 BPMs are normal type BPMs (single path clipping circuit).

- 22 BPMs are high resolution BPMs (Echotek BPM, developed by FNAL, SLAC).



BBA data analysis only with Echotek BPMs

Advantage

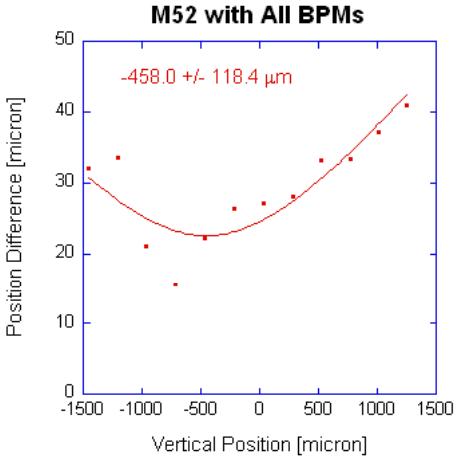
- The resolution of Echoteck BPM was good, around a few μm.

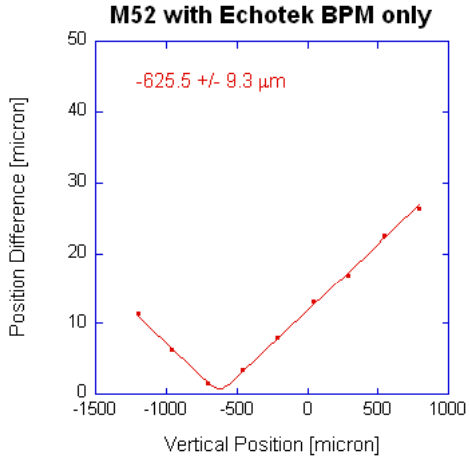
- Intensity dependence was small to the normal BPMs

Disadvantage

- The number of Echotek BPMs (22) are small to the all BPMs (96) .

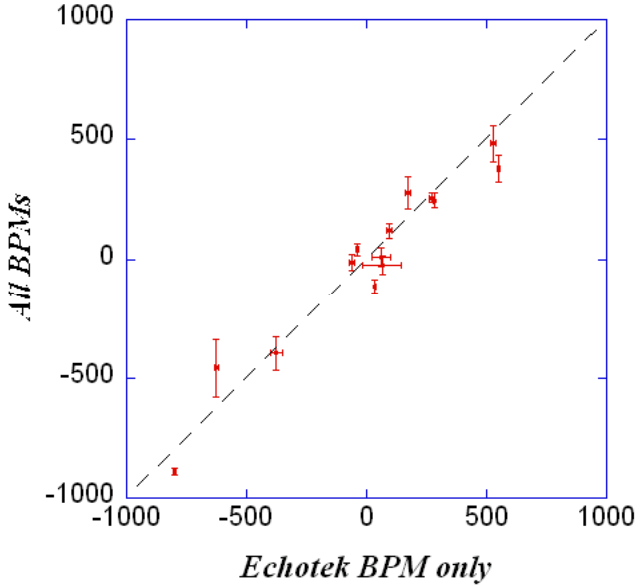
Data analysis only with Echotek BPMs.





Same data was analyzed
- with all BPMs
- only with Echotek BPMs

The noise level and the accuracy was improved only with Echotek BPMs.



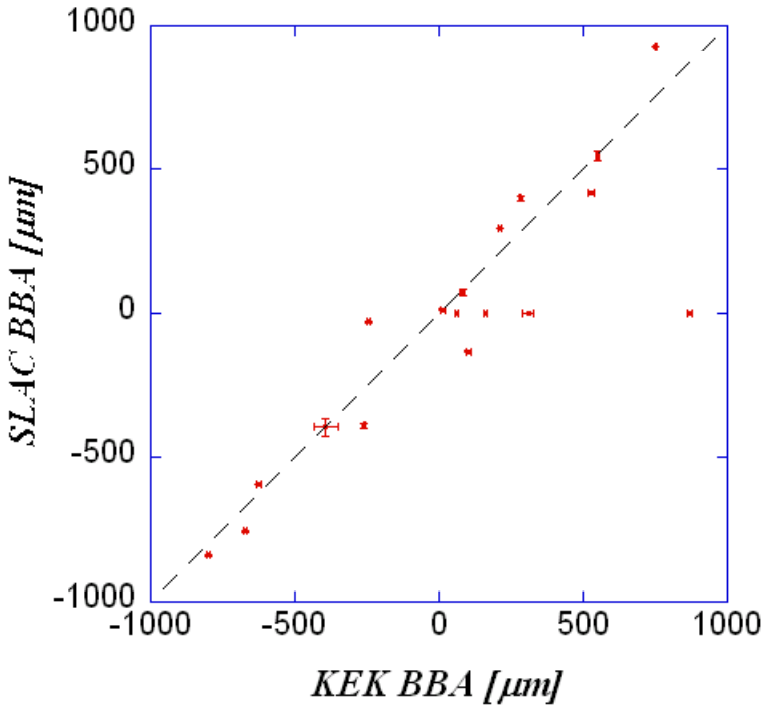
-We can measure the BBA both with all BPMs and only with Echotek BPMs.

-But, the resolution was improved only with small resolution BPMs.

-The performance of BPMs are very important for the BBA measurement.

Comparison with SLAC BBA measurement in 2007 Dec.

Magnet	BPM name	SLAC measurement		KEK measurement	
		mean	error	mean	error
QM20R1	M.32				
QM23R1	M.34			-77.34	15.72
QF2R8	M.36	-1205.40	3.90	-485.08	41.34
QF2R9	M.38	-391.30	6.00	-258.40	4.42
QF2R10	M.40	927.10	0.40	752.27	4.31
QF2R11	M.42	71.80	10.60	80.95	7.07
QF2R12	M.44	-841.10	1.60	-797.40	5.36
QF2R13	M.46	398.90	7.40	280.99	3.74
QF2R14	M.48	543.20	17.90	552.17	5.30
QF2R15	M.50	-212.60	0.20	2222.80	9.74
QF2R16	M.52	-594.40	1.40	-625.47	9.29
QF2R17	M.54				
QF2R18	M.56	417.10	0.20	529.04	9.61
QF2R19	M.58			36.21	4.50
QF2R20	M.60			273.11	9.72
QM1R2	M.62			-374.84	23.65
QM4R2	M.64			65.29	81.84
QM20R2	M.81				
QM23R2	M.83			171.29	11.99
QF2R21	M.85			95.78	11.07
QF2R22	M.87			-36.64	4.89
QF2R23	M.89			61.72	36.63
QF2R24	M.91			-60.36	10.69
QF2R25	M.93	miswired		161.66	5.28
QF2R26	M.95	miswired		310.69	18.91
QF2R1	M.1	miswired		63.53	5.98
QF2R2	M.3	miswired		868.35	7.29
QF2R3	M.5	13.80	0.60	12.80	7.43
QF2R4	M.7	-130.90	2.10	101.10	7.56
QF2R5	M.9	-29.40	1.00	-243.27	4.85
QF2R6	M.11	295.40	0.50	209.35	4.93
QF2R7	M.13	-756.50	2.00	-671.94	8.01
QM1R1	M.15	-396.80	32.50	-392.71	41.14
QM4R1	M.17				



The measured results well agreed with SLAC BBA measurement in 2007 Dec.

Vertical BPM offset measurement with respect to SD1R.

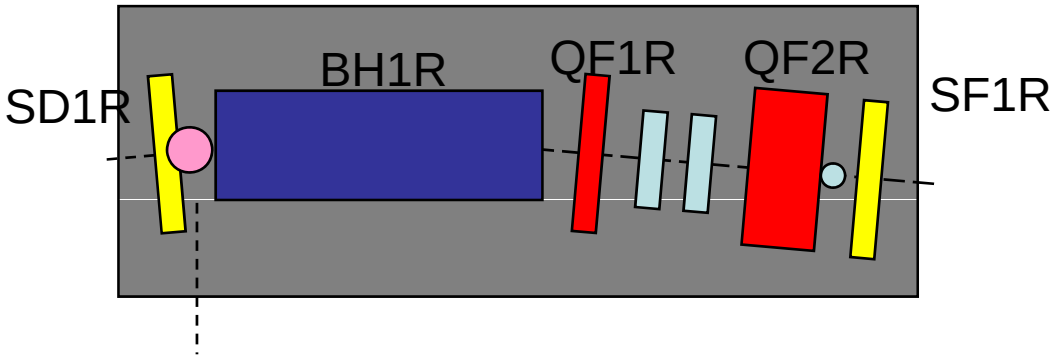
- There are no quadrupoles near by the series 2 BPM.

- The trim coil of sextupole magnets are wired to skew quadrupole like connection.

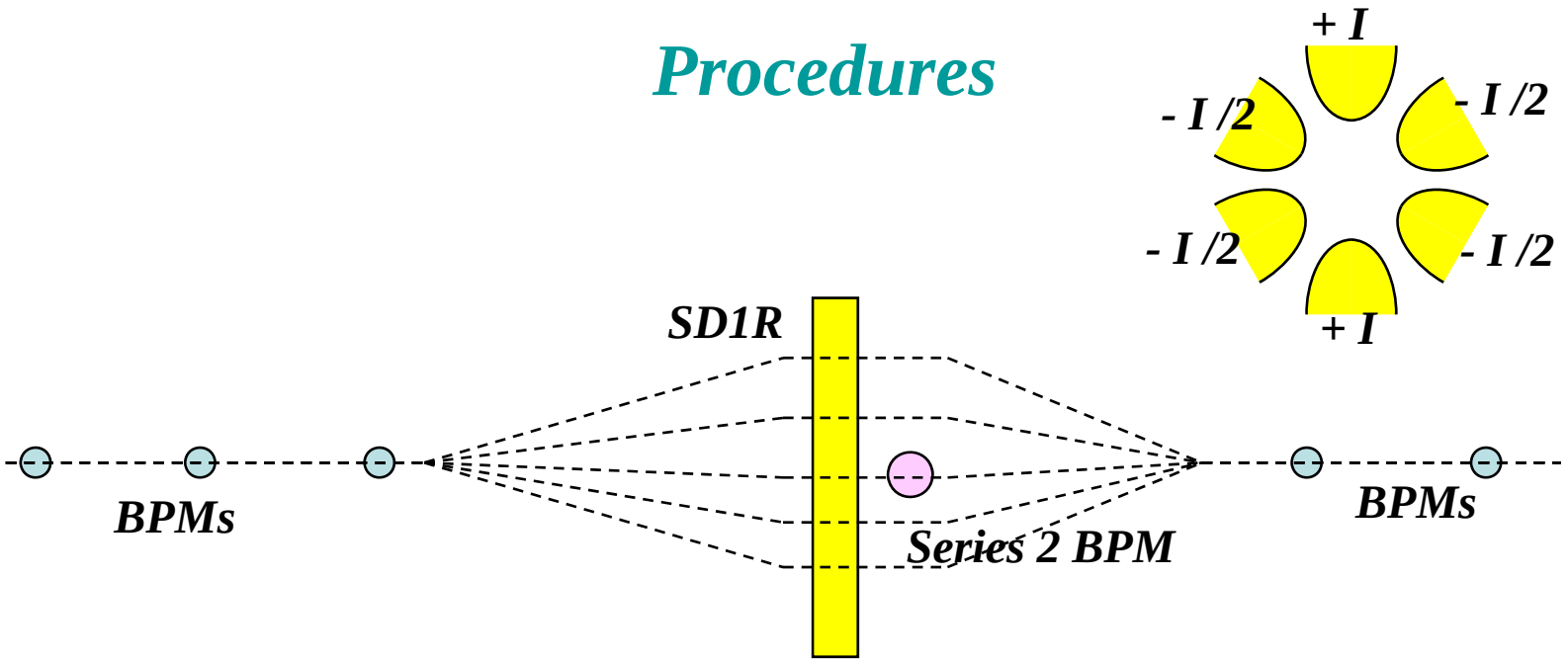
- We can measure the BPM offset with respect to SD1R directly.

-This measurement is the first trial in ATF.

-We measured the offset only for the half of east arc section,
because we have no time to measure the all BPMs.



Procedures



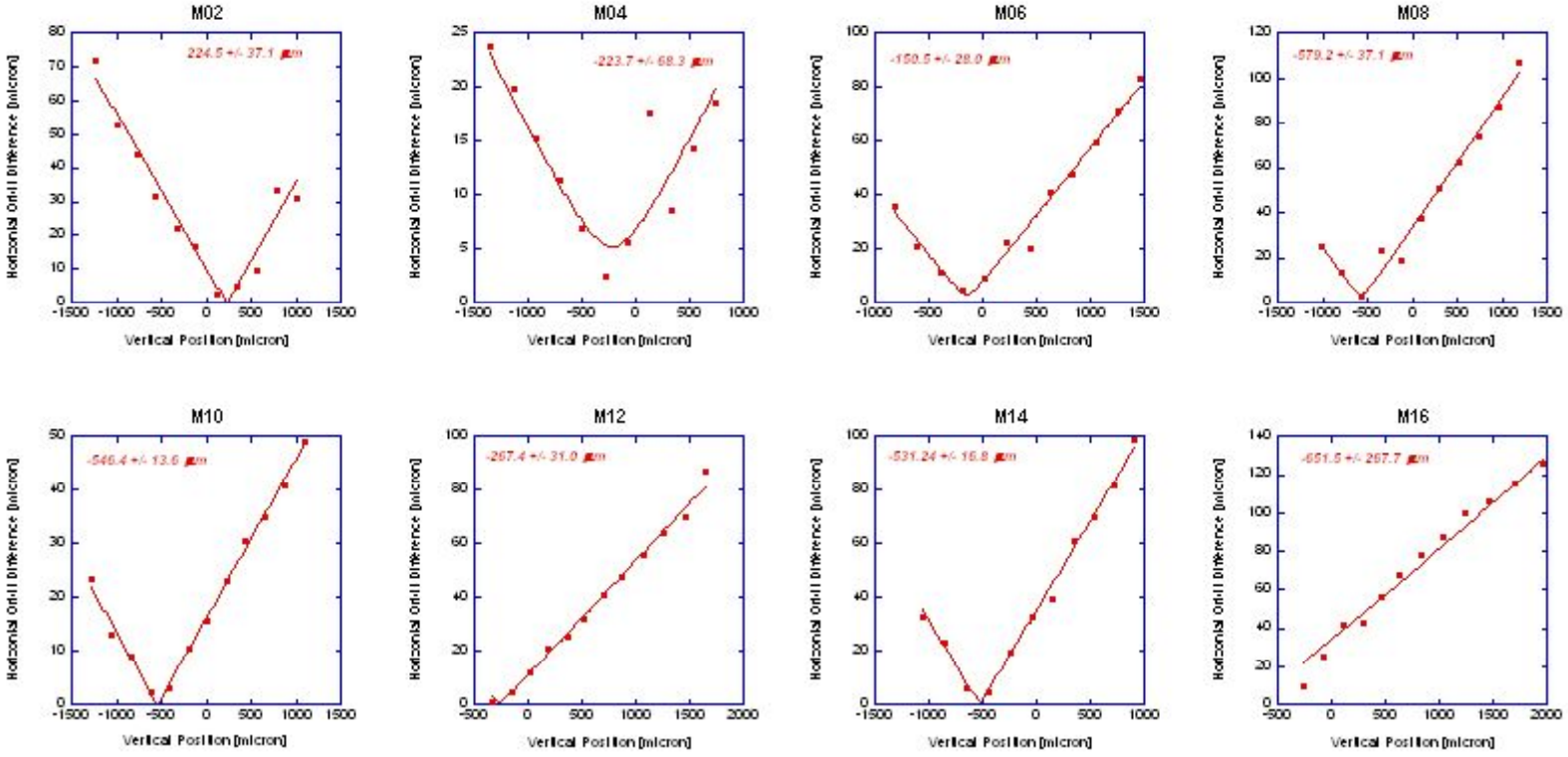
1. *Make a vertical local bump at the BPMs.*

2. *Change the SD1R strength by +/- 8A (ΔK_1 = +/- 0.008 /m).*

3. *Measure the horizontal orbit difference for all the BPMs.*

4. *Estimate the minimum orbit difference point by parabolic fitting.*

Measured Results



We can estimate the BPM (series 2) vertical offset with respect to SD1R by changing the SD1R strength.

The estimated accuracies of the offsets are around 30μm.

Summary of the BBA measurement

We measure the vertical offset for all of series 1 BPM with respect to QF2R.
The QF2Rs are aligned to the SF1R within 100μm.

We measure the vertical offset for half of east arc series 2 BPMs with respect to SD1R.

For the BBA measurement, the BPM resolution is quite important.
The Echotek BPMs help us to estimate the BPM offset.

Future Plan

We will continue to estimate the series 2 BPM offset with respect to SD1R.

We will estimate the series 1 BPM vertical offset with respect to SF1R
and compare the estimated offset with respect to QF2R.