ATF2 beam operation status

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The 9th TB&SGC meeting
KEK, 3-gokan Seminar Hall
2009/ 12/ 16

Improvement of beam tuning from the 8th TB&SGC meeting

The improvement of cavity BPM systems helps the beam tuning for ATF2 beamline.

Improvement of cavity BPM system

- Diode was installed and the readout software were improved in order to avoid the sampling timing change.

- We established the calibration procedure.
  The calibration of all cavity BPMs in ATF2 beamline spends 4 hours.

- The calibration constants for C-band BPMs was kept within 5% accuracy more than 3days.
  Small readout position change between bunch population of 0.1-0.5e10.

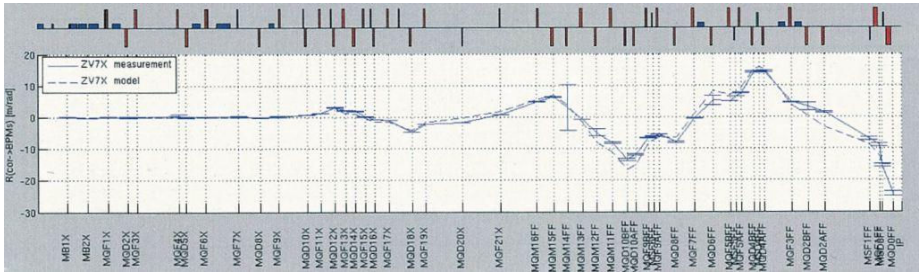
- The I-Q rotations for S-band BPMs are not stable yet.
  We will investigate the unstability of I-Q rotation in this evening (12/16 swing shift).

Optics Modeling (Orbit Response Matrix)

- Orbit response measurement was used for the R12 response test.
  - The precision of the optics modeling was improved with cavity BPM improvement.
  - DAC readback was used to calculate the magnet strength instead of ADC.

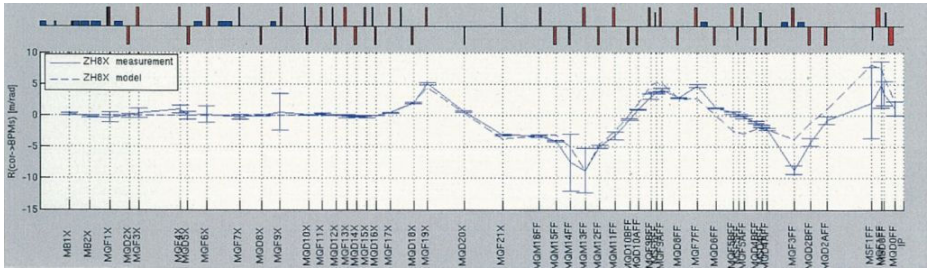
For example

ZV7X



Good agreement

ZH8X



Not Good

Some correctors are consistent with the model, but some are not. (?)

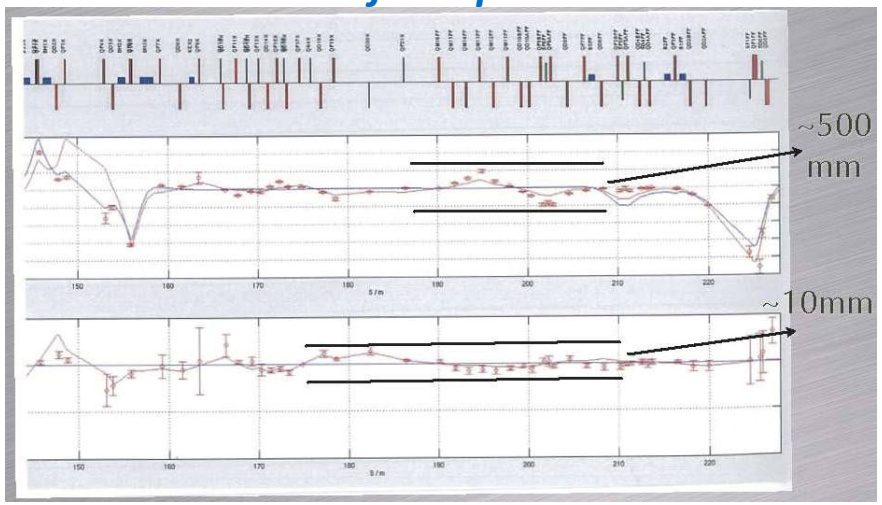
- The orbit response measurement was also used for quick test of the cavity BPM calibration.

Dispersion correction

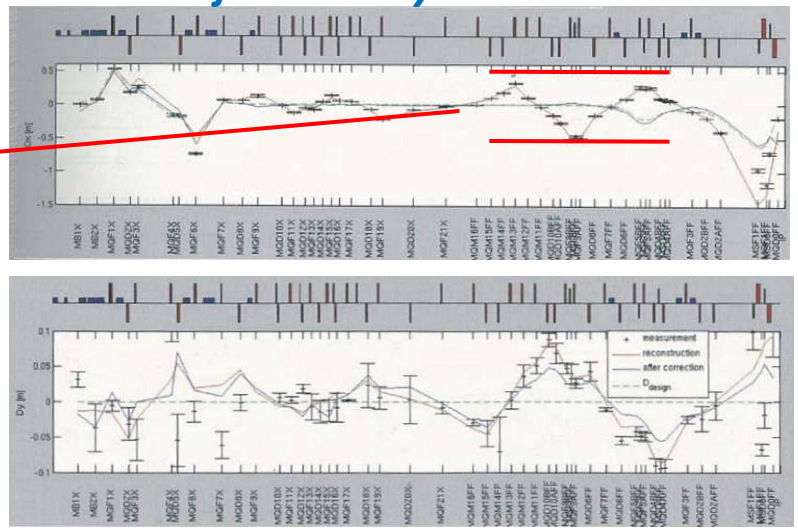
•Dispersions were evaluated with 2 methods.
  1) Delta-f ramp in DR
  2) Orbit jitter analysis SVD matrix
 The results are consistent each other.

•The vertical dispersion correction is improved not only with QS1X, QS2X sum-knob, but also with ZV5X, ZV6X and ZV7X local bump.

Delta-f ramp in DR



Orbit jitter analysis SVD matrix



•Vertical dispersion for all ATF2 beam line is corrected within 10mm.

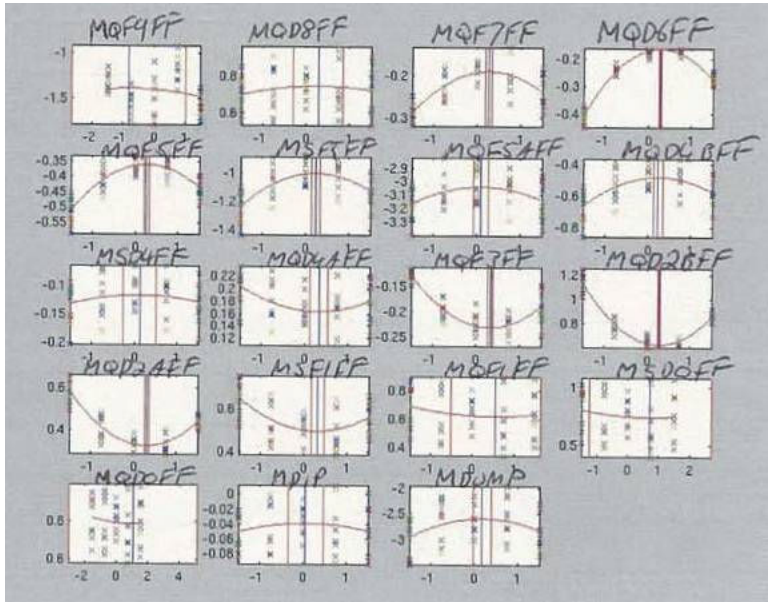
•Large horizontal dispersion at the end of straight line (500mm) sometimes exists.

BBA

•BPM offsets with respect to magnets are measured and put to the database.
All quadrupoles are aligned within 1mm range, but some BPMs for sextupoles has large offsets.

•Mechanical alignment of sextupoles are measured with respect to nominal beam orbit for the preparation of nominal optics.
First 3 sextupoles are aligned within 1mm, the FF sextrupoles are not yet measured.

Example : SF6FF Horizontal Scan



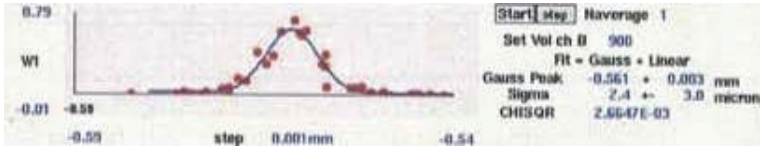
Summary Table of Sextupole BBA

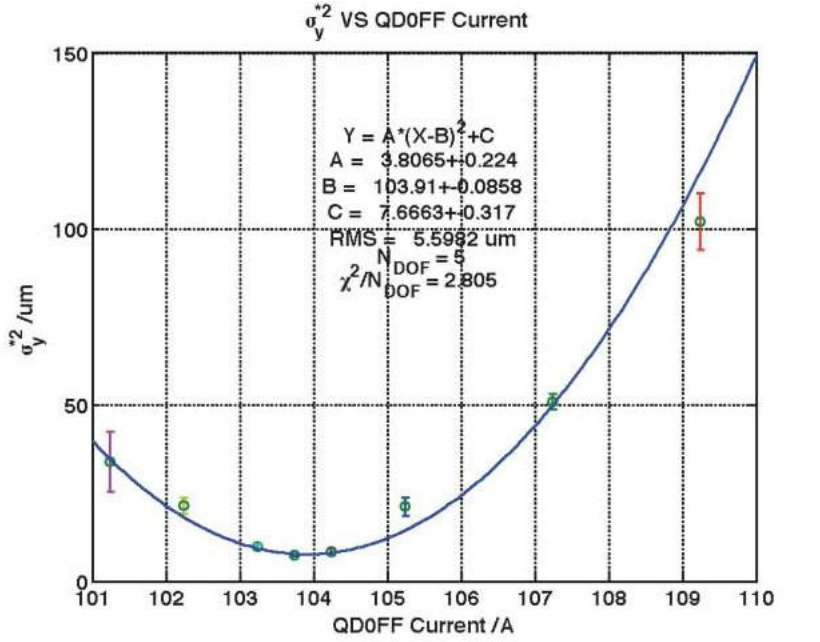
FFS Sextupole	Magnet -> Beam (mm)	Magnet -> BPM (mm)
SF6FF	0.29 +/- 0.01 (x) -0.106 +/- 0.02 (y)	1.75 +/- 0.16 (x) 0.604 +/- 0.034 (y)
SF5FF	-0.811 +/- 0.06 (x) 0.012 +/- 0.02 (y)	2.315 +/- 0.11 (x) 0.205 +/- 0.083 (y)
SD4FF	0.226 +/- 0.026 (x) 0.0729 +/- 0.034 (y)	0.395 +/- 0.038 (x) 0.375 +/- 0.029 (y)
SF1FF	0.537 +/- 0.159 (y)	0.42 +/- 0.16 (y)
SD0FF		

IP tuning

- We concentrate to minimize the vertical beam size only.
  We did not measure the horizontal beam size in 2009 autumn operation period.
- We can achieve the vartical beam size almost the resolution limit (around 3um) of 10um tungsten wire at IP.
- We minimized the vertical beam size to be 1.5um at post-IP with carbon wire scanner.

Beam size measurement with Carbon wire





IP-BSM Improvement

The hardware works in 2009 summer shutdown

We align the Final Doublet and all of the sextupole magnets.

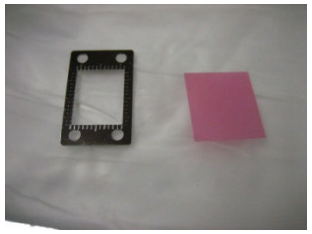
We prepare the wide aperture vacuum camber to BDMP.

We prepare new IP target with Screen, knife edge and wire scanner.

We install the new IP-BSM laser (400mJ/pulse -> 1500mJ/pulse).

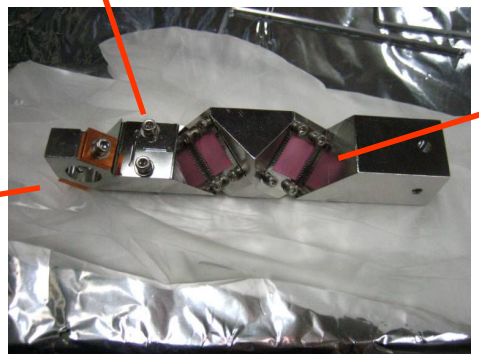
Laser beam size measurement

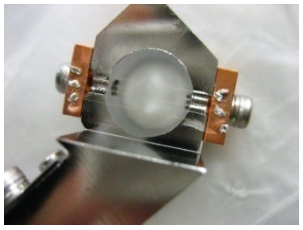
Prepare knife edge target
to make 10μm laser spot at IP



Electron beam size measurement

Attach10μm tungsten wire
at the tip of the holder
to make 1μm beam size at IP





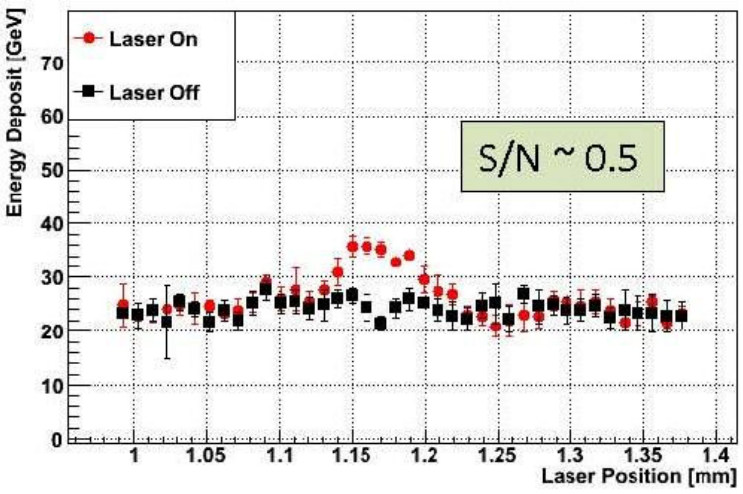
- Laser-laser collision for all laser mode
- Electron-laser collition

Prepare 2 screen monitor

Improvement of S/N (Laser wire mode)

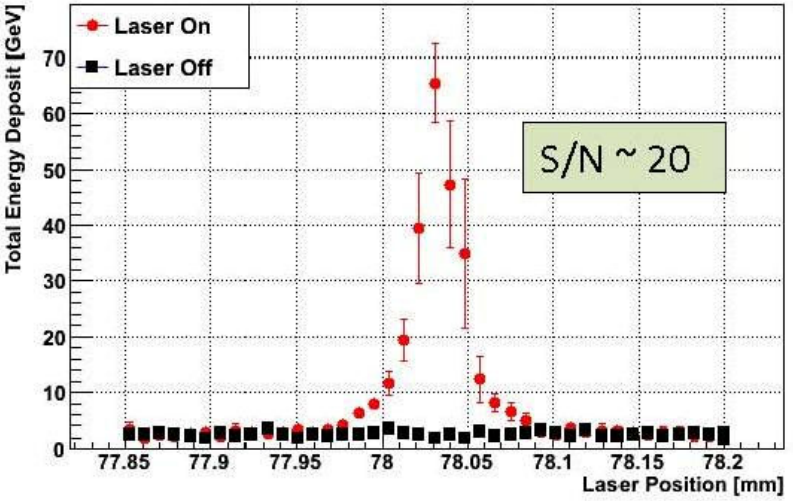
- Elecrtron beam size tuning and Laser –beam collision is easy with new target.
- Signal was increased by the factor 4 with new intense laser.
- Noise was reduced by the factor 1/10 by various hardware improvements.

In 2009 spring run



laser wire mode measurement on May 29, 2009

In 2009 autumn run



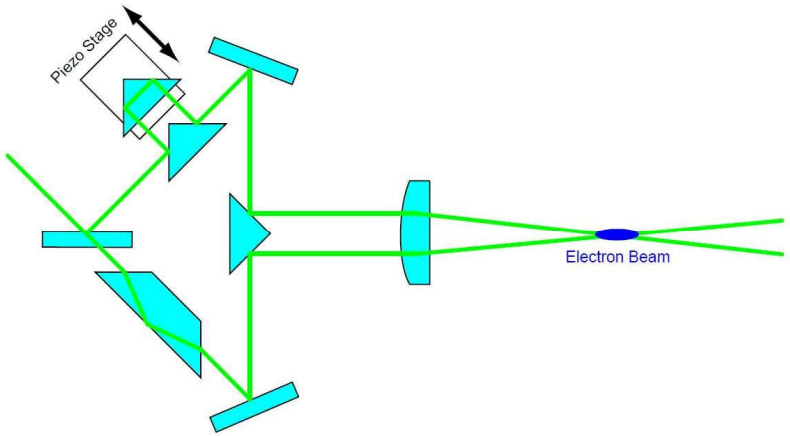
laser wire mode measurement on Nov. 13, 2009

Laser was focused at IP, and the laser spot size was around 20um.

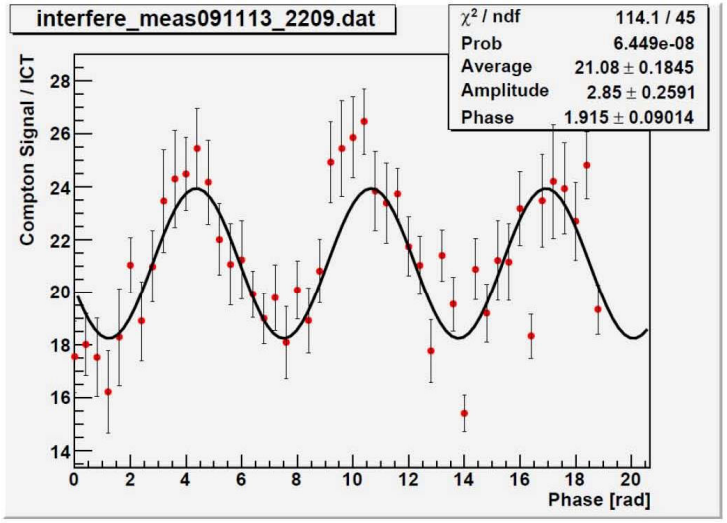
The measured beam size by the laser wire mode was 20um.

Observation of the Fringe Pattern (Interference Mode)

- Elecrtron beam size tuning and Laser –beam collision is easy with new target.
- The first observation of the fringe pattern is 2009/11/13.
  The beam test at 2009/11/13 is the first trial of the fringe pattern observation in the 2009 autumn beam operation period.
- The fringe pattern is measured by changing the path length of one laser.

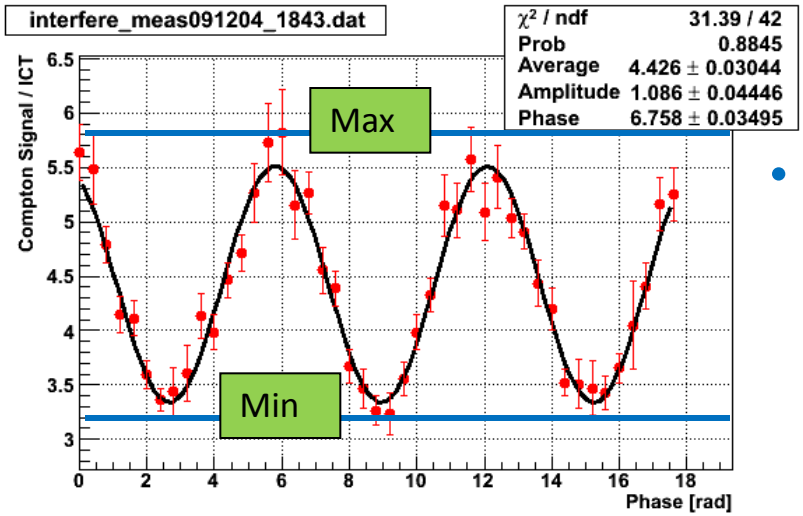


Schematic of the phase scan

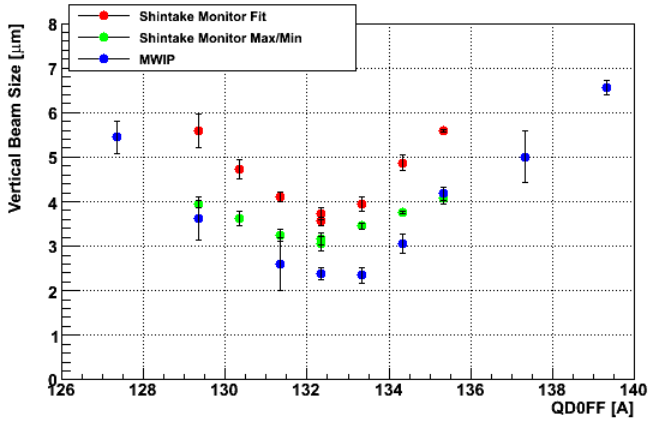


First observation of the fringe pattern signal

Beam Size Evaluation



- ***Fitting***
  - uses sinusoidal function for fitting and obtain modulation depth from fitted parameters
  - has tendency to underestimate the modulation

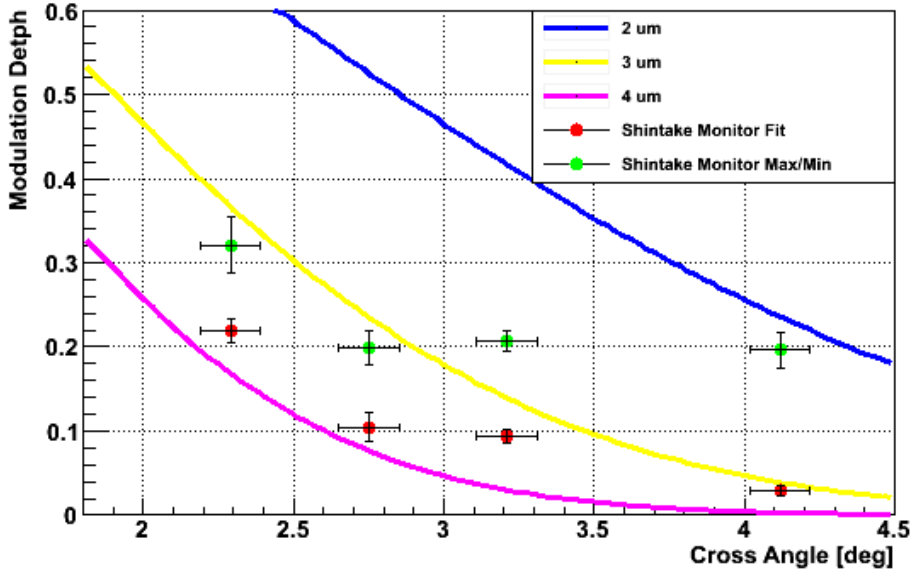


- ***Max/Min***
  - uses maximum and minimum data only to calculate the modulation depth
  - has a tendency to overestimate the modulation

Evaluated beam size were larger than wire scanner measurement for both methods.

Crossing Angle Dependence

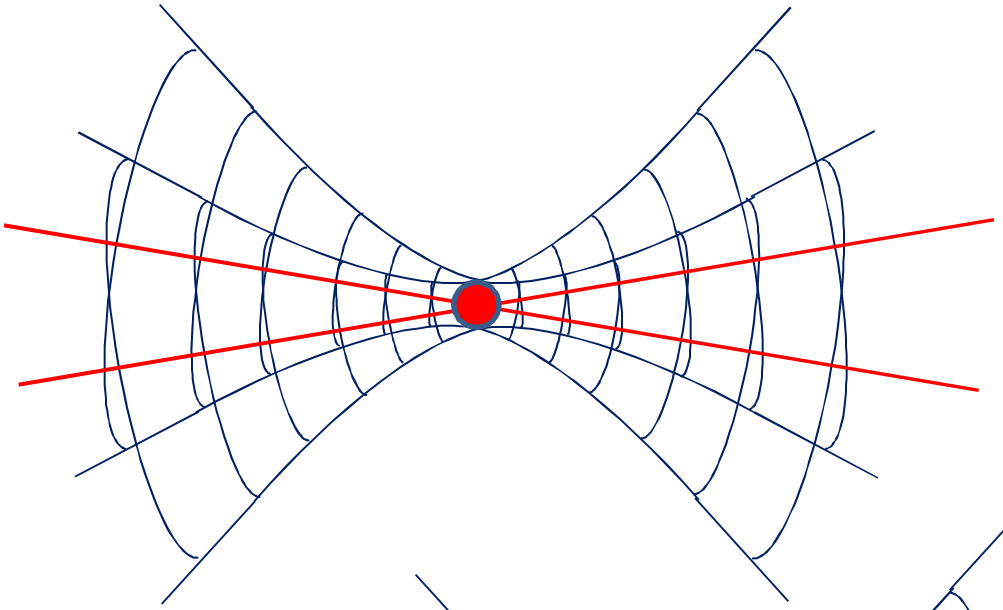
- Consistency check was done by changing the laser crossing angle chenge.
- The evaluated beam size by wire scanners were limited by the its resolution (less than 2.5um).
- The evaluated beam sizes by fitting method were in between 3-4um for all crossing angle.
- The evaluated beam sizes by Min/Max method were in between 2-3um for all crossing angle.
- The evaluations sizes for larger crossing angle showed smaller beam for both methods.

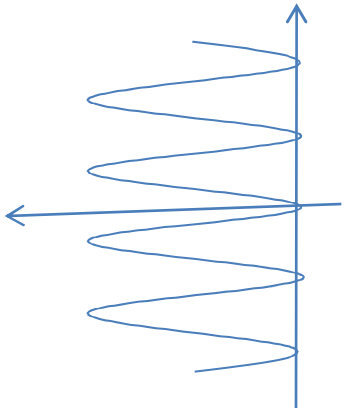


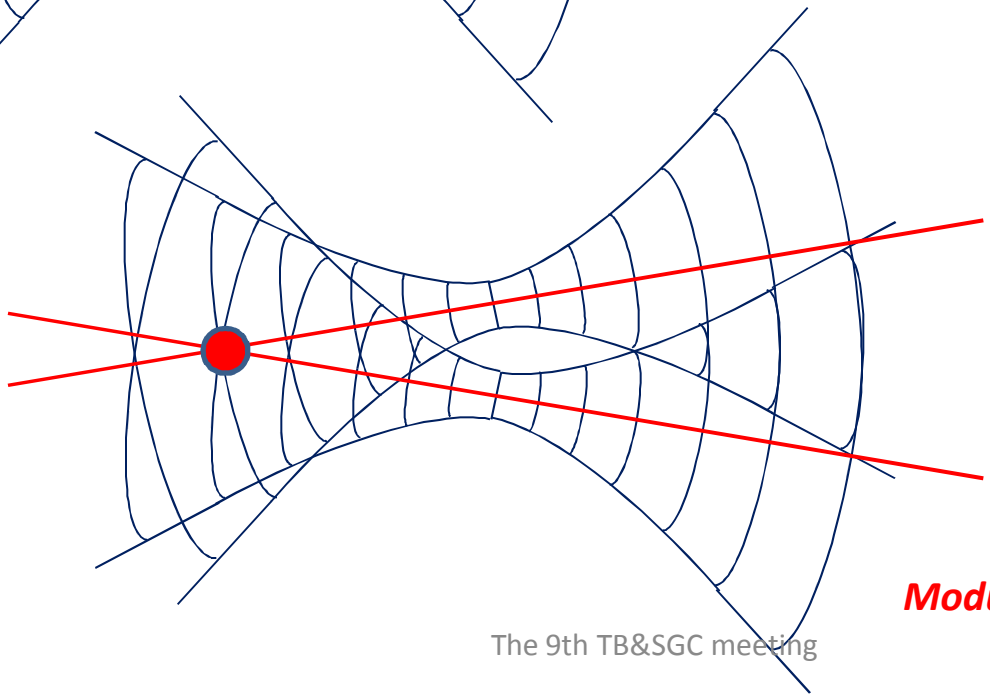
Source of Systematic Error

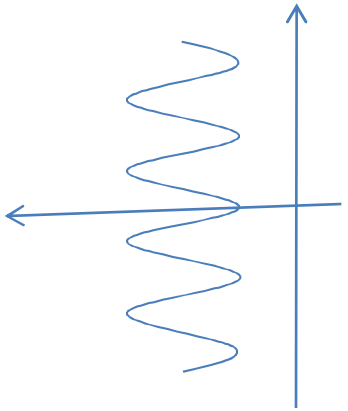
- Crossing angle estimation
- Degradation of the fringe visibility
  - Power and size imbalance between two laser beams
  - Temporal coherence
  - Spatial coherence
  - Displacement from the laser waist
- Beam position, laser phase jitter
- Tilt of the interference fringe
- PMT linearity

The collision point was not set to the laser waist.









Modulation pattern was deformed.

Summary of IP-BSM status

Improved from the 8th TB&SGC meeting

- The new IP target is very useful for beam size tuning and laser-beam collision.
- The background was reduced to be 1/10.
- We observed the laser interference patterns with beam for 2-4 degrees mode.
  We measured 3 times the interference patterns (11/13, 11/20 and 12/4).
- We established the procedures of the beam size measurement by interference mode.
  It spend about 4 hours for the preparation work for IP-BSM measurement.

The present problems to be solved

- We did not yet established to evaluate the beam size from laser interference patterns, because the many systematics are not yet understood.
- The seed laser was broken twice in 2009 autumn operation period.
  We must solve the problem.