SESAME Storage Ring
Diagnostics and Commissioning

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On be half of SESAME staff

IBIC 2017 , Grand Rapids, Michigan, USA

Outline

- **What is SESAME?,SESAME Members**
- **The Facility.**
- **Main Parameters.**
- **SESAME Millstones.**
- **The Facility.**
- **Diagnostics**
  - **FS**
  - **CT's, Problems**
  - **BPM**
  - **Measurements**
  - **SRM, Problems**
  - **BLD**
  - **Other's DI**
  - **Next Steps**

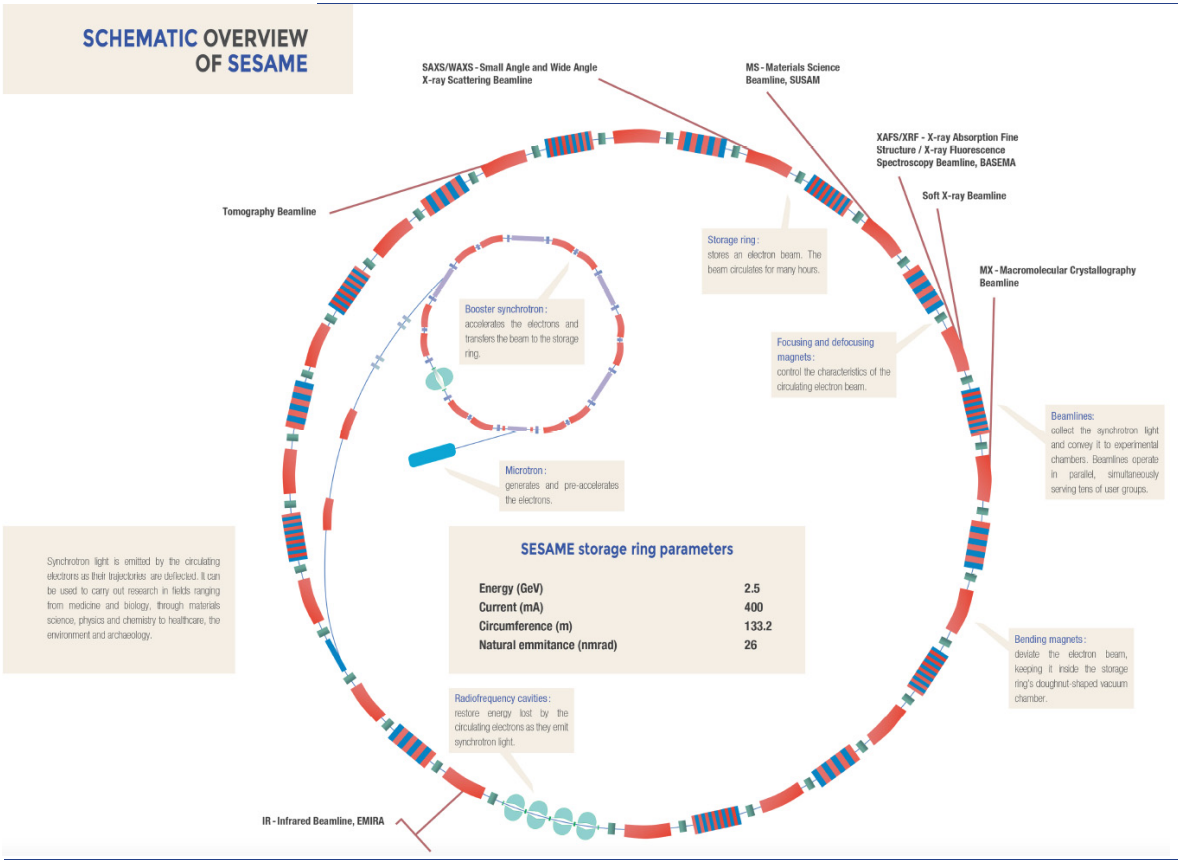
SESAME, Members

(**S**ynchrotron-light for **E**xperimental **S**cience and **A**pplications in the **M**iddle **E**ast)

1st 3rd Generation Synchrotron Light Source in Middle East, located in Allan, Jordan

SESAME Members

The Facility



Main Parameters

Energy (GeV)	2.5
Circumference (m)	133.2
RF Frequency (MHz)	499.654
Repetition freq.(Hz)	1
Betatron tunes Q_X / Q_Y	7.23 / 6.19
Horizontal emittance ε_x (nm.rad)	26
Momentum compaction factor	0.0083
Phase 1 Circulating Current(mA)	250
Energy loss per turn (keV)	603

Millstones


SESAME
2003 Ground Breaking
2003 Building Construction
2004 SESAME Independent of UNISCO
SESAME
2008 Soft Integration
2012 Microtron Commissioning
2014 Booster Commissioning
2015 First Storage Ring Cell Installation
2016 Storage Ring Commissioning
2017 First Operating Beamlines

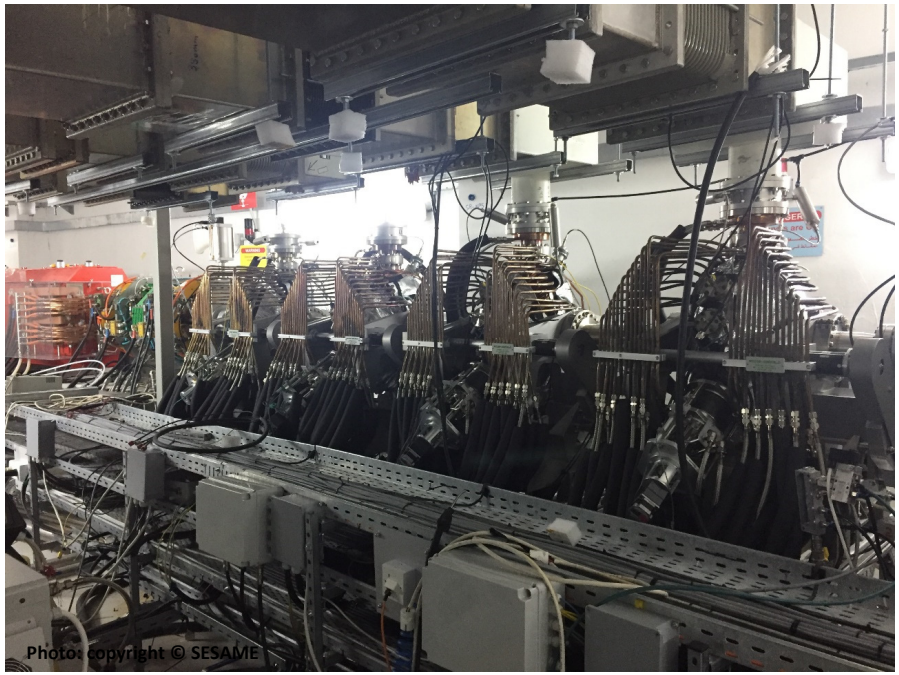
The Facility

Microtron and Transfer Line 1 (2011)

Microtron, TL1 and 800 MeV Booster (2014)

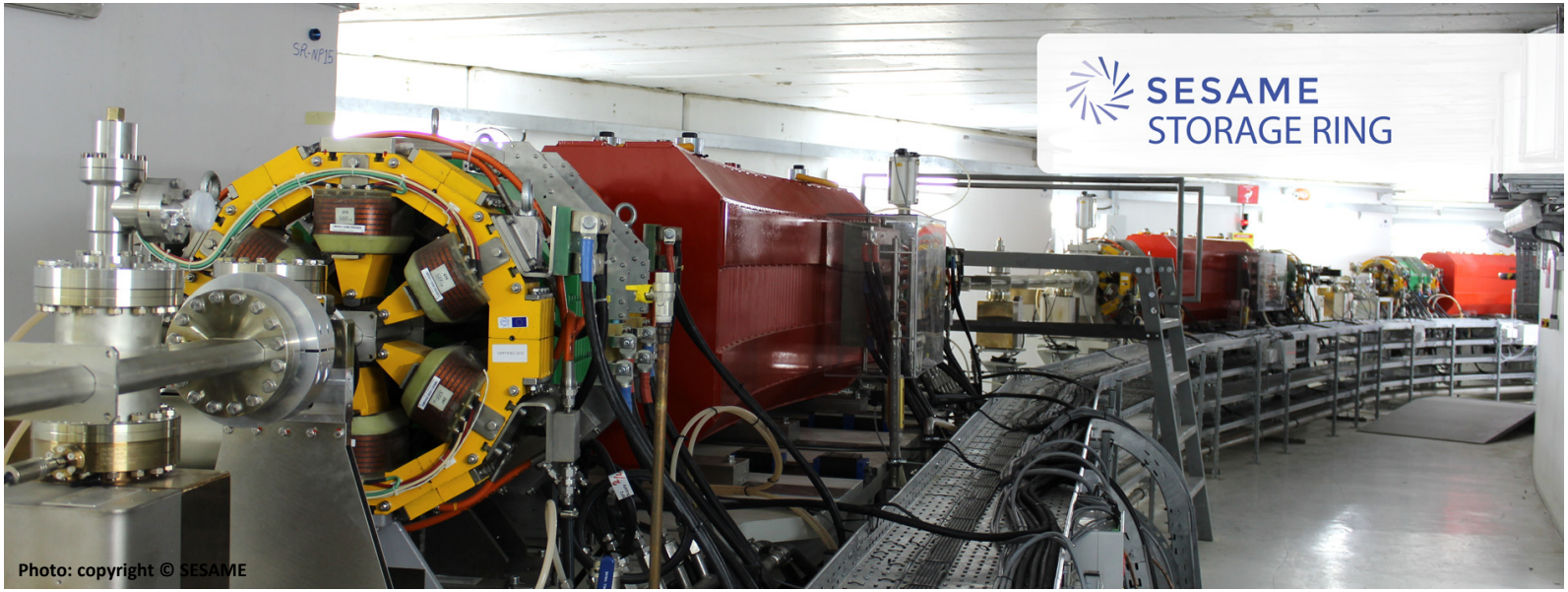
The Facility

RF Plant (4*80KW SSA)



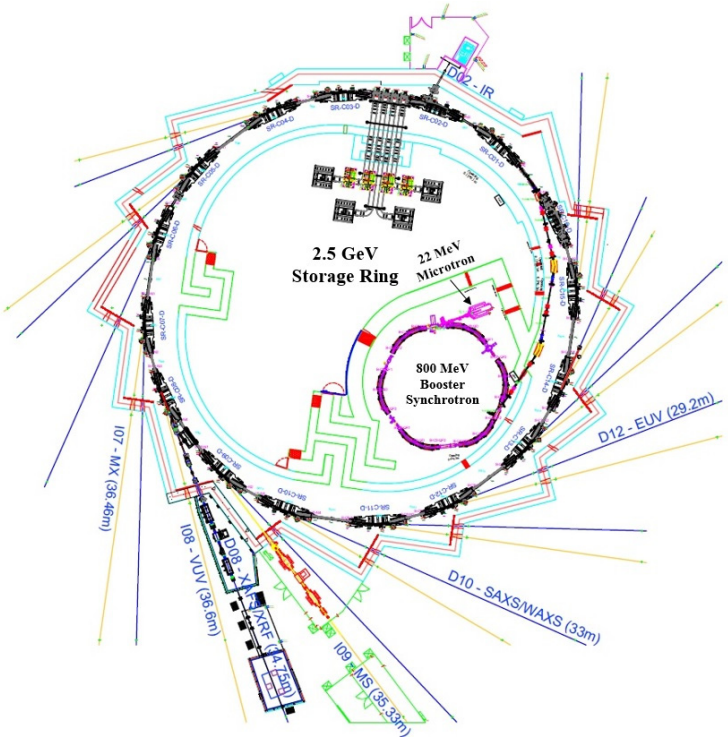
4 ELETTRA Cavities in SR

The Facility



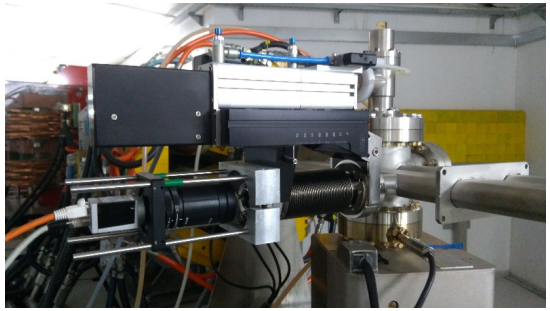
Diagnostics Overview

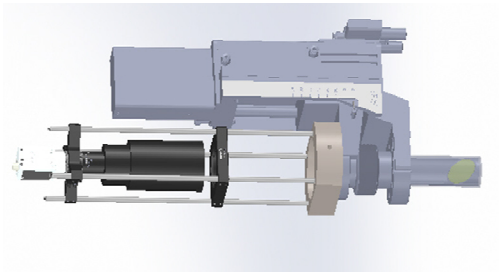
	Instrument	Quantity
TL_1	FS	1
	FCT	1
BO	FS	4
	BPM	6
	FCT	1
	DCCT	1
	SRM	1
TL_2	FS	4
	FCT	1
SR	FS	3
	BPM	64
	FCT	1
	DCCT	1
	SRM	1
	VSCR	1
	BLM	4
	BbB	2

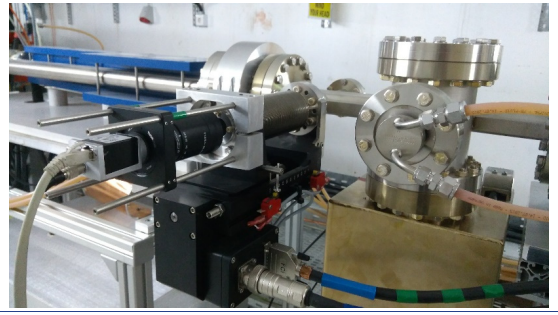


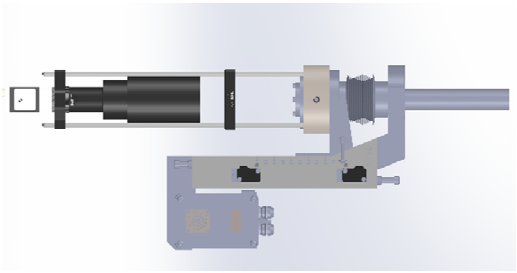
Florescent Screens

- All the FS are in-air, mounted horizontally.
- Pneumatic type and 1 stepper motor.
- Aluminum Oxide Screens.
- Basler CCD PoE Camera.
- Kowa Lens.

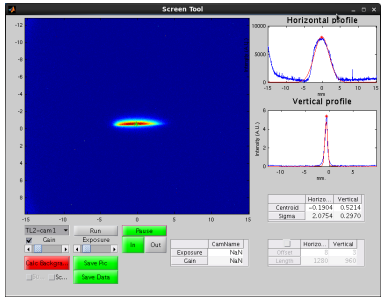




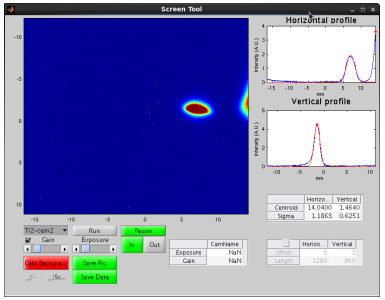




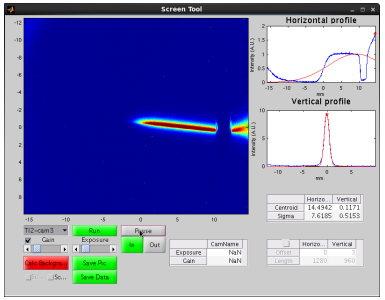
Florescent Screens



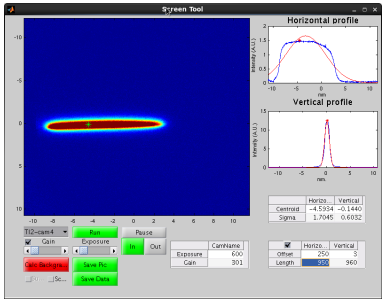
TL2-FS1



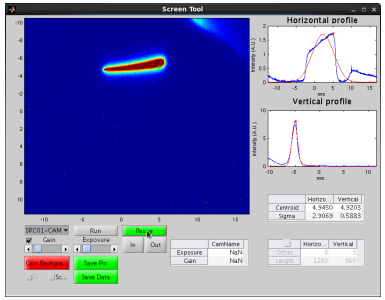
TL2-FS2



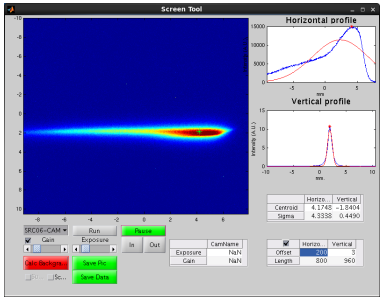
TL2-FS3



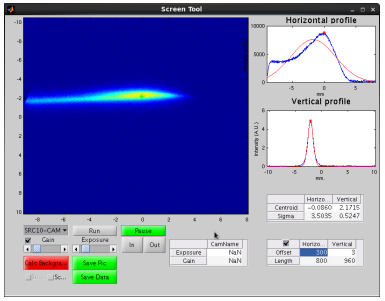
TL2-FS4



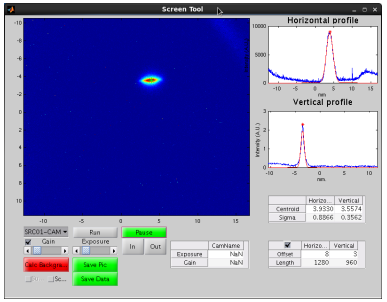
SR01-FS



SR06-FS



SR10-FS

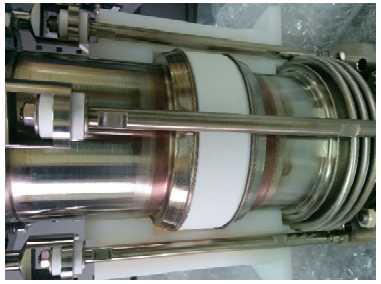


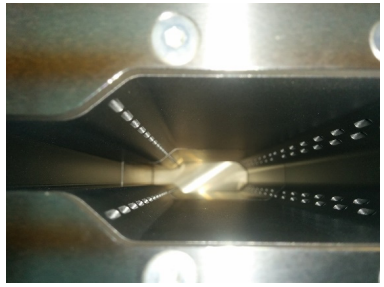
SR01-FS
Full Turn Beam

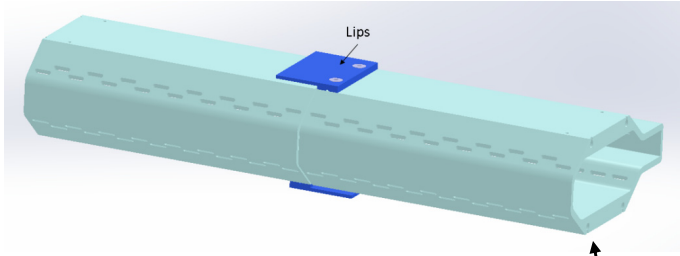
Current Transformers

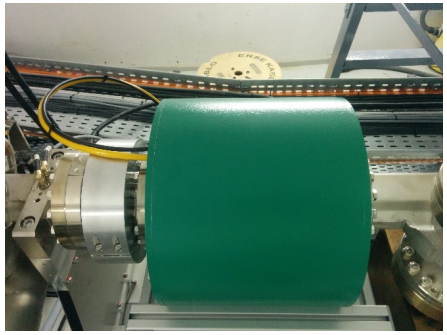
- Both FCT and DCCT share same ceramic break and outer shield.
- The vacuum chamber is a standard circular CF150 with a ceramic break of 22.8 mm length. In order to preserve the impedance for the beam and have a specific capacitance value for the FCT we designed a beam shield having the same shape as the standard vacuum chamber with overlapping lips as break.
- The outer shield has two thin sheets of μ-Metal and a soft iron outer layer to improve the shielding from external EMI and RFI.

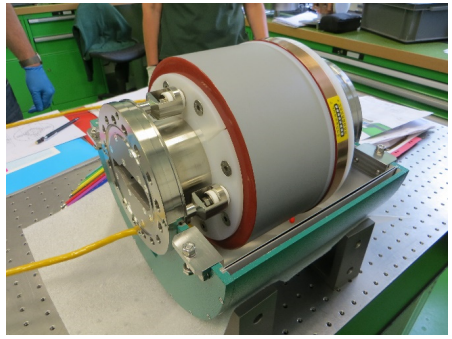
Current Transformers

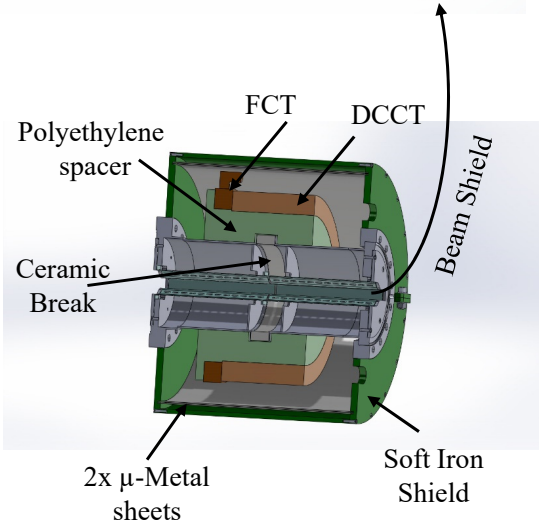










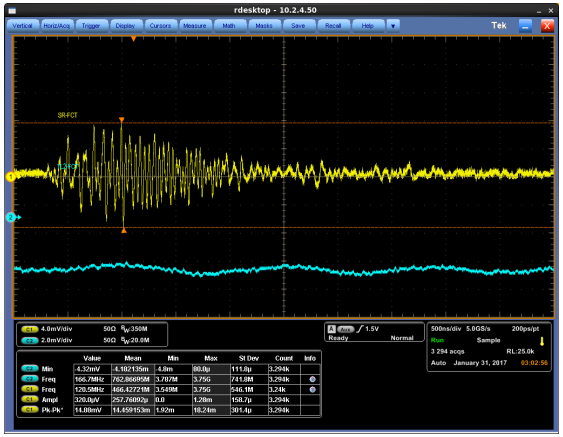


FCT Problem!!

- Once the pulse elements (PE) specially booster extraction kicker (128nS, 25KV) (old from BESSY I) and SR injection kicker are turned ON, big noise appears picked up by SR-FCT. The noise is much bigger than the beam pulse and it was hard to see the beam on the scope.
- So we have to check the PE ? ➔ PE engineer left SESAME before 1 month of commissioning !
- ➔ Power supply group just have *one* engineer who's responsible for all machine PS!!
- ➔ with the help from other groups we look to the system.
- ➔ the conclusion is: Ground loop in the system !! ➔ try to minimize it by :
- Put ground sheet on all PE boxes and FCT,DCCT shield.
- Check RF coaxial cables from FCT to Scope

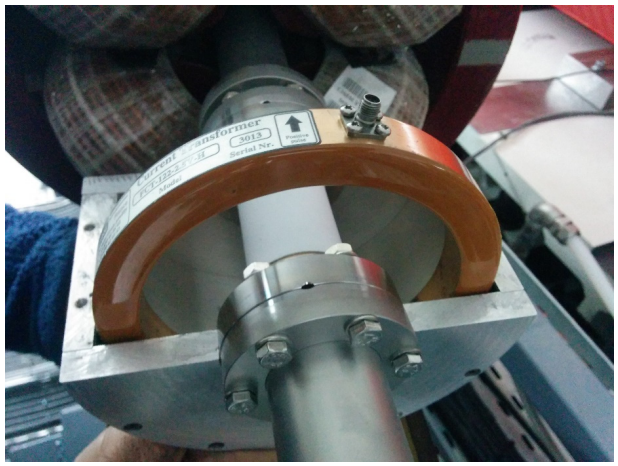
  (the cable connected to the scope directly, no patch panel).
- Move the scope inside the tunnel !!! After put lead shielding

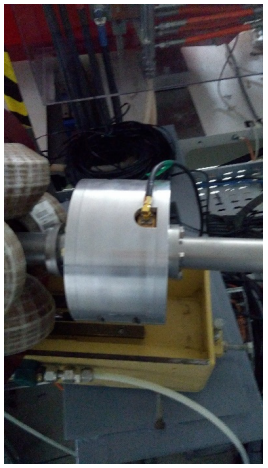
  on it and use another short coaxial cable.

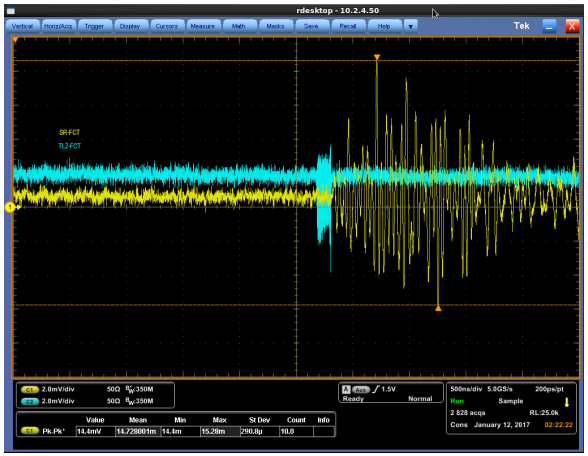


FCT Problem!!

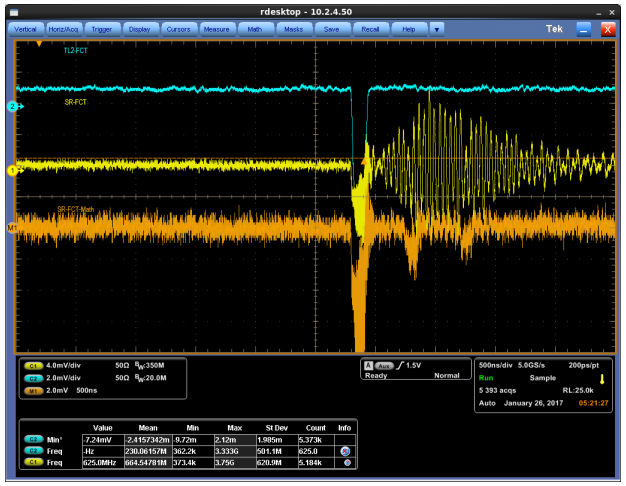
- The sheets improve noise reduction but unfortunately the noise still there.
- The system needs more time to be improved and to solve noise problem.
- ➔ So we made a simple math on the scope !!
- ➔ Turn on all PE with no injection to the ring ➔ take this signal as a reference ➔ subtract the FCT signal from the reference one ! ➔ we got the beam ☺ …….until we will solve the problem !!
- BUT the TL2 FCT not affected ?! And this not far from SR FCT.





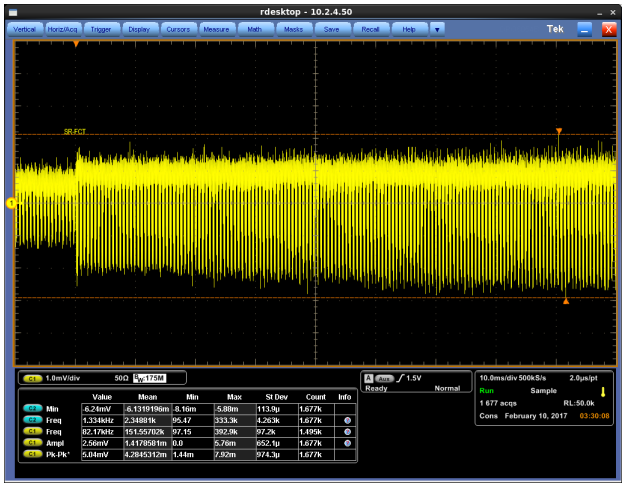


FCT Problem!!



1st 2 turns in the SR.
TL2-FCT don't pick up any noise (blue).
SR-FCT with PE noise (yellow).
SR-FCT after math function (orange).

Few turns in SR



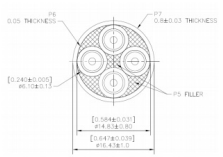
SR-FCT after beam stored without math function

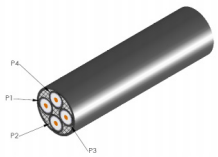
BPMs

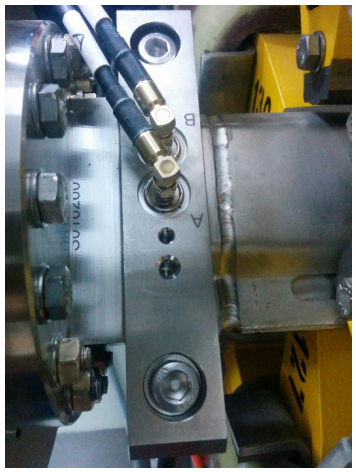
- 64 Button type BPM, 4 BPMs/Cell.
- 12 Libera Brilliance +, 8 are equipped with 8 GDX modules, 4 of them are donated from Instrumentation Technologies.
- 48/64 BPM are connected to the Libera.
- 32 BPM will be used for FOFB.
- Low Loss TWS240-FR Coaxial Cables.

Instrumentation Technologies

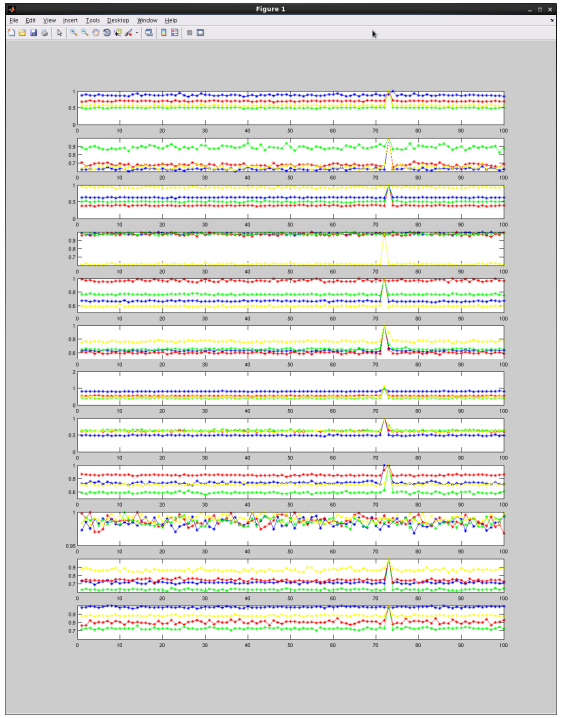
Many Thanks!



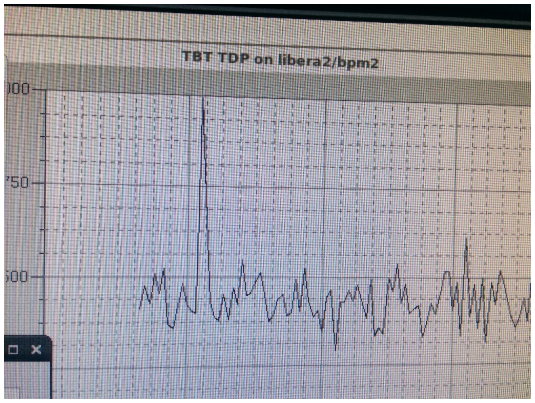




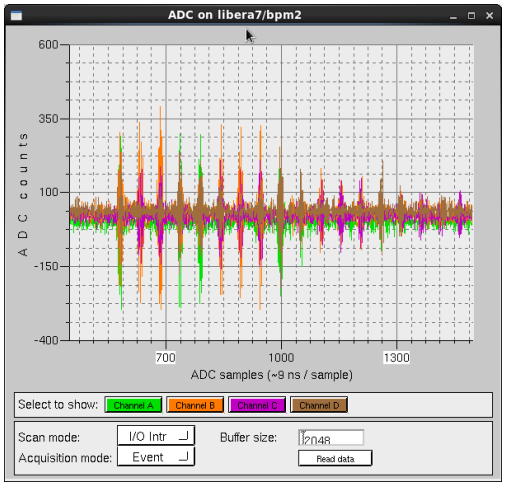
1st Turn(s)!!



1st Turn on all BPMs

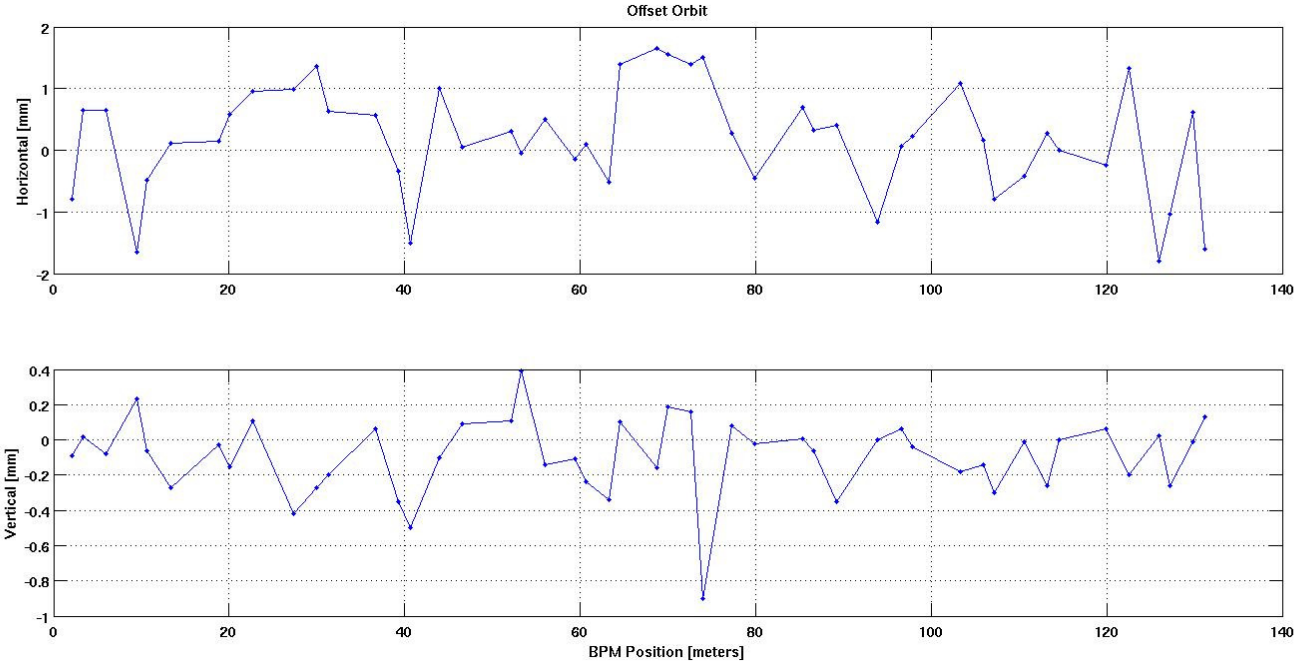


1st Sum signal from BPM1

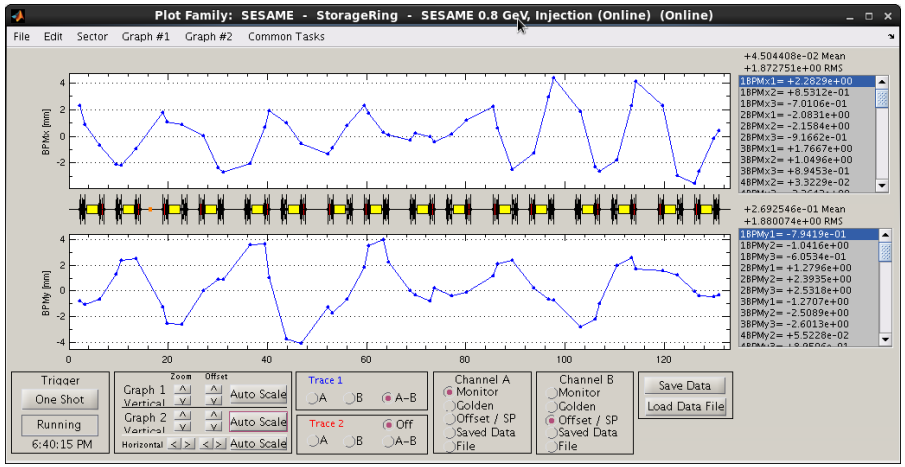


ADC Buffer, 1st few turns in the SR

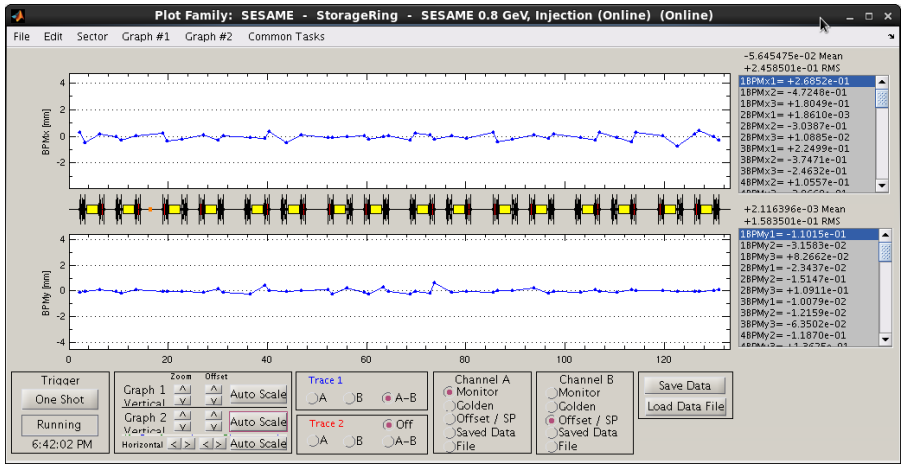
Stored Beam


Offset Orbit
Horizontal [mm]
Vertical [mm]
BPM Position [meters]

Orbit Correction

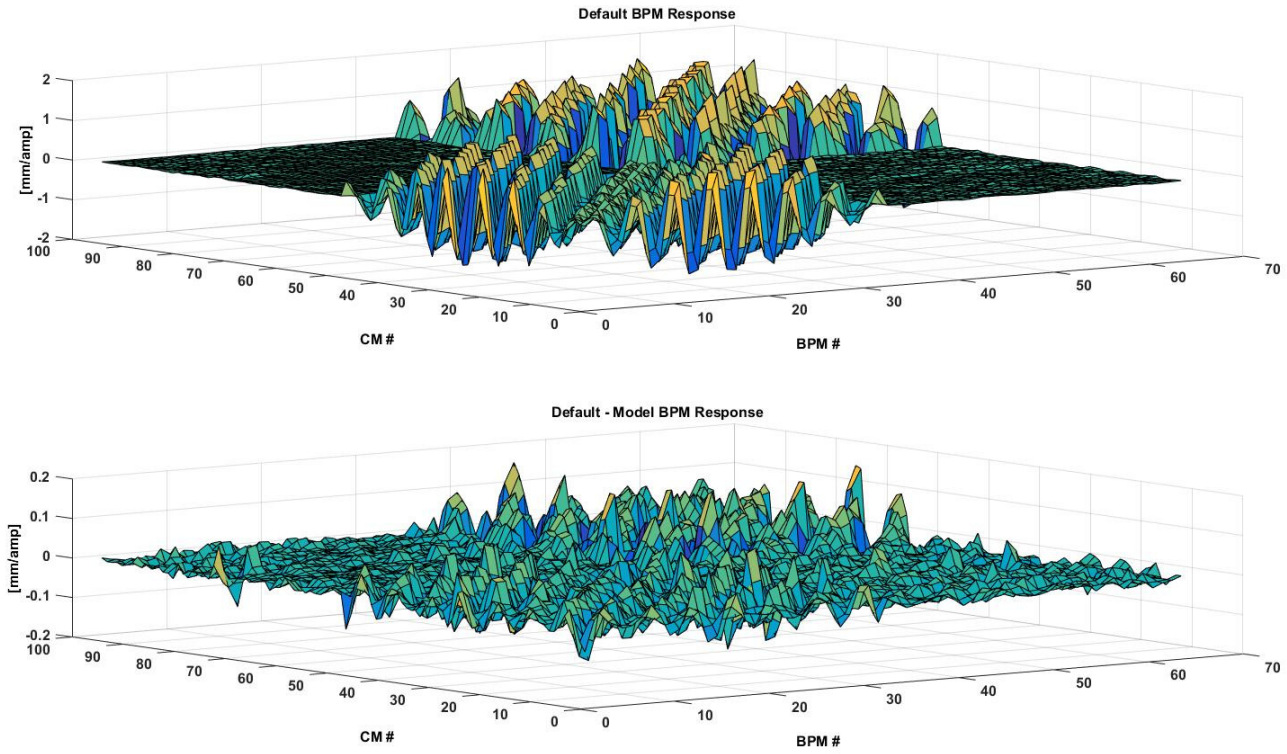


Uncorrected orbit



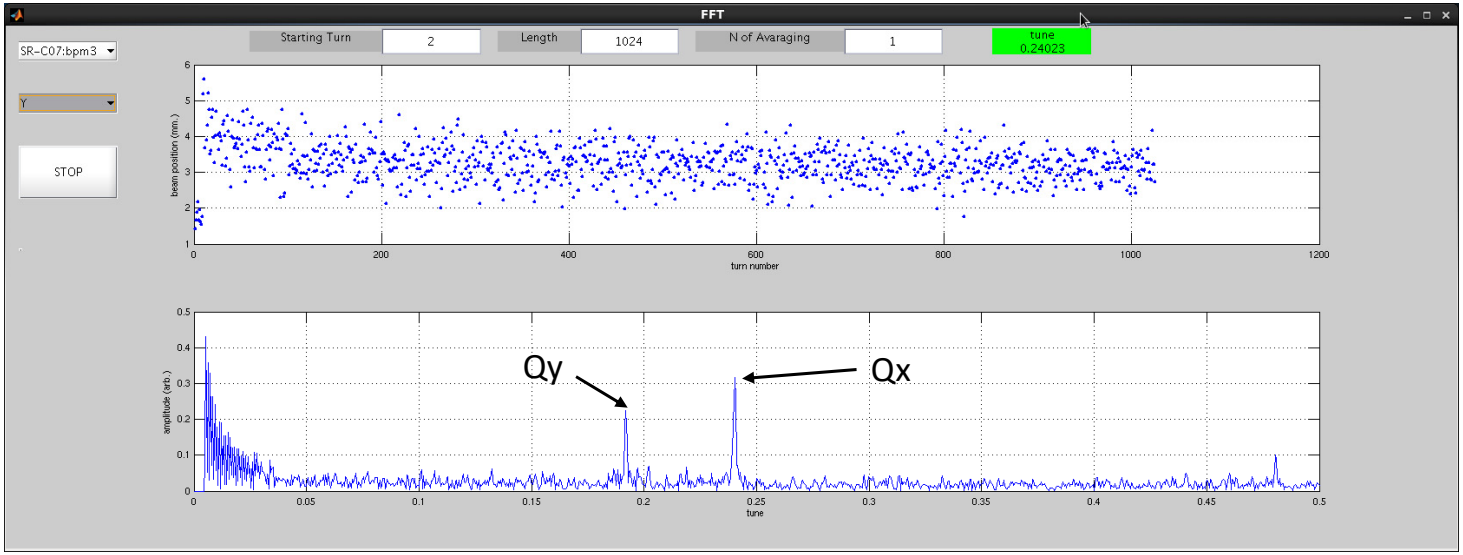
Corrected orbit
(same scale)

Response Matrix



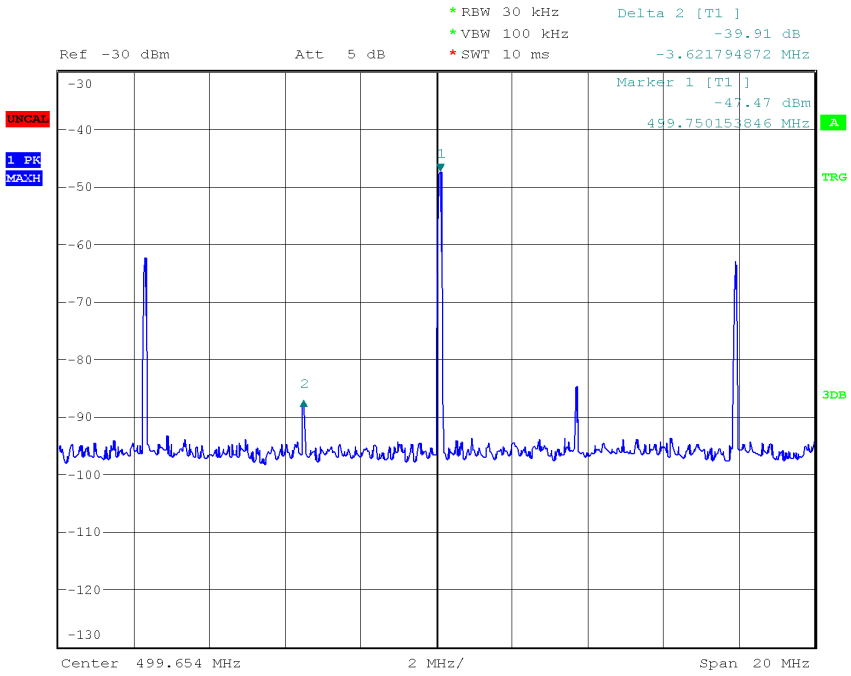
Tune Measurement

- Turn-by-turn data were used to determine both horizontal and vertical tunes by FFT.

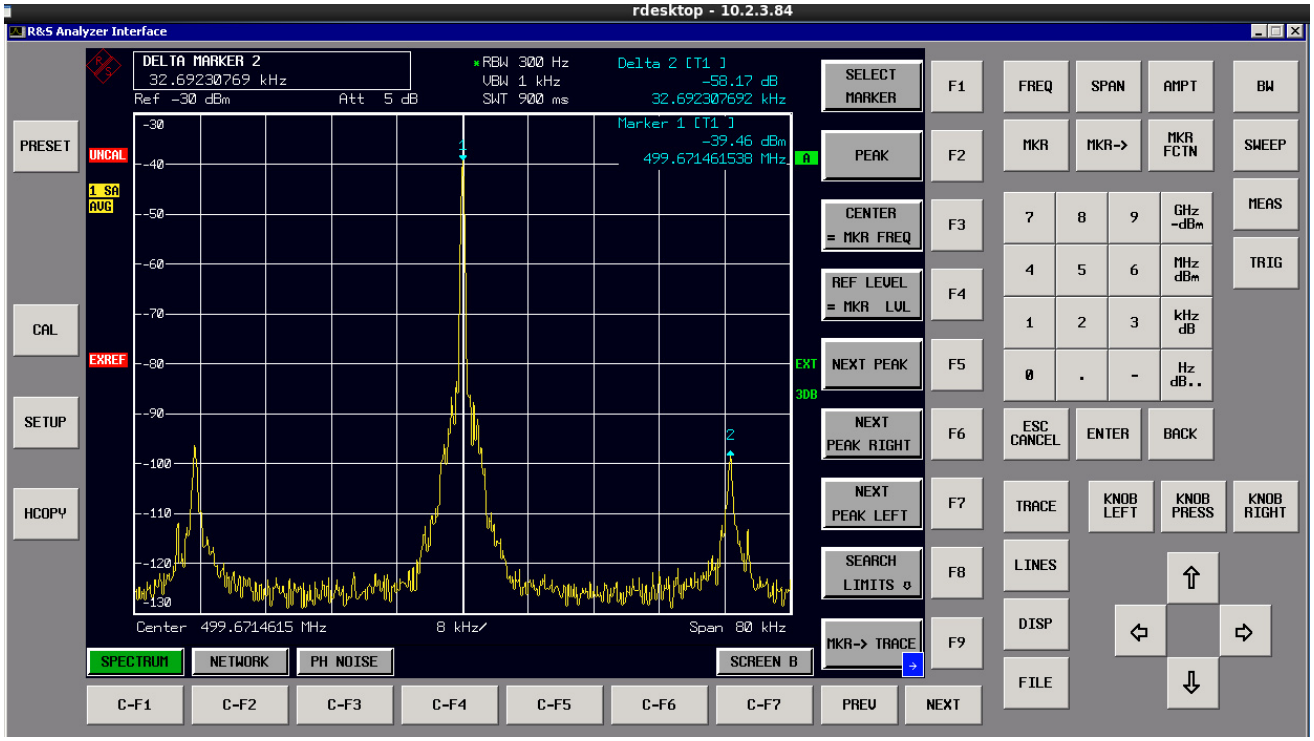


Tune Measurement

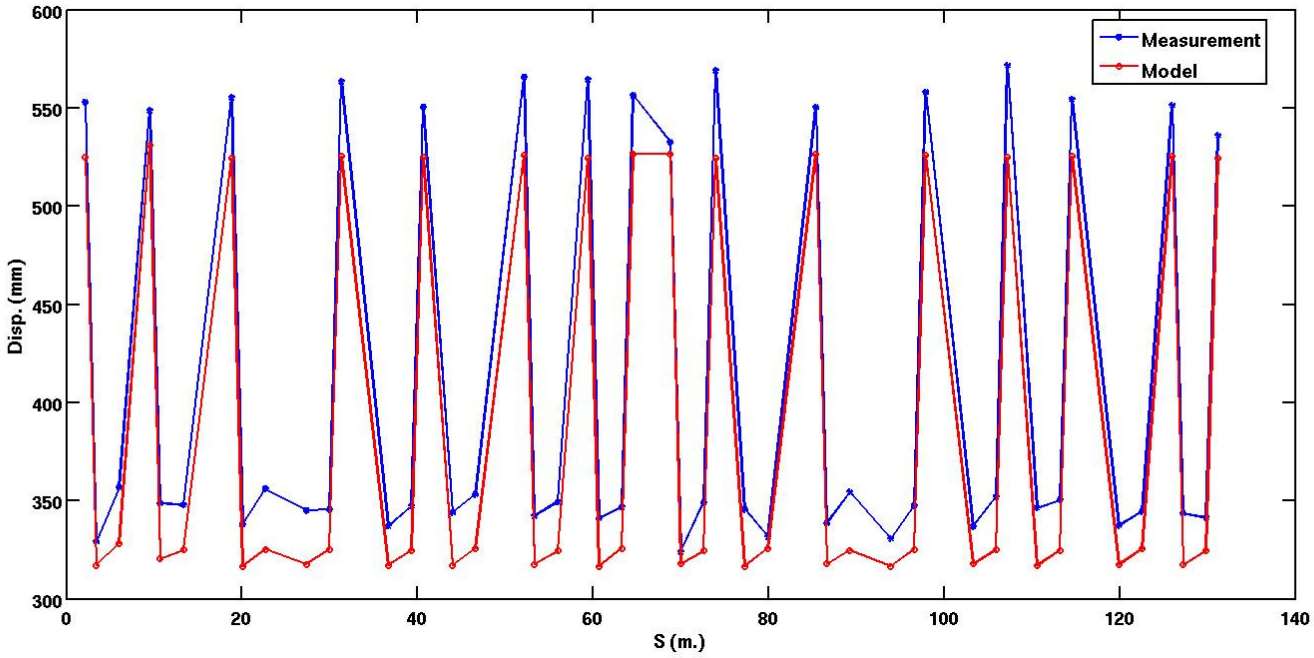
Tunes measured by spectrum analyzer from a cable connected to one BPM



Synchrotron Tune



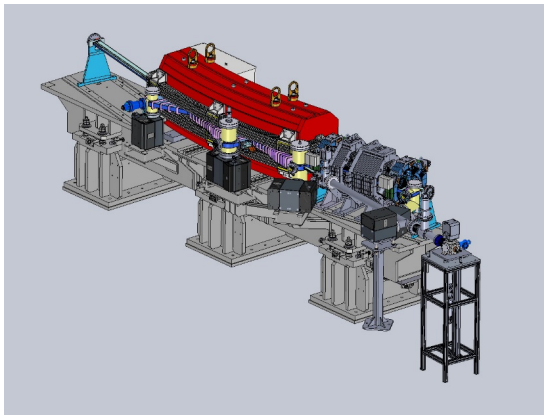
Dispersion

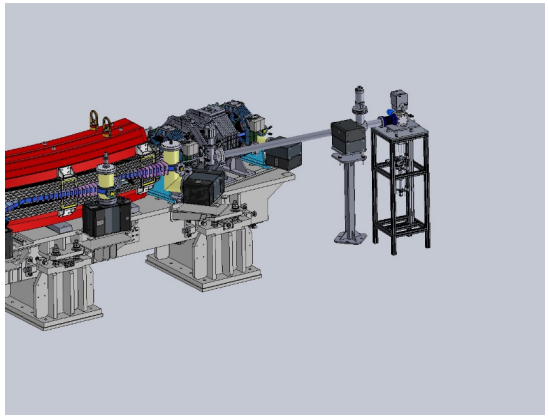


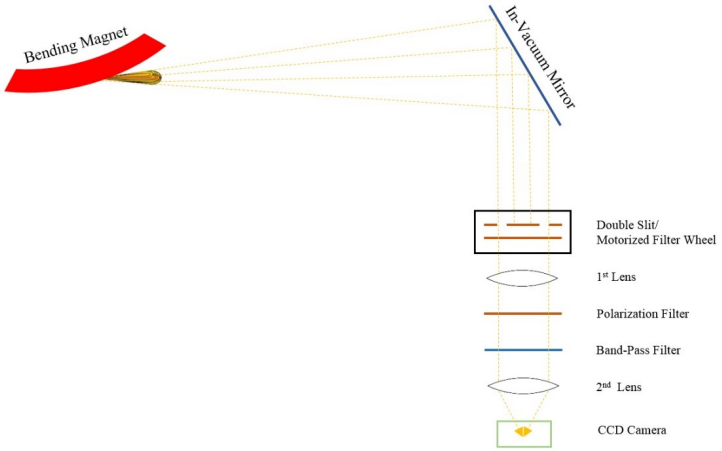
~4% error

SRM

- One SRM in SR. It's designed to measure both horizontal and vertical beam size in the ring and monitor transverse instabilities.
- The challenge here to measure both planes on same SRM, the vertical resolution is limited due to diffraction caused by a crotch absorber in the vacuum chamber. To overcome the diffraction limit and to be able to measure the vertical beam size a double slit was installed to allow interferometry measurements.

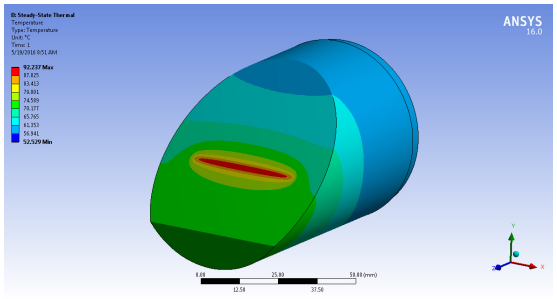


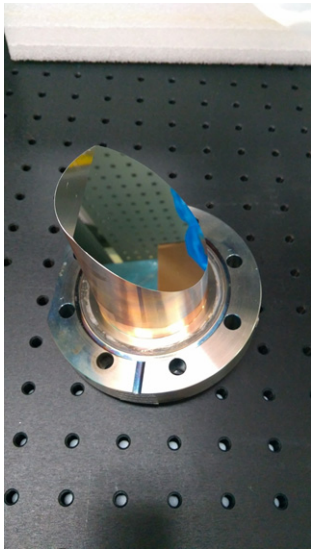


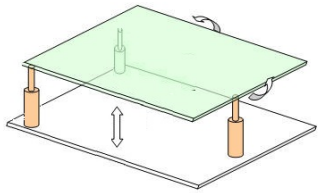


SRM / Mechanical Setup

- The in-vacuum mirror design is borrowed from ANKA.
- In the phase one of SESAME the SRM will be inside the tunnel.
- So a motion system was designed to control and to do fine alignment for the in-vacuum mirror.
- The motors are mounted in vertical and triangle shape to move the mirror with 1µm step.

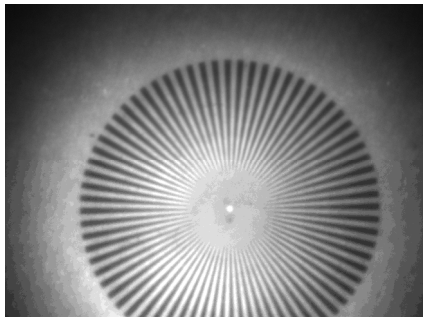


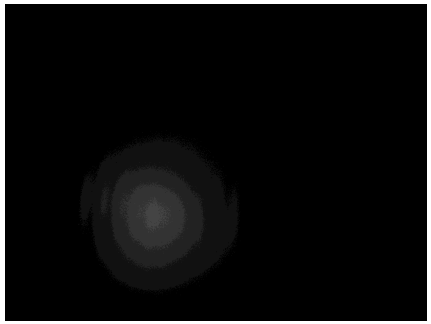


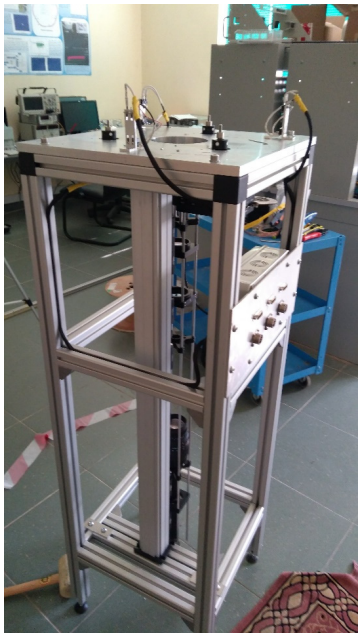


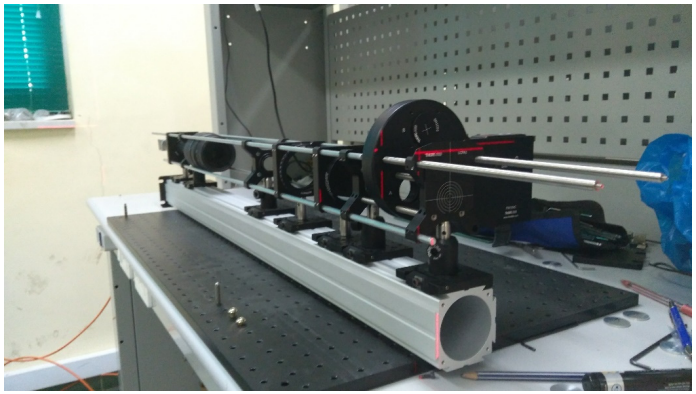
SRM / Optical Calibration

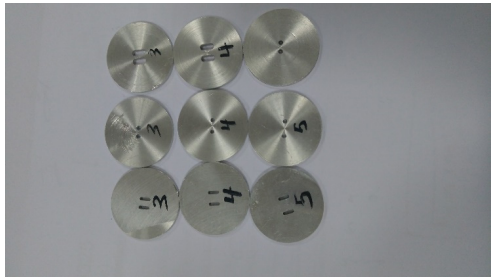
- Since the SRM will be inside the tunnel, the optical calibration was done in the lab.
- The calibration done for direct imaging and inferometrey setup, the light source was different specific wavelength LED. A sector star was used to calculate the resolution .

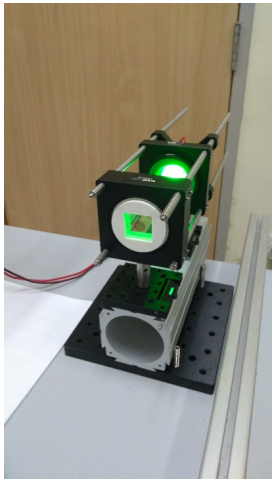






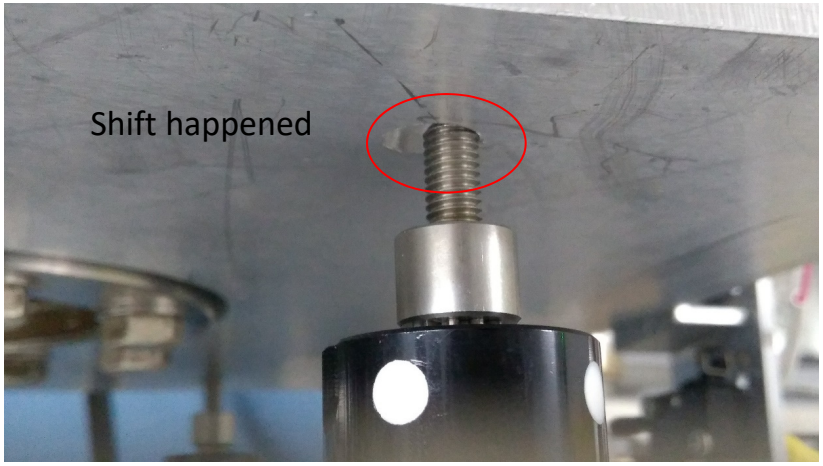






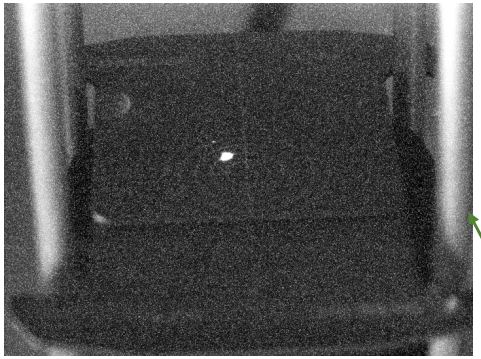
SRM / Problems !!

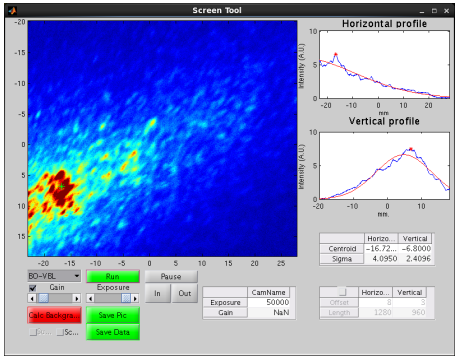
- The main problems for SRM are the parts delivery!! AND the wrong delivery orders !!
- Vacuum box arrived in “non-standard” one from the manufacturer!!.
- Manufacturer is excused for this and gave us free replacement but ➔ 8 weeks lead time !!
- Also the motors manufacture did the same but 2 weeks lead time!!
- After installing, baking out and put the system under vacuum, the system need more mechanical consideration.

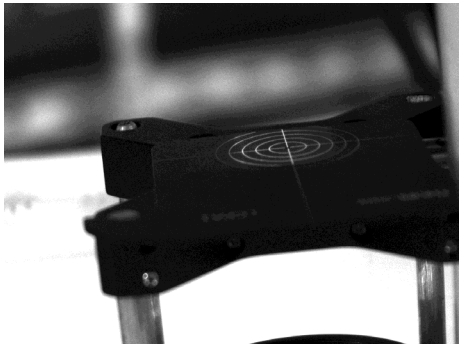


SRM / 1st results

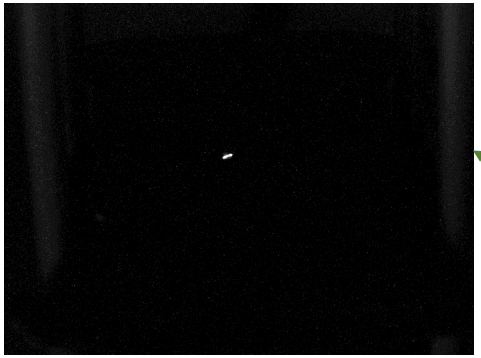
- This is the 1st result from 1st trial! The system need more commissioning and alignment.
- We did some quick measurement when we take a restricted access to the tunnel, to track the beam on the beam line !.





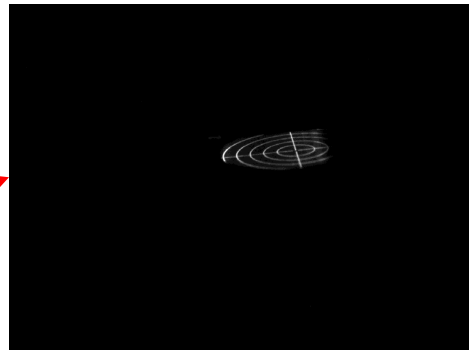


1st Synchrotron Light (800MeV) in SESAME On the SRM Camera



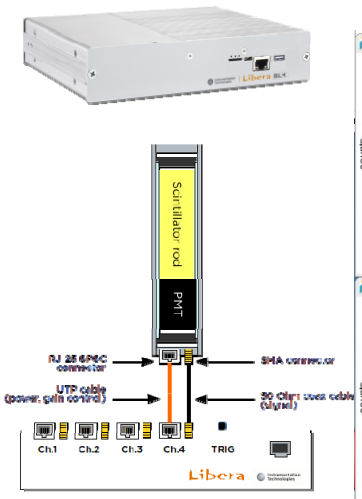
1st Synchrotron Light (2.5GeV) in SESAME The target were put on the intermediate image plane On August 16th ,2017

1st Synchrotron Light (2.5GeV) in SESAME The target were put directly after the in-vacuum mirror On August 16th ,2017



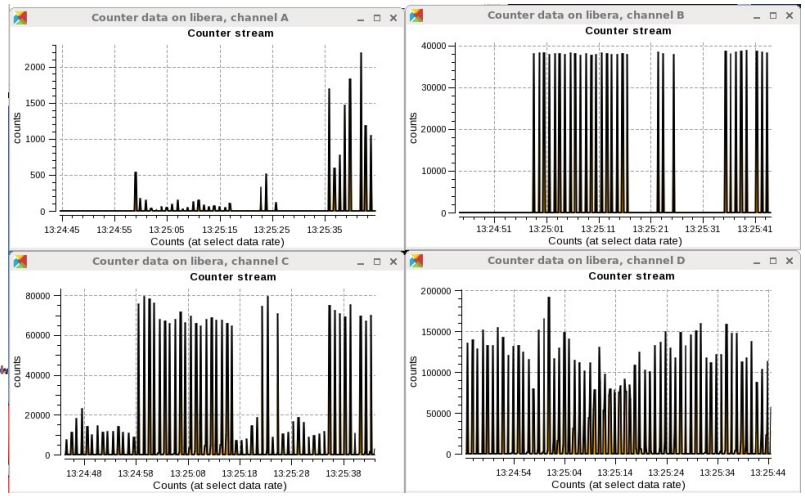
BLM

- Four Beam Loss Detectors (BLD) were installed in the machine and connected to one Beam Loss Monitor (BLM).
- One BLD and BLM are donated from I-Tech as a support to SESAME project.
- The BLDs are installed in 4 cells in the machine, their cables are long ~50m so we can turn them around to see the loses in all the ring.



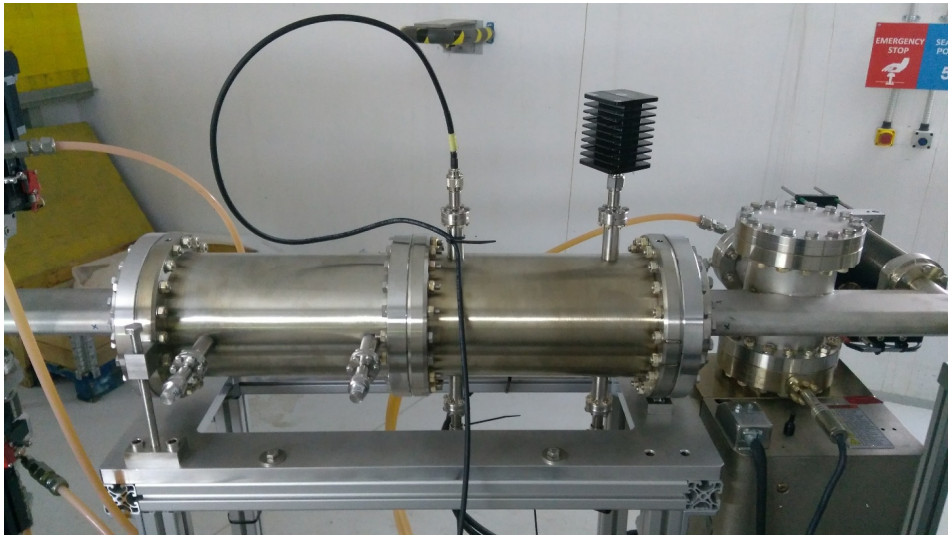
Instrumentation Technologies

Many Thanks!



Others DI

- BbB Kickers used now as beam shaker for tune measurement.
- Vertical Scraper still to be used on next days.
- Both of them are installed in injection section.



What's Next ?

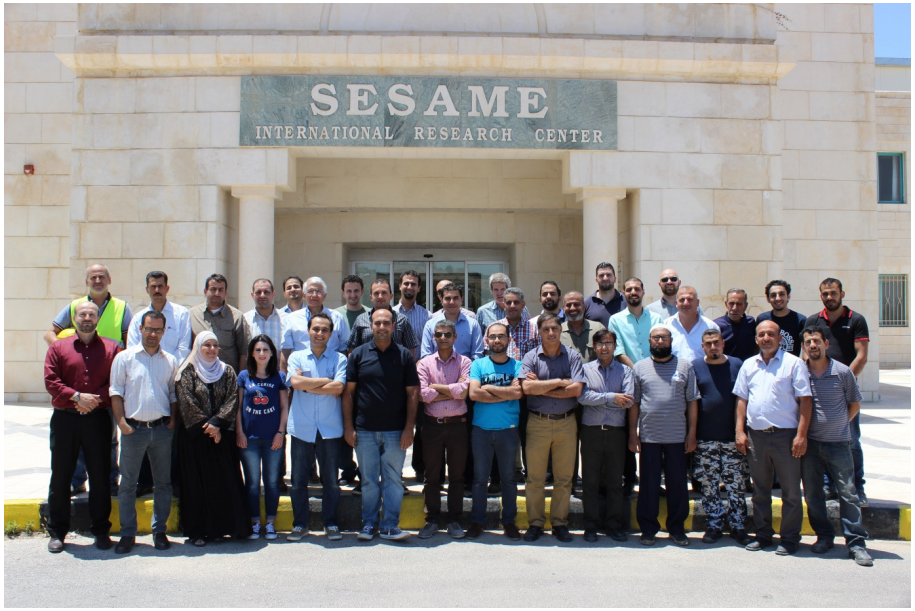
- Still a lot of commissioning to be done!
- Problems to be solved.
- Upgrade SRM and light diagnostics.
- System Improvements.
- BbB feedback and FOFB to be done.
- For phase one, we believe we have the necessary diagnostics!
- We just need to carefully observe them!

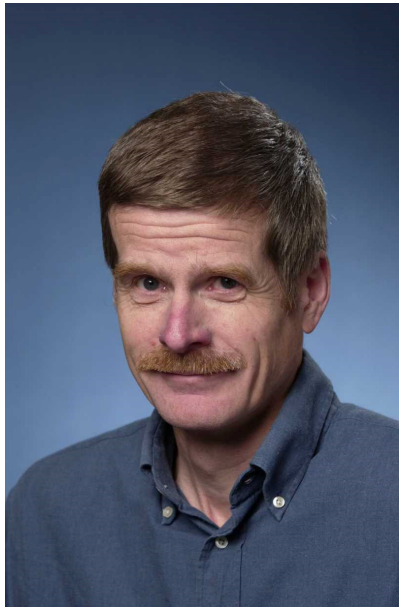
What's Next ?

- 1st Synchrotron Light Source powered by solar power in the world (May,2018).

Acknowledgment

- I would like to thank all SESAME staff and special thanks to our former technical director Erhard Huttel for his hard work and guidance for SESAME technical staff for this achievement.






THANK
YOU
SESAME