Status of SESAME Synchrotron Light Source

H. Tarawneh

Outlines

- Introduction
- SESAME Accelerator Complex
  1- SESAME Storage Ring
  2- SESAME Injector
- Scientific Programme and Beamlines

SESAME STORY

SESAME

Synchrotron-light for Experimental Science and
Applications in the Middle East

1997: Original idea (Voss from DESY, Winick from SLAC); Upgrade/rebuild BESSY 1 (0.8 GeV) in the Middle East, as centerpiece for a new international research center.

1998: The UNESCO agrees to support the project

1999: CDR for BESSY Ia with an extended spectral range, SESAME proposal (Green Book)

1999: Site decision: Jordan, Al-Balqa Applied University

2000: Training Program initiated

2001: Jordan will provide the Land, Building and Conventional facilities.

2002: Shipment of BESSY I to Jordan

2002: Decision to build a new 2.5 GeV ring (still using BESSY injector). Yellow Book.

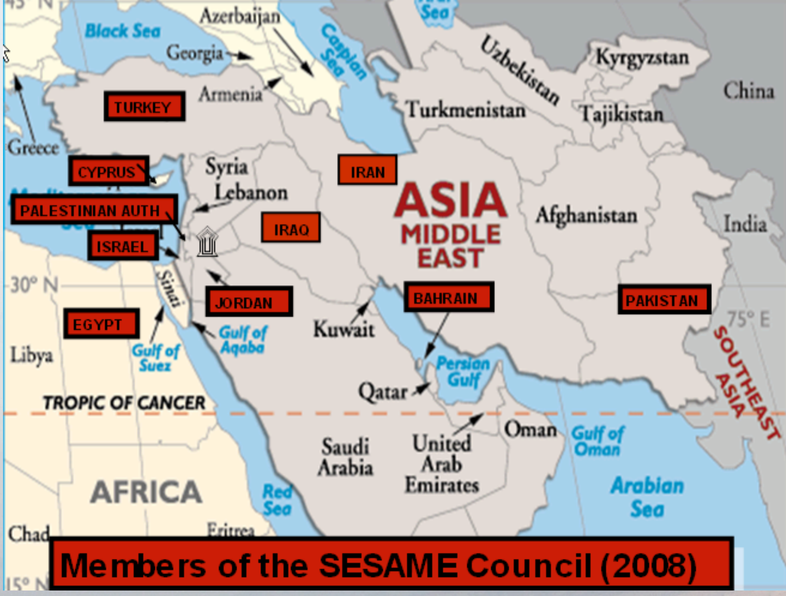
2004: SESAME Centre formal creation.

2008: Building completion.

SESAME Member States:

Jordan, Israel, Egypt, Turkey, Pakistan, Cyprus ,
Iran, Bahrain and Palestine

SESAME



Members of the SESAME Council (2008)

2012: Major Capital Funding

- Jordan, Israel, Iran, Turkey: Each country for 5 year: 1.25 M$/Y
  total: 25.00 M$
- EU/CERN (dedicated for storage ring magnets) 5 M $
- Will allow to finalize the storage-ring and Day-One-Beam-Lines

SESAME FACILITY

BESSY storage ring will not be used.

Main Ring Parameters:

Energy = 2.5 GeV

Circumference = 133.2 m

Emitt. = 26.0 nm.rad

16 Straights sections

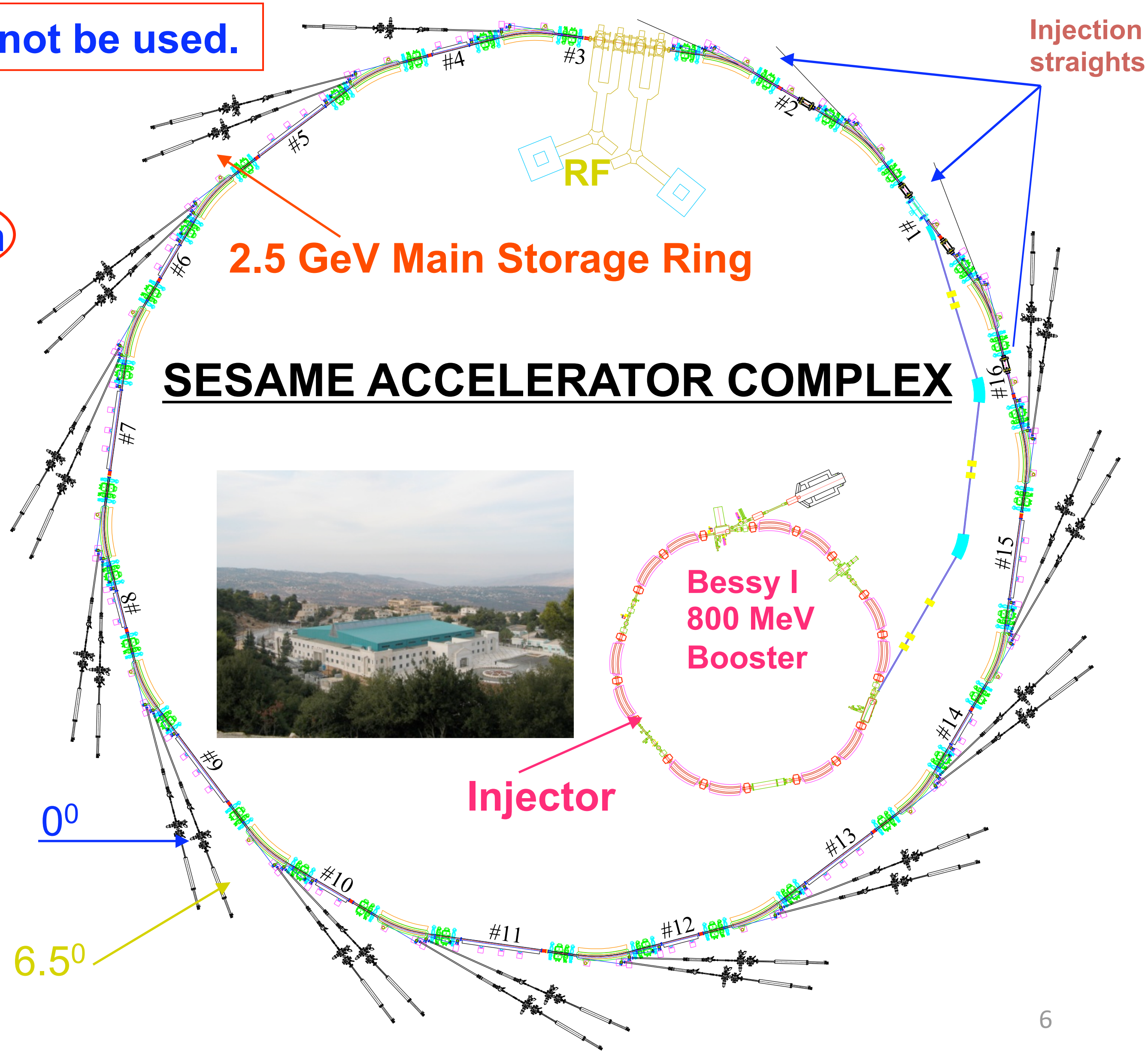
{8 x 4.44 m + 8 x 2.38 m}

Up to 28 Beamlines:

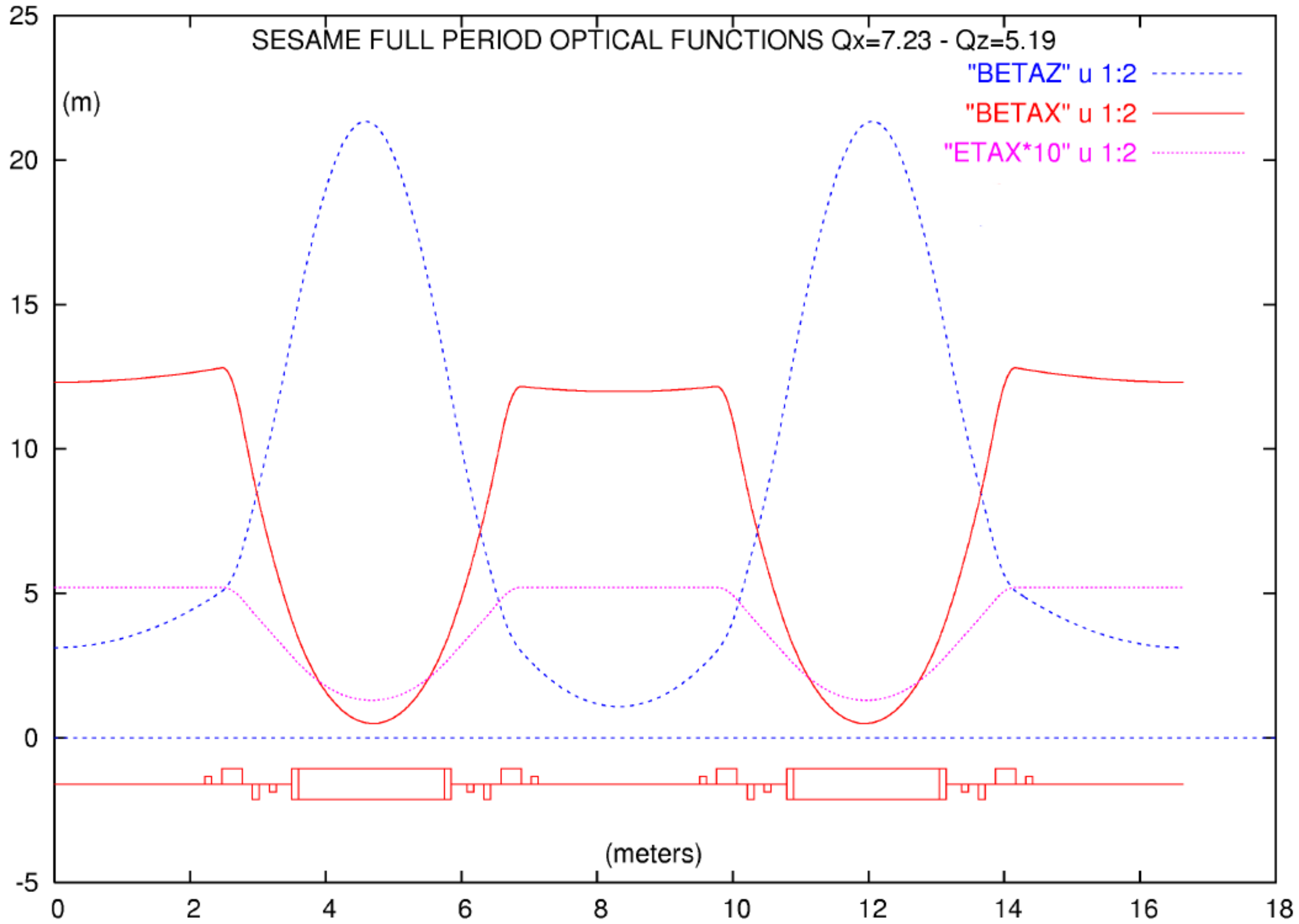
12 Insertion Devices

16 Dipole ports.

Beamlines
length range from
21 m – 36.7 m



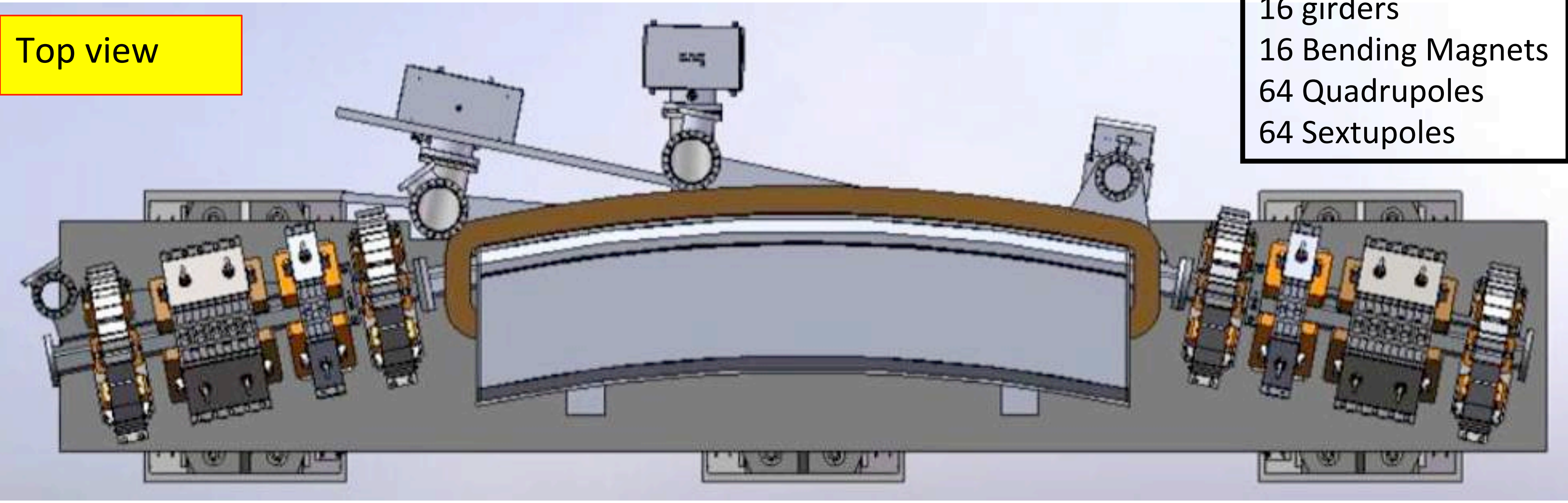
STORAGE RING OPTICS



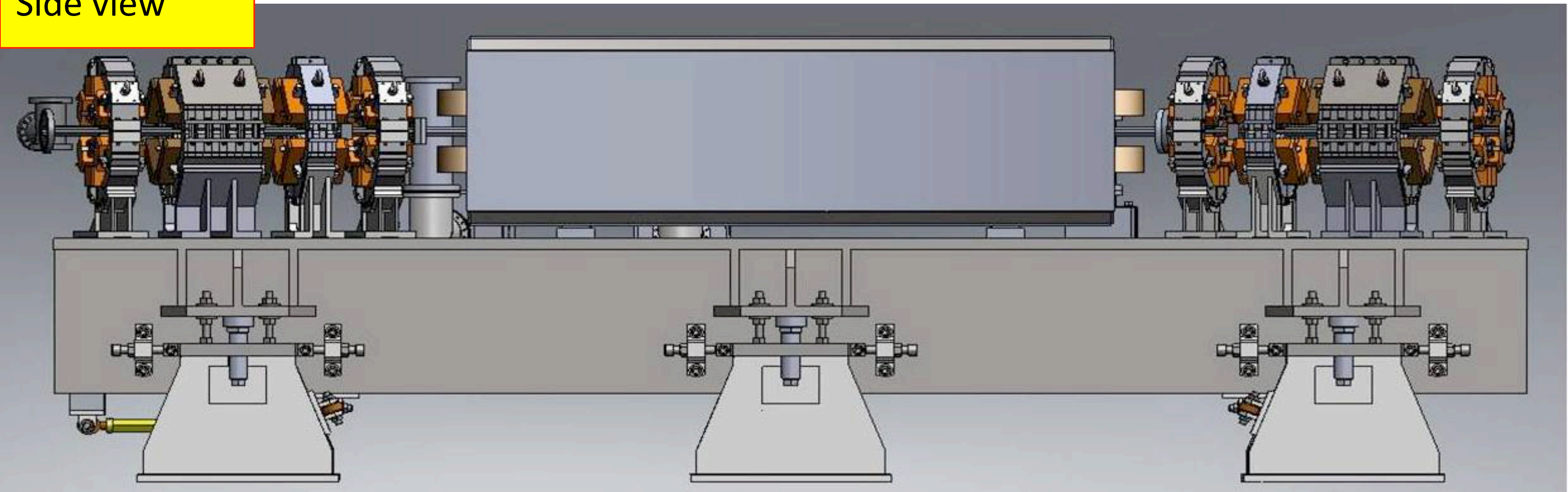
Storage Ring Girder_One Cell

16 girders
16 Bending Magnets
64 Quadrupoles
64 Sextupoles

Top view



Side view



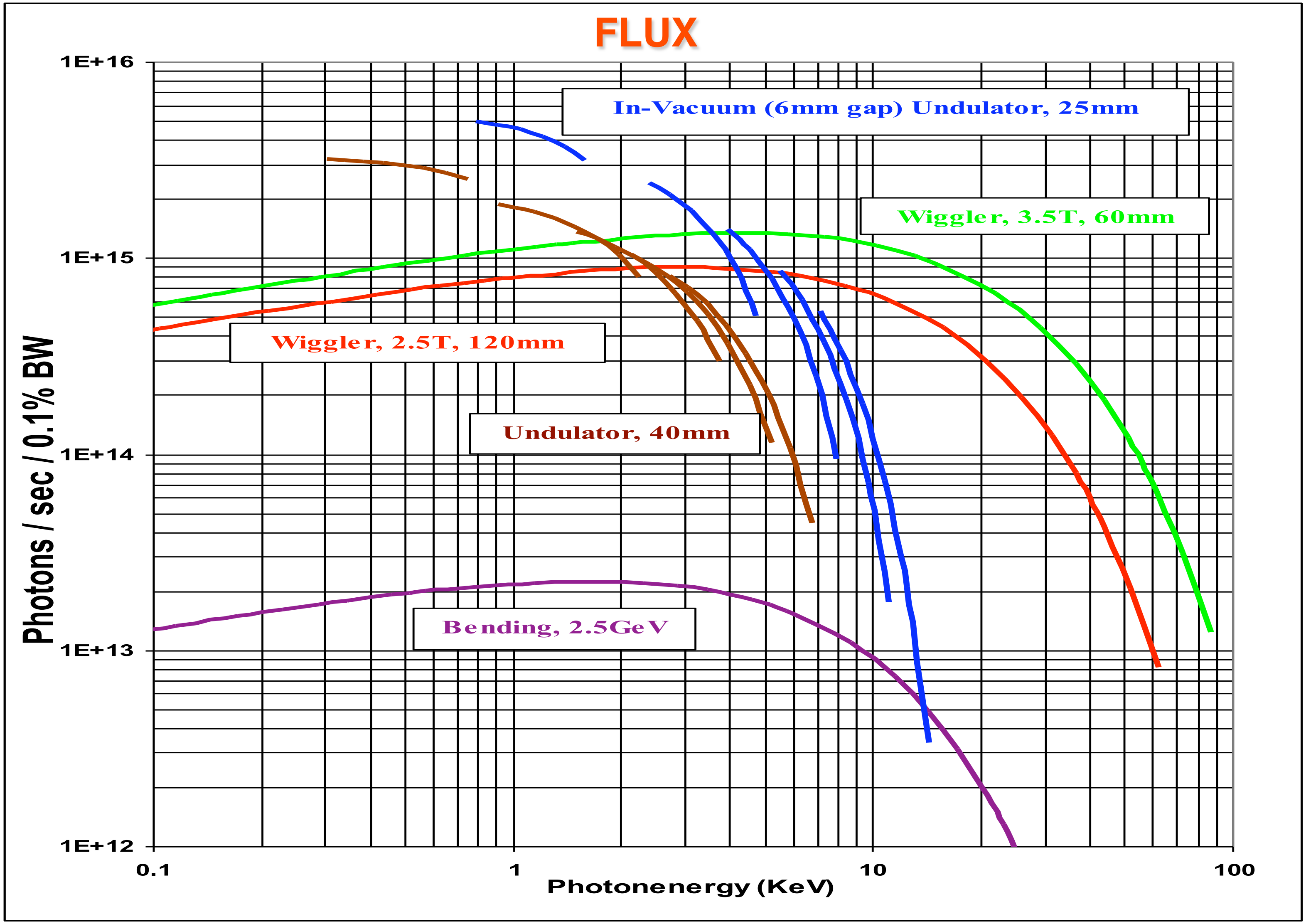
STORAGE RING Main Parameters

Parameter	Unit	Value
Energy	GeV	2.5
Circumference	m	133.2
Maximum Current	mA	400
Bending Dipole field; gradient	T; T/m	1.45545 ; -2.794
Emittance x / z	nm.rad	26 / 0.26
RF frequency ; peak voltage	MHz ; kV	499.564 ; 2.4
Natural bunch length	cm	1.16
Expected Beam Lifetime	h	18

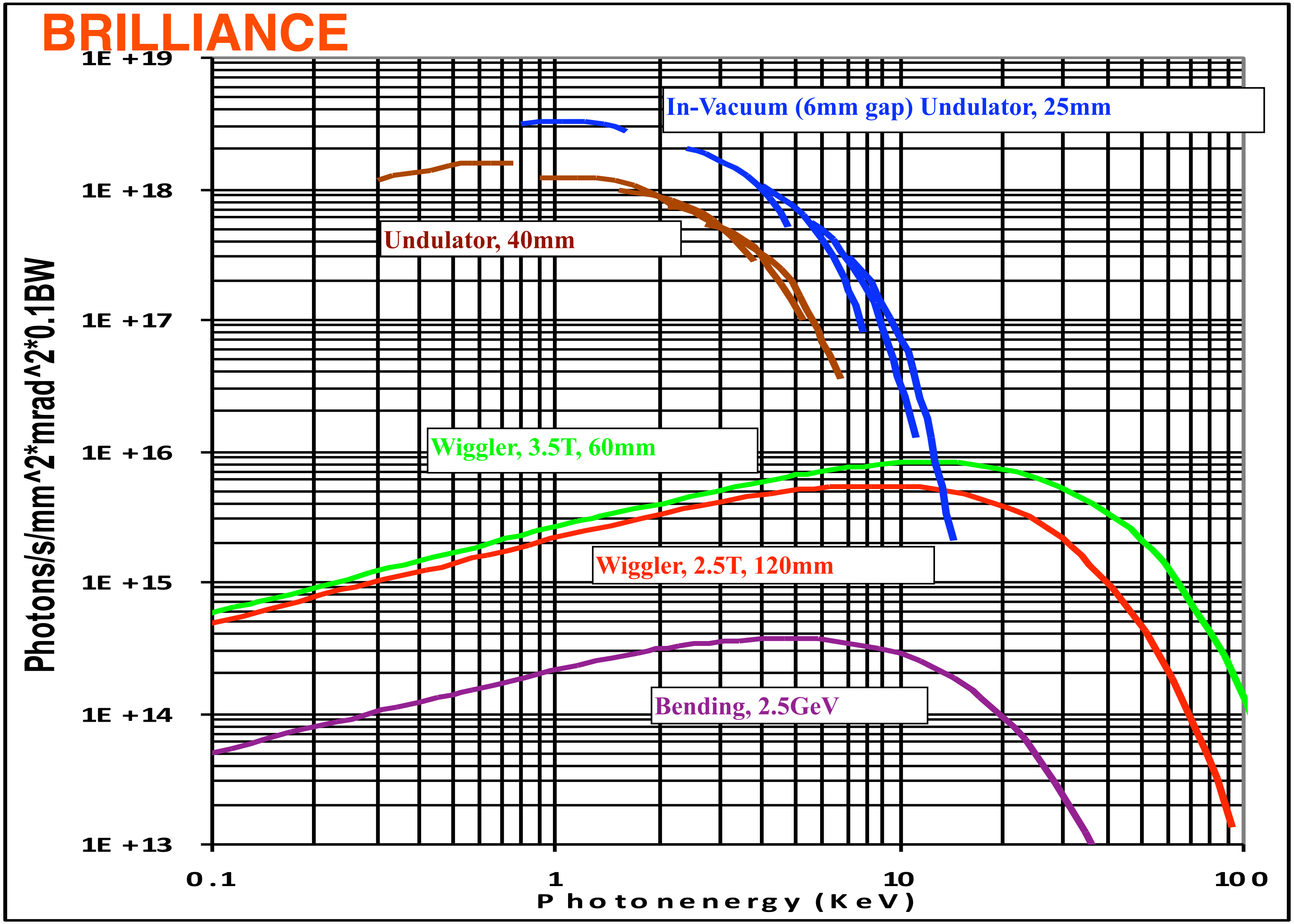
Beam Sizes and Angular Divergences

Horizontal Beam Size (σ_x):			
Long straight /Short straight/ Dipole	**μm**	**794.8/ 789.7/ 232.0**	**827.8/ 822.8/ 231.1**
Vertical Beam Size (σ_z):			
Long straight/Short straight/Dipole	**μm**	**28.1 / 16.6 / 71.5**	**20.6 / 14.0 / 79.5**
Horizontal Beam Divergence (σ'_x):			
Long straight/Short straight/Dipole	**μrad**	**45.3 / 45.9 / 260.9**	**43.5 / 44.0 / 267.1**
Vertical Beam Divergence (σ'_z):			
Long straight/Short straight/Dipole	**μrad**	**9.0 / 15.2 / 12.1**	**12.5 / 18.3 / 13.3**

Radiation from Bending Magnets, Wigglers and Undulators



Radiation from Bending Magnets, Wigglers and Undulators

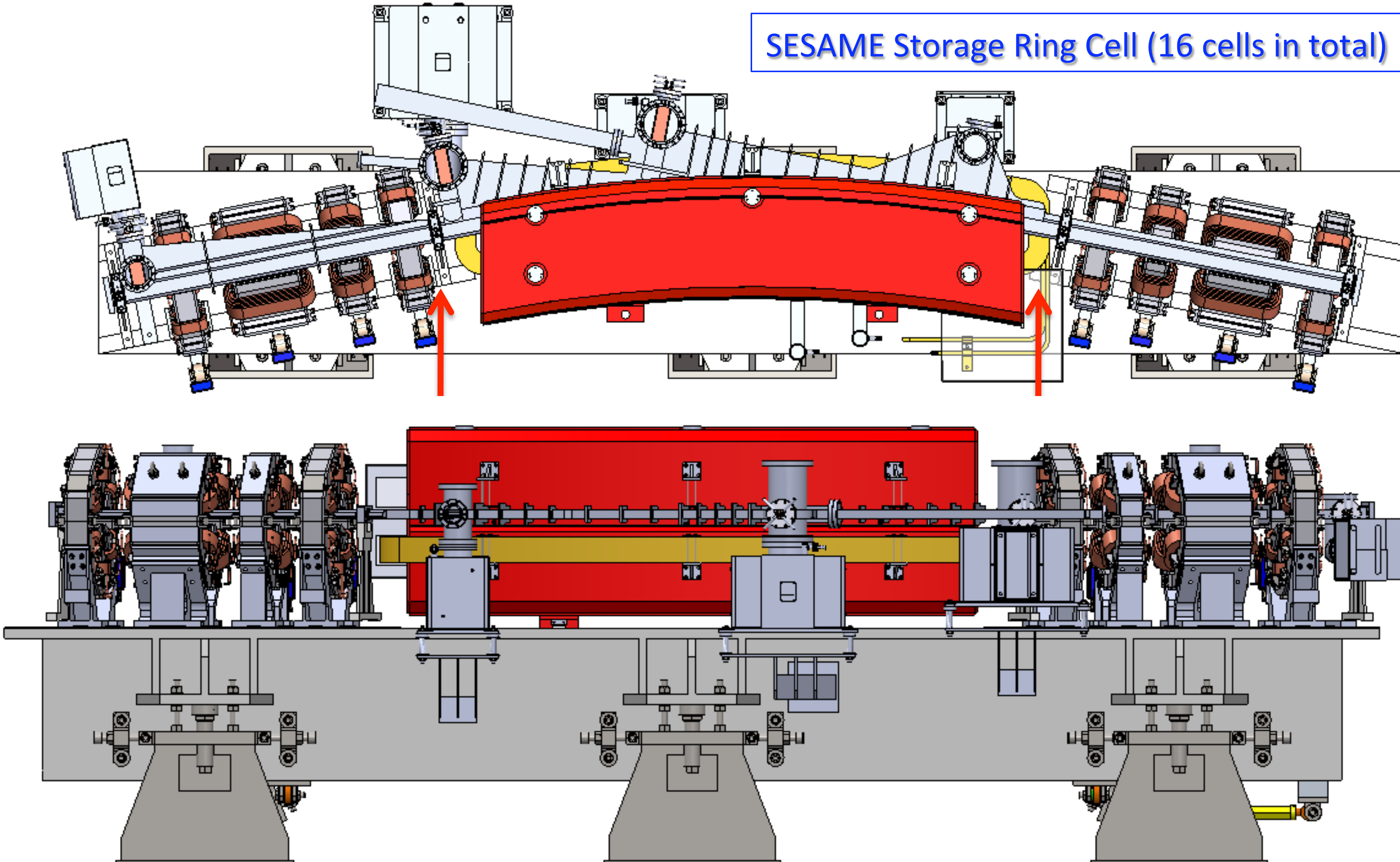


The Radiation Shielding Wall is complete!

BOOSTER TUNNEL

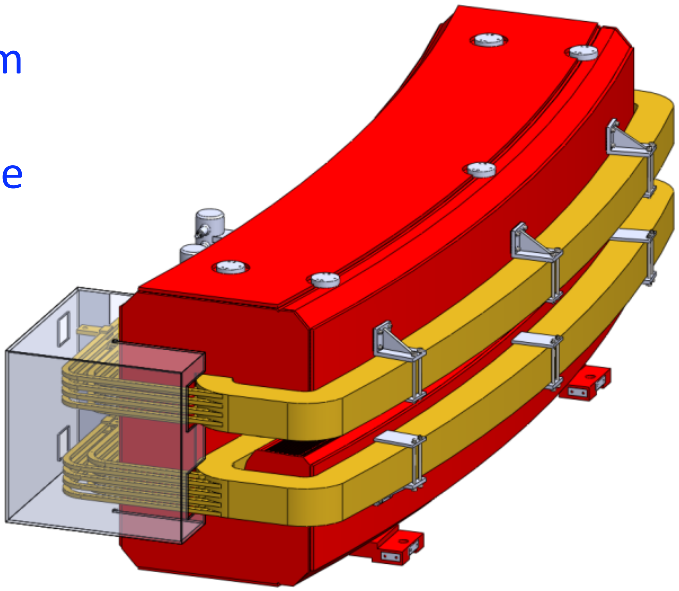
SR TUNNEL

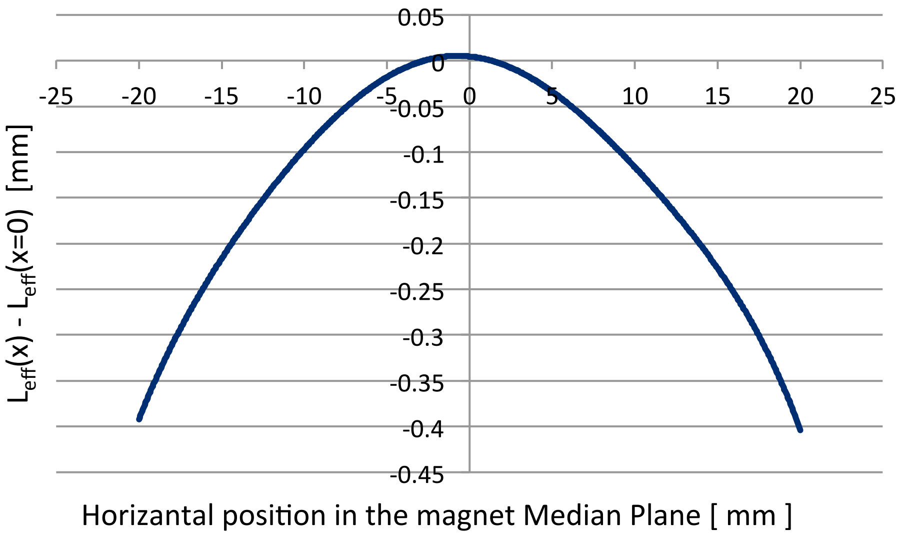
SESAME Storage Ring Magnet System

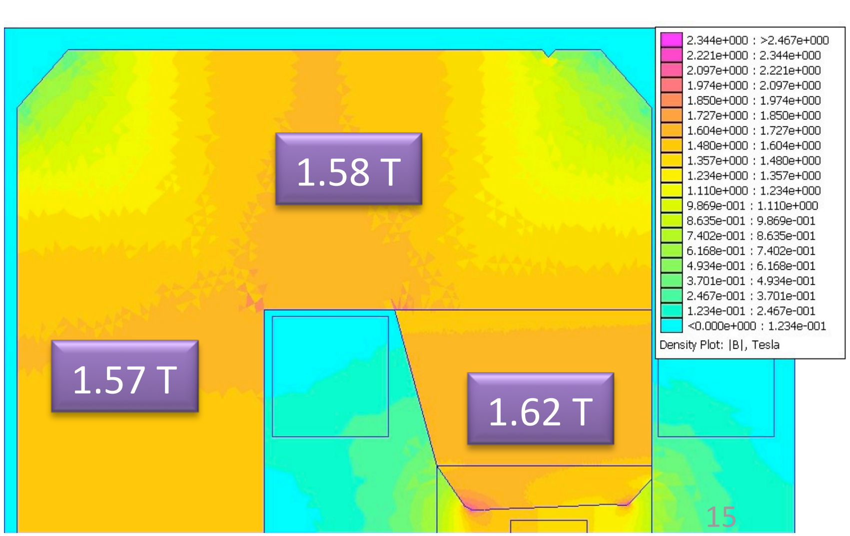


SESAME SR Bending Magnet

- ❑ Optimized cross section with 1.4554 T and -2.79T/m with iron Loss of 3.2 %.
- ❑The “same” effective magnetic length along the transverse position of the electron beam within ±20mm



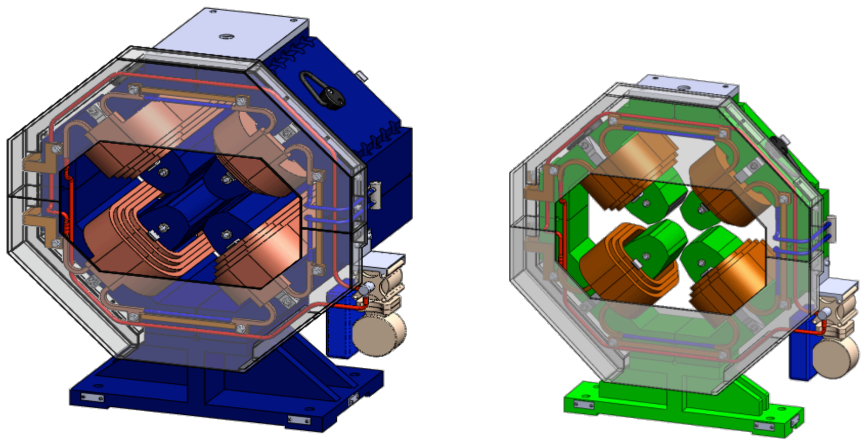


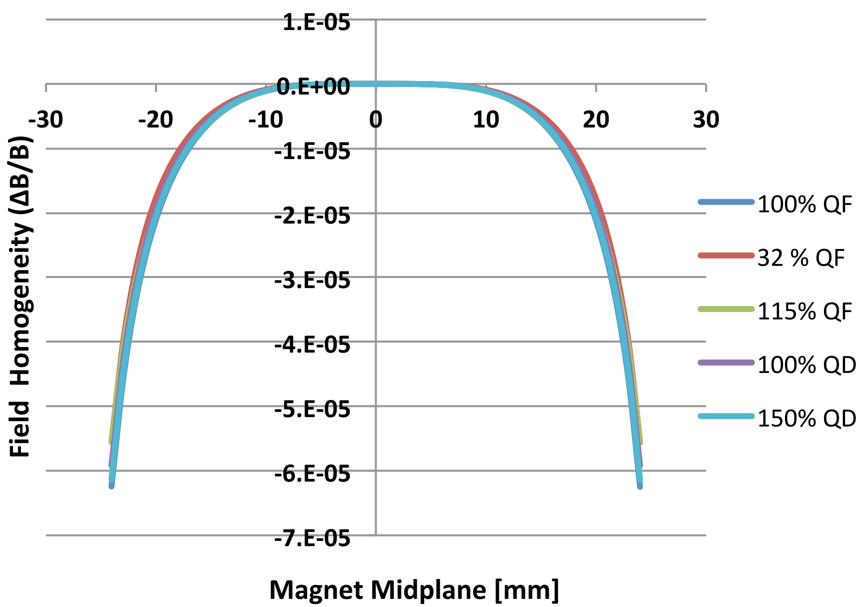


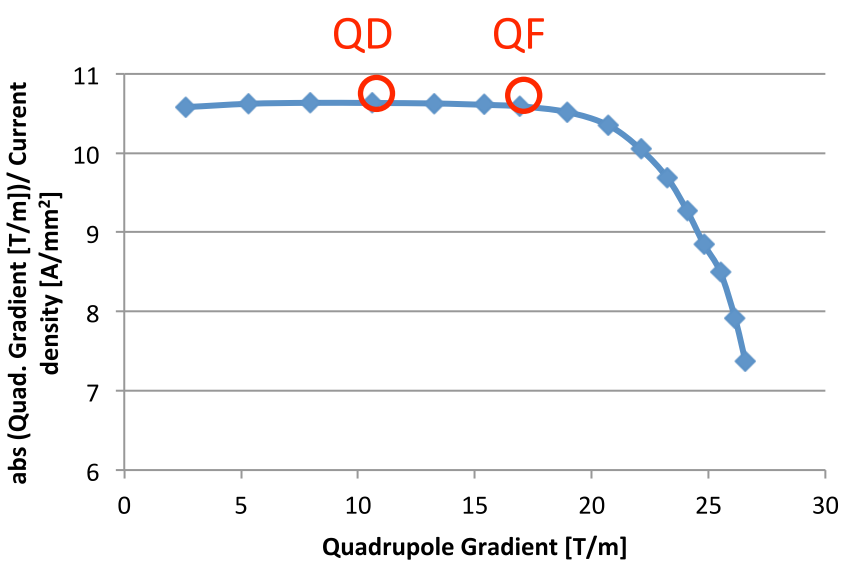
SESAME SR Quadrupole Magnet

- An iron length of 100 mm for QD (10T/m) and 280mm for QF (17T/m) with same lamina.

- Power supplies ratings will be for 115% of the nominal quadrupole strength value for QF and 150% for QD.
- Unsaturated up to 21T/m (20%)



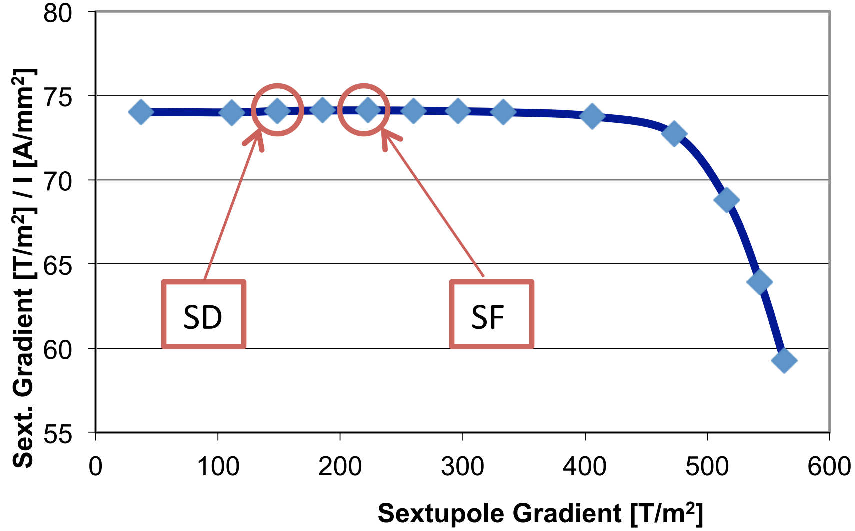


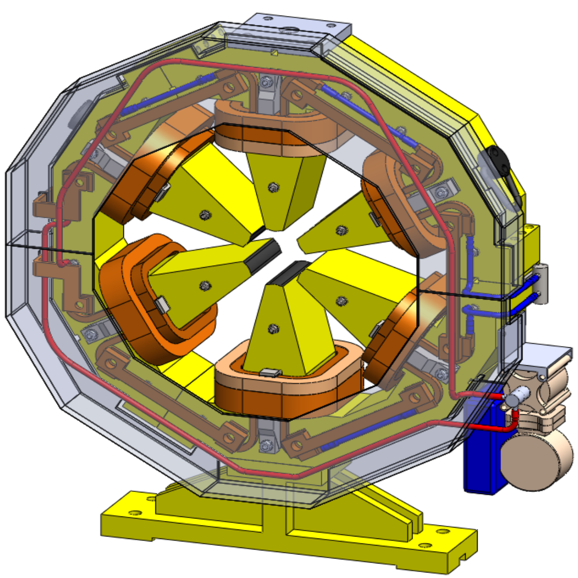


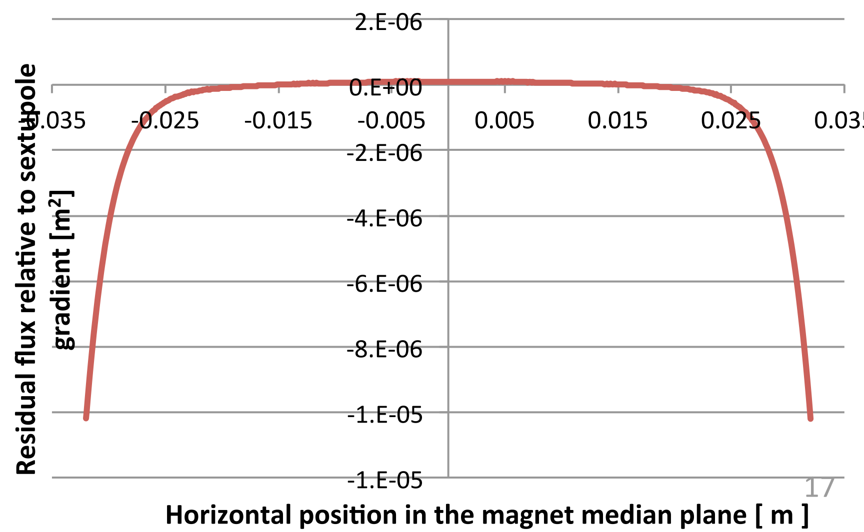
SESAME SR Sextupole Magnet

- ❑ Minimum iron length of 100mm SF and SD with same lamina cross section.
- ❑ Chromaticity of +1 in both planes SD=220T/m^2 and SF=150T/m^2.
- ❑ Max. 25% increase in power supplies rated power.
- ❑ Correctors and skew quad coils integrated in both families.

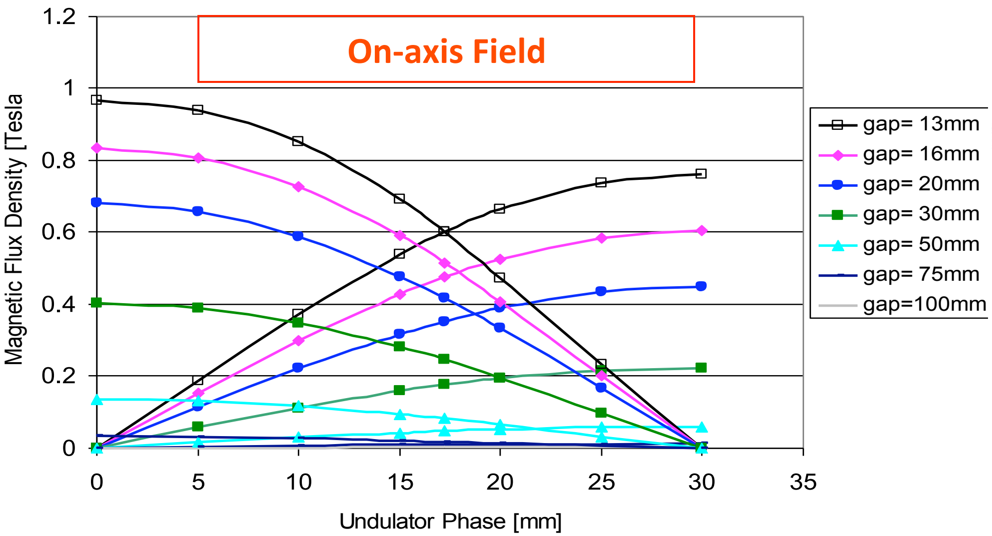
Unsaturated up to 470T/m^2 (53%)

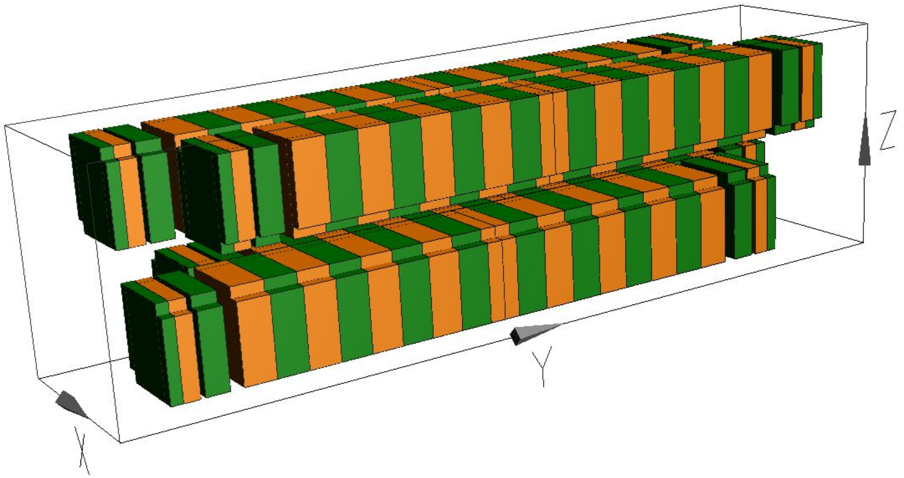


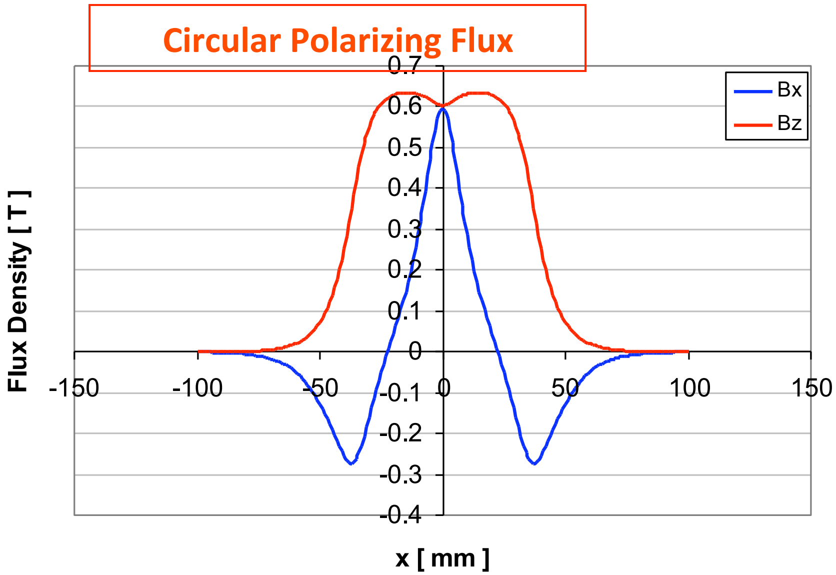


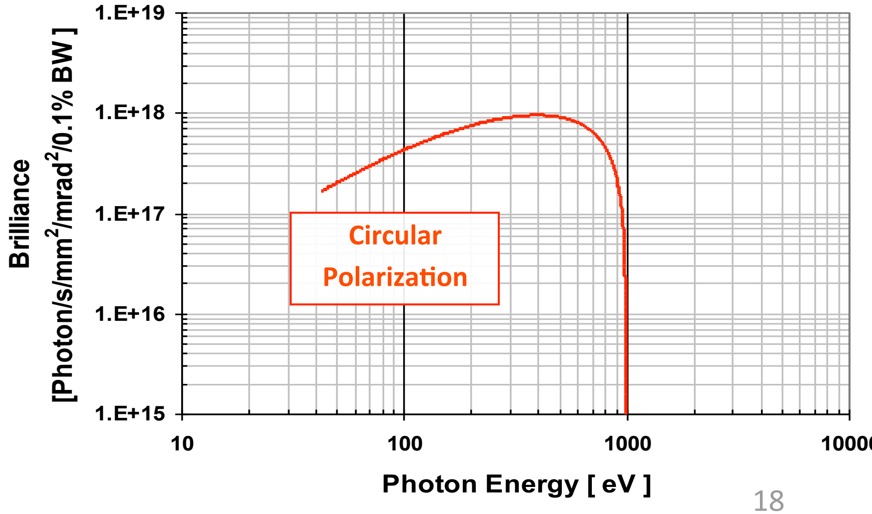


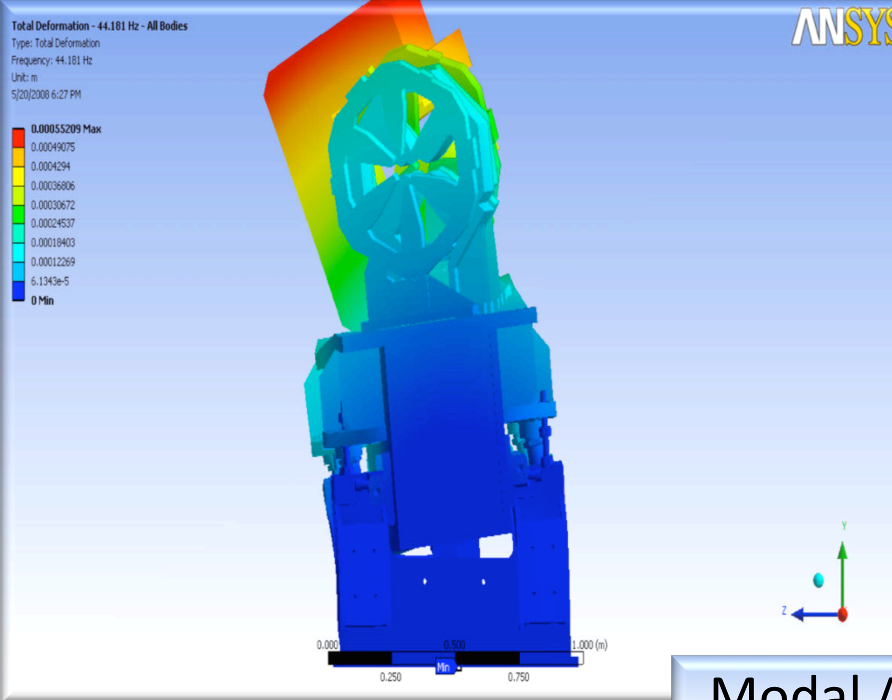
Conceptual Design Study: EPU for SESAME

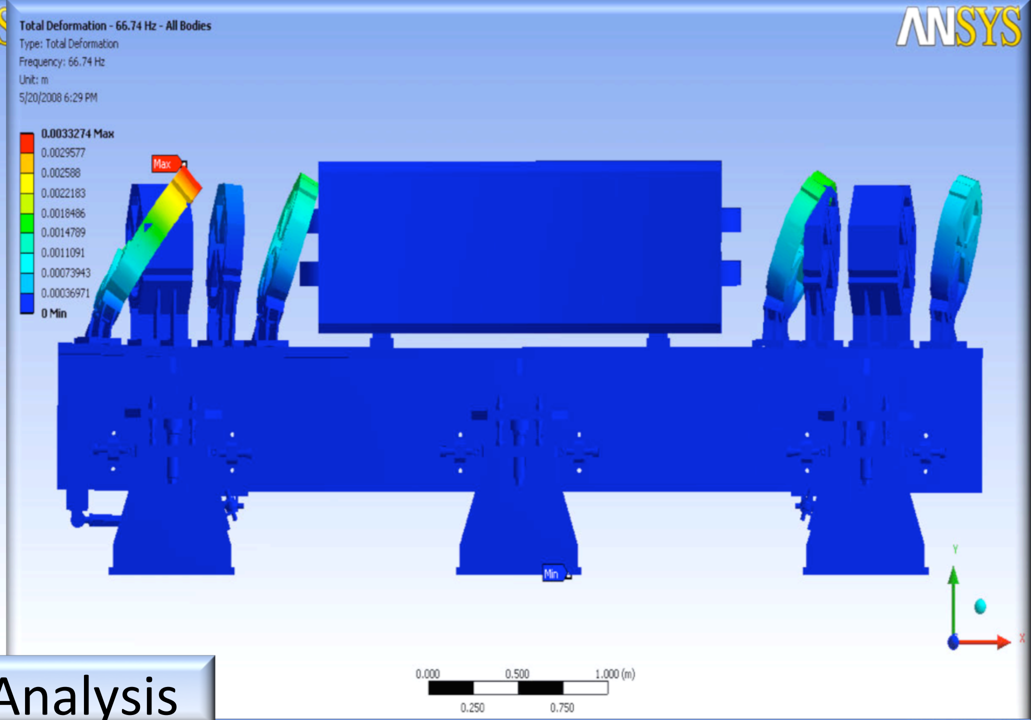




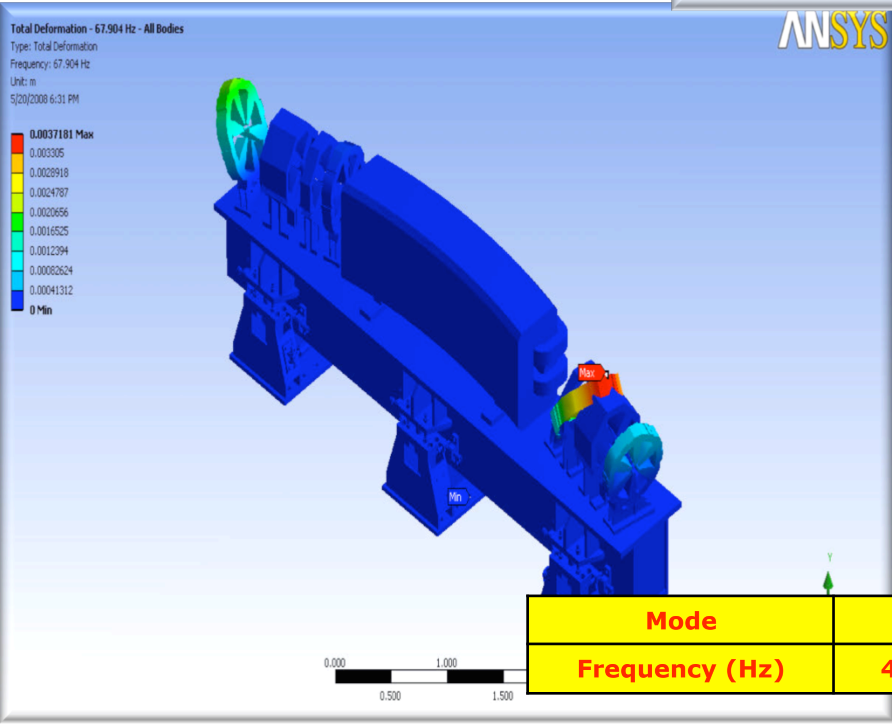


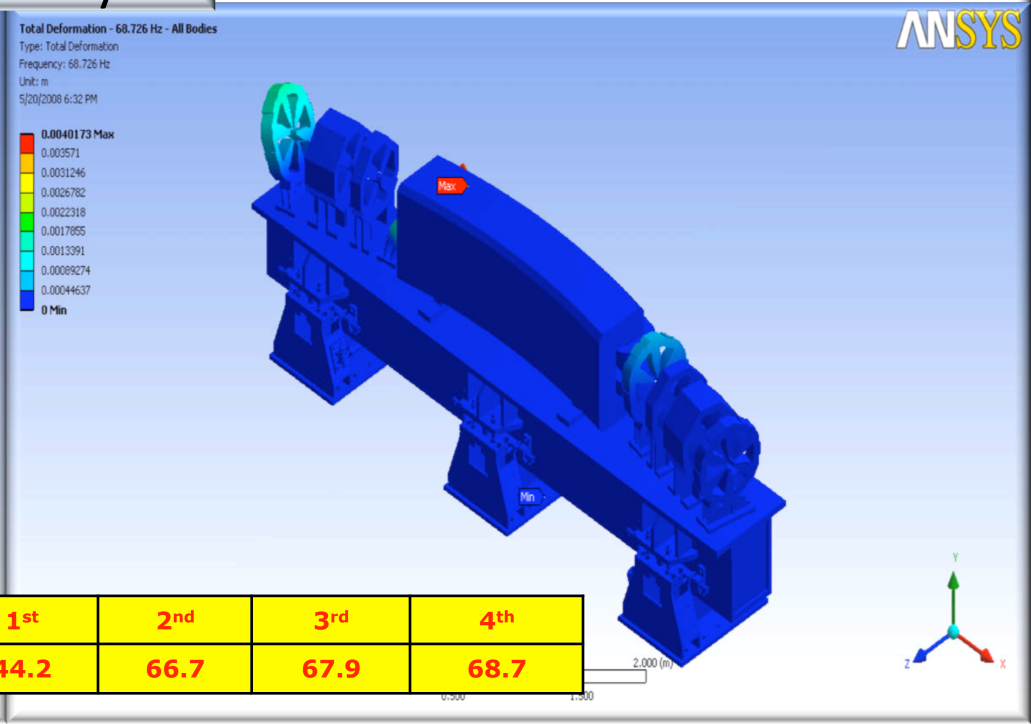






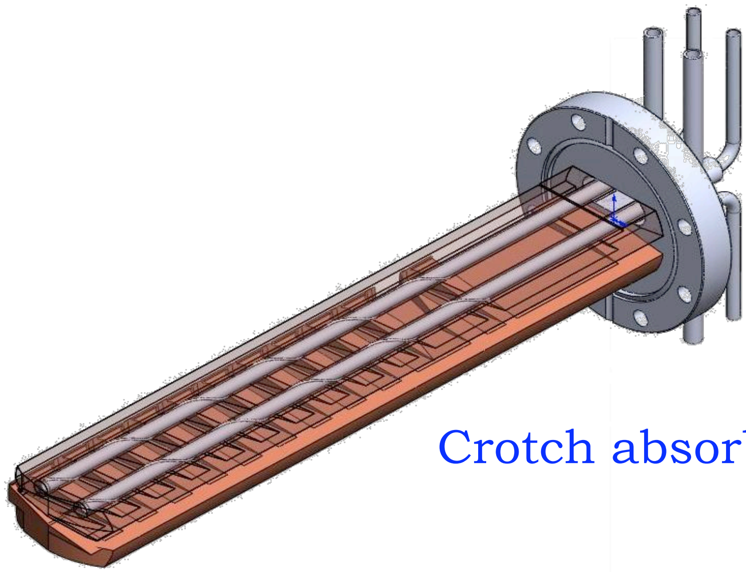
Modal Analysis



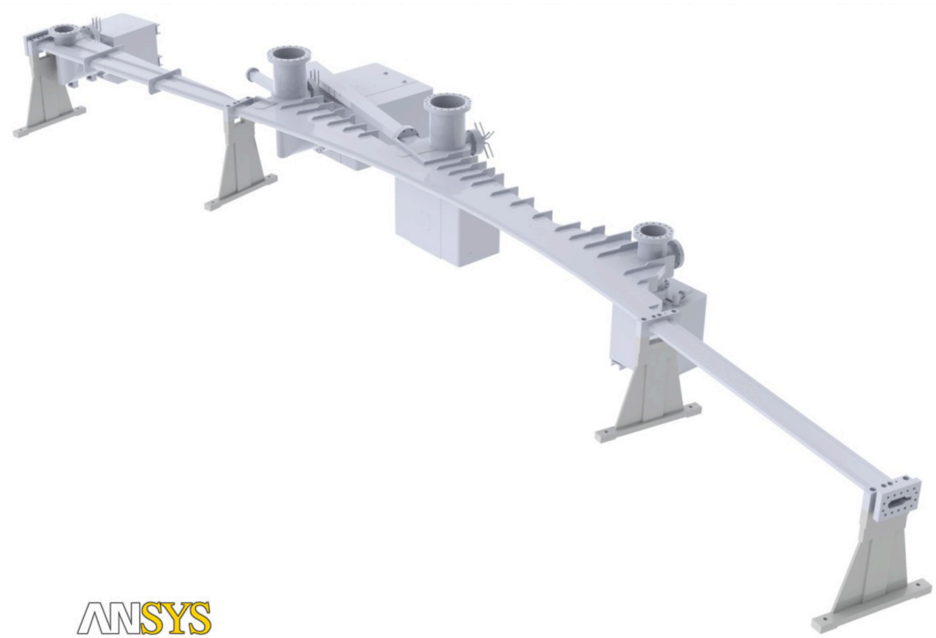


Mode	1st	2nd	3rd	4th
Frequency (Hz)	44.2	66.7	67.9	68.7

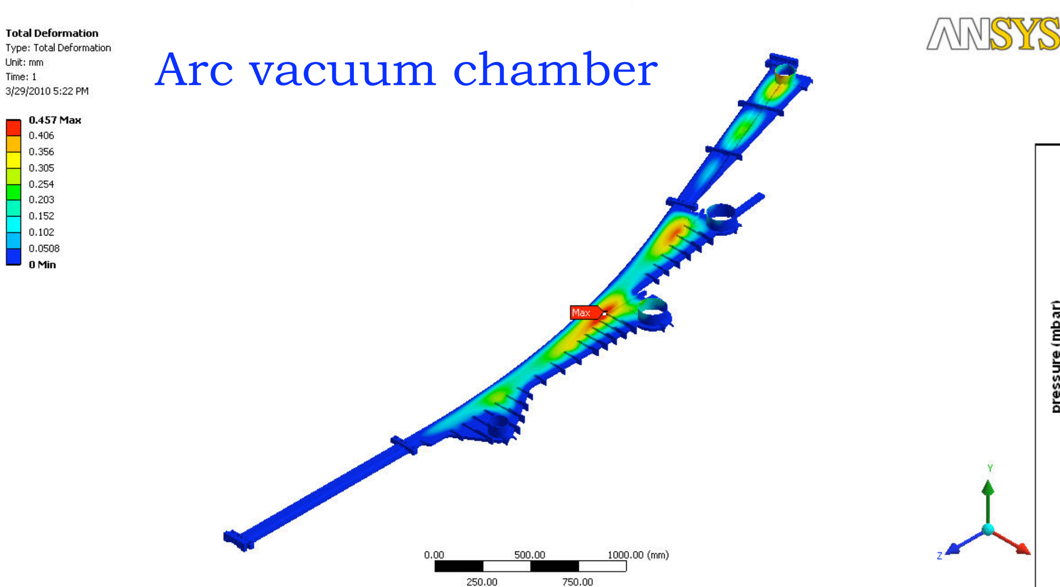
SESAME Storage Ring Vacuum System



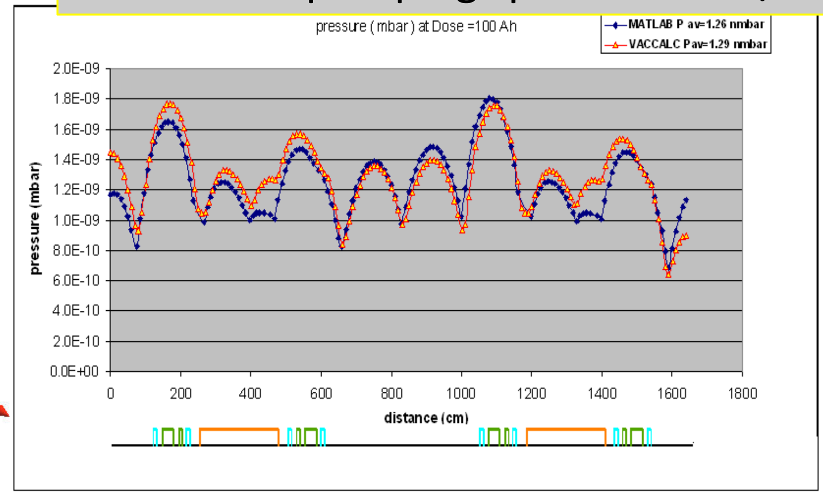
Crotch absorber



Arc vacuum chamber

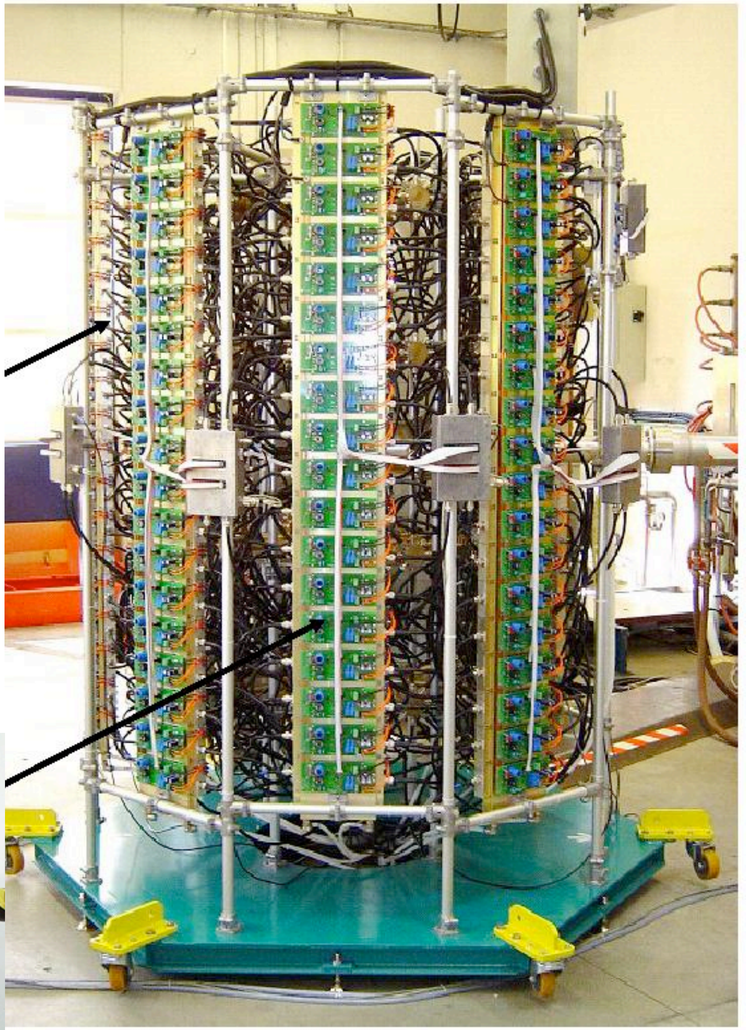


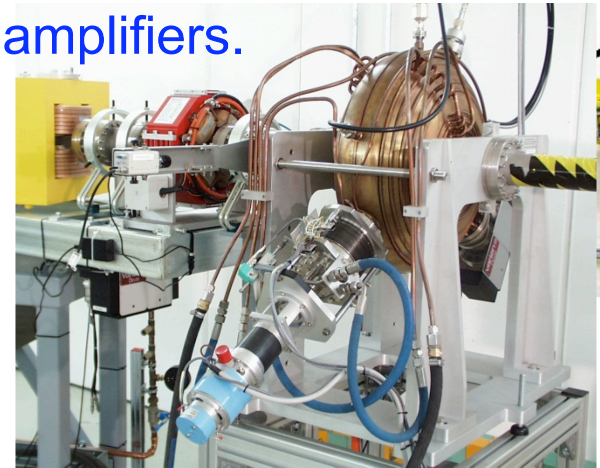
SR nominal pumping speed 20400 l/s



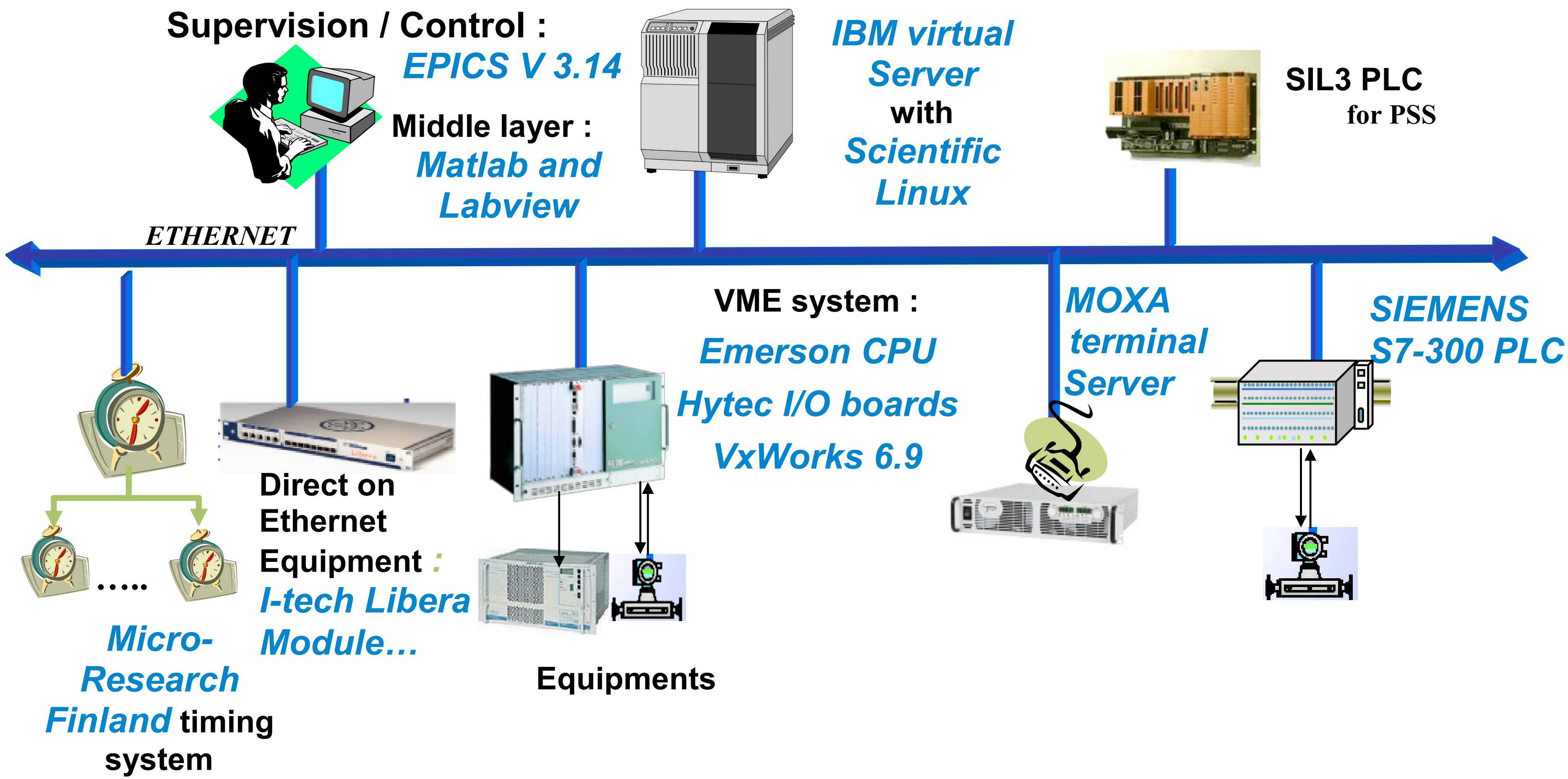
STORAGE RING RF

- The RF system is based on ELETTRA type cavity
- 2 RF cavities of ELETTRA (4 is needed for nominal performances)
- Storage ring RF system in phase 2, i.e. feeding 4 cavities each by 150 kW.
- Collaboration with SOLIEL to build 500 MHz Solid state amplifiers.

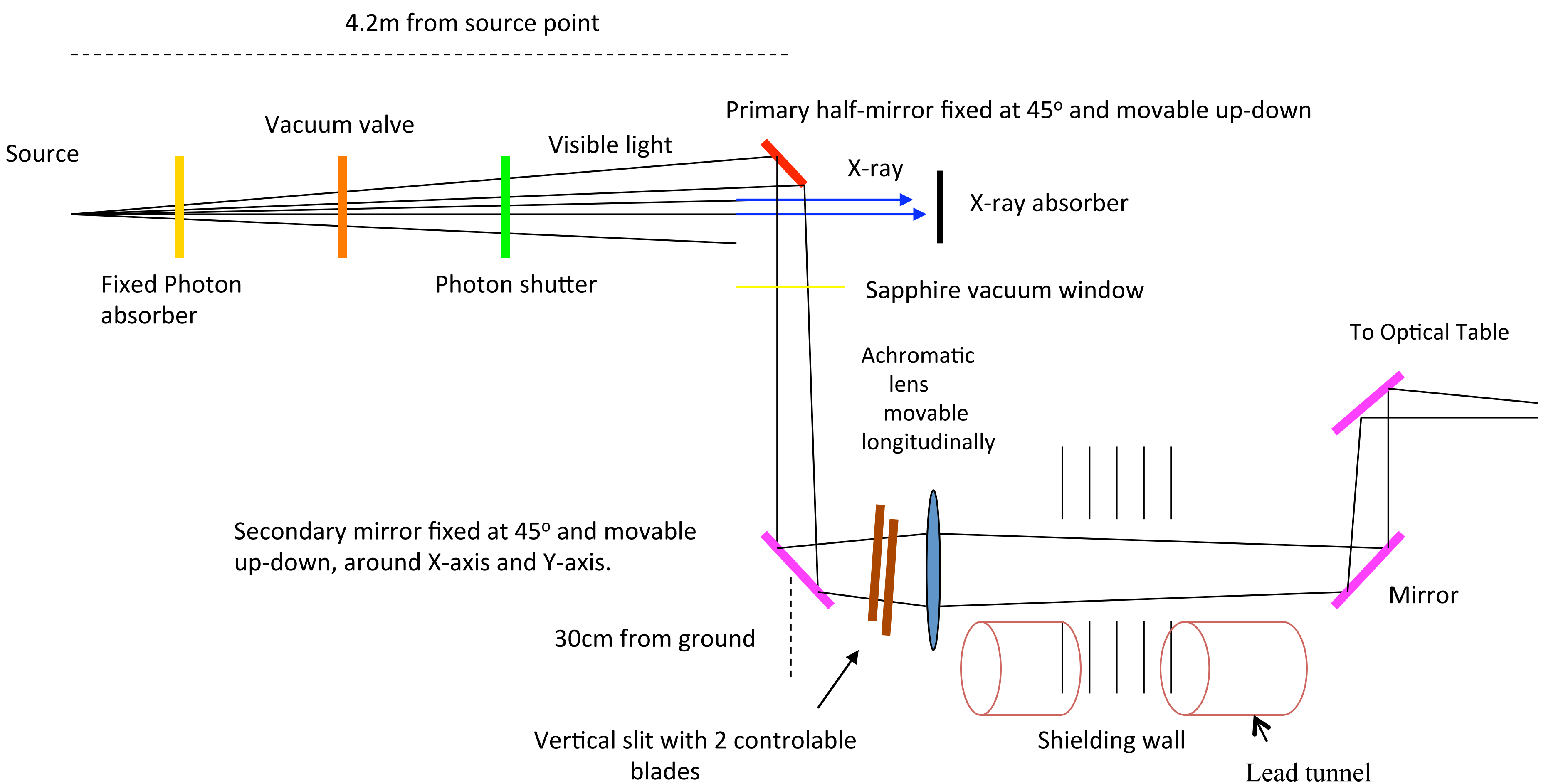




CONTROL SYSTEM



Machine Visible Light Diagnostics beamline



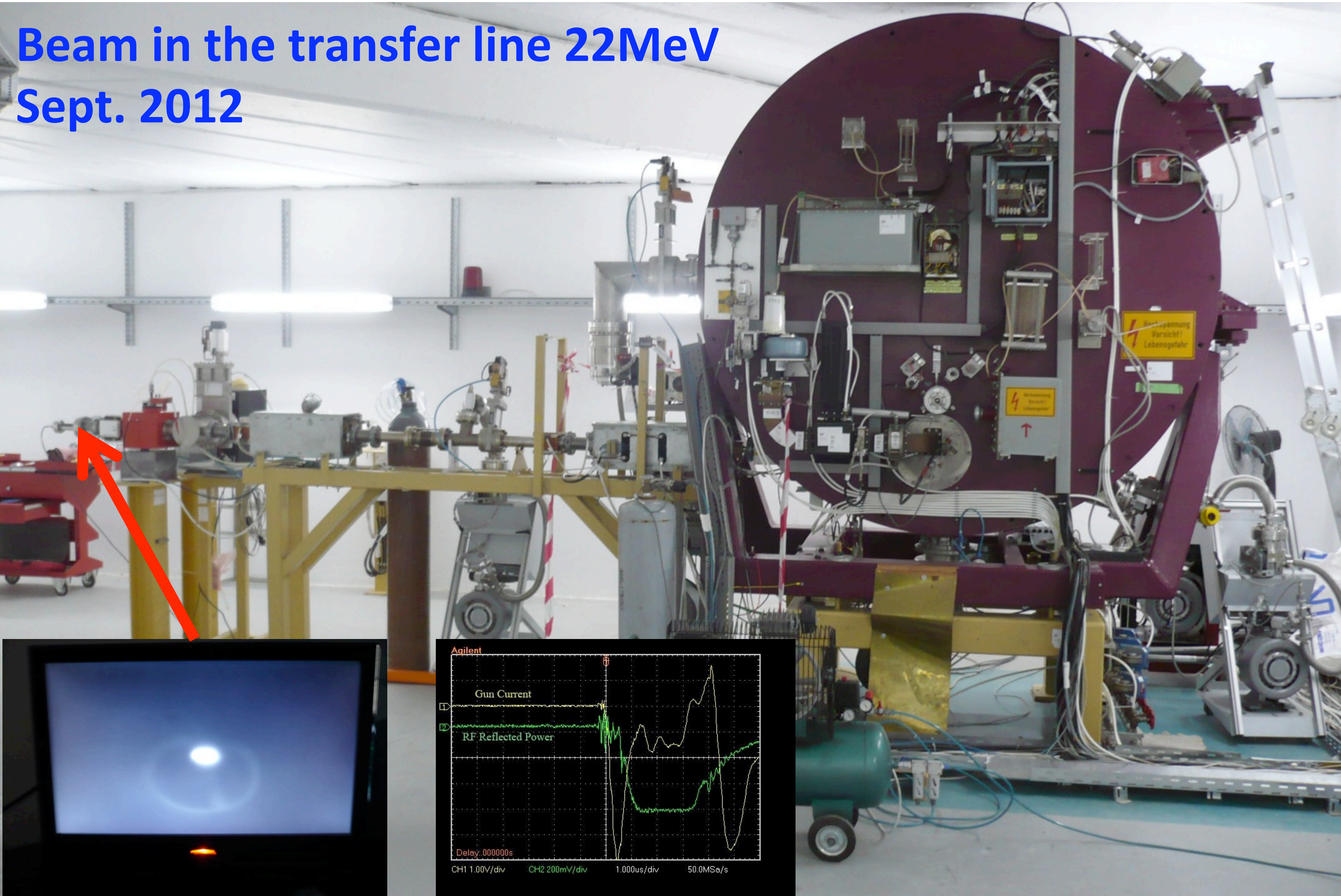
Total beamline length = 2 [4.2m (source-1st mirror) + 1.1m (1st-2nd mirror)+0.4m (1st mirror-lens)] =11.4 m.

Injector

Microtron & Booster Synchrotron

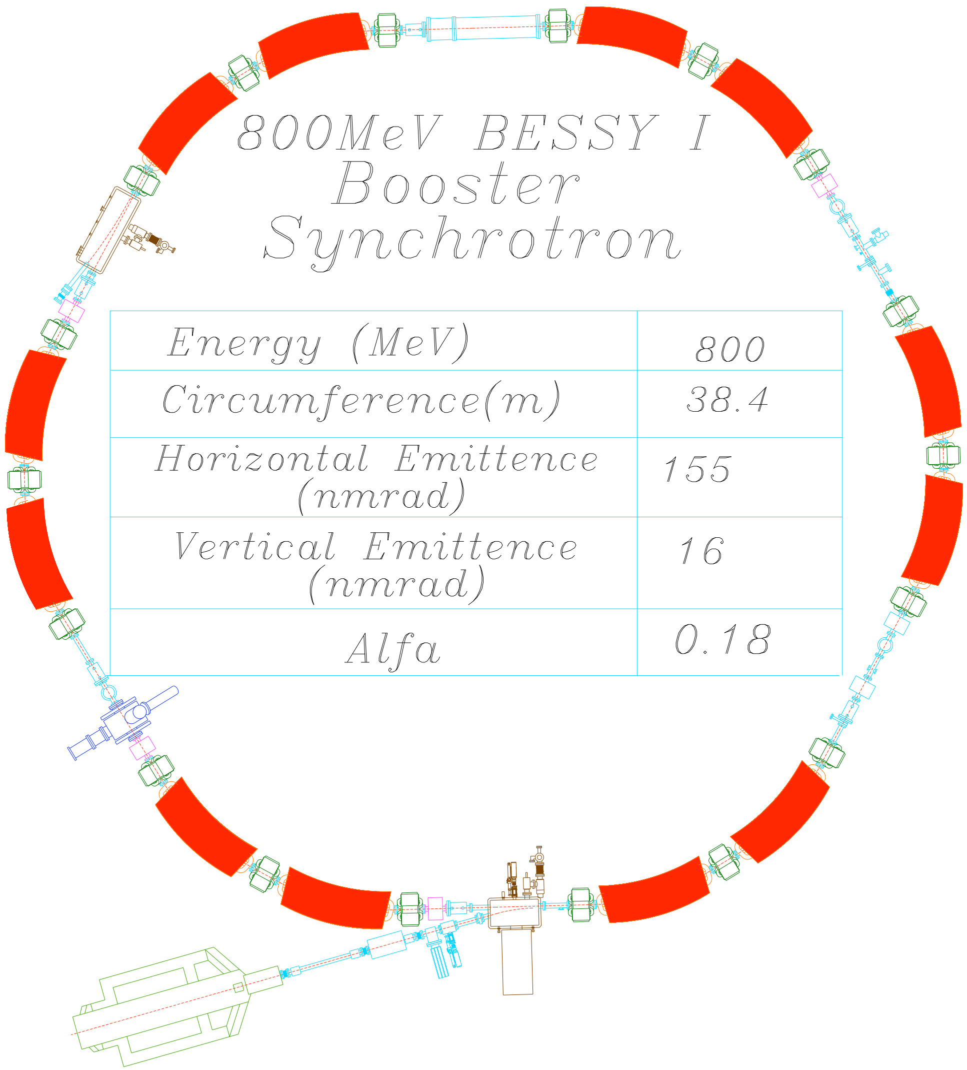
Microtron in Operation

Beam in the transfer line 22MeV
Sept. 2012



Booster Parameters

Maximum energy , *MeV*	800
Injection energy , *MeV*	20
Circumference , *m*	38.4
Super periodicity	6
Number of bending magnets	12
No. of focusing quadrupoles	12
No. of defocusing quadrupoles	6
Repetition rate , *Hz*	1
Horizontal tune , Q_x	2.22
Vertical tune , Q_y	1.30
Momentum compaction factor α	0.18
Harmonic number	64
RF-frequency , *MHz*	500
RF-output power , *kW*	2
Cavity shunt impedance , *MΩ*	3
Current @maximum energy , *mA*	7
Vertical emittance , mm-mrad	0.016
Horizontal emittance , mm-mrad	0.155



Booster Installation

❖ Major Upgrades:

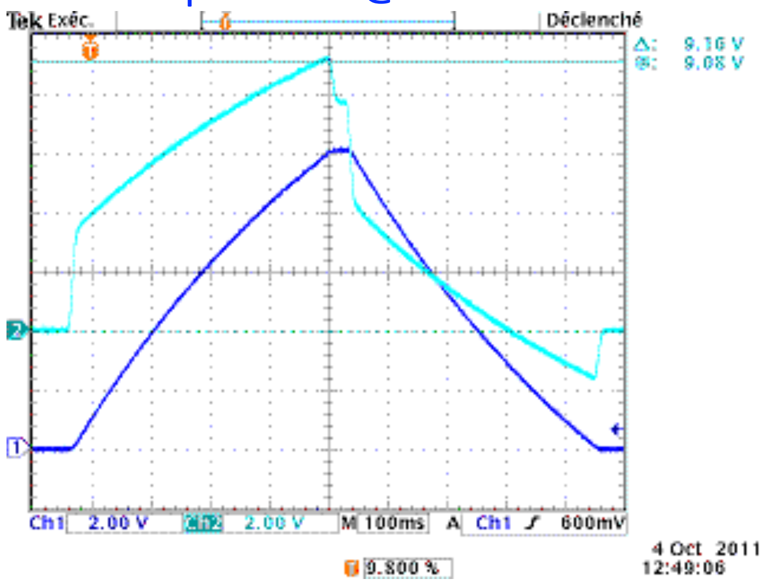
1. New DC & Pulsed Power supplies.
2. New vacuum system (VC, IP,…).
3. Control and Timing system.
4. New Diagnostics.

❖ Installation started June 2012.

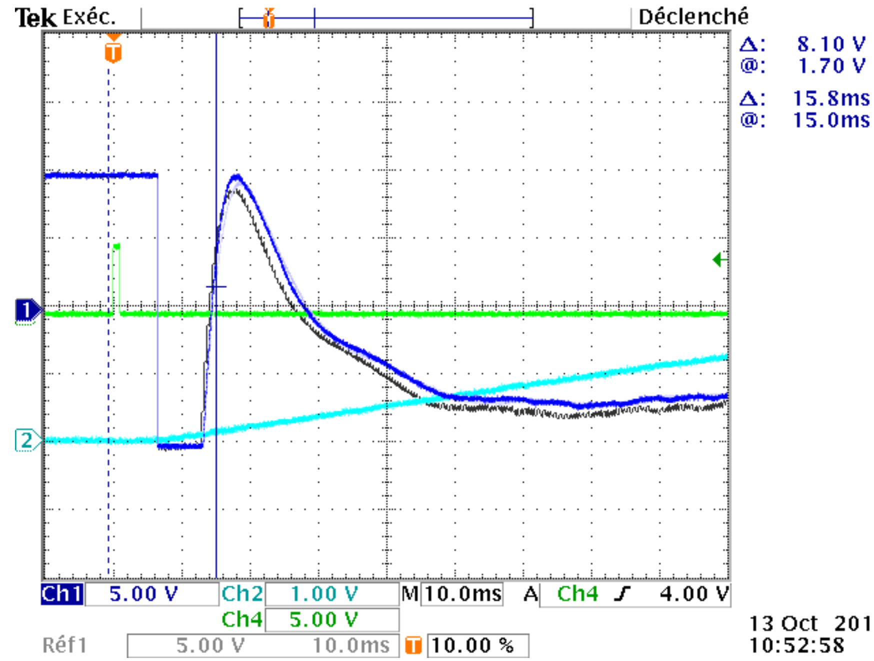
Booster Power Supplies Site Acceptance Tests

Conformity of the power supplies with the technical specifications.

Operation @ 1 Hz



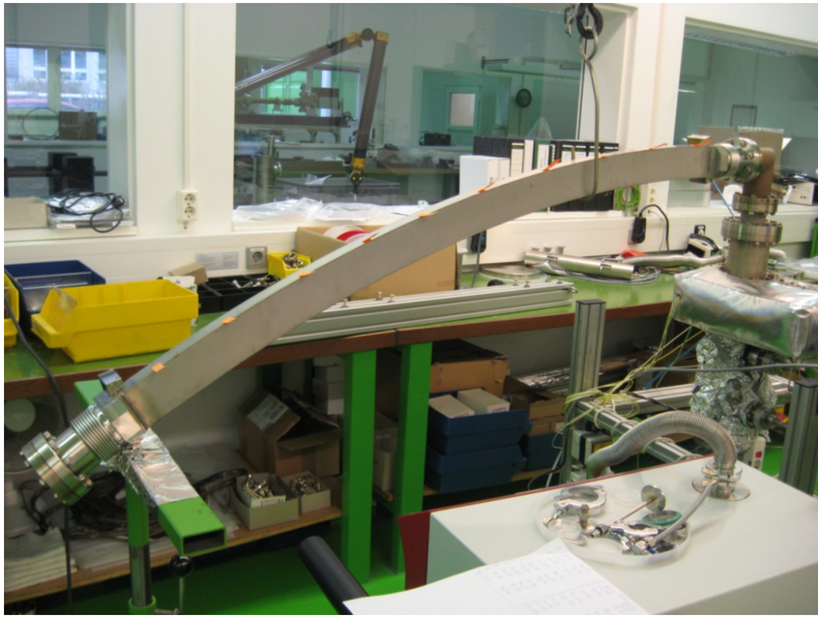
Tracking measurement

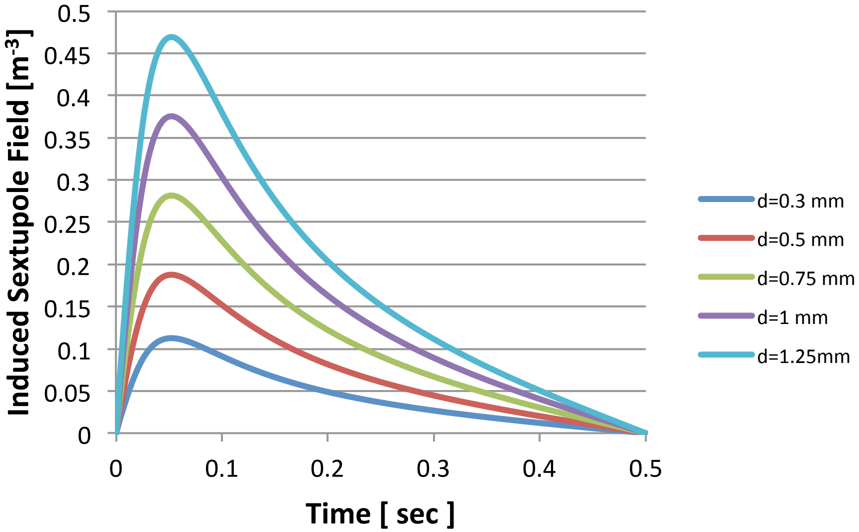


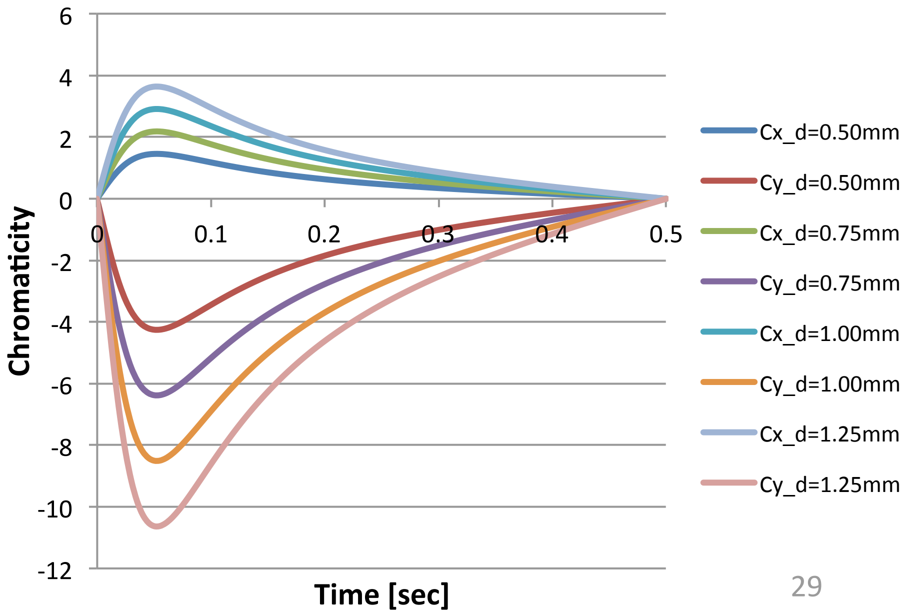
As for the tracking QF vs Dipole, once the offset is tuned on the quadrupole power Supply, the tracking error measurement (+/-2.10^{-3}) remains very stable while the power supplies are running.

New Vacuum Chamber of Booster

- ❑ Rep. Rate of 1 Hz instead of 10 Hz.
- ❑ All vacuum chambers of bending magnets are going to be changed with different wall thickness. As a result the induced sextupole field budget will be changed, i.e. chromaticity change.
- ❑ Chamber thickness of 1mm instead of 0.3mm of the old one.







Scientific Programme @ SESAME

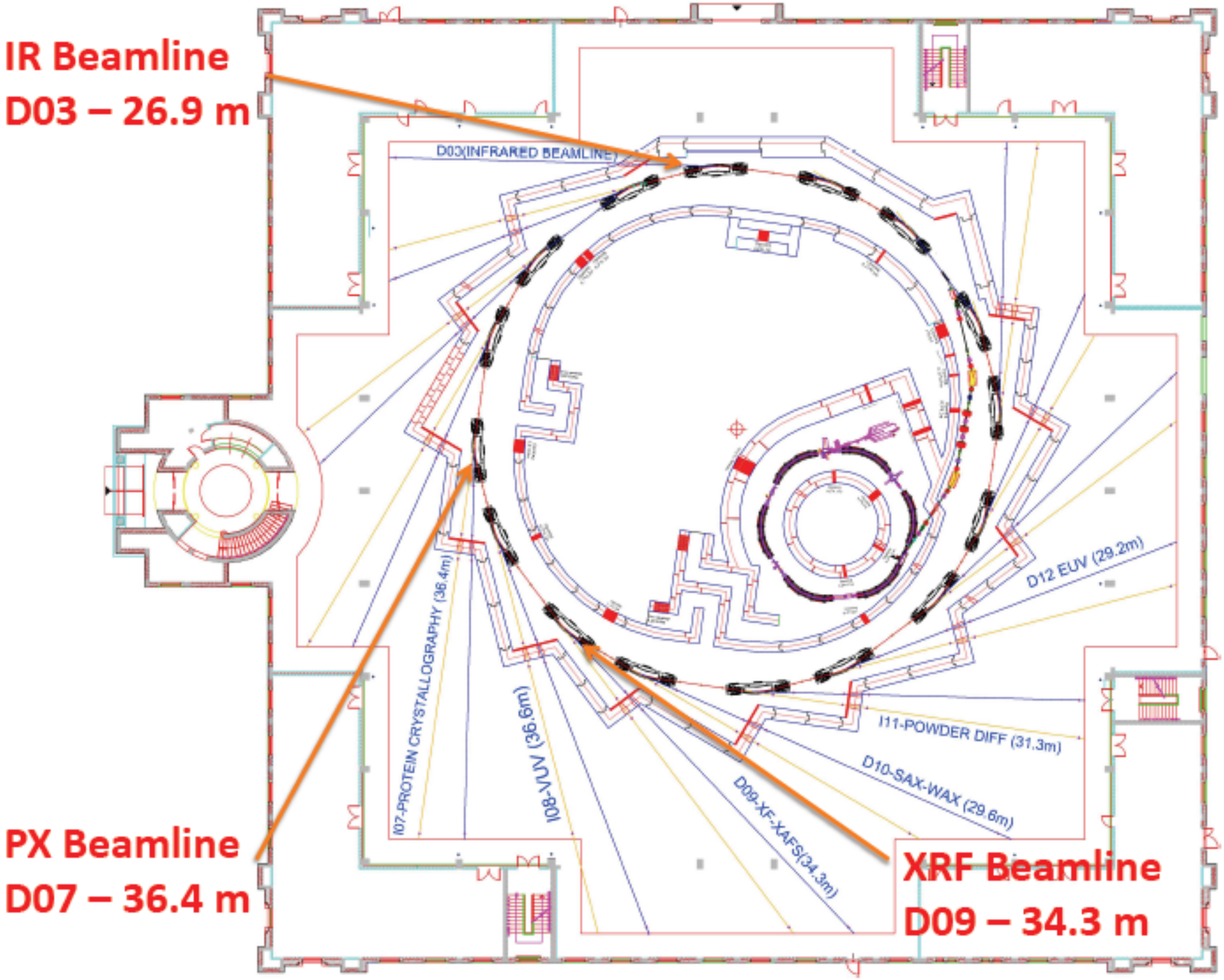
Science with Day-One Beamlines:

- Structural Molecular Biology.
- Electronic Materials and Devices
- Energy Production, Storage and Conversion.
- Material Chemistry.
- Nanotechnology.
- Environmental Sciences.
- Archeology.

SESAME PHASE – I BEAMLINES

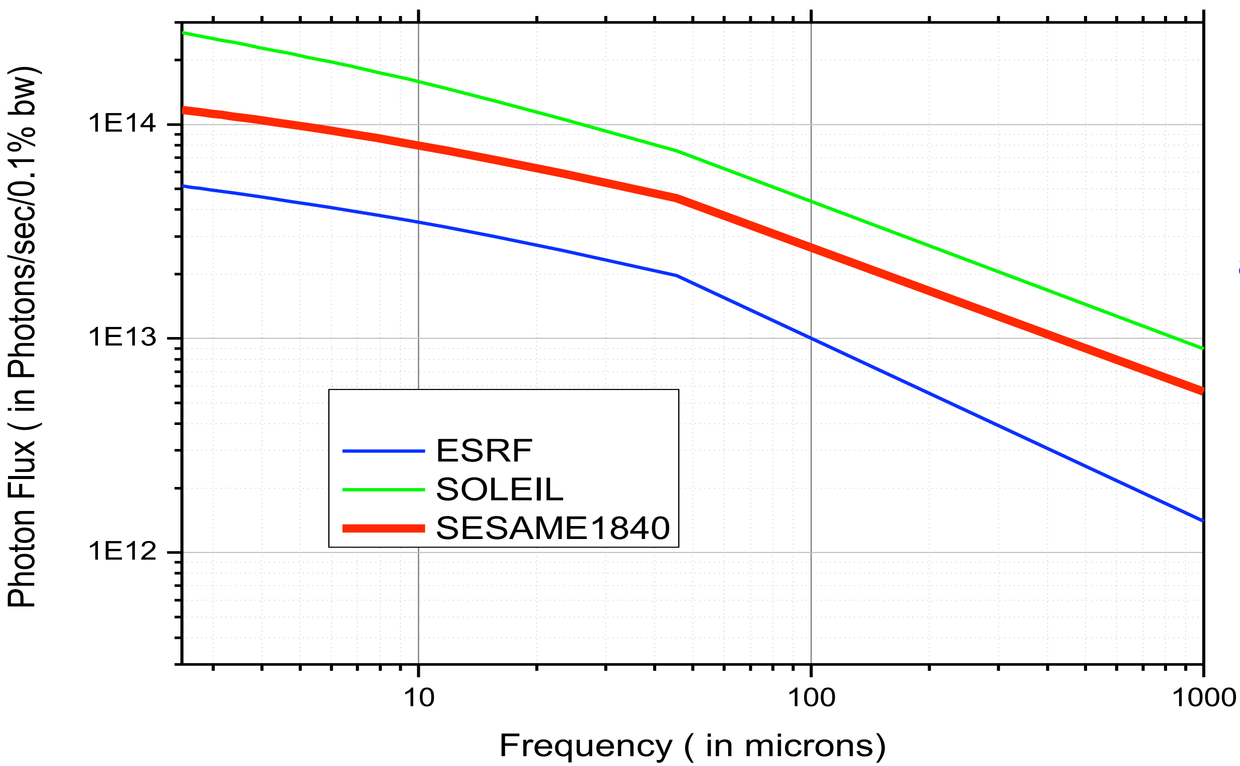
Beamline	Energy Range	Source
Protein Crystallography *(PX)*	4 – 14 keV	Bending Magnet
X-ray Absorption Fine Structure & X-ray Fluorescence *(XAFS/XRF)*	3 – 30 keV	Bending Magnet
Infra-red Spectro-microscopy *(IR)*	0.01 – 1 eV	Bending Magnet
Powder Diffraction *(PD)*	3 – 25 keV	MPW
Soft X-ray	0.05 – 2 keV	EPU
Small and Wide Angle X-ray Scattering *(SAXS/WAXS)*	8 – 12 keV	Bending Magnet
Extreme Ultraviolet *(EUV)*	10 – 200 eV	Bending Magnet

Day-One Beamlines



Infrared Spectro-Microscopy

- ✓ At SESAME, IR radiation will be collected from Constant Field & Edge Radiation.
- ✓ Opening of 17 mrad vertical and 39 mrad horizontal.



Note: SOLEIL is running 500 mA, and an 20 mrad V x 78 mrad H ESRF is running 200 mA, and 8 mrad V x 15 mrad H

THANK YOU

Many thanks to A. Nadji, H. Hoorani, E. Huttel from SESAME
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