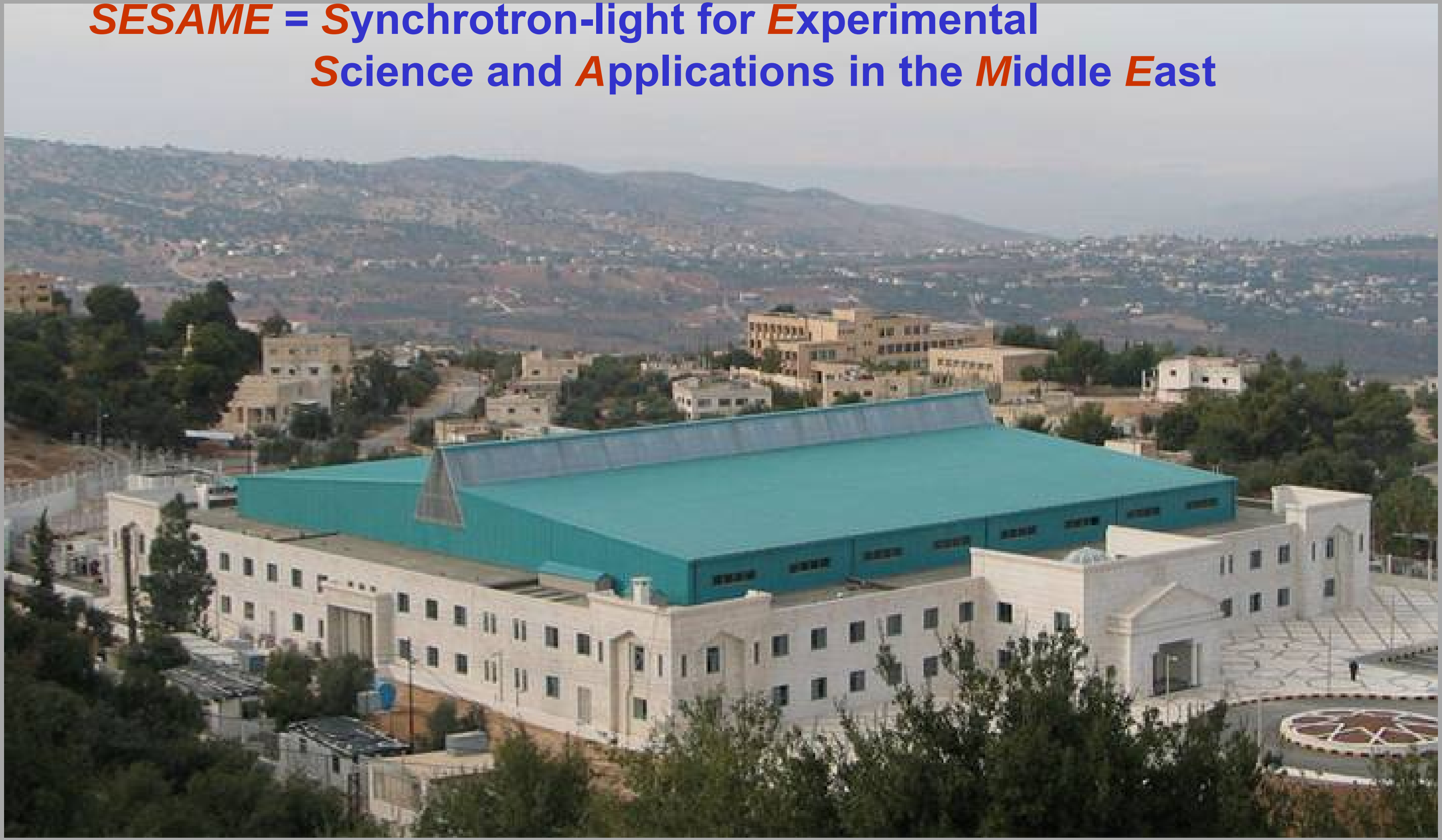
SESAME

SESAME: A Dream Becomes Reality

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



Outline

- History
- Management
- Building
- Injector
- Storage-Ring-Magnets
- Storage-Ring-RF
- Storage-Ring-Vacuum
- Shielding
- Control-System
- Cooling
- Beam-Lines

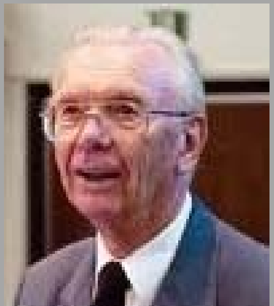
The SESAME History

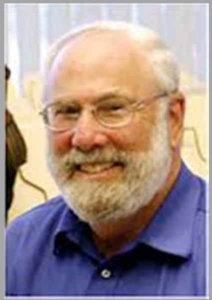
1990's: A scientific cooperation as a vehicle of peace in the Middle East been proposed;I n particular, Middle East Scientific Cooperation (MESC) group, based at CERN (Sergio Fubini, Eliezer Rabinovici, Herwig Schopper, Tord Ekelof…)

1997: Original idea *(*Voss, Winick*)*; Upgrade/rebuild BESSY 1(0.8 GeV) in the Middle East, as centerpice for a new international research center. Voss presents the concept to a *MESC* meeting in Turino.

1999: 1st meeting at UNESCO; (Interim) Council established – Herwig Schopper, President.

2002 - Decision to build a new 2.5 GeV ring (still using BESSY injector)
2003 - Ground breaking for building; completion in 2008
2008 – Chris Llewellyn-Smith takes over as Council President



SESAME

Homage to Gustav Adolf Voss 1929-2013

G.A. Voss played an essential role SESAME becomes into existence.
It is our task now to get it work.

Gustav Adolf Voss (DESY) watching the boat with BESSY I leaving the Hamburg harbor on its way to Aqaba, Jordan.

SESAME Mission and Organization

Foster excellent science and technology in the Middle East (and prevent or reverse the brain drain

Build bridges between diverse societies

SESAME-Members:
Bahrain, Cyprus, Egypt, Israel, Iran, Jordan, Pakistan, Palestin, Turkey.

Observers:
Brazil, China, France, Germany, Greece, Italy, Japan, Kuwait, Portugal, Russia, Sweden, Switzerland, UK and USA.

The means had become available to built up SESAME

2012:
CERN/EU contribute 5 M€ for the purchasing of the magnet system.

2012:
Iran, Israel, Jordan, Turkey will contribute 5 M$ within next four years.

2014:
Italy will contribute 1 M € in-kind.

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Financial Aspects till 2016

Injector-upgrade	0.9 M€
Magnets and PS:	**5.0 M€**
Girder:	0.8 M€
Vacuum:	**3.0 M€**
RF:	**3.0 M€**
Diagnostics:	1.5 M€
SR-Cooling:	0.5 M€
Cabling:	0.5 M€
Commissioning:	1.5 M€
Control-System	1.1 M€
Safety P+A	0.8 M€
Front-Ends:	0.5 M€
Sum [€]	19.0 M€
Sum [$]	23.3 M$
10%	**25.6 M$**

Income

EU-CERN: 5.00 M €

Jordan: 4 x 1.25 M $
Turkey: 4 x 1.25 M $
Israel: 4 x 1.25 M $
(Iran: 4 x 1.25 M $)

Italy: 1 x 1.00 M €

Machine:	**25.6 M$**
4 Beamlines upgrade:	**8.7 M$**
Guesthouse+	**1.3 M$**
Sum	**35.6 M$**

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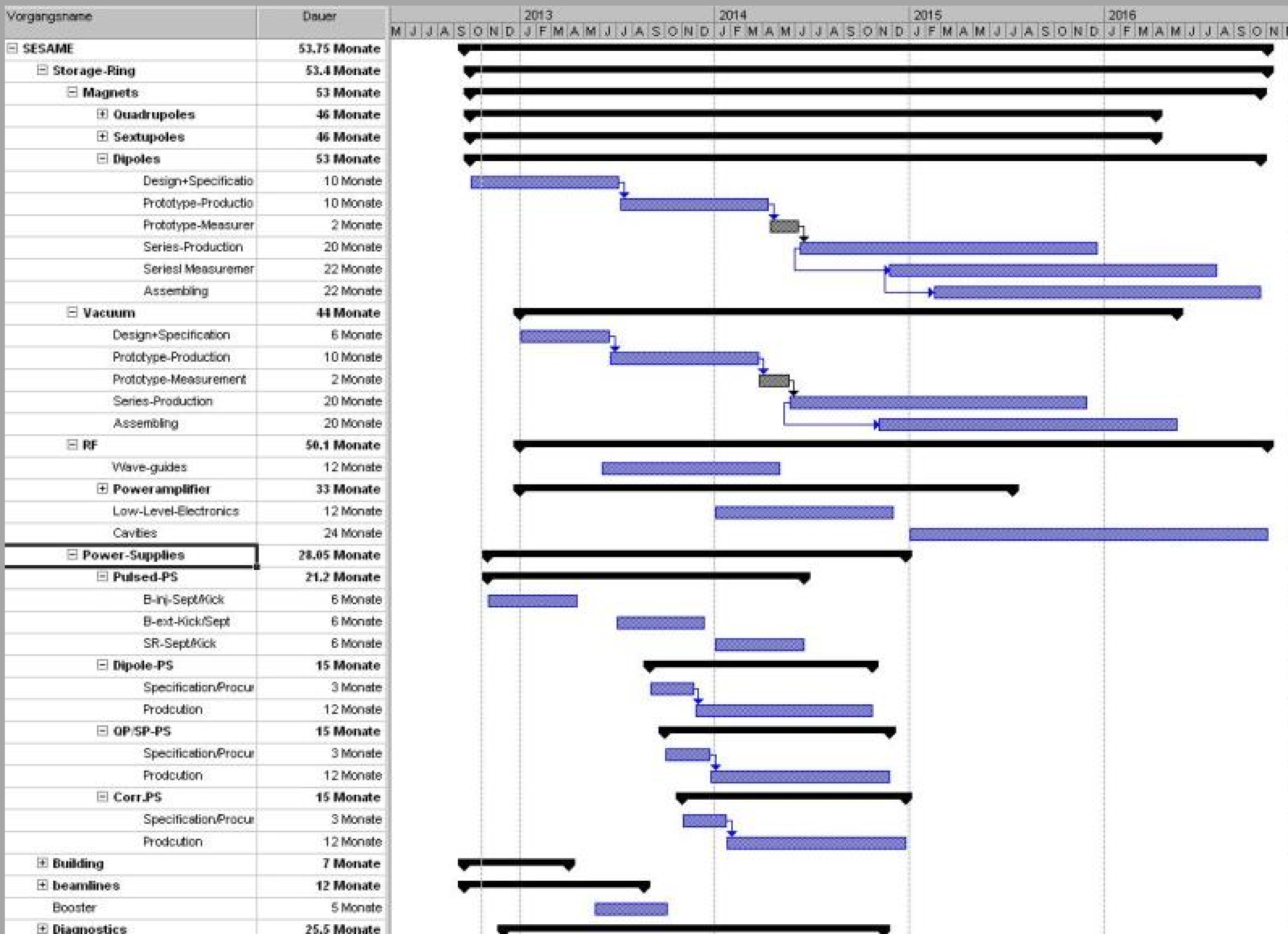
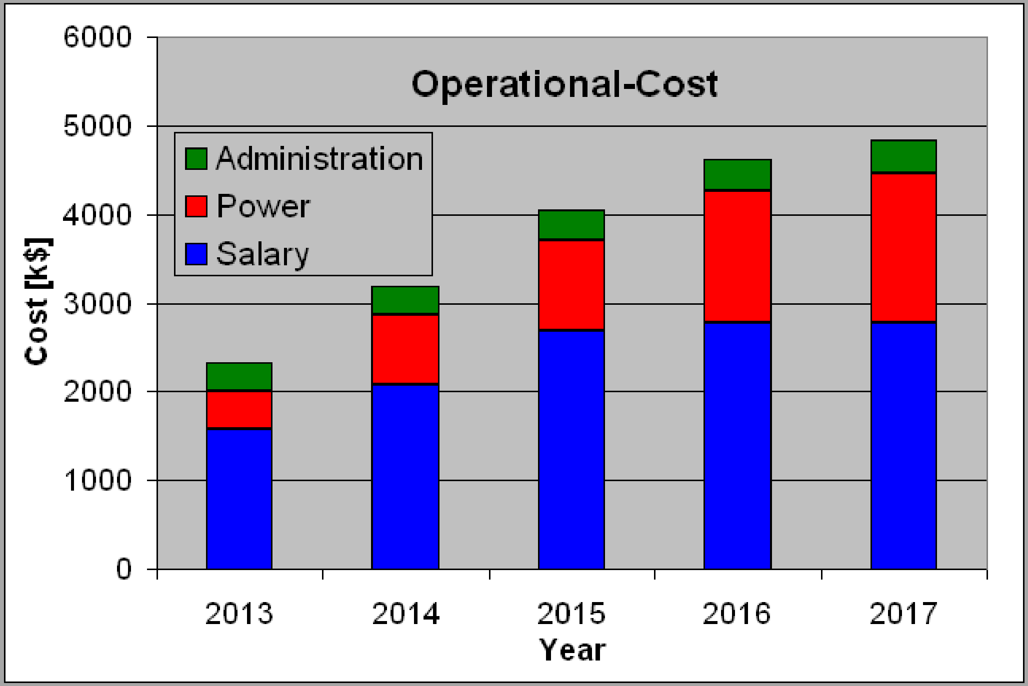
Project-Development



Vorgangsname	Dauer
SESAME	53.75 Monate
Storage-Ring	53.4 Monate
Magnets	53 Monate
Quadrupoles	46 Monate
Sextupoles	46 Monate
Dipoles	53 Monate
Design+Specificatio	10 Monate
Prototype-Productio	10 Monate
Prototype-Measurer	2 Monate
Series-Production	20 Monate
Seriesl Measuremer	22 Monate
Assembling	22 Monate
Vacuum	44 Monate
Design+Specification	6 Monate
Prototype-Production	10 Monate
Prototype-Measurement	2 Monate
Series-Production	20 Monate
Assembling	20 Monate
RF	50.1 Monate
Wave-guides	12 Monate
Poweramplifier	33 Monate
Low-Level-Electronics	12 Monate
Cavities	24 Monate
Power-Supplies	28.05 Monate
Pulsed-PS	21.2 Monate
B-inj-Sept/Kick	6 Monate
B-ext-Kick/Sept	6 Monate
SR-Sept/Kick	6 Monate
Dipole-PS	15 Monate
Specification/Procur	3 Monate
Prodcution	12 Monate
QP/SP-PS	15 Monate
Specification/Procur	3 Monate
Prodcution	12 Monate
Corr.PS	15 Monate
Specification/Procur	3 Monate
Prodcution	12 Monate
Building	7 Monate
beamlines	12 Monate
Booster	5 Monate
Diagnostics	25.5 Monate

Operational-Cost-Development



Power: Based on 4000 h operation time, 10 GWh / y
Salary: Increase 35-75 employees

Organization

Beamlines
XABS:Messaoud Harfouche
IR: Ibraheem Yousef

Machine-Physics
Maher Attal (optics,+).
Mohammad Ebeni (Magnets)
Koryun Maunkyan (Optics)

RF/Diagnostics
Darweesh Foudeh
Nashat (RF)
Alaa Alkurdi (RF)
Hussain Al-Mohammad (Diagnostics)

Administration
Sonia Al-Faques (Assistant)
Majeda Salama (Purchasing)
Ayman Al-Zoubi (Human resources)
Ibrahim Radwan (Accountant)
Rawan Ramadan
Basheer Amareyh (Security)
Abd Al Mawla Gnaimat (Bus-driver)
Khaled Al-Zoubi (Bus-driver)

Cooling/Vacuum
Firas Mahahleh
Osama Nour (Cooling)
Mohammad Al-Nadjdawi
Adel Amro (Vacuum)
Saed Budair (vacuum)

Computing
Salman Matalgah
Mustafa Zoubi

Control
Ibrahim Saleh
Abdallah Ismail
Yazan Dabain

Radiation-Safety
Adli Hamad
Morteza Mansouri

Electronics/Electric
Sofian Javar (Power supplies)
Ifikhar Abid (pulsed PS)
Osama Khader (Electric)

Yazeed Momani (beam-lines)
Farouq Al-Omari (beam-lines)

Design/Mechanics
Maher Shehab (Design)
Thaer Abu-Hanieh (Alignment)
Akrum Al-Homoud (Design)

Ahmad Ateieh (Craftsman)

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Challenges

Jordan is not in the EU: Industrial structure is missing:

Qualified mechanical work shops

Specialized manufacturer (vacuum)

import needed

custom delay

Jordan is not Schengen: User-access, Visa needed

SESAME:

35 year old Electronics: replacement in progress

Equipped (mechanical) workshop not available: to be built up

35 year old Microtron: to be replaced

But SESAME has excellent engineers!

Snowload

Sat. 14.12. 2014: SESAME roof deflected

SESAME, Sun 15.12.2013

Precipitation:	13-15.12.2013
Salt:	130 mm
Swaileh:	87 mm
Jordan University:	65 mm

SESAME roof, Mon 16.12.2013:
15 cm wet snow

25 cm wet snow (0.4 kg/l): ~100 kp/m^2 ~ 100 mm ~ 360 t

SESAME Roof January 2014

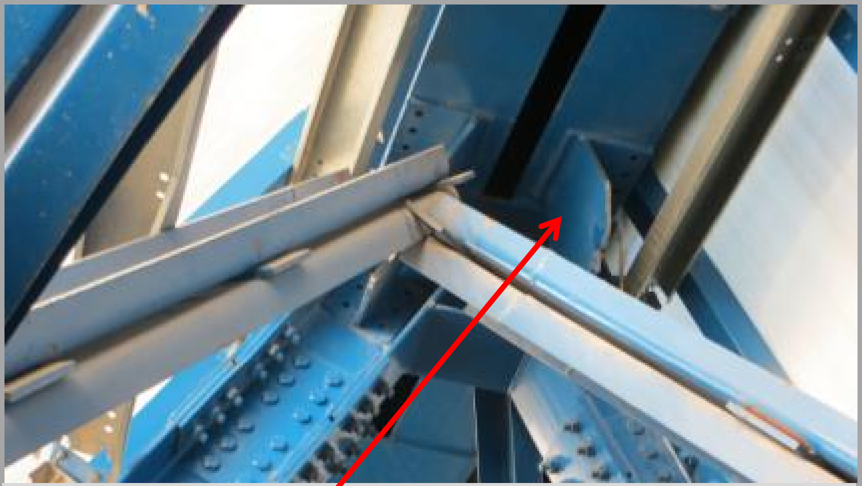
SESAME Roof

SESAME Hall based on ANKA design (got plans)

ANKA:	**75 kp/m^2,**	**Safety factor 1.8: 135 kp/m^2**
SESAME Spec:	**175 kp/m^2**	**Safety factor?**

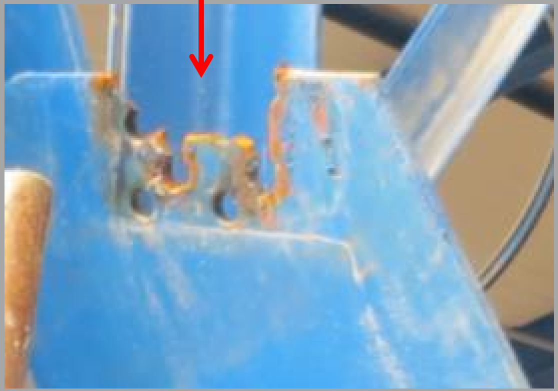
Damaged Structure

All Connection to secondary trusses broken at east side



Diagonal trusses from upper to lower spine beams broken (26 out of 32) partly at top, partly at bottom connection plate

Main beam bend at connection



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What next?

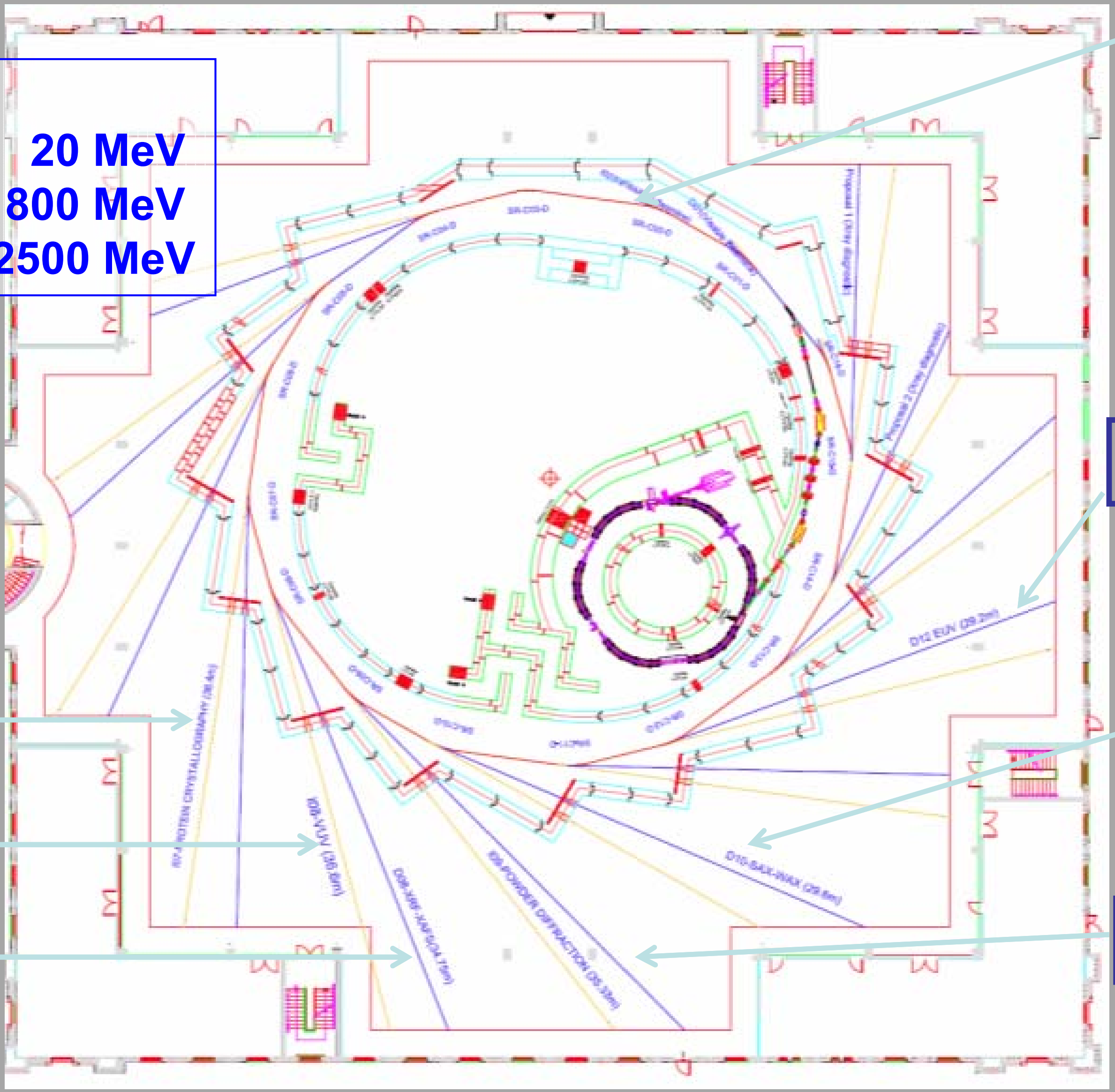
Expert commission from Jordan and Extern (CERN,PSI,ELETTRA)

Conclusion:	**Design Failure**	**Connection plate**
	Construction Failure	**Modified Design**
	Supervision Failure	**No Supervision**

Negotiation ongoing between SESAME, Designer, Constructor

Layout of SESAME Experimental Hall

3 Accelerator
Microtron: 20 MeV
Booster: 800 MeV
Storage-ring: 2500 MeV



IR

EUV BL

SAXS-WAXS

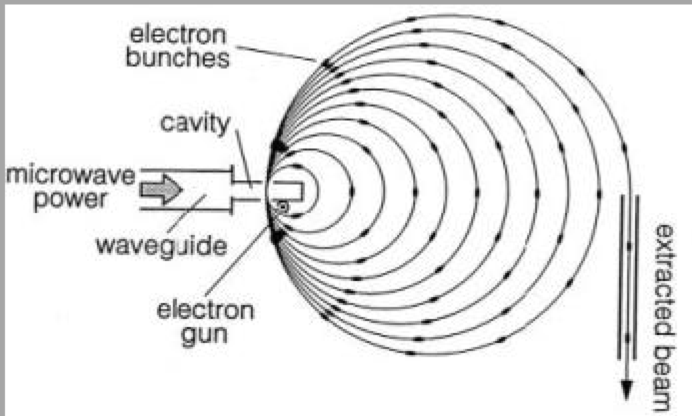
PD

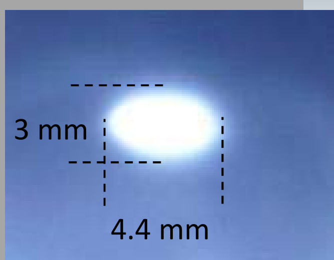
PX

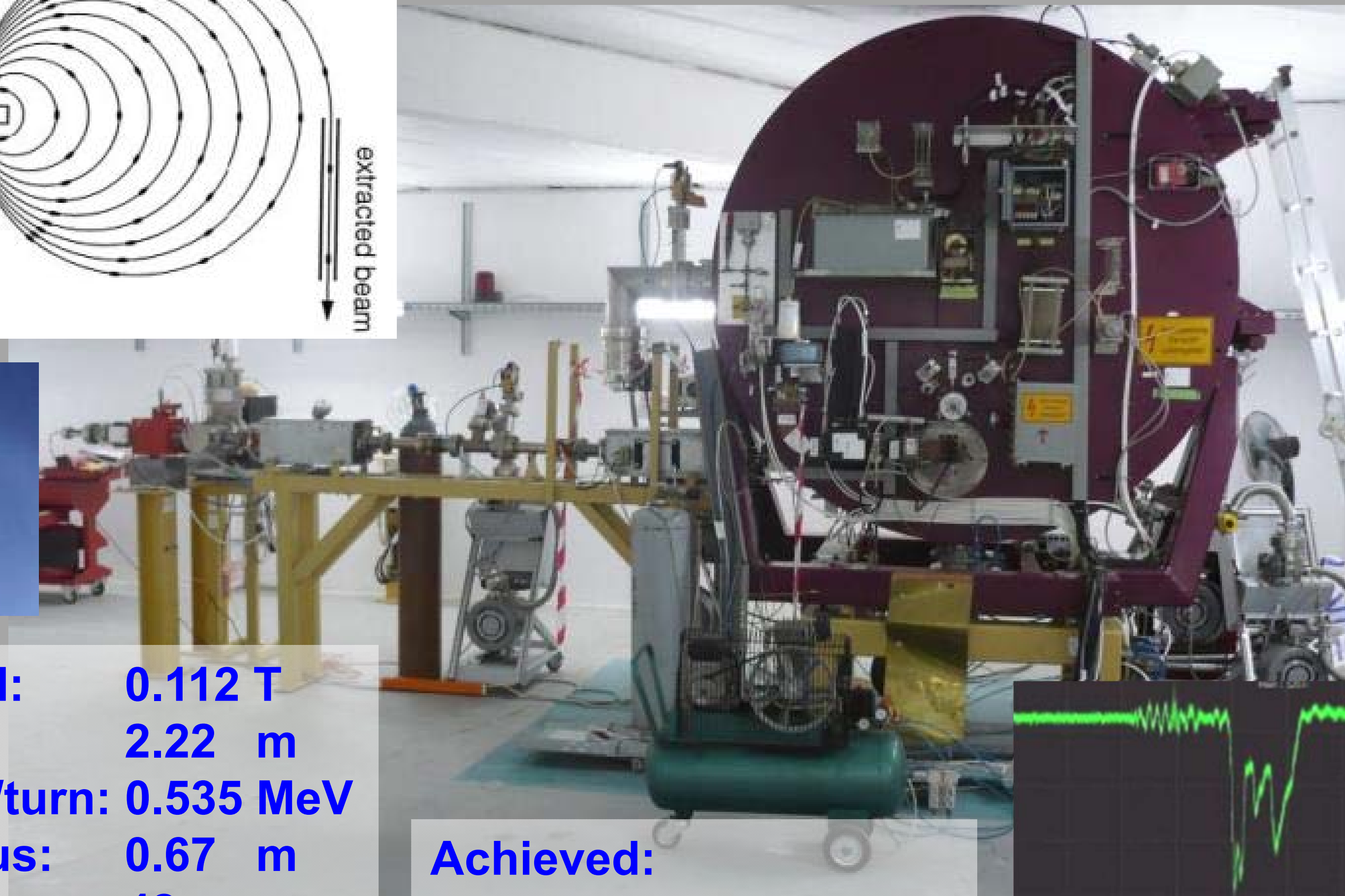
VUV

XRF-XAFS

Microtron in Operation, Beam in the transfer line





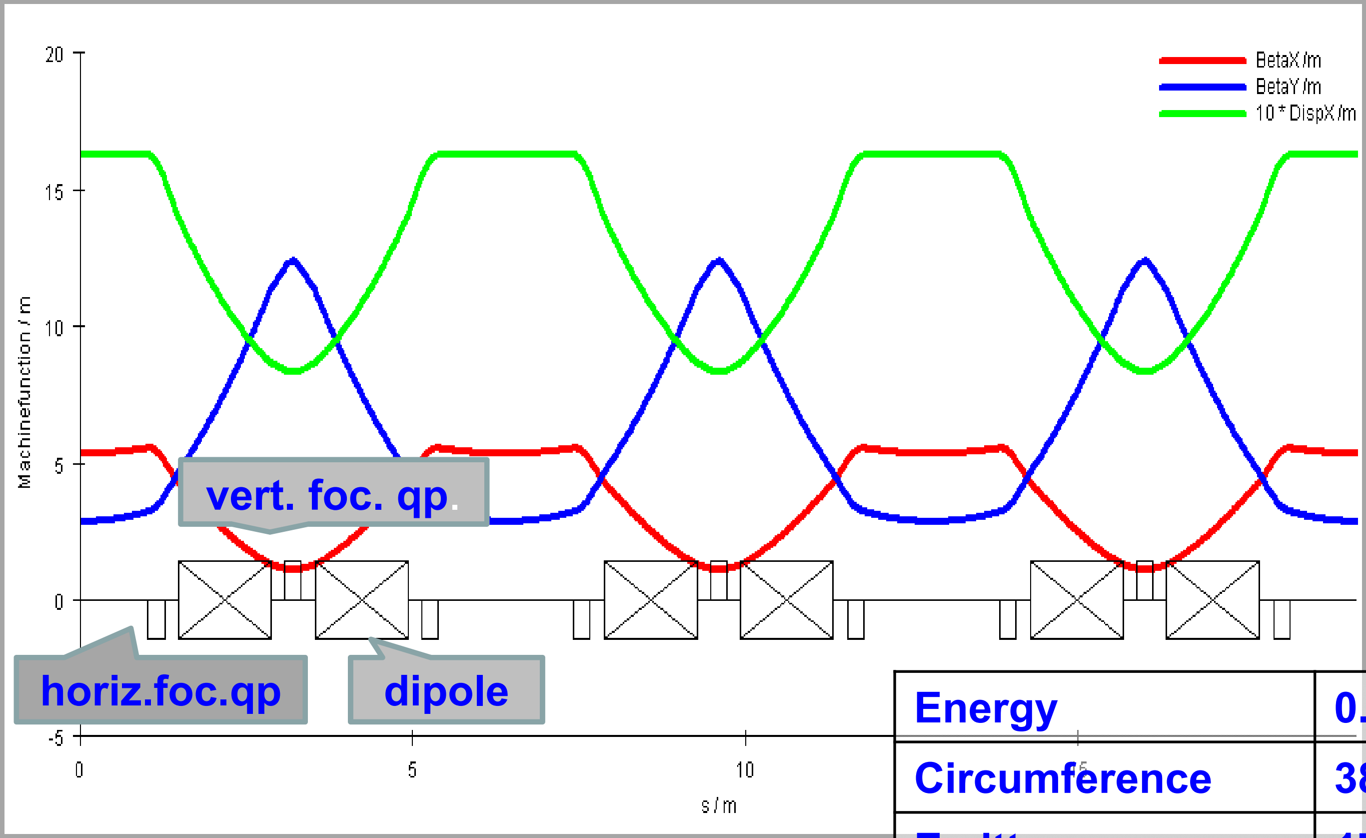


Magnet Field:	**0.112**	**T**
Diameter:	**2.22**	**m**
Energy gain/turn:	**0.535**	**MeV**
Max. e-Radius:	**0.67**	**m**
No turns:	**42**	
RF frequency:	**3.00**	**GHz**
RF-Peak-Power:	**2**	**MW**

Achieved:

Energy:	**22MeV**
Pulse-Width:	**1 µs**
Pulse-Current:	**4 mA**

Booster-Optics



Energy	0.022-0.8	GeV
Circumference	38.4	m
Emittance	170	nmrad
Mom.Compaction	0.18	
Energy loss	14	keV
Tune	2.2 / 1.3	
Chromaticity	-2.0 / -0.5	
Periodicity	6	

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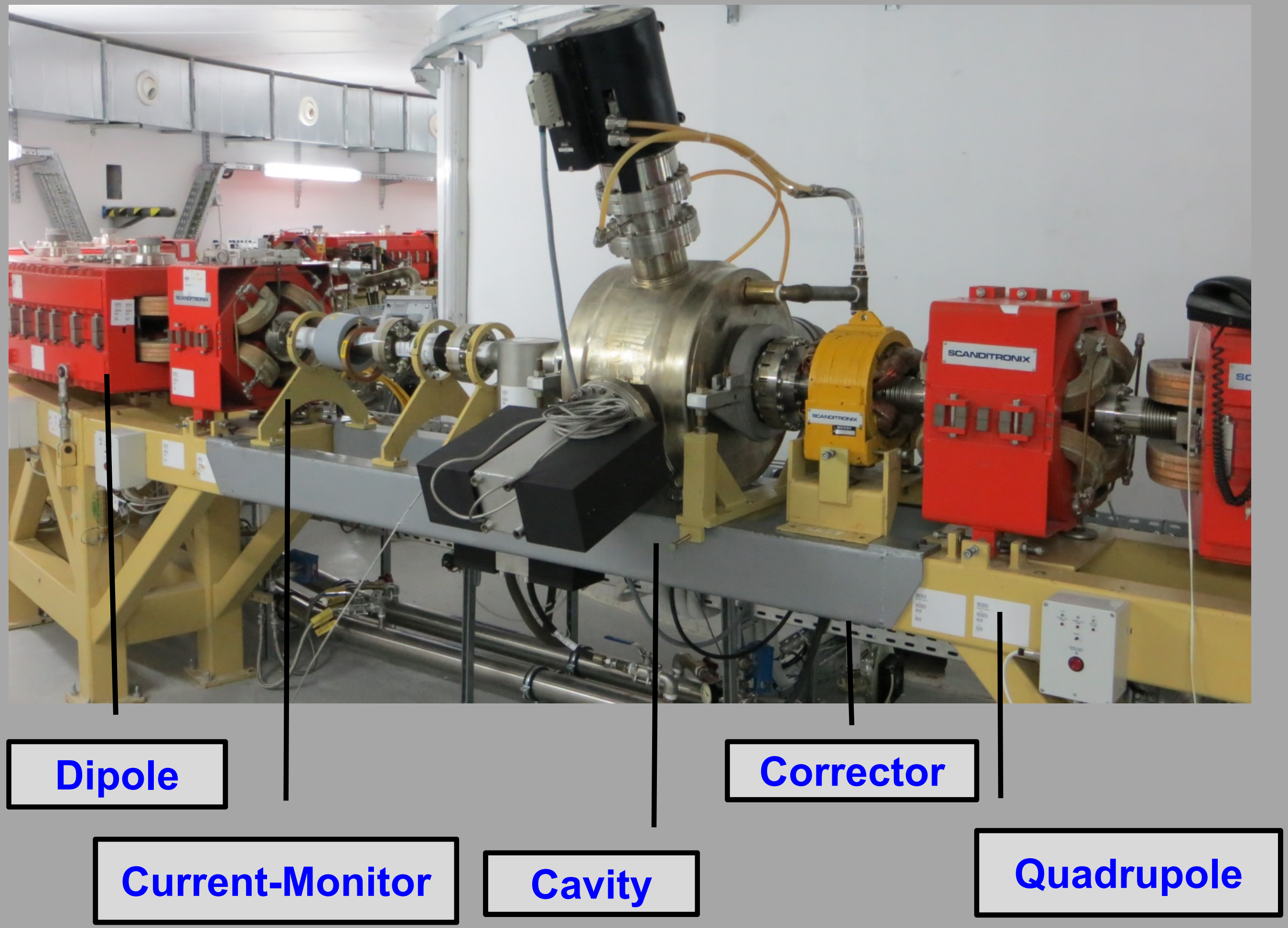
Booster Installation



Booster-Magnets

Dipole		
Number	**12**	
B-field	**1**	**T**
Radius	**2.67**	**m**
Gap	**40**	**mm**
Current	**1000**	**A**
No windings	**2x16**	
Resistance	**0.015**	**Ω**
Inductance	**8.6**	**μH**

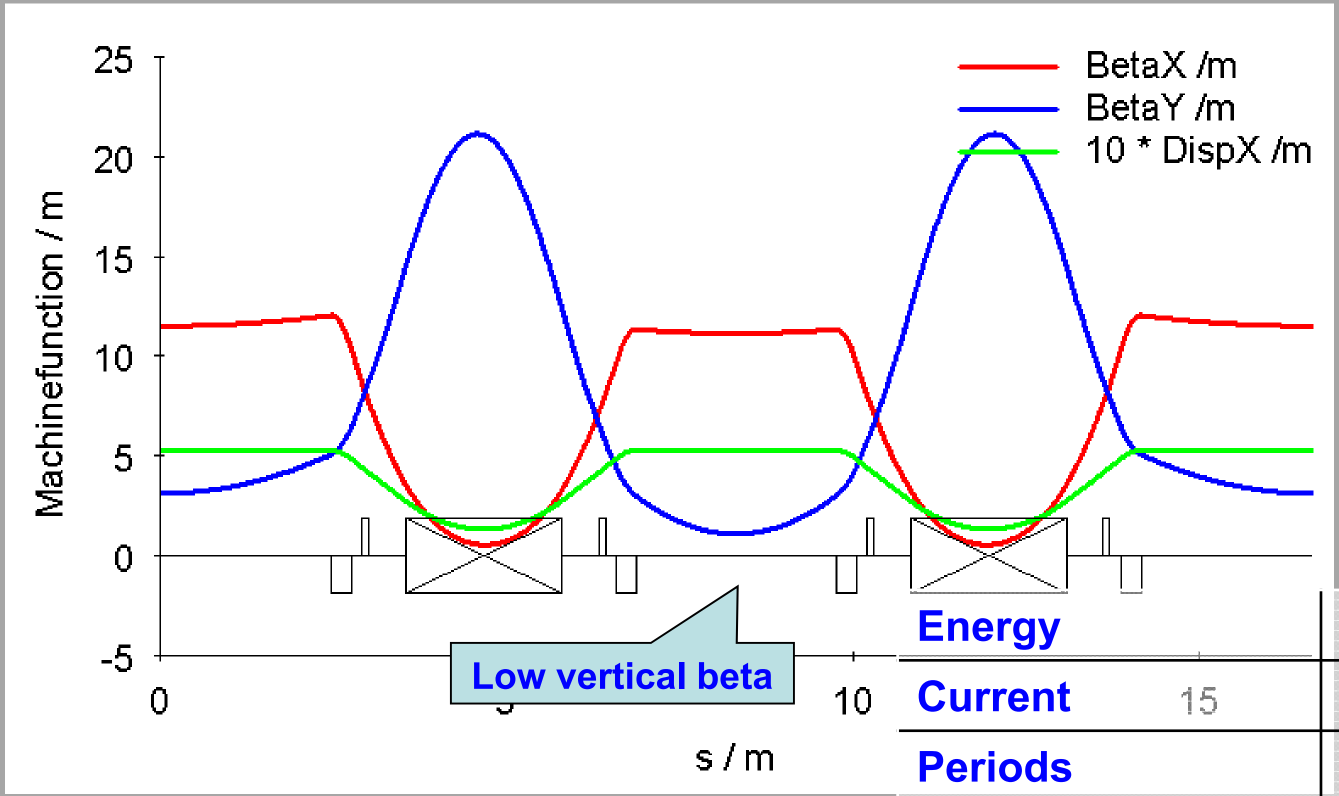
Quadrupole		
Number	**12 / 6**	
Gradient	**5.77**	**T/m**
Length	**0.25**	**m**
Bore-	**78**	**mm**
Current	**146**	**A**
No windings	**4 x 24**	
Resistance	**0.054**	**Ω**
Inductance	**6.8**	**μH**

Power-Supplies and Control

To warranty reliability: All Power-supplies and Control-units will be new.

Main Magnet PS; 4-quadrant
DP: 1000 A, +/- 350 V
QF: 120 A , +/- 100 V
QD: 120 A , +/- 50 V

SESAME-Storagering Optics



Energy	2.5	GeV
Current	0.4	A
Periods	8	DBA
Circumference	133.2	m
Tune horiz. / vert.	7.25 / 5.19	
Nat. Chroma. h / v	-14 / -14	
Emittance (ε_x)	25	nm
Mom. Comp.	0.008	
Radiation loss	0.6	MeV

Beta function: β_x, β_y:

$$\sigma_x = \sqrt{(\varepsilon_x \beta_x)}$$

$$\sigma_{x'} = \sqrt{(\varepsilon_x / \beta_x)}$$

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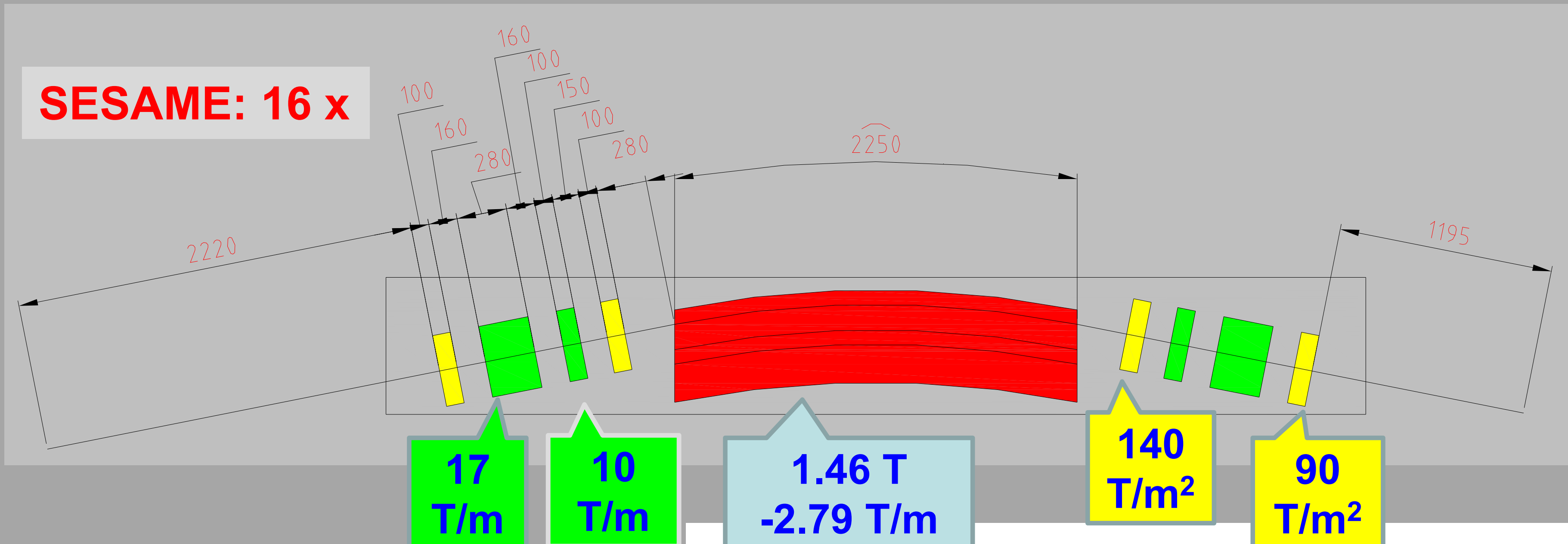
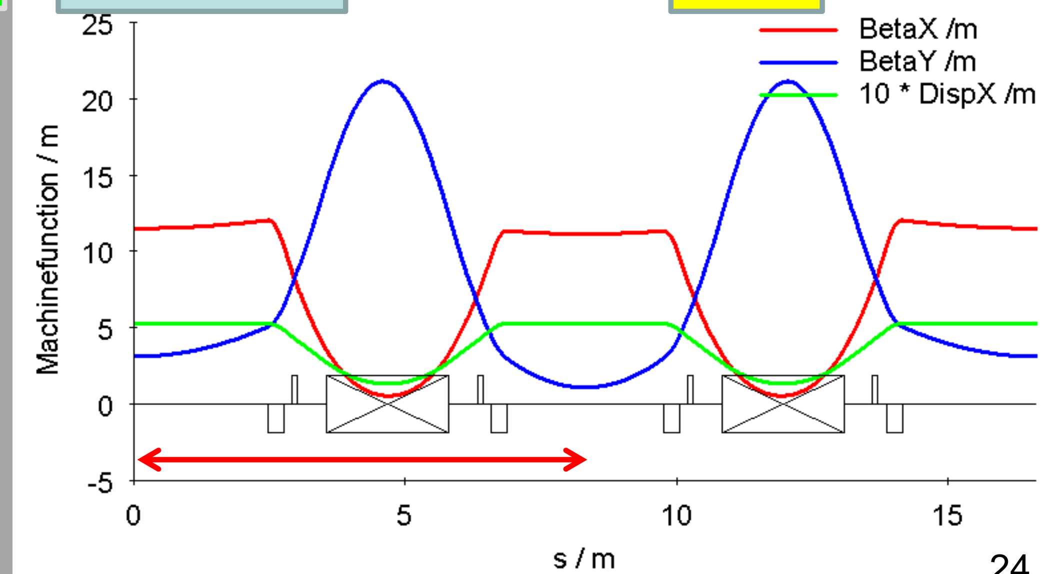
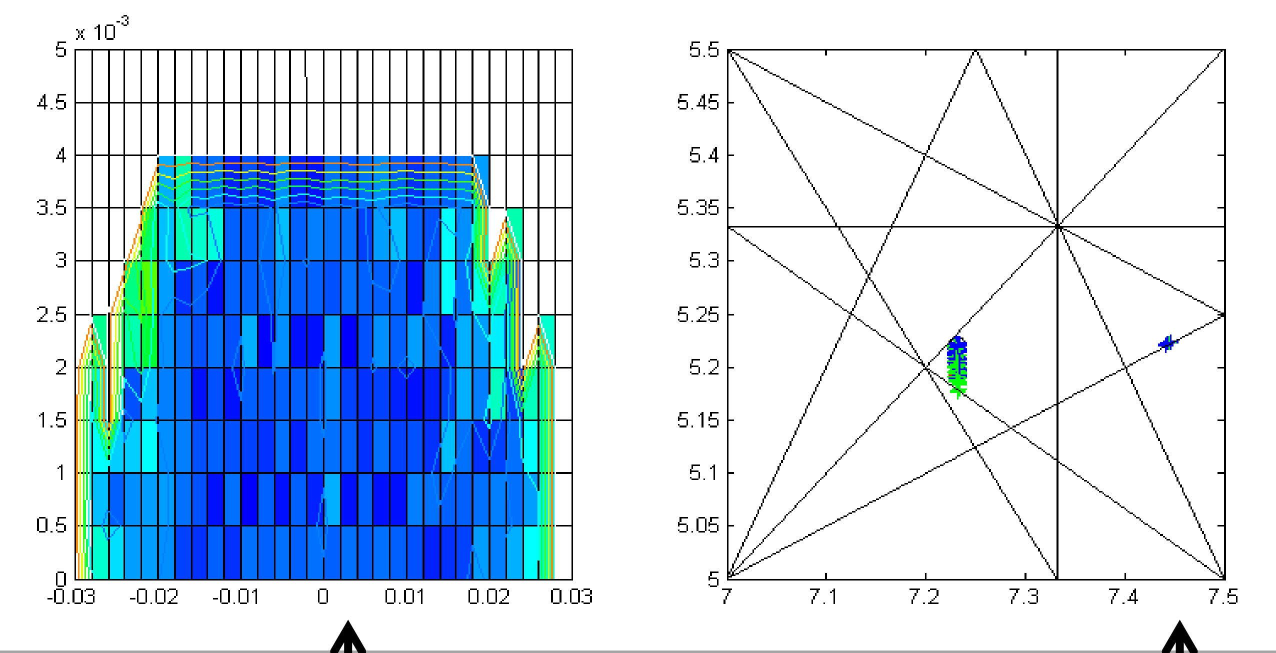
Storagering Half Cell





Dynamic Aperture



Electron beam size about 1x0.1 mm^2
Some Electrons are scattered into cm range.
Might not get focused again and get lost.
Dynamic Aperture gives space, they are captured again.

Tune (h_x, h_y) : Scattered electrons oscillate with h_x, h_y cycles per revolution.
If h_x, h_y has certain values, oscillations are not damped.
Particles can get lost.

CESSAMag-Project

CERN SESAME agreement: 15.05.2012
EU CERN agreement FP7: 11.04.2013

CERN
Jean-Pierre Koutchouk
Davide Tommasini
Attilio Milanese
Louis Walckiers
Theodor Tortschanoff
Jean Paul Burnet
Miguel Bastos

SESAME
Erhard Huttel
Maher Attal
Maher Shehab
Mohammad Ebeni
Abdallah Ismail
Sofian Javar
Iftikhar Abid

5 M €
16 Dipoles
2 x 32 Quadrupoles
2 x 32 Sextupoles + Correctors
Power supplies

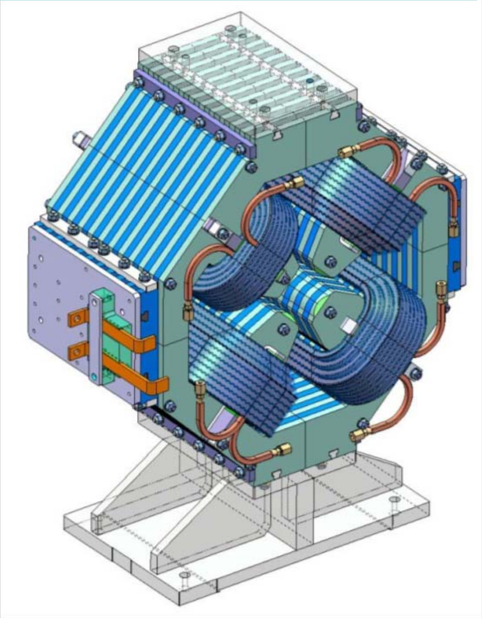
Prototypes: Jun. 2014
Series: Oct. 2015

ALBA
Montse Pont

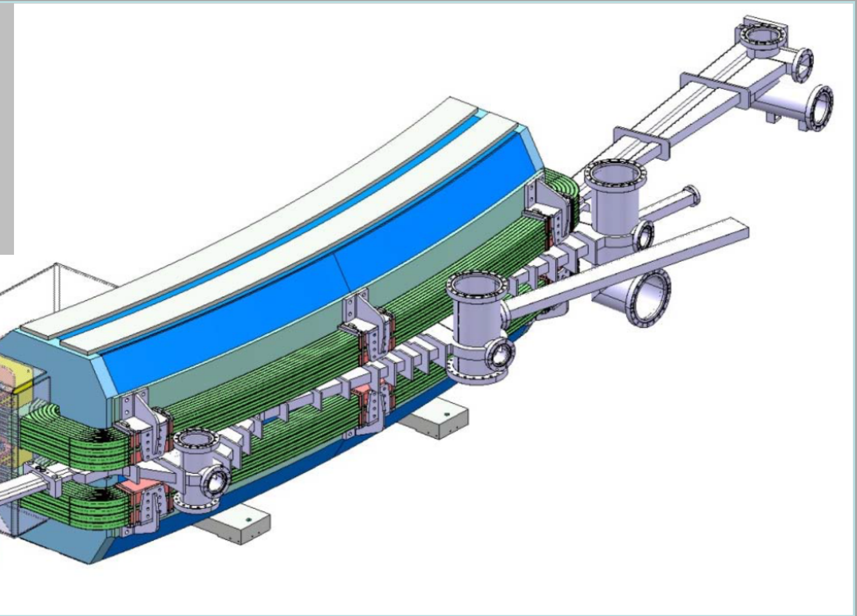
Contracted to:	Dipole:		Tesla (GB)
	Quadrupole:		ELYTT (Spain)
		Coils:	STS (Turkey)
	Sextupole:		CERN
		Tools:	CERN
		Punching:	OMEDEC (France)
		Coils:	SOFILEC (France)
		Assembling:	CNE (Cyprus), HMC3 (Pakistan)

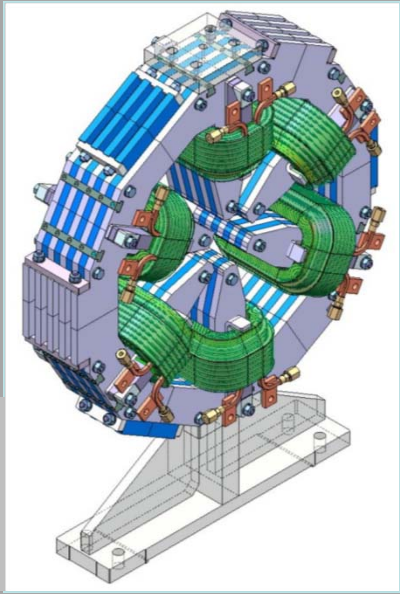
Storagering Magnets

Quadrupole:
B’: 17 (-9) T/m
L: 0.28 (0.1) m



Dipole:
B: 1.46 T
B’:2.79 T/m
L: 2.25 m





Sextupole:
M: 90 (-140) T/m²
I.: 0.1 m

First punched laminations

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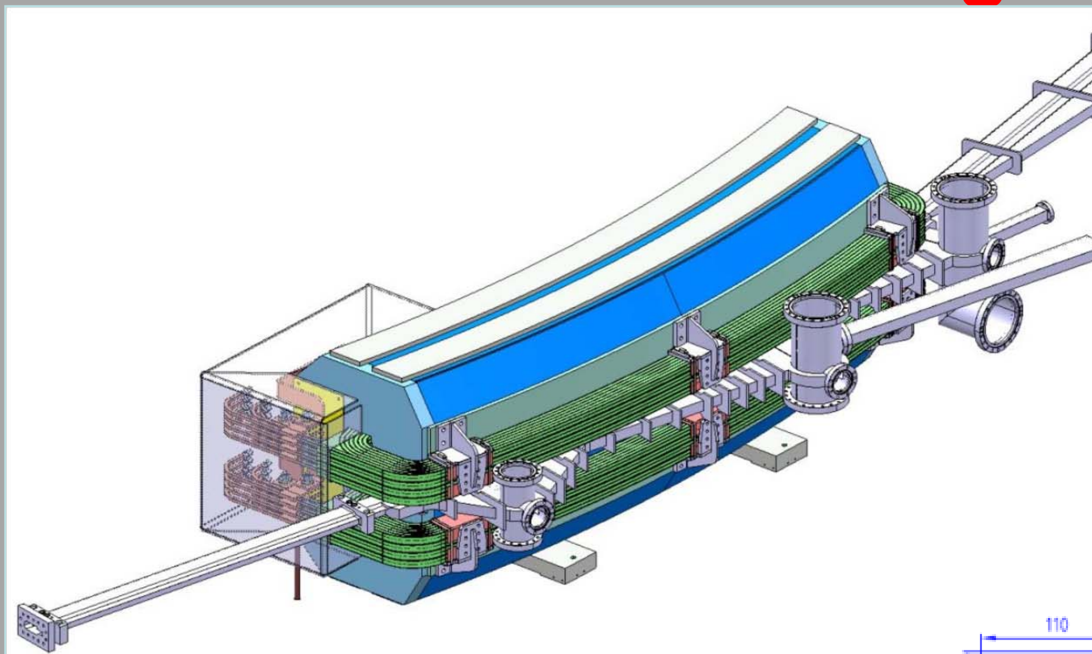
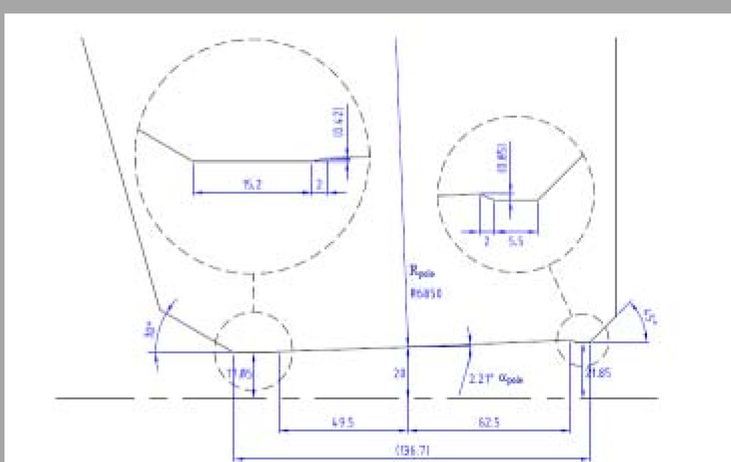
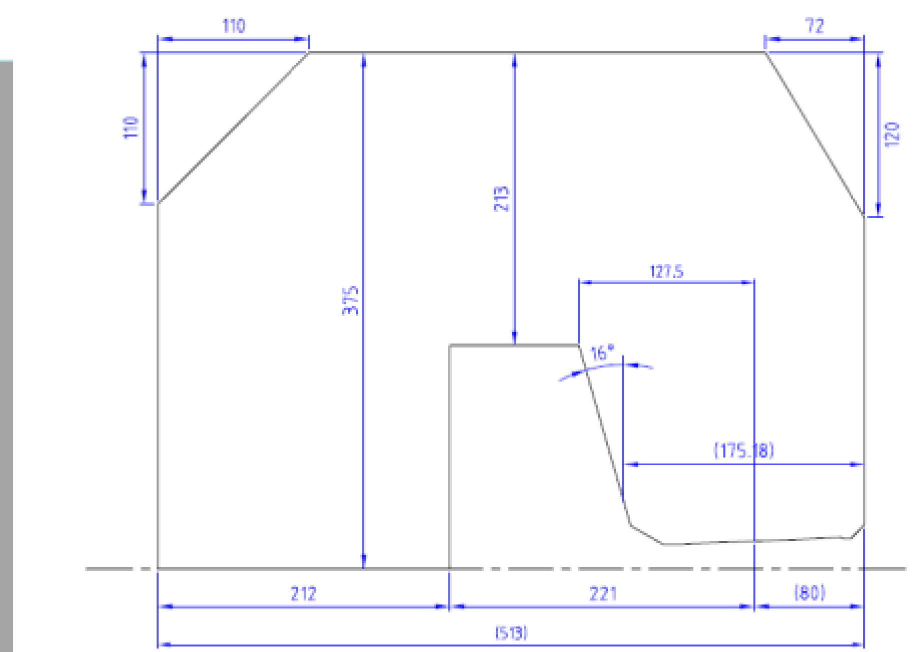
Design Dipole

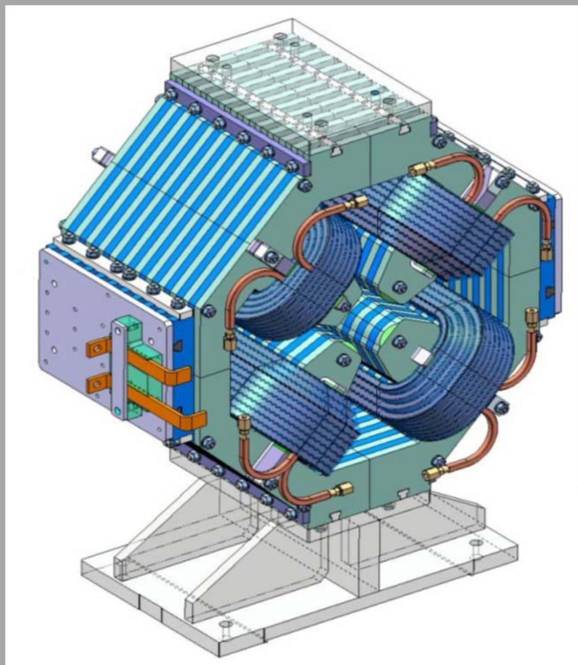


Dipole		
B-field	1.455	T
Gradient	2.79	T/m
Radius	5.729	m
Mag. Length	2.25	m
Gap	40	mm
No windings	2 x 48	
Current	500	A
Voltage	40	V

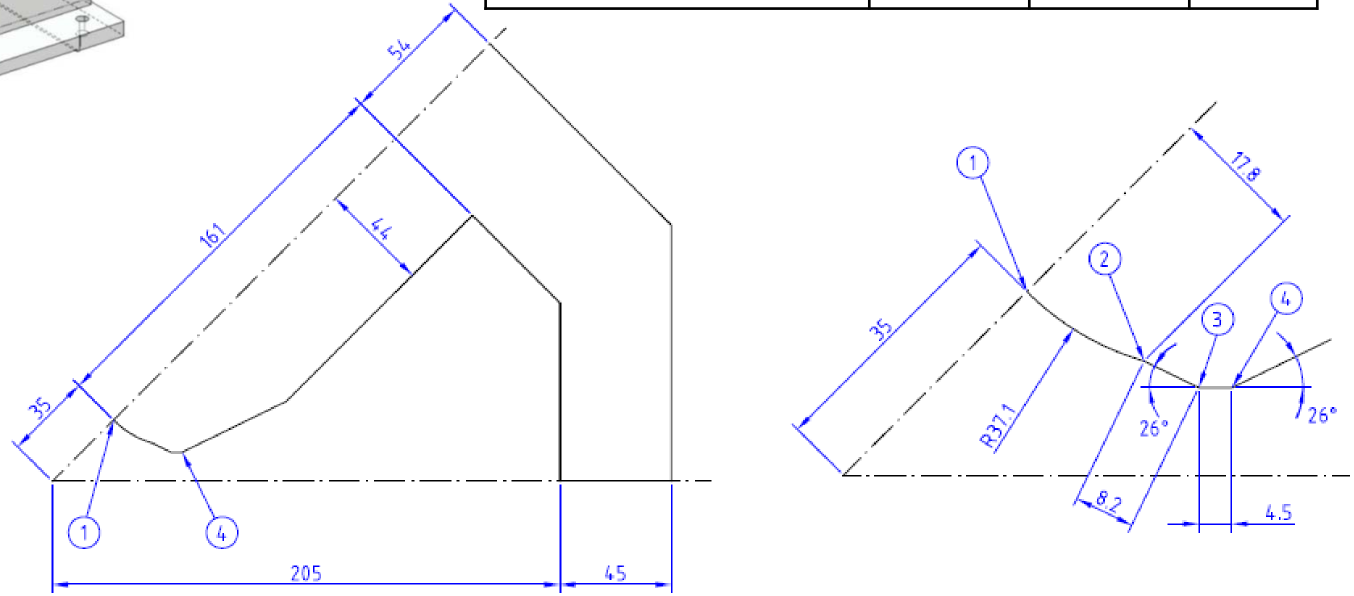




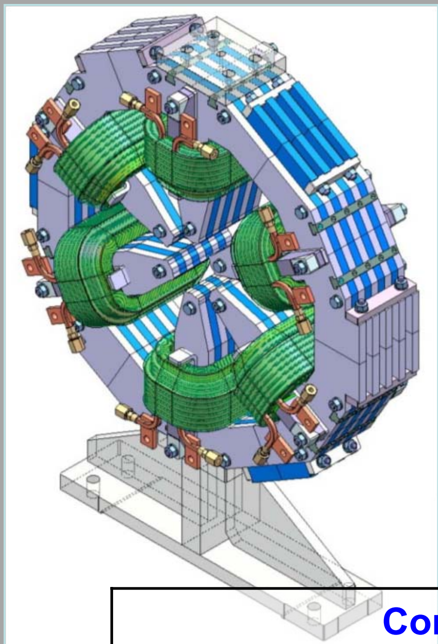
Quadrupole Design

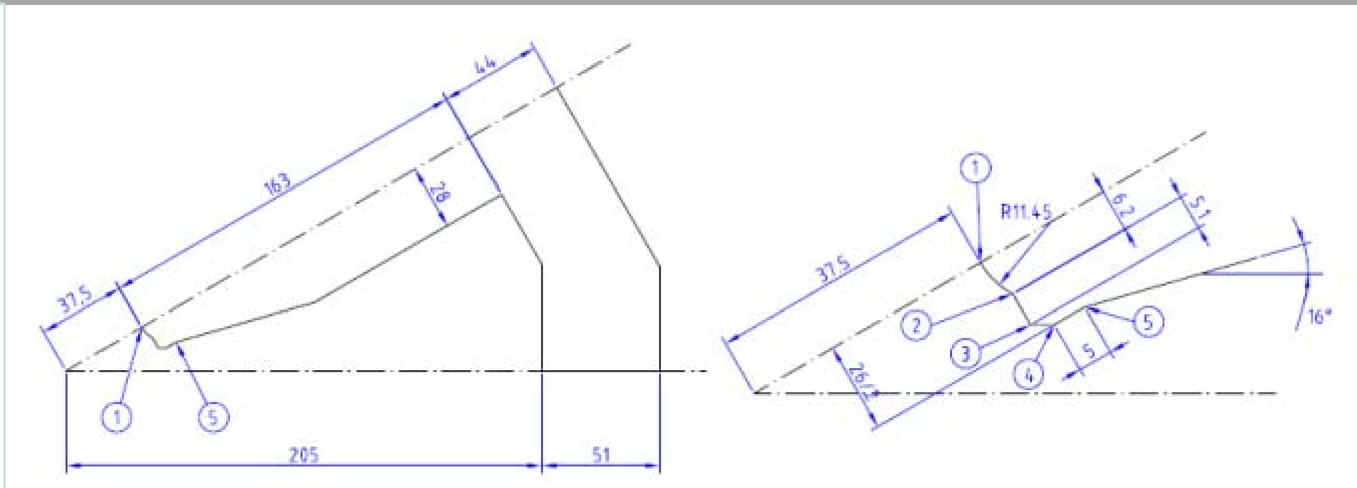


Quadrupole	QF	QD	
Gradient	17	-10	T/m
Int. Gradient	5.1	-1	T
Bore-Diameter	70	70	mm
Iron-Length	.28	.1	m
No windings	4 x 34	4 x 19	
Current	240	195	A
Voltage	11	2.5	V



Sextupole Design

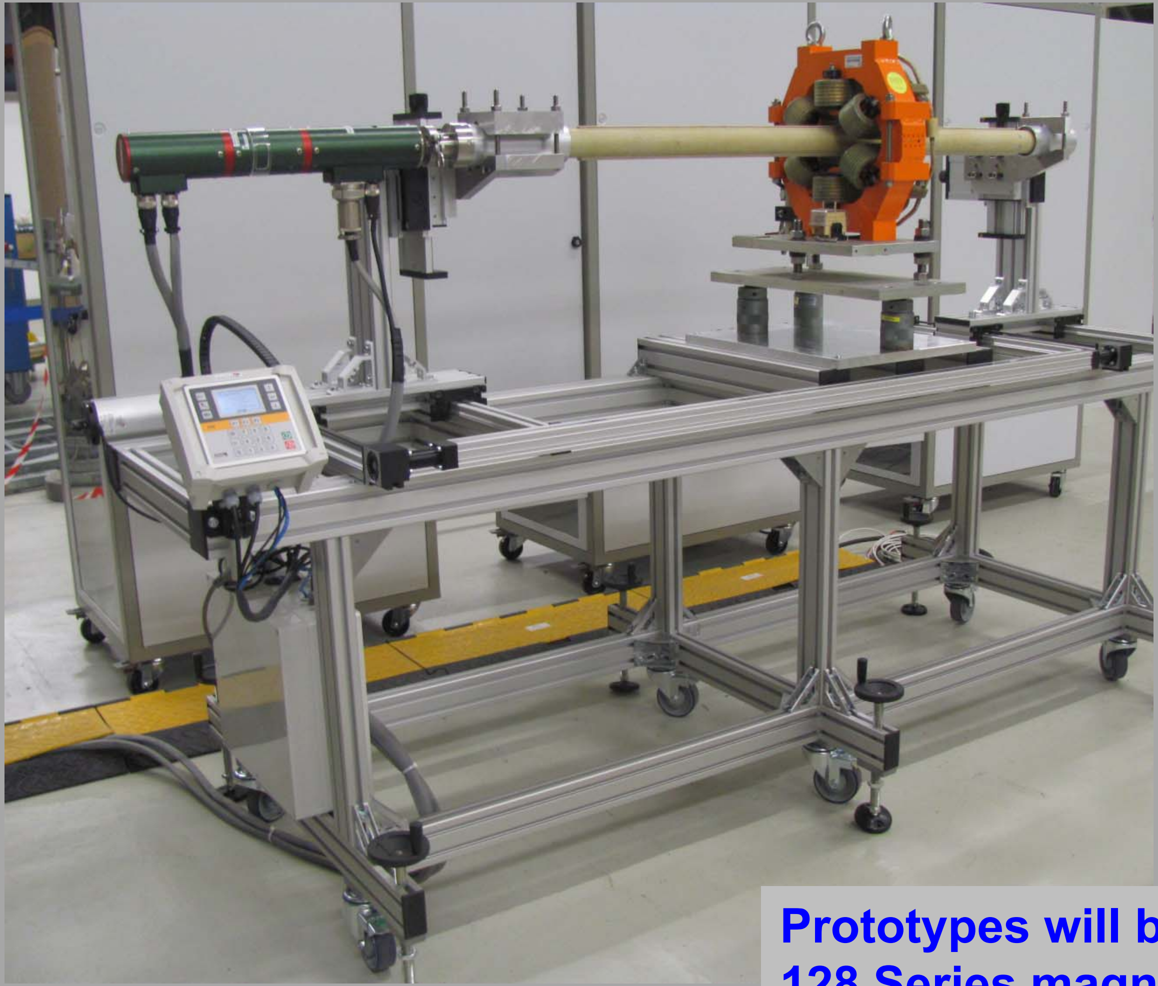


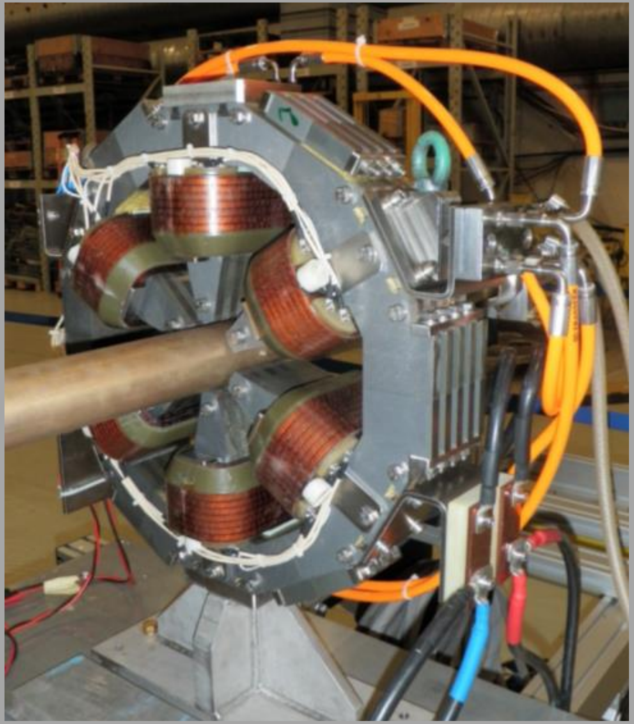


Corrector v		
Int. Field	0.004	Tm
Amp-Turns	4 x 800	A
Corrector h		
Int. Field	0.004	Tm
Amp.-Turns	4 x 300 / 2 x 600	m
Skew Quad		
Int. Gradient	0.85	T/m
Amp.-Turns	2 x 1050	A

Sextupole	SH	SV	
Corr. Chromaticity	+5	+5	
M = ½ B'' = $B(r_0)/r_0^2$	90	140	T/m²
Int. Strength	9	-14	T/m
Bore-Diameter	75	75	mm
Iron-Length	.1	.1	m
No windings	6 x 14	6 x 14	
Current	86	135	A
Voltage	2	3	V

Measuring Bench





Prototypes will be measured at CERN (2014)
128 Series magnets at SESAME (2015)

SESAME

Storagering Power-Supplies

	No of magnets	No in series	Current [A]	Resistance per magnet [mΩ]	Voltage per magnet [V]	Voltage per PS [V]	Power per PS [kW]
Dipole	16	16	550	83	44	800	440
Quadrupole-H	32	1	250	38	11	16	90
Quadrupole-V	32	1	220	12	3.5	16	20
Sextupole-H	32	16	90	24	2.2	40	4
Sextupole-V	32	16	130	24	3.5	80	12
Corrector-H	32	1	10	400	4.0	24	0.05
Corrector-V	32	1	10	400	4.0	24	0.05
Skew-quad	16	1	10	100	1.0	24	0.05

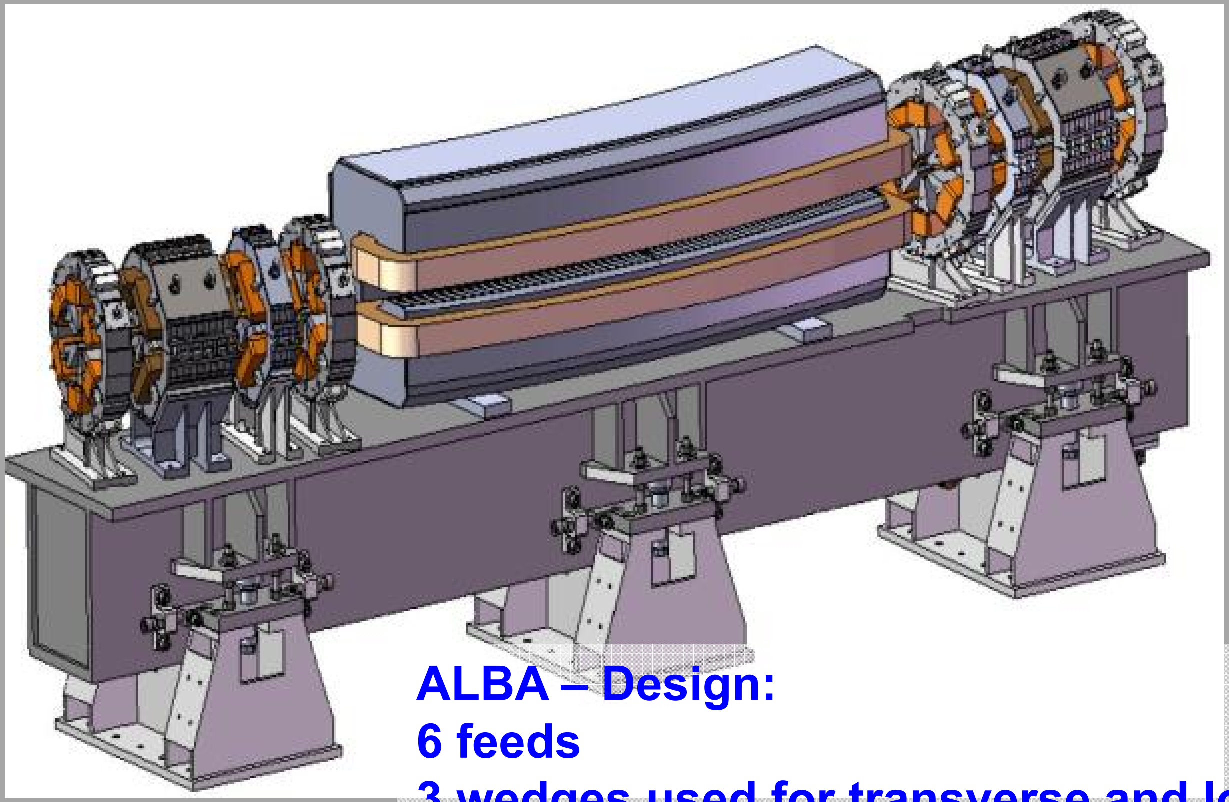
Dipole:
PSI Controller
Serial link
PS
DCCT
ADC

Quadrupole, Sextupole:
PSI Controller
DAC
PS Voltage controlled
DCCT
ADC

Correctors:
PSI Controller

PS-PWM
DCCT
ADC

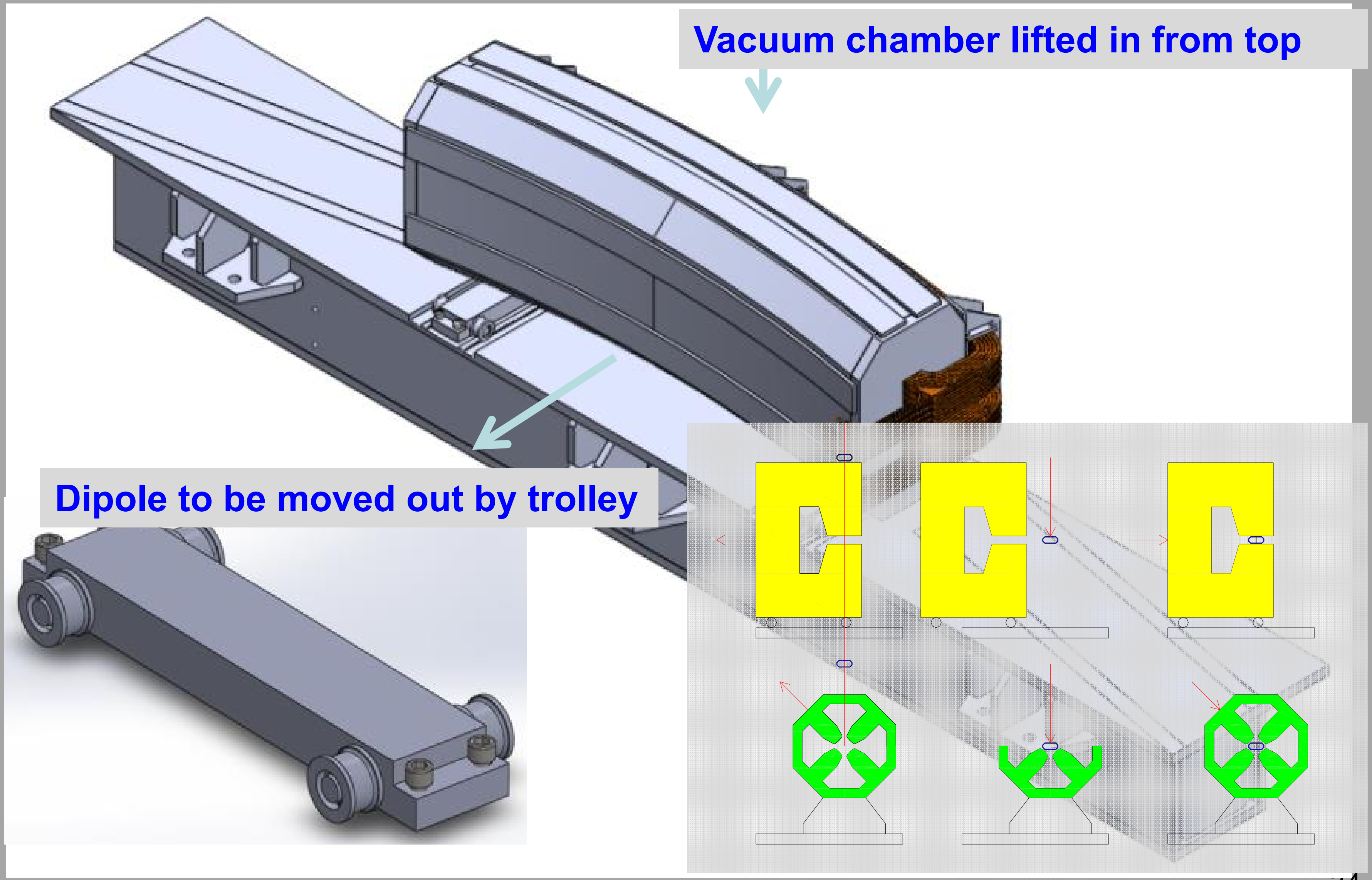
Girder-Design



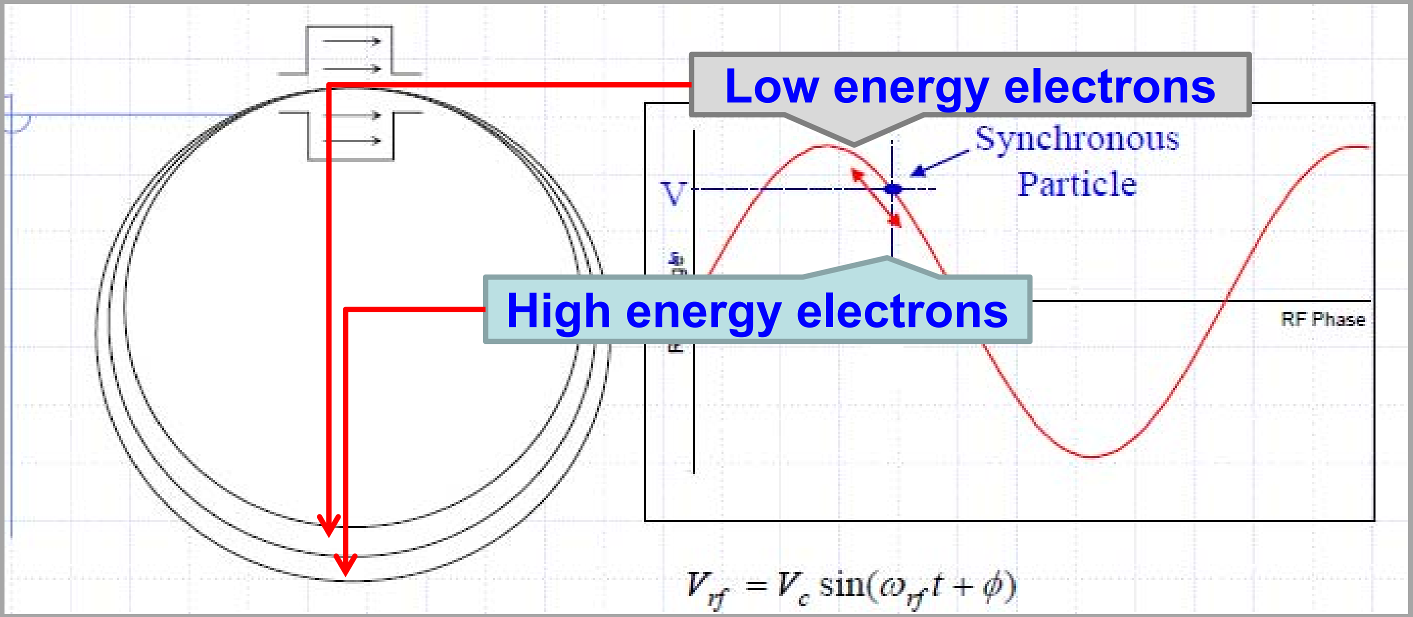
ALBA – Design:
6 feeds
3 wedges used for transverse and longitudinal adjustment
3 wedges used for vertical adjustment and clamping
Magnet Position defined by pins

Request for bids Feb. 2014
6 bids received (France, Iran, Israel, Pakistan, Russia, Spain)

Girder and Vacuum Assembling



RF for Electron-Synchrotrons



Electrons with higher energy take longer path , see less voltage

	E [GeV]	B [T]	U [keV]	No Cav.	Over Voltage	P cav. [kW]	Pbeam [kW]	P total [kW]
Booster	0.8	1.0	14	1	4	0.42	0.07	0.50
SESAME	2.5	1.5	602	4	3	4 x 31	4 x 31	248

$U = 26.5\ E^3\ B$

RF-Cavities

ELETTRA cavity
HOM detuned but not
at 0.8 MeV

BESSY cavity (RI)
HOM damped but not
at 0.8 MeV

KEK/PF cavity (Toshiba)
HOM damped but not
at 0.8 MeV

Request for bids Sept. 2013

Offer from ELETTRA, Research Instruments, Toshiba

Purchasing canceled due to cost above foreseen budget

Offer from Italy for in-kind contribution

SESAME

RF Amplifier

SOLEIL developed Solid State Amplifier 350 MHz 150 kW tower
based on 300 W modules

LNLS developed Solid State Amplifier 500 MHz 40 kW tower
Based on 300 W modules

SOLEIL proposed for SESAME development of 500 MHz 75 kW tower
Based on 650 W modules

SOLEIL licensed technology to SIGMA-PHI Electronics (Bruker)

CRYOELCTRA developed and built for BESSY 500 MHz 75 kW tower

SOLEIL will built one 80 kW tower for SESAME
SESAME will purchase three additional towers

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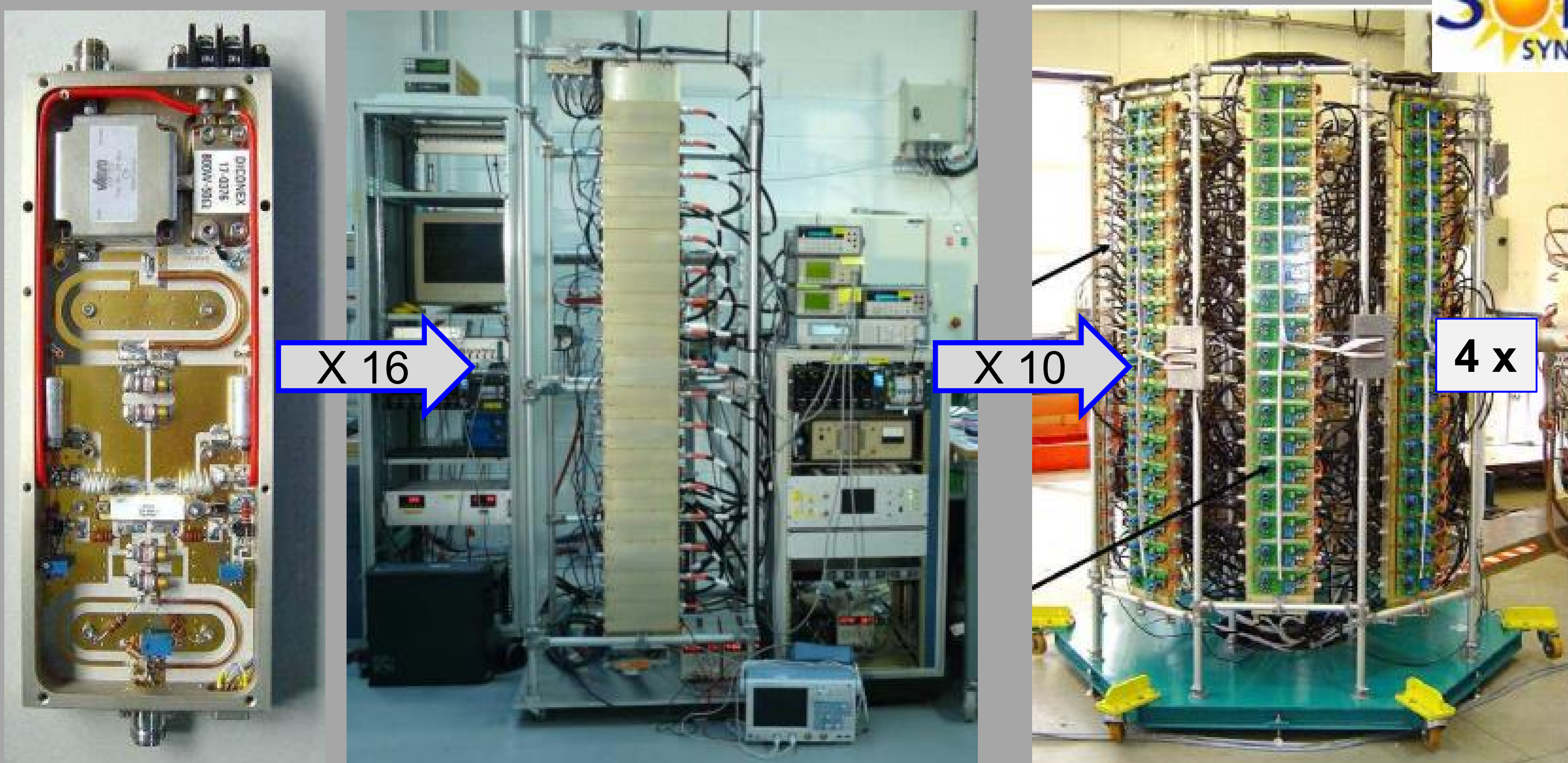
500 MHz 80 kW Solid-State-Amplifier

SOLEIL SYNCHROTRON



0.65 kW

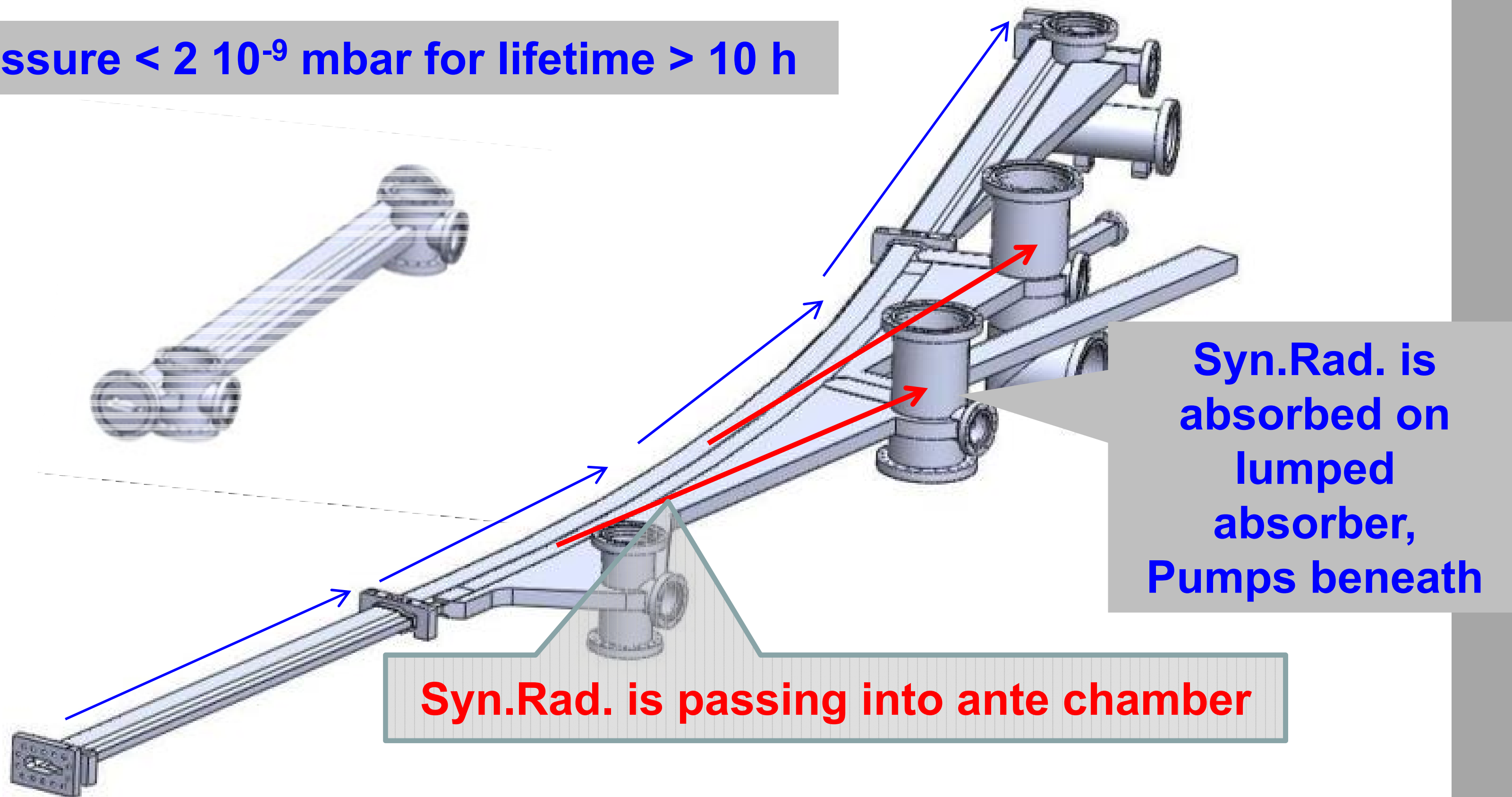
10 kW

80 kW

Syn.Rad. Losses: (200 mA 600 kV) / 4 = 30 kW
Cavity Losses: $(400\ \text{kV})^2 / (6\ \text{M}\Omega)$ = 25 kW
4 Cavities: 220 kW

Vacuum-Chamber

Pressure < 2 10^{-9} mbar for lifetime > 10 h



Electron beam chamber
70 x 28 mm^2

Installed Ion-Pumps:
16 x (2x 300 l/s + 7 150 l/s)

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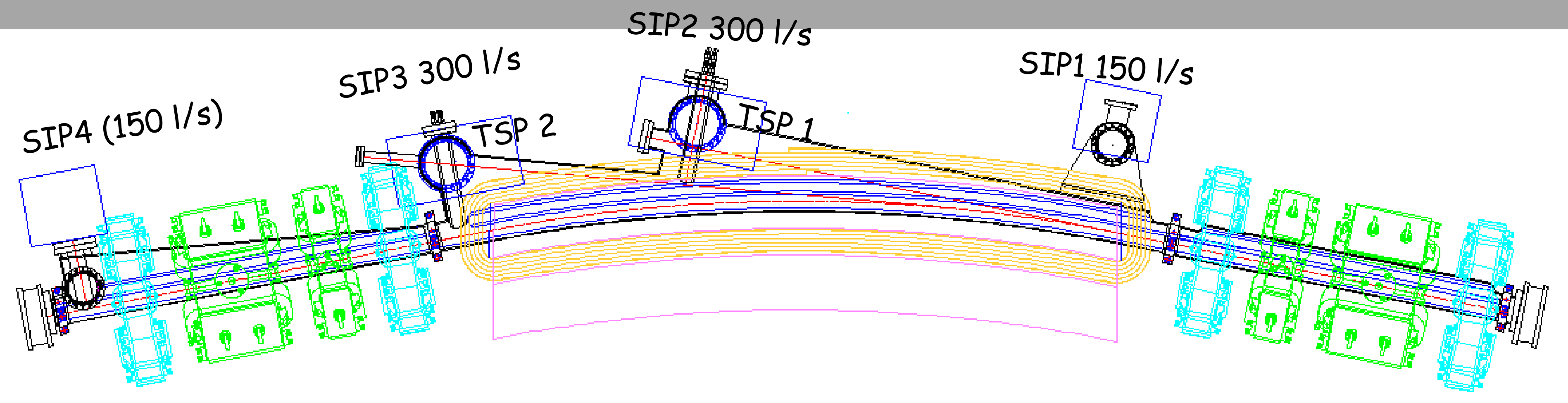
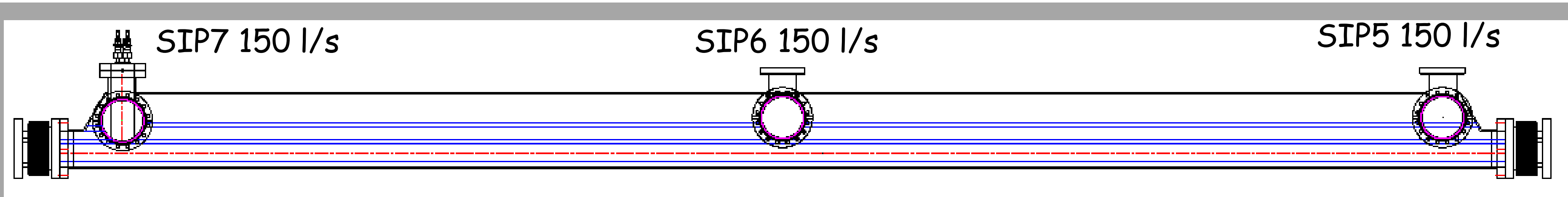
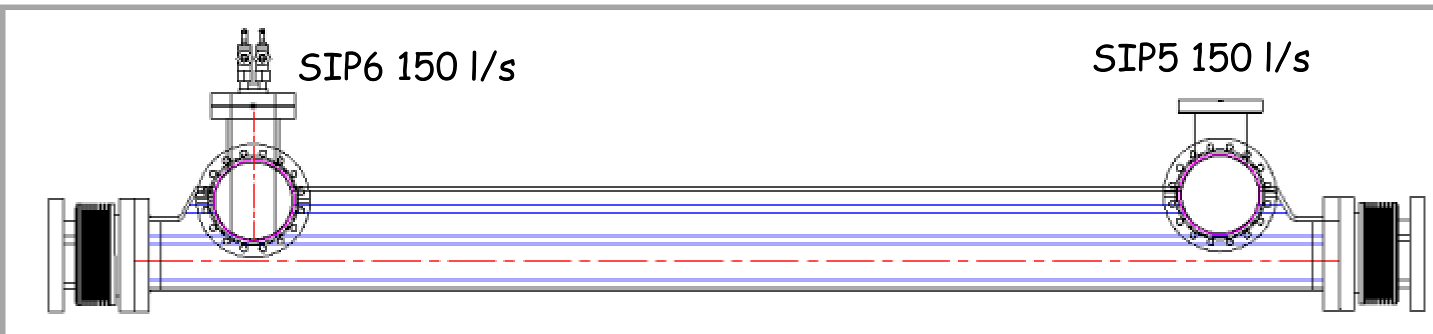
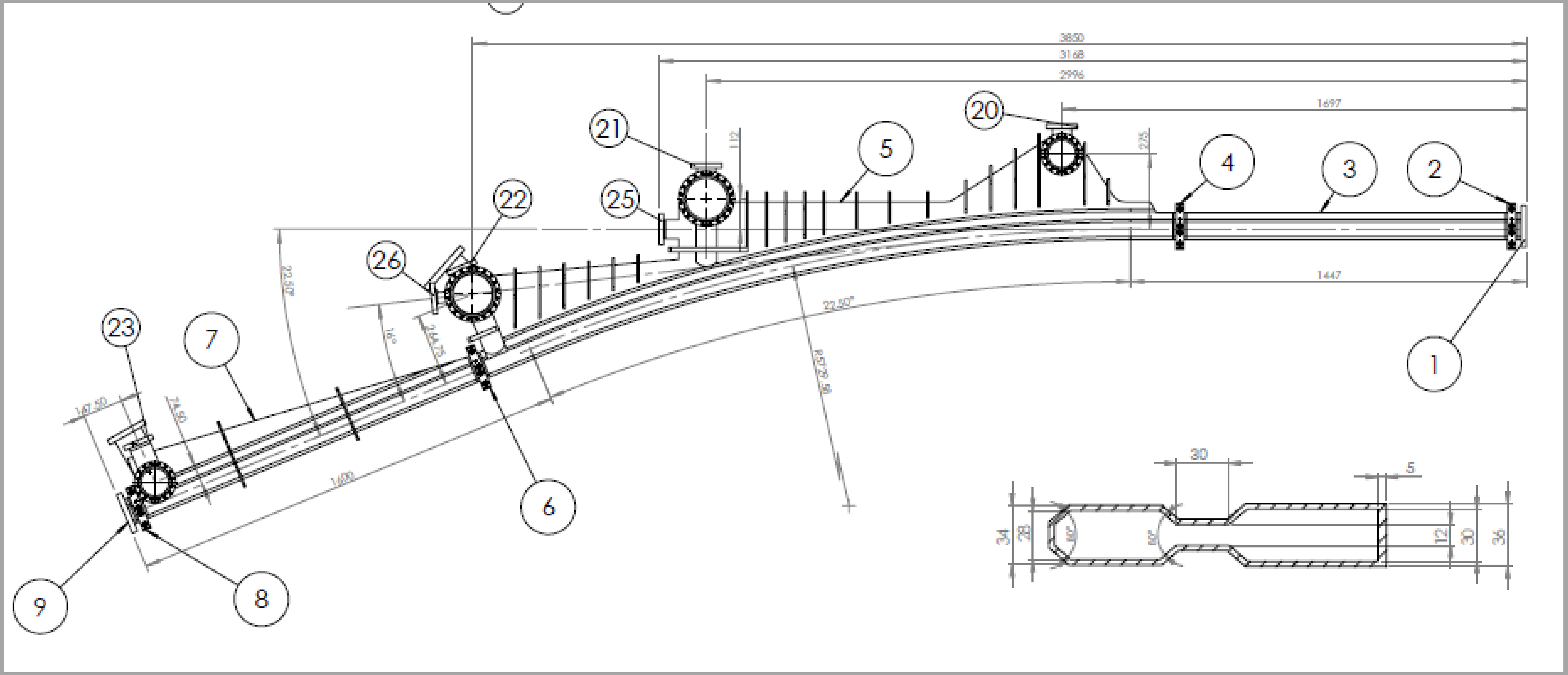
Vacuum-Pumps

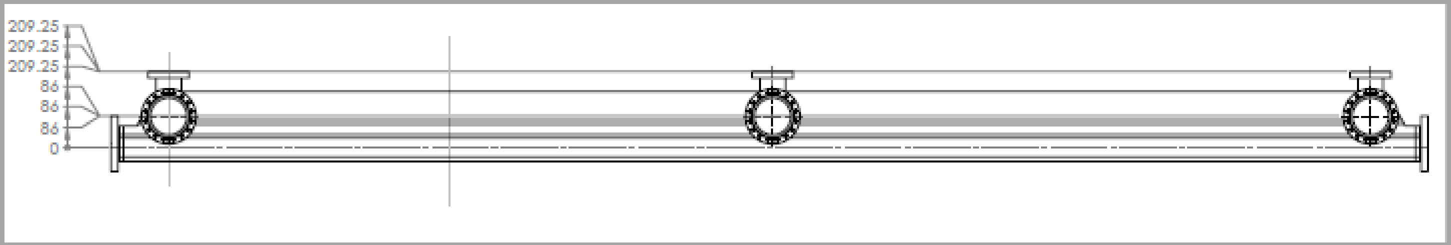






Vacuum-Design





Contracted to FMB-Berlin

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Lifetime

Elastic scattering	$\tau_{elastic}$:	$\sim 1/p\ E^2\ (a / \beta)^2$
Inelastic scattering	$\tau_{inelastic}$:	$\sim 1/p\ \ln(d\varepsilon / \varepsilon)$
Touscheck	$\tau_{touscheck}$:	$\sim E^2\ \sigma_x\ \sigma_y\ \sigma_z\ (d\ \varepsilon / \varepsilon)^3 / I_B$

E [GeV]	**Elastic [h]**	**Inelastic [h]**	Tousch. 1 % accept. [h]	**Tousch. 1.5 % Accept. [h]**	**Total [h]**
0.8	15	60	4	13	6
1.5	54	60	13	46	17
2.0	95	60	24	82	25
2.5	150	60	36	128	32

Pressure	$p\ (N_2)$:	10^{-9}	mbar
Energy acceptance	$d\varepsilon / \varepsilon$:	1.5	%
Bunch size	σ_x:	0.5	mm
	σ_y:	0.1	mm
	σ_z:	10	mm
Bunch current	I_B:	2.5	mA

Shielding / Radiation Safety

Allowed dose: < 1 mSv/y
(Allowed dose for Non-Radiation Workers)

Electron -loss:	γ,n cascade	2500 MeV
Inelastic scattering:	gas-Bremsstrahlung	25 MeV
Synchrotron Radition:		50 keV

Radiation Monitor

Side-Wall: 1m concrete
Front-Wall:1m concrete
+0.15 m lead

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Radiation Monitors

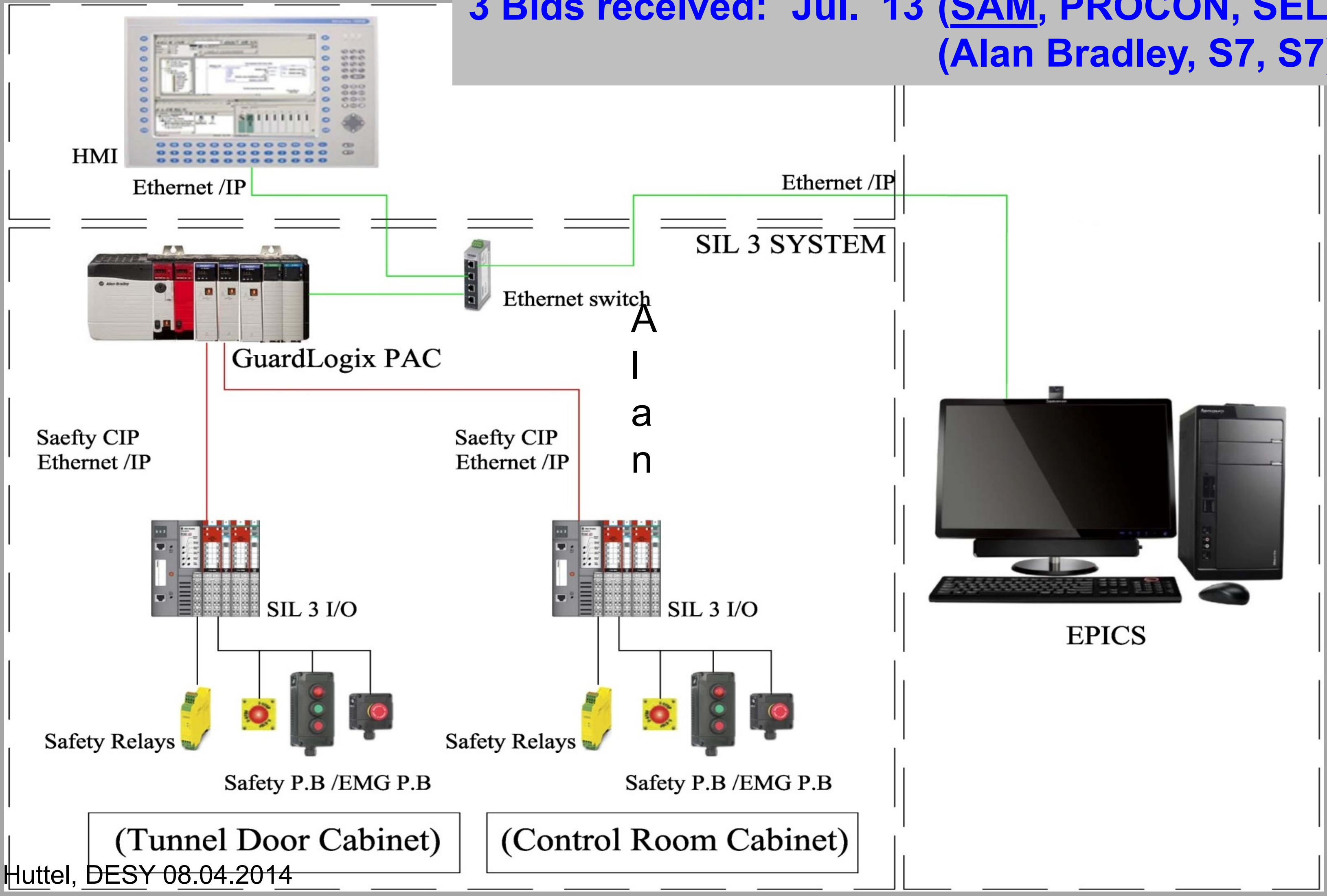
On-line-Radiation Monitors:
5 movable +2 portable stations:
Gamma (Thermo/Eberlein) :
10 nSv/h – 1 Sv/h
30 keV -10 MeV
Neutrons:
10 nSv/h – 0.1 Sv/h
25 meV – 100 MeV

X-ray and Neutron Personal (Luxel) Dosimeter ordered from Landauer

Radiation Monitor installed on top of the SESAME Booster

Personal Safety System

Personal-Safety System
Invitation to bid: May 13
3 Bids received: Jul. 13 (SAM, PROCON, SELMER)
(Alan Bradley, S7, S7)



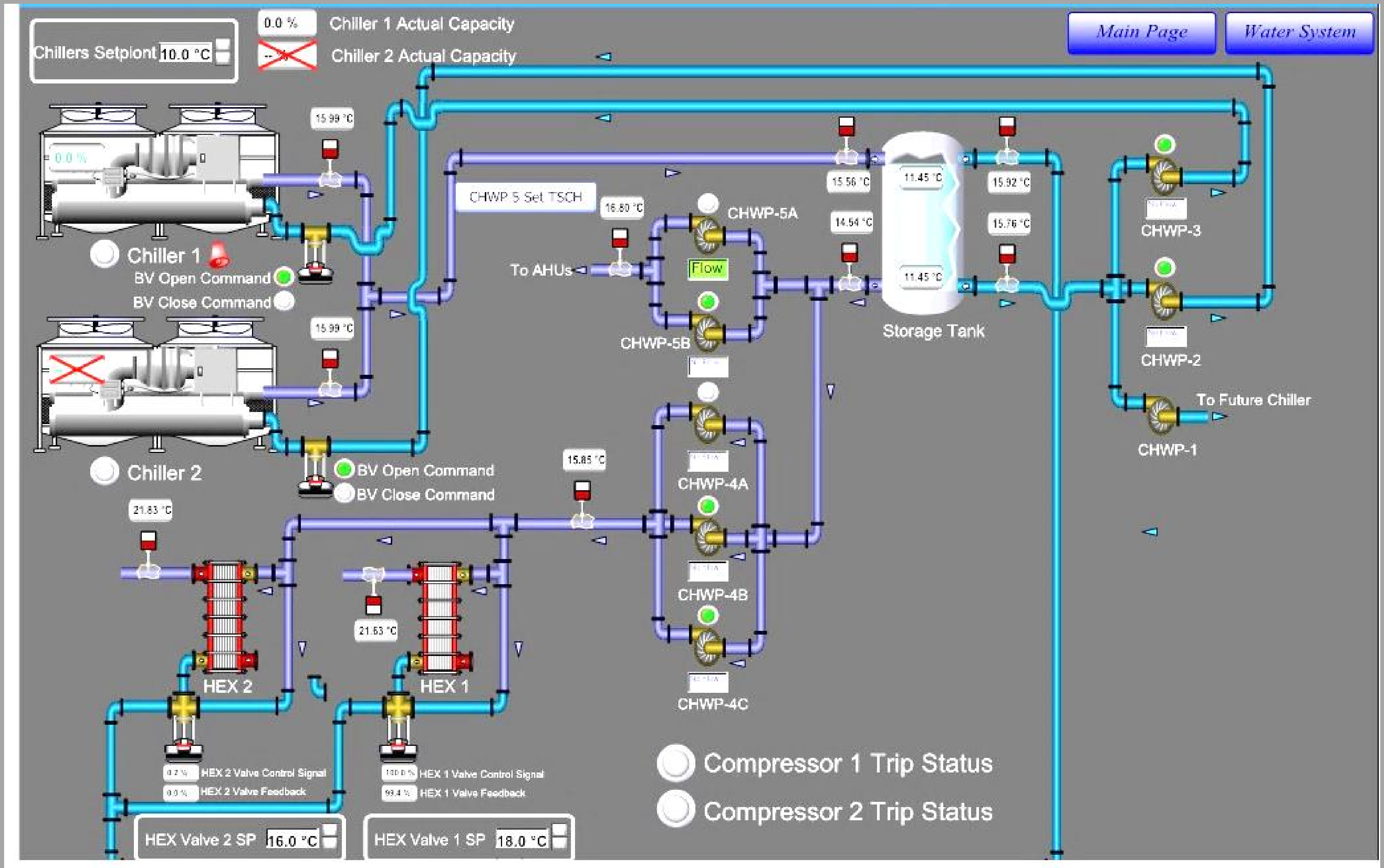
Cooling System

Power

Design by SESAME	(Firas Makahleh)
Done by local provider:	(Alpha-Amman)
Volume: 2 M $,	Built up: 2011-2013

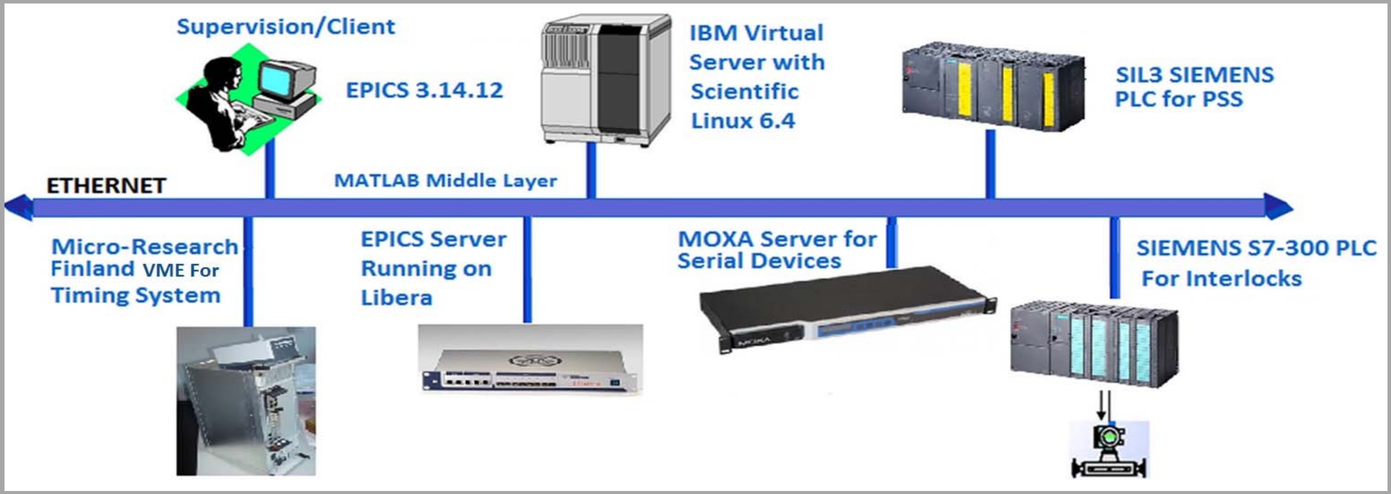
	Electric Power	Cooling Capacity
Cooling Tower Compressor	400 kW	2x 1 115 kW
Chilling water tank		
Pumps	100 kW	
Heat Exchanger		2 x 870 kW
Pumps	120 kW	
Air-Conditioning	300 kW	600 kW
De Ionized Water Circuits:		
SR Magnet	500 kW	
RF Amplifier	250 kW	
RF-Cavities 200 mA	125 kW	
SR Absorber (200 mA)	125 kW	
Booster	100 kW	
Sum	2 000 kW	

Cooling Chiller Circuit (GUI)



Control System Architecture

Control-room:	Linux-PC	GUI: EDM (↓) → CSS	
Server Layer:	Virtual Servers	(EPICS Middle layer)	
Field Layer:	PLC	Embedded Controller	VME (↓)



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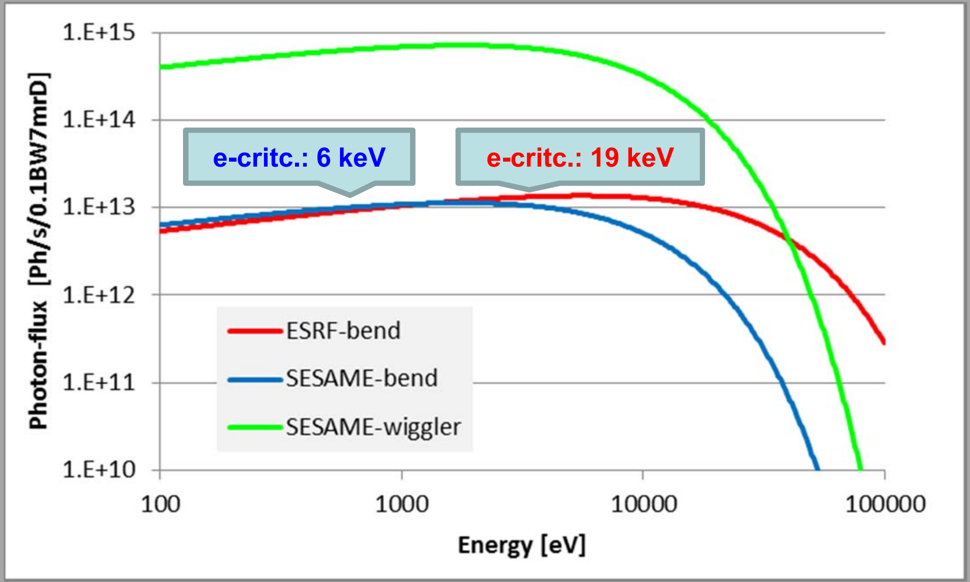
Field-Devices

Day One Beamlines

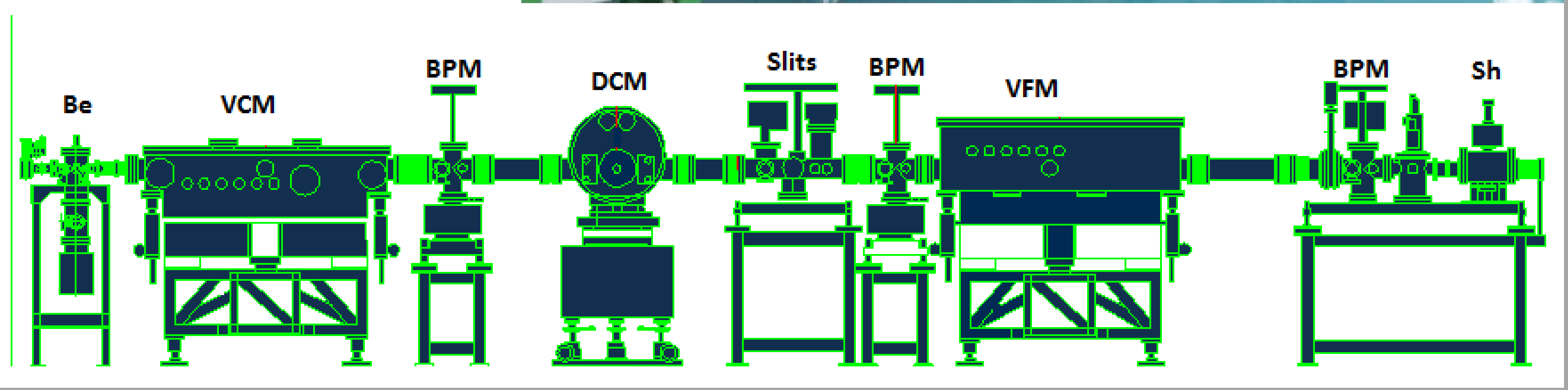
Method	Energy-Range	Remark
X-ray Absorption/Fluorescent	3-30 keV	ROBL (ESRF)
Powder-Diffraction	3-25 keV	SLS
Infrared	0.01- 1 eV	New
Protein Crystallography?	4-14 keV	Daresbury



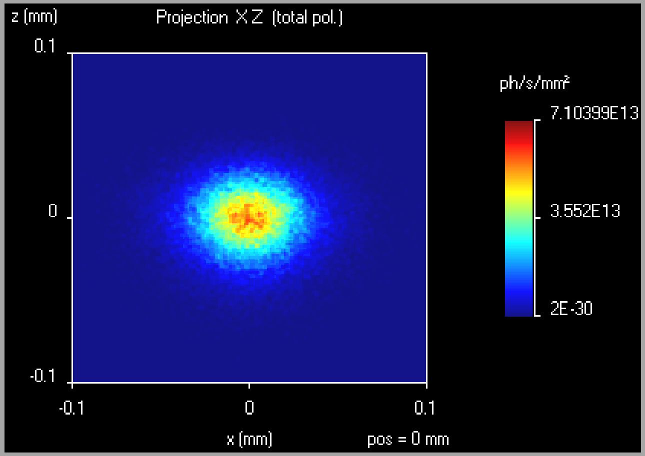
e-critic: $0.665\ E^2\ B$

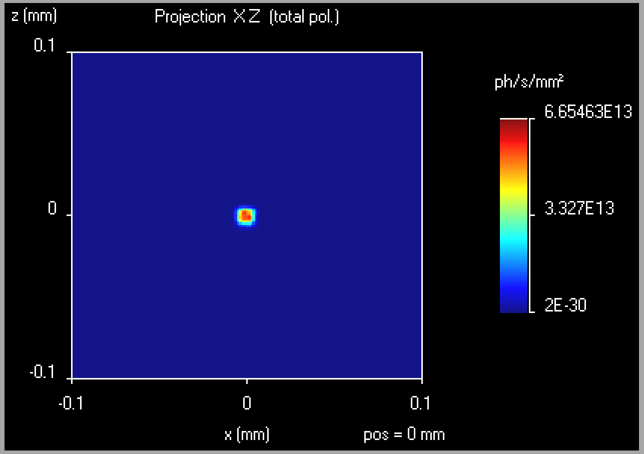
XAFS-Beamline (ROBL-ESRF)

Beamline Components set up in lab
Under Test with ESRF experts



XAFS-Beamline (ROBL-ESRF)



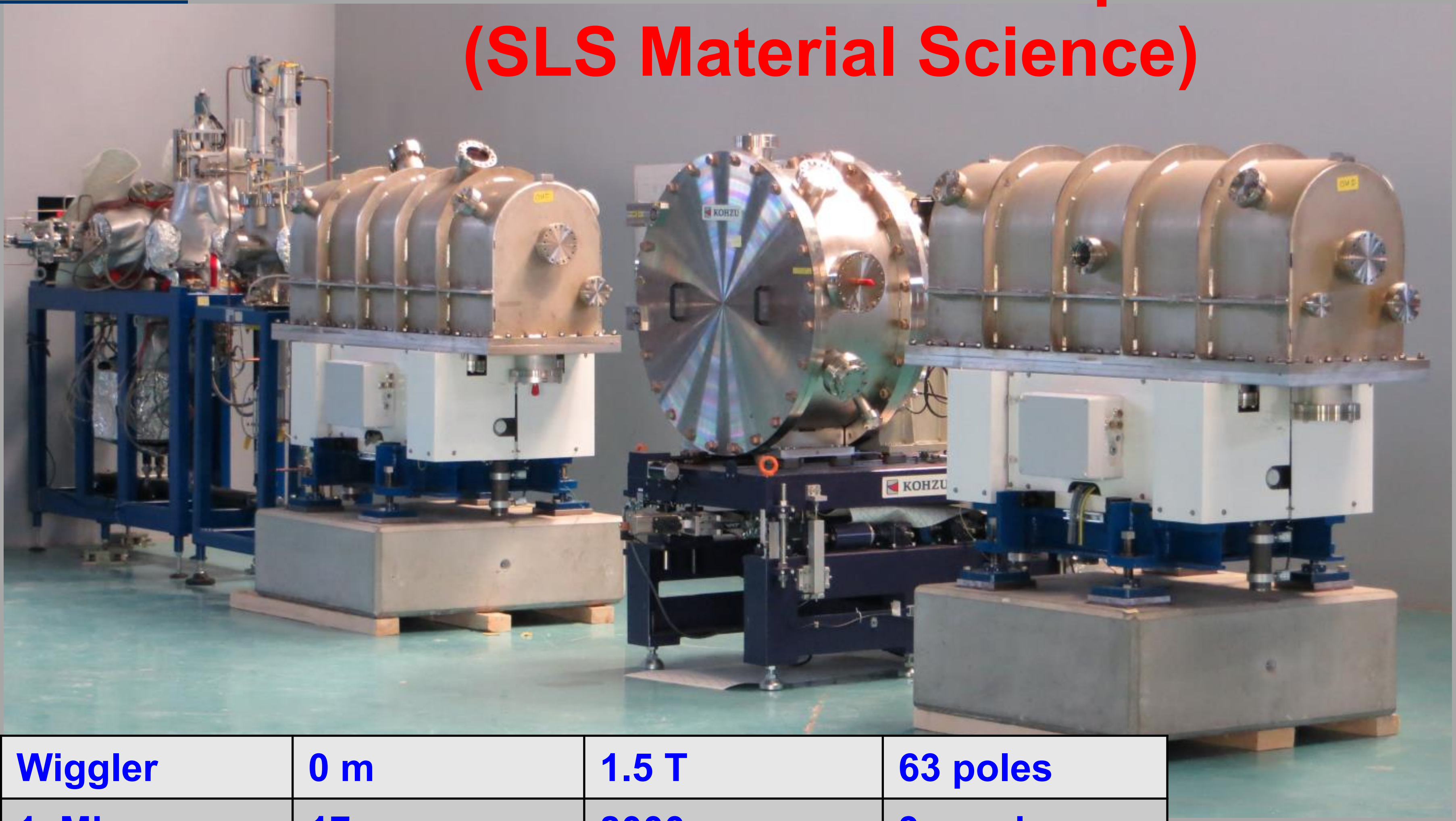


Source Bend	0 m	1.5 T	
1. Mirror v	12.7 m	8000 m	3 mrad
DCM h	15.2 m	2.6 m	10°
2. Mirror v	18.3 m	8000 m	3 mrad
1. Image h/v	30 m	1:1 / 1:1	111 / 72 µm
KB v	33 m	333 m	3 mrad
KB h	33.5 m	183 m	3 mrad
2. Image h/v	33.7 m	1:0.1 / 1: 0.2	15 / 15 µm

Powder-Diffraction Wiggler (SLS Material Science)

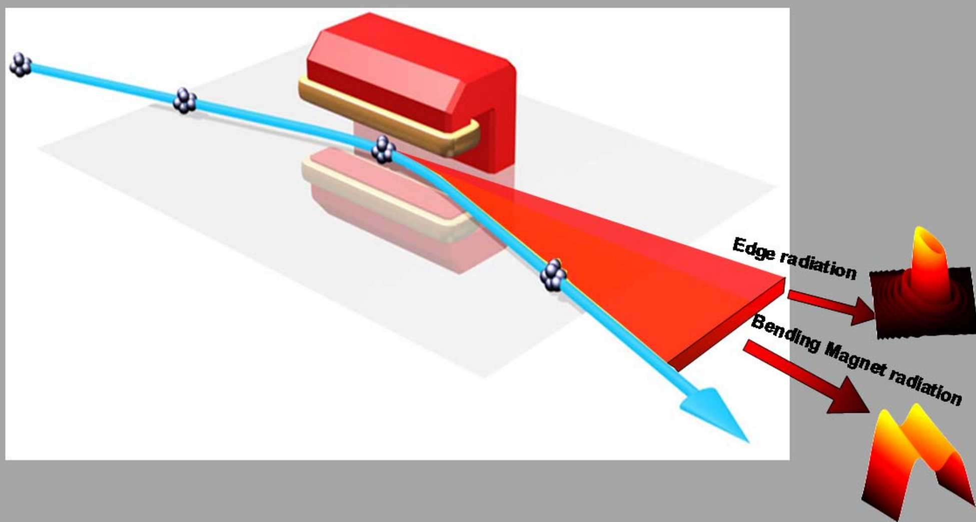
Wiggler-Parameter		
Length	2	m
Period	60.5	mm
No. Pols	63	
Magnet gap	14 / 10 / (7)	mm
Vacuum gap	12 / 8 / (5)	mm
Field	1.1 / 1.5 / (1.9)	T

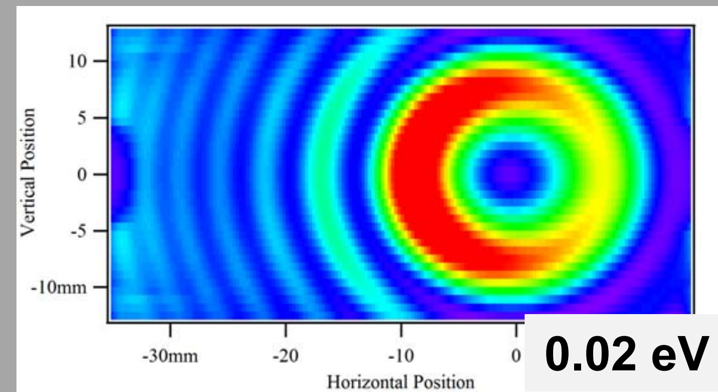
Powder Diffraction Optics (SLS Material Science)

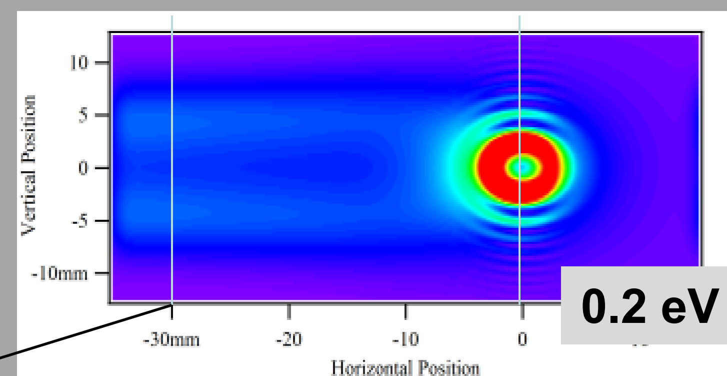


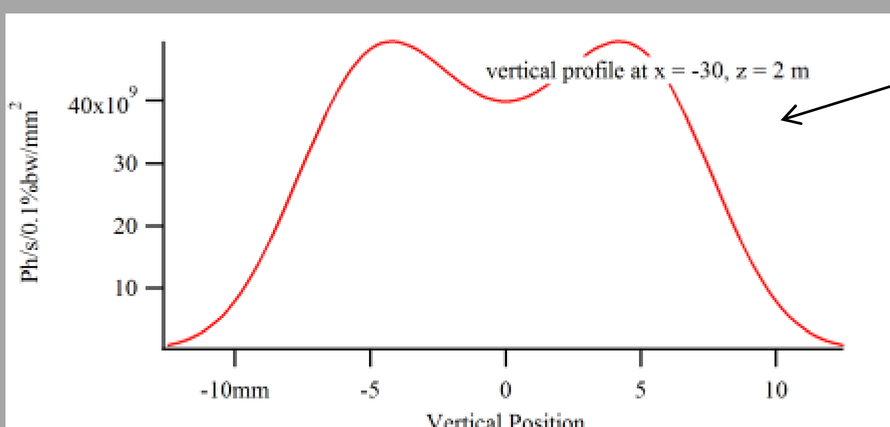
Wiggler	0 m	1.5 T	63 poles
1. Mirror v	17 m	8000 m	3 mrad
DCM h	19 m	2.6 m	10°
2. Mirror v	22 m	8000 m	3 mrad

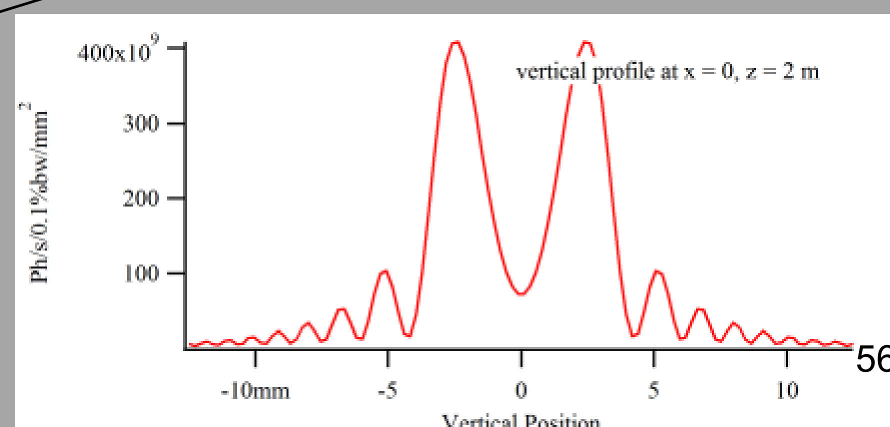
IR Edge/Constant-Field Radiation











IR Microscope at SESAME

Open Tasks

RF:	**Low-Level-Electronics, Waveguides,**
Vacuum:	**Pumps, Bellows, Transitions**
Cooling:	**SR-Piping**
Diagnostics:	**BPM-Electronics, Screens**
Pulsed Magnets:	**SR Septum, Kicker**
Power-Supplies:	**Extraction Kicker, Septa, Injection Kicker**

SESAME

Status

Accelerators:

Microtron:	Microtron is running (2012)
Booster:	Commissioning started (2014)
Storagering:	Design done (2006)

Magnets:	Purchased by CERN (delivery end 2015)
Vacuum:	FMB contracted
RF amplifier:	In negotiation
RF cavities:	In negotiation

Building:	Shielding wall is done (besides lead shielding)
	Cooling plant and Air Conditioning finished (EU funded)
	Radiation Safety system purchased

Beamlines:	Floor-planes in work
	Test of components for XAF done
	IR microscope in operation

Magnet Specification

Steel:
Lamination: 1 mm
Burr: < 25 µm
Coercitifity: < 70 A/m
Carbon content: < 50 ppm
Silicon: < 100 ppm

H [A/m]	B [T]
1000	1.52
2500	1.63
5000	1.71
10000	1.81

Shuffling
Swopping

Coils:
2 thermo coupler per coil
Isolation test: 5 kV
Inductance, p-p: < 4 %
Resistivity, p-p: < 2 %

Mechanical tolerances Dipole

Lamination:
Form-tolerance (pole): < 30 µm
Form-tolerance (interface): < 50 µm
Flatness: < 50 µm

Yoke:
Length: < 0.5 mm
Angularity: < 0.1 mm
Flatness (pole): < 0.1 mm

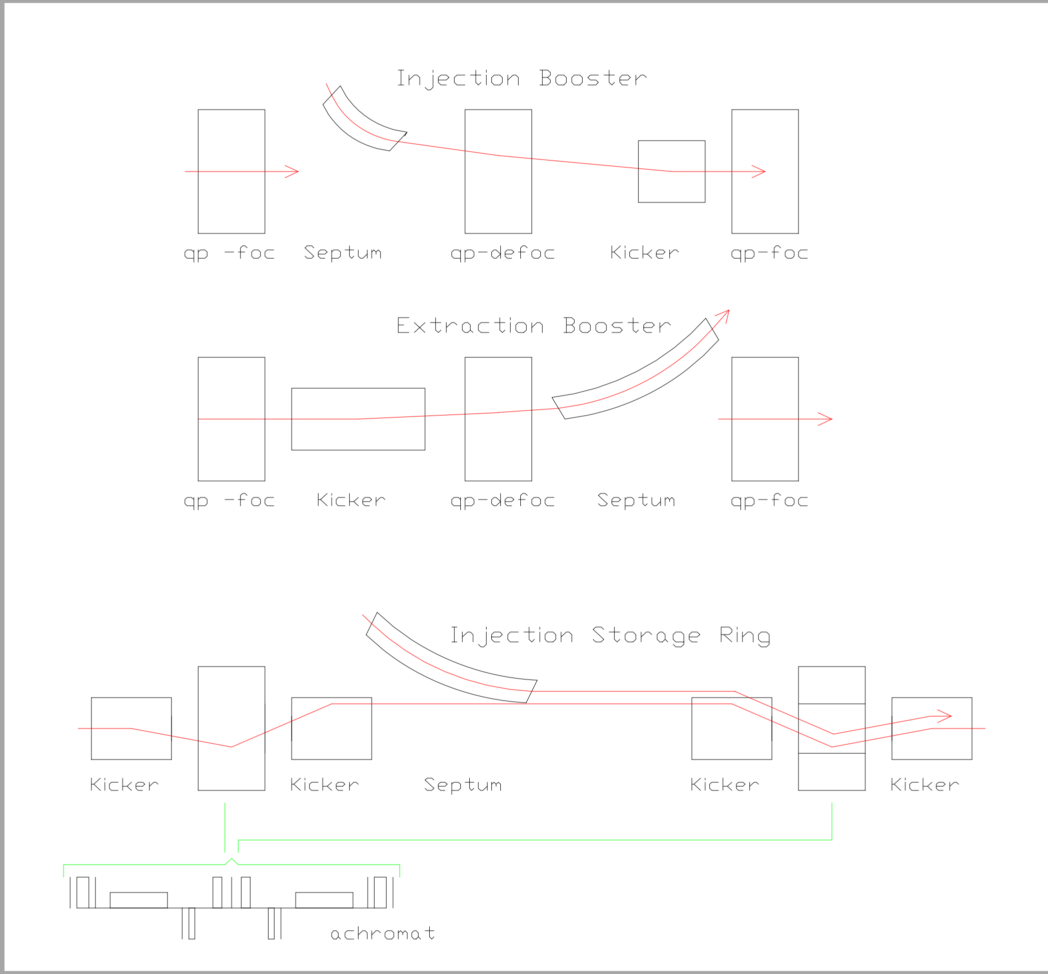
Mechanical Tolerances Quadrupole

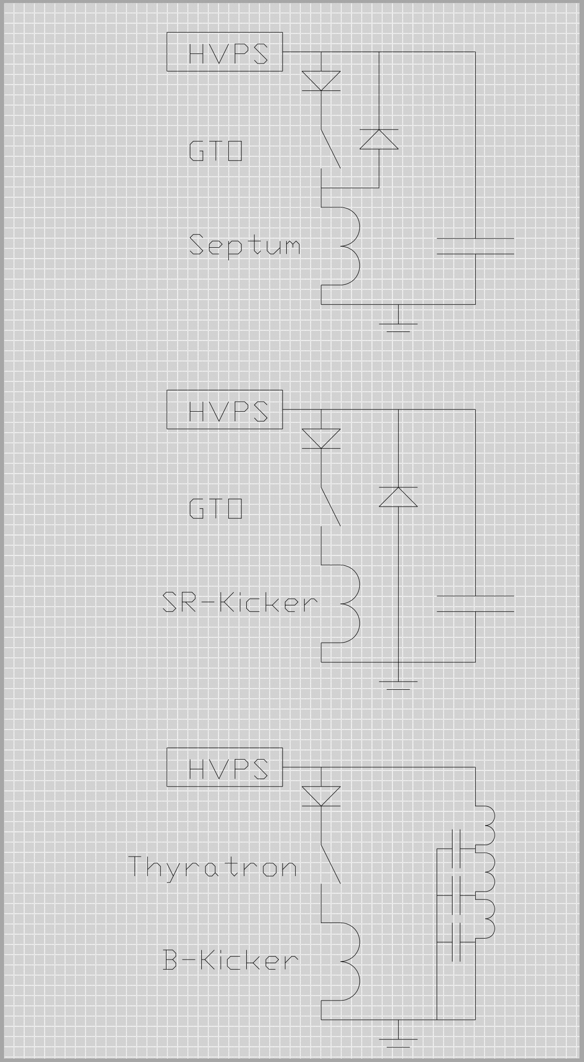
Lamination:
Form-tolerance (pole/else):< 30/100 µm
Angularity: : < 30 µm
Shim-distance, p-p: < 30 µm
Diameter distance p-p: < 50 µm
Planarity: < 50 µm

Yoke:
Length: < 0.5 mm
Angularity: < 0.05 mm
Planarity: < 0.05 mm

Tolerances ~ 50 µm

Pulsed-Magnets Principle





Pulsed Magnets Parameter

Element	Type	Length	Kick	Pulse length	L [µH]	U [V]	I [A]	C [µF]	Field
Injection Septum	Electrostatic Half sine	R: 2 m	14.5°	250 µs		220		3.75	10 MV/m
Injection Kicker	Stripline Half sine	L: 0.3 m	3 mrad	6 µs	2	220	100	1.6	0.001 T
Extraction Bumper	Iron Magnet Half sine	L 0.17 m	5 mrad	1.7 ms	700	200	150	440	0.080 T
Extraction Kicker	Stripline Flat-top	L: 1 m	2 mrad	40/190ns	1	25000	280	50 Ω 20 m PFN	0.005 T
Extraction Septum	C magnet, eddy current Half sine	R: 5.73 m	10°	560 µs	10	220	4000	3500	0.465 T

General Policy for the Booster:
Keep BESSY Magnets.
Replace Power-Supplies.