17TH ADVANCED BEAM DYNAMICS WORKSHOP ON
FUTURE LIGHT SOURCES

Ring-Based Sources Report No. 1

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ARGONNE NATIONAL LABORATORY, ARGONNE, IL U.S.A.

"RING BASED SOURCES" REPORT

6th april WGS1

Programme presentation of the working group

- presentation of the members of the working group activity and interests

wide representation of machines :

operating : APS (3rd), UVSOR (2nd), Elettra (3rd), DELTA, BessyII (3rd), KEK, ESRF (3rd), Super-ACO (2nd), DCI (1st), Taiwan LS, Spring8(3rd), Brazilian LS, DUKE, VEPP2, Vepp3, Niji4, ETL...

project : Diamond + add, Canadian Light Source, SOLEIL, Swiss Light Source

SRFEL : UVSOR, Elettra, DELTA, DUKE, NIJI4, SOLEIL

various interests:
- **beam dynamics**
- **small gap in-vacuum undulator**
- **topping-up**
- **lifetime issues**
- **MB feedbacks**
- **SRFELs**

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answers to questions of WG IV

* tolerable trajectory wander and tolerable phase errors in long undulators
appropriate parametrization for specifying integral multipoles

In general, need of multipole expansion of the field
important for dynamical aperture
coupling terms:
ex : step of lifetime whem an ID is closed (APS, SPring-8 in case of a change of the gap of a circularly polarized undulator)
the critical issue is the lifetime

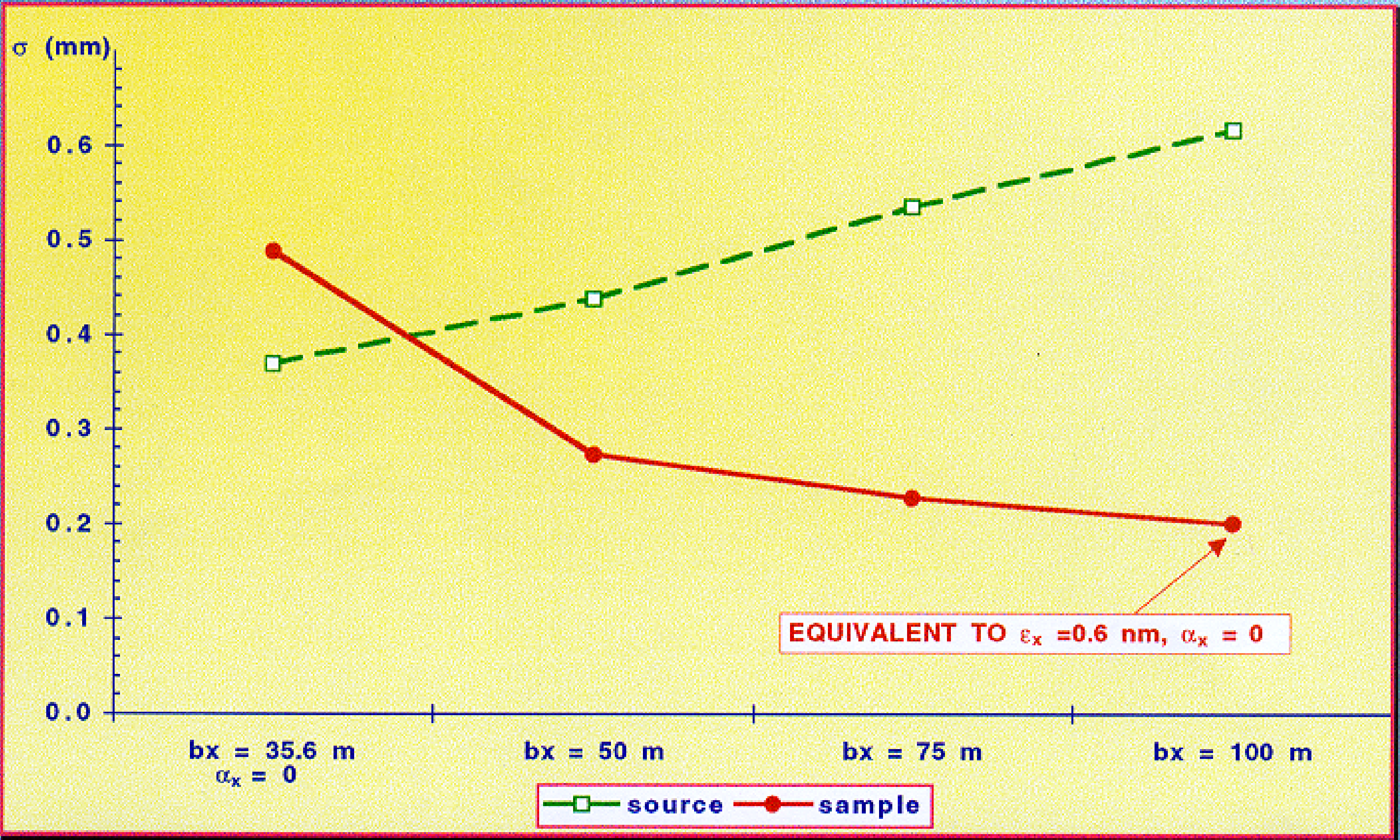
* important tolerances
field integrals over the cross section of the beam
depends on the machine type (E...) and on the ID (ideal field)

* Are the tracking tools for ID sufficient?
at Elettra : comparison between simulations and exper. :OK
→ Present quality of ID is sufficient for existing SC
* Is there a chance for energy spread reduction in 3rd generation light source?
o natural zero current energy spread:
manipulation of longitudinal emittance
o increase of energy spread with I :
suppression of microwave instability
→ how much is energy spread critical to users?
trade-off with lifetime if ID used on low harmonics.

HORIZONTAL FOCUSING

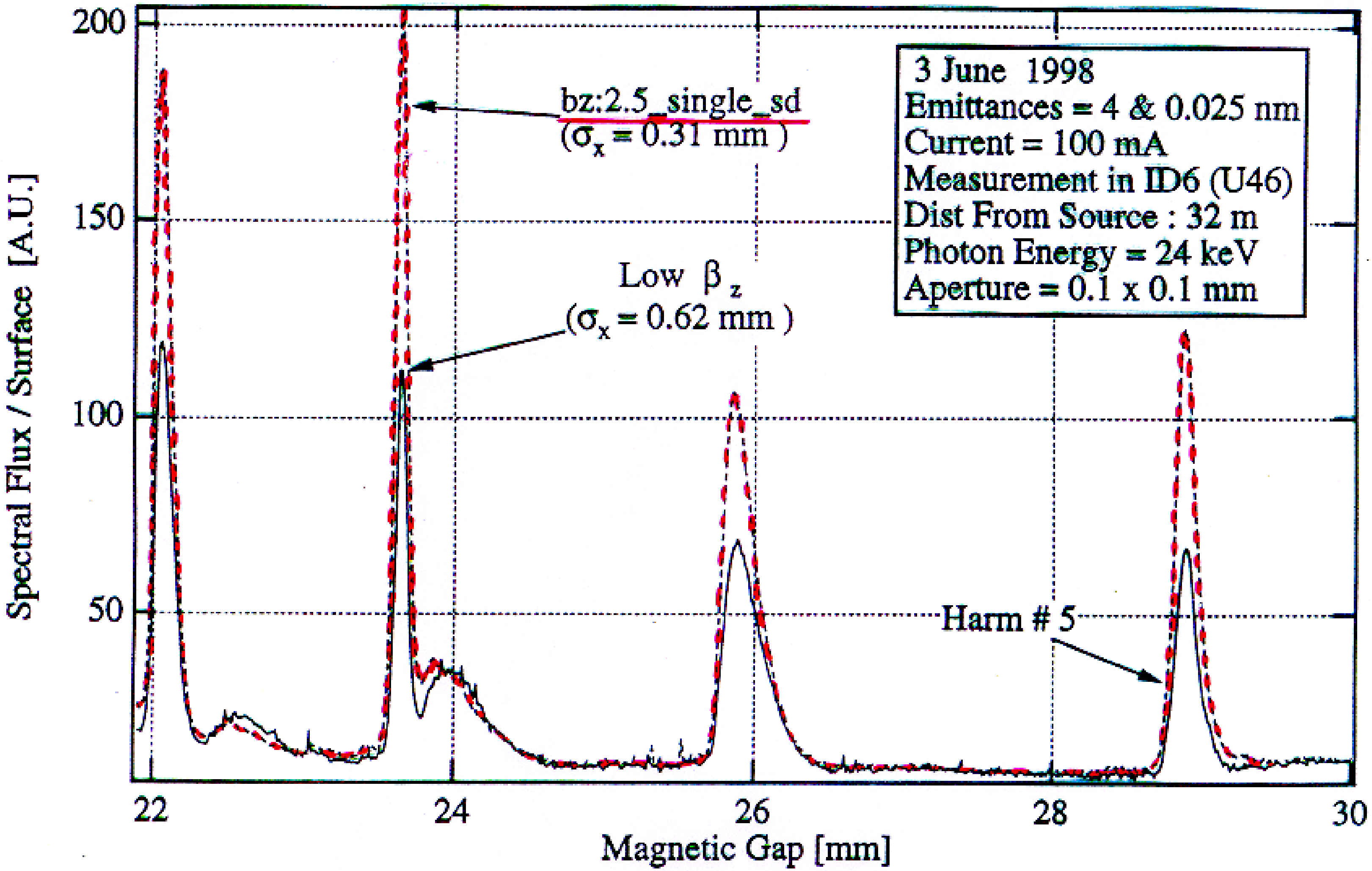
ESRF

COMPARISON OF BEAM SIZES AT A PHOTON ENERGY OF 20 keV AT A DISTANCE OF 30 M



A. Ropert, ESRF

Focusing the Electron Beam in ID6



"RING BASED SOURCES" PROGRAMME

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MARS : a project of the diffraction limited fourth generation X-ray source. G. Kulipanov
Multi turn Accelerator Recuperator Source

o emittance corresponding to the diffraction limit (10^{-11} mrad at 1 Å)

o beam energy spread down to the fundamental limit due to quantum fluctuations of undulator radiation ($<10^{-4}$)

o use of very long undulators $N = 10^4$

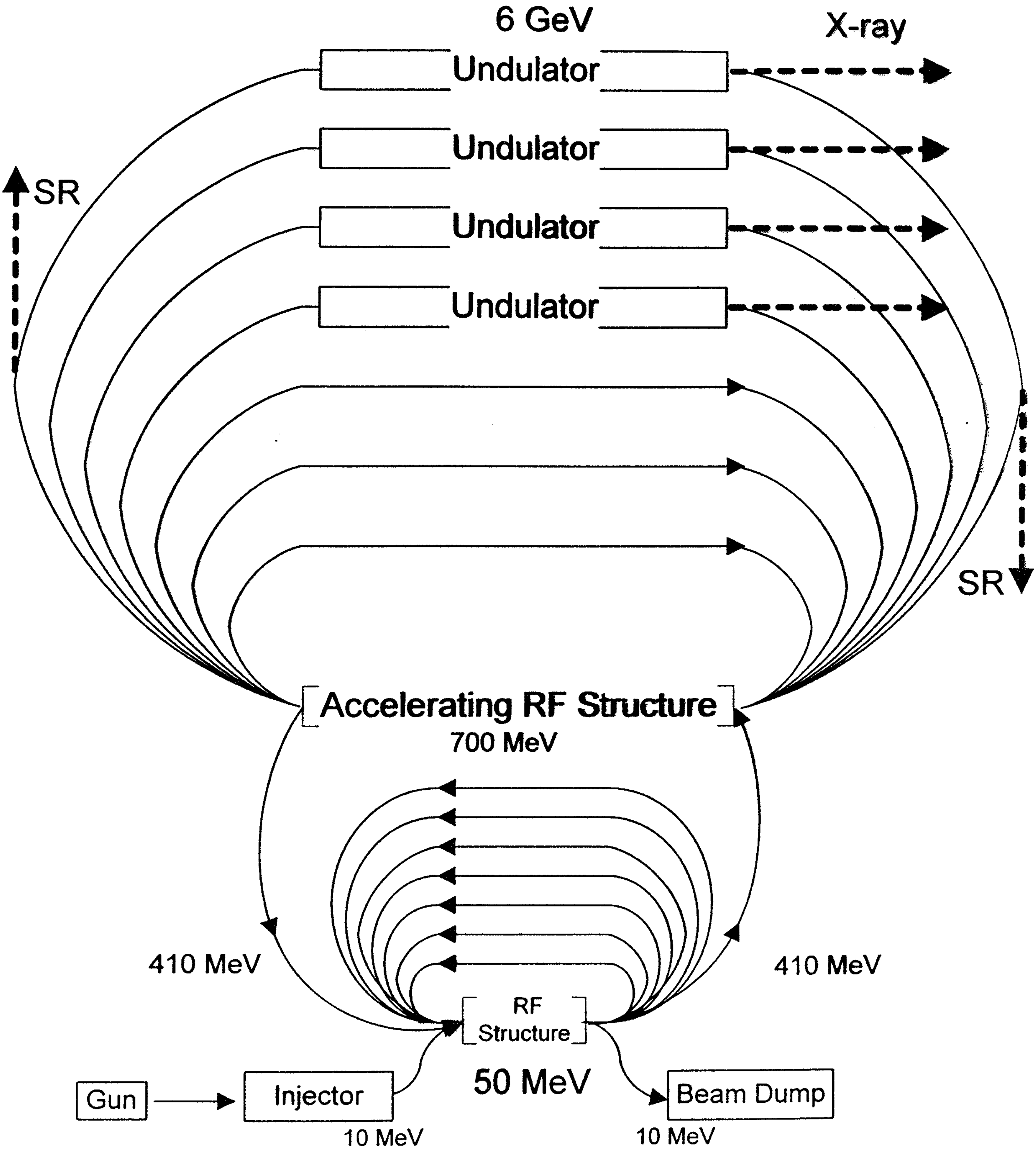
⇒ large length of temporal coherence
narrow peak spectrum

⇒ high spectral brightness

SRing :
radiation damping + diffusion processes (quantum fluctuations + IBS) ⇒limitation in the decrease of ε and energy spread

LINAC :
low average current for pulse conventional linac
high cost of SC LINAC
radiation hazard

⇒ rough conceptual design of MARS


6 GeV
X-ray
Undulator
Undulator
Undulator
Undulator
SR
SR
Accelerating RF Structure
700 MeV
410 MeV
410 MeV
RF
Structure
50 MeV
Gun
Injector
Beam Dump
10 MeV
10 MeV

Comparison of various types of the coherent X-ray sources:

	ESRF storage ring	LCLS linac	MARS
Wavelength, nm	.1	.15	.1
Electron energy, GeV	6	14	5.4
Average current, A	.2	3×10^{-8}	10^{-3}
Peak current, A		3.4×10^{3}	1
Relative energy spread		2×10^{-4}	1×10^{-5}
Emittance, nm εx εz	4 2.5×10^{-2}	3×10^{-2}	3×10^{-3}
Undulator period, cm	4.2	3	1.5
Undulator length, m	5	100	150
Coherent flux, photon/s	6×10^{12}	6×10^{14}	7×10^{13}
Bandwidth	10^{-2}	10^{-3}	10^{-4}
Average brightness, ph/s/mm^2/mrad^2/0.1%BW	10^{20}	6×10^{22}	3×10^{23}
Peak brightness, --//--		5×10^{33}	3×10^{26}
Transverse size of source (standard deviation), μm	σ_x 350 σ_y 8	9	10
Radiation transverse divergence (standard deviation), μrad	$\sigma_{x'}$ 13 $\sigma_{y'}$ 3	2	1