Necessity of Moving from *Green Book* to *White Book*

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Green Book?

- **SESAME**

  A Proposal for a Synchrotron Radiation Source in the Middle East, October 1999

  On the basis of recommendations made by the IC committees, in their Berlin meeting in August 1999, for a 5-year program.

- in the "Green Book" we read..

  "….a plan is presented to bring to the Middle East a major, international user facility for basic and applied research with a synchrotron source as its centerpiece. It capitalizes on the availability of the BESSY I synchrotron radiation source and injector system after the shut down of this facility in Berlin."

- "….the (new) facility could support frontier research by a large user community (up to about 1000 users) over a broad spectral range extending from the infrared (10^{-2} - 10^{-1} electron volts) to hard X-rays (10^{4} electron volts). It is anticipated that the facility would have a major impact on the development of science and technology in the Middle East region, with particular relevance to:"

- *health & environmental issues,*
- *benefits to industrial development,*
- *student training,*
- *general economy, and*
- *promotion of understanding and peace in the region.*

- "A primary goal of the upgrading of BESSY I, is to improve its capabilities as a hard X-ray source, since much of today's interest in scientific and technological applications requires hard X-rays.“

(*a goal supported later on by workshops organized by* **Herman Winick**)

What to do?

- *increase the energy from 0.8 GeV to 1 GeV, by the modification of bending magnet poles, and doubling of the existing radiofrequency system; and*

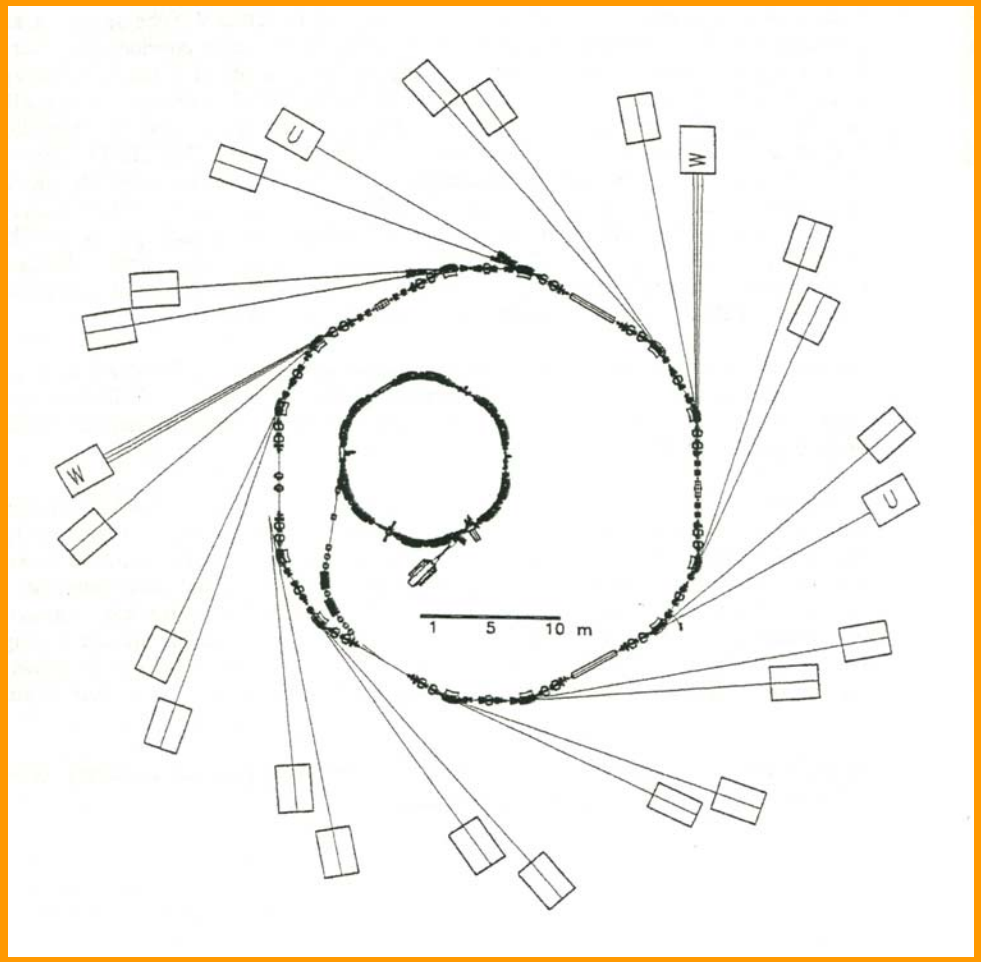
- *introduce superconducting* (SC) *7.5* T *wigglers.*

Why?

- "This will result in photon energies up to 20-25 keV (with ε_c of 5 keV), which, together with the large stored current of 700 mA, will produce photon fluxes in the 1 Angstrom (12 keV) region competitive with the larger storage rings in operation. An increase in circumference from 64 m to 100 m will provide the space for up to 4 "insertion devices".

- "The electron optics of this upgraded version is characterized by its 6-fold symmetry, its low horizontal and vertical beam emittances (50 nm.rad and 1.5 nm.rad respectively), low beta-sections at the wiggler locations (4 m and .5 m in the horizontal and vertical directions) and large dynamic apertures (> 30 standard deviations)".

Footprint of SESAME storage ring layout foreseen by Green Book



Number of Beam Lines?

- *in principle, twenty beam lines originating in the 12 bending magnets with a critical energy of* ε_c= *1.25 keV,*

- *two straight sections for the installation of* 7.5 T *multipole* SC *wigglers* (ε_c = *5. keV), and*

- *two straight sections for undulators to provide high brilliance photon beams in the energy range of several tens of eV to about 1 keV.*

Fig 6.2.1

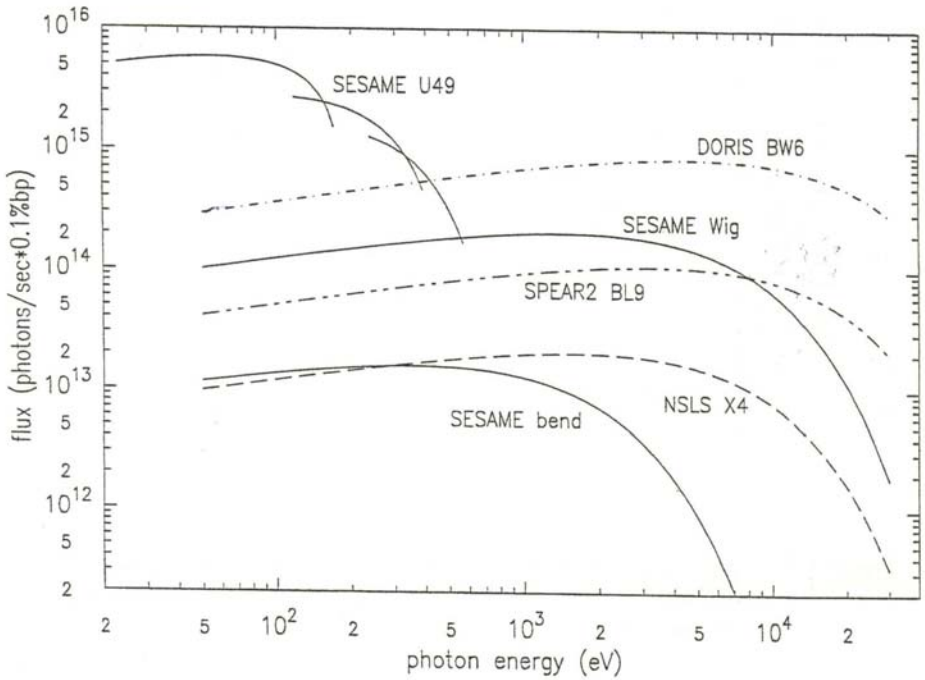


Figure 6.2.1: Calculated flux from the six sources listed in Table 6.2.1. The U49 spectrum is integrated over the central cone and includes tuning curves from the fundamental, third harmonic, and fifth harmonic. The other spectra are integrated over 1 mrad horizontal acceptance.

Fig 6.2.2

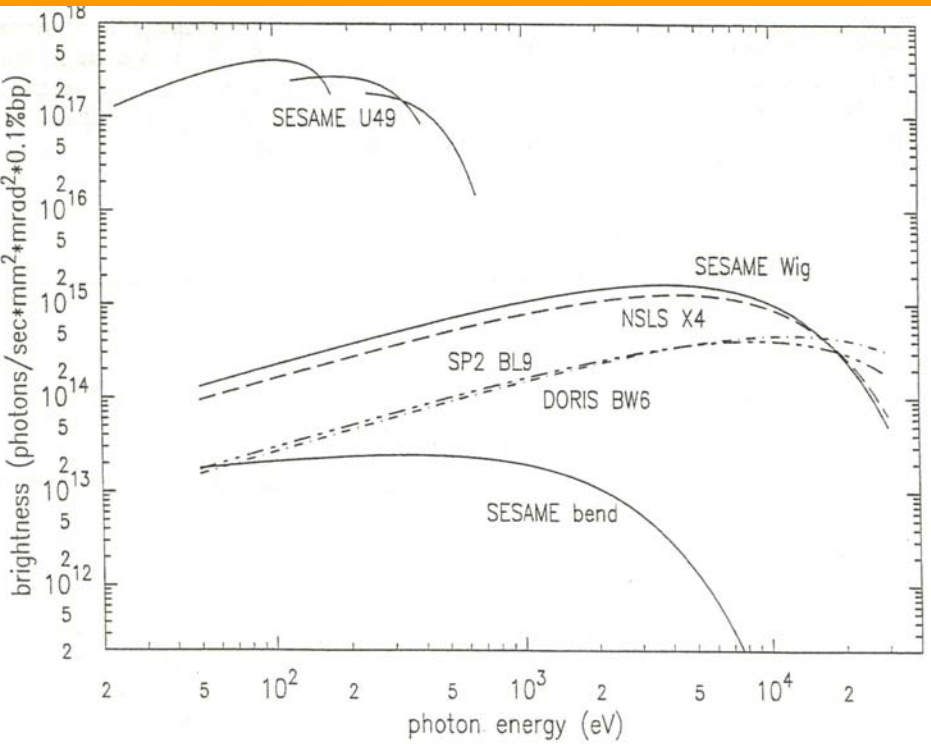


Figure 6.2.2: Calculated brightness of the tabulated sources. As discussed in the text, the SESAME wiggler calculation includes only 7 poles. The undulator calculation includes both emittance and energy spread effects.

but recommendations for a 5-year program call for:

design & construction of 10 beam lines for users:

- *1) 1 IR, (from bending magnets and some monochromators)*
- *2) 3 VUV/soft X-ray, (// // //)*
- *3) 6 hard X-ray (from wiggler sources)*
- **(In addition there would be one bending magnet line for machine diagnostic use)**

White Book?

- **SESAME**

  Conceptual Design for the Upgrading of SESAME to 2 GeV, July 2002

  On the basis of recommendations made by the IC in December 2001.

- in the White Book we read..

  In order to reach the spectral range of 20 keV, it is foreseen in the *"Green Book"* to run the machine at 1 GeV and make the installation of up to three SC 7.5 Tesla wigglers. This leads to critical photon energy of 5 keV. The useable spectrum extends to roughly four times the critical photon energy. …

The 20 keV range can also be covered with a 2 GeV beam and a magnetic flux density of 1.88 Tesla (ε_c *is proportional to the square of the electron beam energy and proportional to the magnetic flux of the magnet*). The present technology allows construction of permanent wigglers with flux density of 2.25 Tesla. A 2 GeV beam deflected in such a wiggler would cover a spectral range of up to 24 keV. The radiation from the bending magnet (*"Green Book"* Design, 1 GeV and 1.87 Tesla) covers a range up to 5 keV. That one of a 2 GeV beam deflected in a bending magnet with 1.5 Tesla covers a range of 16 keV.

Because the spectrum range goes with the square of the energy, it would be very worthwhile increasing it. But this is limited, because the emittance is proportional to the square of energy.

Decision made?

"copy more or less that one of the synchrotron light source ANKA, which houses a 2.5 GeV storage ring with a circumference of 110 meters. With a required 30 meters length of the beam lines, the largest circumference of a machine in this "ANKA-building" is 124 meters".

Right person to be in charge?

he who led the team that designed, constructed, and commissioned the very successful 2.5 GeV ANKA synchrotron radiation facility in Karlsruhe Germany.

Professor Dieter Einfeld, the SESAME Technical Director, has been working full time for SESAME since September 2001.

Goals?

…. to have a machine with:

- an 8-fold symmetry,
- energy of 2 GeV,
- 8 long straight sections,
- 3 short straight sections,
- natural emittance of 18 nm.rad.

- The budget for the "White Book" version is in the same order of magnitude as for the "Green Book" design. The only thing that has to be done is the shifting of money between the different components. For example, in the "Green Book" design it is proposed to use a new pre-accelerator, while in the "White Book" design the intention is to continue with the use of the 22 MeV Microtron and to shift the money to the new bending magnets. For the upgrading of the RF system donations are expected from DESY, ELETTRA, and SPEAR.

Three steps have been foreseen:

- First, useful parts of BESSY I, like quadrupoles and sextupoles, should be used in order to reduce the erection costs but provide already photon beams with a good quality for the first synchrotron radiation experiments.
- 2nd step could be the changes of the above elements by new ones with a shorter length to increase the lengths of the long straight sections and the brilliance of the radiation.
- The 3rd step would be the introduction of mini beta sections to increase the brilliance of the SR by ID's. The 1st step could be avoided if funds are made available.