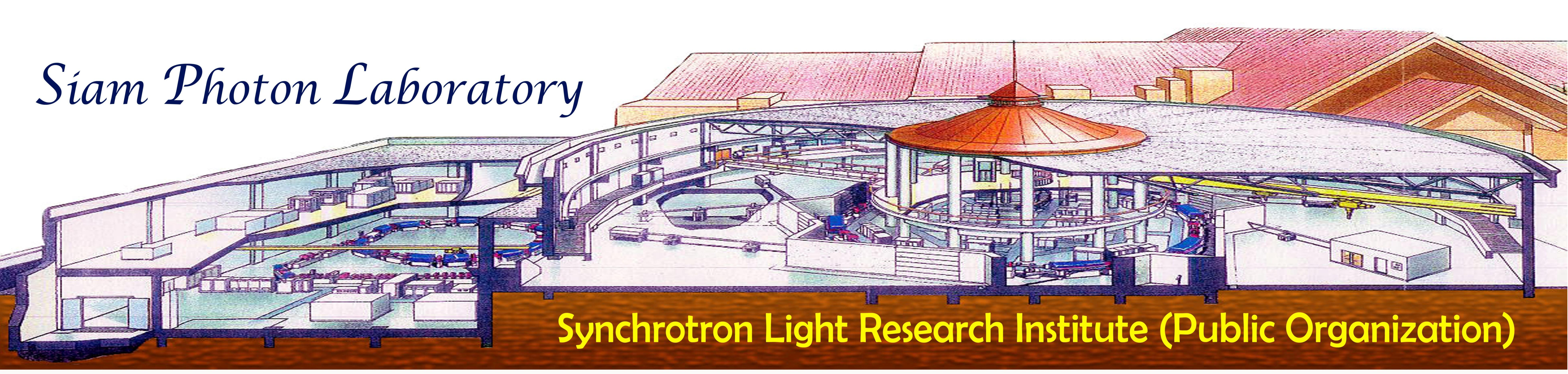


PRESSURE DISTRIBUTION OF THE SPS STORAGE RING

Prapaiwan Sunwong, Nawin Juntong, Anusorn Tong-on and Supan Boonsuya

Accelerator Technology Division, Synchrotron Light Research Institute (Public Organization)

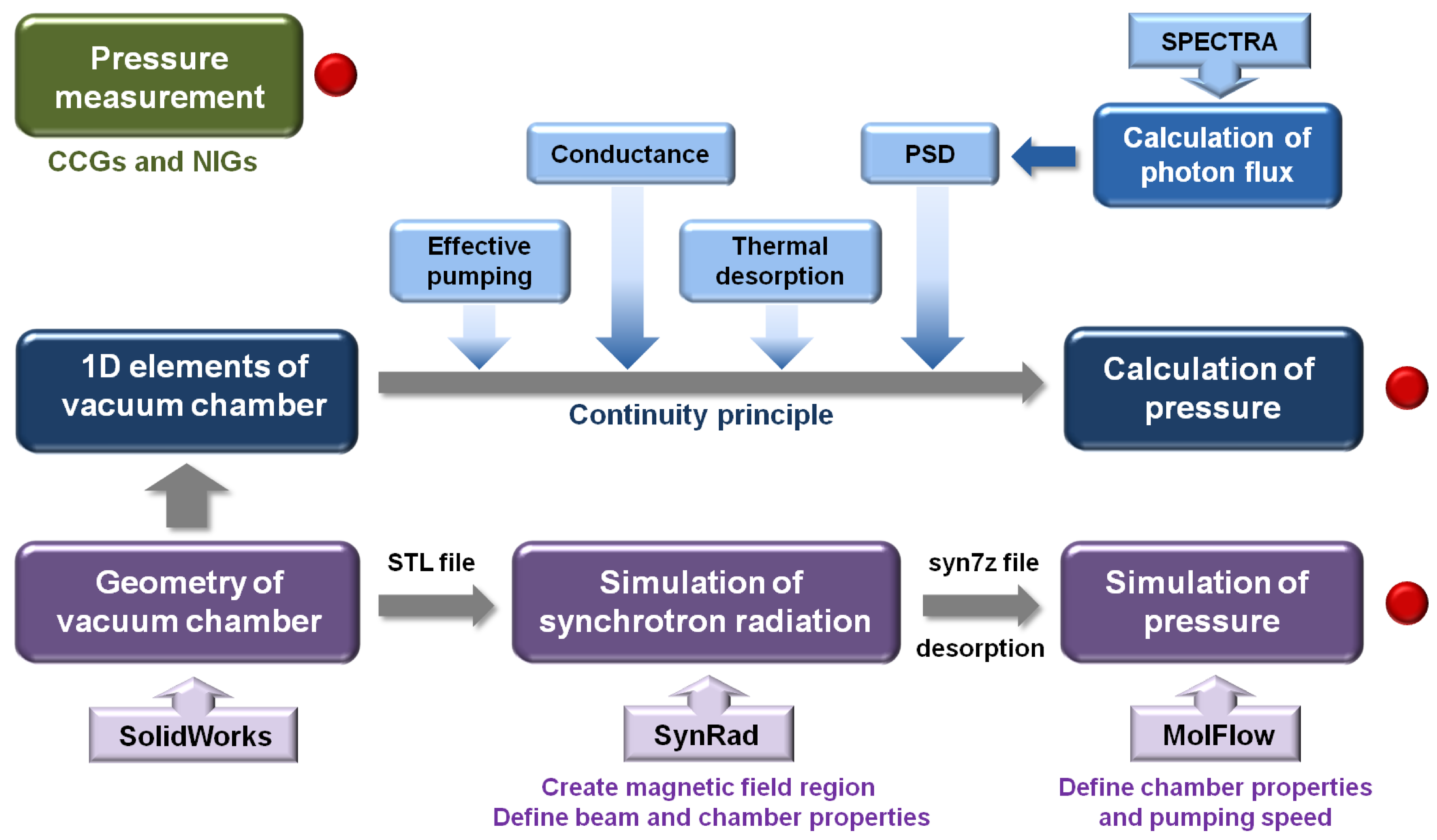
111 University Avenue, Muang District, Nakhon Ratchasima, 30000 Thailand

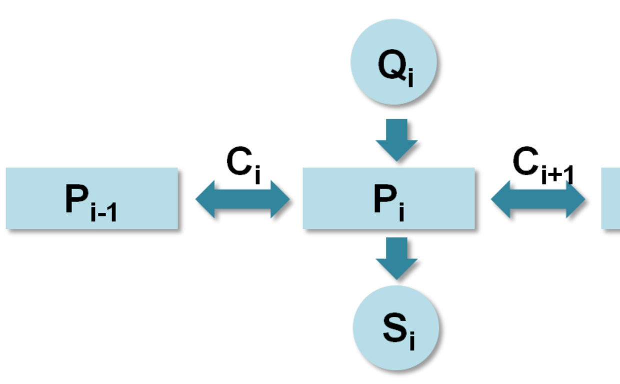
Ultra-high vacuum is a key requirement that determines electron beam quality and lifetime for an electron accelerator complex. In operation of the Siam Photon Source (SPS), pressure distribution of storage ring has been monitored using a series of Cold Cathode Gauges (CCGs) installed in proximity to the vacuum pumps around the ring. Pressure between the CCGs was calculated based on the continuity principle of gas flow [1]. Photon-stimulated gas desorption (PSD) from synchrotron radiation was also taken into account. It was found that averaged pressure of the SPS storage ring is 1.0×10^{-9} Torr, calculated at the averaged beam current of 115 mA, the beam energy of 1.2 GeV and the photon dose of 2,000 A·hr. This value meets the requirement for ultra-high vacuum, although high local pressure (up to 4×10^{-9} Torr) was found near the downstream of insertion devices. Three-dimensional (3D) simulation using Test Particle Monte-Carlo (TPMC) method [2, 3] will be conducted to confirm the result and to provide more information for further improvement of the SPS storage ring.

Introduction

The SPS storage ring has been used as a synchrotron radiation source with the electron beam energy of 1.2 GeV and the beam current of 80 – 150 mA. It consists of eight 1.4 T bending magnets (BMs) and insertion devices which include undulator (U60), 2.4 T hybrid multipole wiggler (MPW) and 6.5 T superconducting wavelength shifter (SWLS, currently operated at 4.0 T). Vacuum components of the storage ring were originally designed for a bare ring. Use of the insertion devices results in radiation of photons with higher energy and higher flux density. This not only causes more heating, but also generates more gas desorption stimulated by photons. In order to maintain ultra-high vacuum within the ring, pressure distribution needs to be investigated and the vacuum components need to be improved, if necessary.

Methods





$$C_i(P_{i-1}-P_i)+C_{i+1}(P_{i+1}-P_i)+Q_i = S_iP_i$$

Continuity principle of gas flow

$$Q_P = k\eta\Gamma$$

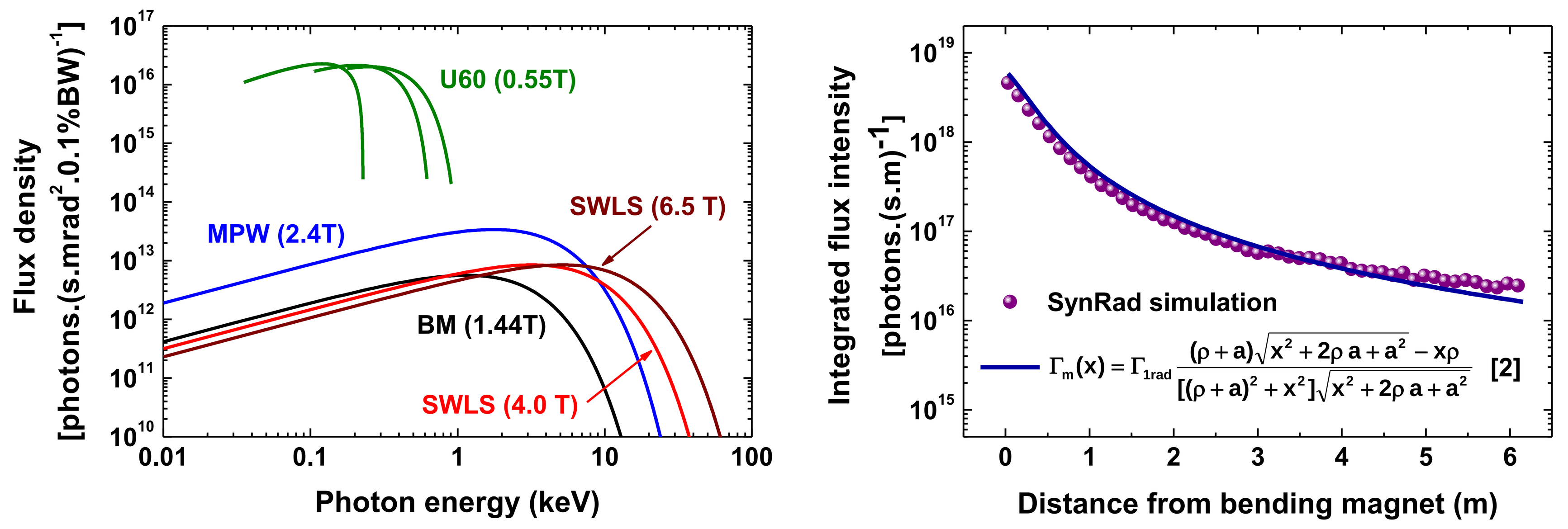
$$S=\left(\frac{1}{C_{pump}}+\frac{1}{S_0}\right)^{-1}$$

$$C \cong 3.65\,\delta A_o\sqrt{\frac{T}{M}}$$

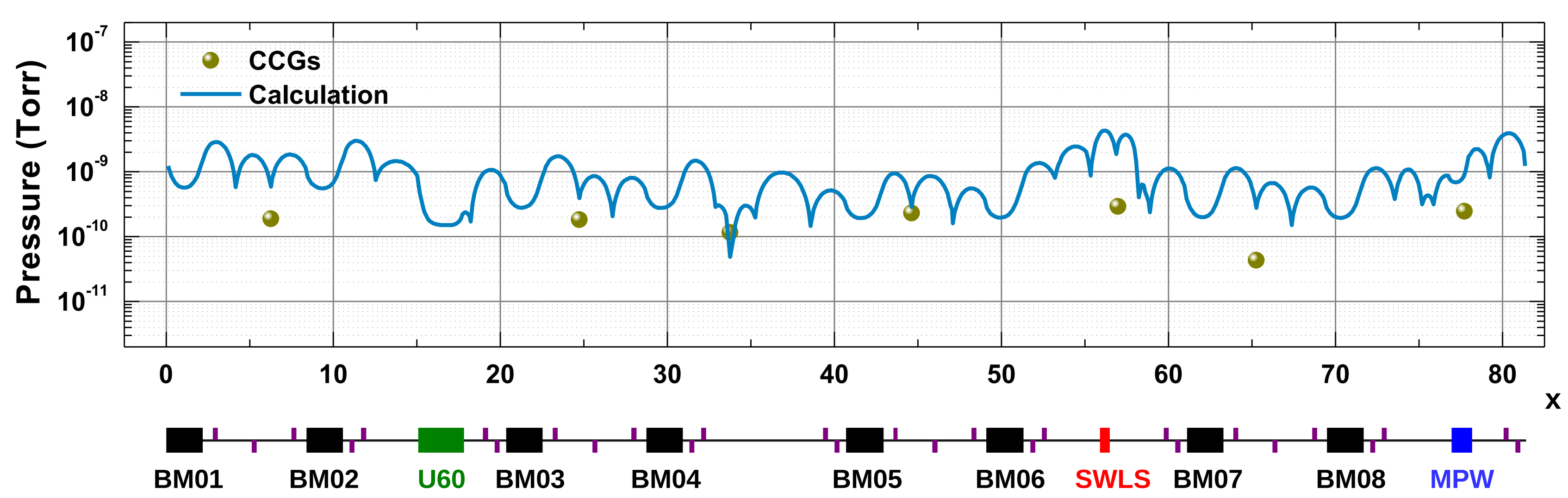
P = Pressure (Torr)
Q = $Q_T + Q_P$ = Gas desorption flux (Torr·L·s^{-1})
S = Effective pumping speed (L·s^{-1})
C = Conductance (L·s^{-1})
k = 3.10×10^{-20} Torr·L·molecule^{-1}

η = PSD yield (molecules·photon^{-1})
Γ = Photon flux (photons·s^{-1})
δ = Transmission probability of gas flow
A_0 = Area of an orifice (cm^2)
T = Temperature (K)
M = Molecular mass of gas (amu)

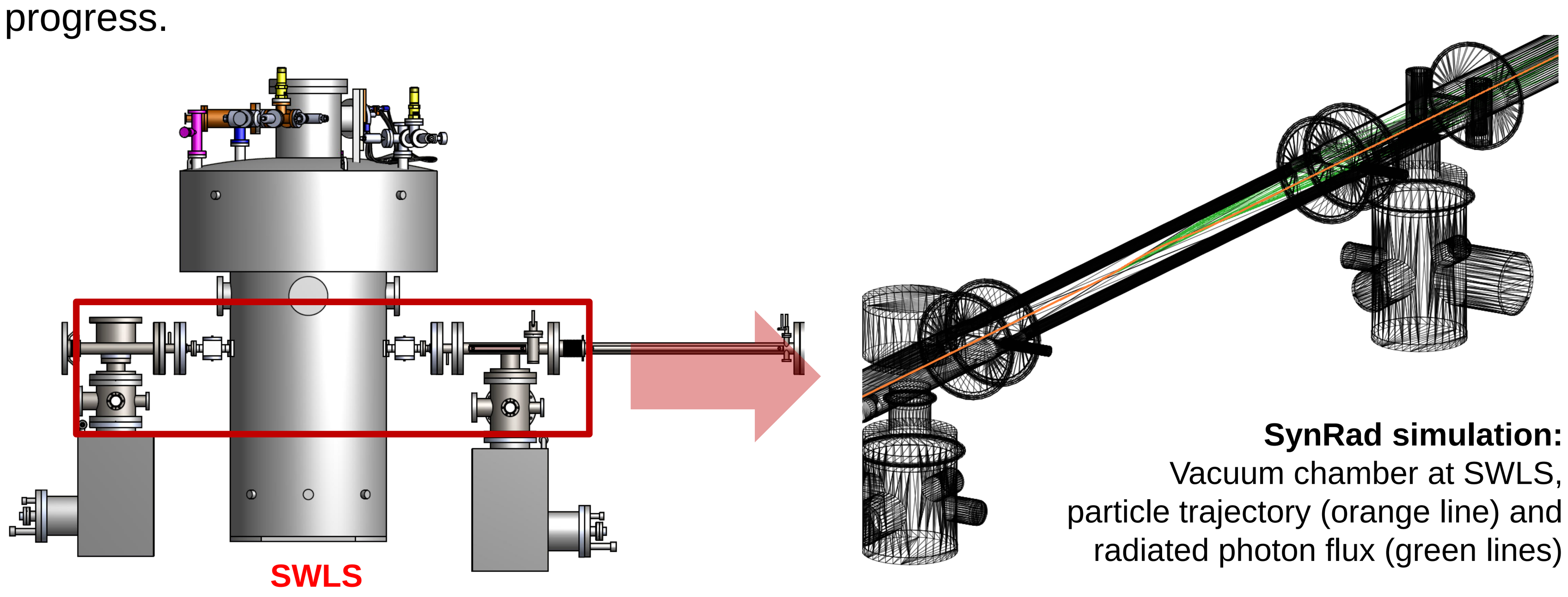
Results



Left: SPECTRA [4] radiation spectrum of the bending magnet and insertion devices installed within the SPS storage ring at the beam current of 150 mA. **Right:** Integrated flux intensity (radiated from a bending magnet) along straight section from 3D SynRad simulation [5] and from calculation using relation proposed in [2].



Calculated pressure distribution along the SPS storage ring at the averaged beam current of 115 mA and the photon dose of 2,000 A·hr, in comparison with measured pressure from CCGs. 3D simulations using SynRad and MolFlow are currently in progress.



SynRad simulation:
Vacuum chamber at SWLS,
particle trajectory (orange line) and
radiated photon flux (green lines)

References

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[4] T. Tanaka and H. Kitamura, "SPECTRA: a synchrotron radiation calculation code," *J. Synchrotron Rad.*, vol. 8, pp. 1221-1228, 2001.

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