Electron and Photon beam monitors

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Introduction

Ultra high brightness electron beams are used in advanced accelerator facilities, FELs and colliders, with micron level beam sizes. The control of machine optics and transport requires transverse profile measurements of such small beams. In many FEL facilities such as LCLS and FERMI, optical transition radiation screens have shown severe performance degradation due to coherent emission from micro-modulations in the bunch and can no longer being used. For such reasons wire scanners have regained strong interest: they employ free standing very thin wires but with limited choice for materials an thicknesses. By a multidisciplinary approach to the problem, we have adapted the nanofabrication technique to electron beam diagnostics: the result is a new device allowing for much greater flexibility in the choice of design parameters materials, thickness and width of the wires.

The Idea/Concept

A new wire scanner for application in FELs or Synchrotron beam lines for beam characterization

Present technology:

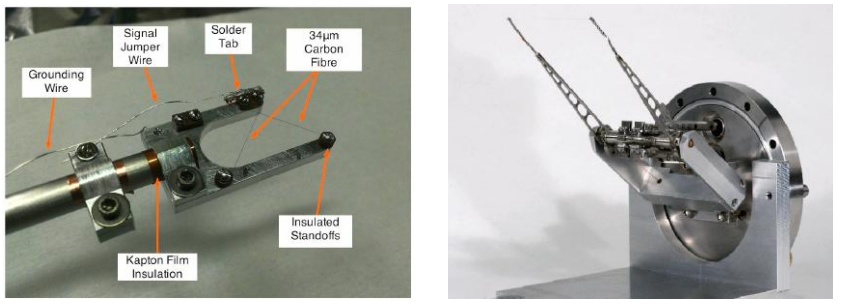

Fig.1 A carbon (left[1]) and metal (right[2]) based wire scanner at the present employed in the FEL, collimators and synchrotrons beam lines

The short term goal: to produce a device capable of overcoming the present wire-scanner technological limitation offering:

- Higher resolution,
- Higher mechanical stability and reliability
- higher flexibility in terms of design parameters such as wire width, thickness and material
- lower impact on the electron/photon beams

The long term goals:

- To reach an non perturbing operation leading to an online diagnostics suitable for slow feedbacks
- Application to both electrons and soft X-ray beams

NanoFabrication approach device:

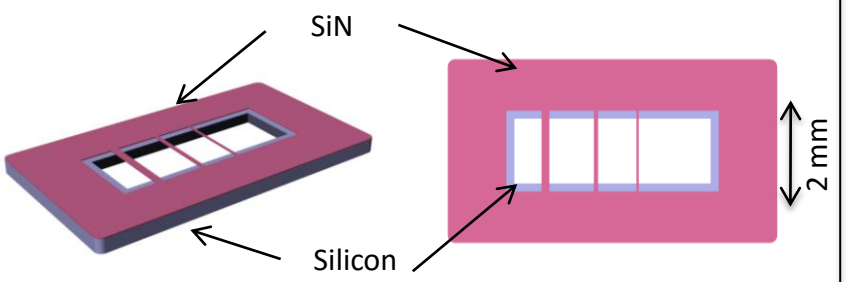

Fig.2 Scheme of the proposed device

The proposed device: a SiN thin membrane (100-2000 nm) is patterned to produce suspended the micro "bridges", 1-2 mm long and 1 to 50 µm wide

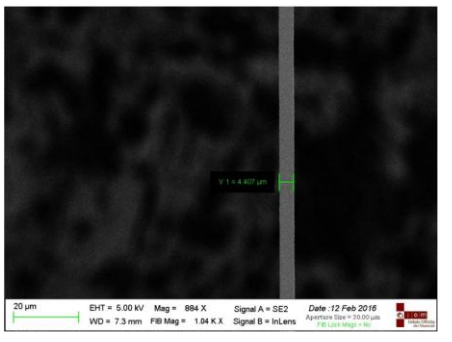

Fig.3 SEM image of a detail of a produced SiN "bridge" device

First results: extension of application of this novel device to:
-monitor high brilliance photon source such as synchrotron radiation facilities (test on BEAR beamline at Elettra).
-characterization in FEL beamlines where micron-level FEL beam spots are produced (in progress).

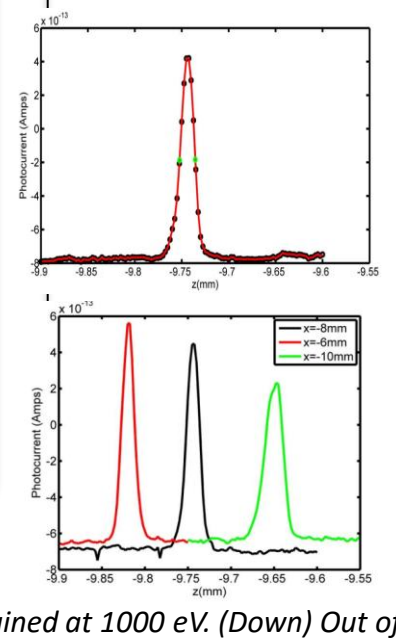

Fig.4 (Up) Beam vertical scan obtained at 1000 eV. (Down) Out of focus scans (focus position is at x=-7mm).

Potential Impact

The enhanced range of design parameters offered by nanofabrication can lead to devices which are much more adaptable to different beam parameters, more flexible and applicable also to photon beams. Potentially designable to be almost not invasive, allowing for online optics measurements and use in feedbacks. This would lead to a real breakthrough in the management of electron optical functions in FELs which define the stability of transverse electron distribution and thus photon density in FELs. The long term goal is to demonstrate devices capable of sub micron transverse beam size measurements reaching the demanding resolutions of colliders such as ILC and CLIC.

(1) Scanning wire beam position monitor for alignment of a high brightness inverse-Compton x-ray source, Michael R. Hadmack, Eric B. Szarmes, Proceedings of IBIC2013, Oxford, UK (WEPF21) ; 2) http://sl-div-bi-pb.web.cern.ch/sl-div-bi-pb/WelcomeBWS.html