PAUL SCHERRER INSTITUT

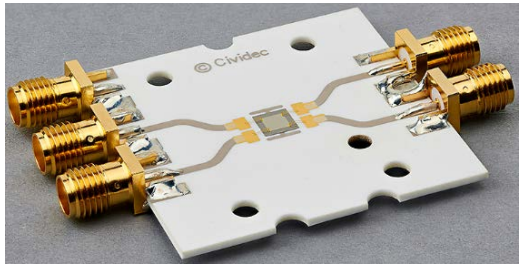
PSI

4H Silicon Carbide for whitebeam monitoring

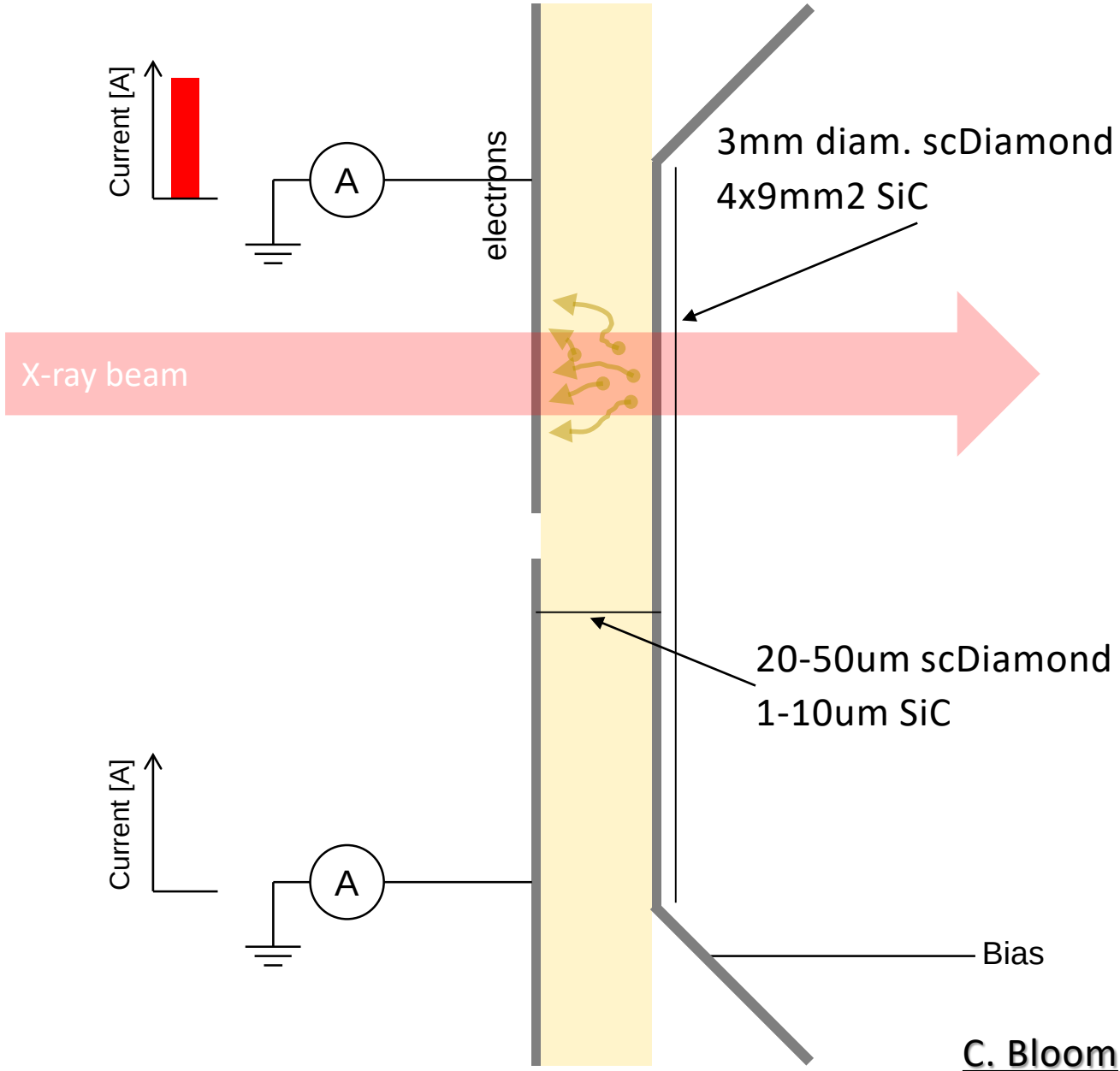
Massimo Camarda

Standard "thin-membrane" XBPM

scDiamond XBPM



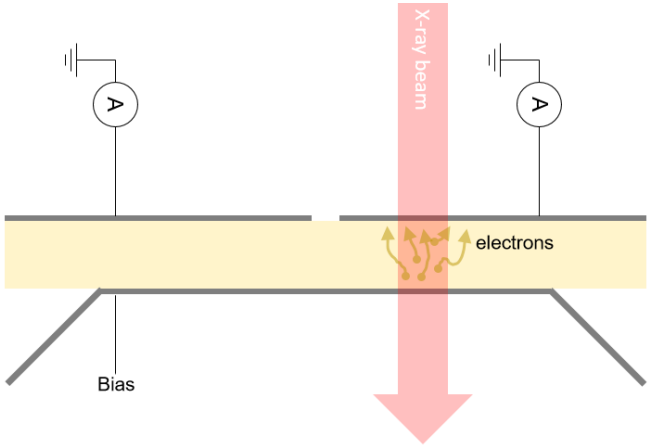
SiC XBPM



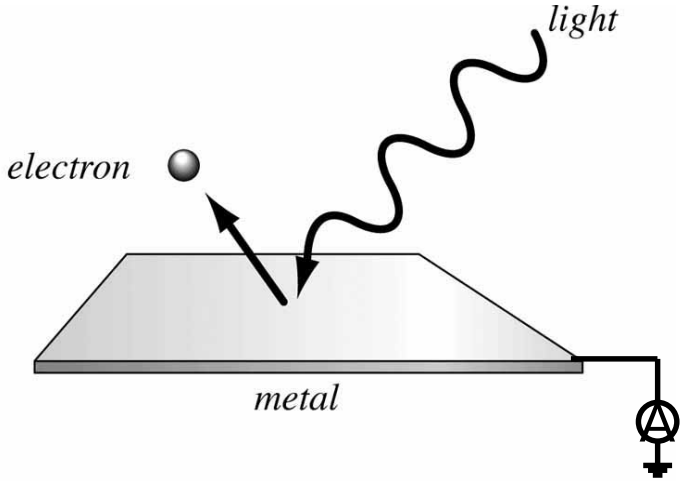
C. Bloom

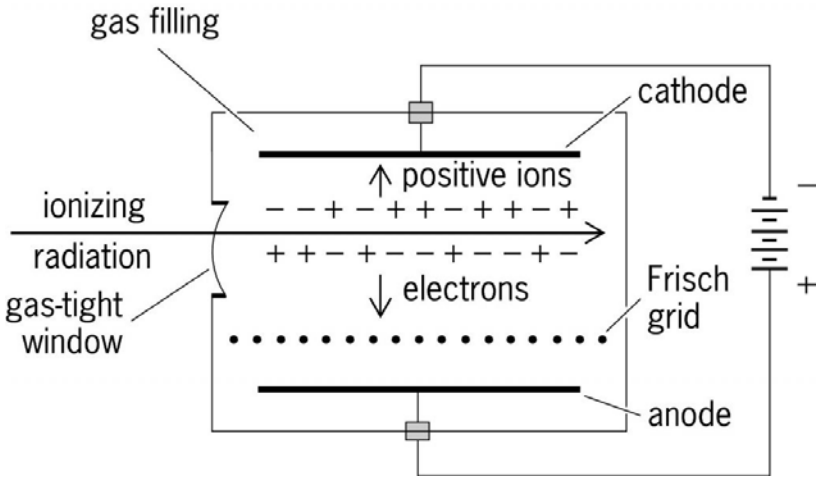
Comparison of Xray sensors

semiconductor based
internal photoemission



metal based
external photoemission





gas based
photoionization

Comparison of detectors

sensor type	Gas chambers	Blade monitors	Semiconductor sensors
transparency	high	very low very high	low/medium
radiation hardness	intrinsic high	medium/high	medium
foot print	medium	medium	very low
lateral resolution	low	medium	very high
time response	low	low/medium	high
signal strength	low	low	high (too?)

When moving from monochromated beam to pink/white beam, signal strength might become critical. E.g. **1W** of absorbed energy will generate (1/7.8)A=**120mA**

1W≤120mA

10W≤1.2A

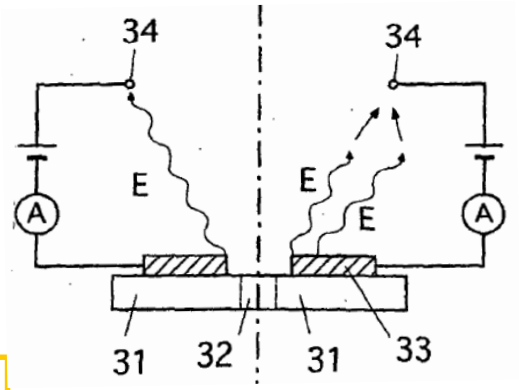
100W≤12A ...

"new" holed SiC XBPM concept

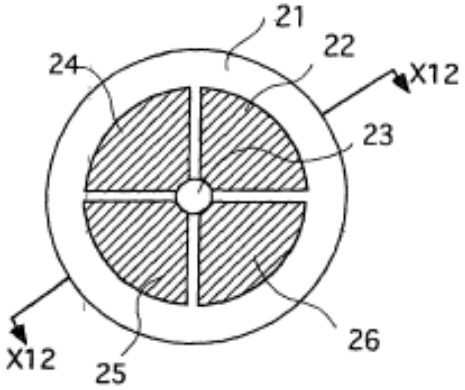
BASIC idea is to combine the sensing concept of the blades wit that of SC sensors. Idea not fully new...

Radiation beam position monitor and position measurement method (2002)

Applicants: RIKAGAKU, SUMITOMO ELECTRIC

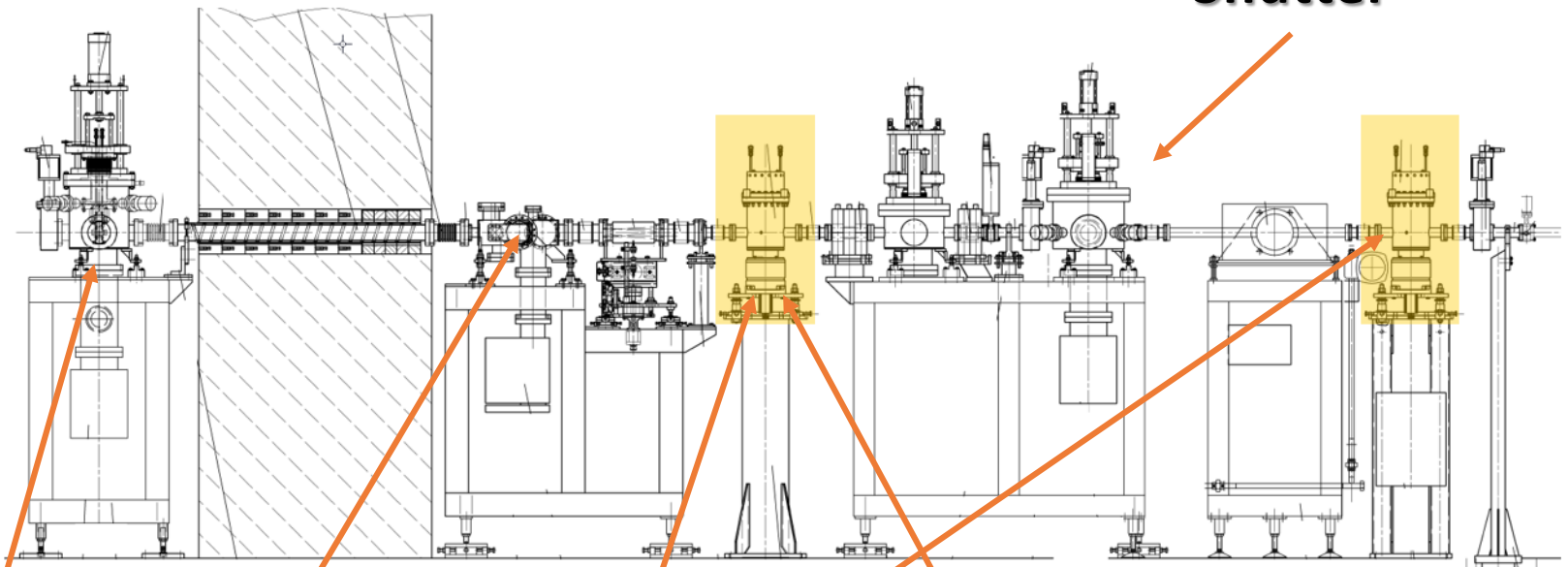


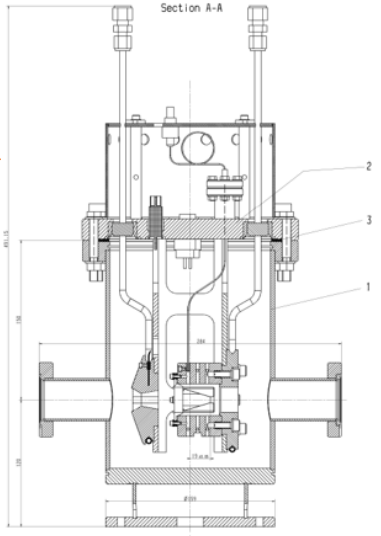
The detection sensitivity and position controllability of beam position **remain unchanged even after 3 weeks use**. In addition, the diamond plate and metal electrodes were observed after the test. **The damage of the monitor by the irradiation of the beam could not be found.**



DEVICE: diameter of 15mm, thickness of 0.2 mm
BEAM: Electron beam energy: **6.5 GeV Electron** beam current: 50 mA, Undulator, Max Flux density: 1E16 ph/s mrad^2 0.1% b.w.
OUTPUT: 1mA @ 400V

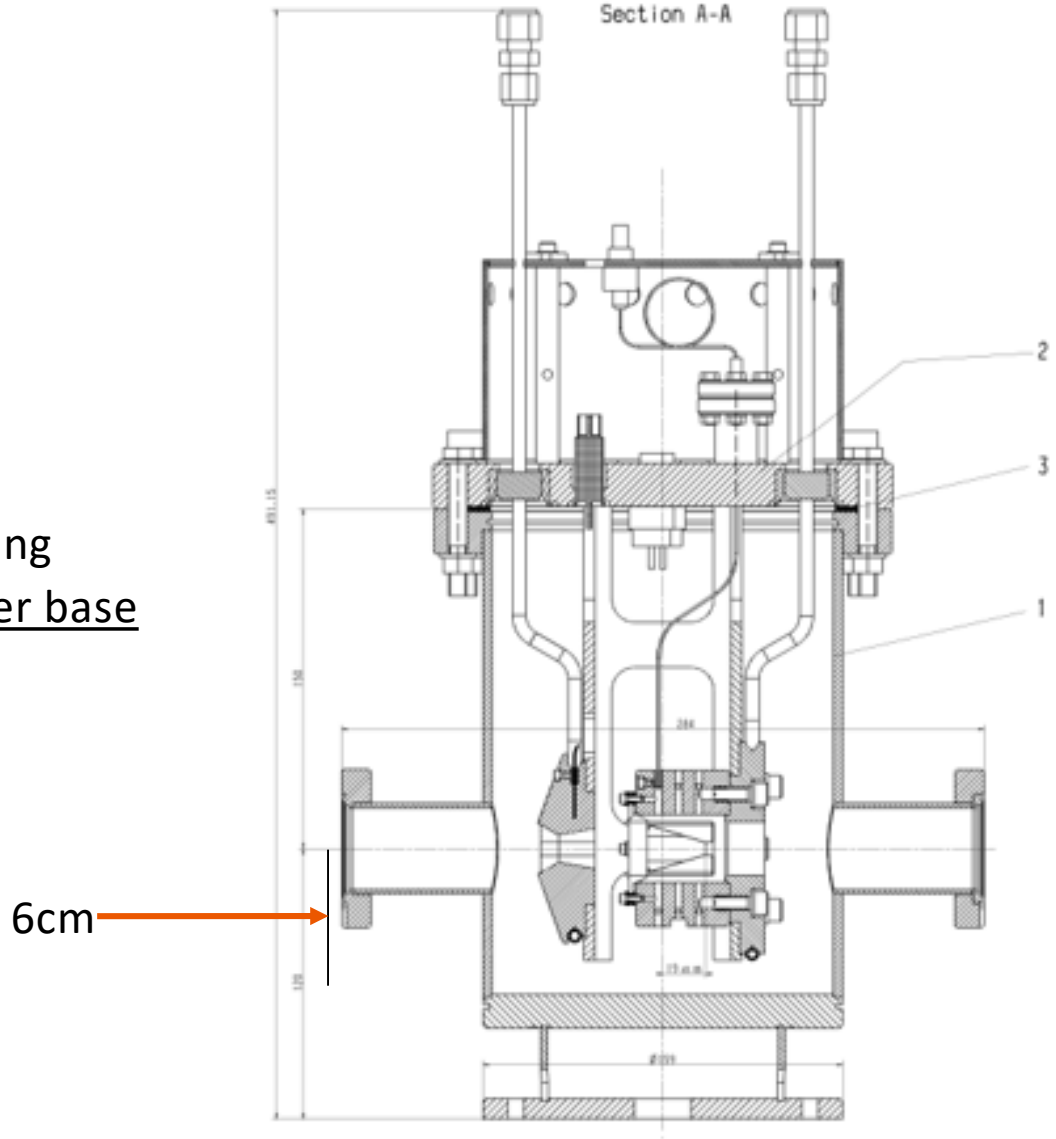
Pinkbeams and whitebeams





second XBPM chamber (X07MA)

- D150 flange
- 12mmH 12mmV excursion
- 2 cooled devices, Blade+Ring
- 6cm distance from chamber base
- Beam size (1.4x0.57 mm)
- Blade size (2.2x3.4 mm)



Possible SiC XBPM schema

I assumed a vertical "safe" configuration of 3mm > 4xFWHM

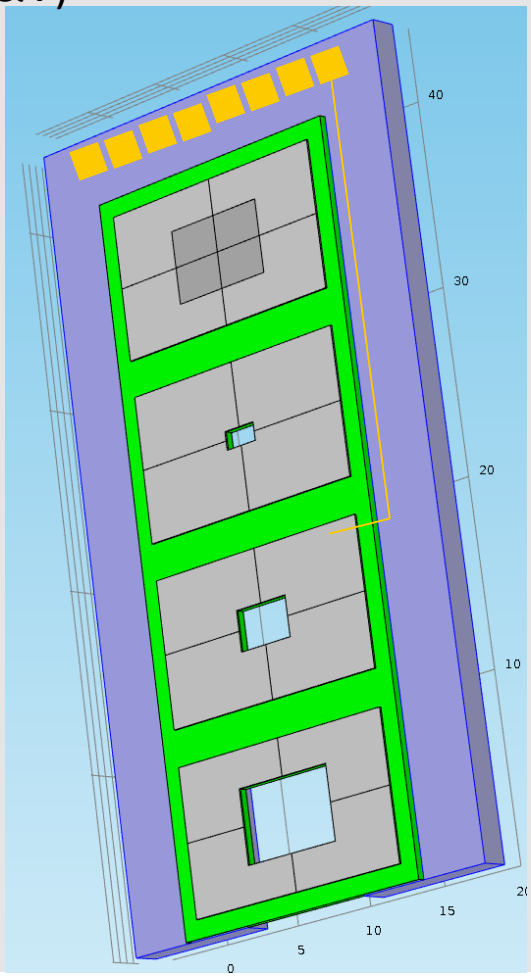
Possible device schema: array of 4 devices, 10/device (H&V)

1. -- **full membrane**, -- "high resolution"
2. -- **small opening**: 2.0x1.0 HxV
3. --"**blade opening**": 3.4x2.2 HxV
4. --**"larger opening"**: 6.0x4.0 HxV
5. **no device**

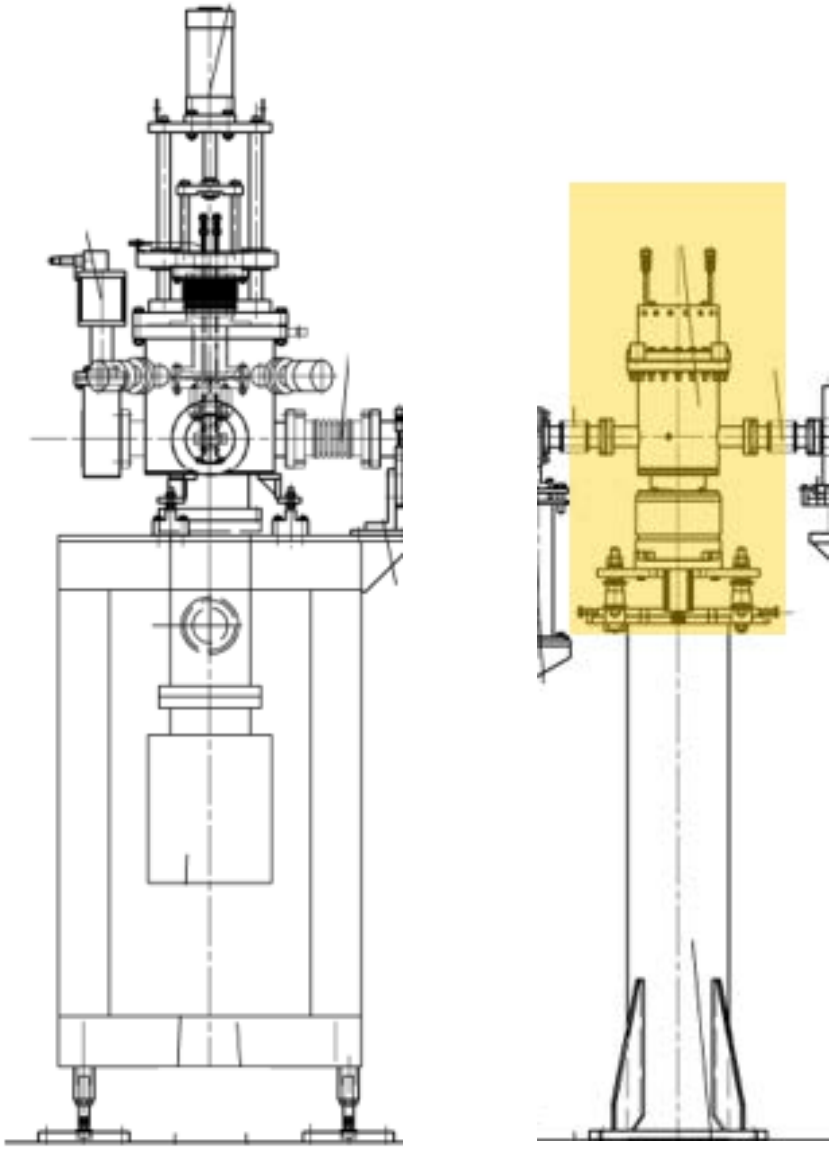
Total Device area 15x40 (up to 50)

Total PCB area 20x45 (up to 60)

Total required vertical excursion >80



Could we use the pinkbeam chambers? --Drawings? Flange?



Conclusions

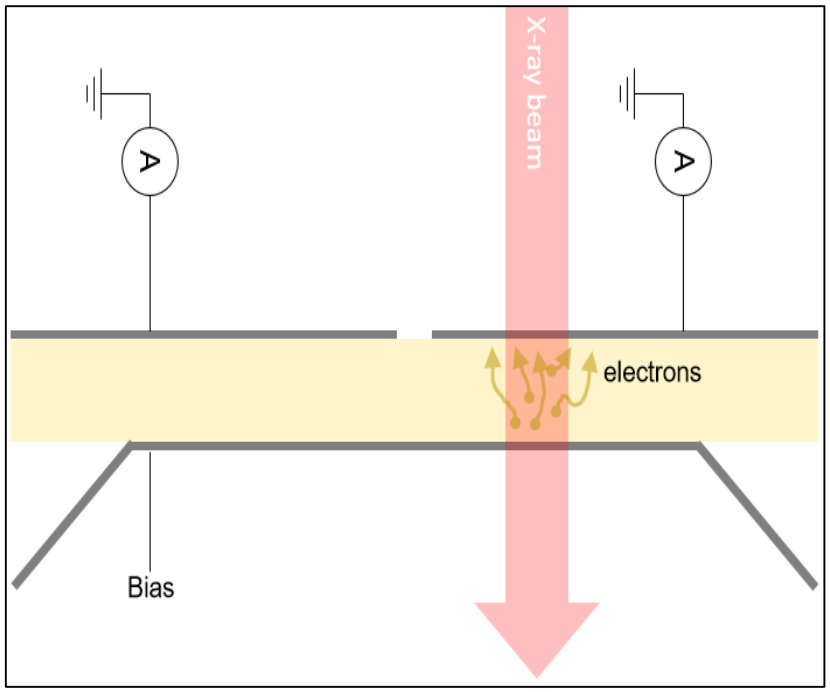
- "holed SiC XBPM" could combine take the benefits of semiconductor based sensors with those of blade monitors*
- The new "array of devices" can be designed and fabricated at PSI, in view/preparation of the SLS2.0 upgrade.
- First test chamber could be realized starting from pinkbeam chambers (but sufficient cooling power?). Later combined Blade/SiC XBPM chamber could be developed

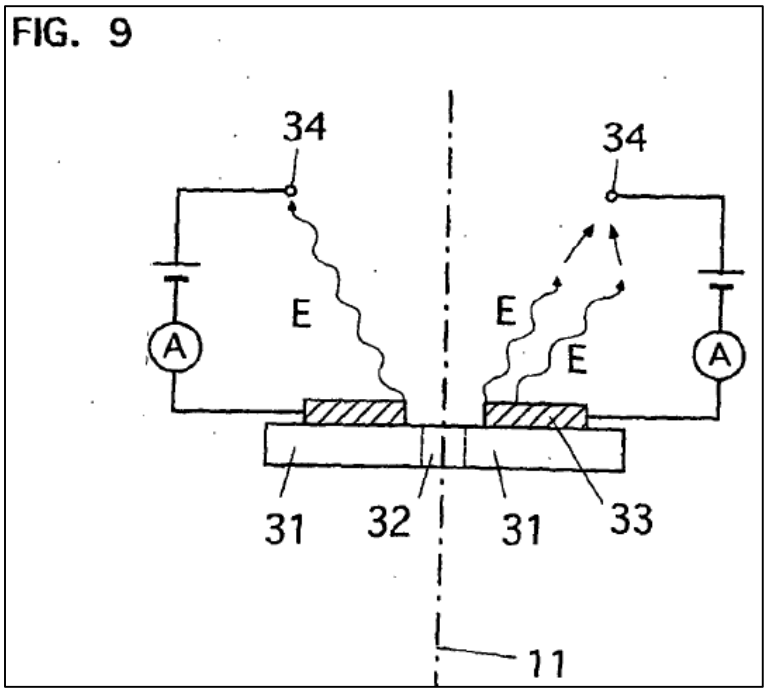
We need to clarify:

- **IF** (final decision? "official starting"?)
- **WHERE** (X07MA?)
- **WHEN** (time frame for chamber/device realization)
- **WHO** should be actively involved
  - Chamber design/realization
  - Devices design/realization (I need -some- support)
  - Beamtimes

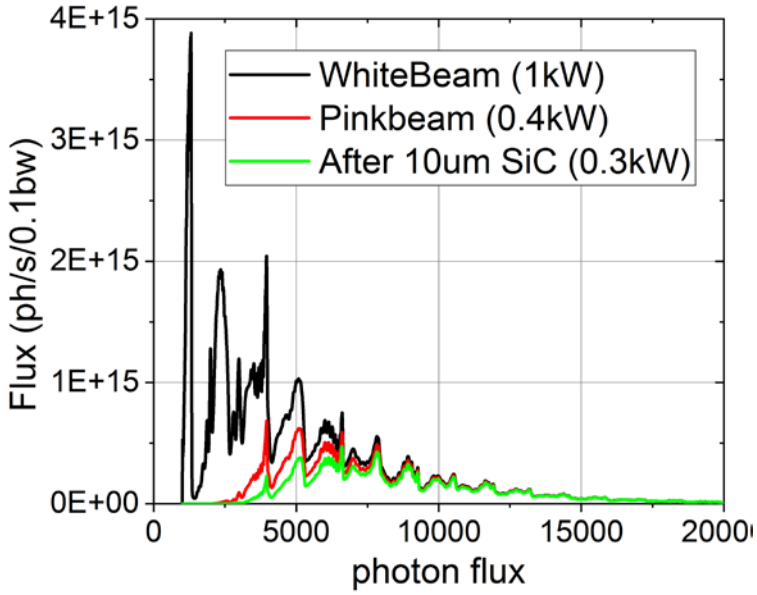
*some resolution will be lost due to opening, but compensated by array of devices with different characteristics

internal/external photoemission

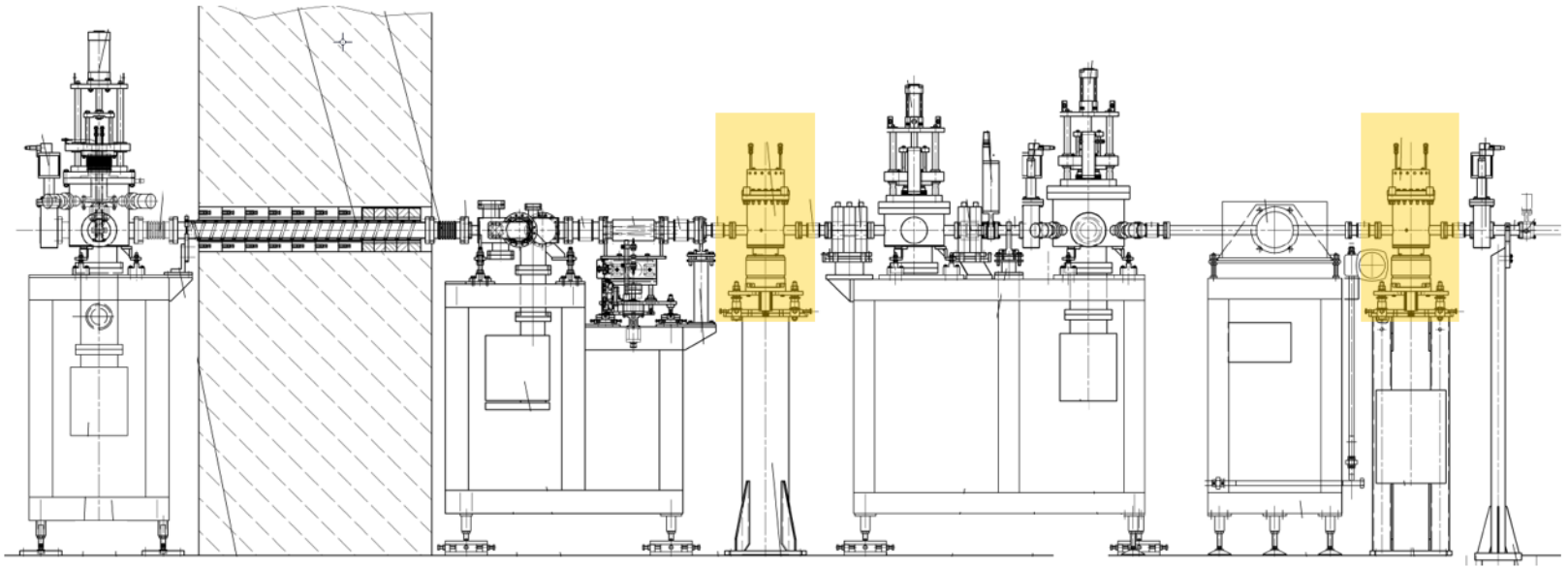




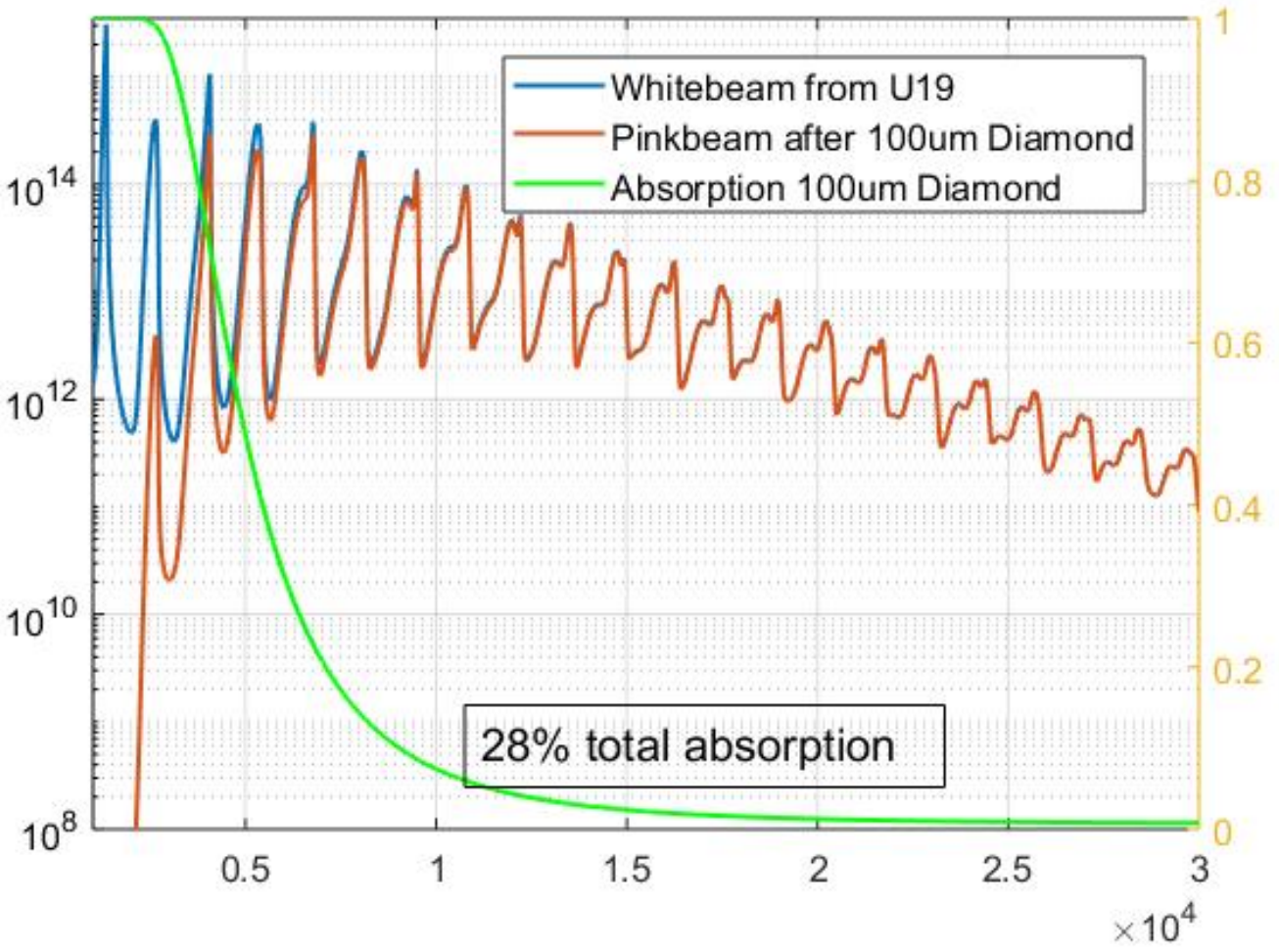
Pinkbeams and whitebeams



10um SiC absorbs >100W
will generate several Amps...



Pinkbeams and whitebeams

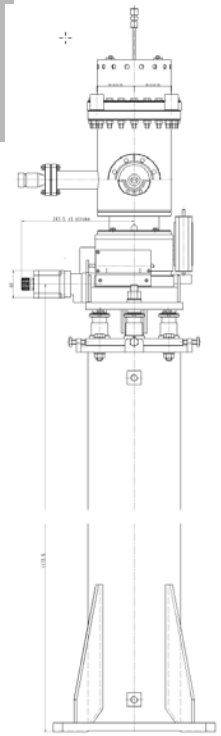


Calculations to be reanalyzed (proper whitebeam?) 28% is too low abs

Beam at 2nd XBPM

- Distance from source (2nd XBPM): 11.46 m
  - 1st XBPM: 8.8 m
- Beam :
  - Horizontal: 1.98 mrad (wall) +1.05 mrad (ring)
    - @11.46: 22 mm+ 12 mm
  - Vertical: +- 0.05 mrad
    - @11.46: 0.58 mm
- Opening of 1st XBPM (@ 11.46)
  - Horizontal: 28 mm
  - Vertical: 7 mm
- Acceptance
  - Horizontal 0.125 mrad
    - @11.4: 1.425 mm
  - Vertical 0.05 mrad
    - @11.4: 0.57 mm
- Power: 1.65 kW
- Power density: 8 kW/mrad^2
  - @11.4: 61 W/mm^2

Second XBPM



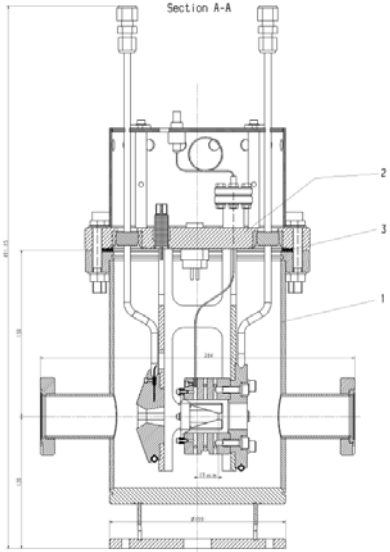


Table 1: Monitor Parameters according figure 7 (W-blade thickness 0.15-0.2 mm):

Parameter:	*1st PBPM*	*2nd PBPM*
Distance [m]	8.8	11.4
Vertical gap a [mm]	2.1	3.4
Horizontal gap b[mm]	2.1	2.2
Vertical aperture [mm]	7	11
Horizontal aperture [mm]	12	17
Blade angle (°)	45	30

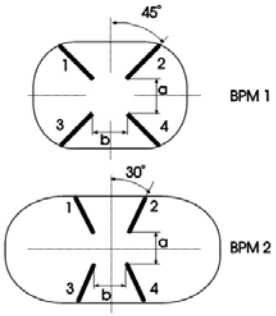
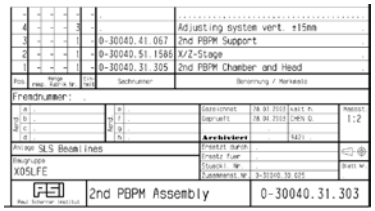
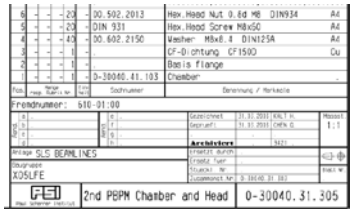


Fig 7: Blade geometry for the upstream (BPM1) and the downstream (BPM2) monitor, respectively.





Motor driven:

H +- 6 mm

V +- 6 mm