The University of Illinois at Chicago

UIC

Argonne NATIONAL LABORATORY

An overview of the Intermediate energy X-ray beamline

A joint project between

Advanced Photon Source (G. Srajer)

University of Illinois-Chicago (J.C.C.)

University of Illinois-Urbana (P. Abbamonte)

University of Michigan (J. Allen)

We thank

The DOE — $ 4.5 M

The NSF — $ 3.9 M

The burning question

Why build this beamline?

Because the

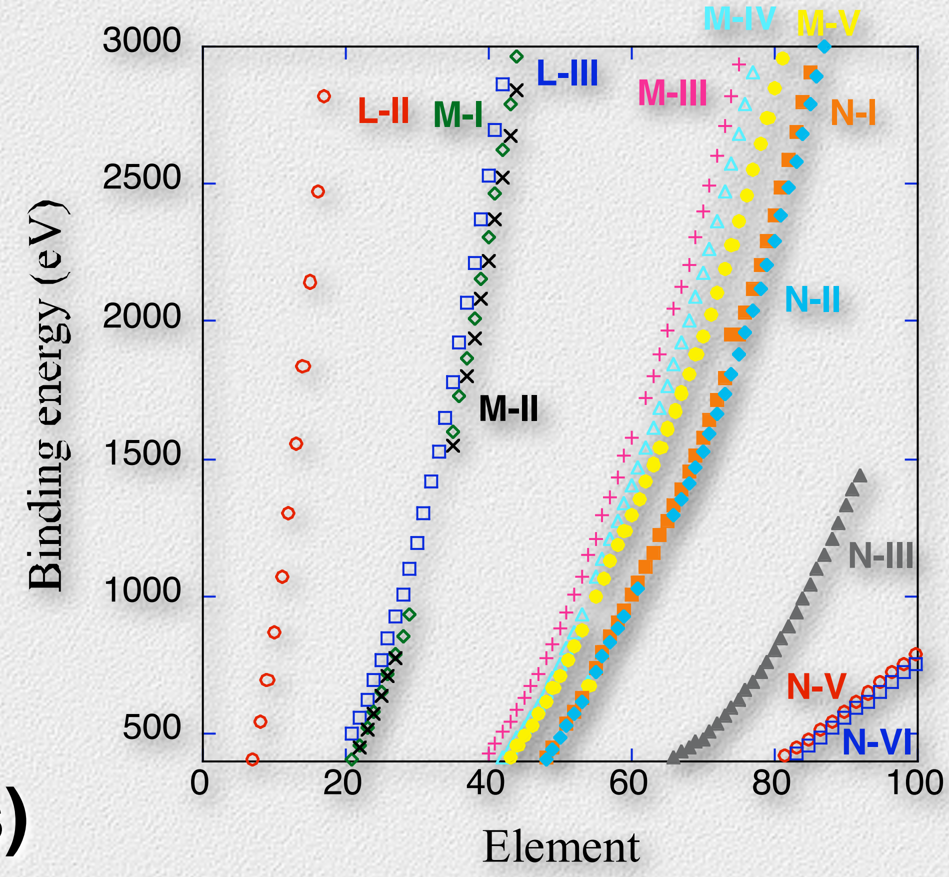
- ***Physical*** { *color, electrical and thermal conductivity, etc*
- ***Chemical*** { *reactivity*
- ***Mechanical***

properties of materials
are determined by the low-energy excitations of valence electrons

i.e. a spectroscopy beamline

Science considerations

- **Since we will be looking at the valence electrons,it is best to use soft energy X-rays (400-3000 eV)**
- **Relevant excitations have energy scales of the order of the temperature $\mathcal{O}$(meV)**



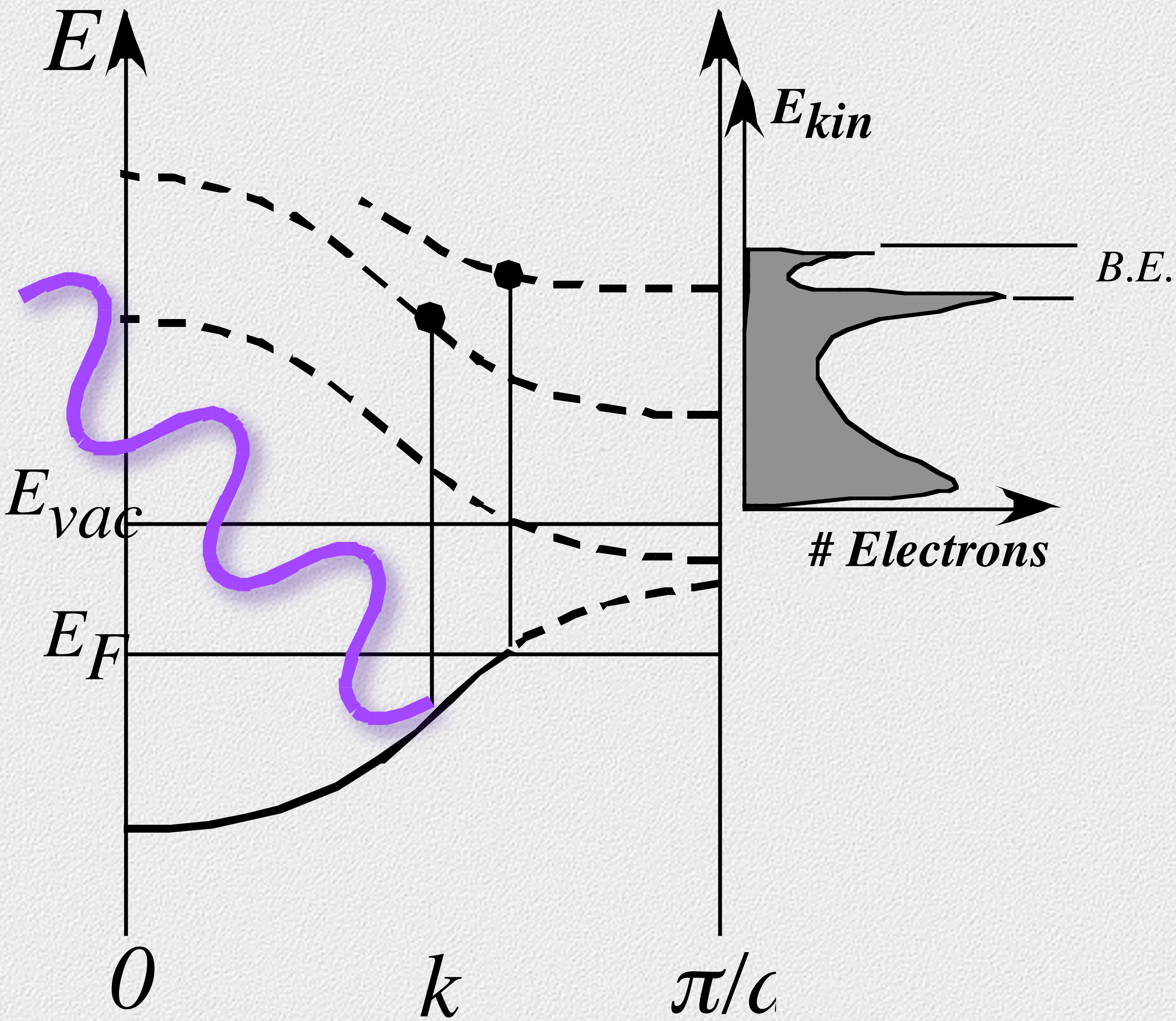
Two experiments

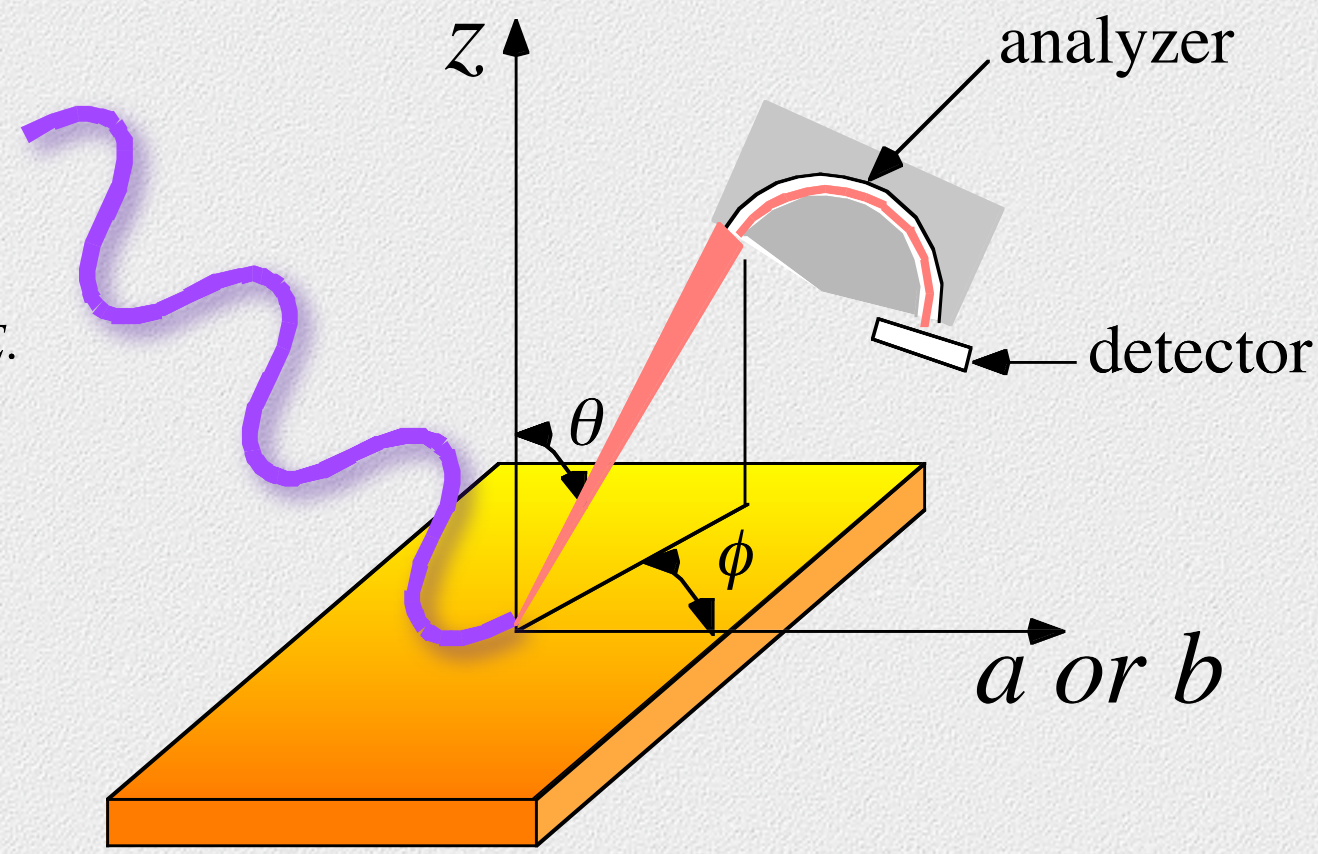
- **Angle resolved photoemission (ARPES)** **(electronic excitations)**

These are complementary techniques

- **Resonant soft X-ray scattering (RSXS)** **(electronic order)**

Angle resolved photoemission



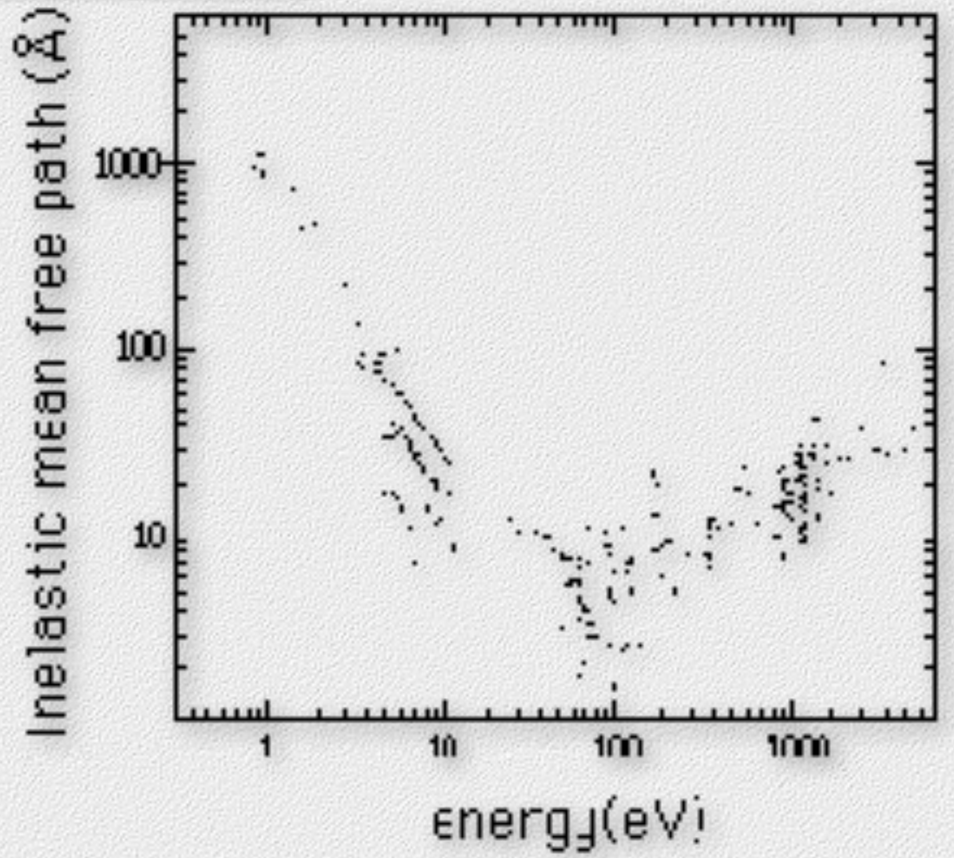


$$\vec{k}^f_{//} = \vec{k}^i_{//} = \sqrt{\frac{2mE}{\hbar^2}} sin\theta$$

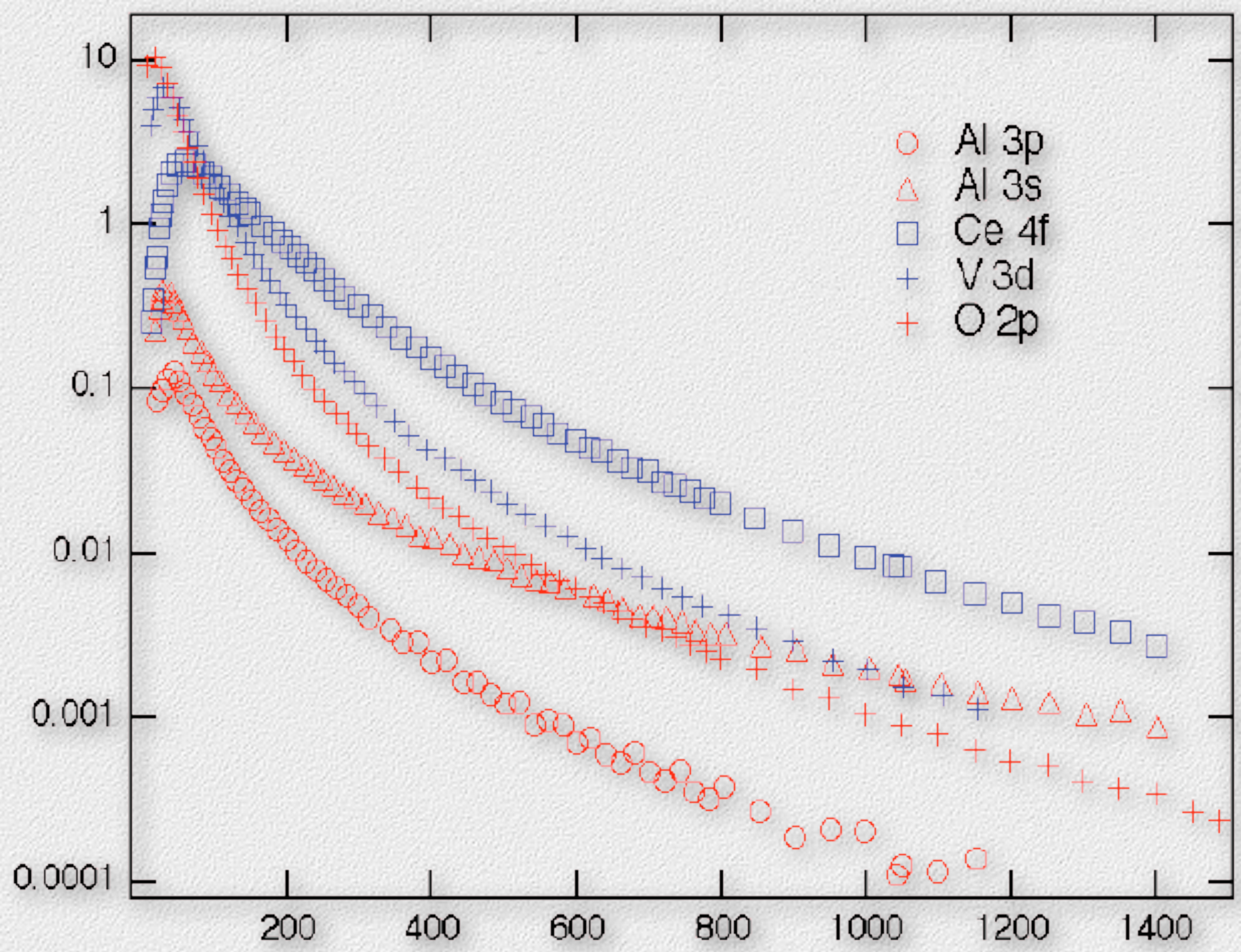
Caveat

ARPES is surface-sensitive

⇒ need high photon energy



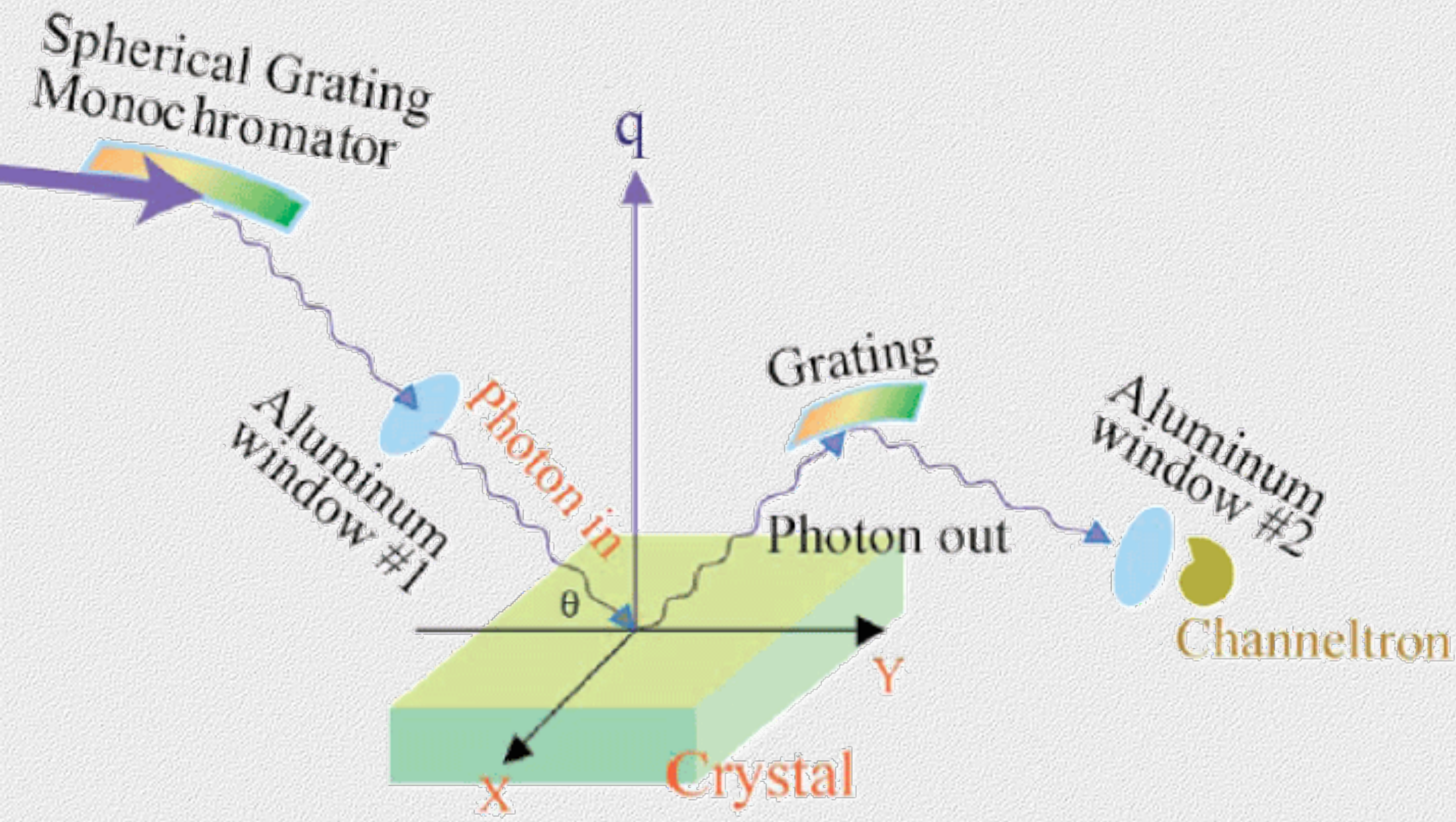
But, cross secions at high hv very small



⇒ need a lot of photons!

Resonant soft X-ray scattering

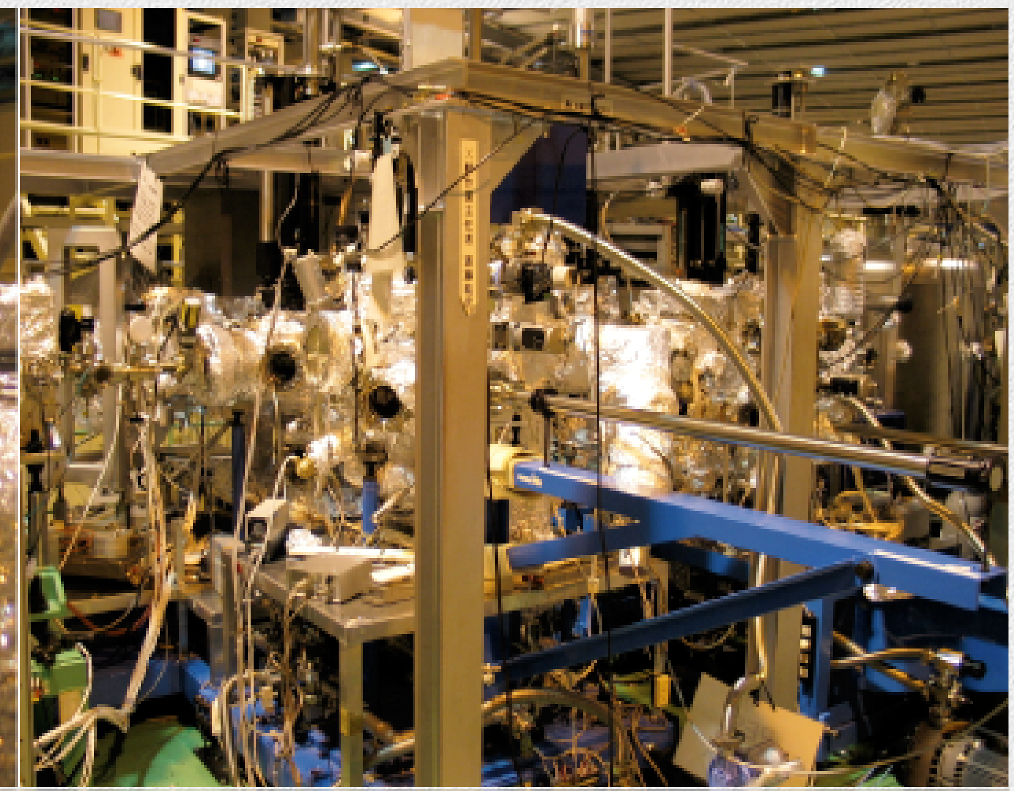
- Many collective phenomena at longer wavelengths
  - Spin ordering, magnons, polarons, bi-polarons, etc.
- Weak phenomena ⇒ need resonant scattering from LOW-lying energy levels which participate in phenomena



State-of-the-art

Sping-8 beamline BL25SU

Looking down the beamline

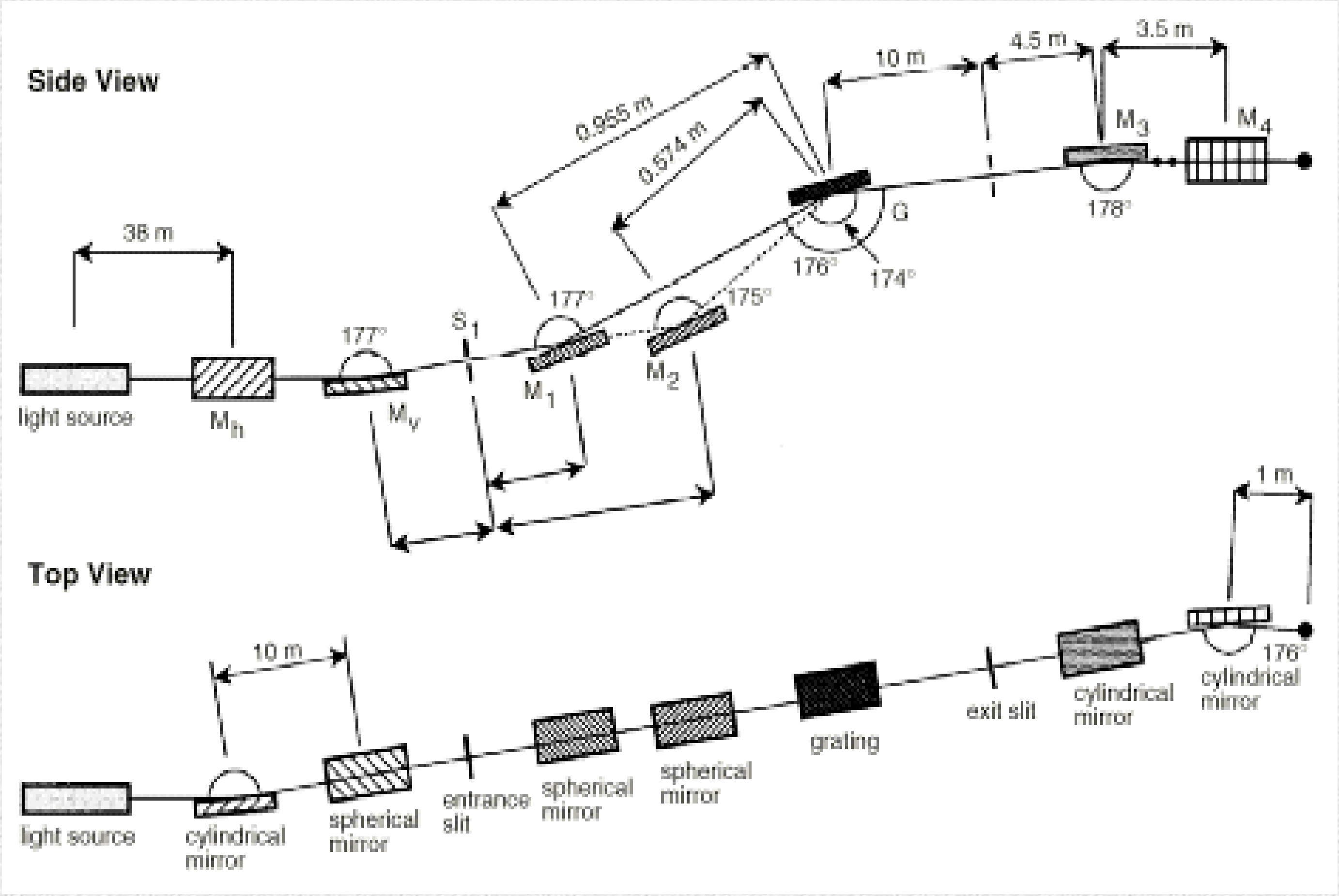


ARPES end-station

Sping-8 beamline BL25SU

Twin helical undualtor beamline

- undulator period : 120mm
- number of periods : 12 x 2
- tunable energy range : 300eV ~ 3keV
- brilliance : 1.89 ~ 7.85 x 10^{17} ph/s/mrad^2/mm^2/0.1% b.w.
- total power : < 1.67kW
- power density : < 3.0kW/mrad^2



Resolving power

E/ΔE > 10000

Photon flux

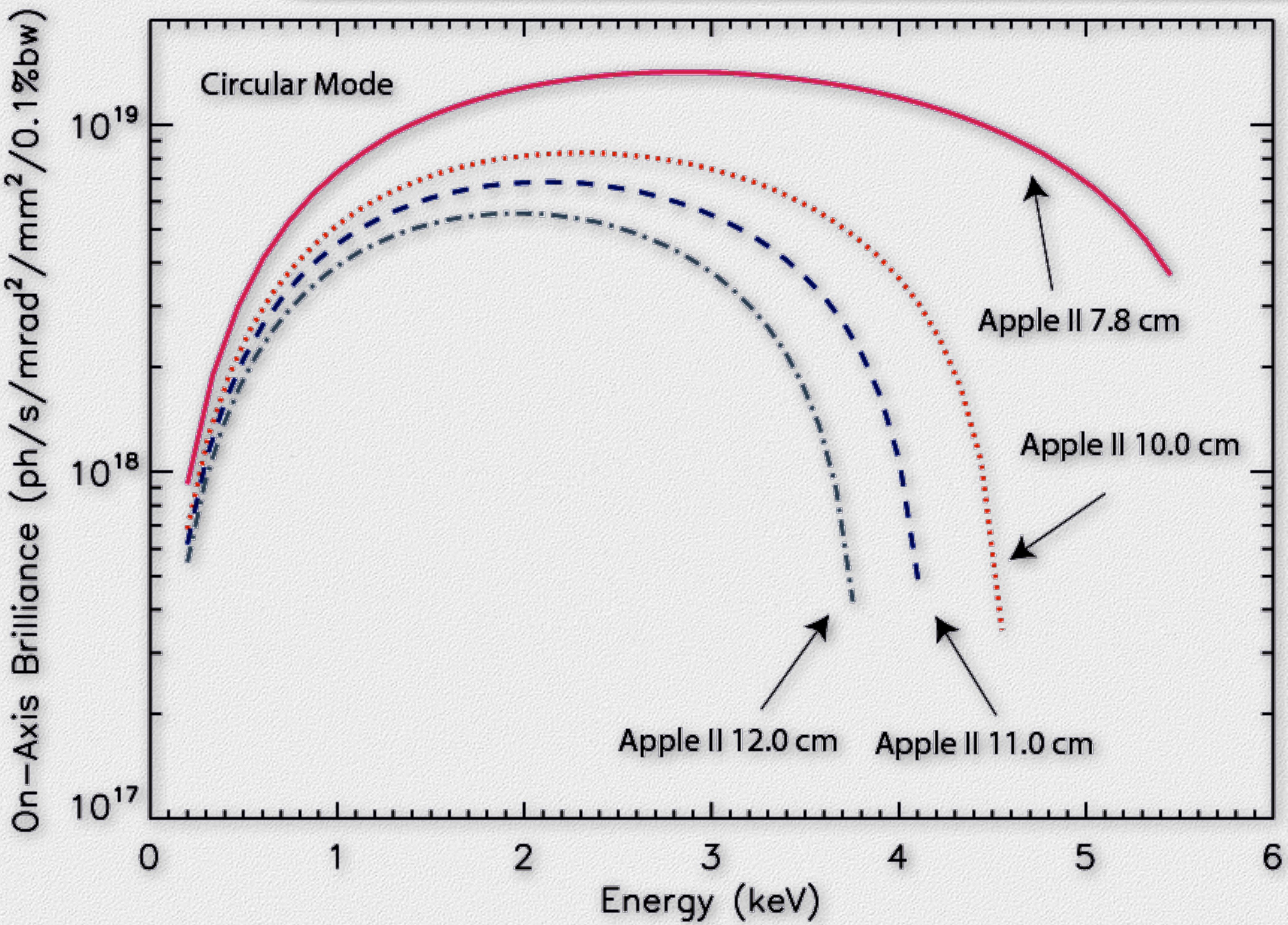
> 10^{11} ph/s/0.2% b.w.

Beamsize

~ 0.1mm x 0.1mm

No such beamline available in the U.S.!

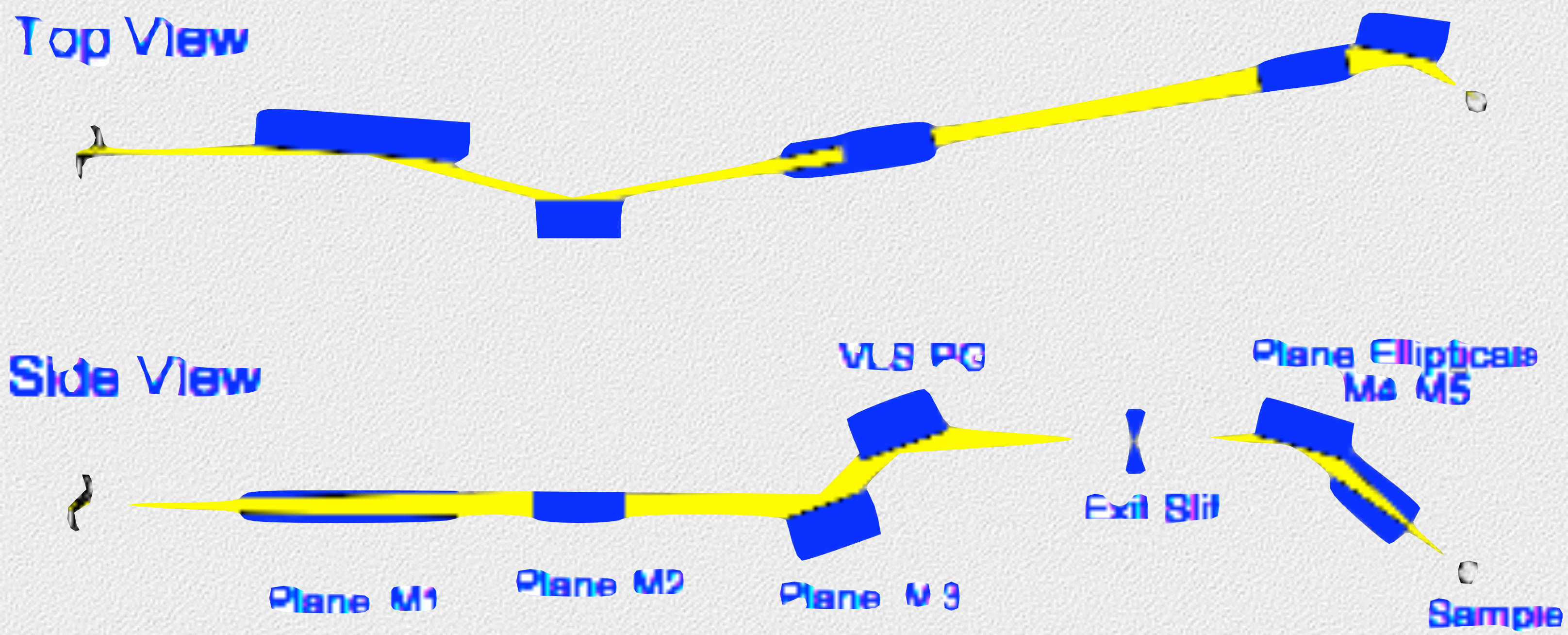
Can we do better at the APS?



On-axis brilliance for the proposed APPLE II with periods ranging from 7.8 to 12.0 cm, 2.4 m device @ 100 mA.
4.8 m device planed for the beamline will provide twice the flux.

The IEX beamline

Optical design: Ruben Reininger

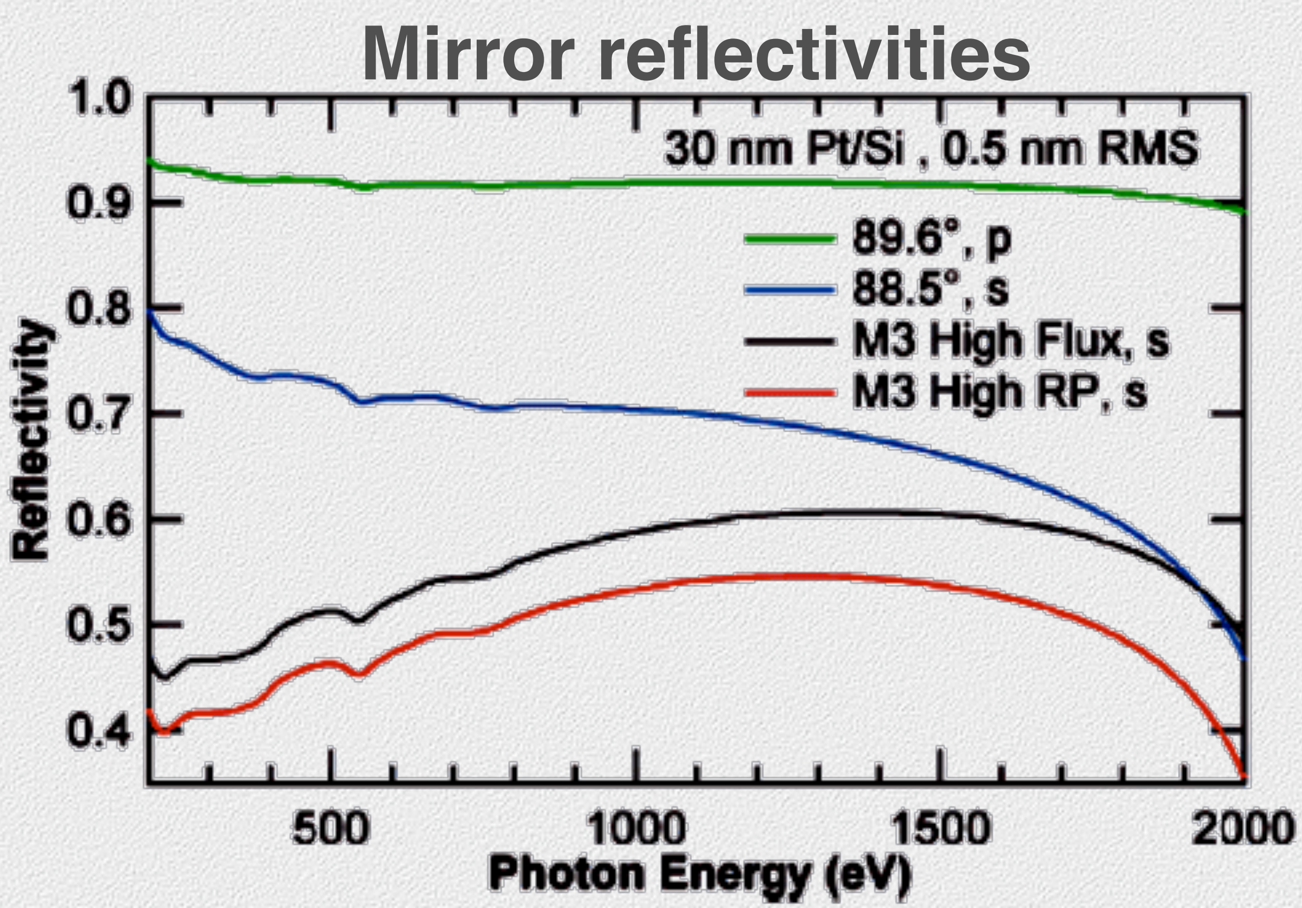


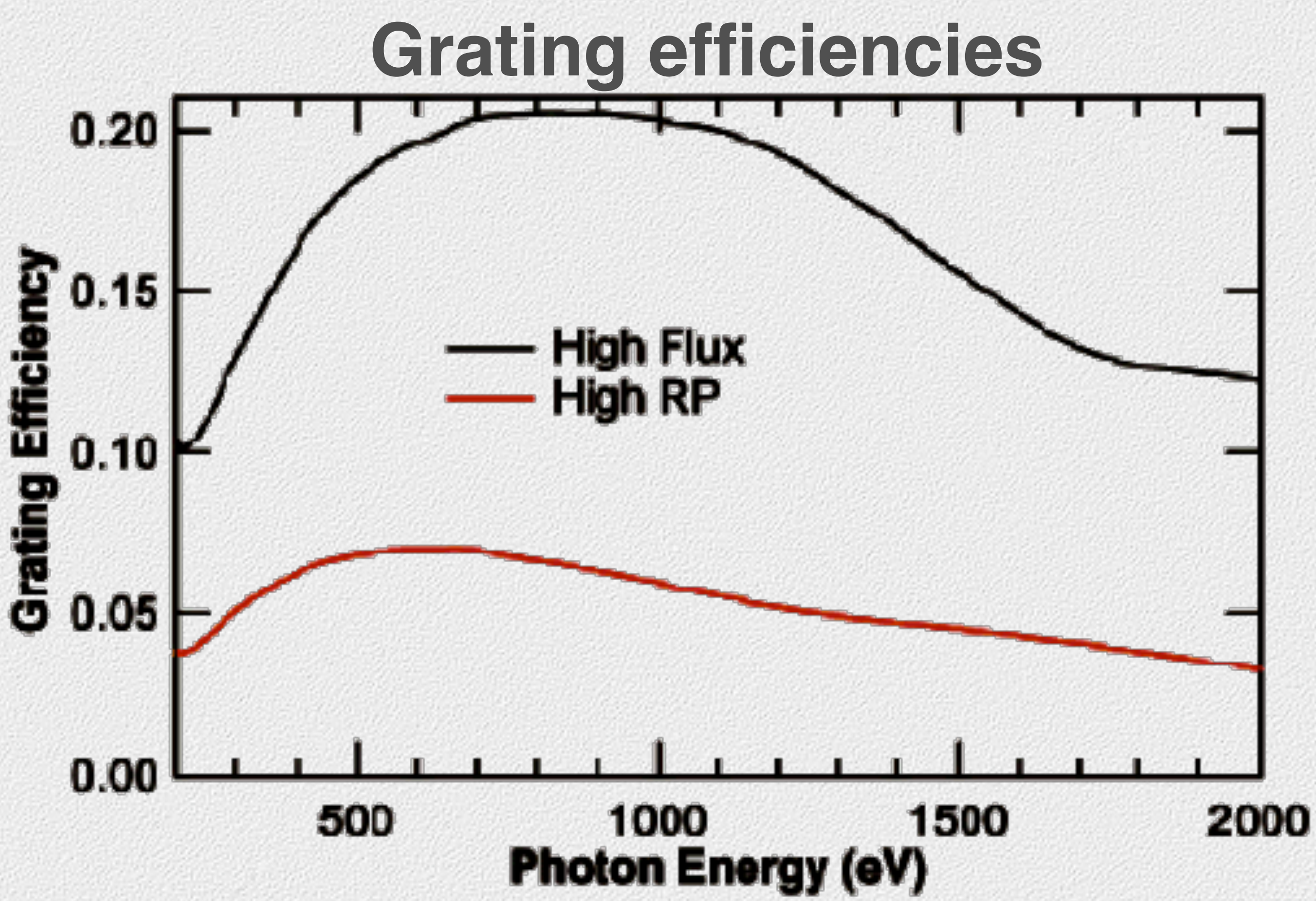
Vacuum UV

400-2000 eV

Reflection optics

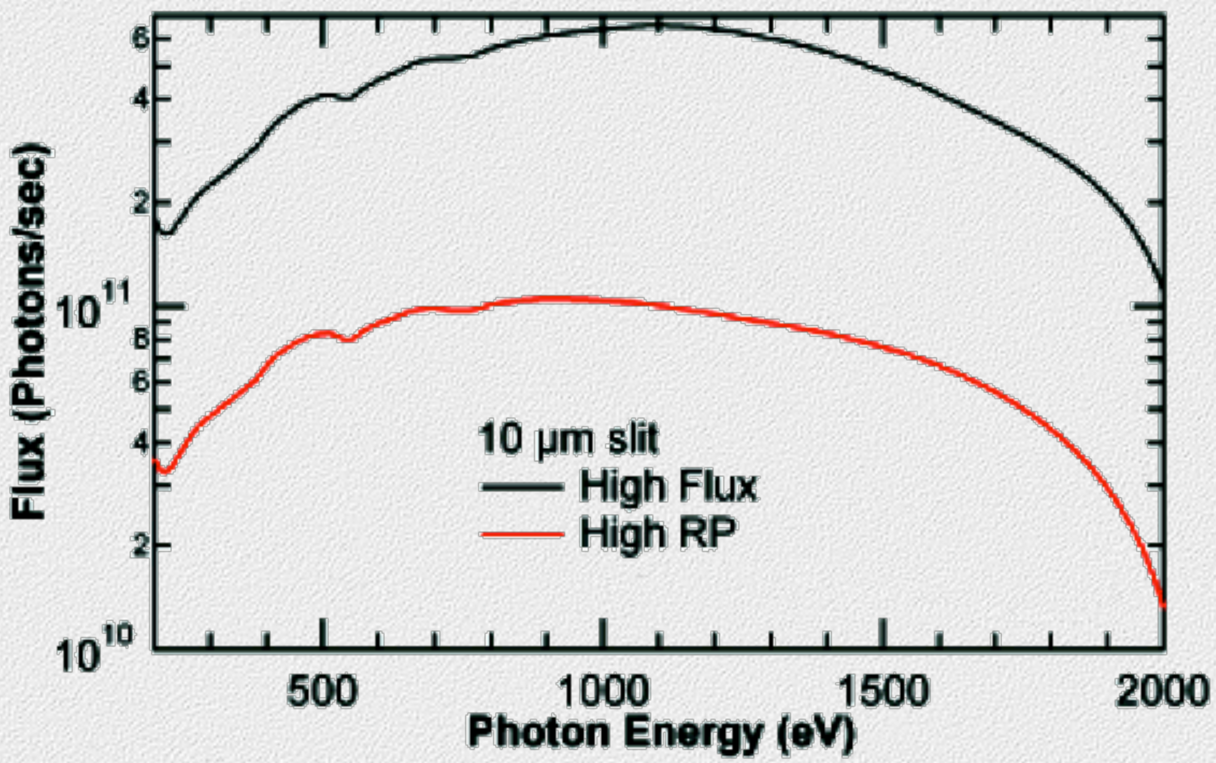
Variable polarization



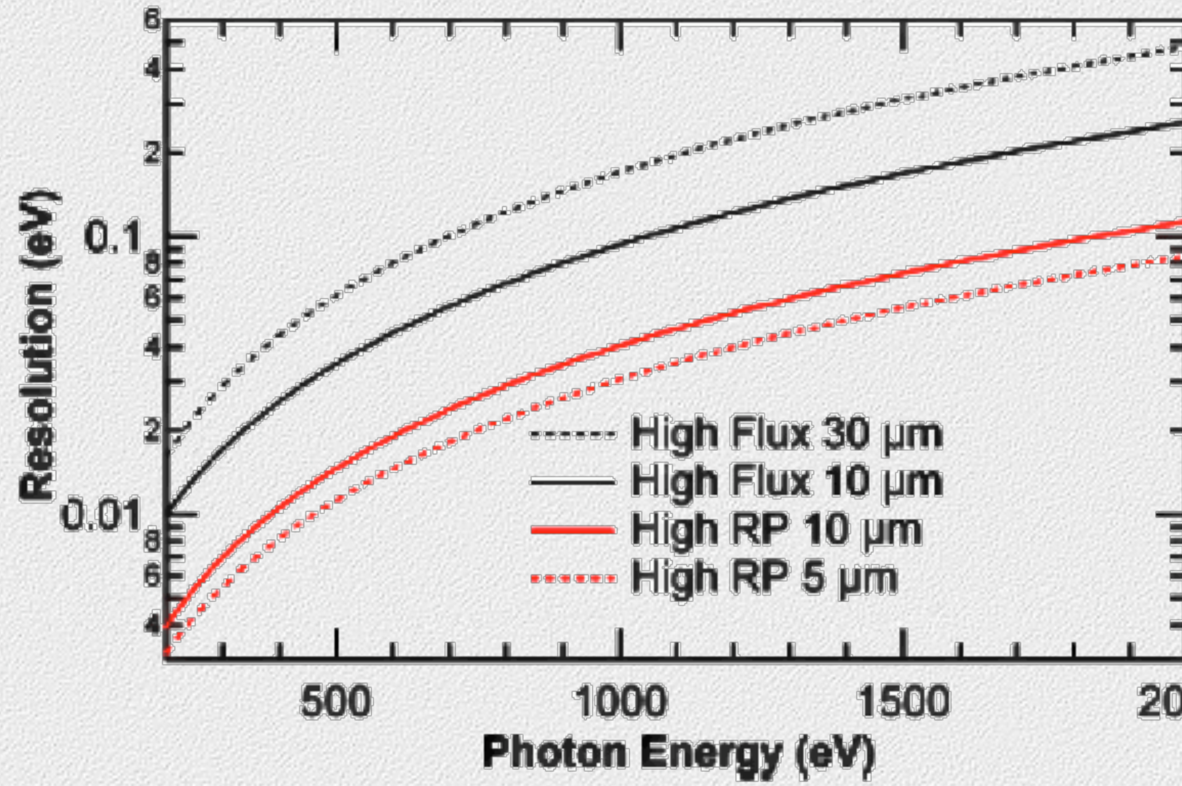


Expected performance

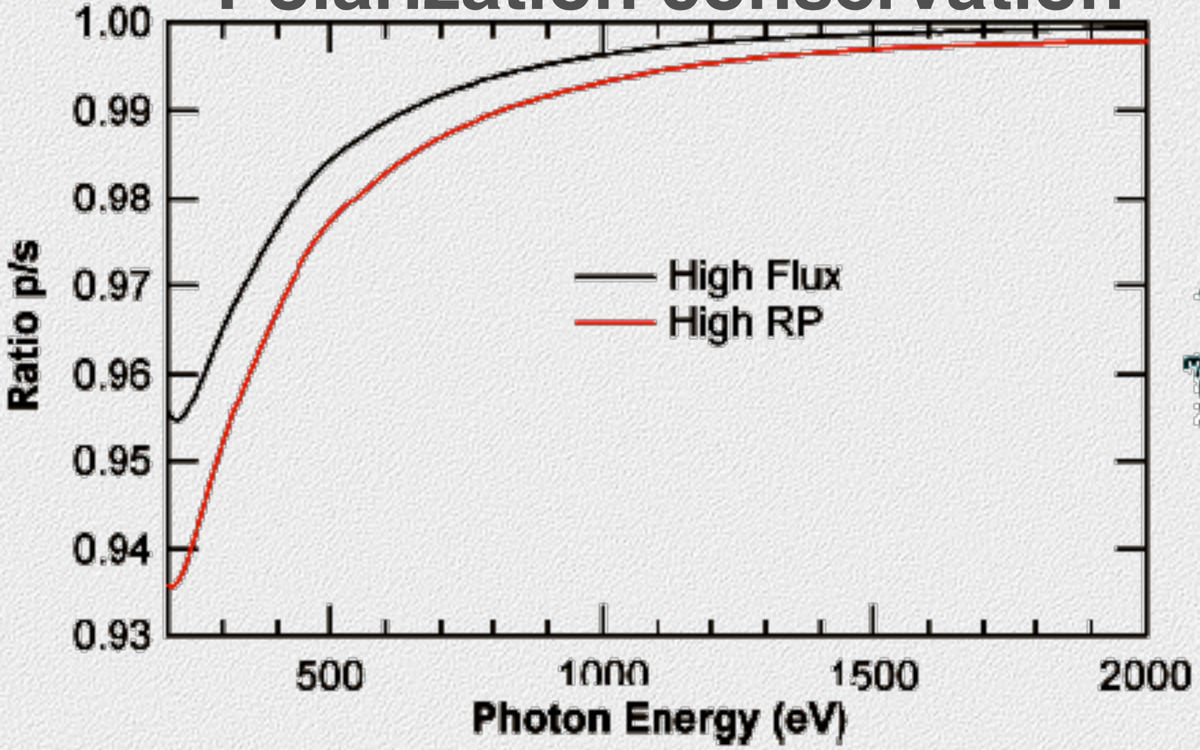
Flux at sample



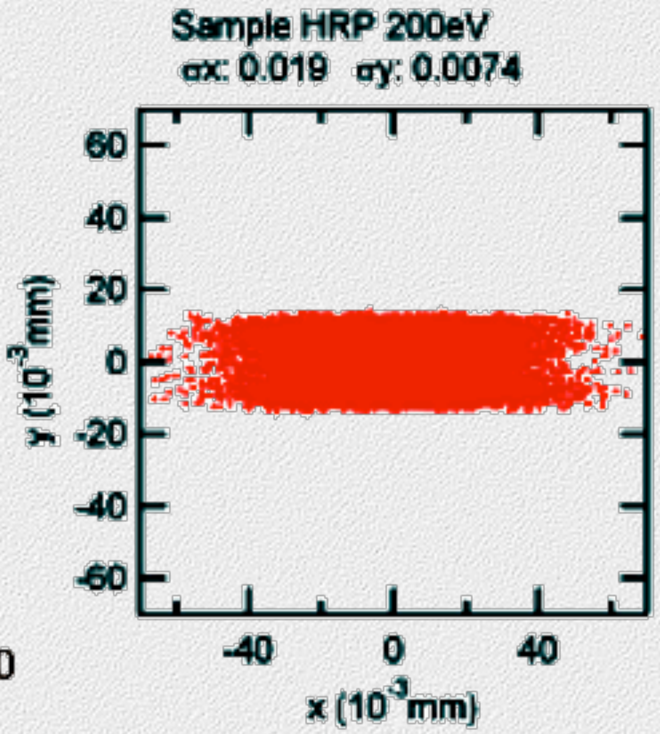
Resolution



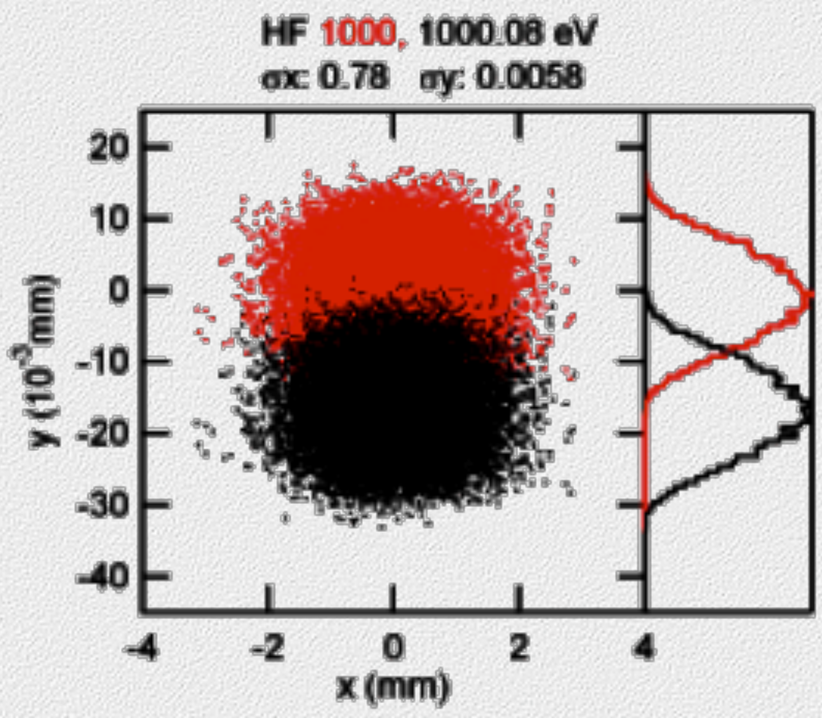
Polarization conservation



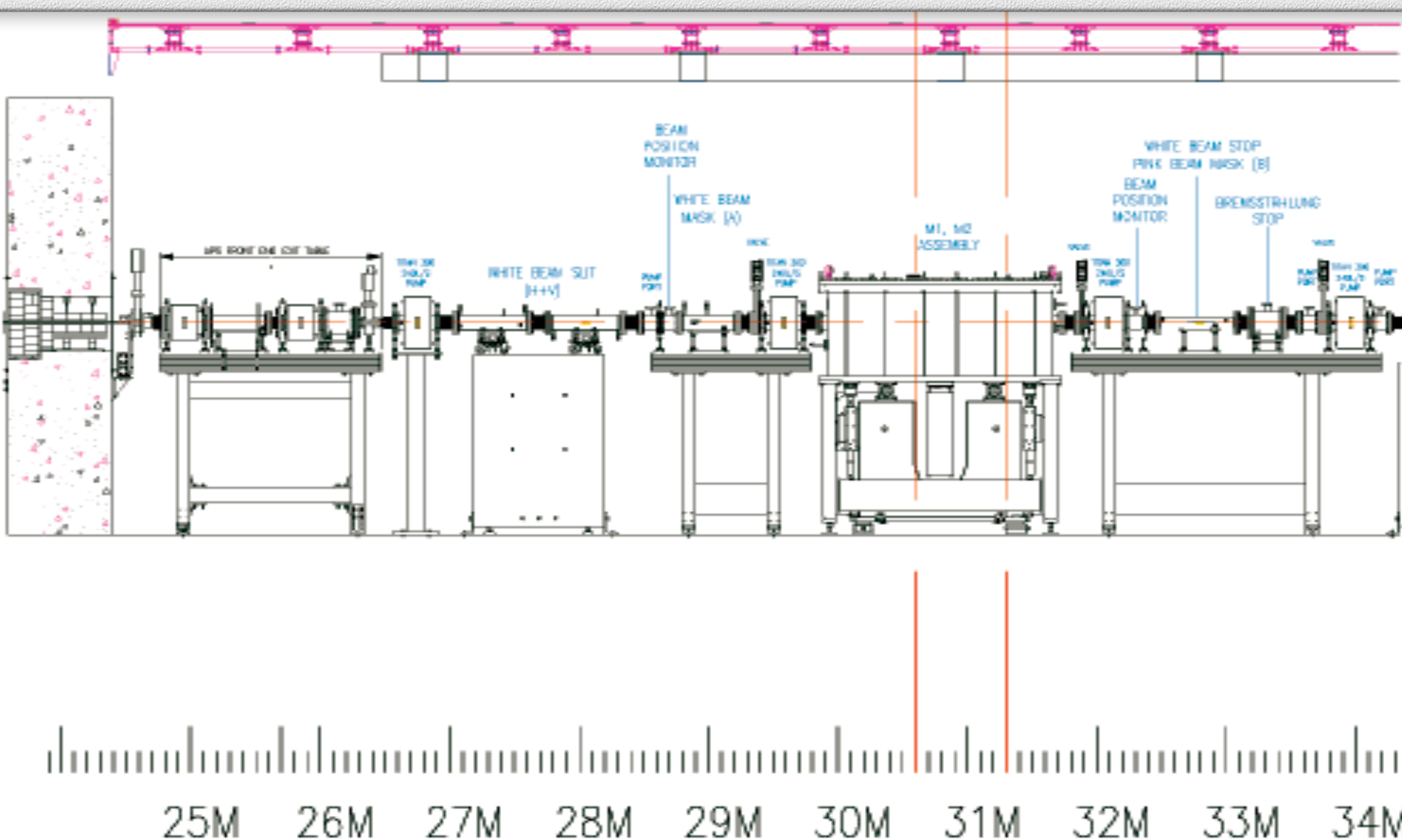
Beam size



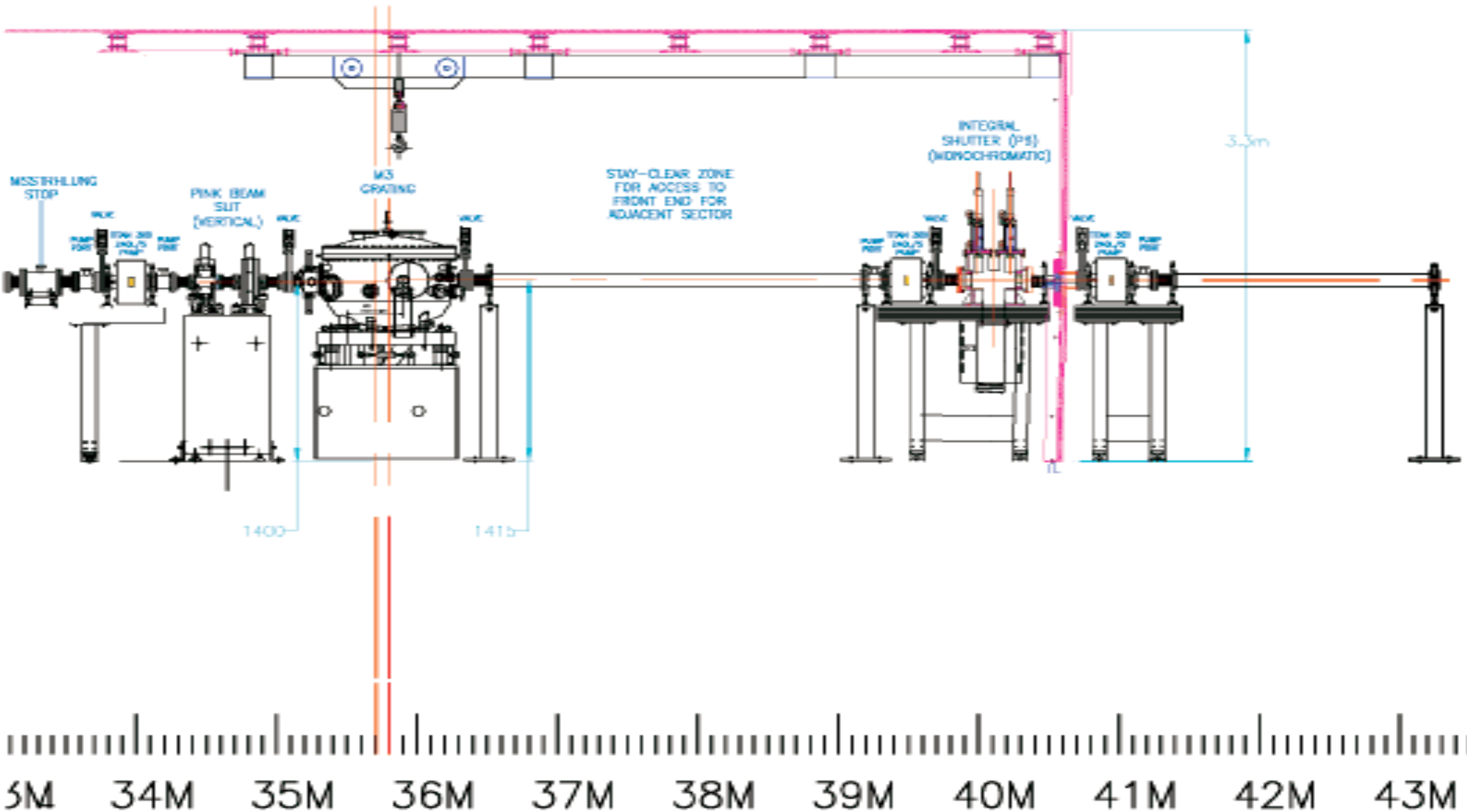
Resolution at slit

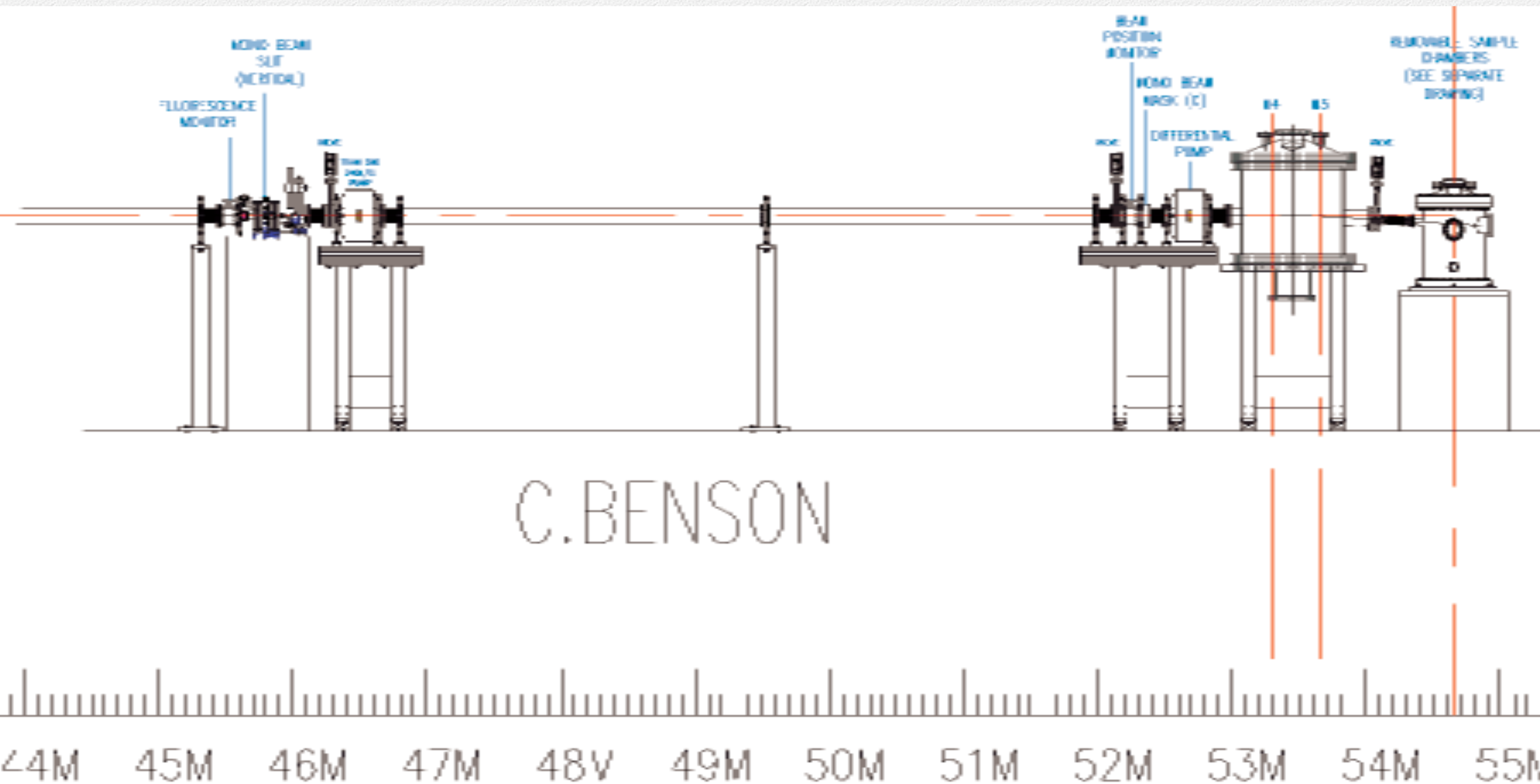


Mechanical design: Christa Benson

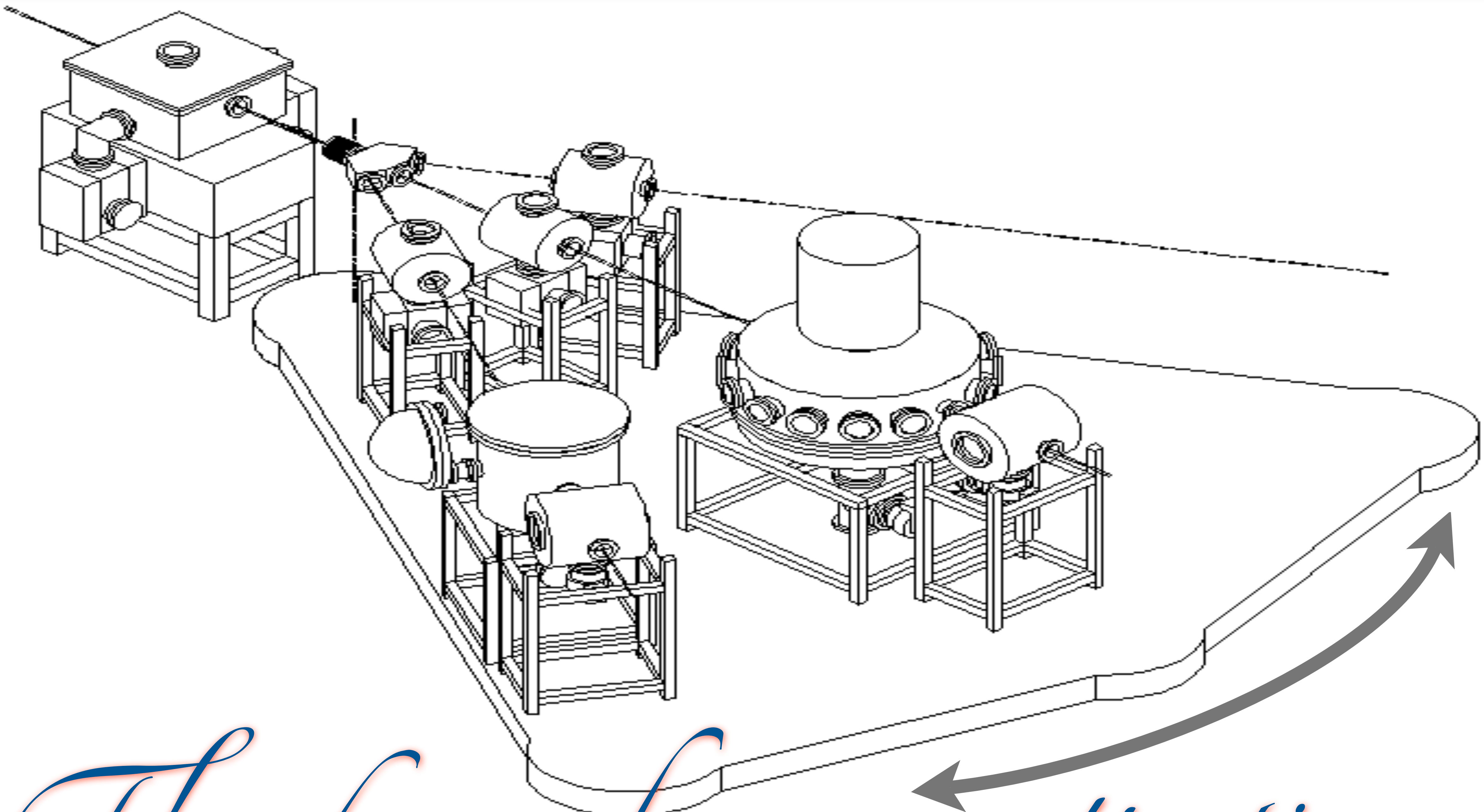


Monochromator section




MONO BEAM SLIT (VERTICAL)
FLUORESCENCE MONITOR
BEAM POSITION MONITOR
MONO BEAM MASK (C)
DIFFERENTIAL PUMP
REMOVABLE SAMPLE CHAMBERS (SEE SEPARATE DRAWING)
C.BENSON
45M
46M
47M
48V
49M
50M
51M
52M
53M
54M

Experimental station rotatable platform



Thank you for your attention