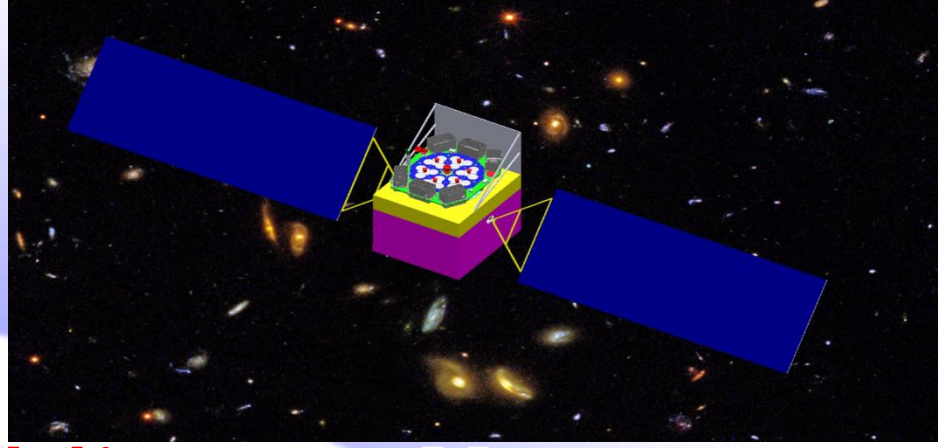

Progress in building an X-ray facility for energy calibration of HXMT

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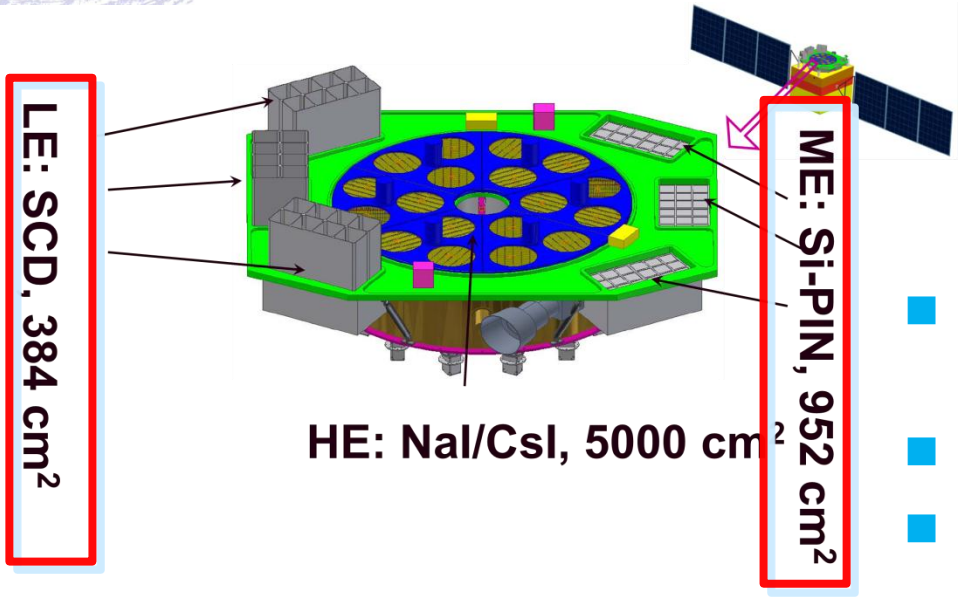
Conference on IACHEC 2013

Outline

- Aim
- Physical design
  - X-ray tube
  - DCM
  - Vacuum chamber
  - Simulation by XOP & shadow
- Time Schedule
  - Current status of the facility

Aim

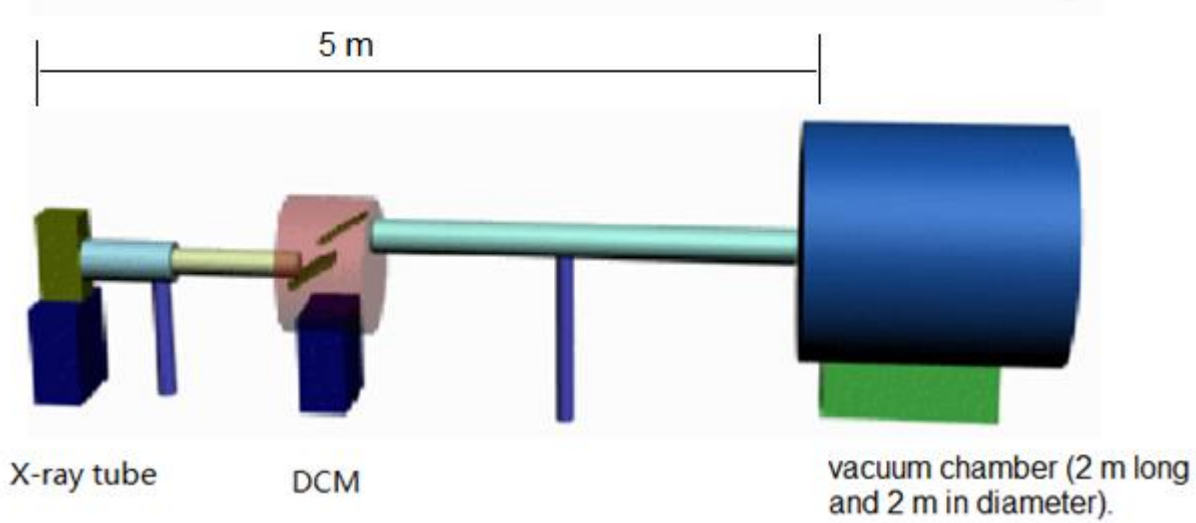


Energy range	**LE: 1-15 keV;** **ME: 5-30 keV**
Energy resolution	**LE: <8% @ 6 keV** **ME: <15% @ 20 keV**

The facility is developed for the Energy Calibration for the detector of HXMT/LE & HXMT/ME

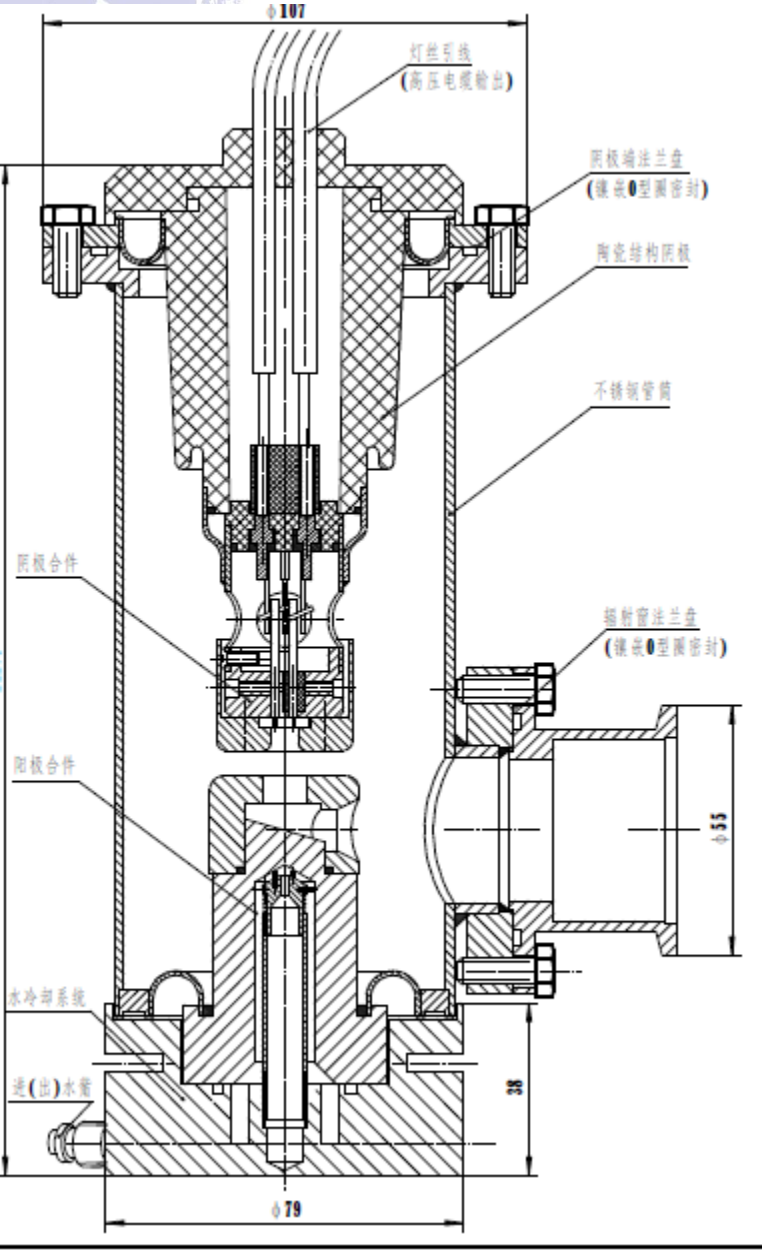
- monochromatic X-ray beam with fixed exit
- Energy range：1-30 keV；
- Energy resolution：
  dE/E<1%@1-30 keV
- Spot size：>1mm*10mm (distance between X-ray tube and test chamber : 5m)
- Flux at the chamber entrance：
  ~100 cts/s/cm^2；

Architecture of Facility



- X-ray tube + double crystal monochromator
  - X-ray tube: 3 kW, 5-50 kV
  - Switchable Double crystal monochromator： KAP(100), Si(111)
- the X-ray source and the chamber are connected with a tube of 10 cm in diameter.
- X-ray source, tube and chamber are kept under high vacuum, at a pressure of ~10-4 Pa, by means of 3 independent pumping system.

X-ray source

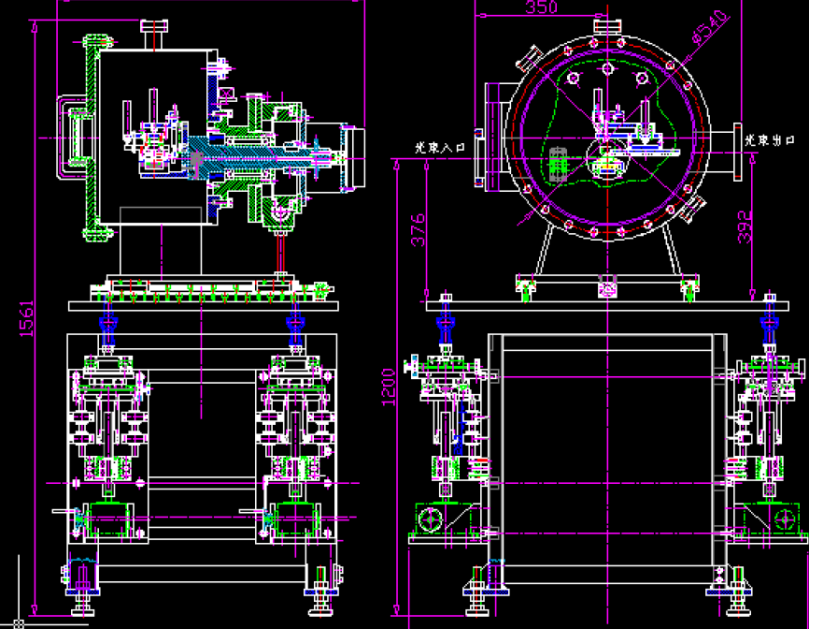


- Spellman (USA) DF3 series X-Ray high voltage power supplies

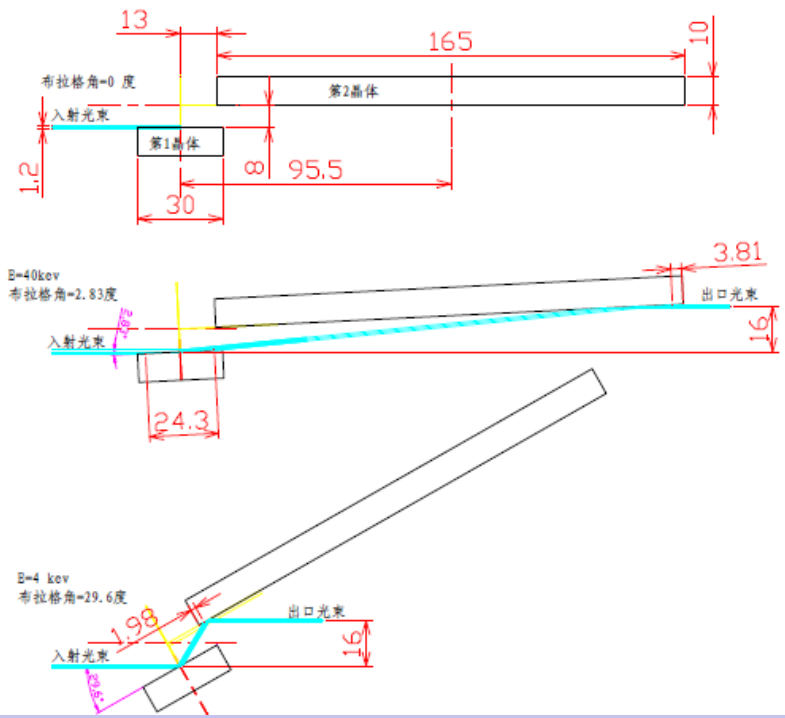
- X-ray tube
  - Voltage: 8-50 kV;
  - Current: <80 mA;
  - Maximum continuous power: 3 kW;
  - an open type (no beryllium window in the beam exit)
  - but with ultra-high vacuum gate valve
  - Cooling system: water flow.
  - copper anode
  - Vacuum: < 10^-4 Pa

Switchable DCM

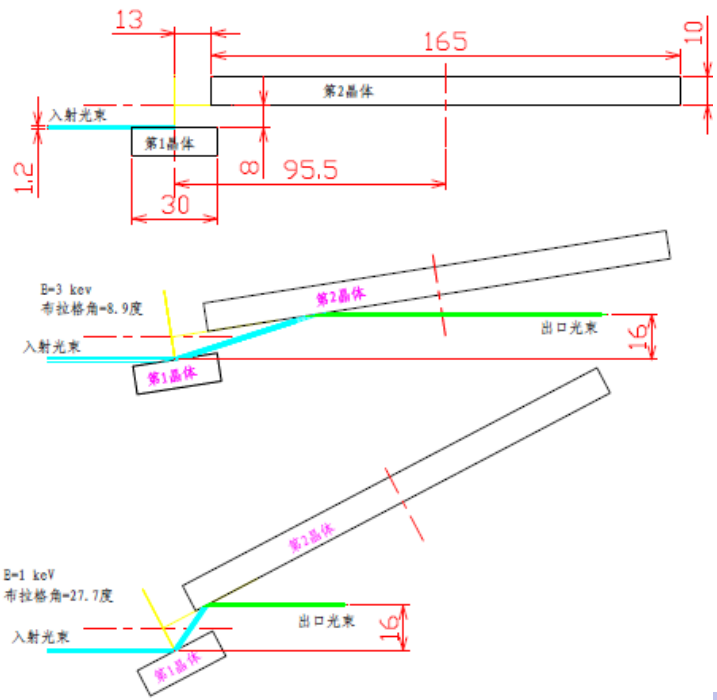
- 2 possible choices of crystals: Si (111),KAP (100)



晶体材料Si (111)



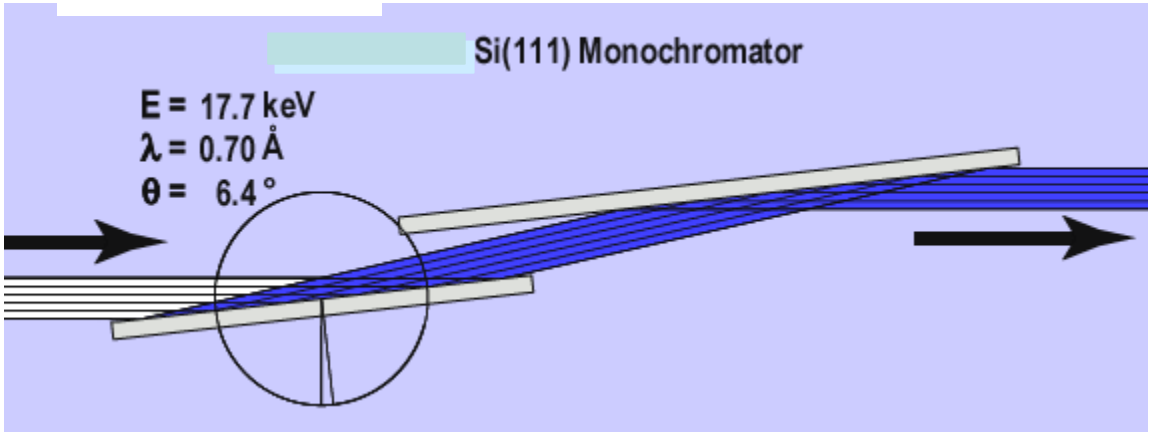
晶体材料KAP (100)



Physical design : energy depend on the incidence angle

- KAP (100): d=13.316 angstrom for 1-3 keV
- **Si (111): d=3.138 angstrom for 3-30 keV**

$$2d\sin\theta = \lambda$$



Physical design : energy resolution

$$2d\sin\theta = \lambda \Rightarrow \frac{\delta E}{E} = \frac{\delta\theta}{\tan\theta}$$

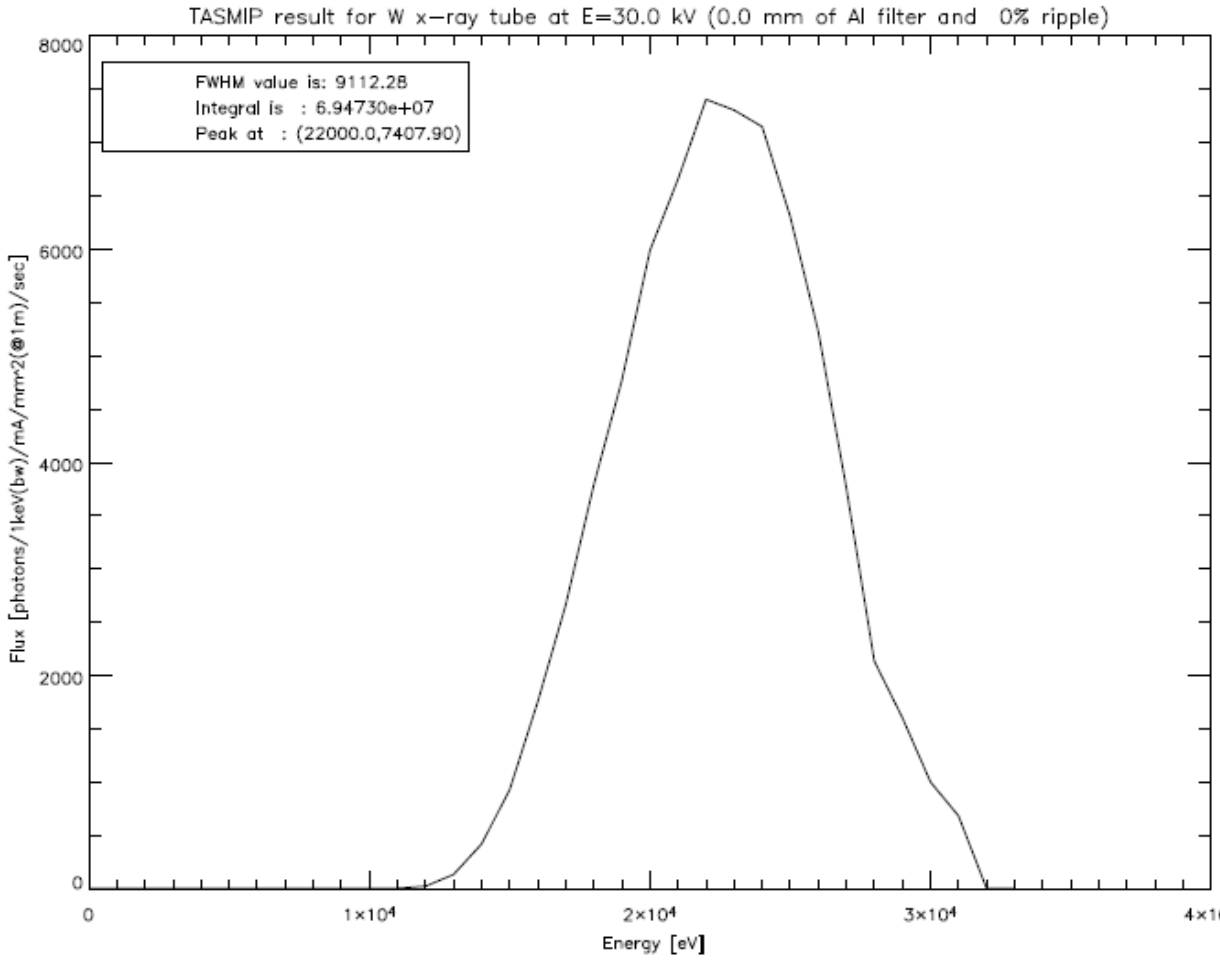
- A set of collimators limits the divergence of the X-ray beam. The divergence of the beam influences the energy width of the monochromatized beam.
- 1mm*10mm (distance between X-ray tube and vacuum chamber : 5m)

E(keV)	1	2	3	4	5	10	20	30	40
θ(degree)	27.7	13.4	8.9	29.6	23.29	11.4	5.65	3.77	2.83
δE (keV)	0.0004	0.002	0.004	0.002	0.002	0.01	0.04	0.09	0.16
$\frac{\delta E}{E}$	0.0004	0.0008	0.001	0.0003	0.0005	0.001	0.002	0.003	0.004

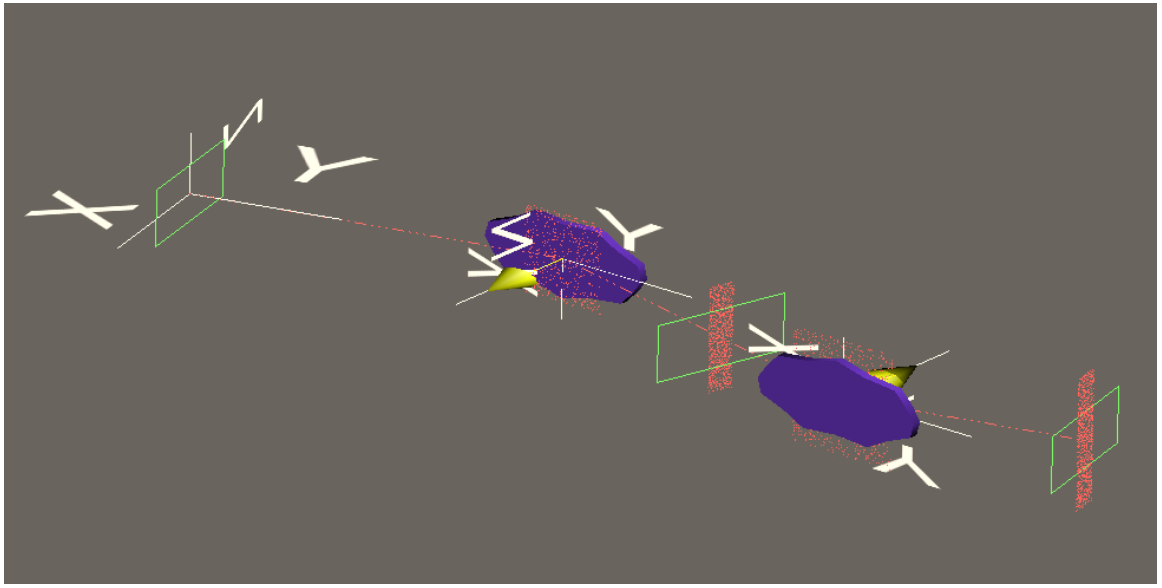
Simulation by XOP & shadow
X-ray tube

- Tungsten target, 30W, 30 kV,
- 7E10cts/s/sr ,
- 6E9 cts/s/keV/sr

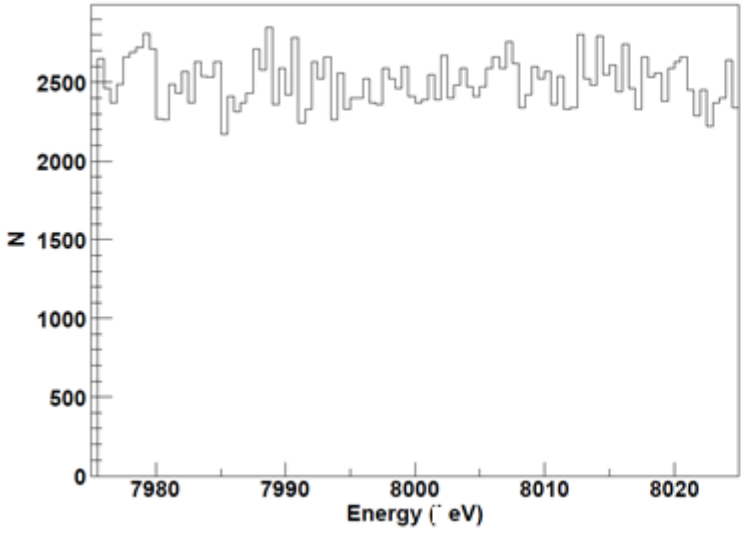
@ 20 keV

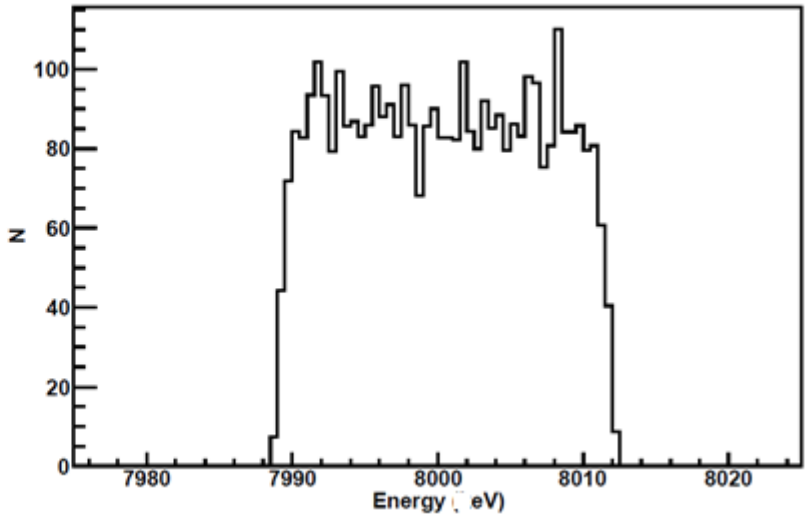


Simulation by XOP & shadow
DCM: reflection efficiency



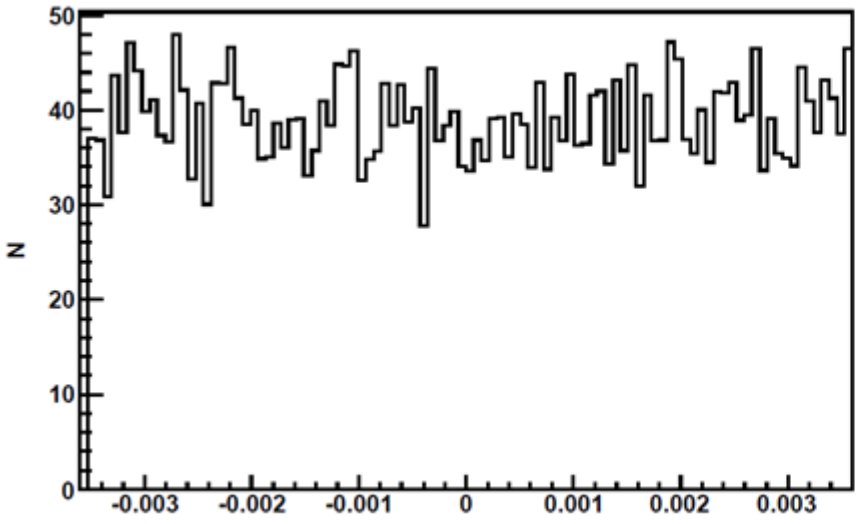
- reflection efficiency~0.04



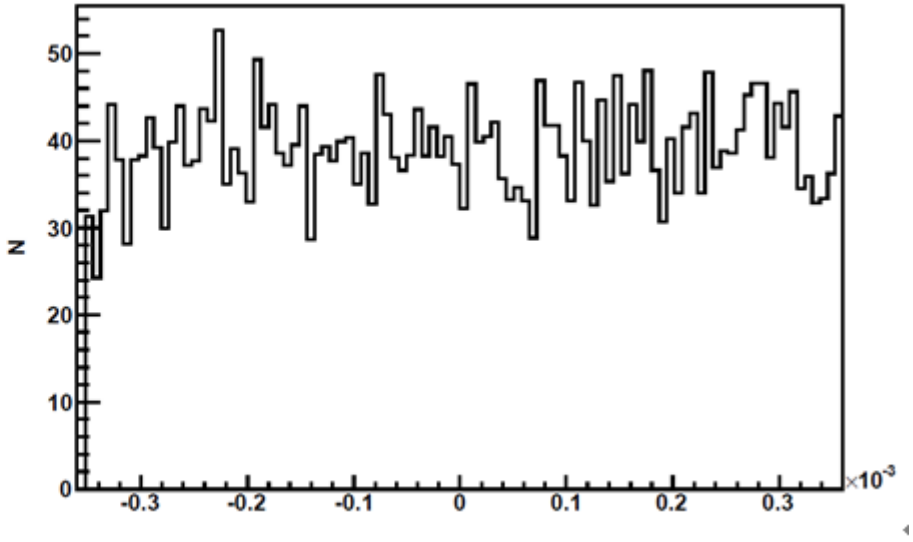


Simulation by XOP & shadow DCM: flux distribution on spot

- Result: spatial distribution is well



Long edge (degree)



short edge (degree)

Simulation by XOP & shadow results

- If we use 3 kW X-ray tube,
  the spot size is 1mm*10mm@5m

we can get:

- 100cts/s@20keV (1000cts/s/cm2, dE/E~0.002)

Under ideal circumstance !!

Time Schedule

time	assignment
2012.06---2012.09	**Physical design**
2012.10--2013.02	**Subsystem design**
2013.03--2013.04	**The overall detailed design**
2013.04--2013.06	**sign contracts Buy equipment**
2013.07---2013.08	**build and install**

Current status of the facility

- Test chamber: finished
- Signed contracts :

  X-ray tube

  X-Ray high voltage power supplier

  DCM

- difficult points
  - Standard detector (efficiency)
  - Beam monitor (test, find the small size beam)
  - Co-alignment of the subsystems
- Under the helps/assistance of the PANTER facility

summary

- The facility is developed for the Energy Calibration for the detector of HXMT/LE & HXMT/ME
  - monochromatic X-ray beam with fixed exit
  - Energy range：1-30 keV；
  - Energy resolution： <1%@1-30 keV
  - Spot size：>1mm*10mm
  - Flux at the chamber entrance ~100 cts/s/cm^2
- The facility is to be completed in August 2013

- Thanks for your attention

summary

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