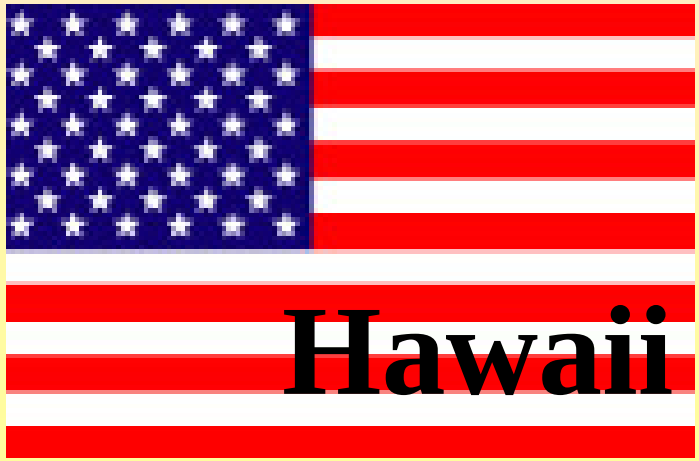
Beam energy calibration system at BEPCII

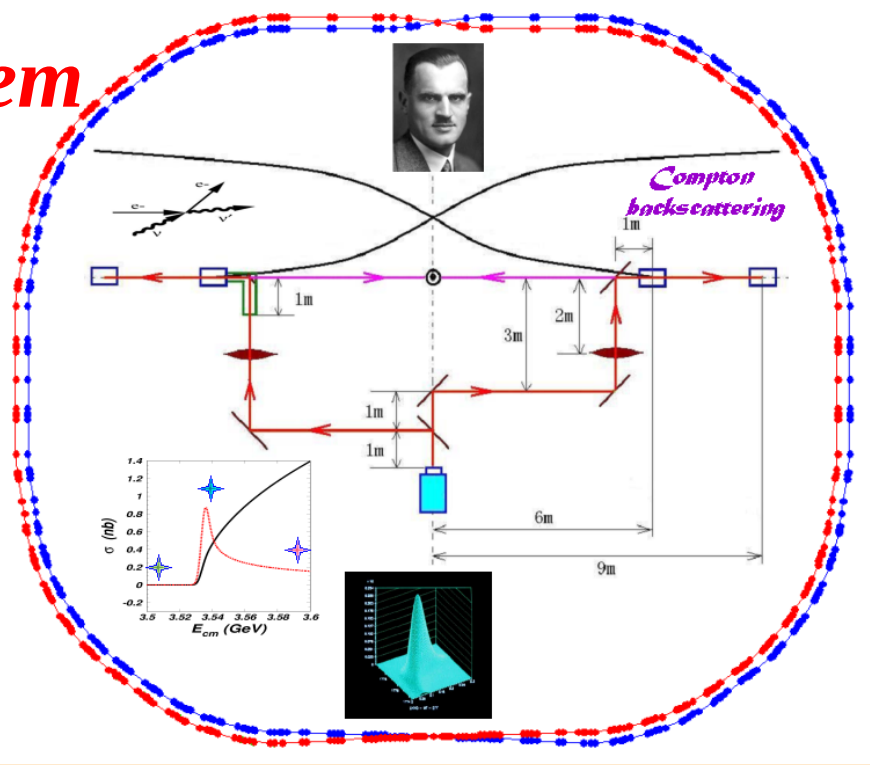
X.H. Mo

on behalf of beam energy calibration collaboration
BINP (Russia),
Hawaii University (USA),
IHEP(CHINA).

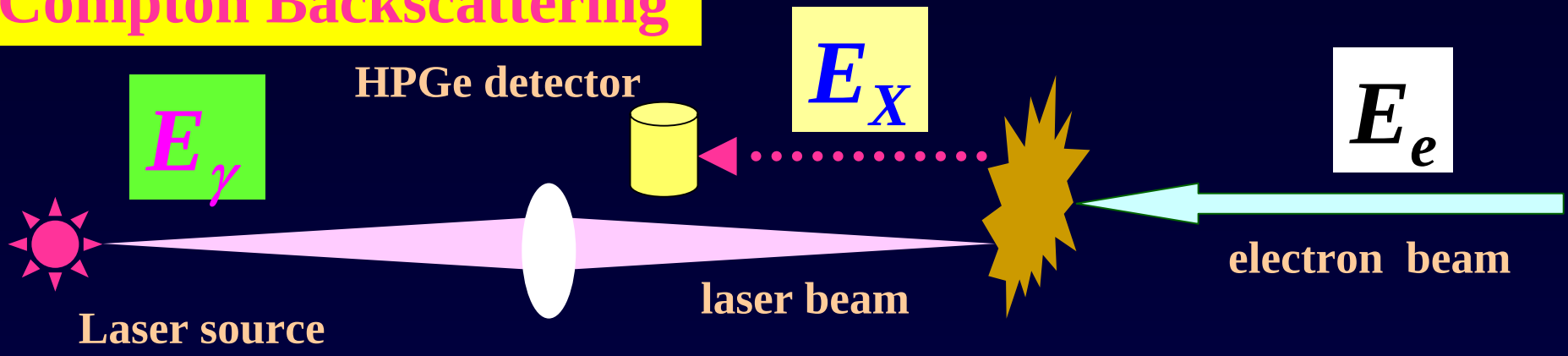
October 16th,2009; IHEP

Beam energy calibration system



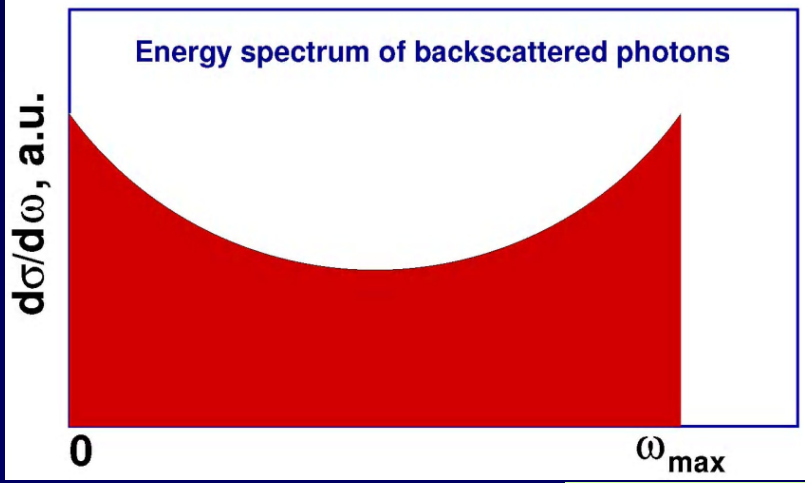


Compton Backscattering

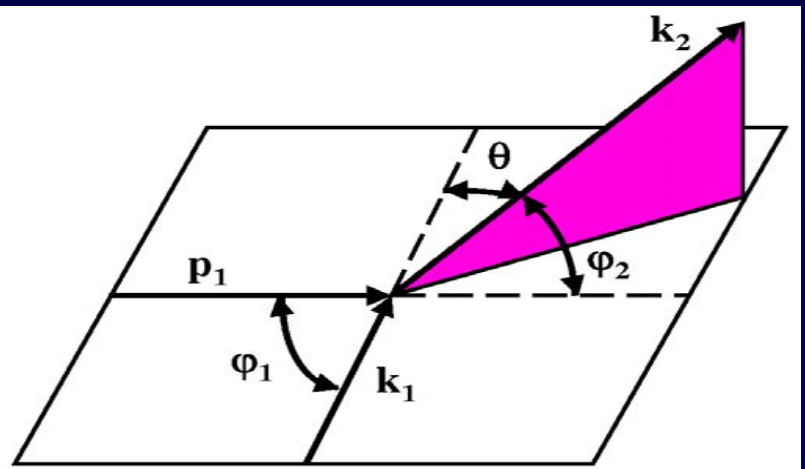


$$g(\vec{p}) = \frac{1}{2}(p_2(x - p_3) + p_0) \cdot \mathrm{erfc}\left[\frac{x - p_0}{\sqrt{2}\,p_1}\right] - \frac{p_1 p_2}{\sqrt{2\pi}} \cdot \exp\left[-\frac{(x - p_3)^2}{2\,p_1^2}\right] + p_4(x - p_3) + p_5$$

p_0 :edge amplitude; p_1 :edge width;
p_2 :slope left; p_3 :edge position;
p_4 :slope right; p_5 :background.



$E =$



$$E_e = \frac{E_X}{2}\left[1 + \sqrt{1 + \frac{m_e^2}{E_\gamma\, E_X}}\right]$$

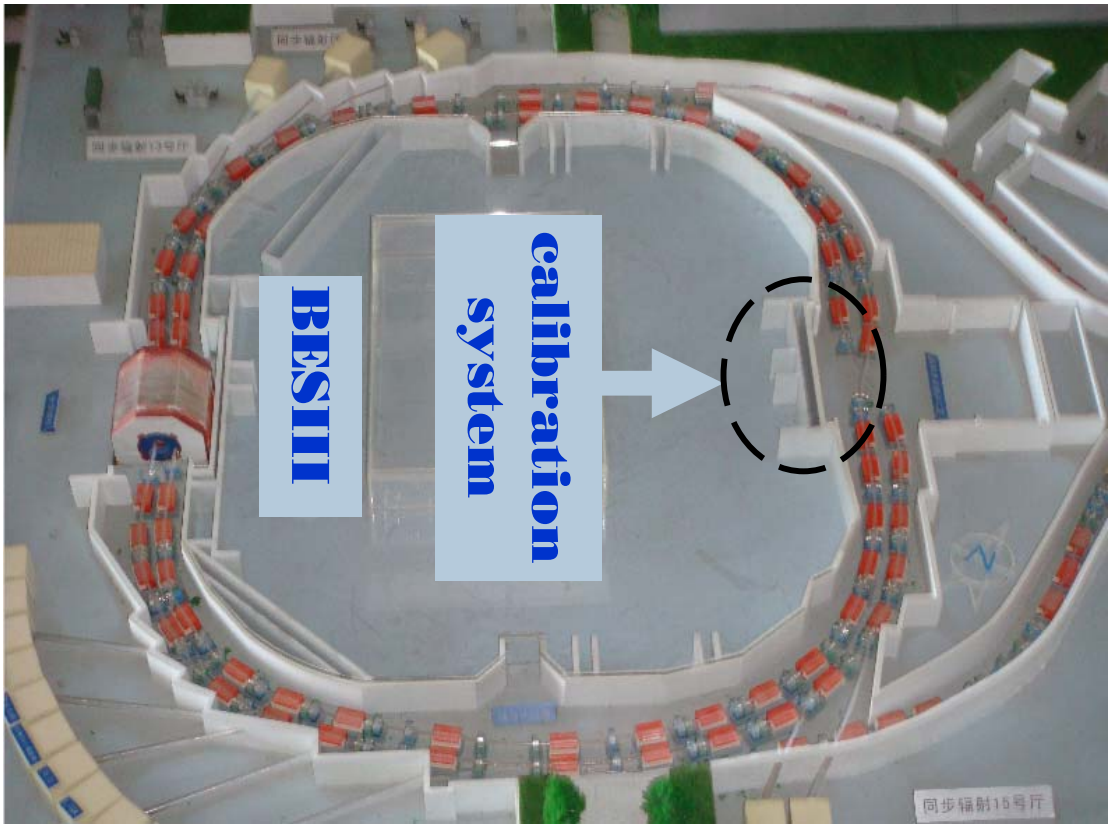
Relative error < 5 ×10^{-5}

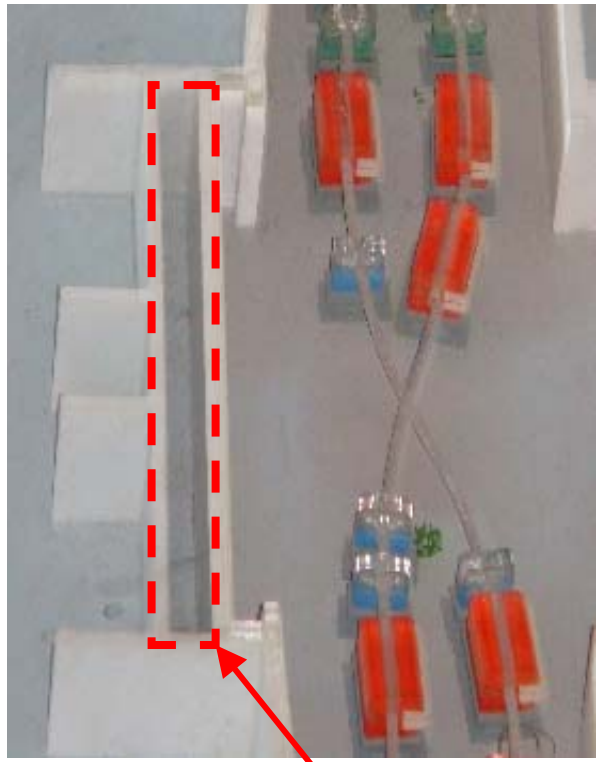
Content

1. Introduction
2. Laser and optics system
3. Interaction system
4. HPGe Detector system
5. Schedule of future work

Laser and optics system

BEPC-II electron-positron storage ring

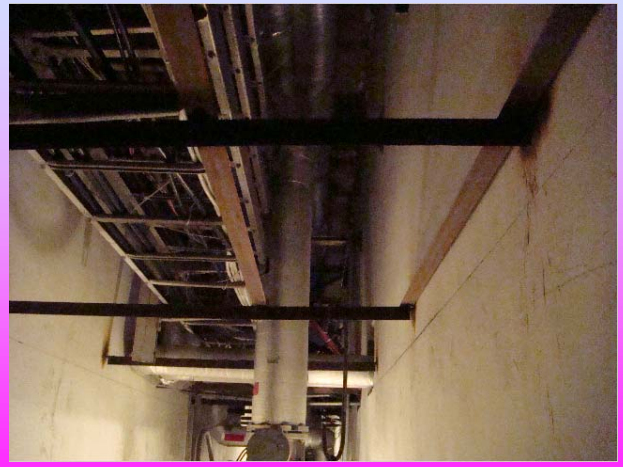




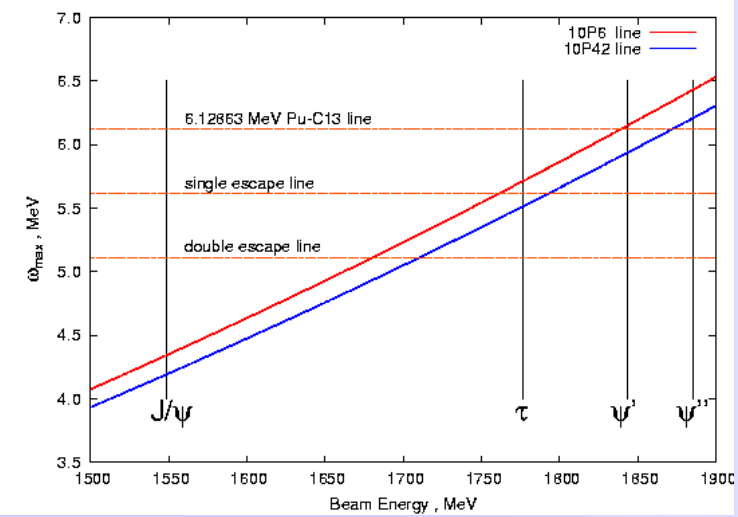
Corridor where optics system located

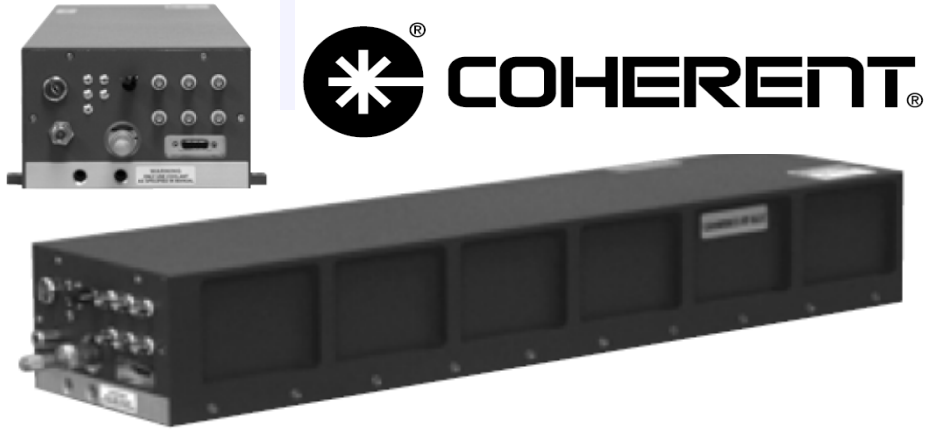
The beam energy calibration system will be located at the north crossing point (***NCP***) of BECPII.

Repairing of corridor at north IP of BEPCII



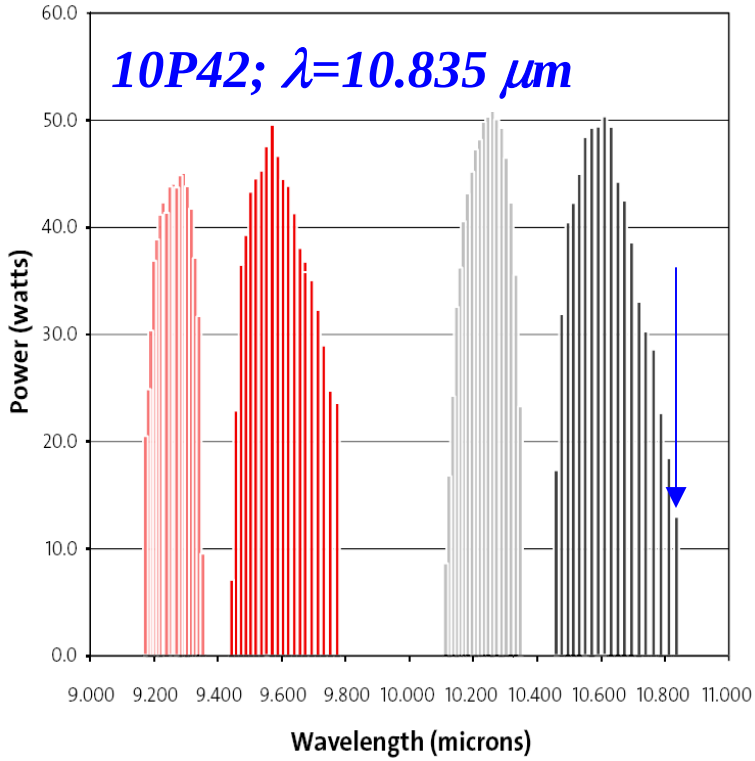
Before RP.ing **During RP.ing** **After RP.ing**





CO_2 Laser: Coherent GEM Select 50

		GEM Select 50
Output Specifications	Output Power (W)	50
	Wavelength (μm)	10.6 nominal
	Mode Quality	TEM_{00}
	Polarization	Fixed Linear
	Beam Diameter (mm, $1/e^2$)	1.7 ±0.2
	Beam Divergence (mrad)	8.3 ±0.6
	Power Stability	±3%
	Specifications are subject to change without notice. Protected under U.S. patents: 4363126, 4443877, 4787090. Licensed by PATLEX Corp. under U.S. Patent 4,704,583.	
Input Specifications	Electrical	200-240 VAC, 50-60 Hz, <8A
	Cooling	Water + 25% Dow Frost* Coolant 1.5 GPM / 20°C ±5°C
	Other cooling and power options are available. Contact your nearest Coherent sales representative. * Dow Frost is a trademark of the Dow Chemical Company.	
Physical Specifications	Weight (laser head)	18.14 kg (40 lbs.)
	Physical Dimensions (LxWxH)	790.575 x 196.85 x 138.86 mm (31.125 x 7.75 x 5.467 in.)



Support by US government (83.7+9.0+8.0+2.8 k US$)

Optics system (BINP)

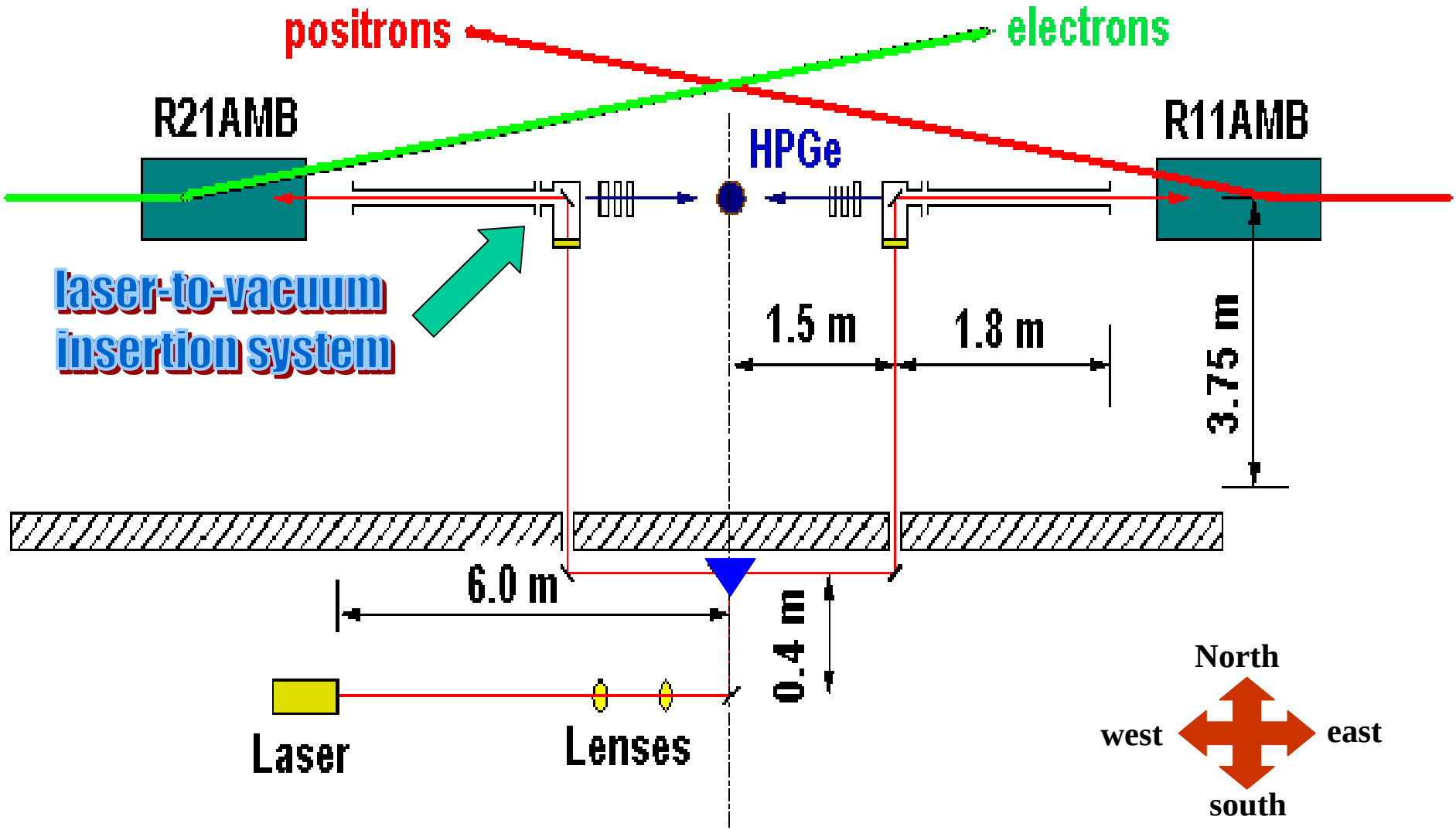
№№	equipment	number
OC-11	Plate for laser	1
OC-12	Laser support	1
OC-13	Optial banch	1
OC-14, 15	Wall mout	2
OC-22, 23	Lense support	2
OC-24	Optical banch	1
OC-25	Mirror with wall mount	1
OC-26, 27	Wall mount	2
OC-30	Prisma with step motor and controller	1
OC-31, 32	Mirror with rotation mechanism, step motor – 2 and controller - 2.	2
OC-33 - 35	Optical support	3
OC-36 OC-37, 38	Optical banch	3
OC-39 - 41	Wall support	3
OC-42 – 44	DC power supply, 24 V (DR-75-24)	3

Design finished by the end of Jan., 2008; Manufacture before May,2008; Installation and preliminary alignment in May, 2008.

Optics system

Laser will be located here !

Layout of the beam energy calibration system

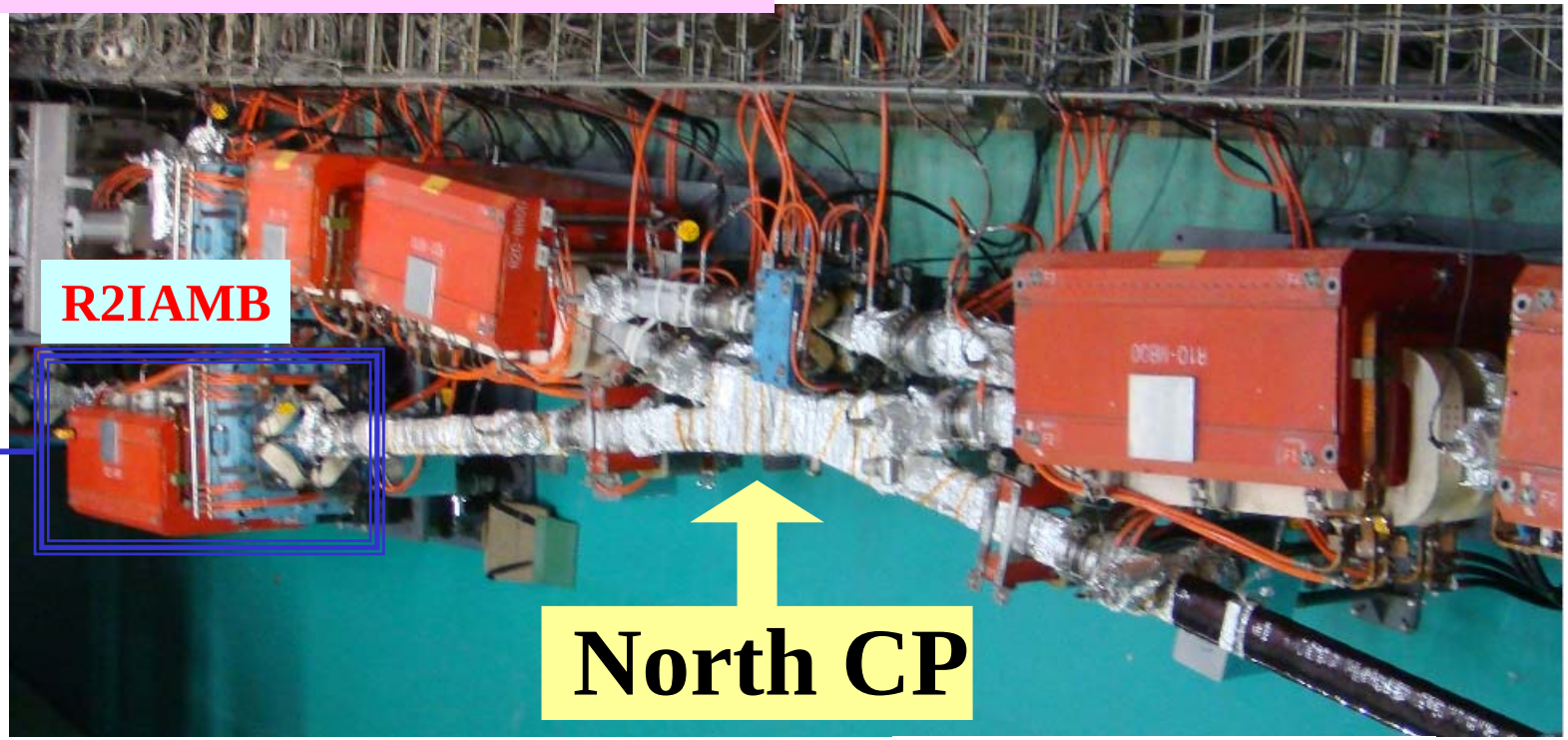


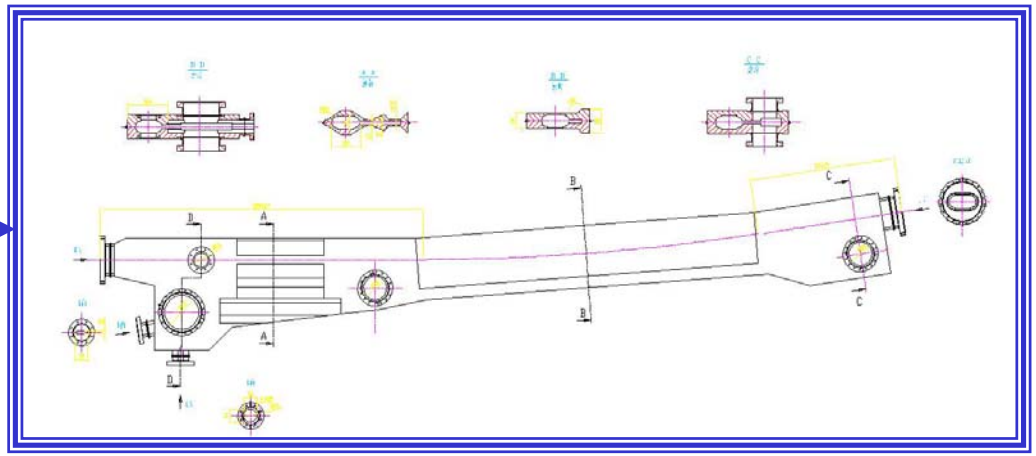
Interaction system

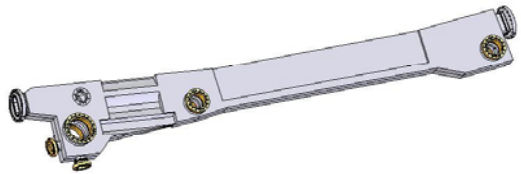
1. Reform of vacuum chamber (IHEP)
2. Insertion part (BINP&IHEP)

Reform of vacuum chamber

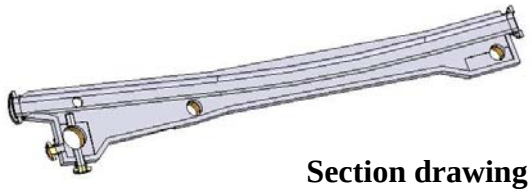
North
west east
south





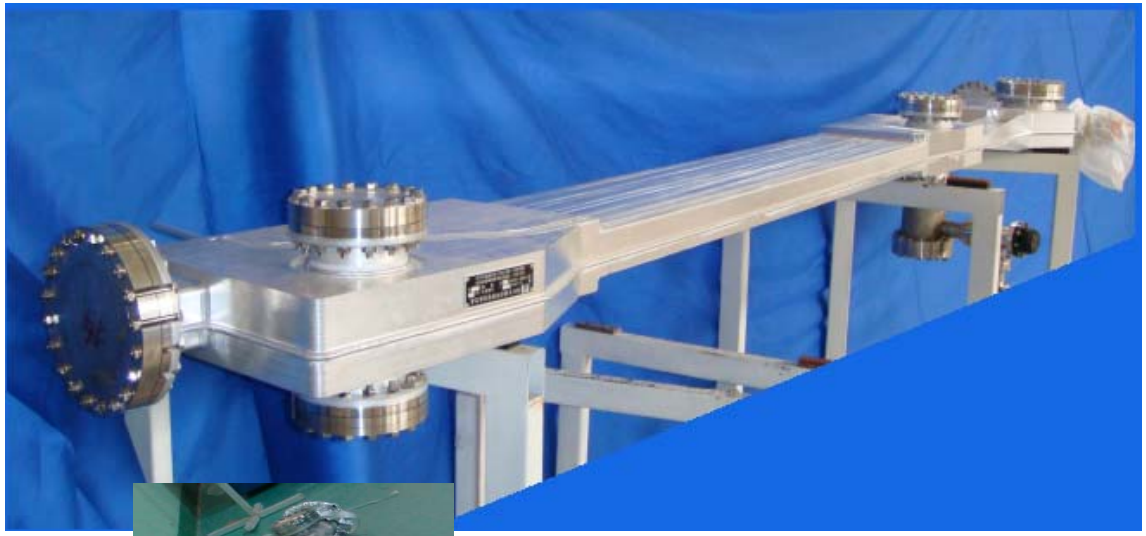


Drawing of vacuum box



Section drawing of vacuum box

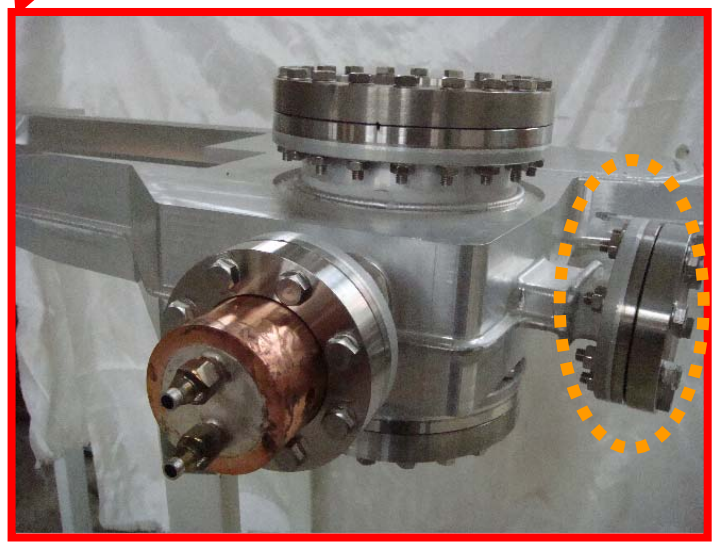
Reformed vacuum chambers (totally two)



photon absorber

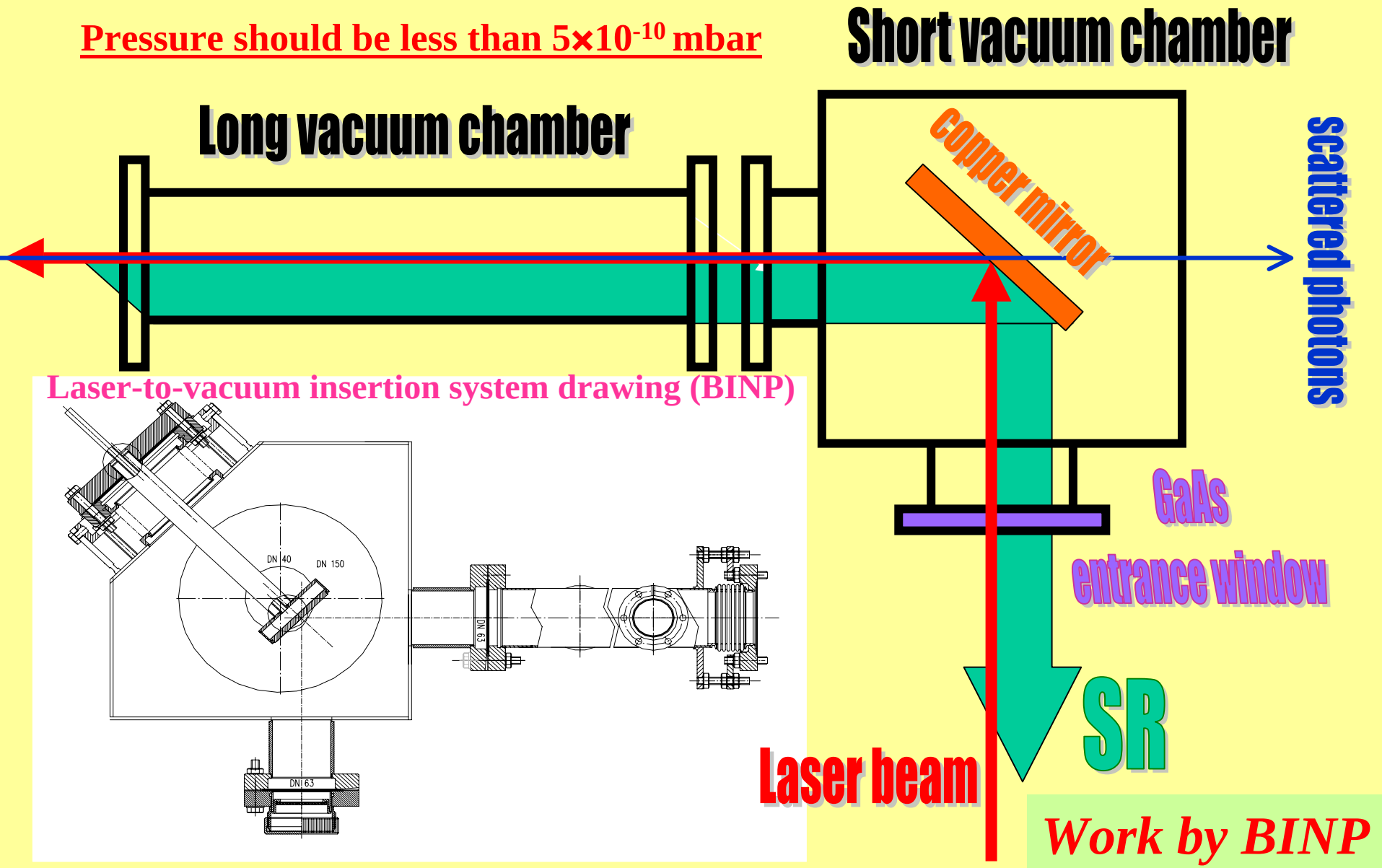
old chambers

Vacuum checks have been finished , photon absorbers are installed and the supports (4 sets) for vacuum boxes are ready



Simplified layout of the laser-to-vacuum insertion system

Pressure should be less than 5×10^{-10} mbar



Laser-to-vacuum insertion system drawing (BINP)

Work by BINP

Test of laser-to-vacuum insertion part (2009.5.12)

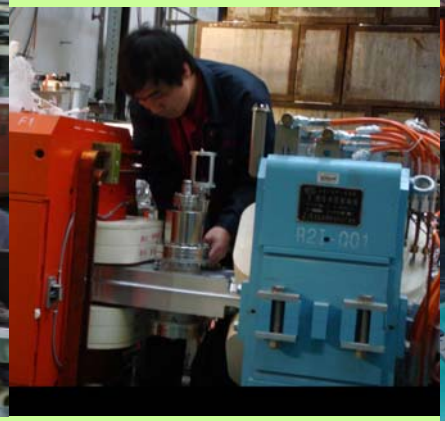
Test at BINP (09.04.26):

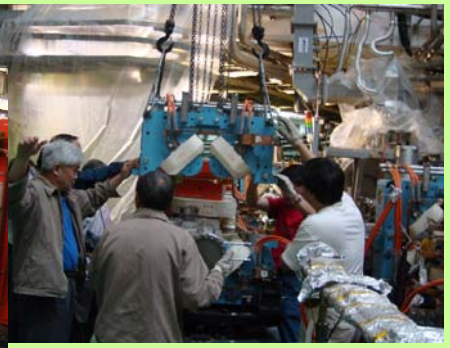
1. *Bakeout temperature 300° ;*
2. *Bake duration 18h;*
3. *Vacuum system pressure 2.5×10^{-10} mbar*
4. *Sensitive limit leak detection He $< 3 \times 10^{-12}$ mbar/s ;*

New Chamber in magnet

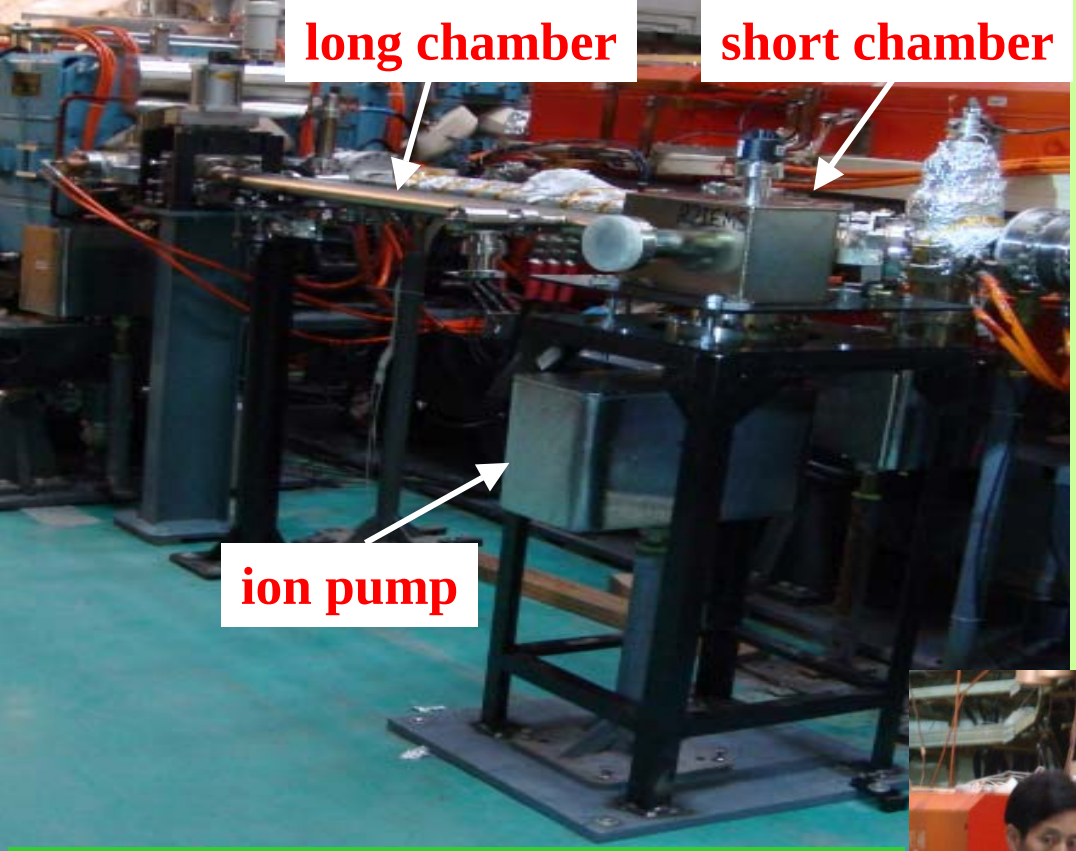
Alignment

Pump Installation





Chamber Installation



chamber installation

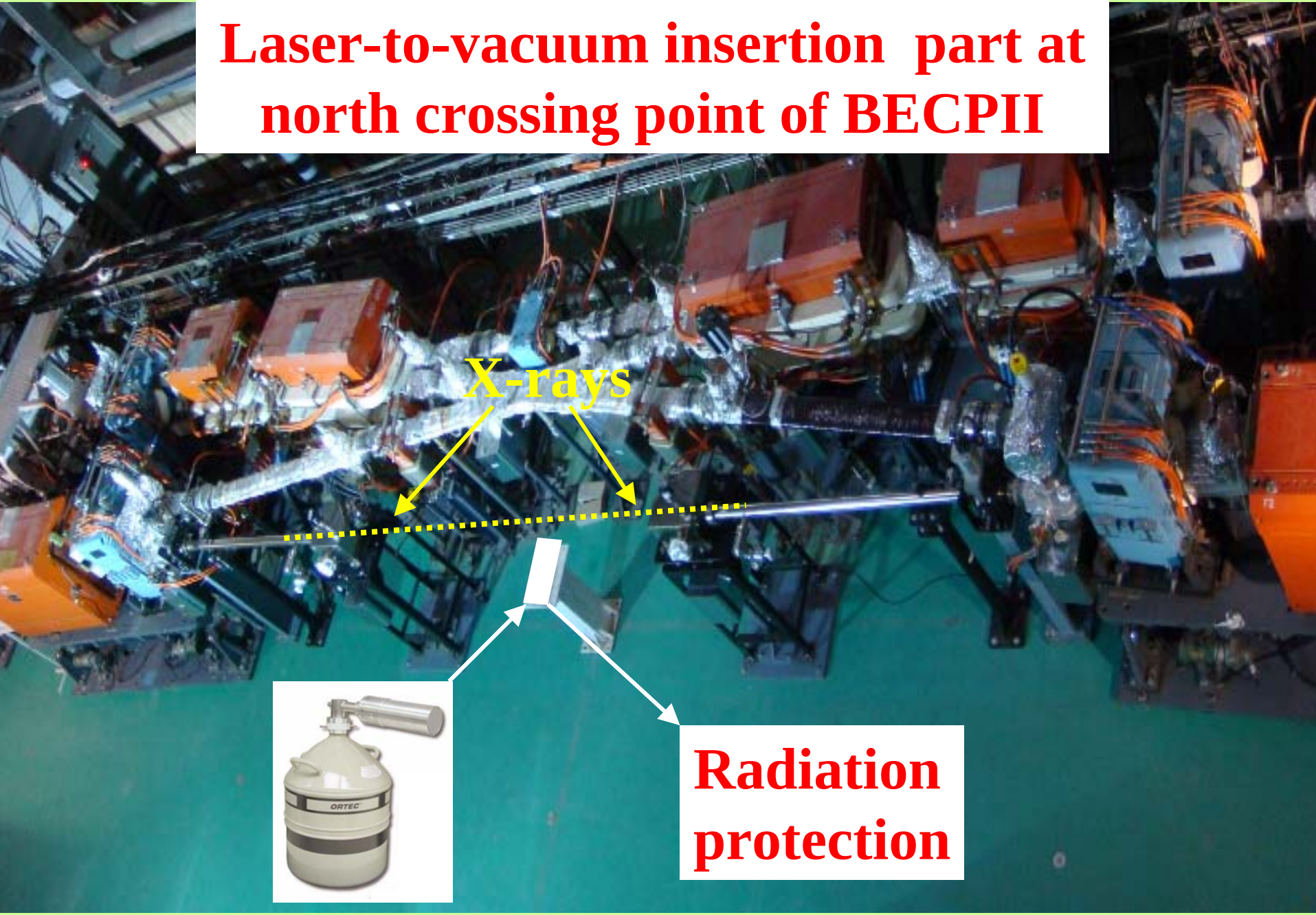
Pump Installation

laser-to-vacuum insertion part

Baking, vacuum up to 1.5 4.5 10^{-10} mbar

Alignment

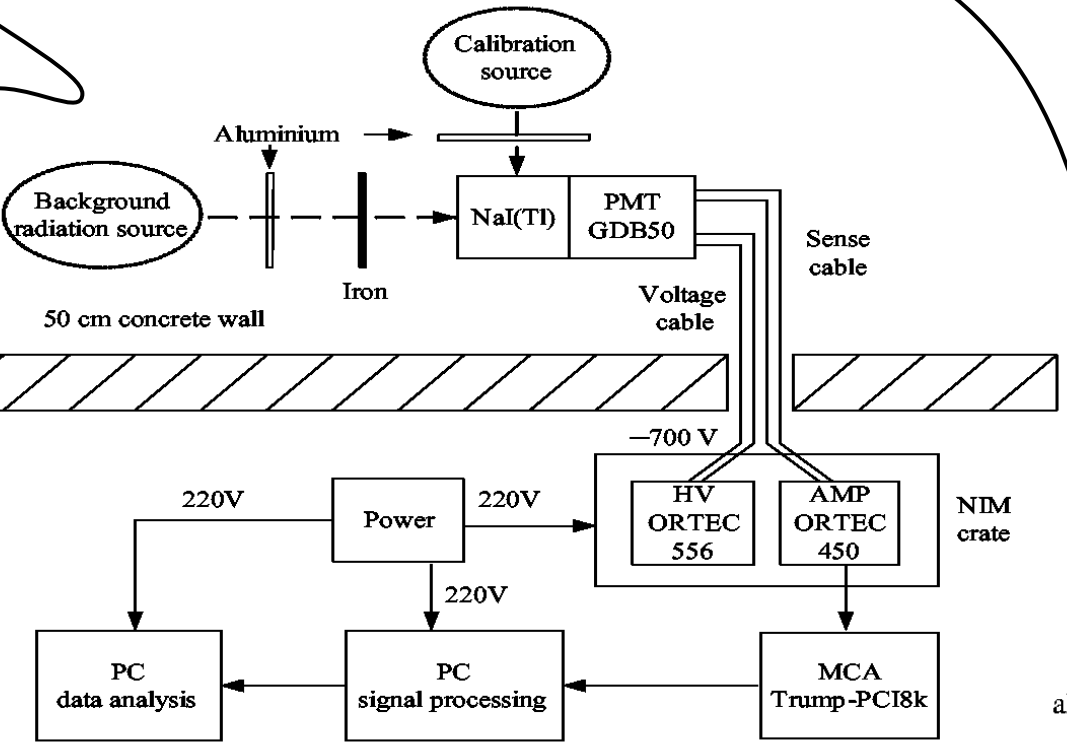
Laser-to-vacuum insertion part at north crossing point of BECPII

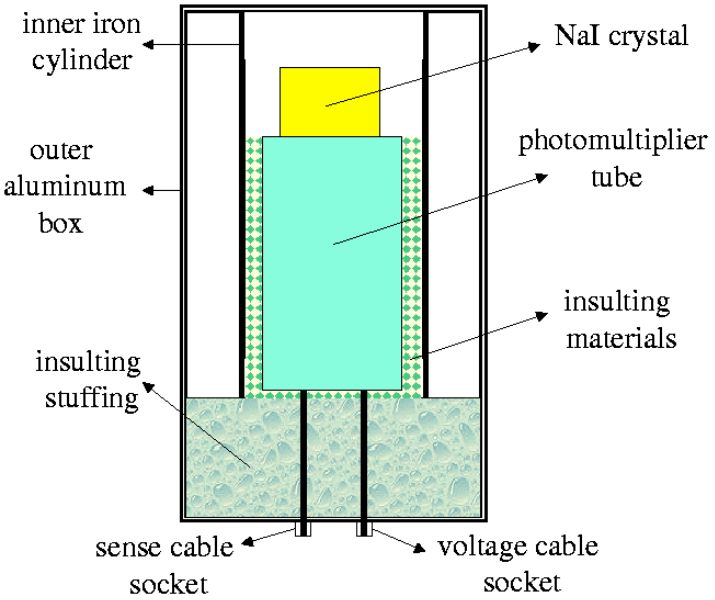


Detector (HPGe)

1. Measurement of radiation background
2. Study of calibration Pu-C source

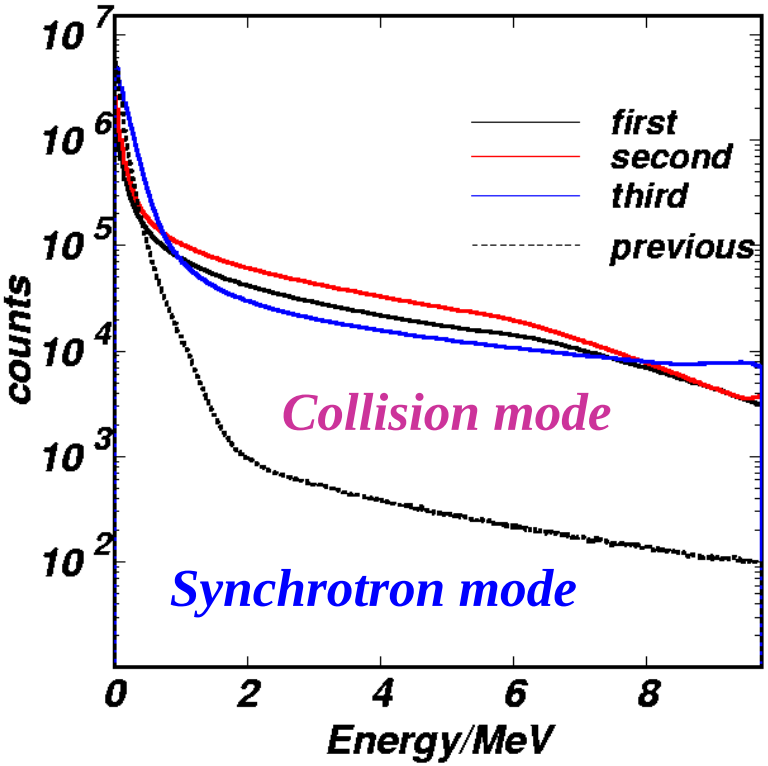
Gamma detection system





NaI detector

Results for radiation background measurement



1. Results for collision mode are similar;
2. Gamma background are much greater for collision mode than that of synchrotron;
3. **The total count is around 10^4 per second;**
4. The background at 5.64MeV (for tau mass measurement) is about **0.24 per second** which is small enough comparing with HPGe efficiency **10^4 per second**.

	First	Second	Third	Previous
date/yy.mm.dd	2009.2.20	2009.3.12	2009.5.18	2008.3.8
Int.Curr./A·H				
$(\mathcal{I}_{e^+} + \mathcal{I}_{e^-})$	5.50 + 2.82	6.85 + 8.13	7.92 + 6.26	0 + 4.58
N_{tot}/day	3.84×10^8	5.53×10^8	9.76×10^8	5.75×10^8
N_{tot}/sec.	4.45×10^3	6.41×10^3	1.13×10^4	6.66×10^3
N_{2-7}/day	8.82×10^7	1.29×10^8	6.43×10^7	1.58×10^6
N_{2-7}/sec.	1020	1494	744.1	18.34
$N_{<2}$/day	2.83×10^8	4.10×10^8	8.93×10^8	5.71×10^8
$N_{5.64}$/day	1.50×10^4	2.11×10^4	1.13×10^4	228

Collision mode: First, Second, Third time measurements;
Synchrotron mode : previous measurement.

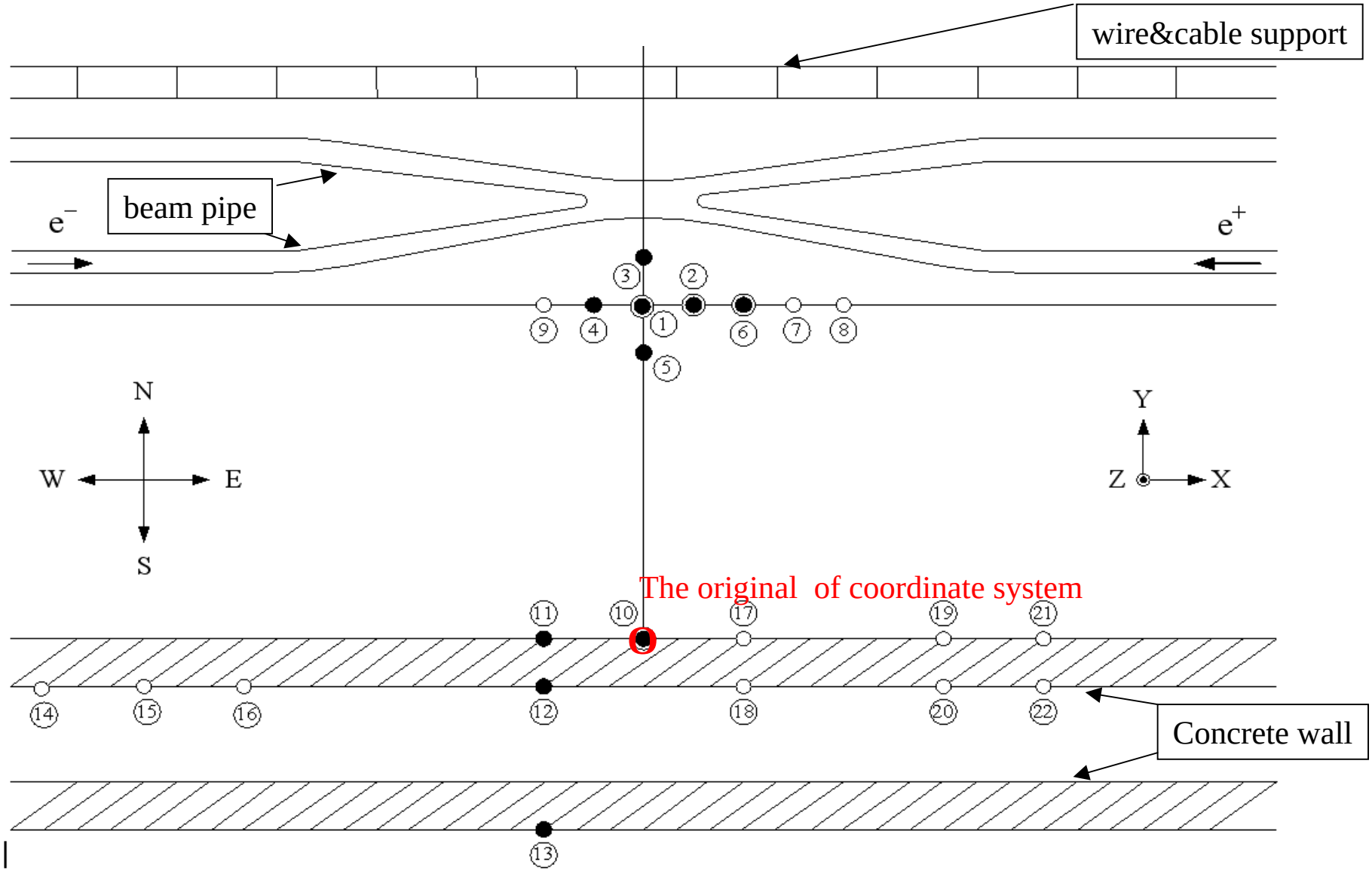
Two types of dosimeters by Landauer company

LANDAUER®

OSLD (optically stimulated luminescence detector) make of carbon-doped aluminum oxide ($Al_2O_3:C$) which is mainly used for **γ and X-ray** detection.

SSBTD (solid state nuclear detector) stimulated luminescence) make of allyl diglycol carbonate ($C_{12}H_{18}O_7$) which is mainly used for **neutron** detection.

Positions of radiation dose measurement



serial number	Position (x, y, z) [cm]	Measured Dose γ&X [m Sv]	Neutron [m Sv]	γ&X [m Sv]	Neutron [m Sv]	γ&X [m Sv]	Neutron [m Sv]
⓪	background	0.02	0.10	0.09	0.06	0.14	0.06
①	(0,370,120)	147.97	27.58	88.8	2.02	157.91	1.91
①a	(0,370,170)	76.03	1.04				
①b	(0,370,70)	73.09	1.52	79.15	0.96		
①c	(0,370,20)	28.47	1.29			21.77	1.39
②	(50,370,120)	81.97	1.18	76.49	1.45	81.49	1.85
②a	(50,370,170)			42.80	0.54		
②b	(50,370,70)	27.55	1.56	37.66	0.69		
②c	(50,370,20)			17.93	1.00		
③	(0,420,120)	792.07	2.20	341.98	19.49	497.93	14.71
④	$(-50, 370, 120)$	89.15	2.45	70.58	1.58	77.14	1.48
⑤	(0,320,120)	29.01	1.45	29.35	0.69	28.47	1.00
⑥	(100,370,120)	68.06	1.10	61.80	1.06	74.38	2.10
⑥a	(100,370,170)					61.69	1.00
⑥b	(100,370,70)					48.37	1.18
⑦	(150,370,120)			71.62	1.23	79.47	1.43
⑧	(200,370,120)					107.94	2.35
⑨	$(-100, 370, 120)$	84.41	1.56				
⑩	(0,0,120)	23.25	1.50	21.64	0.29	27.34	1.18
⑩a	(0,0,20)	16.74	1.02	15.17	0.58	19.17	0.85
⑪	$(-100, 0, 120)$	21.23	1.50	18.91	0.46	24.89	0.94
⑫	$(-100, -50, 120)$	<0.02	<0.1	<0.02	<0.1	0.02	<0.1
⑬	$(-100, -220, 120)$	<0.02	<0.1	<0.02	<0.1	<0.02	<0.1
⑭	$(-700, -50, 120)$	<0.02	<0.1				
⑮	$(-600, -50, 120)$			<0.02	<0.1		
⑯	$(-500, -50, 120)$					<0.02	<0.1
⑰	(100,0,120)	20.02	0.69				
⑱	$(100, -50, 120)$	<0.02	<0.1				
⑲	(300,0,120)			34.67	1.48		
⑳	$(300, -50, 120)$			0.07	<0.1		
㉑	(400,0,120)					82.86	2.91
㉒	$(400, -50, 120)$					0.04	<0.1

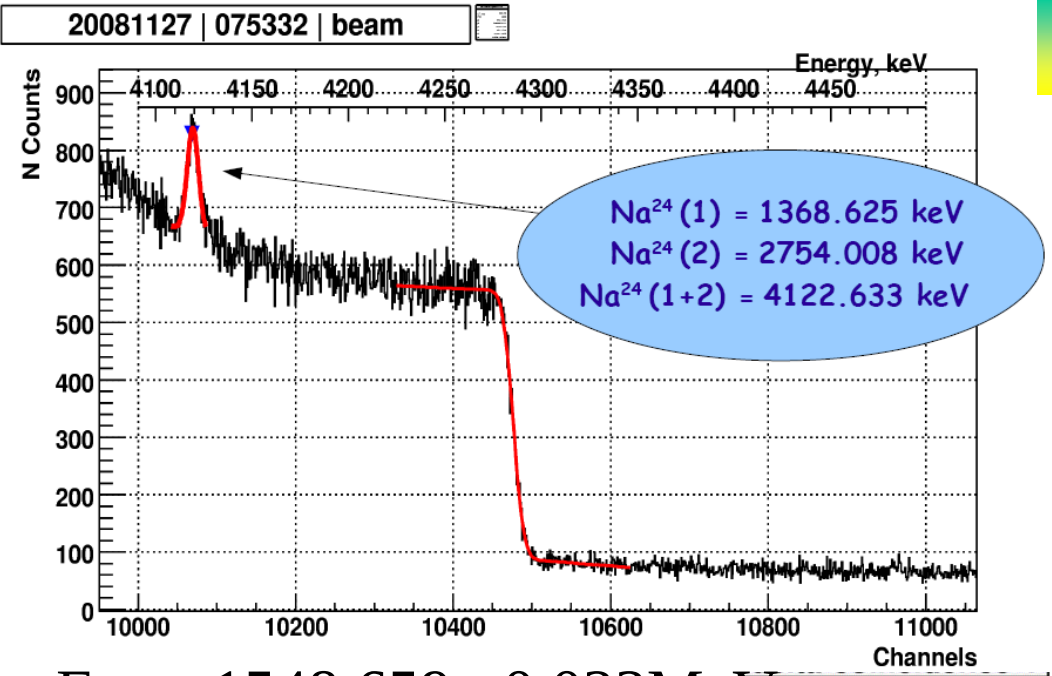
Results of radiation dose measurement

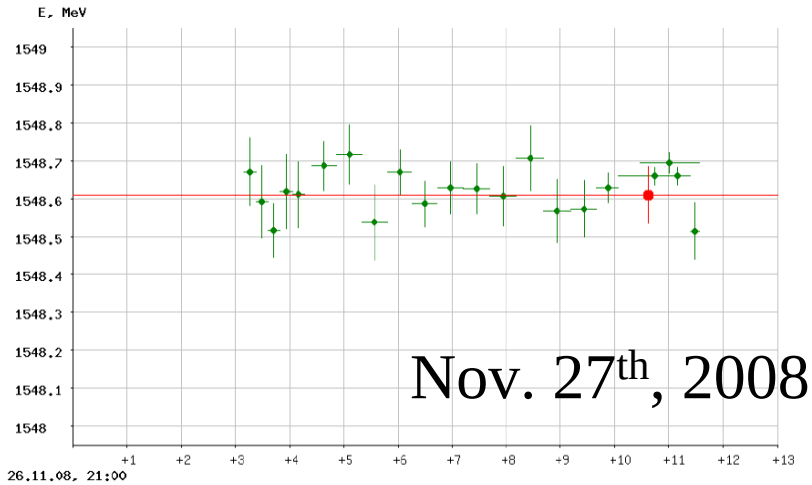
Note:

1. 2009.2.17-24; accelerator machine study; average current ~200mA;
2. 2009.3.10-17;ψ' data taking, average current ~300mA;
3. 2009.5.13-27; accelerator machine study and turn to continuum data taking; average current ~300mA.

The radiation shielding is needed to guarantee that the HPGe works without severe damage.

HPGe test at VEPP-4M(BINP)



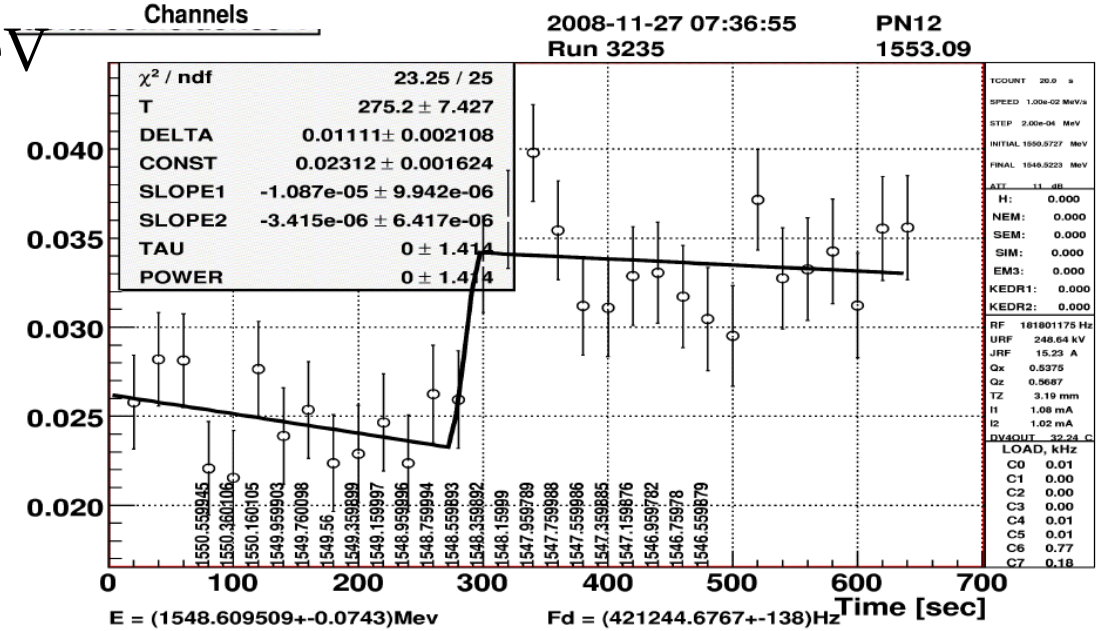


Nov. 27th, 2008

E_{CBS}=1548.659 ±0.023MeV

R.E.<1.5×10^{-5} (statistic)

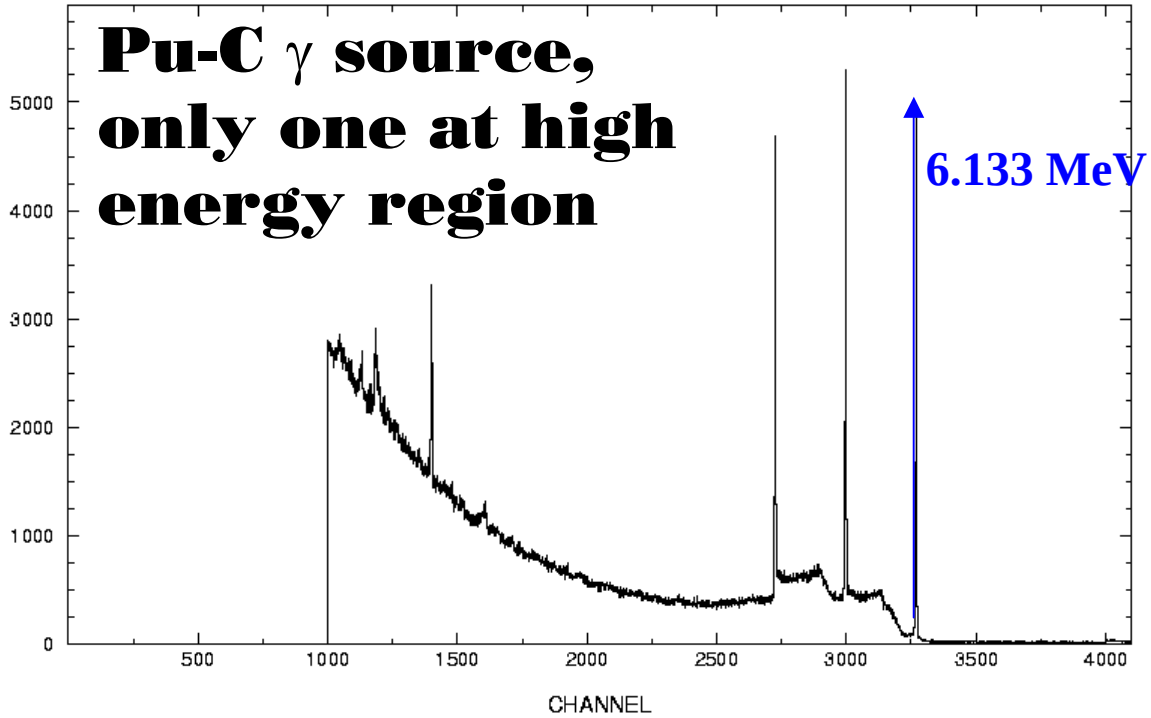
BINP, Novosibirsk: ORTEC HPGe detector

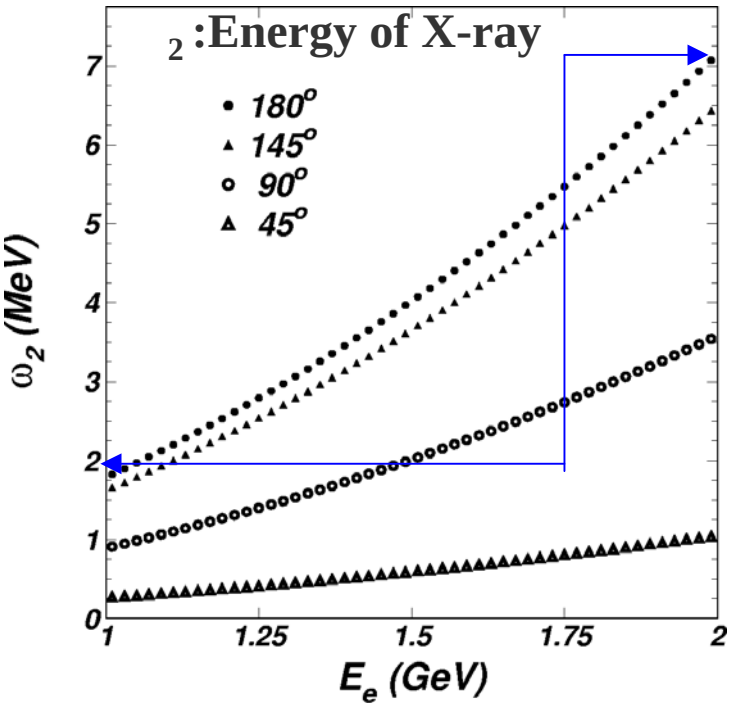


E_{RD}=1548.610 ±0.074MeV

R.E .<4.8×10^{-5} (statistic)

Experiment for Pu-C source (IHEP)





Note about measurement data (for 29 hours record):

Peak:6133.80keV, FWHM: 8.19 keV, Net area: 21638 ± 161,

Gross/Net count rate: 0.23/0.21cps;

Peak: 5620.73 keV, FWHM:8.00 keV, Net area: 17837 ± 206,

Goss/Net count rate: 0.32/0.17cps;

Peak: 5109.00 keV, FWHM:19.53 keV, Net area: 13183 ± 184,

Gross/Net count rate: 0.28/0.13cps. cps= count per second

Schedule

1. December, 2009
   a) Radiation protection design for HPGe detector;
   b) Installation of HPGe detector and CO_2 laser, computer system for data analysis and information communication;
2. January-May, 2010
   a) Commissioning of system;
   b) Test scan for confirming the correctness of working of beam calibration system.
3. Sometime before August , 2011
   a) Fine scans for J/ψ and ψ′ resonances , τ mass measurement;
   b) Fine scan data analyses.

谢 谢！

Thanks！