HIRFL-CSR Cluster Internal Target

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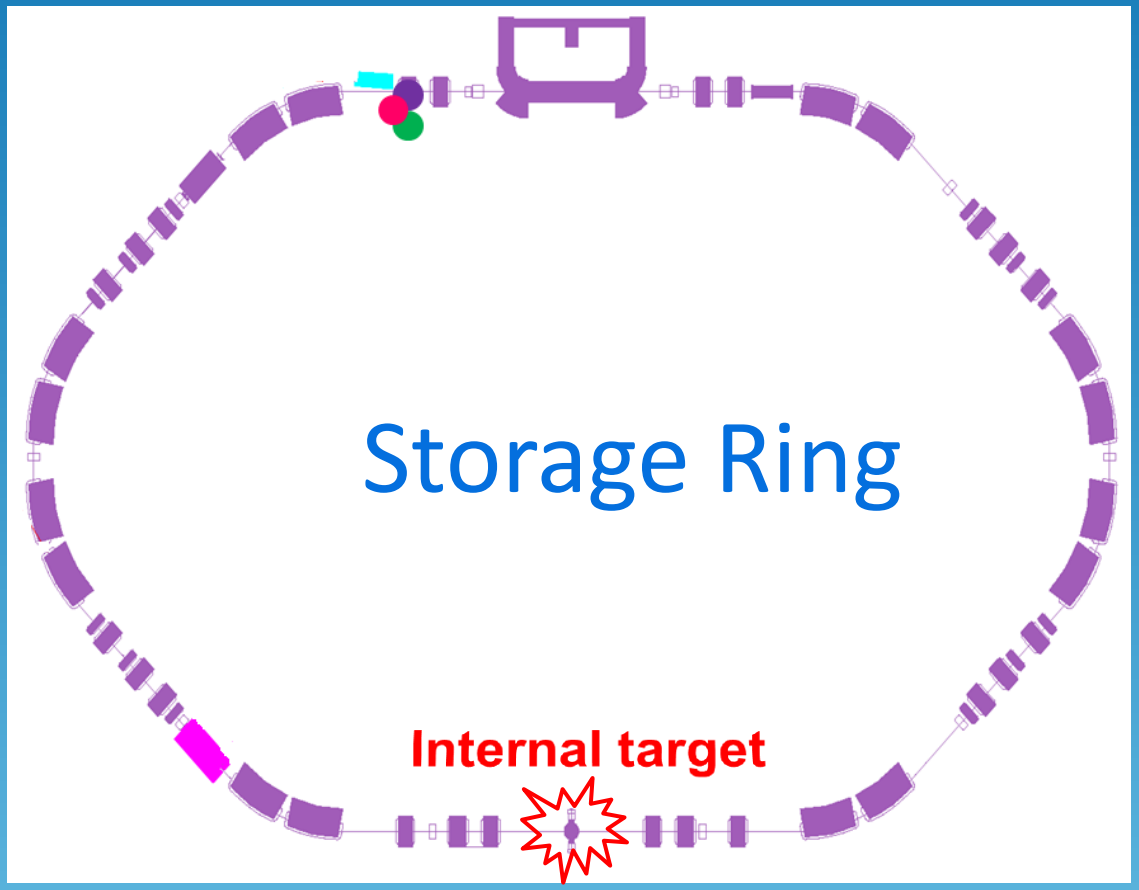
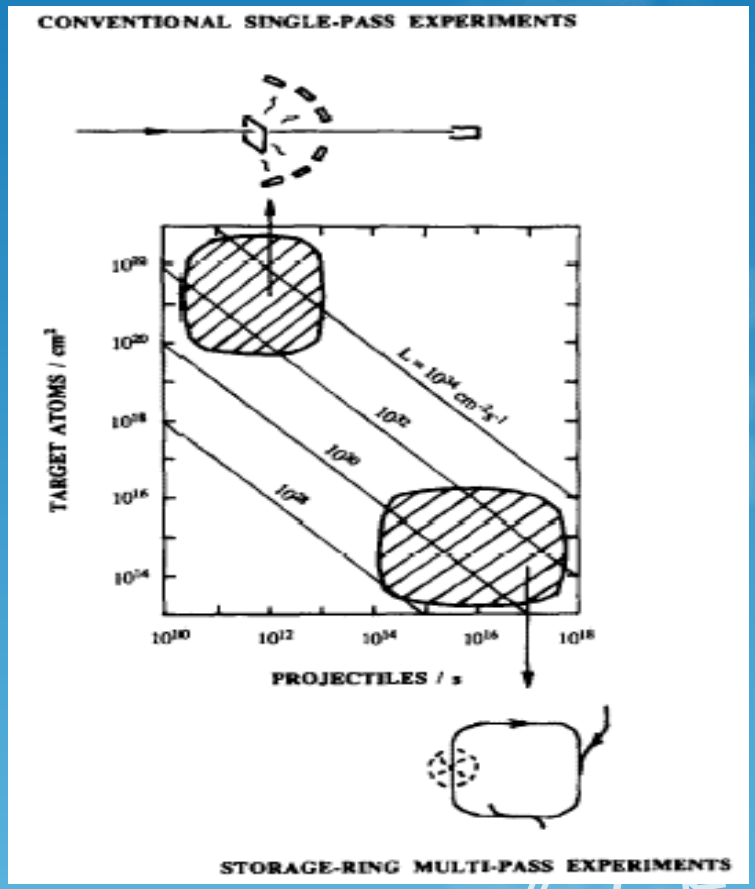
Outline

- Motivation
- Setup of cluster target
- Test results
- Experimental results

Motivation





Luminosity: $L = I \times f \times t \times \Delta x$

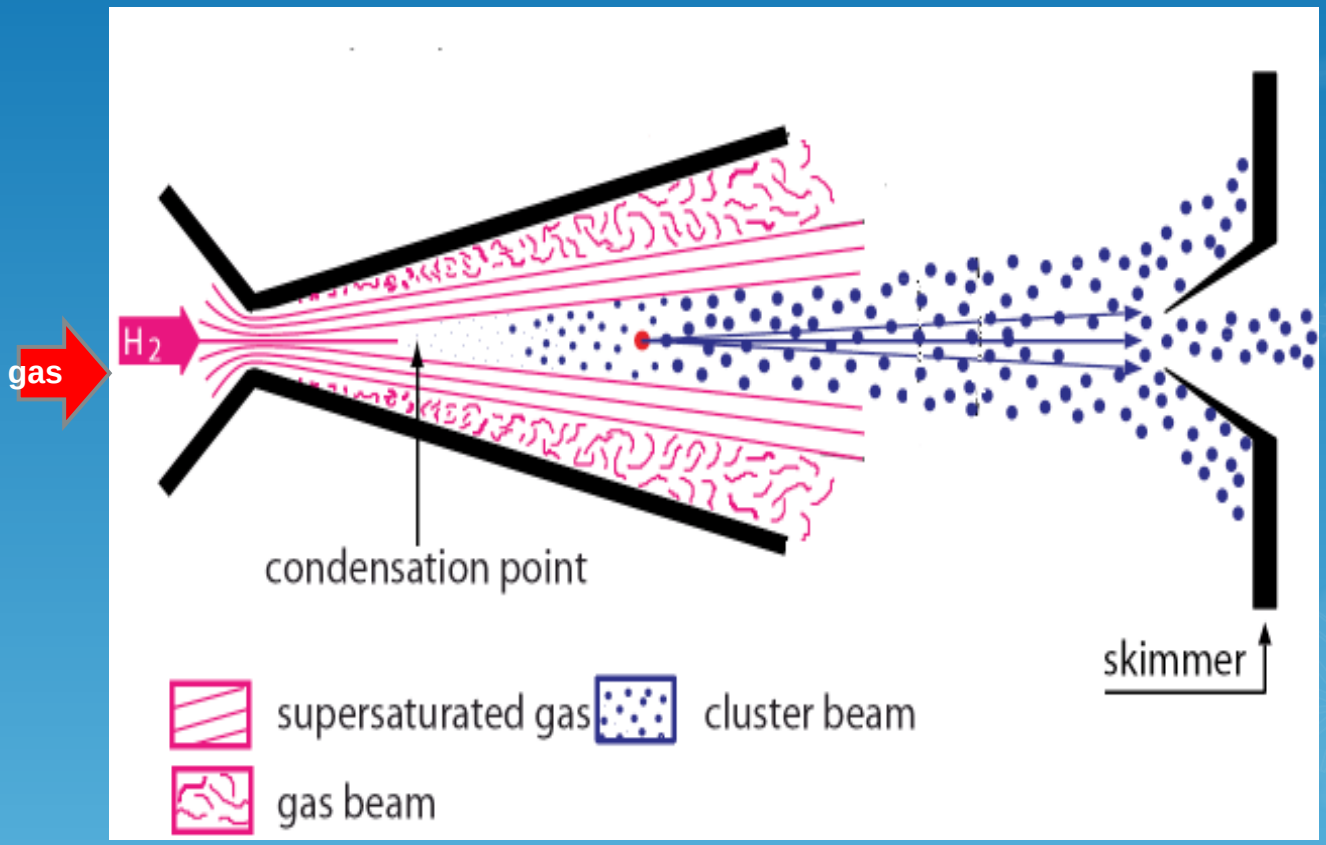
Motivation

Advantages:

- Eficient use of the particle beams from the accelerator
- High energy and angular resolutions
- Unddisturbed reaction products
- low influence on vacuum conditions (10^{-11}mbar)
- high purity of target material (99.999%)

A unique tool for high-precision experiments

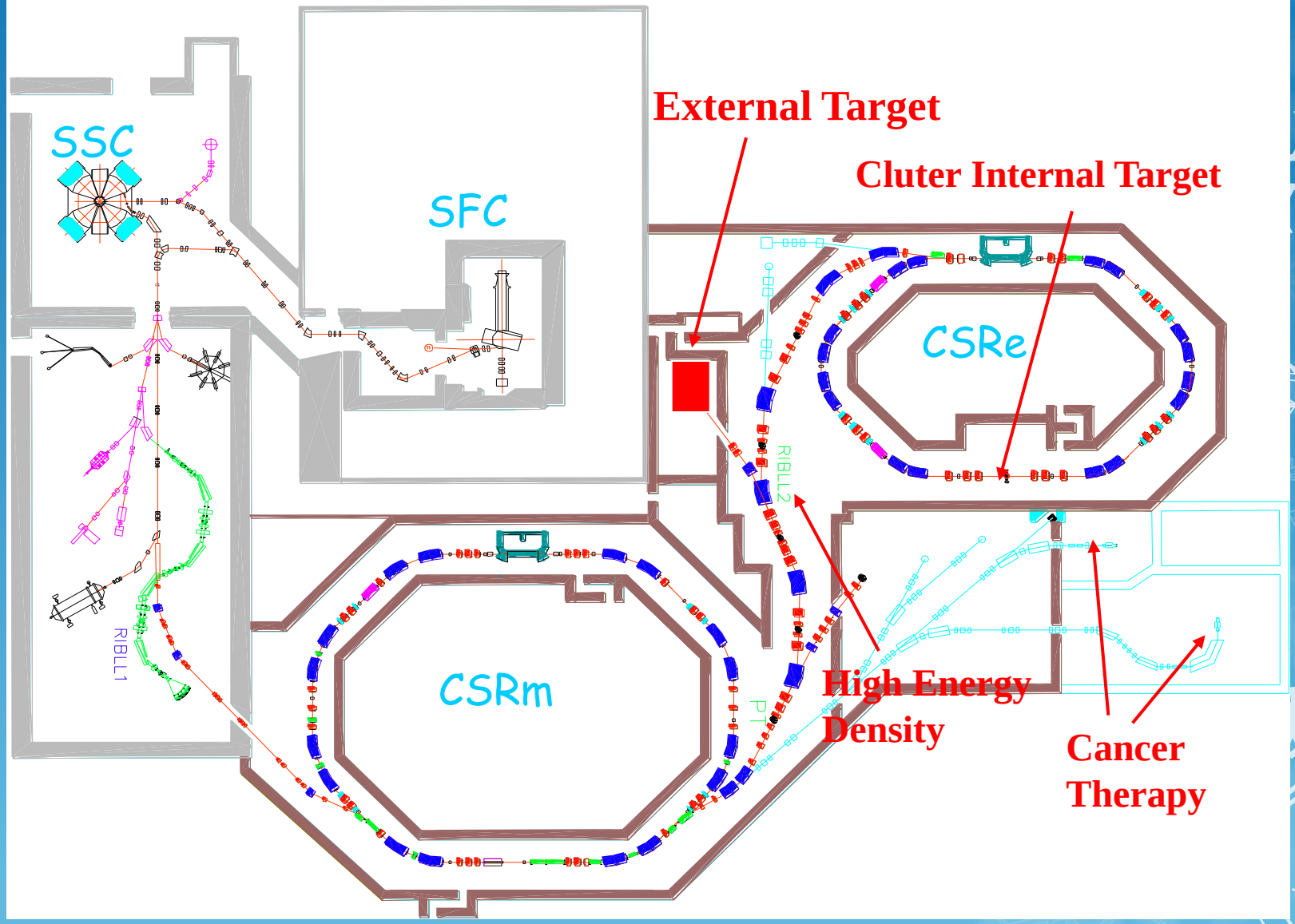
Cluster Target



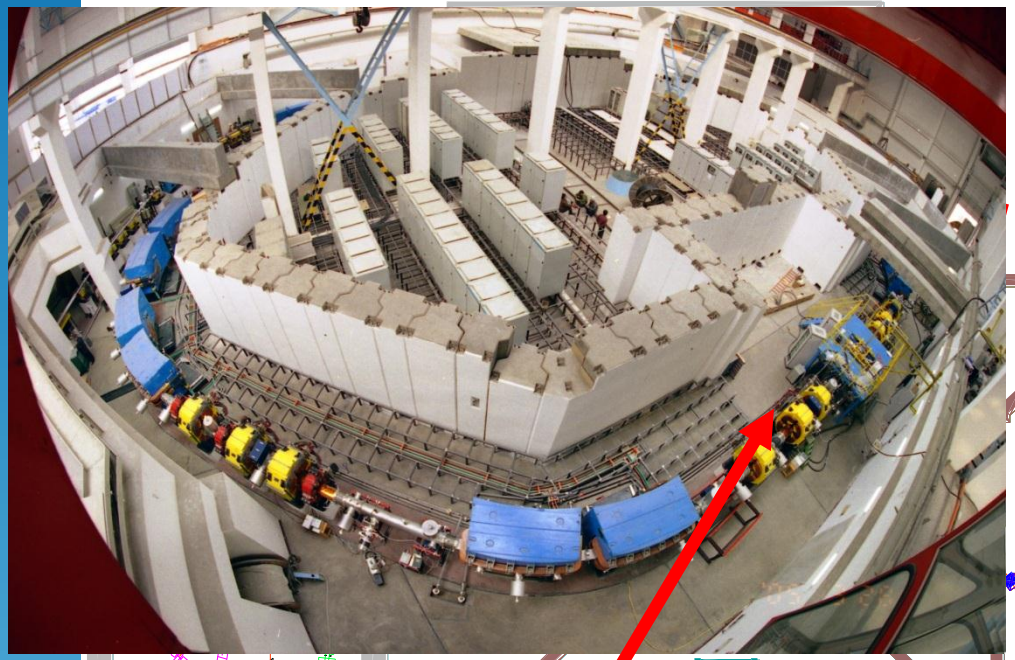
Principle of operation

purified H2 or D2 gas passes a de Laval nozzle ⇒ formation of clusters surrounded by gas

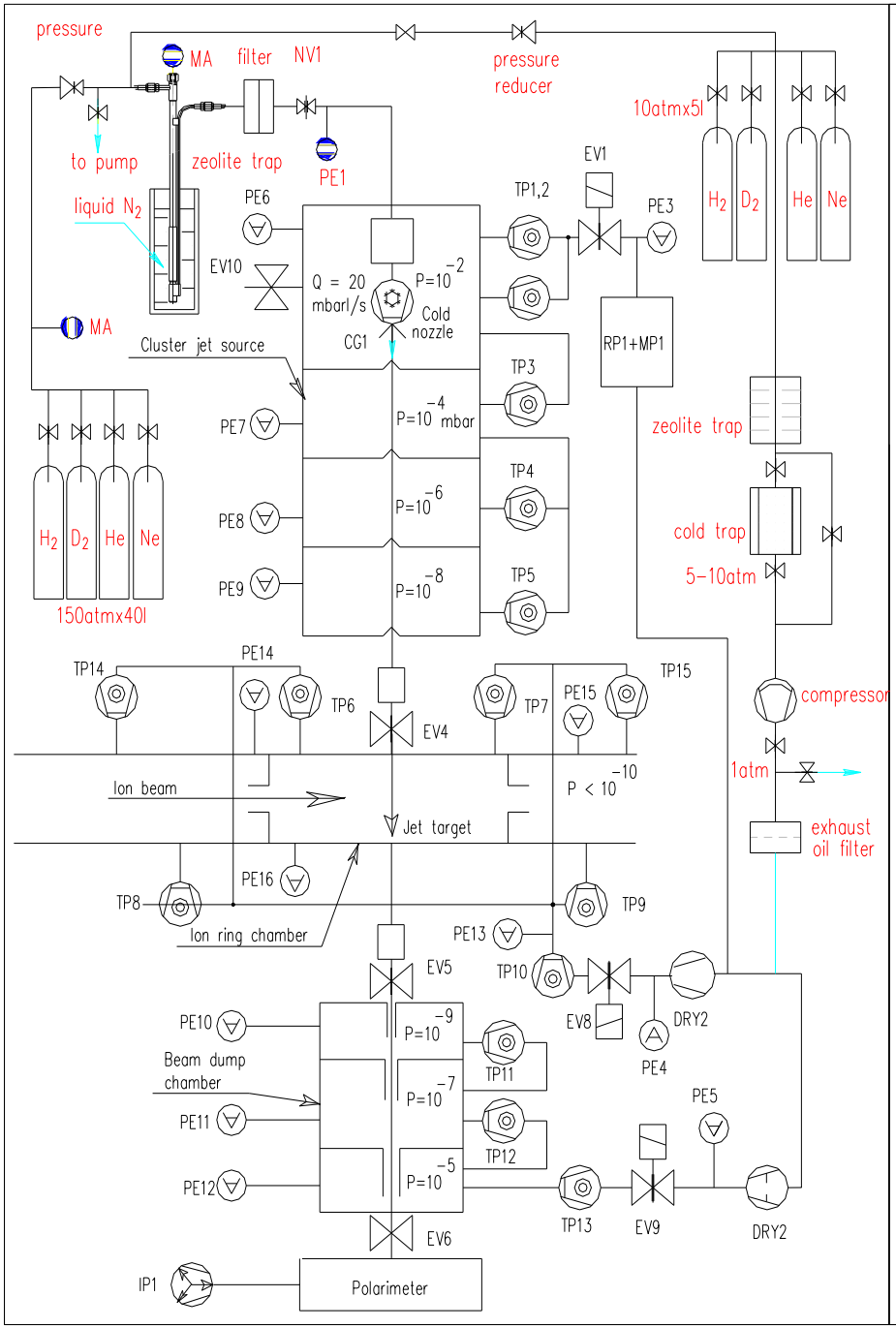
HIRFL-CSR Storage Ring



HIRFL-CSR Cluster Internal Target



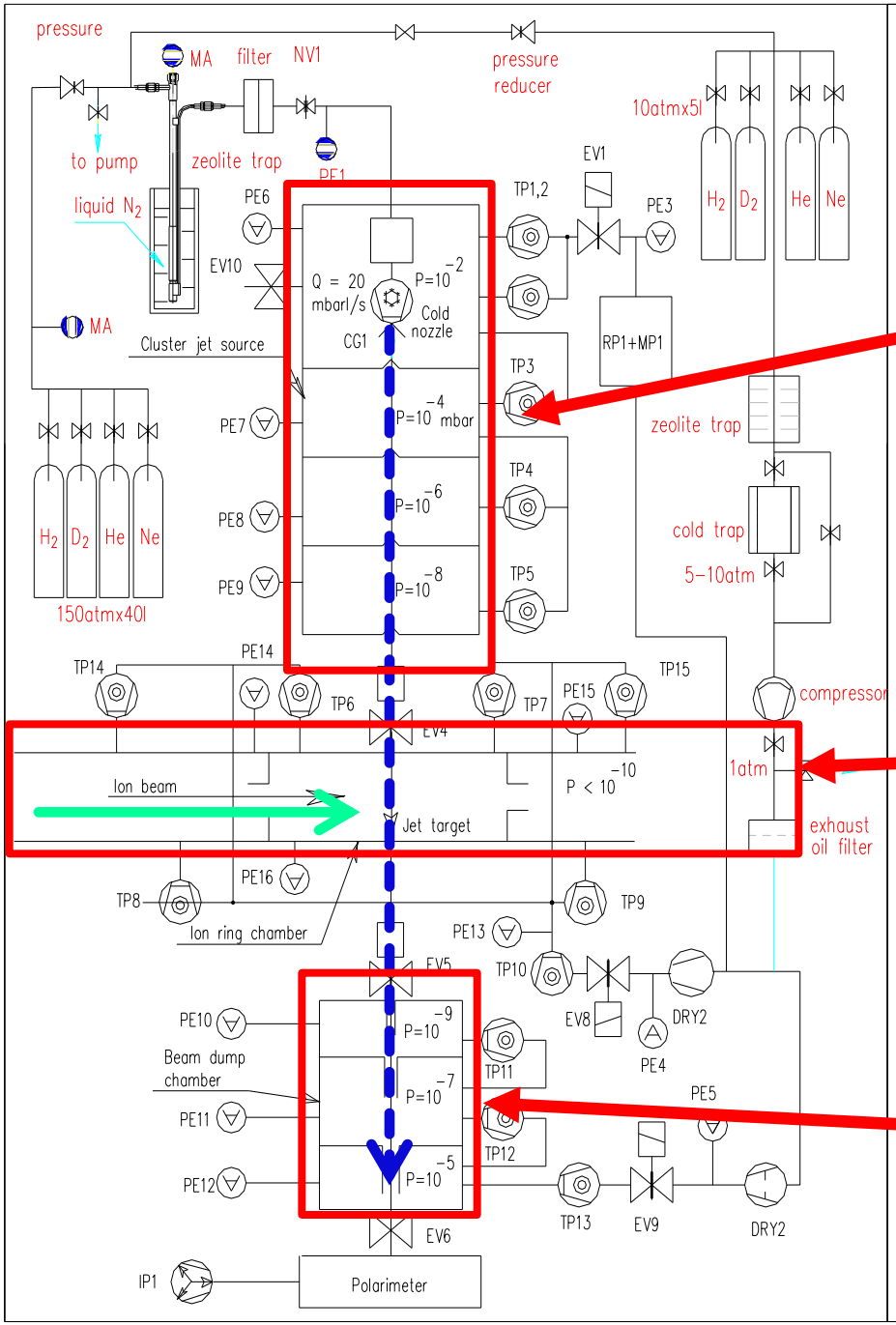
Cluster Internal Target

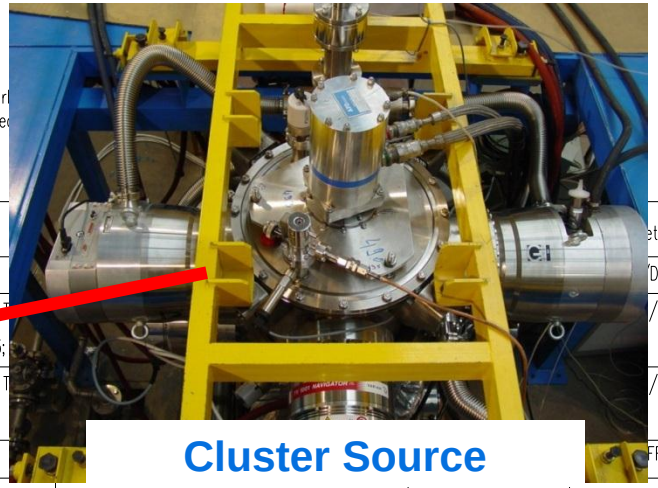


HIRFL-CSR cluster-jet target facility system

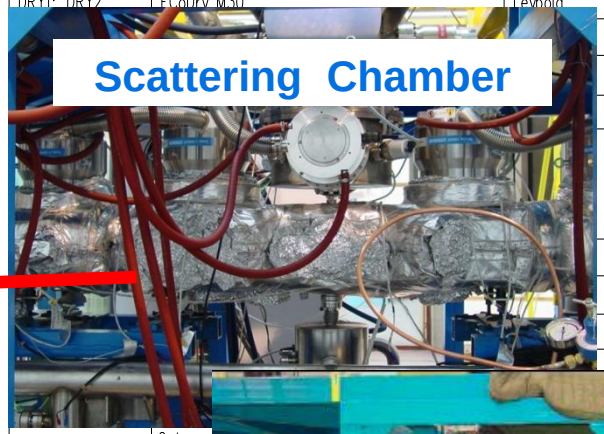
TP-turbo pump, RP-Roots pump, MP- mechanical forpump, IP-ion pump, NV-needle valve, EV-electrical valve

Position	Designation of vacuum equipment	The company	Inlet/Outlet flange
TP1; TP2	TURBOVAC T 1600/ Cat.No.800040V1844	LEYBOLD	DN250CF/DN40KF
TP3; TP4; TP5 TP12; TP13; TP11	TURBO-V1000HT/P.N.9699075	VARIAN	DN200CFF/DN40KF
TP6; TP7; TR8; TP9; TP14; TP15	TURBO-V2000HT/P.N.9699084	VARIAN	DN250CFF/DN40KF
TP10	TURBO-V300 NAVIGATOR	VARIAN	DN 100 CFF
DRY1; DRY2	ECoDry M30	Leybold	DN 25 KF
RP1+MP1	WS/WSU 501	Leybold	DN 63 ISO-F(IN; OUT)
PE14; PE15; PE16	UHV-24P Nude B-A Type Ionization Gauge	VARIAN	DN 40 CF-F
PE3; PE4; PE5	TPR 265/PTR26750	Balzers	DN 16 ISO-KF
PE6; PE7; PE8; PE9; PE10; PE11 PE12; PE13	Compact Cold Cathode Gauge IKR 261/PTR25751	Balzers	DN 40 CF-F
EV6	GATE VALVE/manual/48124-CE01	VAT	DN 16 CF-F
EV4	GATE VALVE/electropneumatic/48124-CE44	VAT	DN 16 CF-F
EV5	GATE VALVE/electropneumatic/48132-CE44	VAT	DN 40 CF-F
EV8; EV9	Gate valves, eletropneumatic SVV 025 PA with control valve 24V DC/PFD48200	Balzers	DN 25 ISO-KF
EV1	Gate valves, eletropneumatic SVV 063 PA with control valve 24V DC/PFE18200	Balzers	DN 63 ISO-F
Gauge Controller	Multi-Gauge for 3 gauges	VARIAN	
NV1;PE1	Gas dosing controller RVC300/PFI00791 EVR116 Regulating valve/PFI39931	Balzers	DN16 ISO-KF
Gauge controller	Maxi Gauge TPG256 for 11 gauges/2 sets	Balzers	

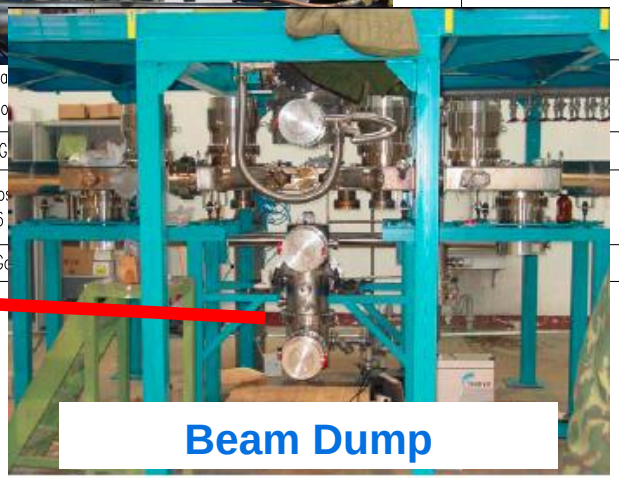




Cluster Source



Scattering Chamber



Beam Dump

Position		
TP1; TP2		
TP3; TP4;		
TP12; TP13;		
TP6; TP7;		
TP9; TP14;		
TP10		
DRY1; DRY2	EcoDry M30	Leybold
EV1	Gate va with co	
Gauge Controller	Multi-G	
NV1;PE1	Gas dos EVR116	
Gauge controller	Maxi G	

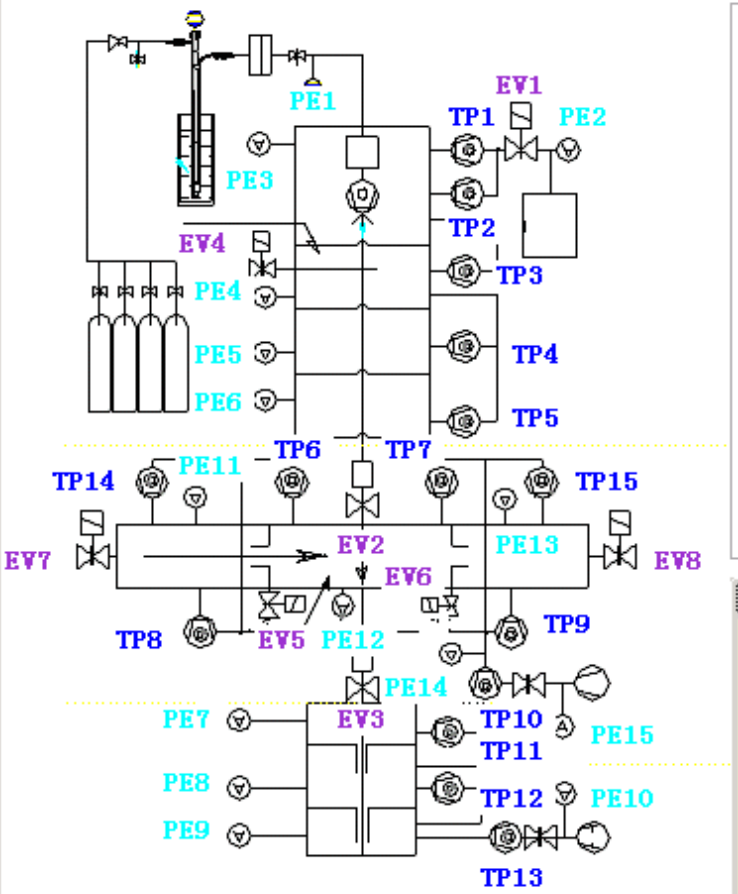
et flange	
/DN40KF	
/DN40KF	
/DN40KF	
FF	
DN 25 KF	
DN 63 ISO-F(IN; OUT)	
DN 40 CF-F	
DN 16 ISO-KF	
DN 40 CF-F	
DN 16 CF-F	
DN 16 CF-F	
DN 40 CF-F	

内靶控制界面

初始化各设备信息

开始监测设备

停止监测设备



监测设备

	STATE	VALUE		STATE	VALUE		STATE	VALUE
PE1		5.7749E+02	PE11		2.242167E-10	TP6		076,33,23,19
PE2		2.586E-1	PE12			TP7		071,33,24,26
PE3		3.696E-4	PE13		2.846469E-10	TP8		080,33,25,16
PE4		3.428E-5	PE14		2.244E-6	TP9		077,33,22,18
PE5		7.000E-7	PE15		1.364E-1	TP10		15,58,15
PE6		3.326E-7	TP1		121,29,23,16	TP11		4,38,12
PE7		2.289E-9	TP2		146,30,24,18	TP12		3,38,12
PE8		2.491E-8	TP3		4,38,12	TP13		6,38,13
PE9		1.209E-6	TP4		5,38,13	TP14		
PE10		4.371E-2	TP5		5,38,12	TP15		

温度控制 | 真空计/真空规控制 | 分子泵控制 | 阀门控制

气 体 选 择： 氢

电阻值 25.45

当前温度： 35.37

开始温度监测 停止温度监测

开始记录 停止记录

设定最值

最小 35 最大 37

加热电压 45 保温电压 30 制冷电压 18

VALUE第一个值的说明：

0->Measurement data okay 4->Sensor off

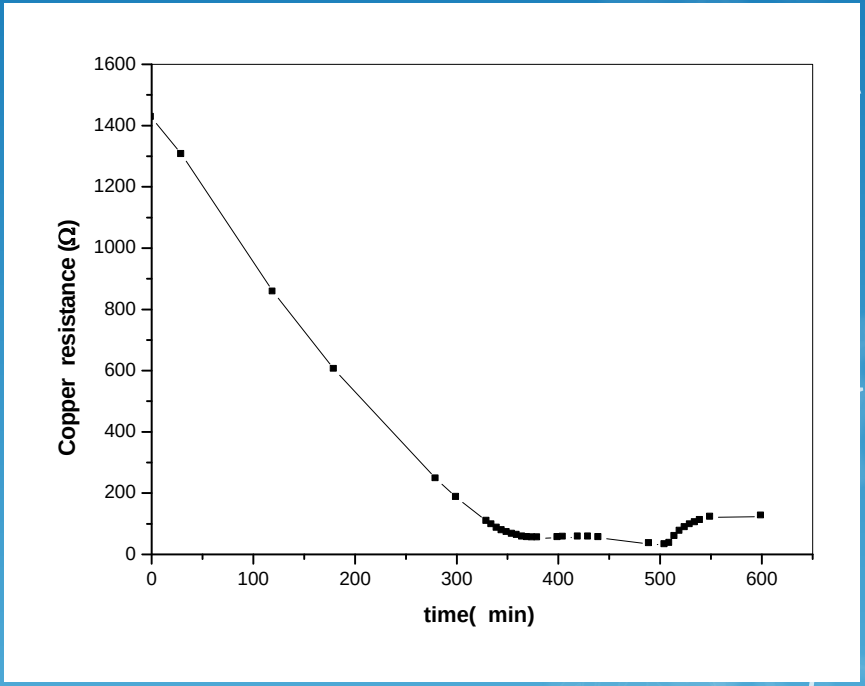
1->Underrange 5->No sensor

2->Overrange 3->Sensor error 6->Identification err

Information:

Test results —— Cooling of the nozzle

- **The temperature of the nozzle is measured by a copper resistance.**
- T_{nozzle} = 20 ~ 300K
- it takes about 7 h to cool the nozzle down to 30K



Cooling curve of the Nozzle

Test results —— Vacuum test

Pressure distribution of the cluster target

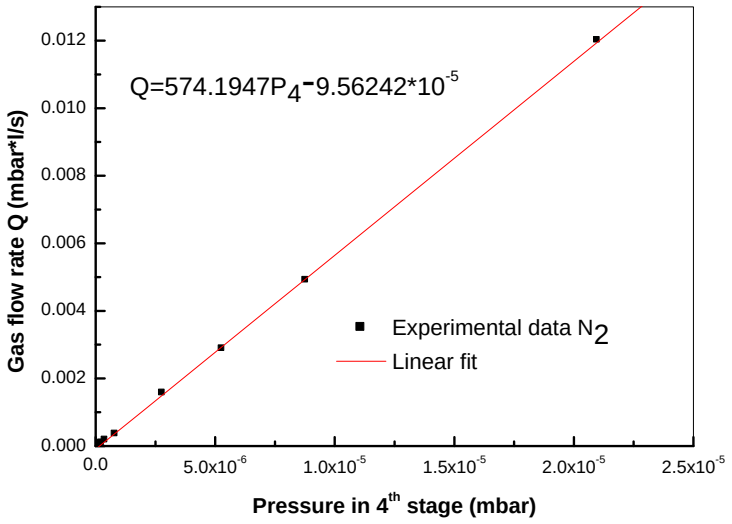
	Stages	Pumping speed（l/s）	Pressure（mbar） without gas in	Pressure（mbar） N_2 1atm
Source	I	3200	10^{-7}	10^{-3}
	II	1000	10^{-7}	10^{-5}
	III	1000	$<2.0\times10^{-9}$	10^{-7}
	III	1000	$<2.0\times10^{-9}$	10^{-7}
Chamber	——	8000	9.0×10^{-12}	1.0×10^{-11}
Dump	I	1000	$<2.0\times10^{-9}$	10^{-7}
	II	1000	$<2.0\times10^{-9}$	10^{-7}
	III	1000	10^{-7}	10^{-6}

Test results——Target density

The intensity of the cluster jet:

$$I = 2.4 \times 10^{19} Q \quad (\text{atoms/s})$$

here, Q is the flow rate.



Calibration Q~P curve for N_2

The target density:

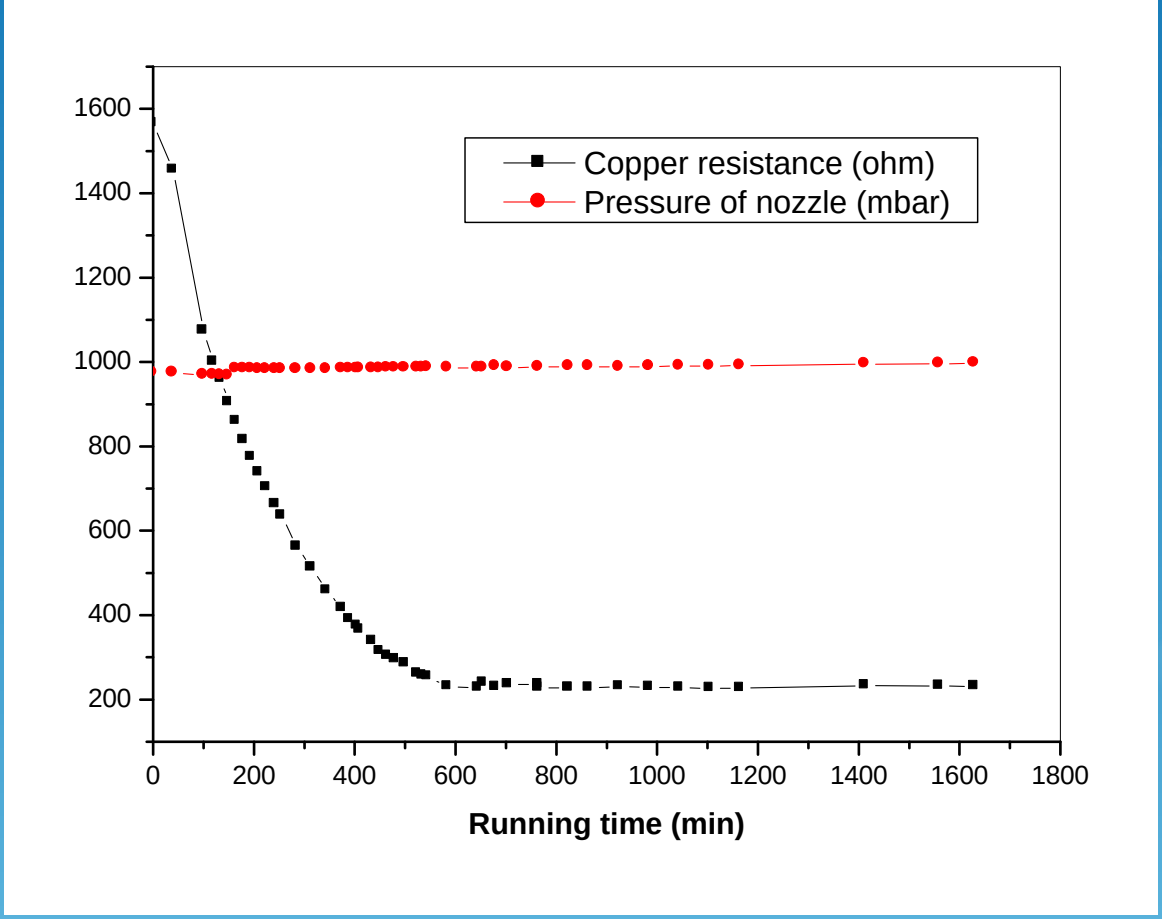
$$n_t = I / \pi r^2 v$$

where r and v are the radius and velocity, respectively.

Test results——Target Thickness

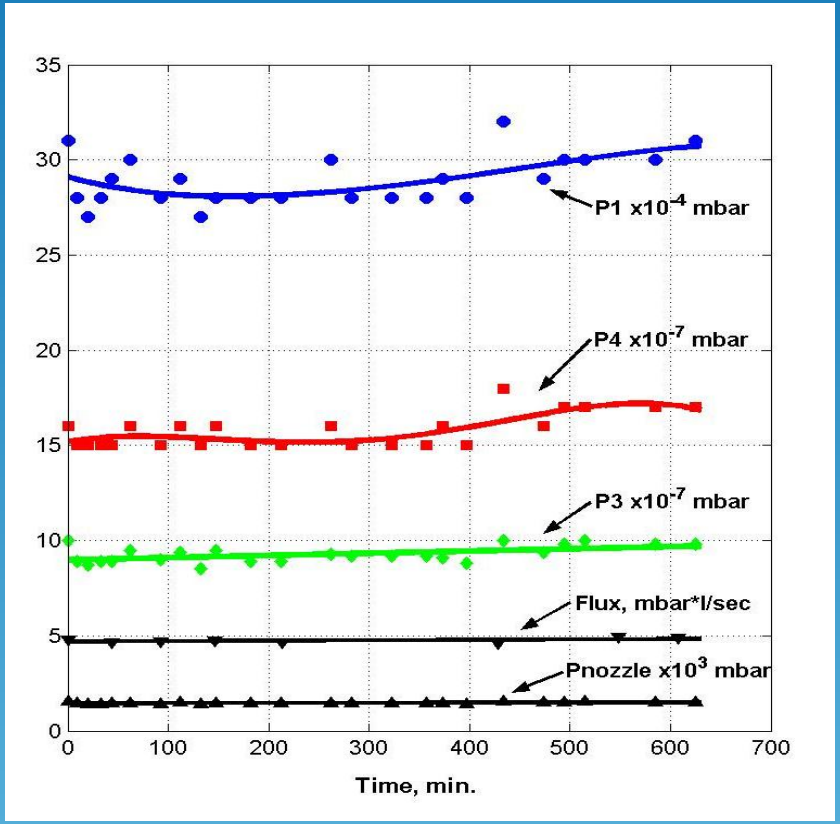
Target	H_2	N_2	Ne	Ar	Kr
Thickness ($atom/cm^2$)	06×10^{13}	1.2×10^{13}	2.0×10^{13}	1.0×10^{13}	1.0×10^{13}

Test results——Long-term stability

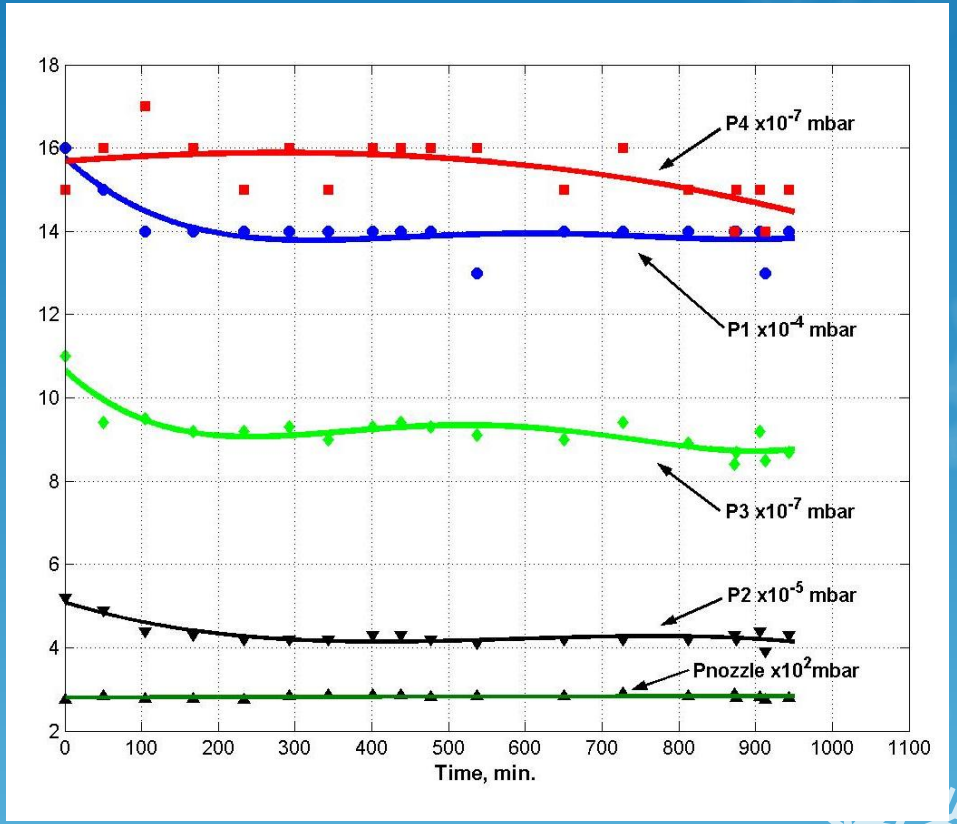


Long time running test for Nozzle (81K)

Test results——Long-term stability

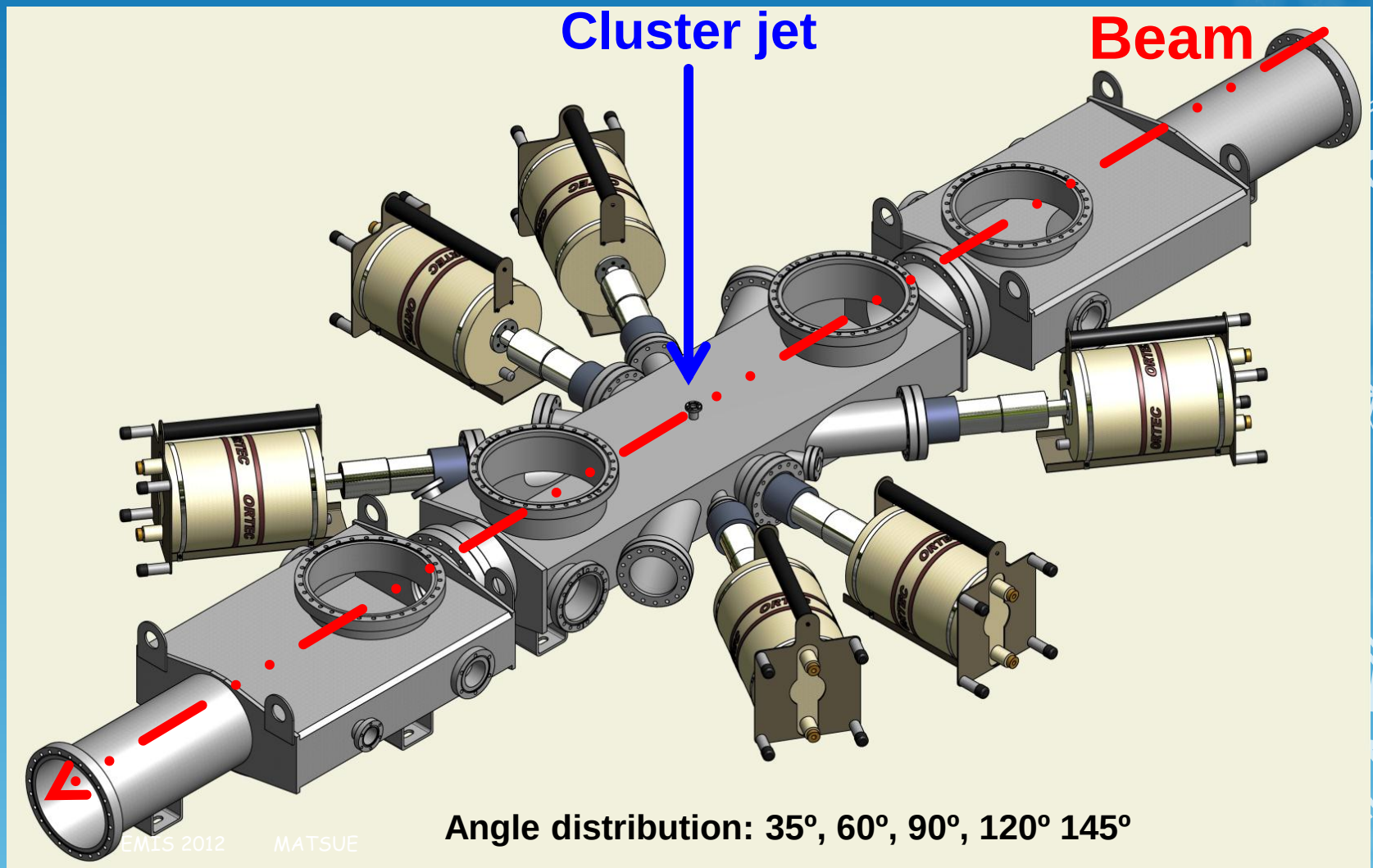


Long time running test for Ar
(T_{nozzl}= 139K)



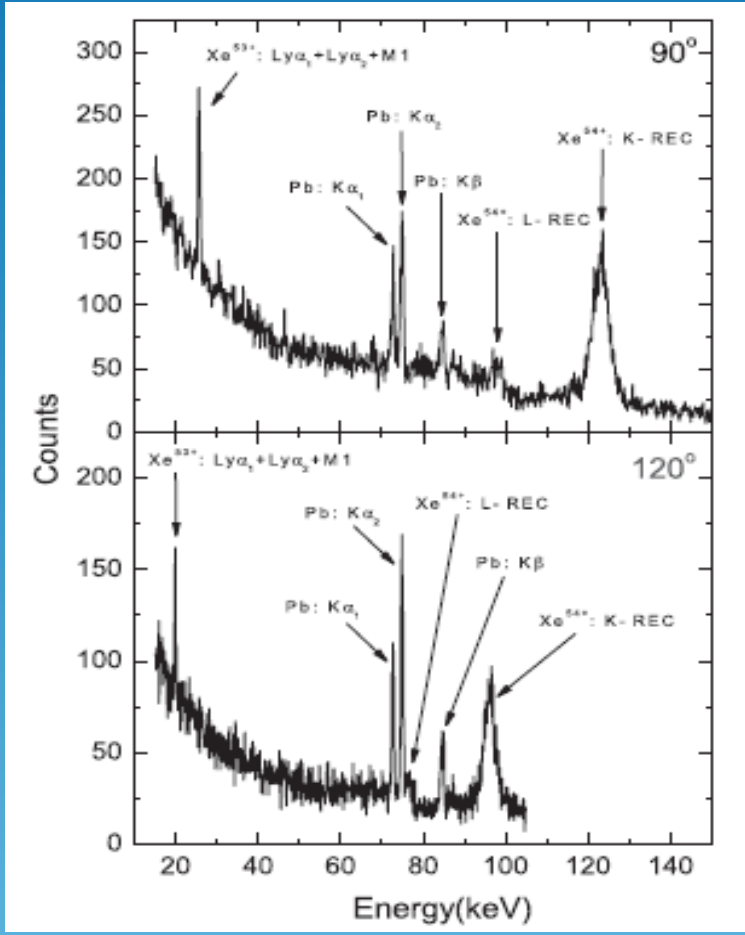
Long time running test for H_2
(T_{nozzl}= 34K)

Detectors for X-rays

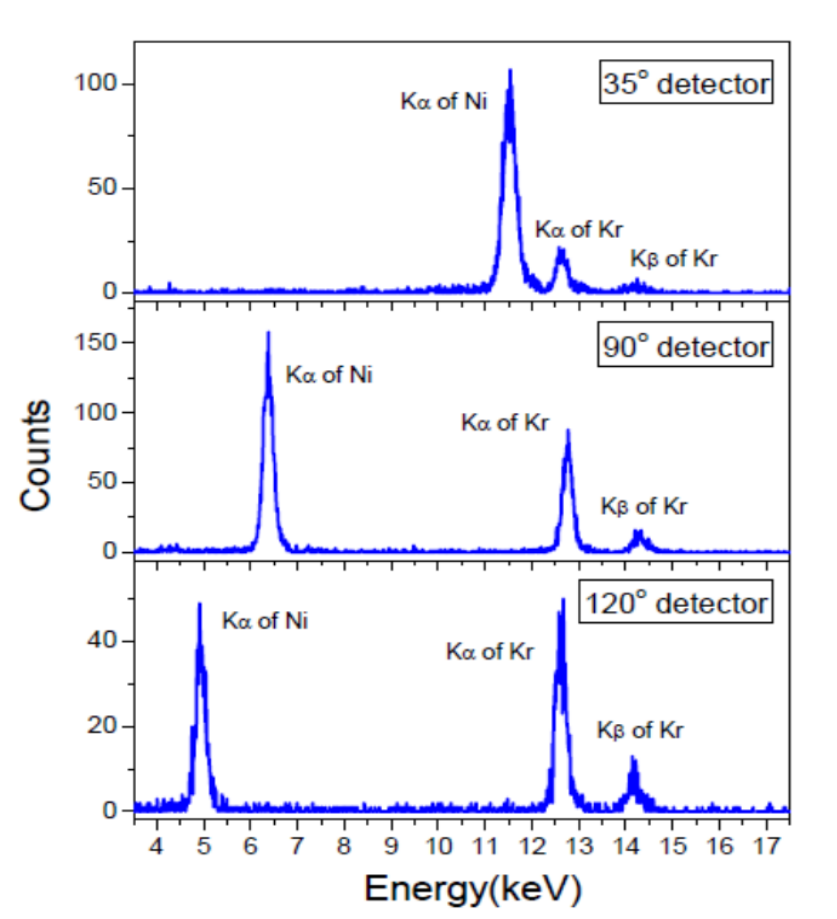


Angle distribution: 35º, 60º, 90º, 120º 145º

Experimental Results



X-ray spectra obtained by 90º and 120º detectors in 200MeV/u Xe^{54+}-N_2 collisions



X-ray spectra obtained by 35º, 90º and 120º detectors in 185MeV/u Ni^{19+}-Kr collisions

Thanks you very much!