Status of the BDC production for LAMPS

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Sanghoon Hwang (KRISS)

LAMPS Monthly meeting

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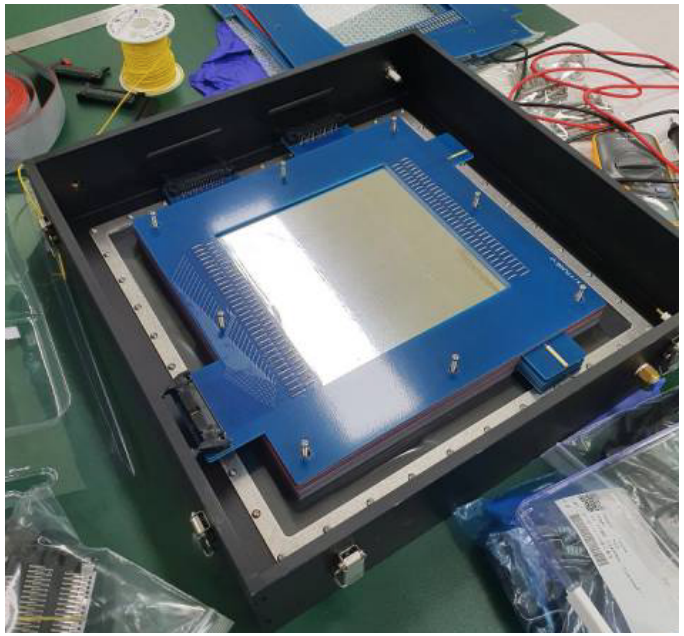
For prototype

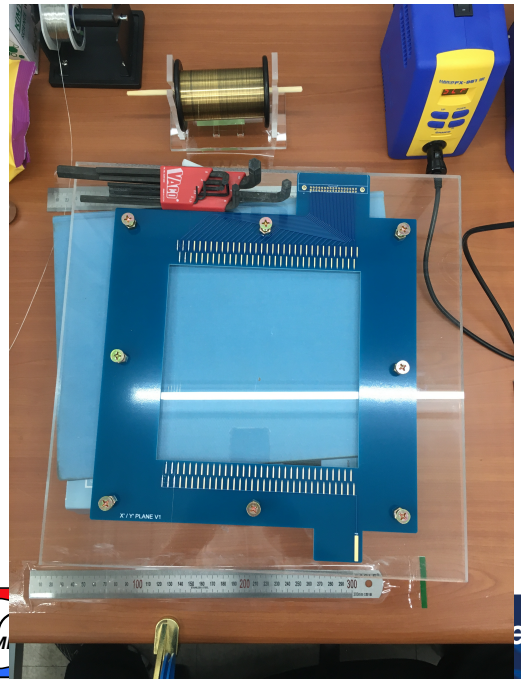
Start to assemble first set of BDCs

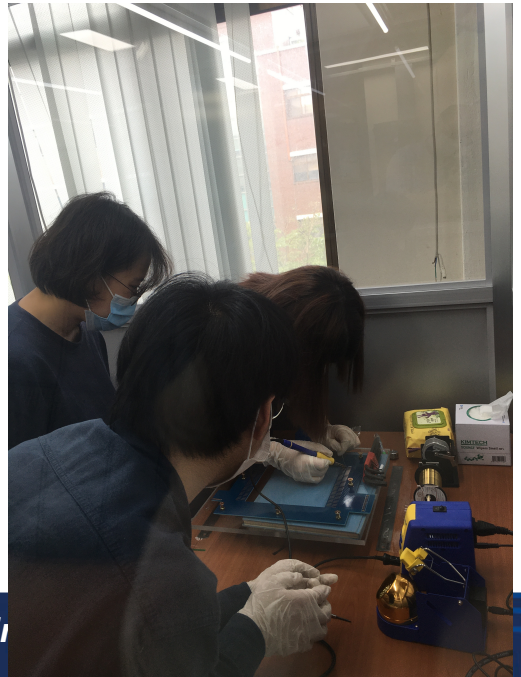
- **Install the wired planes in KRISS**
  - Change of the drift length between vertical horizontal because of assembly issue
    - horizontal : 2.5 mm, vertical : 2.5 mm -> 3.6 mm
- **Transfer from KRISS to CNU safely**
- **Will finalize the assembly at CNU in next week and test**



Prepare for beam test

- **Start wiring for BDC set 2 (+ 1)**
- **Ordered additional LV power supply**
- **Prepare DAQ codes and HUB for 4 ASD boards**
  - 2 ASD boards are transferring to CNU
- **Cosmic ray test with full setting**
  - Similar condition at KOMAC beam test

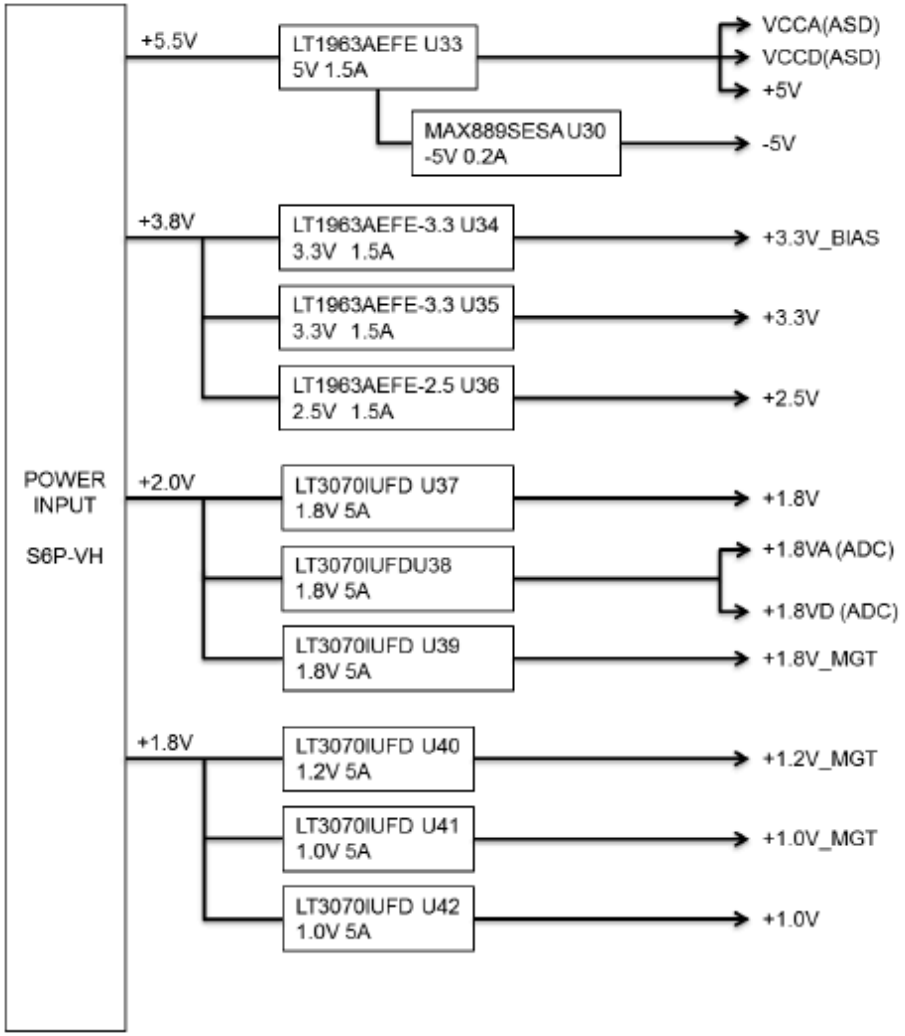




For real type

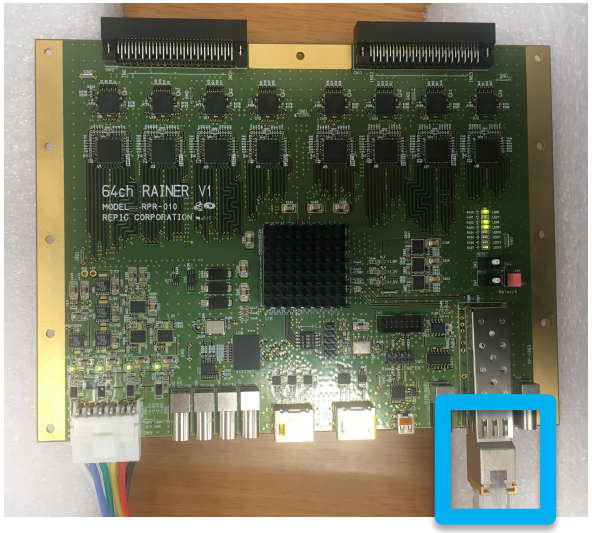
Performance of ASD boards

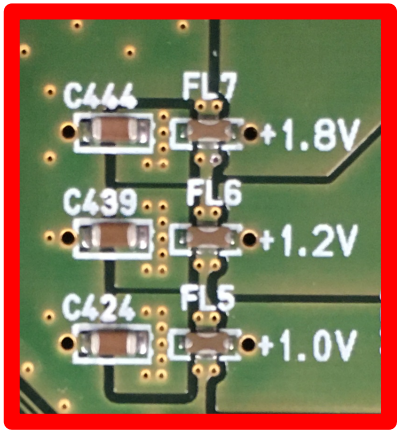
- **Under vacuum**
  - Advice from NOTICE : expect not much heat from the boards (under the 1 atm condition), not sure for vacuum
  - Expect difficulty for cooling
  - Need to avoid vacuum
- **Heat from the board**
  - 전압강하*전류로 추정
  - ~ 20 W



Performance of ASD boards

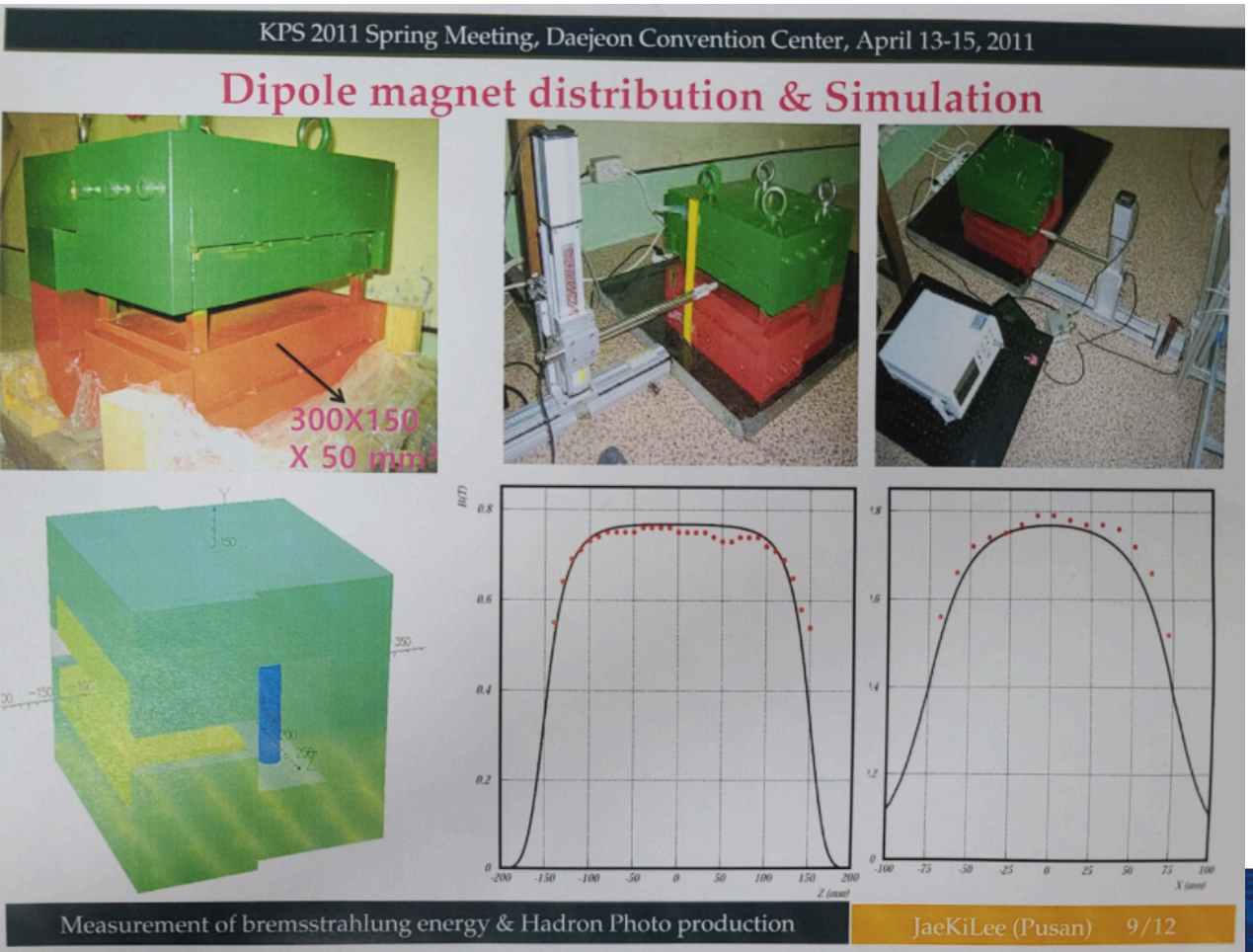
- **Under magnetic field**
  - Advice from Dr. Sangyeol Kim (NOTICE)
    - Components with coil could make problems
      - Under the magnetic field, can make strange working and harmful for all the boards
    - Solution : change or remove coil component (if removing is not affect to the performance)
      - Change the transceiver from UTP to Light one
      - Remove "filters" and directly connect (to be shorted)
        - » Function of the filters
          - If some parts have a problem, disconnect in the filters to keep rest of the parts
          - If the input power is stable, it may not affect so much
        - » Remove all filters in one ASD board
          - Confirm the voltage around some terminals
          - Will test in CNU and compare with original ASD board





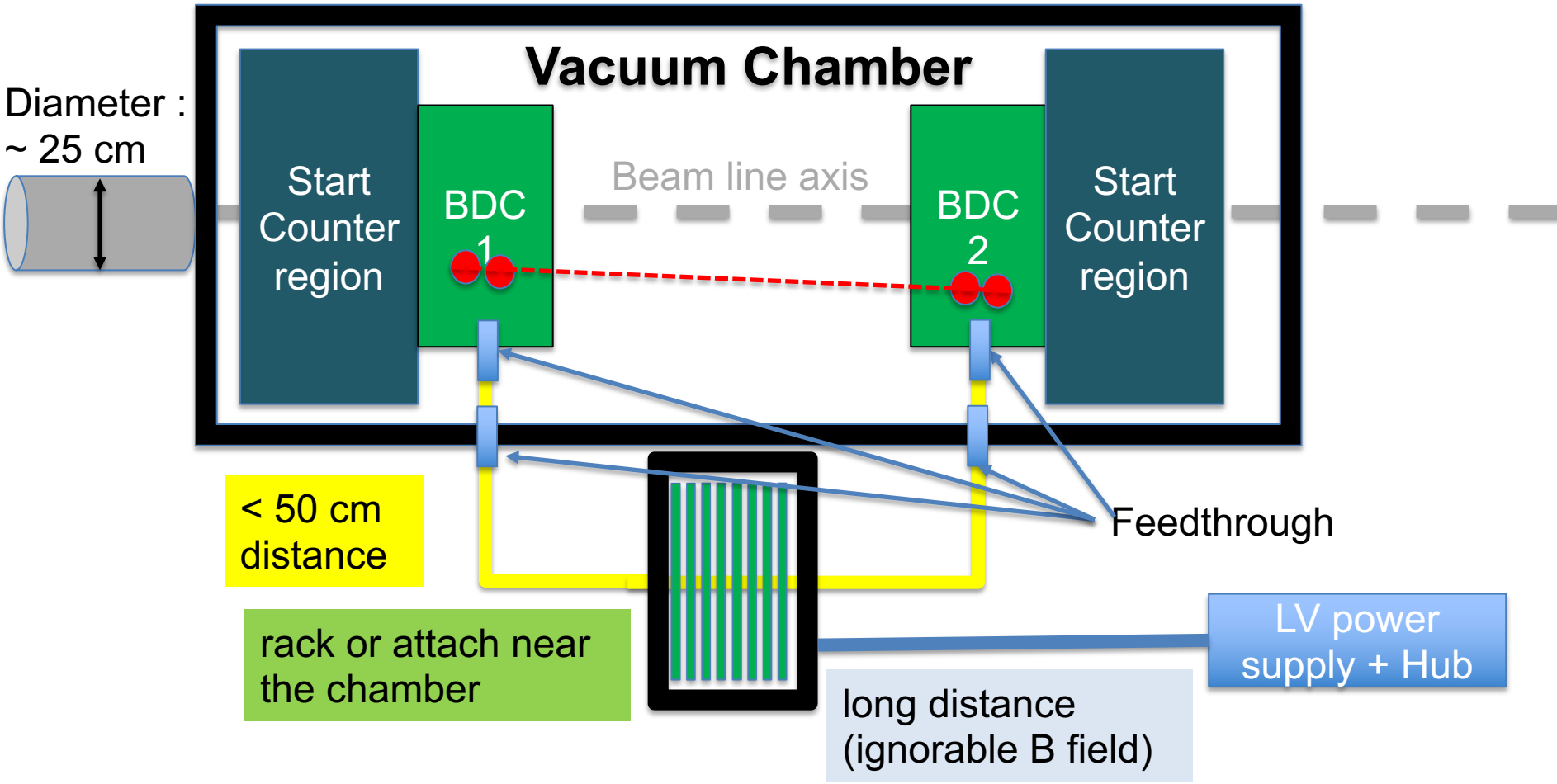
Test of the electronics under the magnetic field

- Today Jaein will test with magnet (0.8 T), with advice from Prof. Ahn
- Aduino board will be used



Suggestion of ASD position

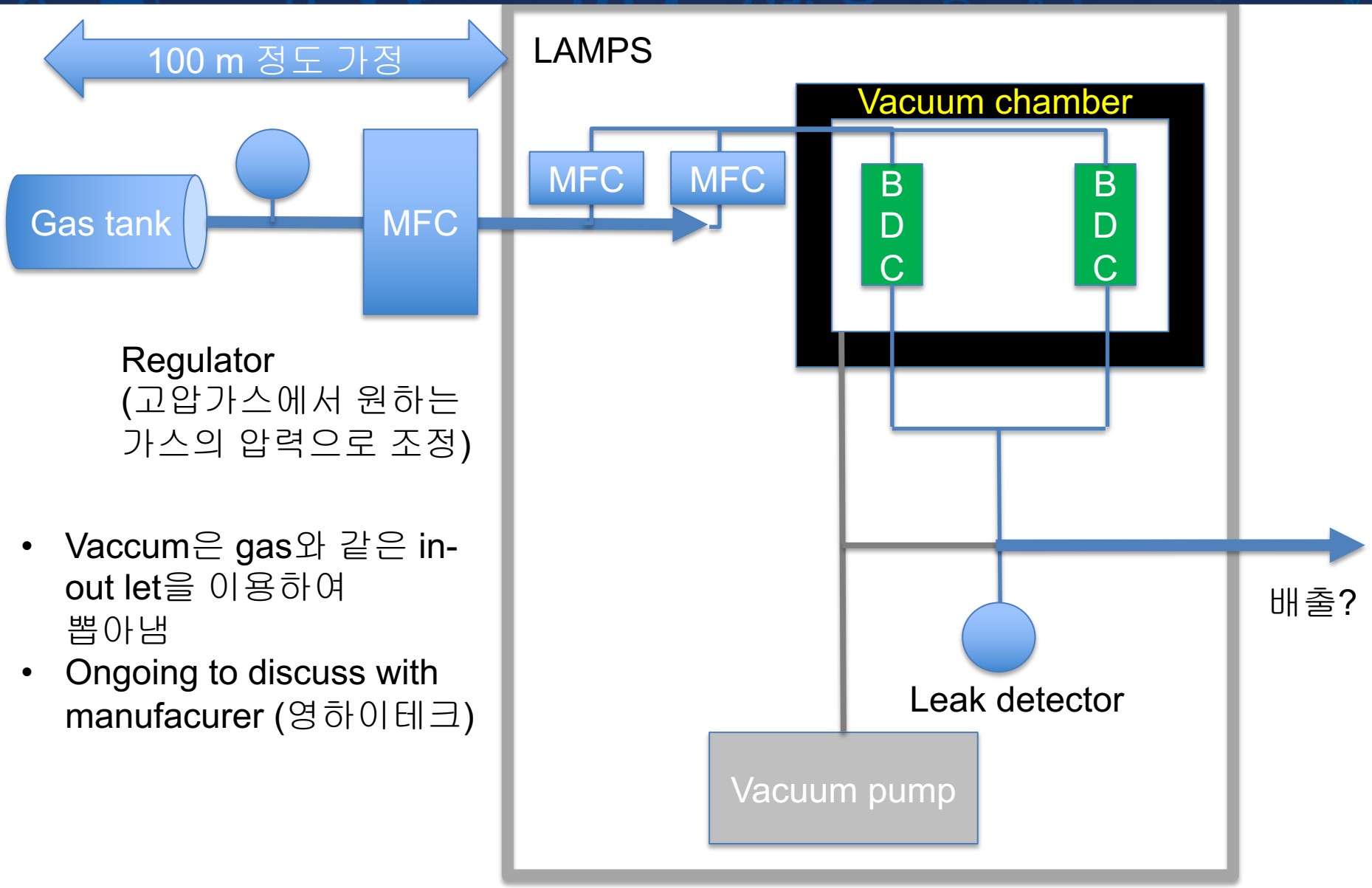
- **Assumption : confirm the stable performance under the magnetic field**



가스 소요량 계산

- 계산은 모두 **1 atm** 기준으로 환산하고, 충전압력을 **12.0 Mpa**로 가정하여 압축가스 용량 계산
- **7.3 L / set**
- 분당 **0.2 L, circulation** 경우 분당 **0.3 L** 공급 가정**(set** 당**)**
- **2 set,** 분당 **0.3 L** 공급시
  - 분당 0.6 L, 시간당 36 L, 하루 864 L, 연간 328.5 kL
- 충전압력 비 고려시 **328.5 kL * 1013*10^2 Pa / 12*10^6 Pa = 2773 kL,** 대략 **2.8 kL/**년

Suggestion for Gas supply system



- Vaccum은 gas와 같은 in-out let을 이용하여 뽑아냄
- Ongoing to discuss with manufacurer (영하이테크)

LV power supply

견적가 Maximum 1500만원
(computer programmable control enable)

- **Current for each ASD board**

5.5 V	3.8 V	2.0 V	1.8 V
0.424 A	0.430 A	2.594 A	1.052 A

- **Capacity of present using LV PS**
  - 2 channels, maximum current : 3 A / each channel
  - For real 2 set of BDCs, 4 ASDs / set * 2 set * 4 voltage channels = 32 LV channels
  - Considering currents from boards, at least 7 LV PSs needed
- **Make specific device for LV supply to boards?**
  - Is there have the contact for it? then order for beam test

	1	2	3	4	5	6	7	8
5.5 V	O	O	O	O	O	O	O	O
3.8 V	O	O	O	O	O	O	O	O
2.0 V	O	O	O	O	O	O	O	O
1.8 V	O	O	O	O	O	O	O	O

OR

	BDC 1	BDC 2
5.5 V	O	O
3.8 V	O	O
2.0 V	O	O
1.8 V	O	O

HV power supply

- Needed for 16 planes
- Possible to apply different voltages to cathode planes and potential wires
- Possible to apply different voltages to some planes
- At lease needed 2 CAEN modules for 8 HV channels (4 HV channels / 1 set)

본 제품을 위한 수정 견적서 - 약 2억 5천만원 예상

BDC 본제품 제작을 위한 견적서

No.1	품 명 및 규 격	단위	수량	단 가	금 액	비고(발주처정보)	사전주문내역과 참고사항
1	outer frame (내부 wired chamber 제외)	식	2	20,000,000	40,000,000	영하이테크 (백병창 : 042-635-2845)	해당 금액으로 발주하고, 추가금액은 타 연구비에서 충당
	-.400mm*400mm*100H (15T)						
	-.Chamber Wall electro polishing						
	-.설계및 제작						
	-.Vacuum Test						
	Flange						
	-.SHV CF1.33", DC5KV10A	ea	4				
	-.SUB-D ,37pin	ea	16				
	-.outside Plug & inside Plug	조	2				
	Chamber 제작을 위한 각종 잡자재 및 인건비						
2	ASD boards	개	7	10,000,000	70,000,000	Hayashi-Repic Co., LTD.	진공, 자기장 중 작동 문제가 해결되어야 주문 가능
	- 총 8개 소요, 7개 추가 주문(여분 1개)					https://www.h-repic.co.jp	
3	chamber 거치대	식	2	2,500,000	5,000,000	영하이테크 (백병창 : 042-635-2845)	해당 금액으로 발주하고, 추가금액은 타 연구비에서 충당
4	와이어(길이 270 m), 운송비 포함		1	2,500,000	2,500,000	California Fine Wire company	발주 확정
	- Signal : Au coated Tungsten (20 micron)					https://calfinewire.com/request-quote/	
	- Potential : Au coated Aluminium (80 micron)						
5	anode, cathode planes, spacers			2,000,000	2,000,000	이룸테크 (임도진 : 02-3281-2484)	해당 금액으로 발주하고, 추가금액은 타 연구비에서 충당
	- anode : xy, x'y' 각 8매 이상						
	- cathode : 18매 이상						
	-spacer : 0.5 mm 간격 35매 이상						
6	Metalized mylar				1,600,000	G-Tech Corp. (Japan)	해당 금액으로 발주하고, 추가금액은 타 연구비에서 충당
						goto@ggg-tech.co.jp	
7	HV module (CAEN N 1471 HET)		1		8,000,000	오토텍	POWER supply 갯수는 적더라도 챔버별 컨트롤러는 필요할 듯, 예상전류 체크하여 추가 여부 재확인
						http://atkinc.com/Introduction	챔버별 컨트롤러의 경우 추가 제작 필요
8	LV modules	개	14	700,000		엘레파츠	LV modules 중 2개는 선구매?
				9,800,000		https://www.eleparts.co.kr/main/index	
	LV 공급 장치(Power supply, LAN hub 겸용)				15,000,000	테림 (김형일 :)	
9	유량자동조절시스템	식	1	15,000,000		영하이테크 (백병창 : 042-635-2845)	
					100,000,000		대략적인 예상금액, 구상도에 대해 황상훈 박사님 검토 후 재견적 요청하고 김영진 박사님 조언을 받아서 수정
10	각종 소형 부품 등 잡비용				4,500,000		비용만 설정
	- 기판 고정용 부품들						
	- Electronics까지 연결할 케이블						
	- 데이터 처리를 위한 DAQ 장비 등						
	소 계				248,600,000	VAT포함	

Remaining question and hopeful plan

- **How to align the detector?**

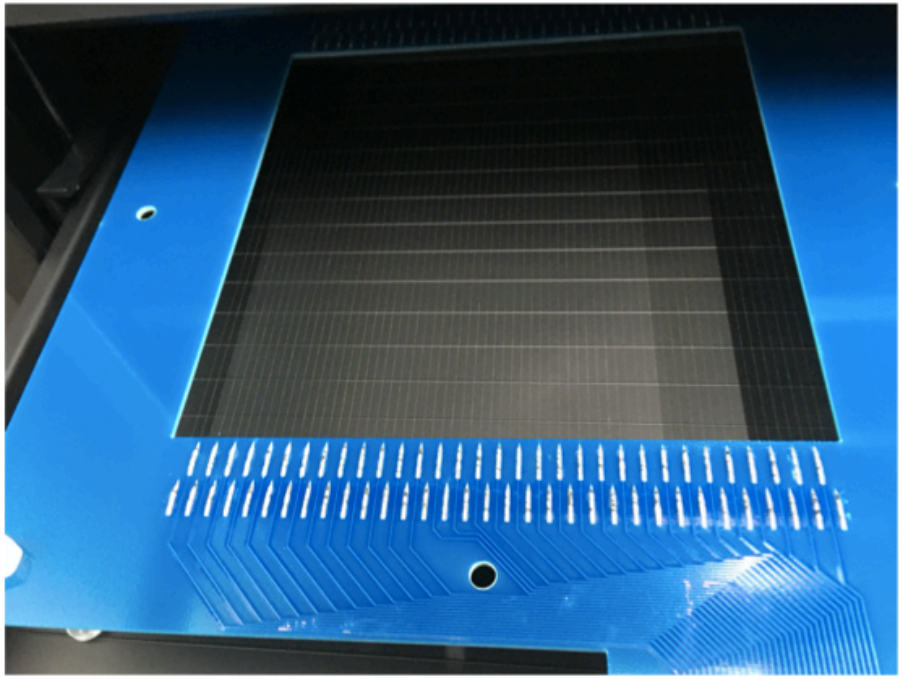
- **Plan**
  - Prepare beam test with 2 BDC set (4 planes / set)

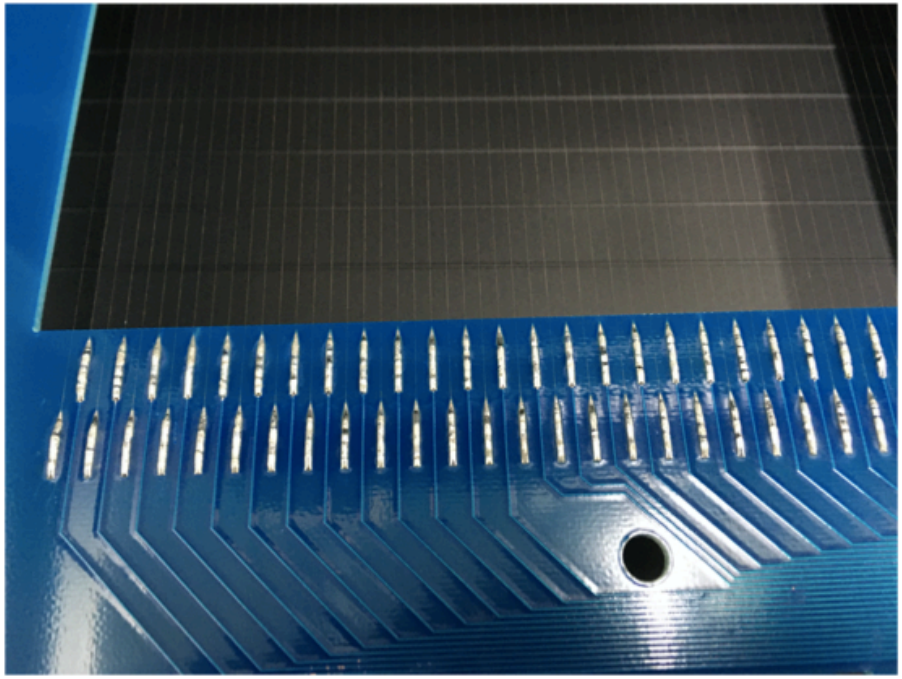
BDC crews are doing the best for the detector with good performance! Stay tuned!

Backup

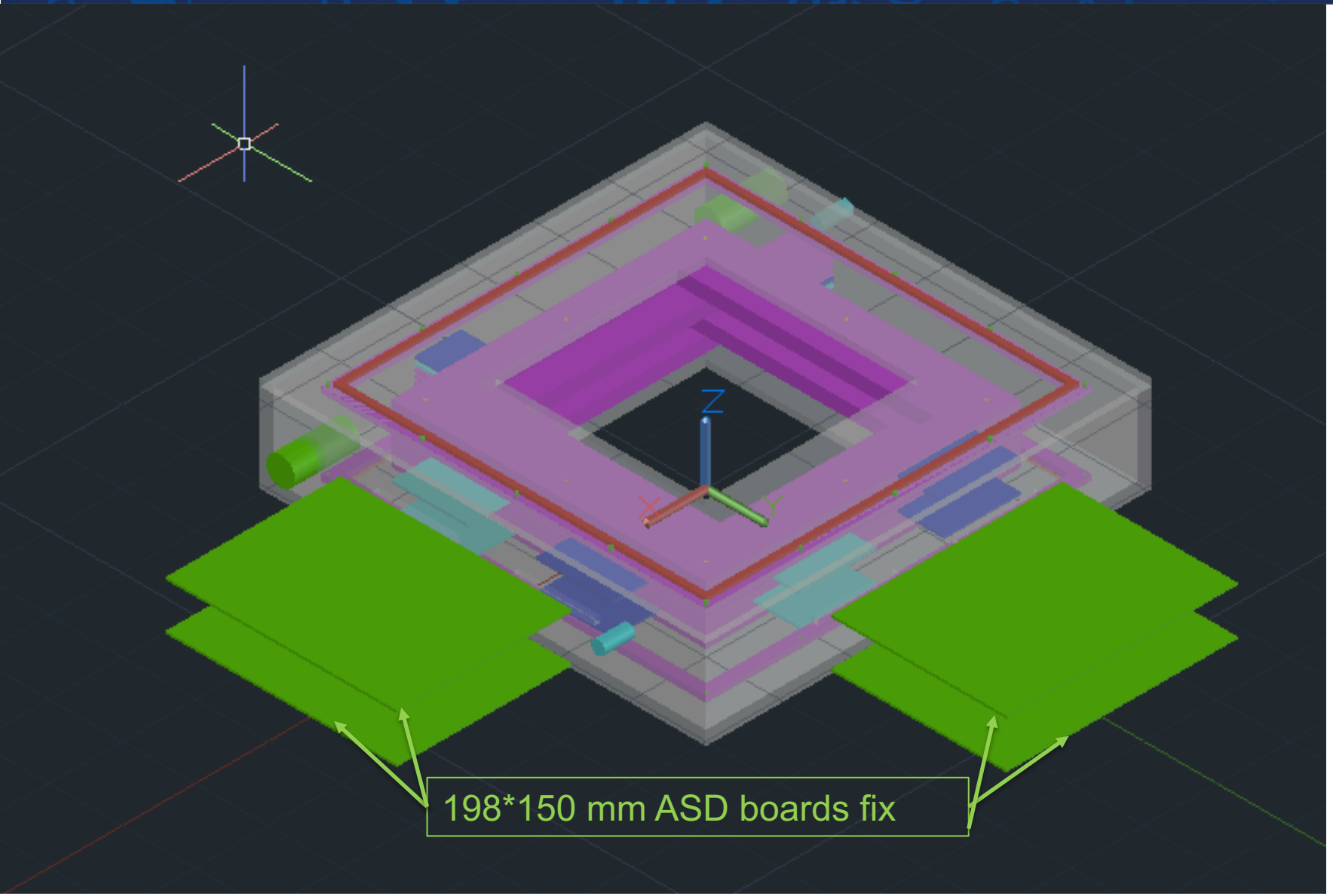
NEWS – 4 anode plane wiring is done

- Hard work by Jaein and Piljun, with many advice from Sanghoon Hwang (KRISS)
- About 3 weeks for 4 anode planes wiring
- Cleaning is done, waiting for chamber assembly





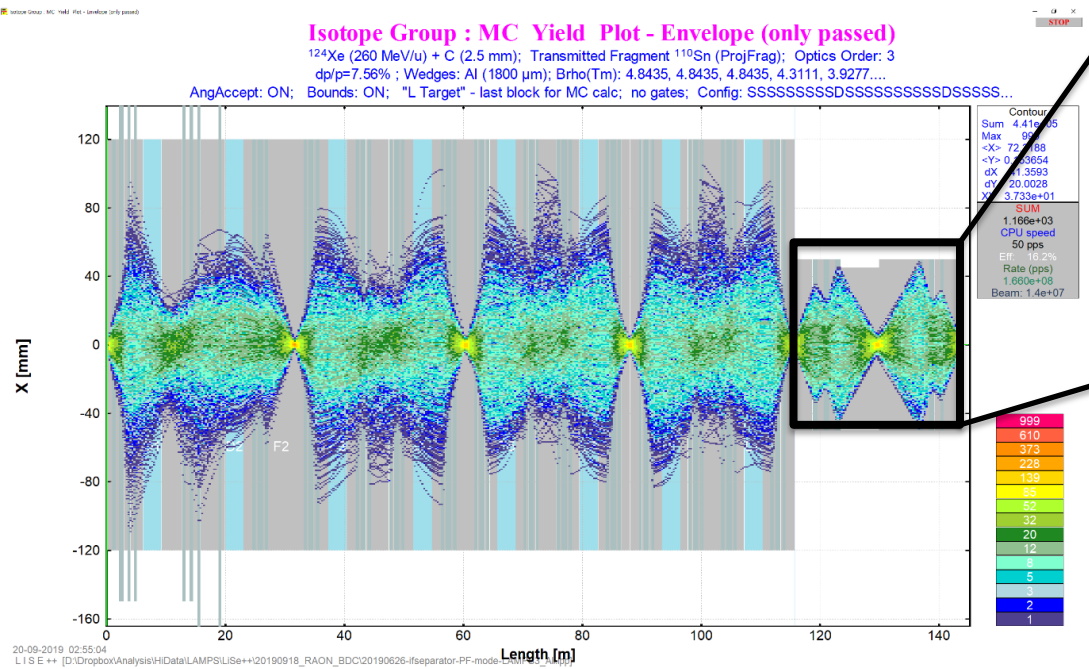
BDC design (preliminary)

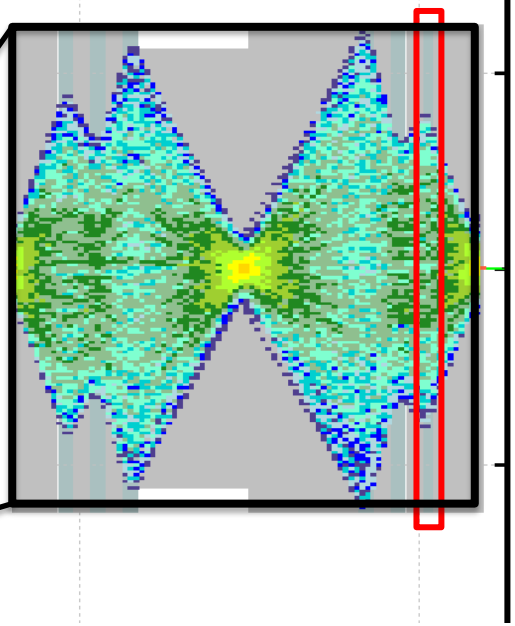


Reminder for active area determination

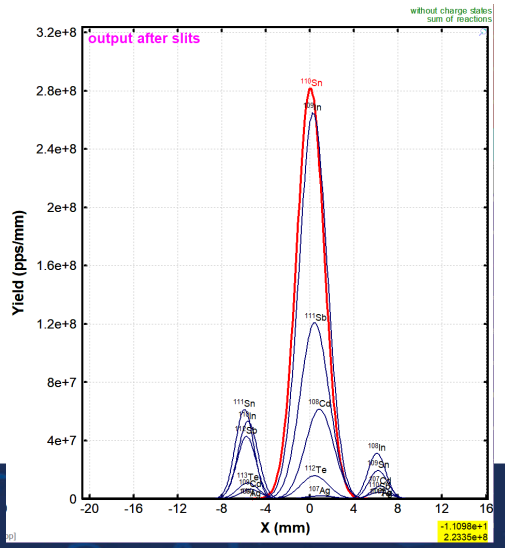
- **Beam study with Lise++**

^{124}Xe (260 MeV/u) Beam and ^{14}C target





Beam size at L-Target (x)
: ± 4.2 mm



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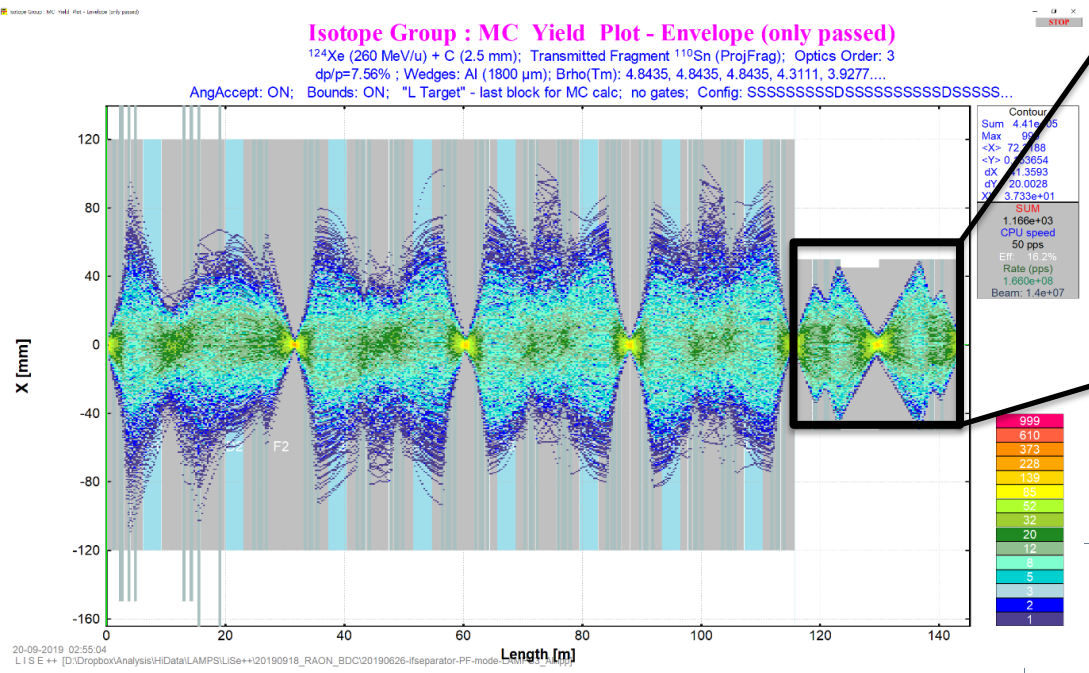
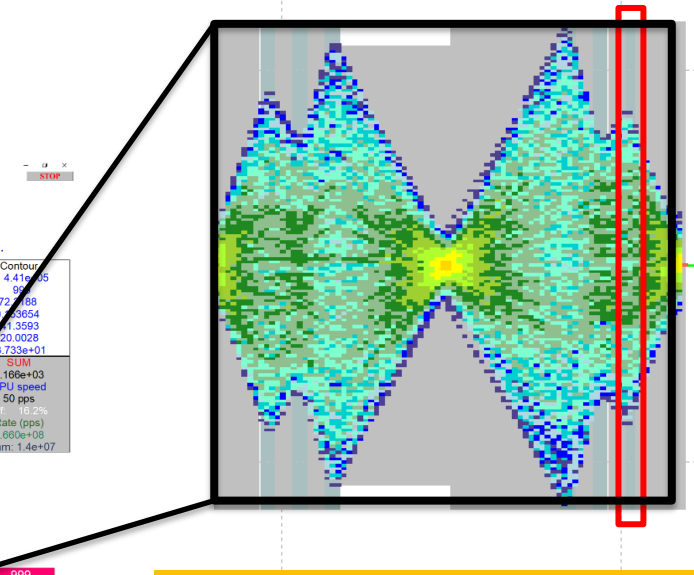
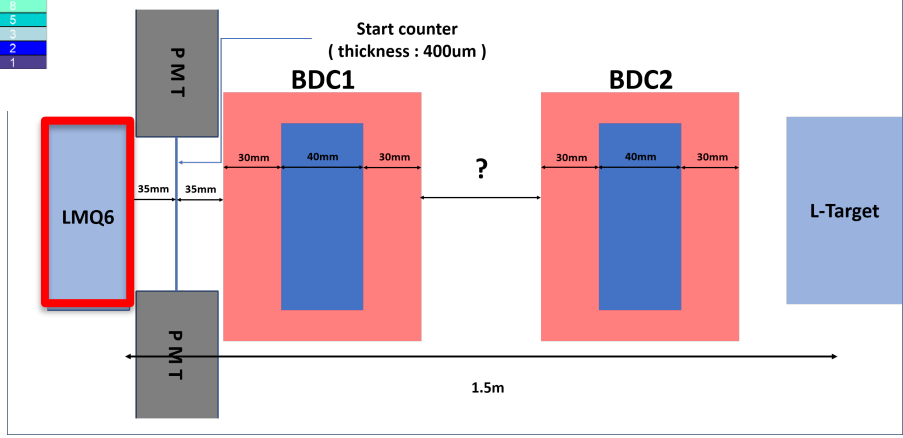




Question : estimated beam size at BC position?

Last quadrupole magnet before BDCs



Reminder for active area determination

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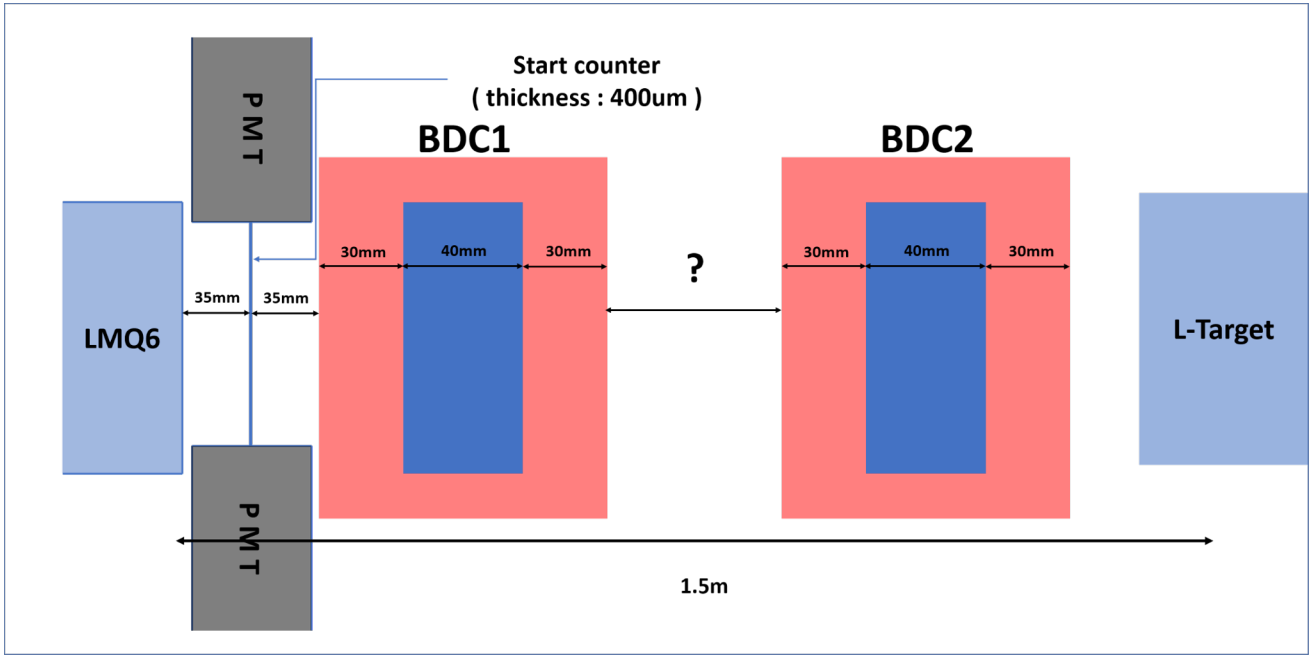
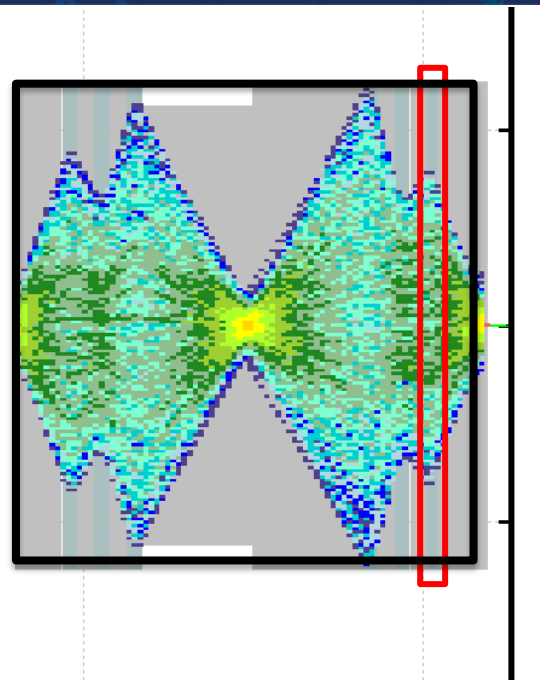
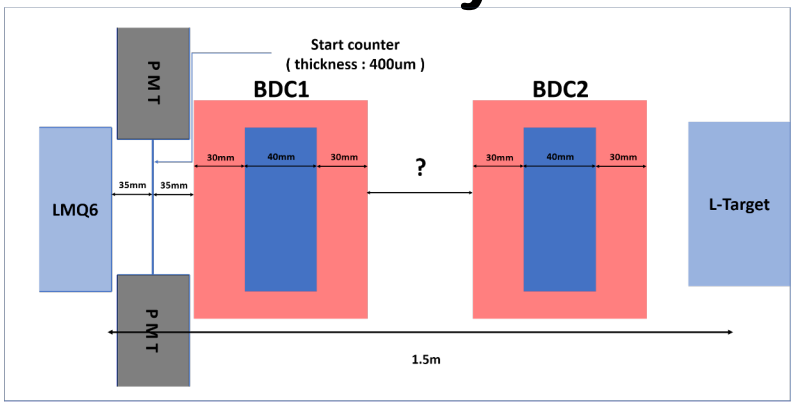


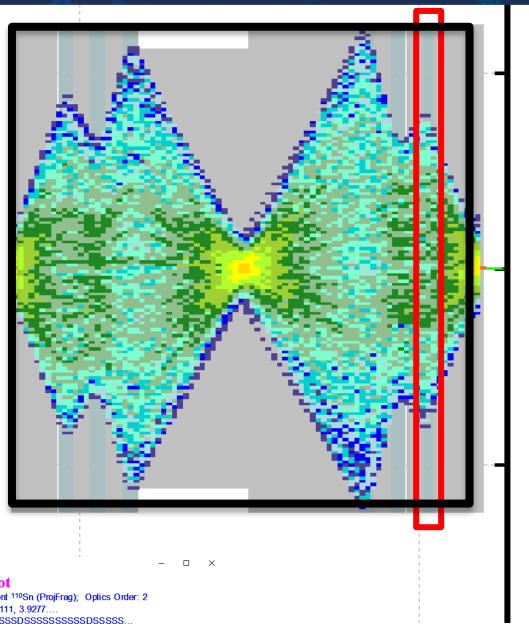


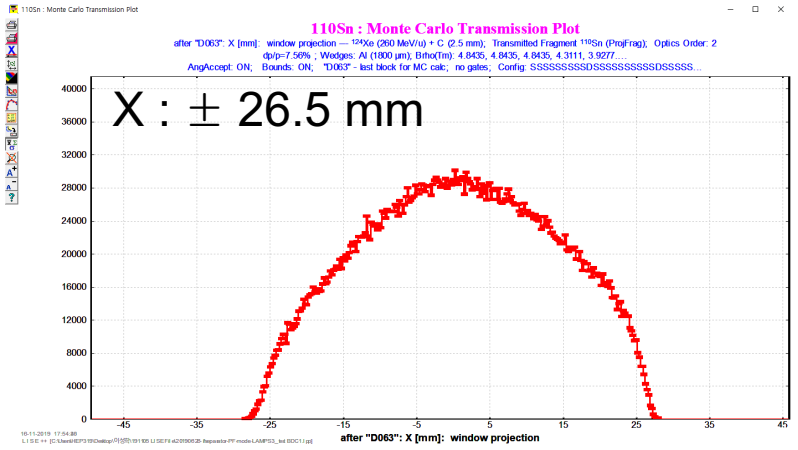
  - Assumption
    - Start counter doesn't effect much to the beam size (ignorable, except the thickness)
    - BDC (active area) is located away from last LMQ6, 100 mm and further

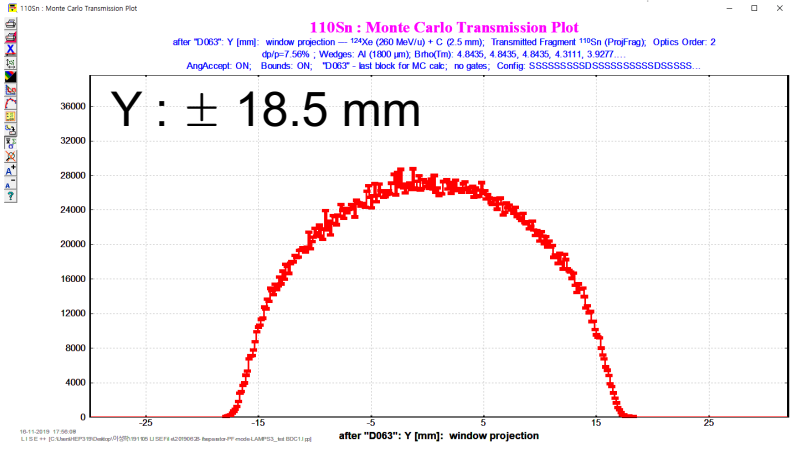
Reminder for active area determination

- **Beam study with Lise++**





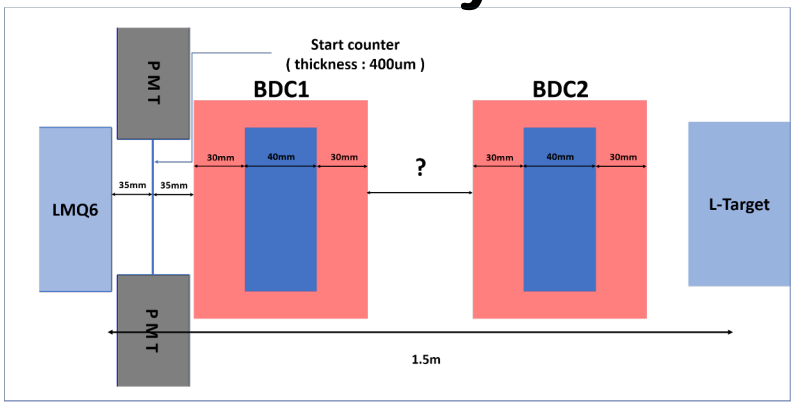


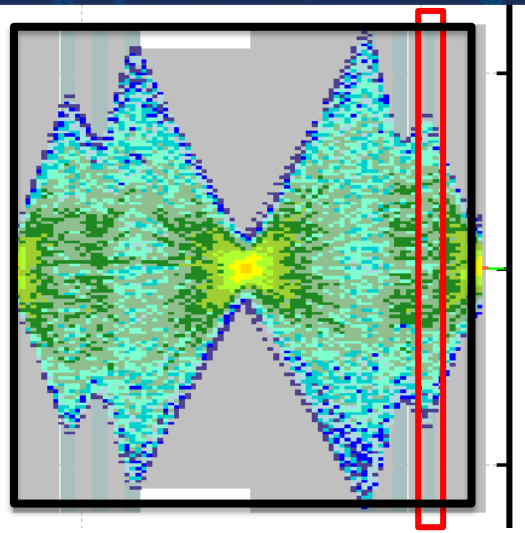


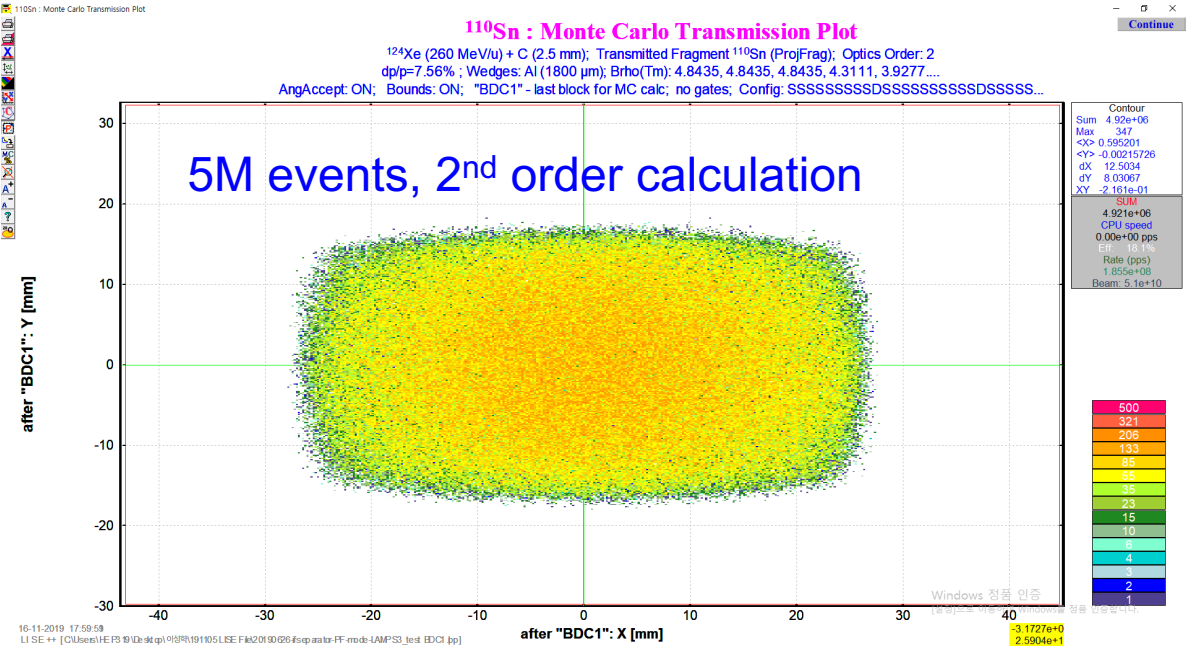
  - MC results with 2nd order calculation

Reminder for active area determination

- **Beam study with Lise++**





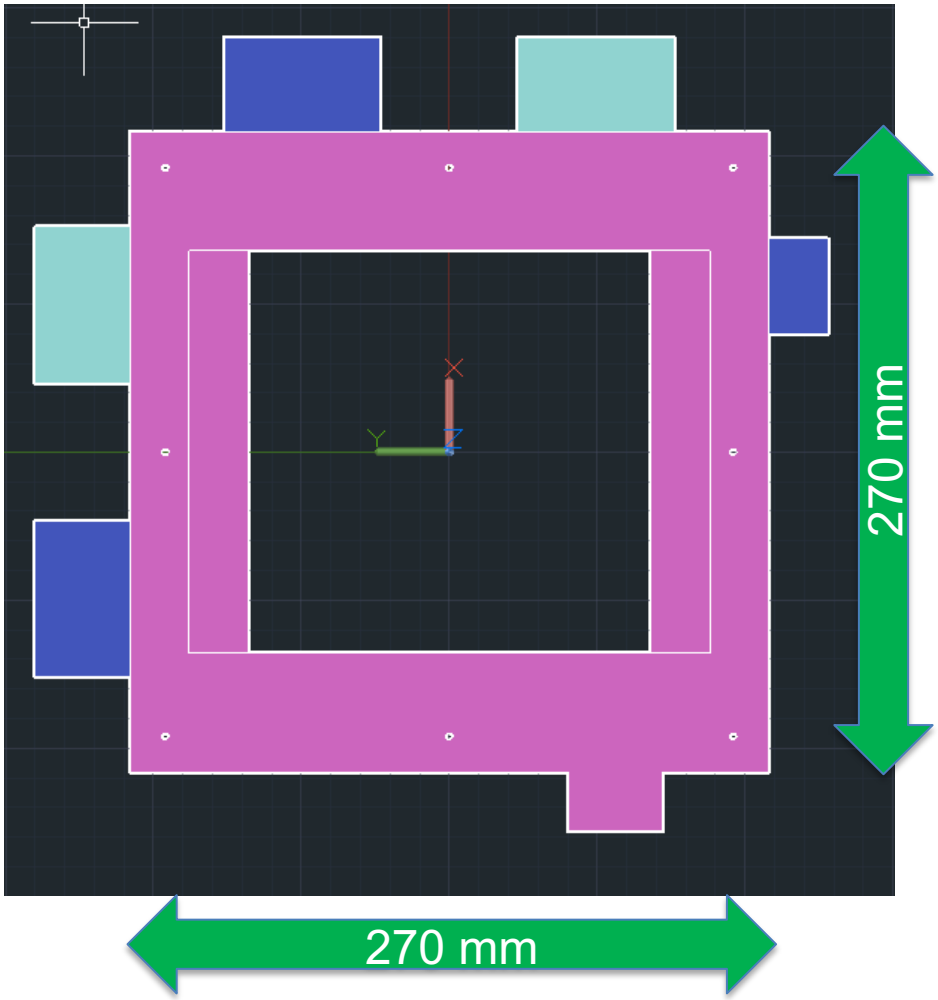


- Active area of BDC1 : 53 X 37 mm^2
- Conservatively consider to ~3-sigma :

(53*3) X (37*3) = 159 * 111 mm^2

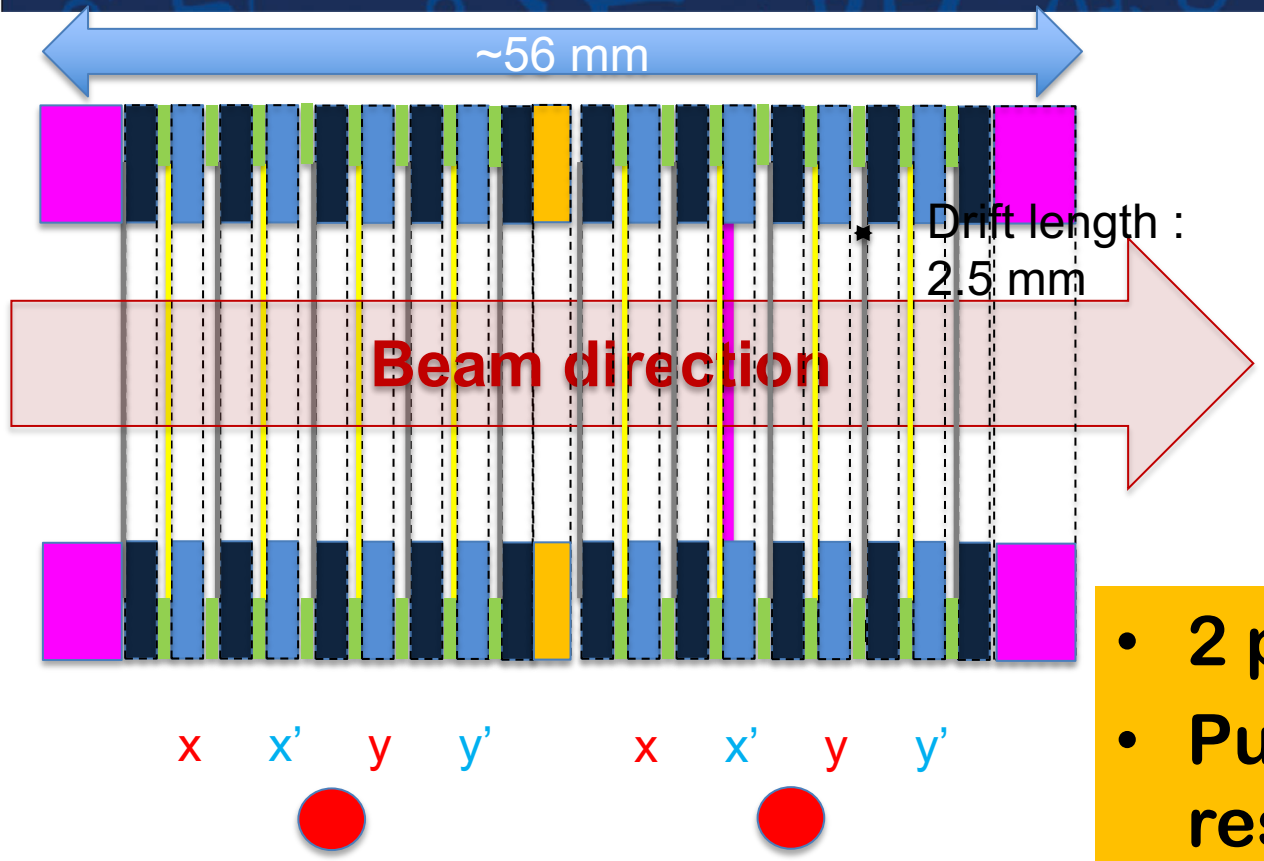
- Also, consider the technical limit and curvature by magnetic field
- Active area is decided to 160 * 160 mm^2

프레임 내부 wired planes 사양 (1세트당)



- **2 mm** 두께의 **wired anode (x,x',y,y'),(x,x',y,y')** 총 **8**매
- **cathode plane** 총 **9**매 **(anode plane** 사이**)**
- 각 **anode** 와 **cathode** 사이에 **0.5 mm** 간격의 **spacer 15**매**, 2 mm** 간격의 **spacer 3**매
- **outer frame**에 **8**개의 나사로 고정

Structure of the chamber



Cathode plane
Signal plane
Mylar (for GND)
Wire
Spacer : 0.5 mm

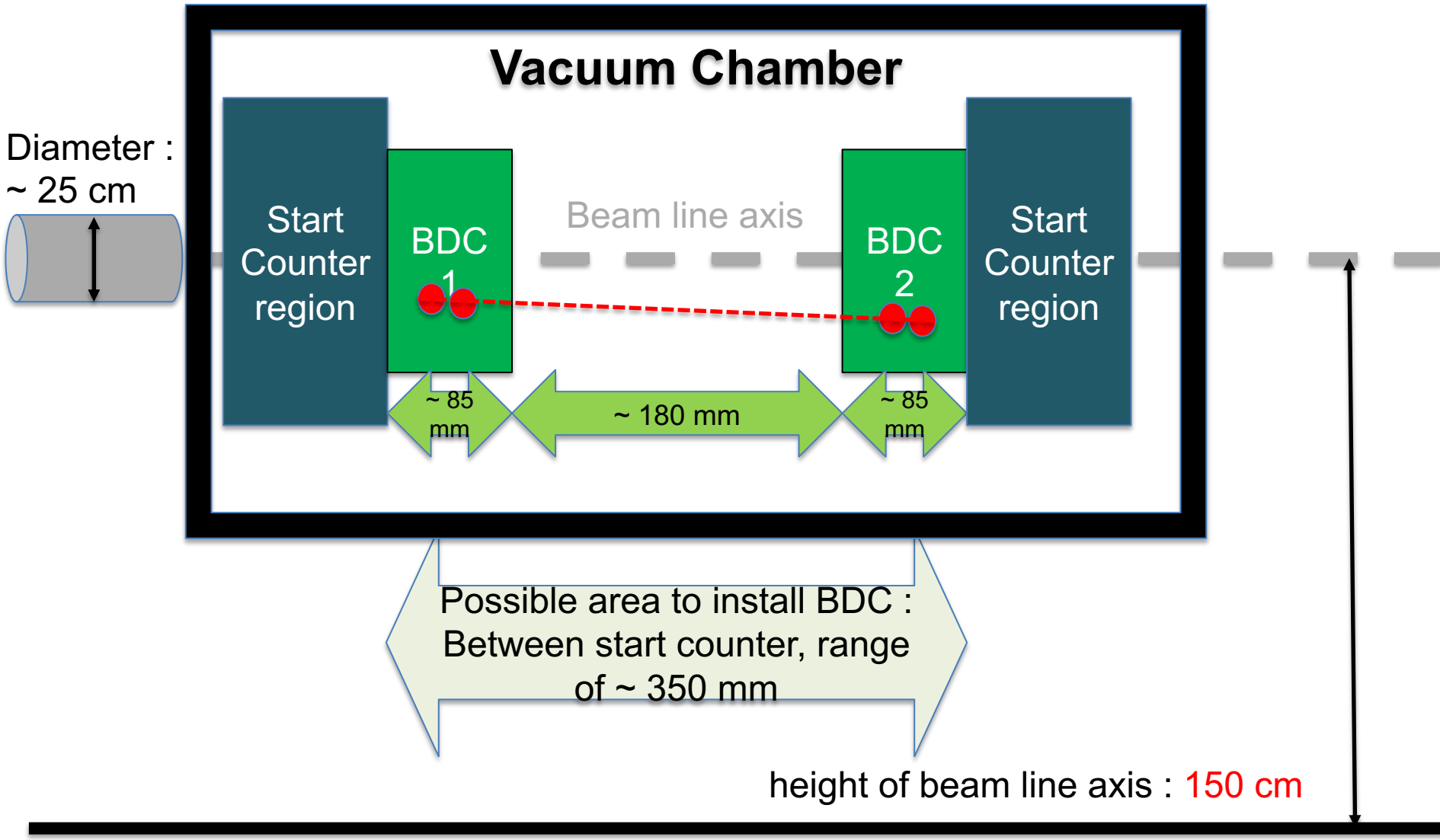
Middle
Spacer : 2 mm

Thick
Spacer : 5 mm

- **2 points in one set**
- **Purpose : position resolution of 100 μm (0.1 mm)**

xy plane is shifted from x'y' plane with 2.5 mm spacing

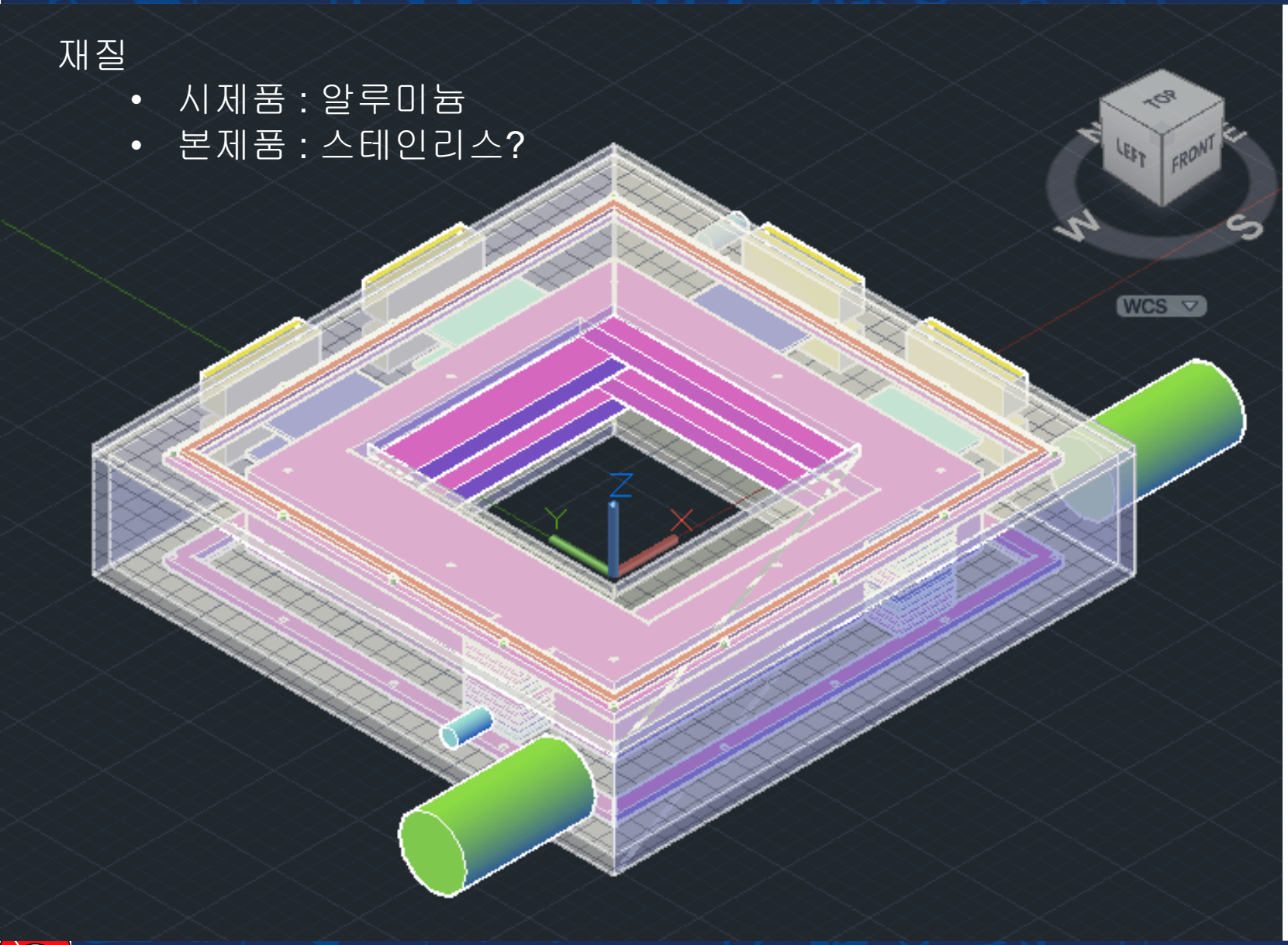
Position of BDC inside the vacuum chamber



BDC design without chamber (preliminary)

재질

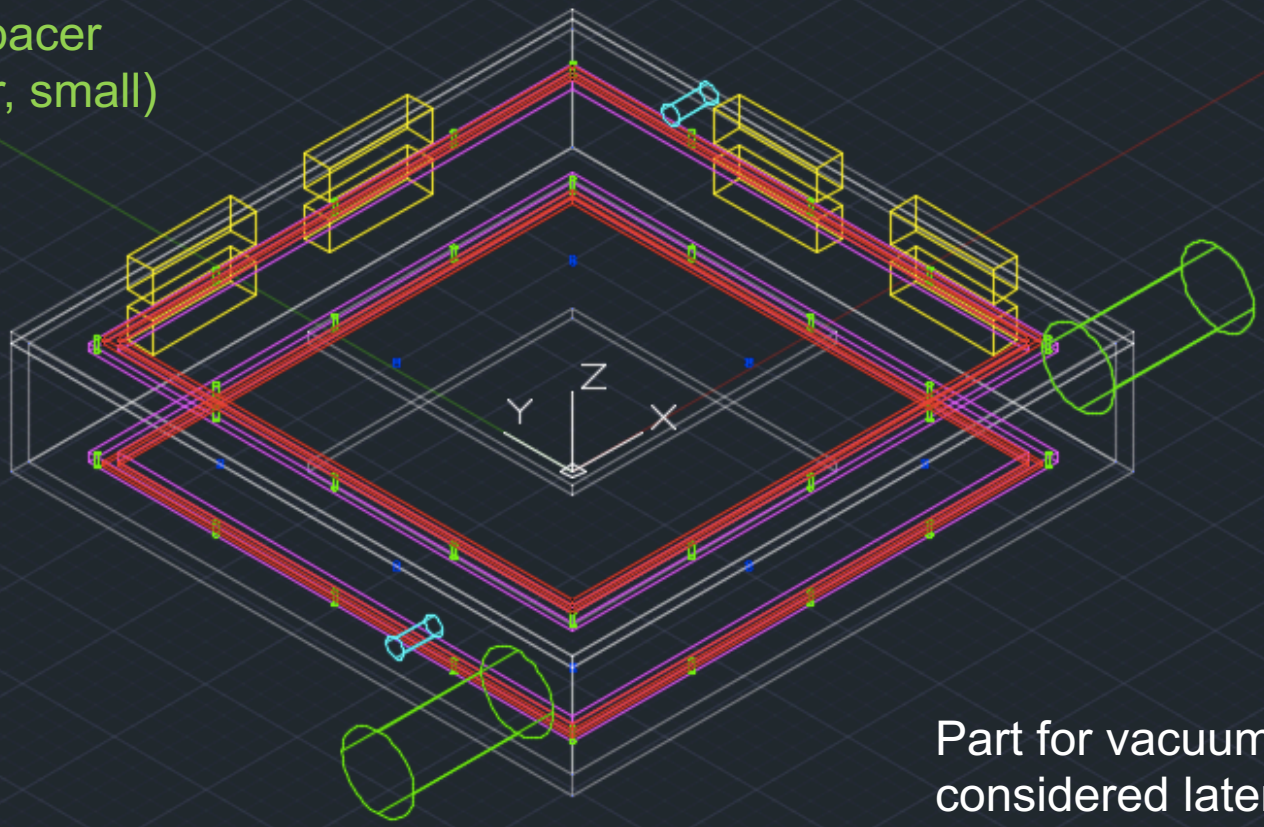
- 시제품 : 알루미늄
- 본제품 : 스테인리스?



Preliminary design of outer frame

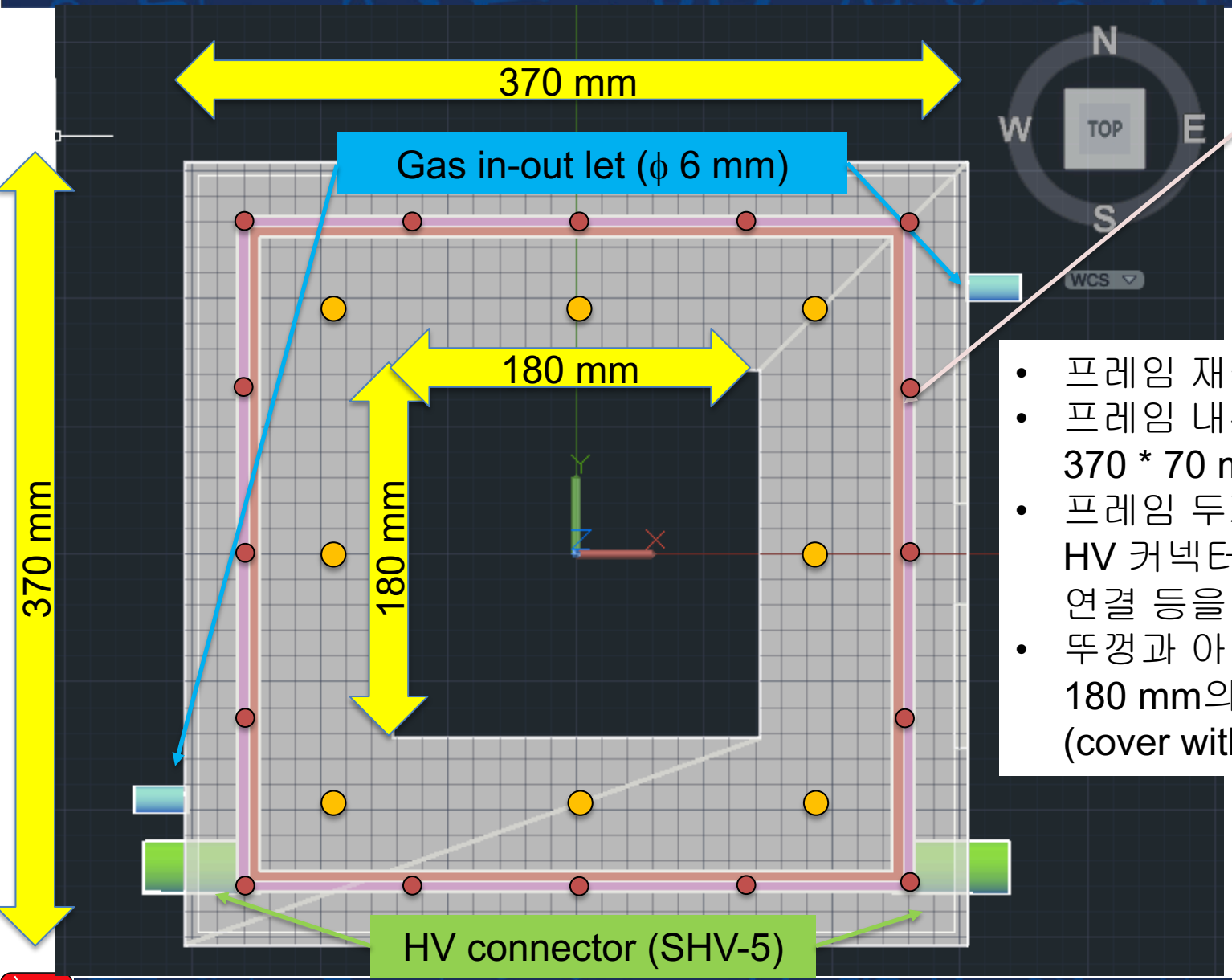
SW Isometric | 2D Wireframe

Type-D feedthrough
SHV-5 feedthrough
Spacer
Oring
gas in-out let
screws for fix spacer
(inside chamber, small)



Part for vacuum will be considered later

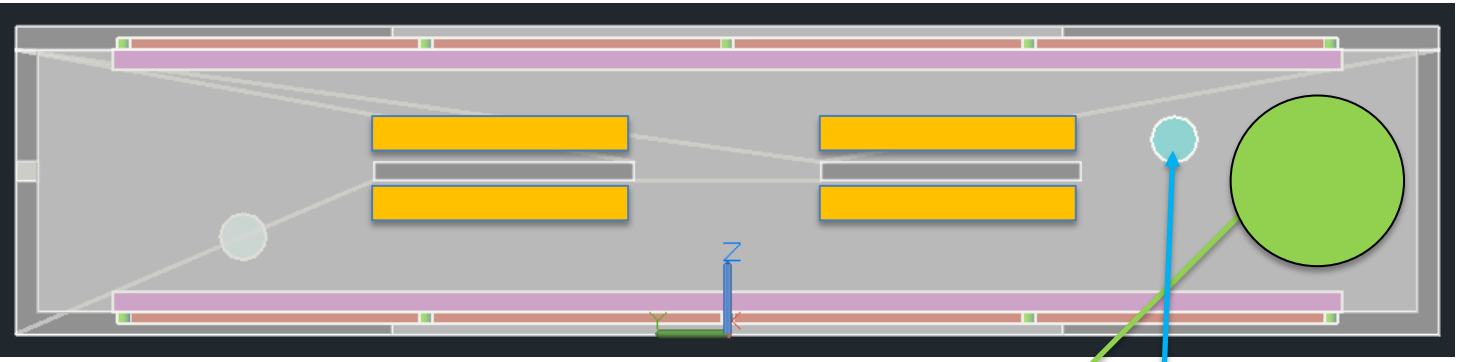
뚜껑 위에서 내려다 본 모양



오링과 5T 두께의 스페이서

- 프레임 재질 : 알루미늄
- 프레임 내부 규격 : 370 * 370 * 70 mm
- 프레임 두께 : 6 mm (단, HV 커넥터, 가스 커넥터 연결 등을 위해 조정 가능)
- 뚜껑과 아래 부분에 180 * 180 mm의 창을 내야 함 (cover with mylar film?)

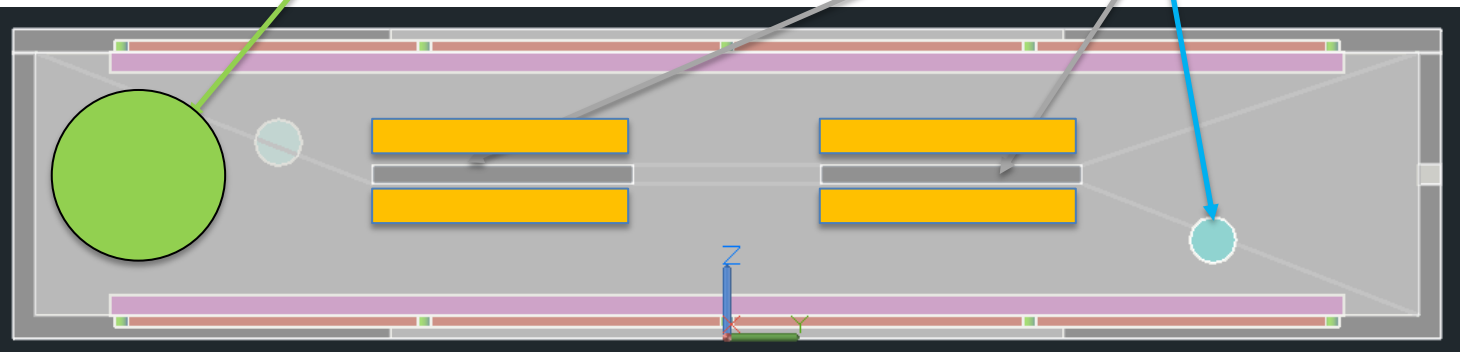
측면에서 바라 본 모양 (본제품)



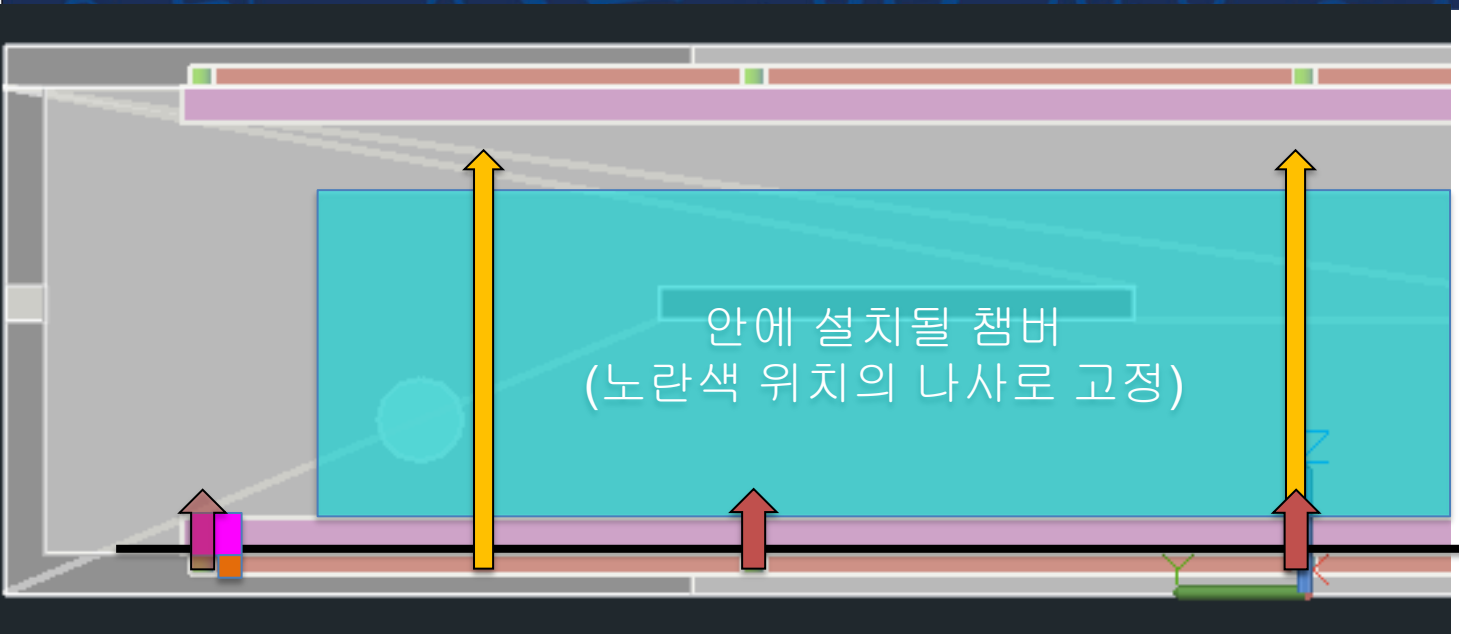
HV connector (SHV-5) feedthrough

Gas in-out let (ϕ 6 mm)

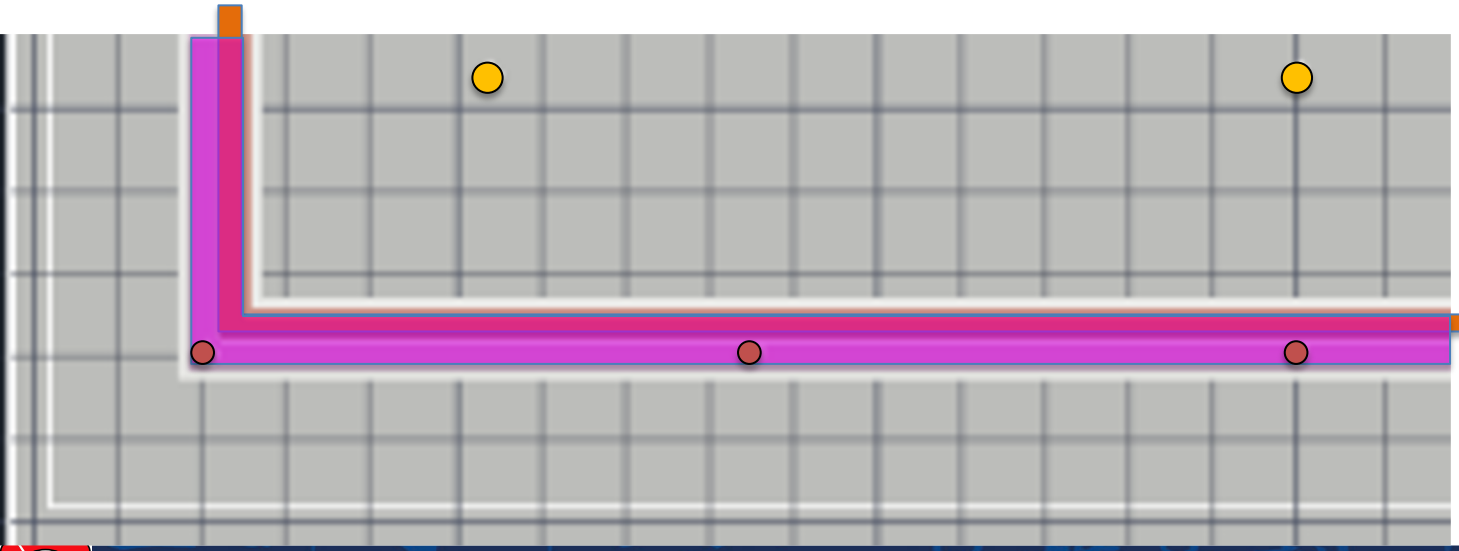
프레임 측면에 IDC cable connection을 위한 feedthrough 설치 (4*2=8 / set)



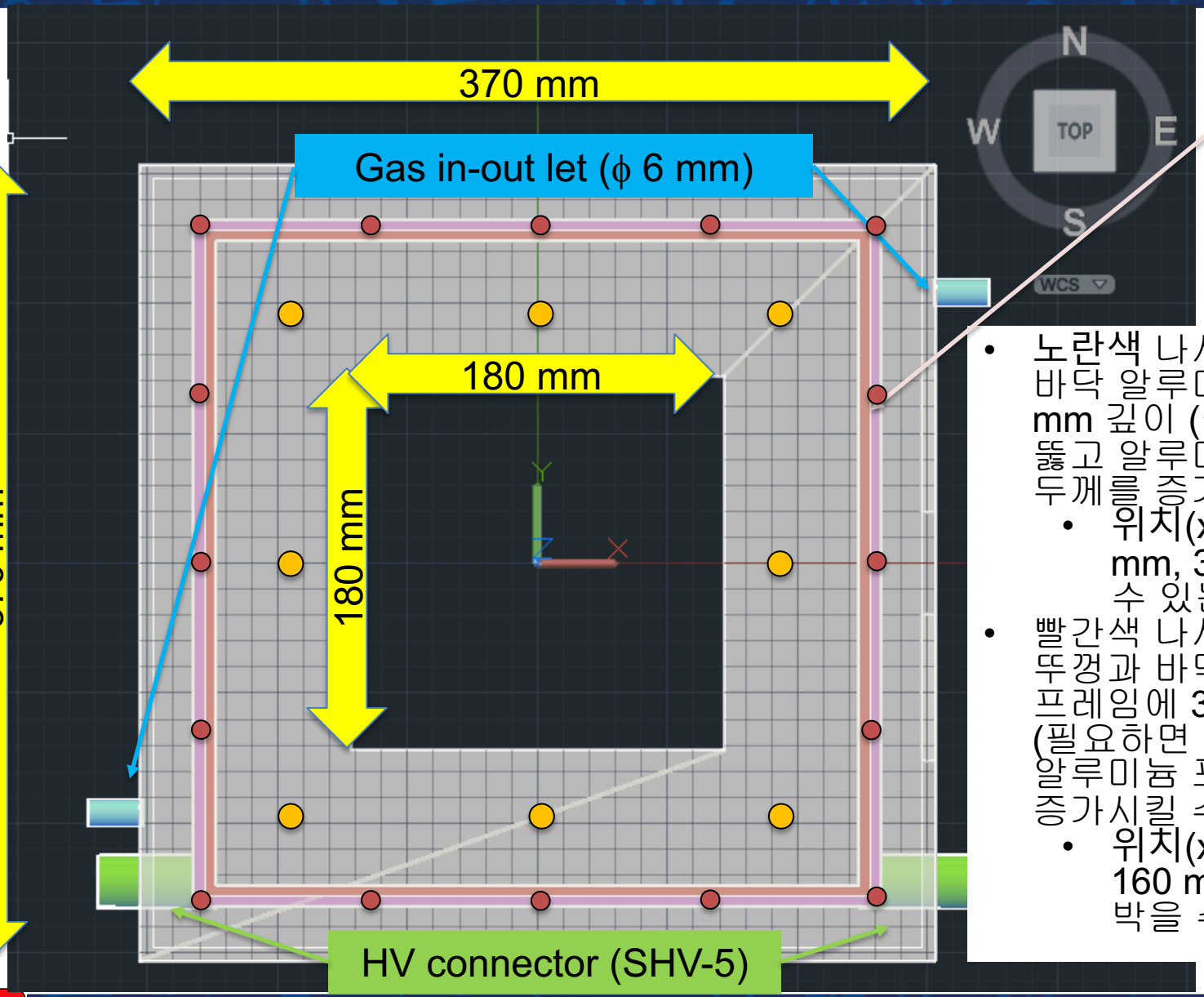
측면에서 바라 본 모양 (프레임에 낼 탭 구멍)



- **빨간색** 나사 부분 – 뚜껑, 바닥 모두 프레임에 3 mm 깊이로 뚫기 (깊이 조정 가능)
- 구멍 위에 5 T 두께, 사각틀 모양의 아크릴(또는 비절연성 재질) spacer 를 대고 위에서 나사로 고정 예정



뚜껑 위에서 내려다 본 모양 (나사 구멍 위치)

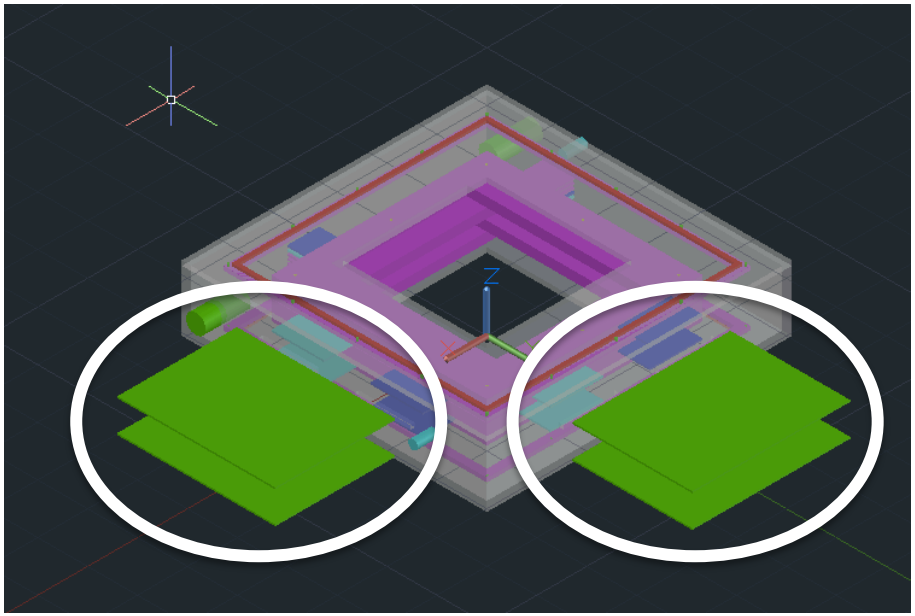


오링과 5T 두께의 스페이서

- 노란색 나사를 박을 구멍 – 바닥 알루미늄 프레임에 3 mm 깊이 (필요하면 더 깊이 뚫고 알루미늄 프레임 두께를 증가시킬 수도 있음)
  - 위치(x, y 축 기준 120 mm, 3T짜리 나사 박을 수 있는 구멍)
- 빨간색 나사를 박을 구멍 – 뚜껑과 바닥 알루미늄 프레임에 3 mm 깊이 (필요하면 더 깊이 뚫고 알루미늄 프레임 두께를 증가시킬 수도 있음)
  - 위치(x, y 축 기준 80, 160 mm, 3T짜리 나사 박을 수 있는 구멍)

기판 지지대

- 2개 측면에 2개 보드를 메인 프레임에 지지대를 이용하여 고정
- 구조는 연결할 각종 커넥터와 구멍을 막지 않으면 어떤 것이든 가능함



시제품용 기판 지지 방식

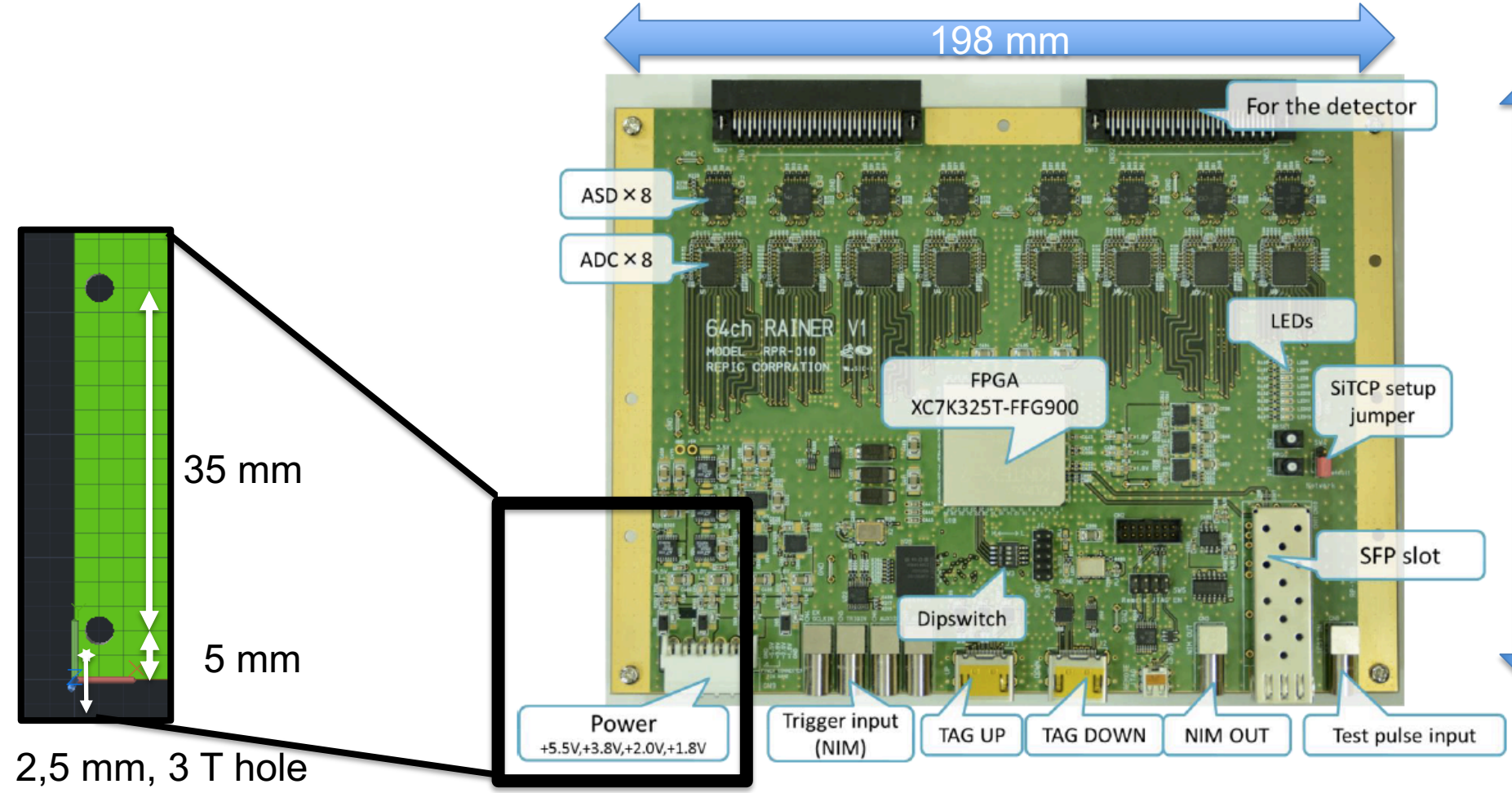
- cosmic muon test까지 가능하도록 프레임에 세워서 지지하는 방식으로

본제품용 기판 지지 방식

- If 기판이 0.2-0.3 T의 magnetic field와 진공 환경에서 동작이 가능하다면 (Anyone have answer?)
  - Y : vacuum chamber 안에 위치(보드와 검출기의 거리는 가까워야 함), 보드는 눕히는 방식으로 공간 최소화
  - N : ASD 보드는 vacuum chamber 외곽에 위치해야 함

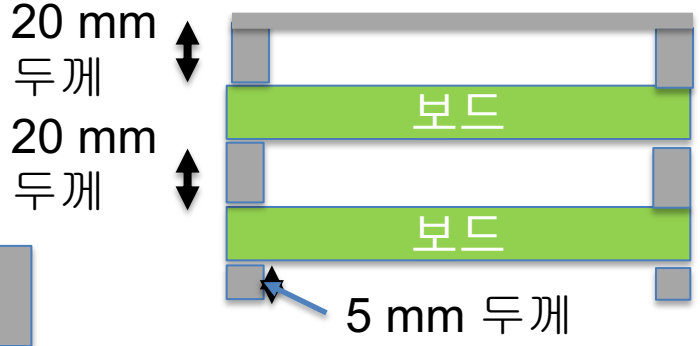
고정 시킬 기판의 정보

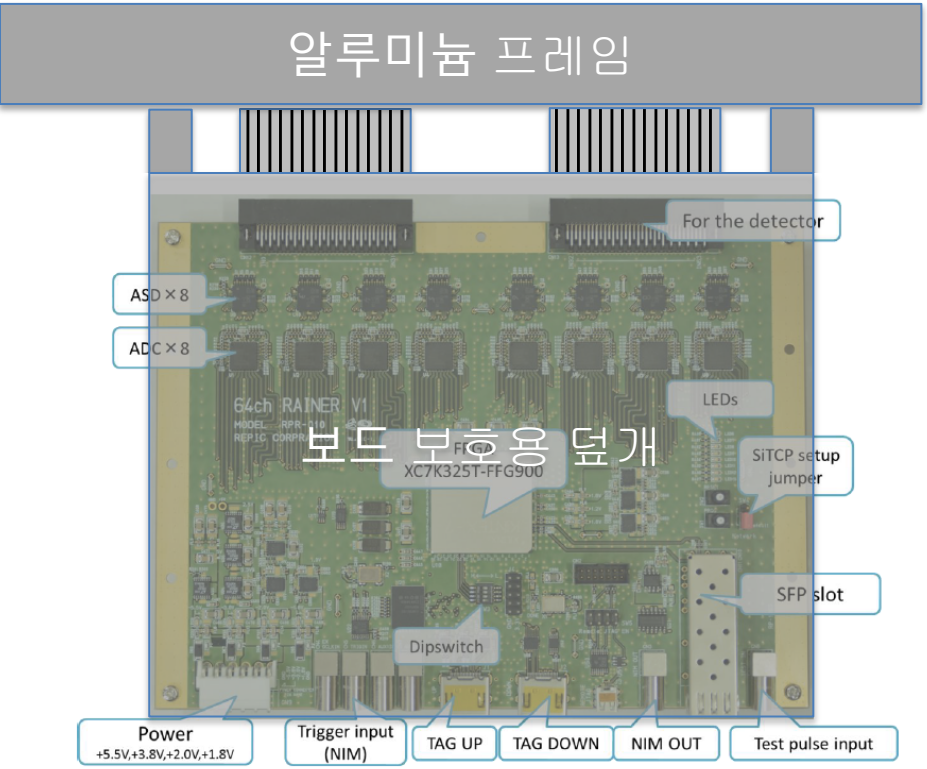
- 두 측면에 이런 기판을 **2**층으로 고정해야 하고,
- 기판 사이 **20 mm** 이상의 차이는 둬야 함

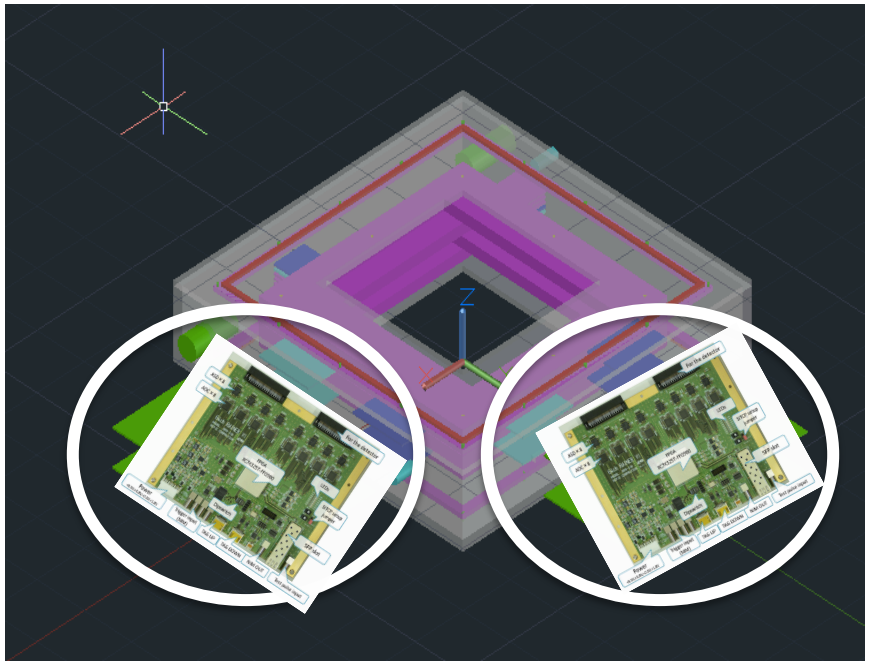


기판 지지대

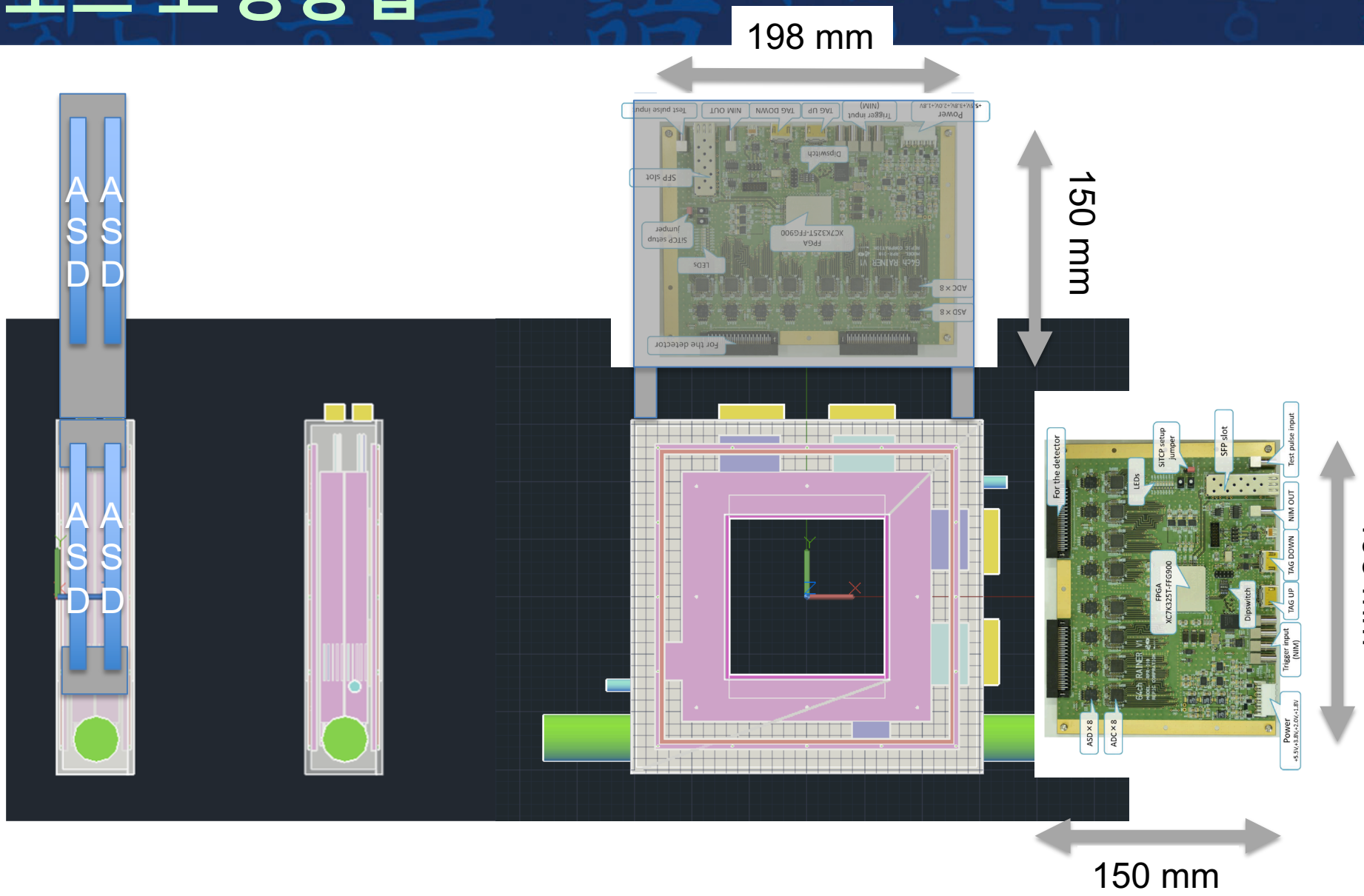
- 보드의 **IDC** 커넥터가 프레임에 가까운 쪽으로 향해 있어야 함







보드 고정방법


198 mm
150 mm
198 mm
150 mm
A S D
A S D
A S D
A S D
For the detector
SiTCP setup Jumper
SFP slot
Test pulse input
LEDs
NIM OUT
TAG DOWN
TAG UP
Dipswitch
Trigger input (NIM)
FPGA
XC7K325T-FFG900
ASD × 8
ADC × 8
Power

예상 견적 내용

총 1억 5000 만원 예상

BDC 본제품 제작을 위한 견적서

No.1	품 명 및 규 격	단위	수량	단 가	금 액	비고(발주처정보)
1	outer frame (내부 wired chamber 제외)	식	2	20,000,000	40,000,000	영하이테크 (백병창 : 042-635-2845)
	-.400mm*400mm*100H (15T)					
	-.Chamber Wall electro polishing					
	-.설계및 제작					
	-.Vacuum Test					
	Flange					
	-.SHV CF1.33", DC5KV10A	ea	4			
	-.SUB-D ,37pin	ea	16			
	-.outside Plug & inside Plug	조	2			
	Chamber 제작을 위한 각종 잡자재 및 인건비					
2	ASD boards	개	7	10,000,000	70,000,000	Hayashi-Repic Co., LTD.
	- 총 4개 소요, 3개 추가 주문(여분 1개)					https://www.h-repic.co.jp
3	chamber 거치대	식	2	2,500,000	5,000,000	영하이테크 (백병창 : 042-635-2845)
4	와이어(길이 270 m), 운송비 포함		1	2,500,000	2,500,000	California Fine Wire company
	- Signal : Au coated Tungsten (20 micron)					https://calfinewire.com/request-quote/
	- Potential : Au coated Aluminium (80 micron)					
5	anode, cathode planes, spacers			2,000,000	2,000,000	이룸테크 (임도진 : 02-3281-2484)
	- anode : xy, x'y' 각 8매 이상					
	- cathode : 18매 이상					
	-spacer : 0.5 mm 간격 35매 이상					
6	Metalized mylar				1,600,000	G-Tech Corp. (Japan)
						goto@ggg-tech.co.jp
7	HV module (CAEN N 1471 HET)		1		8,000,000	오토텍
						http://atkinc.com/Introduction
8	LV modules	개	2	700,000	1,400,000	엘레파츠
						https://www.eleparts.co.kr/main/index
9	유량자동조절시스템	식	1	15,000,000	15,000,000	영하이테크 (백병창 : 042-635-2845)
10	각종 소형 부품 등 잡비용				4,500,000	
	- 기판 고정용 부품들					
	- Electronics까지 연결할 케이블					
	- 데이터 처리를 위한 DAQ 장비 등					
	소 계				150,000,000	VAT포함

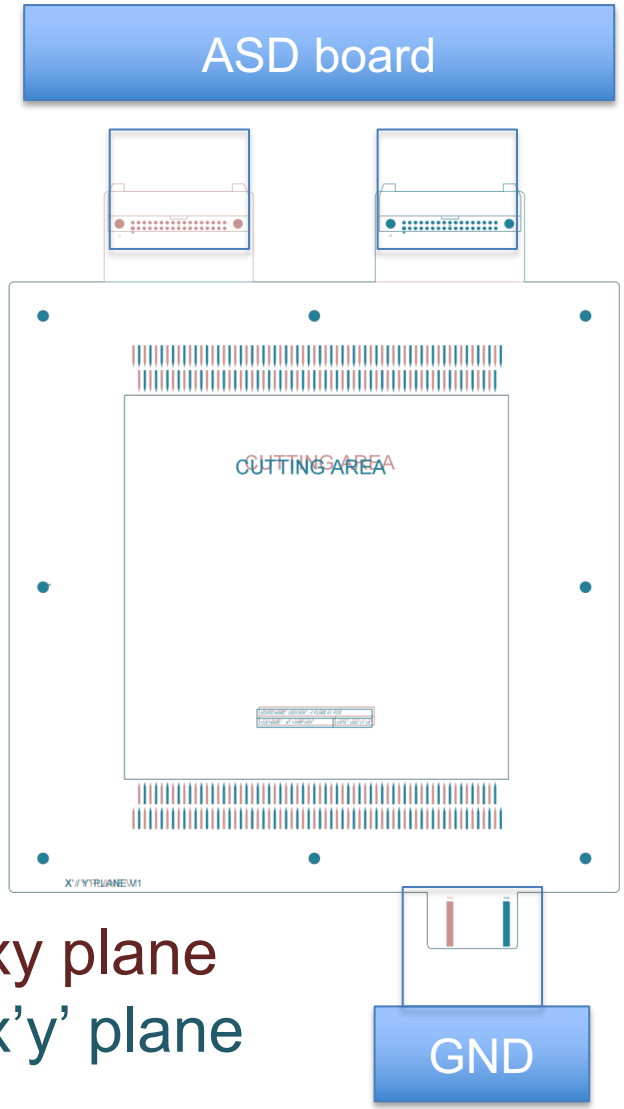
Need 5 more

Hopeful plan for next

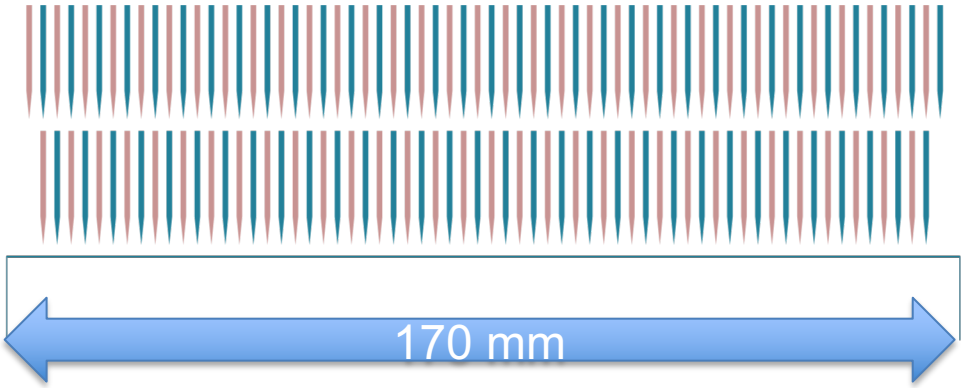
- Aug. 3rd : Order the outer frame, DAQ code check
- Aug. 4th : Assemble the inside chamber with 4 anode layers (KRISS)
- Sep. 1st : Assemble outside frame
- Sep. 2nd : Test with cosmic muons, try to wiring 4 anode planes
- Sep. 3rd : Try to wiring 4 anode planes
- Sep. 4th : Try to wiring 4 anode planes
- Oct. 1st : Assemble the second set + test

- Will continue, if we could

Design of anode planes



Drift length : 2.5 mm

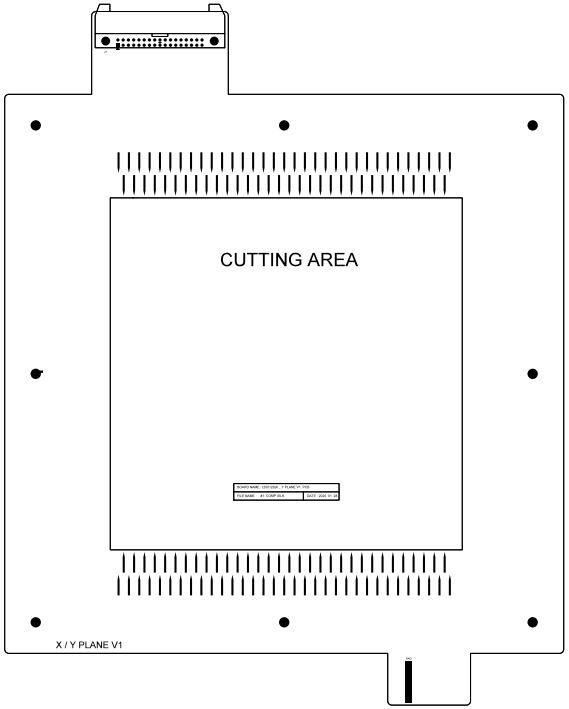


xy plane is shifted from x'y' plane
with 2.5 mm spacing

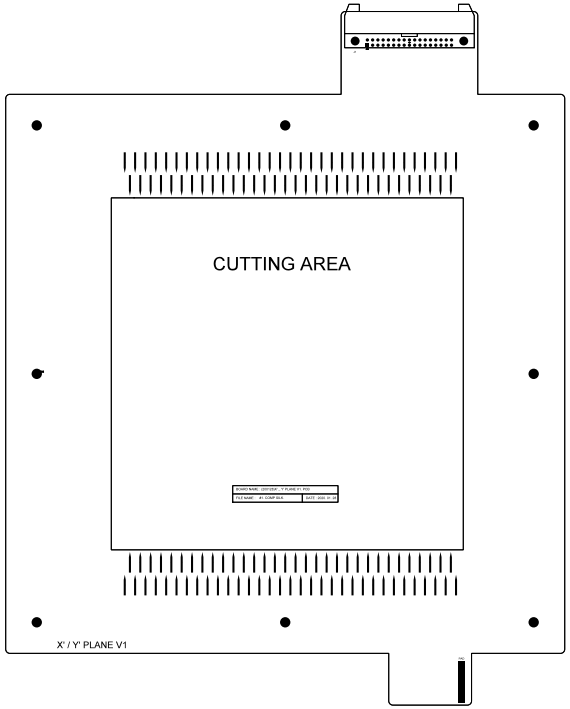
Designed by Sanghoon Hwang

Design of prototype BDC

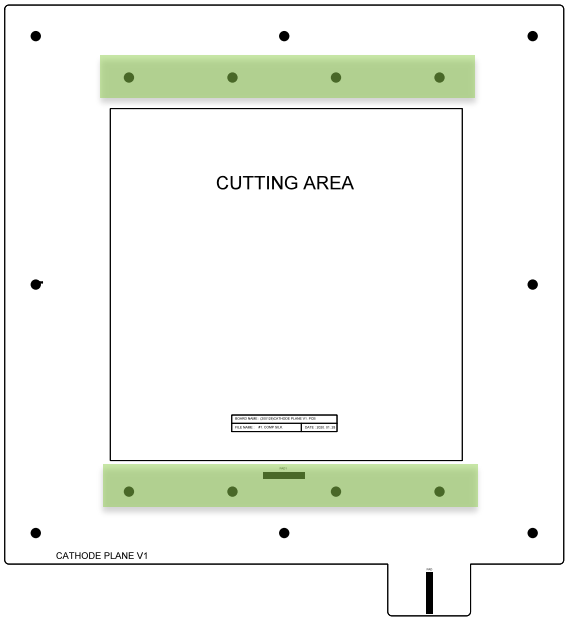
xy plane



x'y' plane



cathode plane



Holes for gas circulation

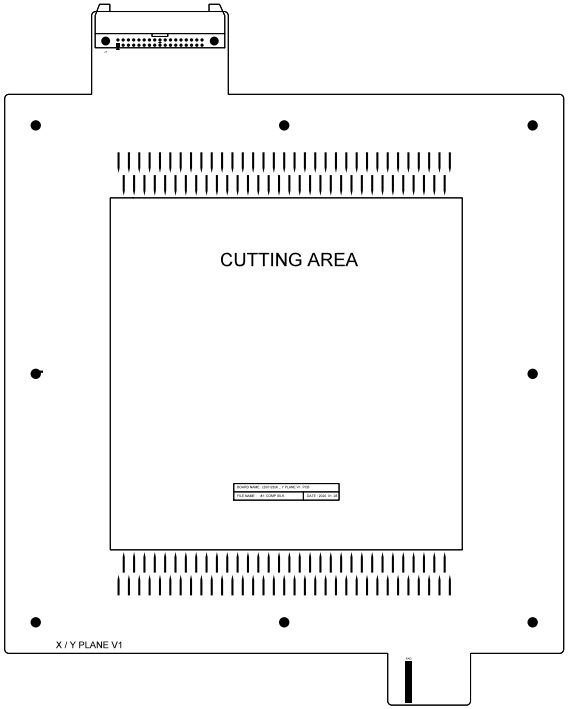
Designed by Sanghoon Hwang

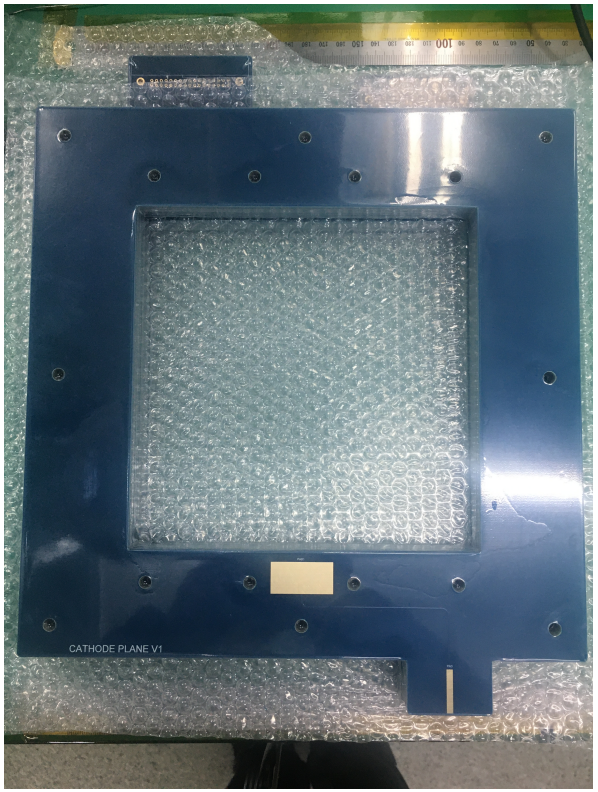
Gas가 순환하는데 이 구멍이면 충분한가?

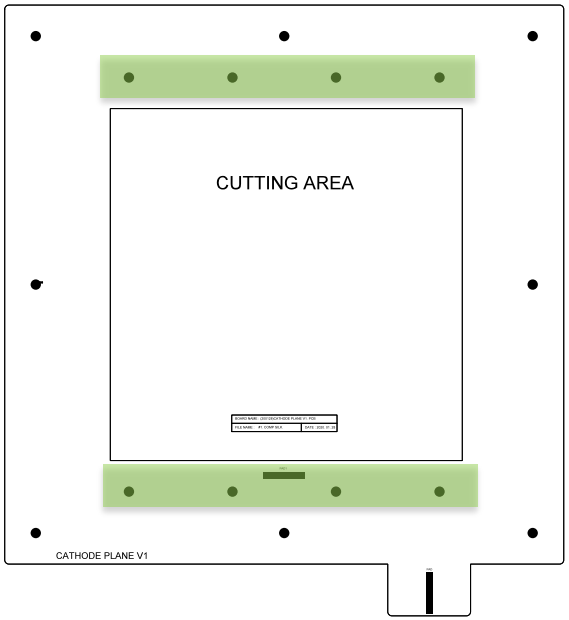
Design of planes

R : 1.5 mm

cathode plane







Holes for gas circulation

Designed by Sanghoon Hwang

Q) Gas가 순환하는데 이 구멍이면 충분한가?

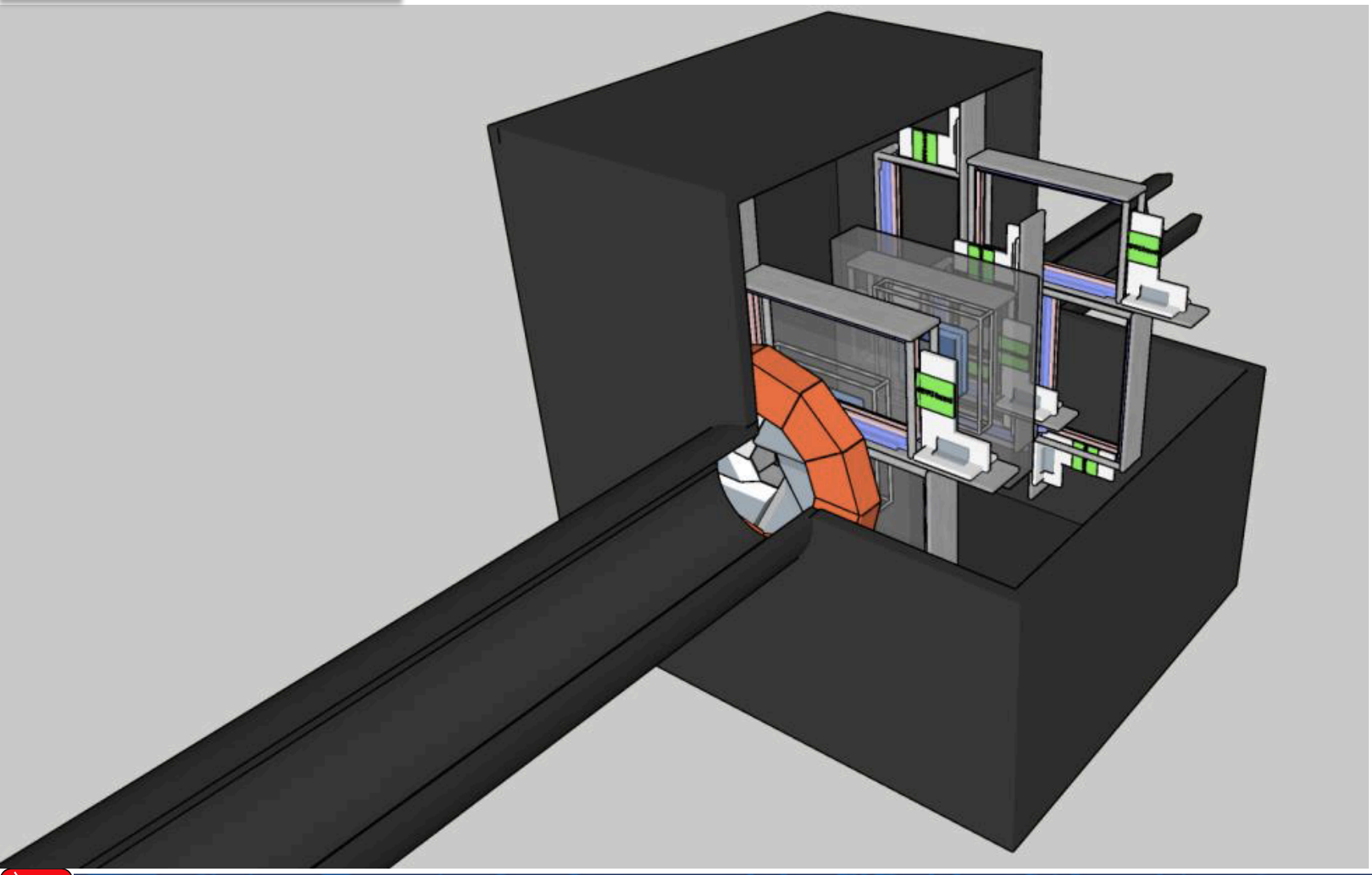
Applied gas to chamber

- **P-10 mixed gas**
- **Pressure : 100 torr (same as the pressure inside the vacuum chamber)**
- **Needed volume**
  - Volume inside BDC : 37*37*7 cm^3 = 9.583 L
  - Structure's volume (planes) = 2.288 L
  - Estimated gas volume : 7.3 L / set
  - Circulation rate : ~ 200 mL / minutes (~ 300 mL / min in initialization step)
    - ~ 35 minutes / 1 circulation

New version of LAMPS design (이형준)

Vacuum chamber

Cylindrical shape -> rectangular shape

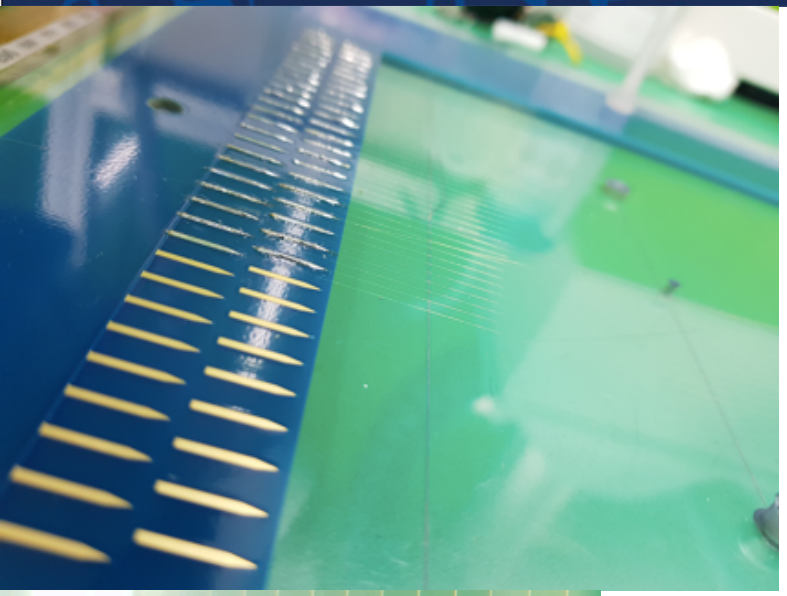


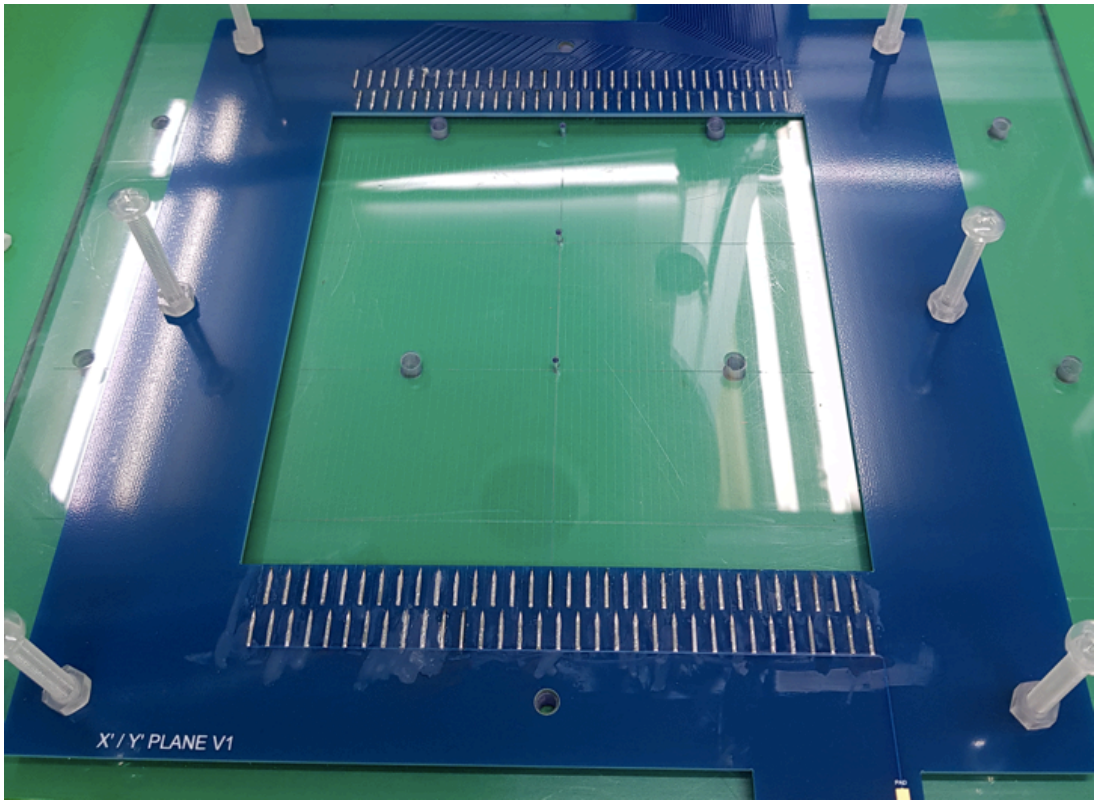
Setup for wiring in clean room, KRISS

- Jaein (undergraduate student) worked at KRISS in Feb. 10-14

Wire thickness : 16 μm
Gold coated tungsten wires
for signal and potential wires

Plane after wiring





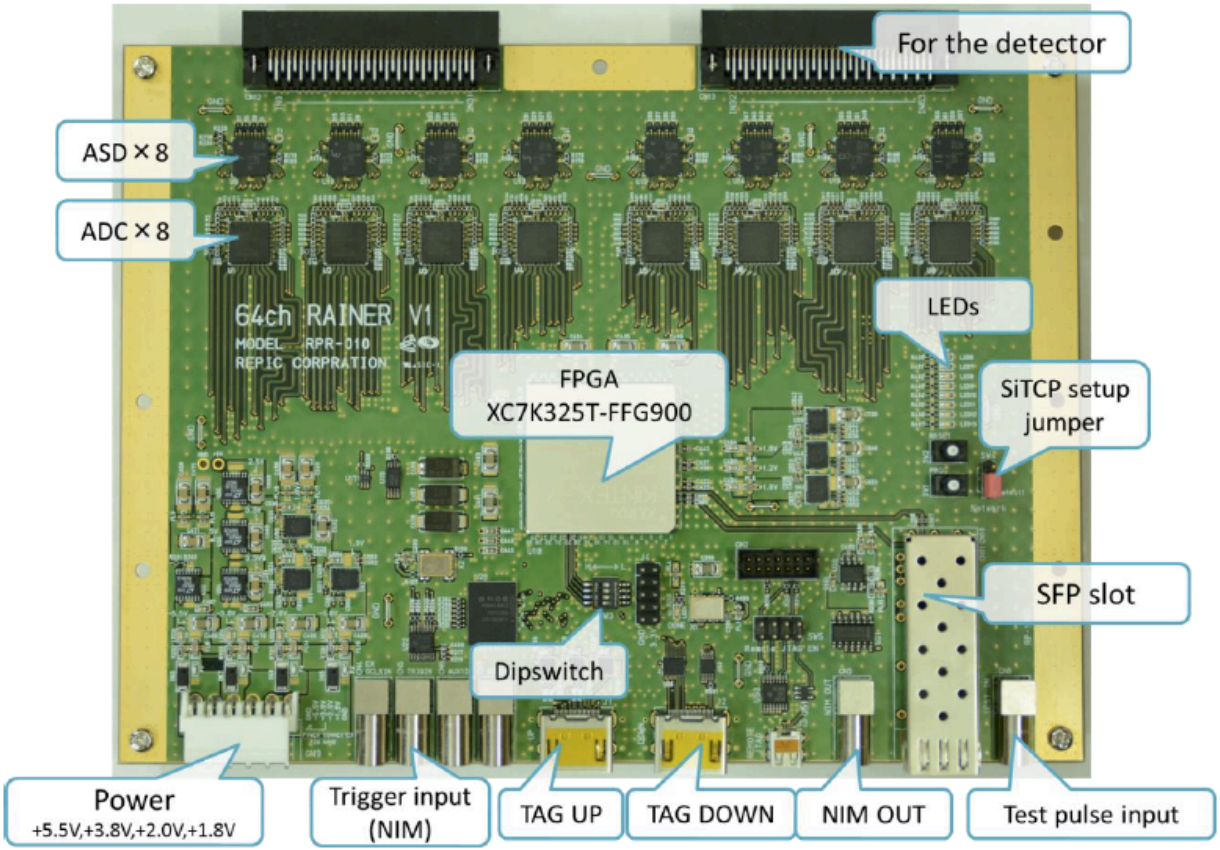
Wiring is done in 1 xy plane and 1 x'y' plane

Next step for prototype BDC

- **Cleaning and assembly chamber**
  - Clean wired planes in the machine
  - On the cathode plane, attach the metalized mylar
  - To keep 2.5 mm spacing between mylar and wires, attach the spacer (0.5 mm thickness)
  - And assembly chamber for the test
    - Cathode-xy plane-Cathode-x'y' plane-Cathode

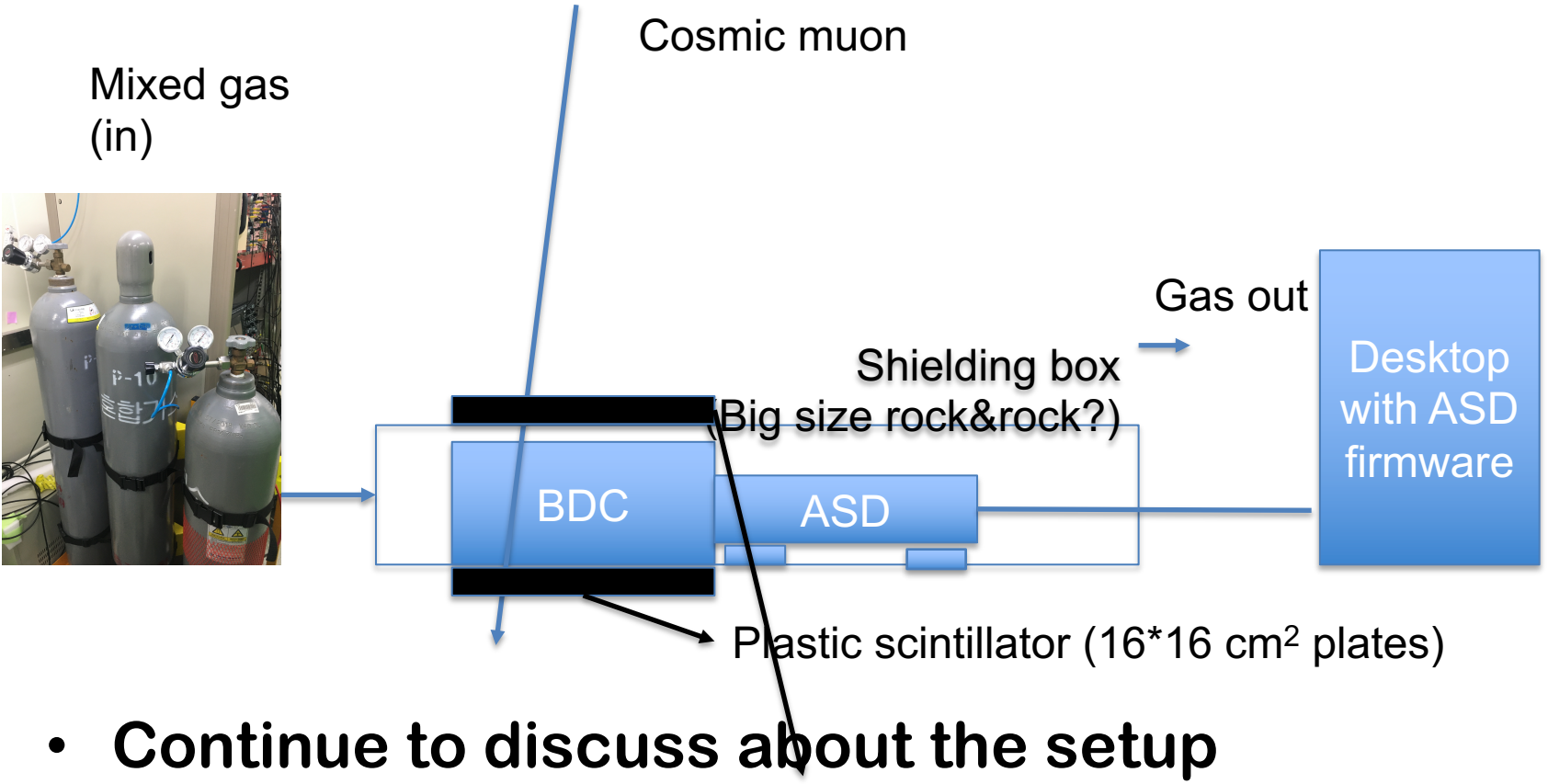
- **Hope to continue in next week..**

Preparation of ASD board test



- Power input connector : S6P-VH
- 6 wires should be connected (GND, +5.5V, +3.8V, +2.0V, +1.8V, GND), Maximum current : 5A
- 2 * 2 channel power supply are needed
  - 1 from KRISS, 1 will be ordered

(Preliminary) setup of the prototype BDC test



- **Continue to discuss about the setup**

SAMURAI BDC (Beam Drift Chamber)

- https://www.nishina.riken.jp/RIBF/SAMURAI/image/Detector-BDC.pdf

[2-4-3] Beam Drift Chambers (BDC1, BDC2)

* Design

Two sets of BDC's are used to measure the phase space of the incident secondary beams on the reaction target. It is a Walenta-type drift chamber with 2.5mm drift distance for high beam rates. BDC is shown in Fig. 2-4-2, and summarized in the table.

Anode wire	16 μ m ϕ Au-W/Re
Potential wire	80 μ m ϕ Au-Al
anode – potential (drift) distance	2.5mm
anode – cathode gap	2.5mm (combination of 2.4mm & 2.6mm-thick G10)
cathode	8 μ m-thick Al-Kapton, x 9
gas window	4 μ m-thick Aramid, x2
effective area	80mm x 80mm
anode configuration	xx'yy'xx'yy'
#anode / plane x #planes	16 wires/plane x 8 planes = 128 wires/detector
Operation gas	He+60%CH_4 at 1 atm, i-C_4H_{10} below 200 torr
HV	cathode, potential
Readout / 2sets	ASD x16, ASD PS x2, TDC x4