



Heavy Ion Physics Experiment lab

Nuclear Physics summer School

2013.06.27

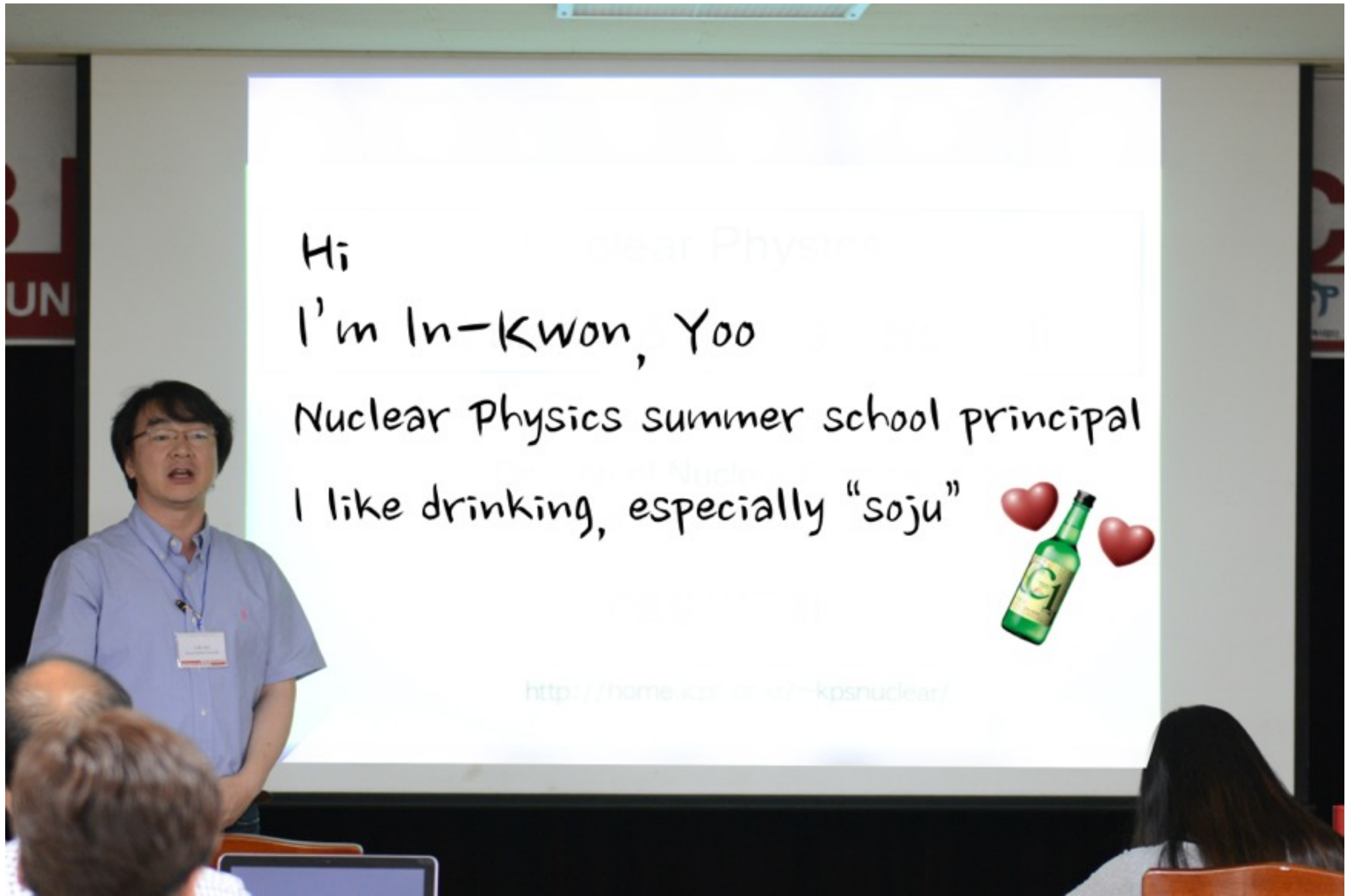
Jiyoung Kim

Pusan National University



Contents

- Introduction of our lab
 - Professor: our boss
 - People: HIPEXers
- Working now
 - participation of research
 - STAR(BNL, USA)
 - CBM(GSI, GER.),
 - ALICE(CERN, SWIT)
 - Mainly doing: RICH R&D
 - Cherenkov radiation
 - RICH2.5 R&D: (PMT / DAQ / Housing)



Our Boss



Our HIPExers

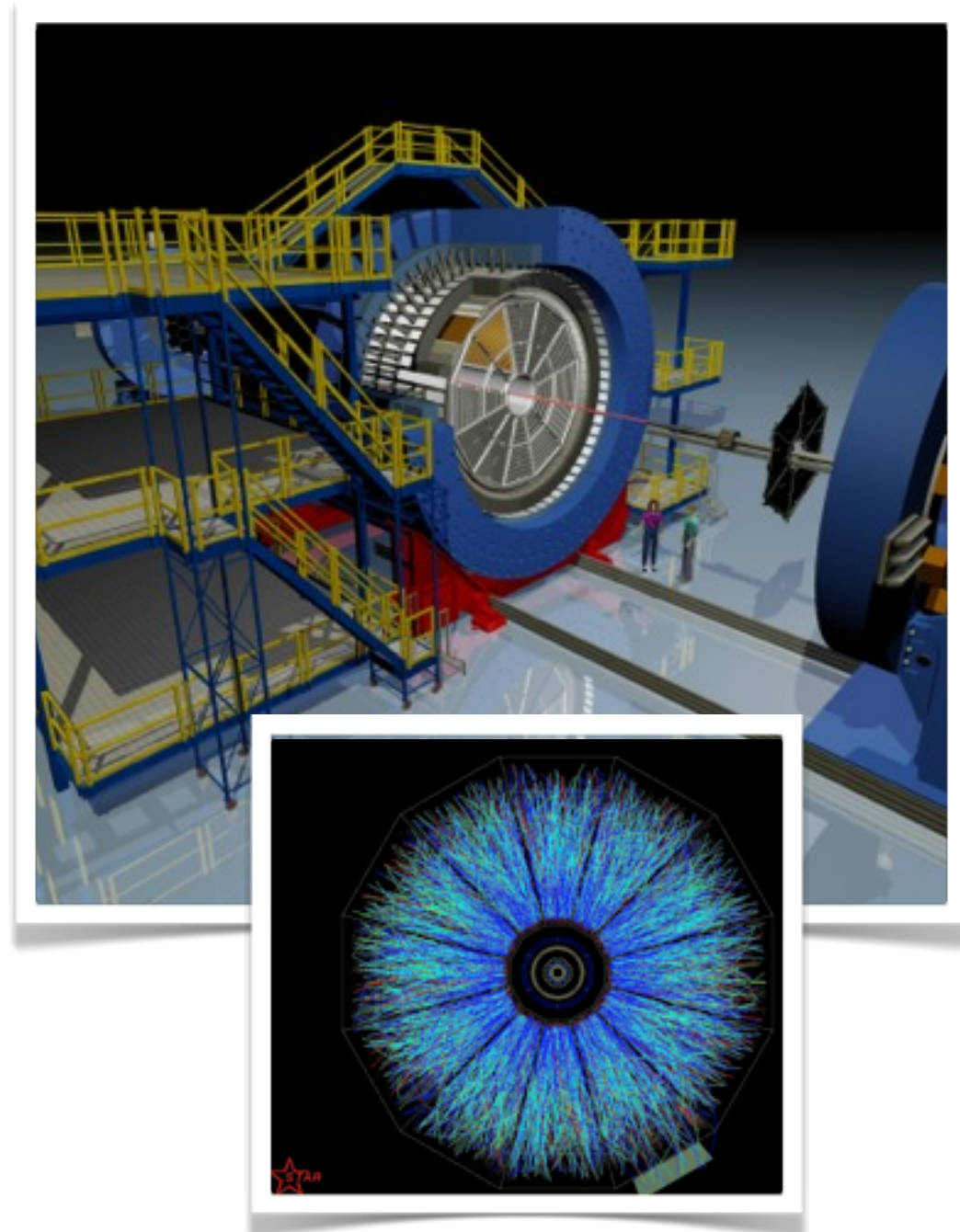
Ph.D course 4
M.S course 5
Secretary 1
(prof.Yoo)
total 11



Research Participation

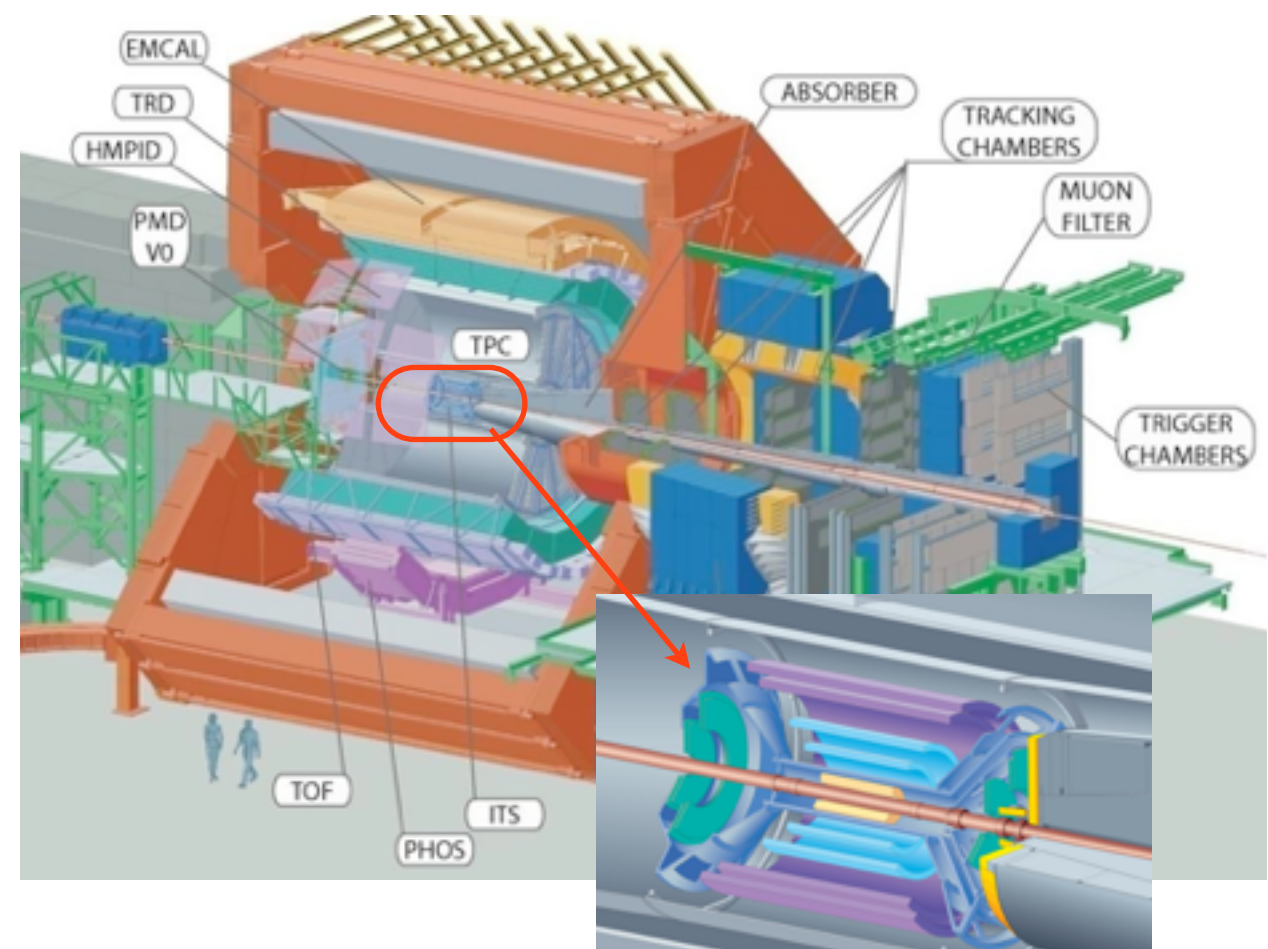
Solenoidar Tracker At RHIC (STAR)

- STAR @RHIC,
Brookhaven National
Laboratory
- Run 10 Au-Au collision low
 p_T non-photonic electron
production analysis
- Contact person of the
STAR Tier I in KISTI
- Kunsu Oh



A Large Ion Collider Experiment (ALICE)

- ALICE @LHC, CERN
- Upgrade of the Inner Tracking System
- Physics performance of beauty electron
- Characterization & qualification of the pixel detector
- Kyungeon Choi, Kunsu Oh, Jungyu Yi, Jiyoung Kim

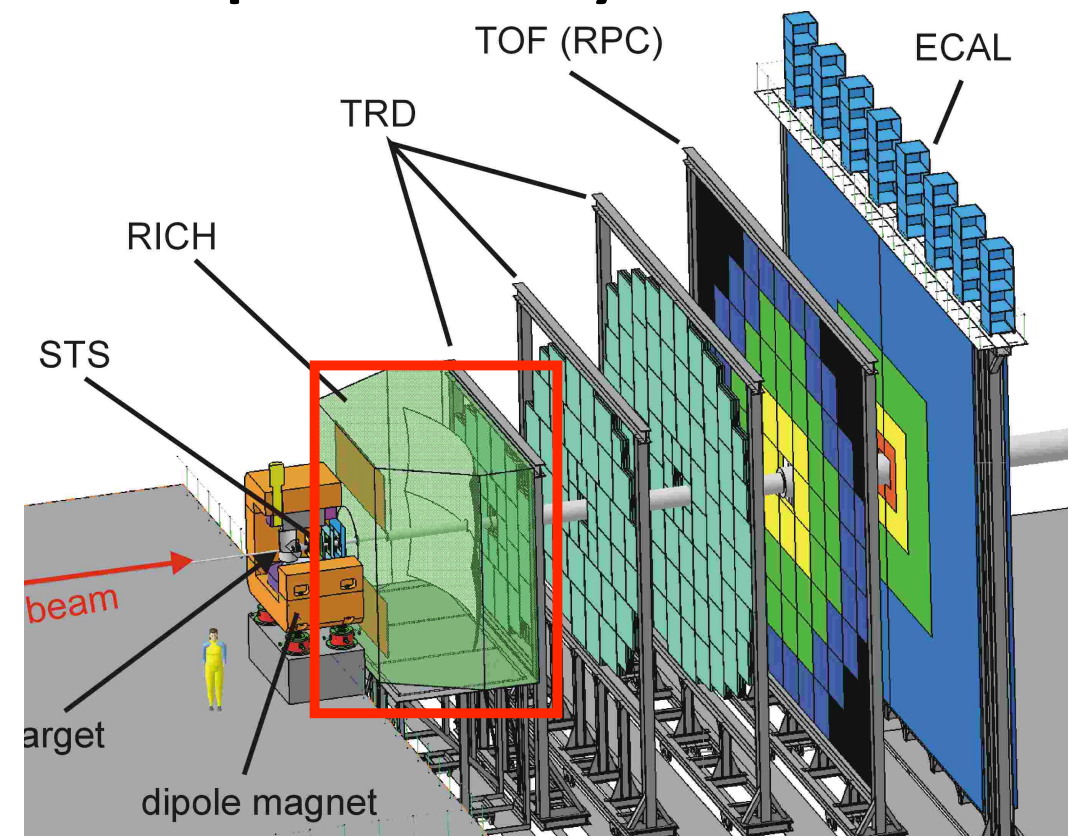


Compressed Baryonic Matter group (CBM)

- CBM experiment @FAIR, GSI
- Aim to construct in 2017~2018
- R&D of Ring Imaging Cherenkov detector system, since 2004
- Jungyu Yi, Jihye Song, Yongho Nam, Yoonsung Jeon, Sanguk Won, Jiyoung Kim

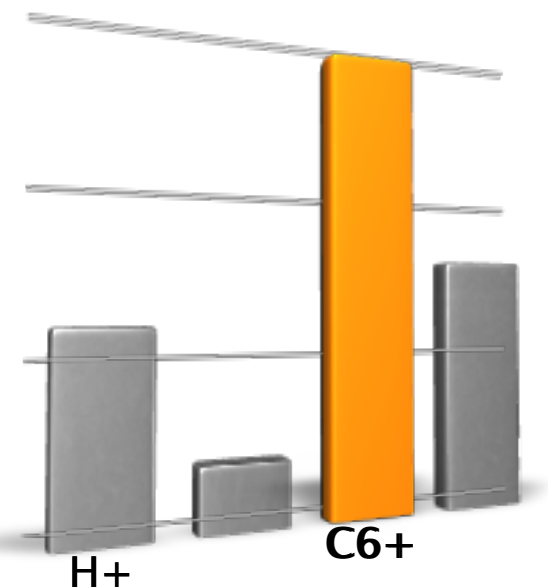
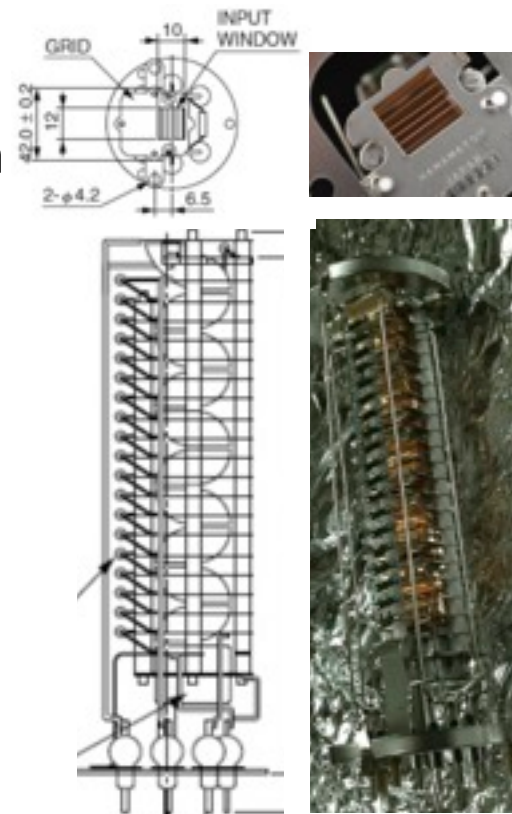
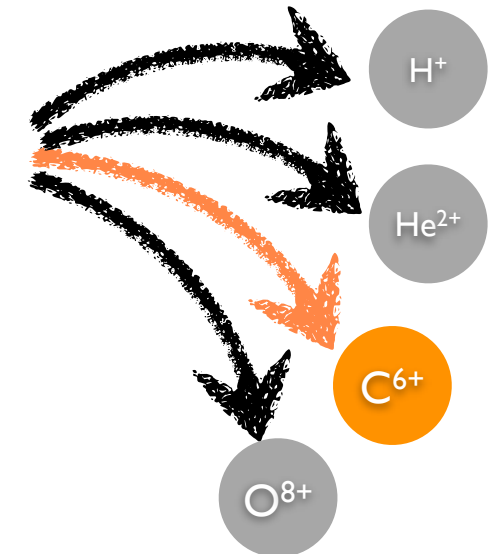
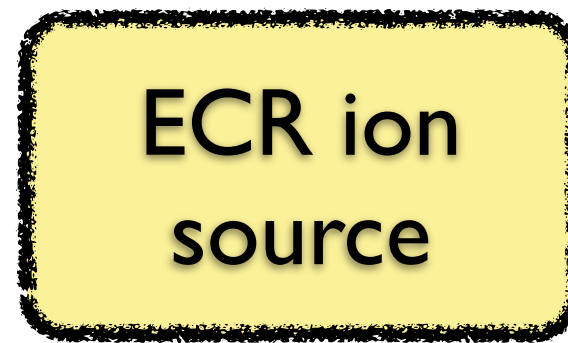


Compressed Baryonic Matter



Development of the analysis method for ECR ion source

- Heavy-Ion medical accelerator uses the $^{12}\text{C}^{6+}$ ions to cure the patient.
- Electron Cyclotron Resonance(ECR) ion source for making $^{12}\text{C}^{6+}$.
 - $^2\text{H}^+$, $^4\text{He}^{2+}$, $^{16}\text{O}^{8+}$
 - We can not distinguish $^{12}\text{C}^{6+}$ ions from $^2\text{H}^+$, $^4\text{He}^{2+}$, $^{16}\text{O}^{8+}$ with B-field because of **same charge-to-mass ratio**.
- Electron Multiplier Tube(EMT)
 - Different gain vs. **ion species**
- The goal is to make the ion distribution from ECR source with EMT.





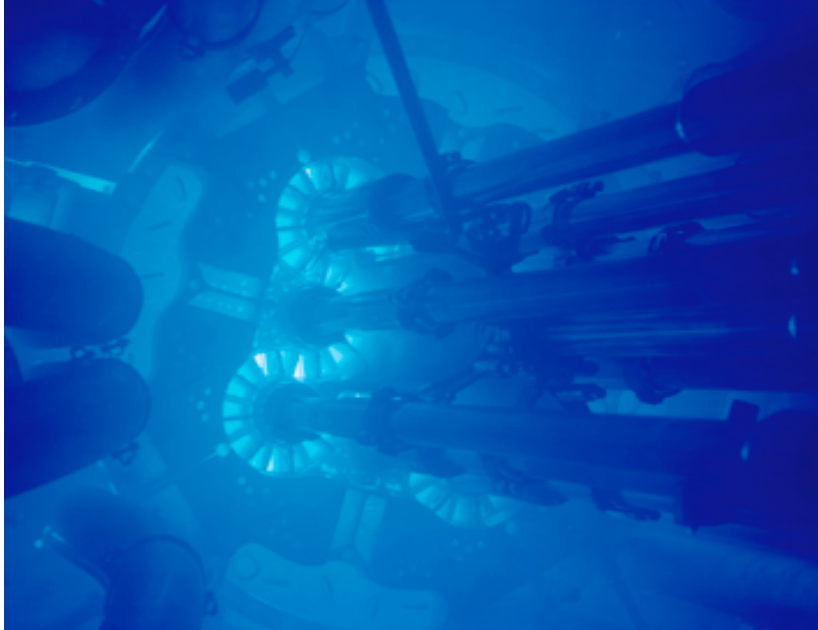
Ring Imaging Cherenkov detector



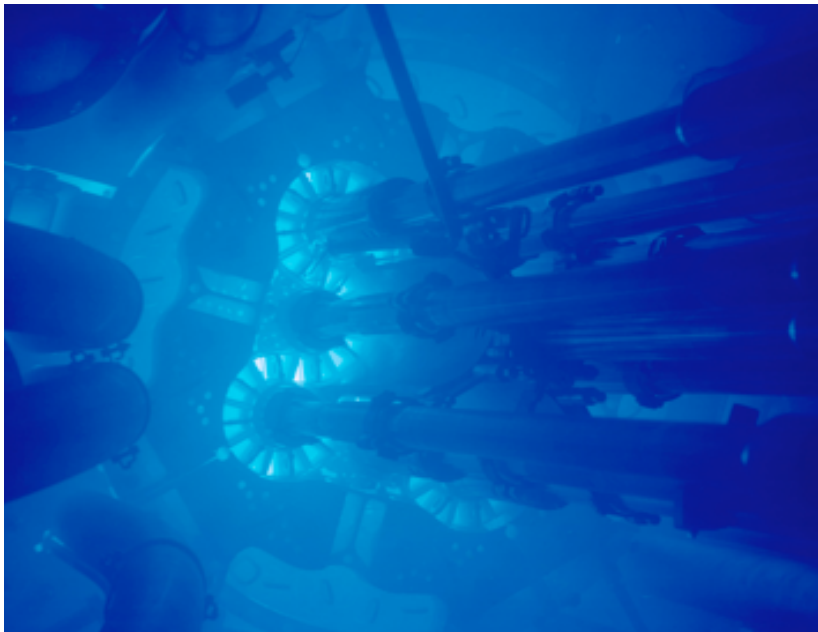
Cherenkov radiation



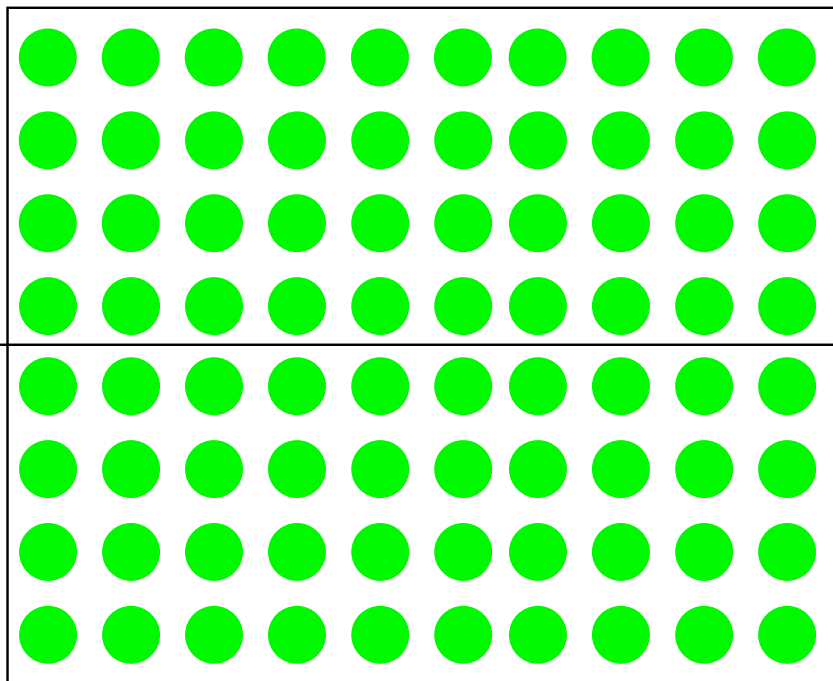
Cherenkov radiation



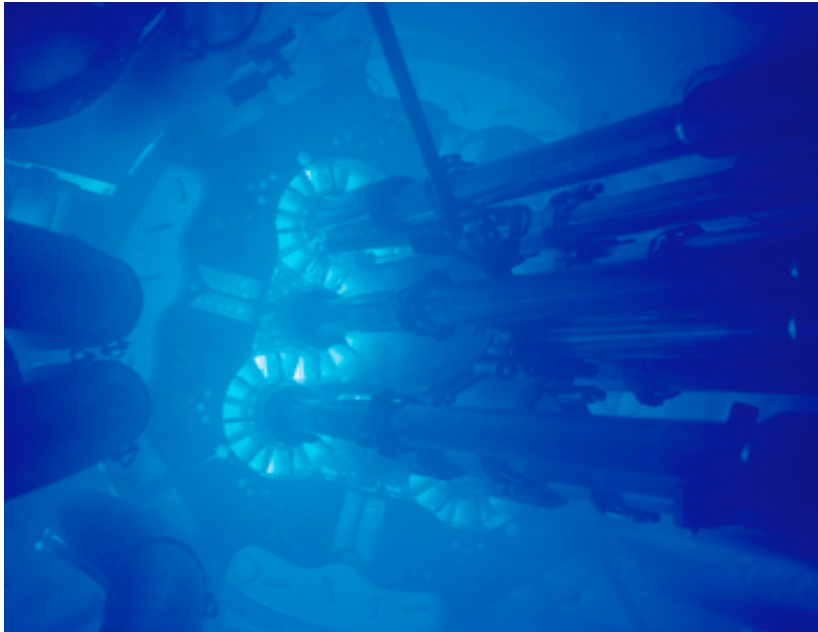
Cherenkov radiation



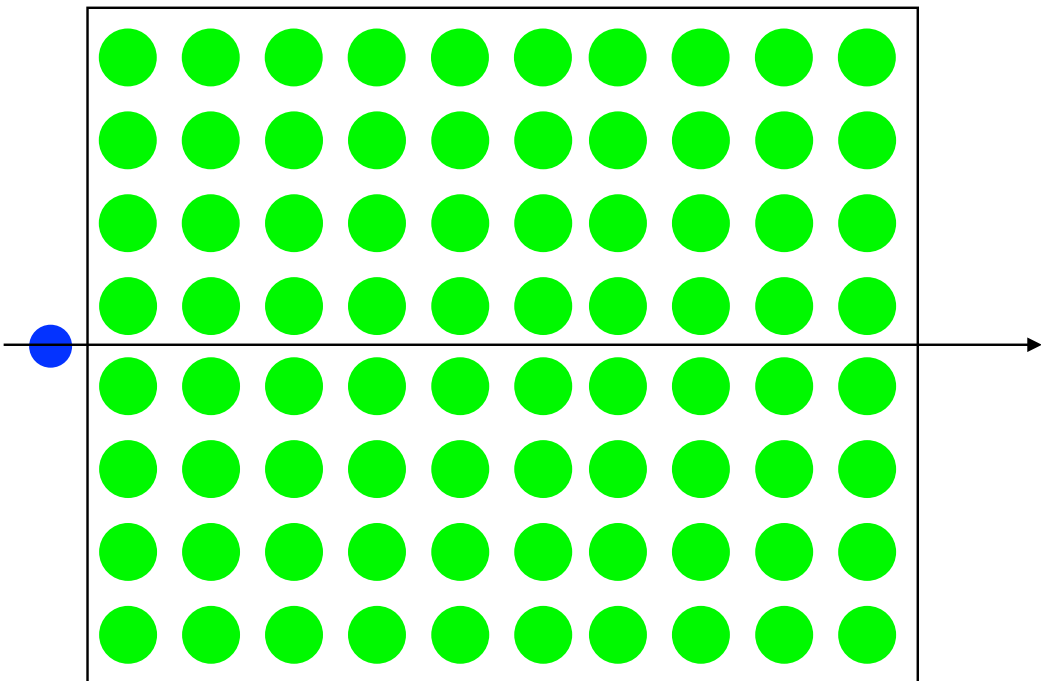
- Neutral Atom
- ↑ Dipole
- charged particle



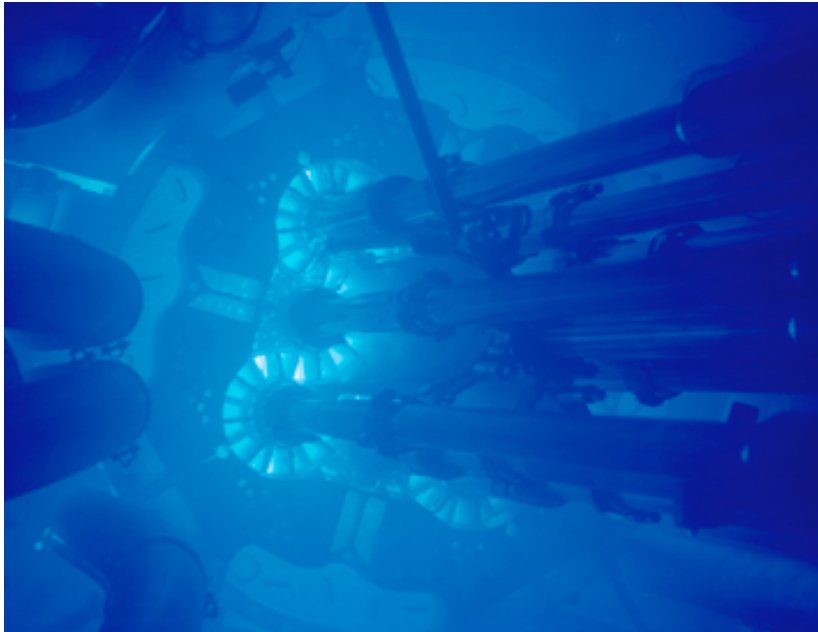
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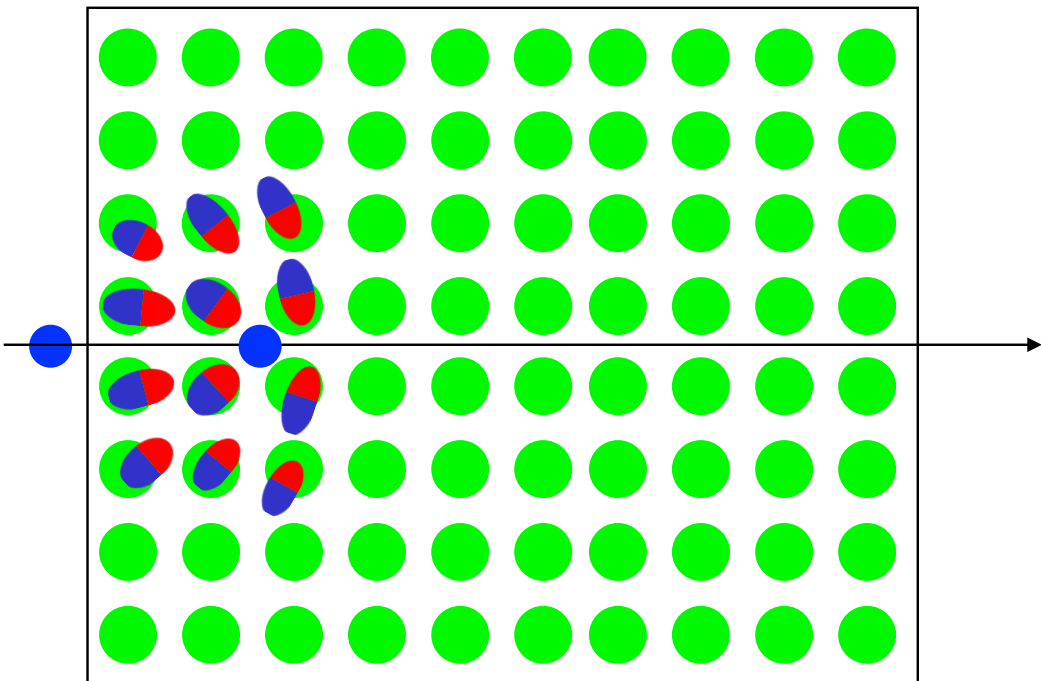
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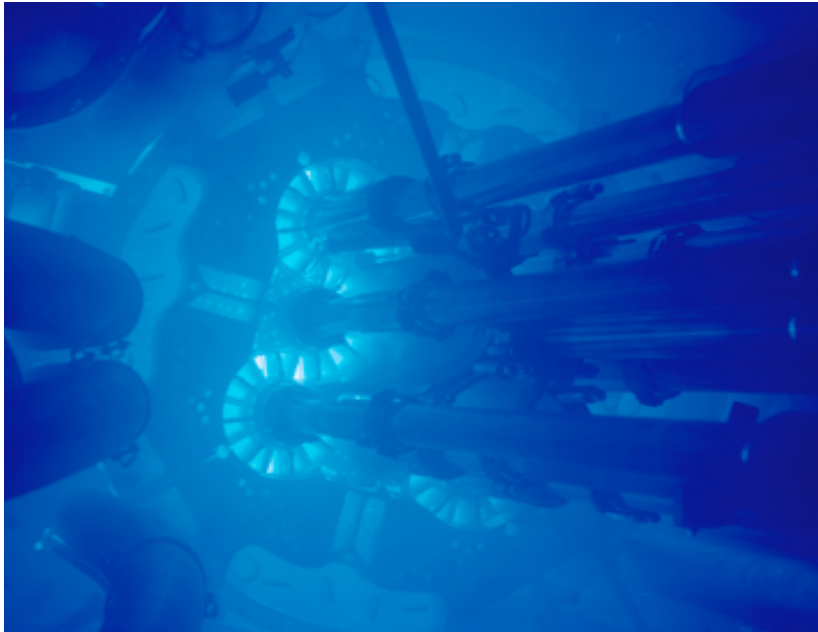
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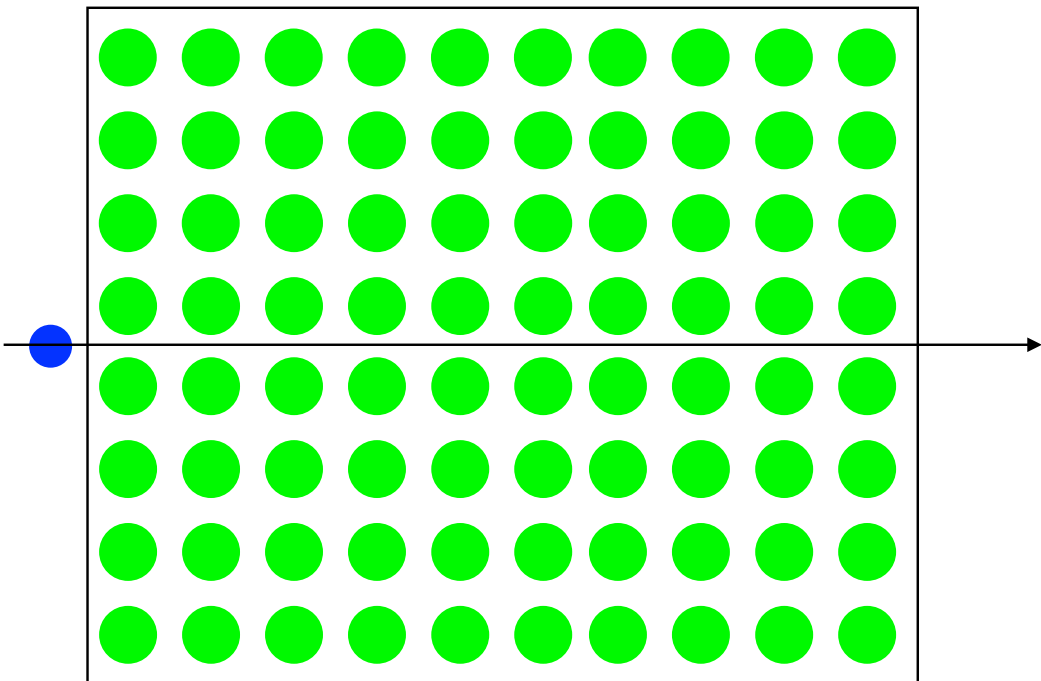
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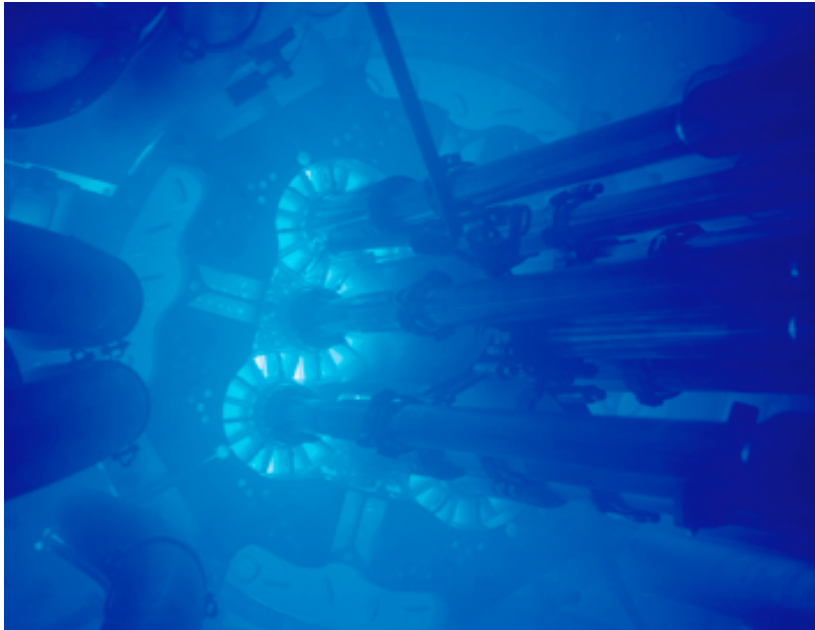
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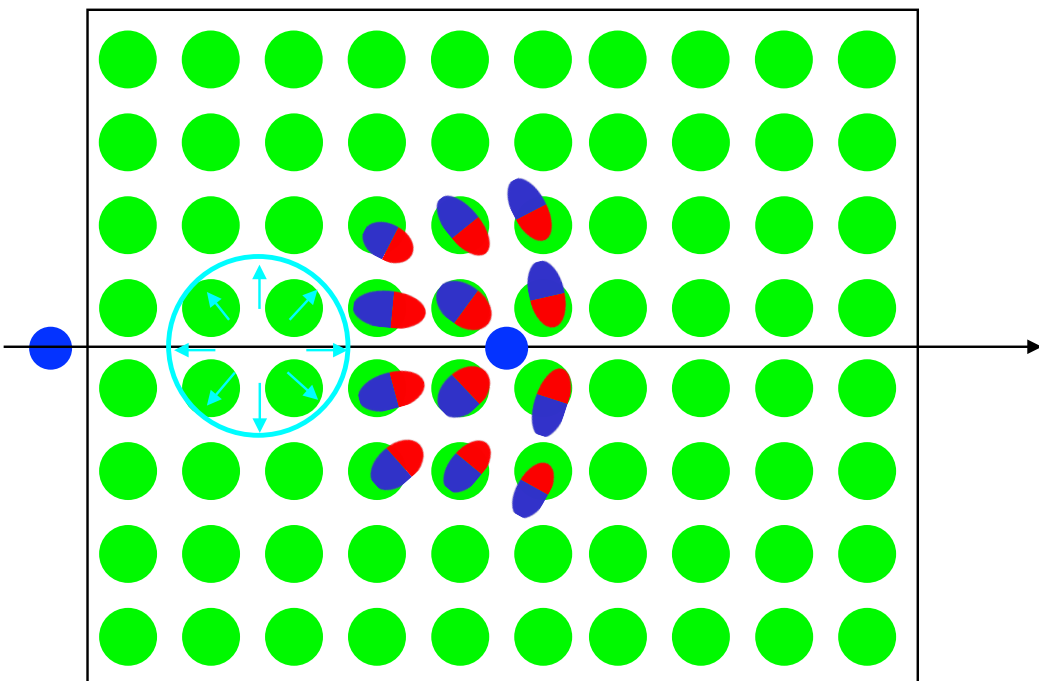
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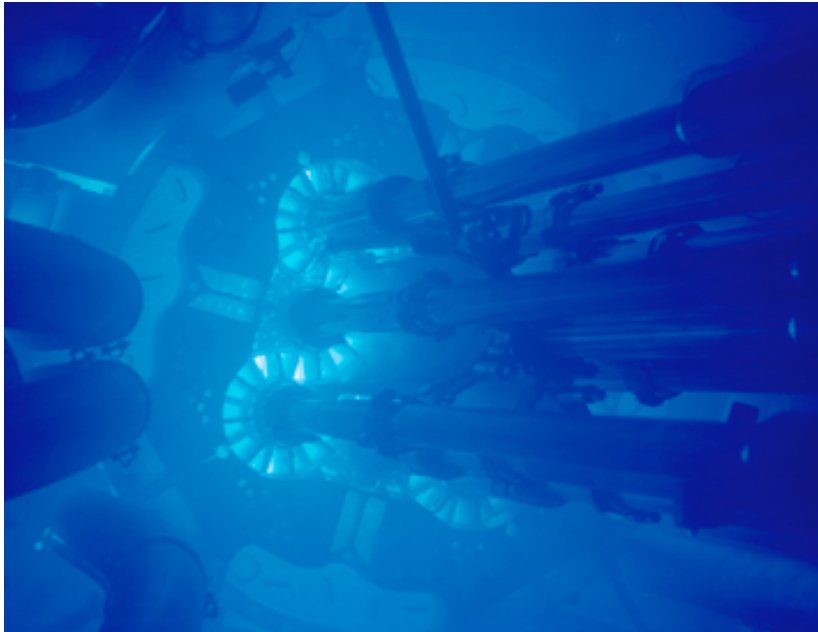
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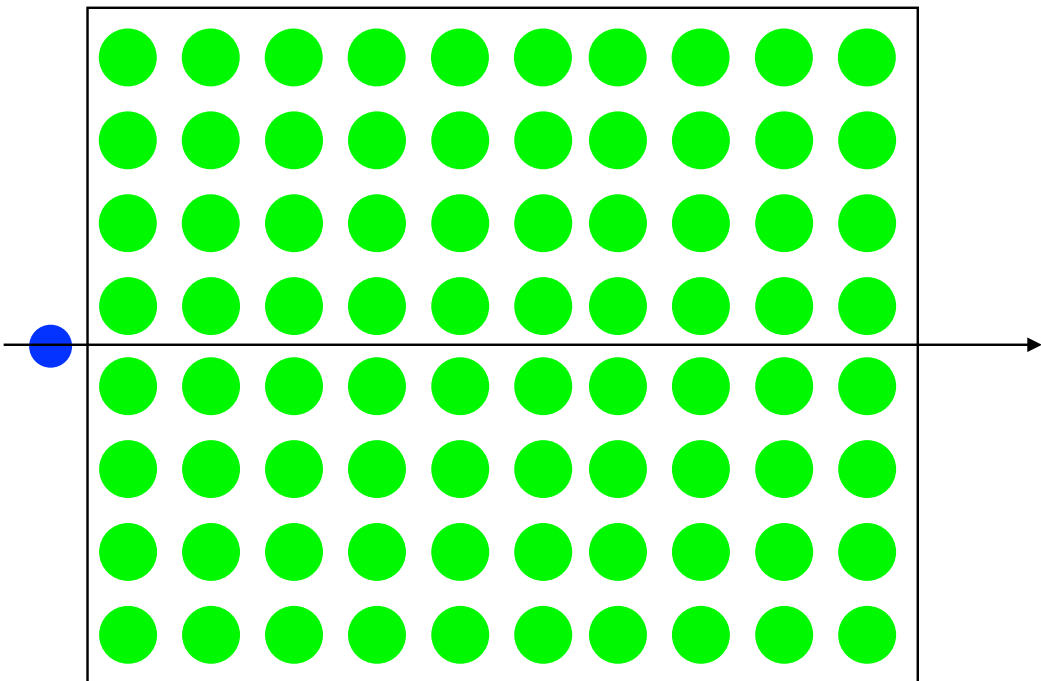
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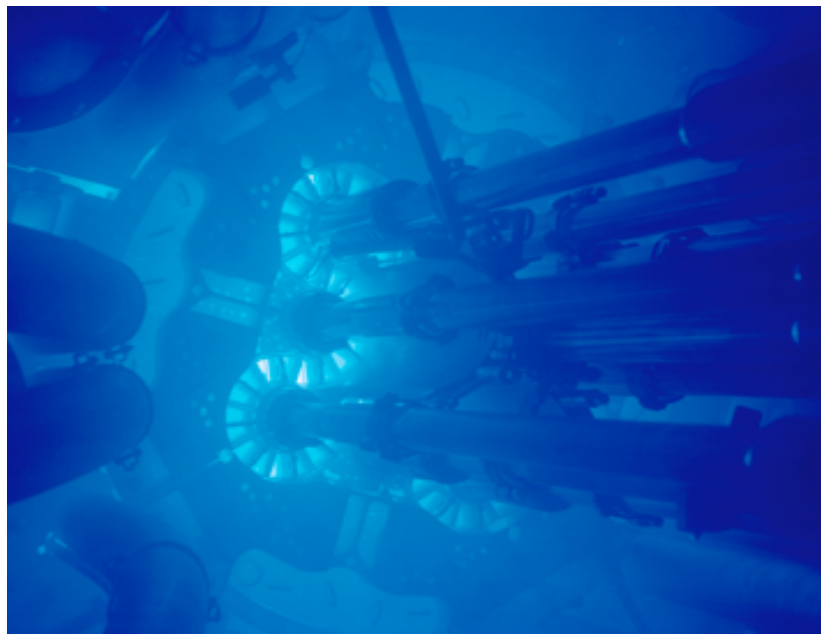
Cherenkov radiation



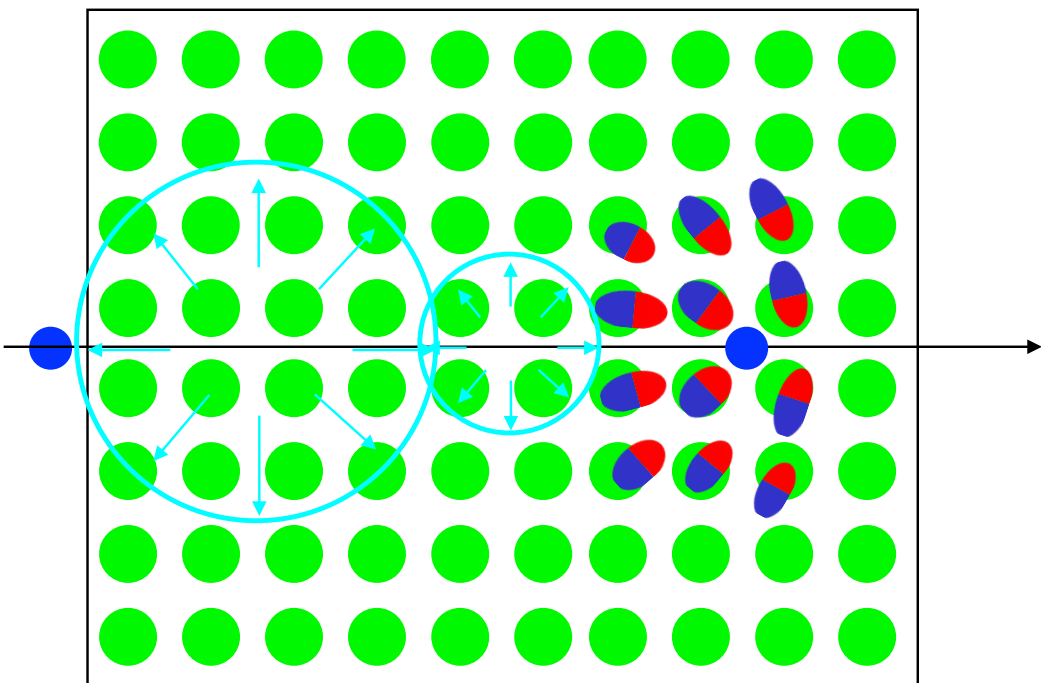
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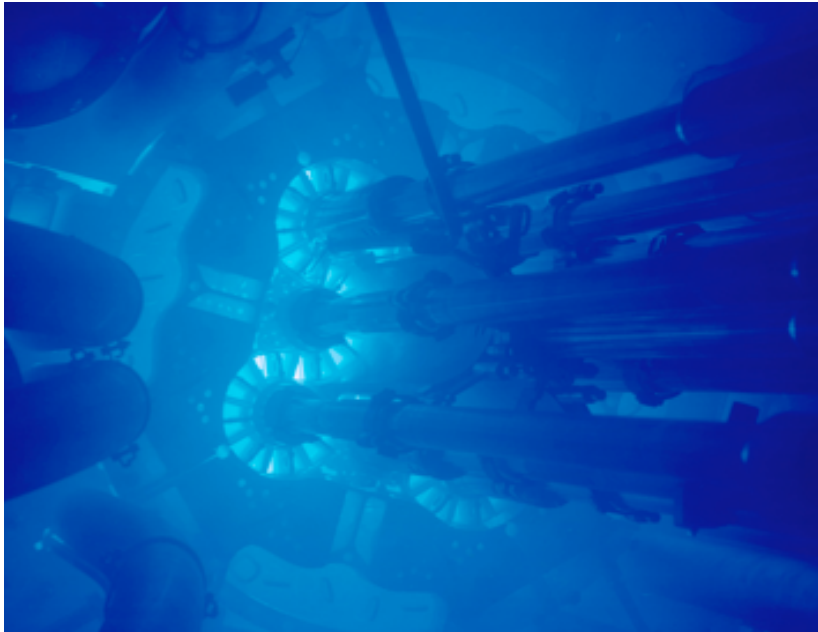
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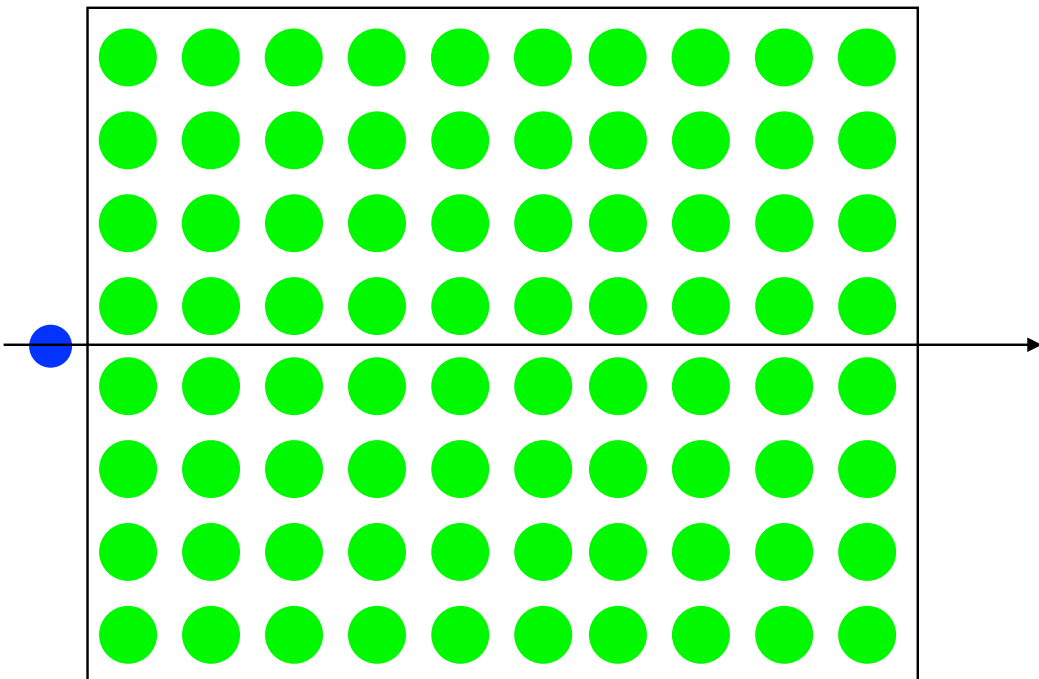
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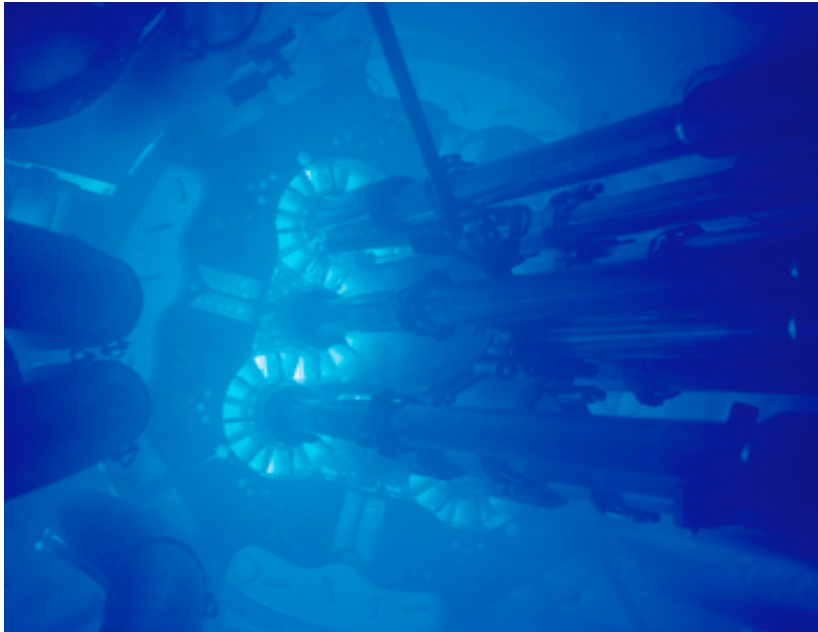
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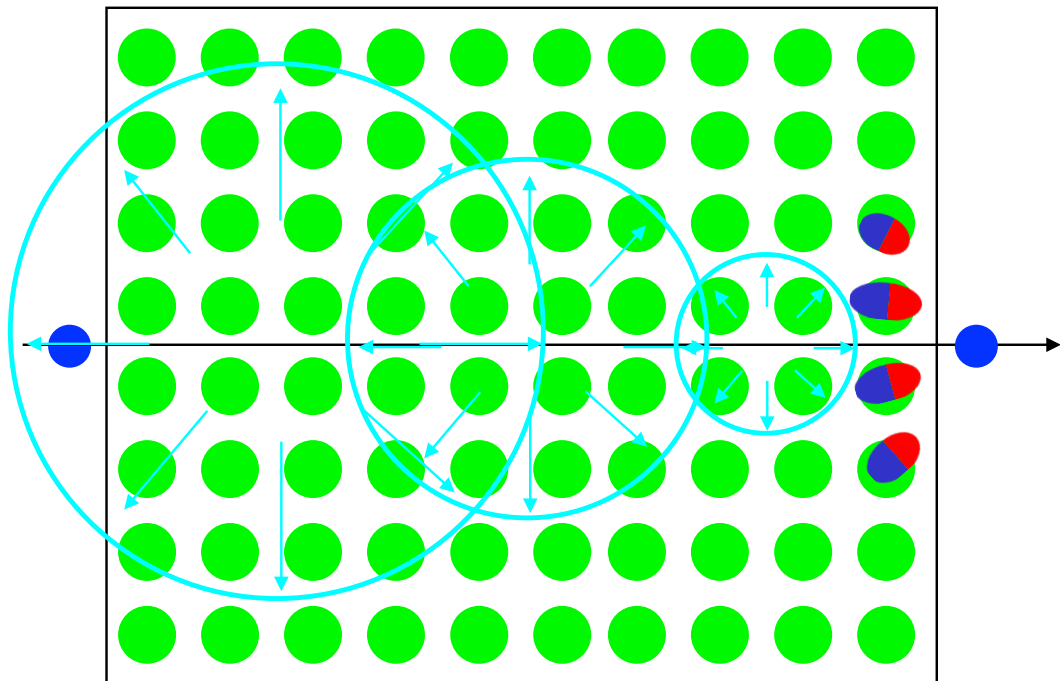
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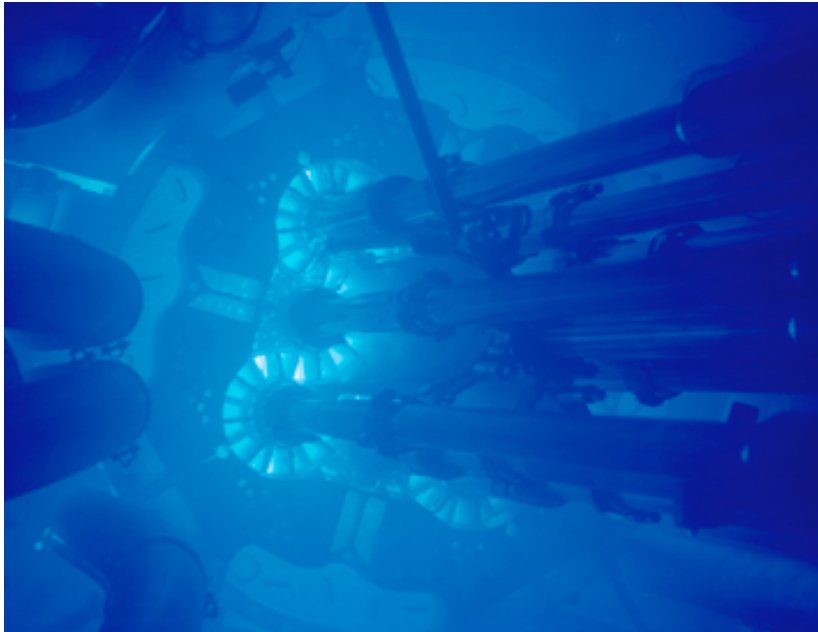
Cherenkov radiation



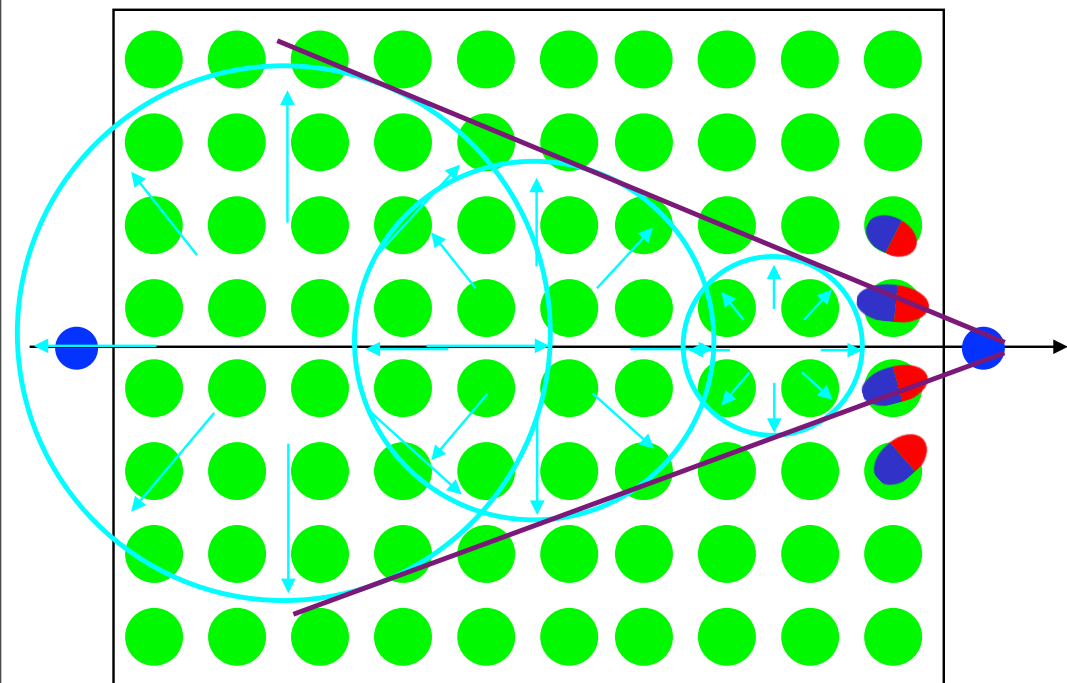
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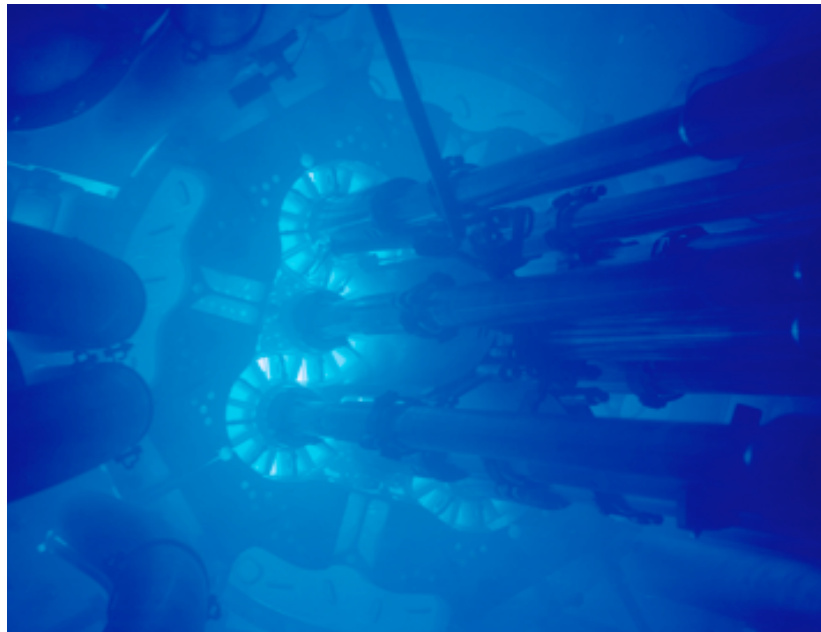
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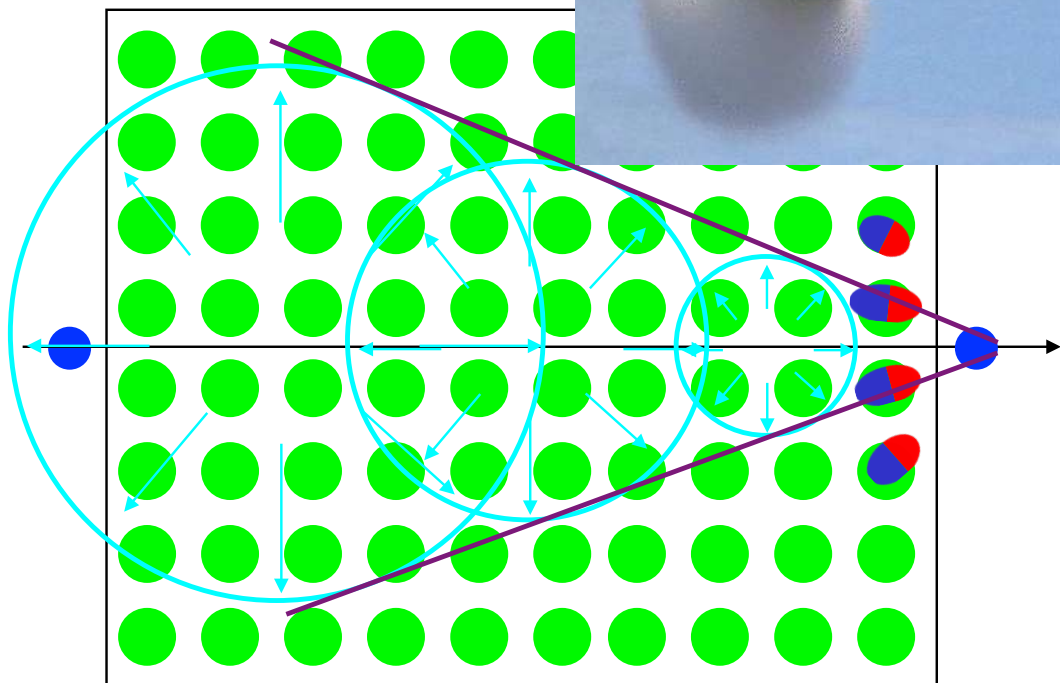
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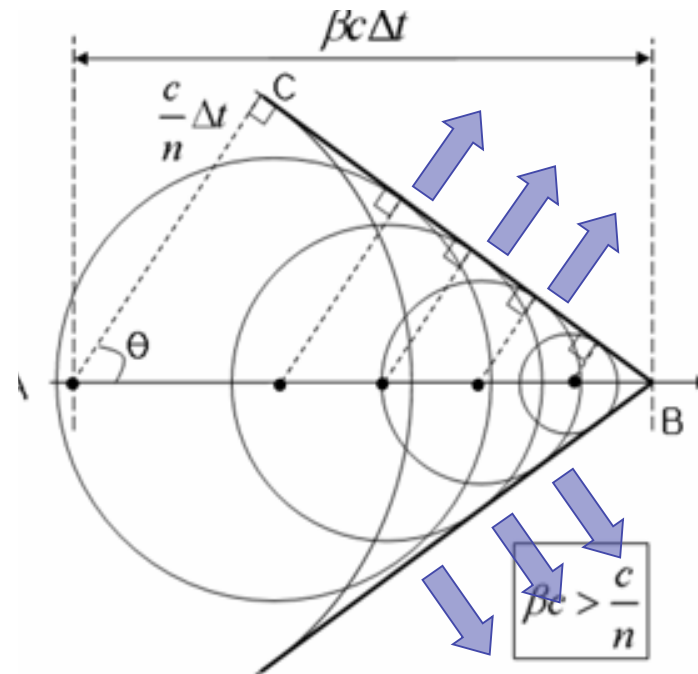
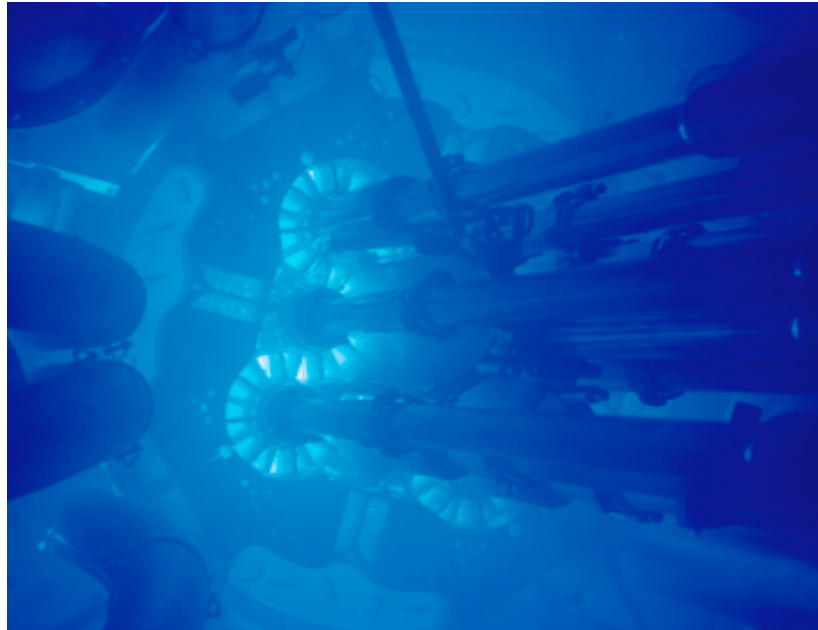
Cherenkov radiation



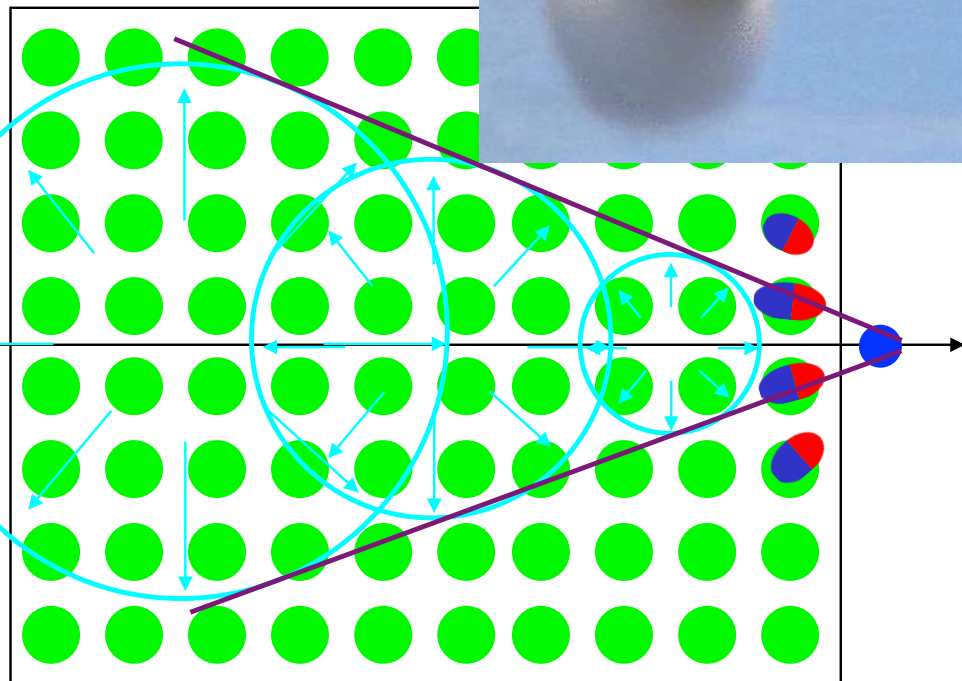
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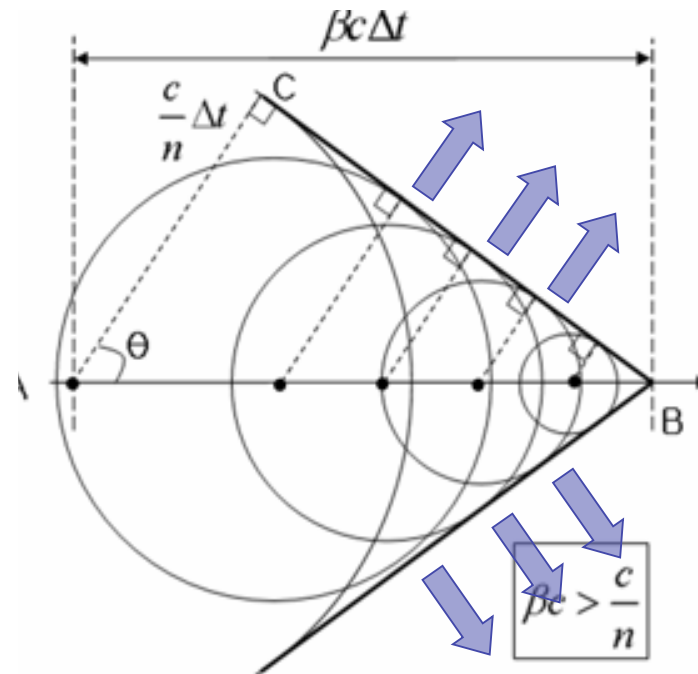
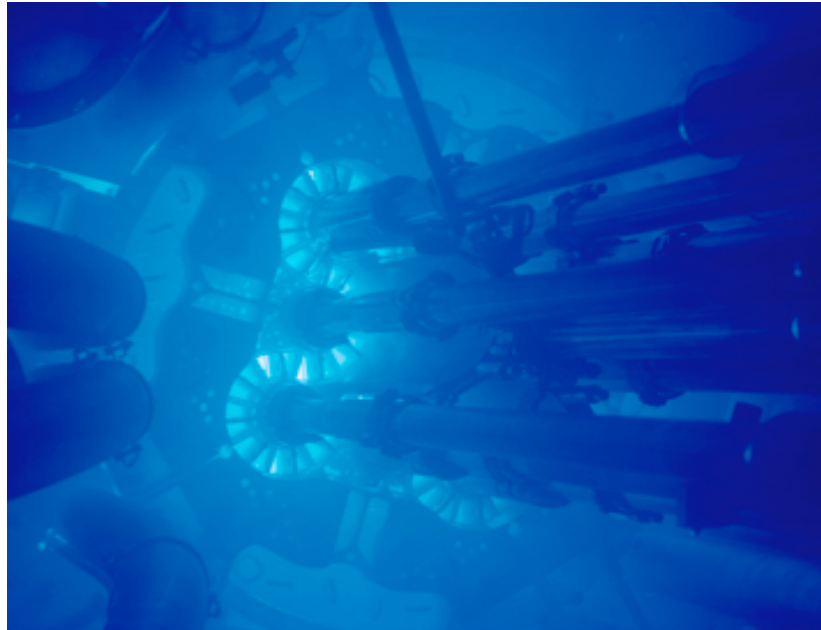
Cherenkov radiation



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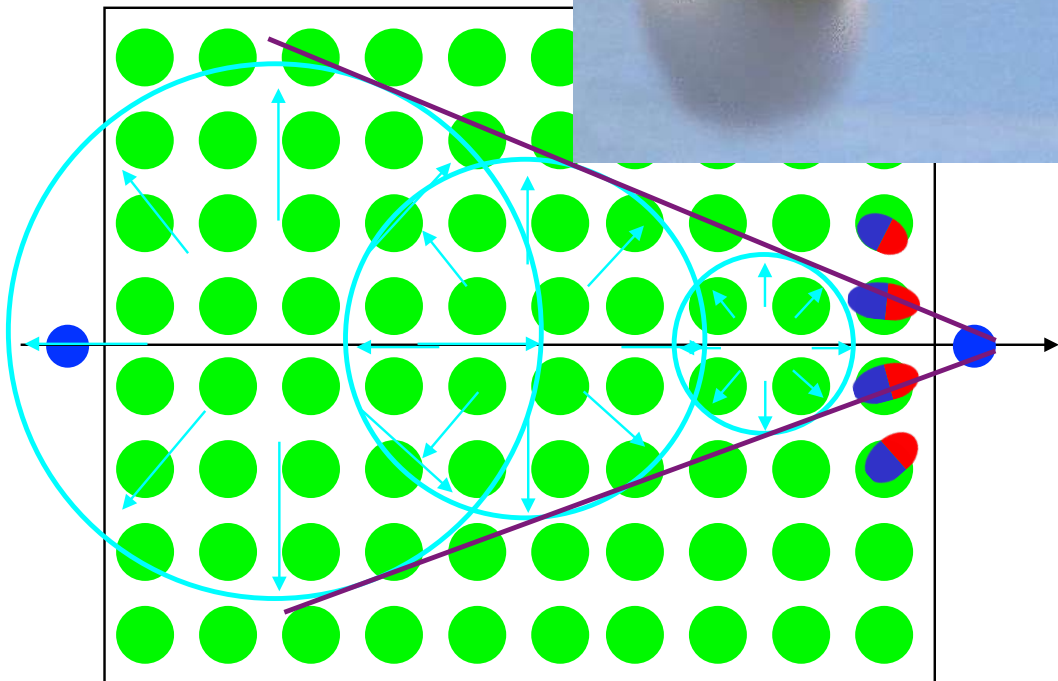
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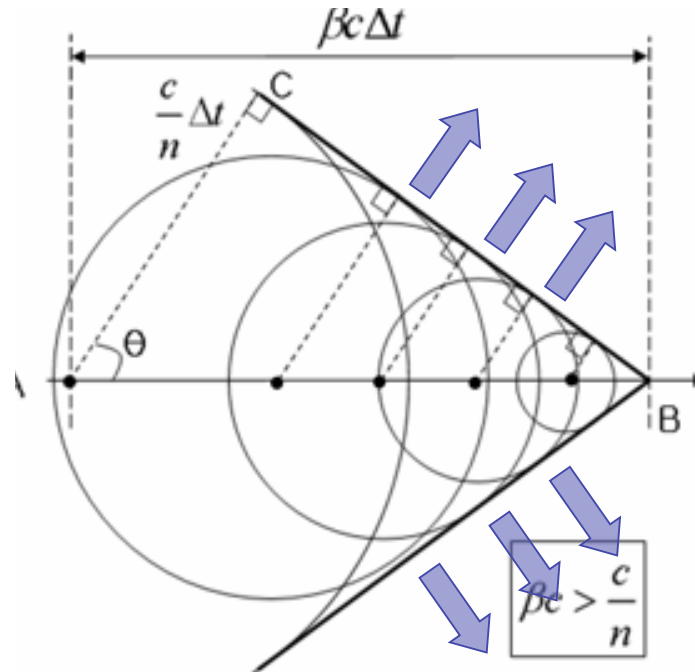
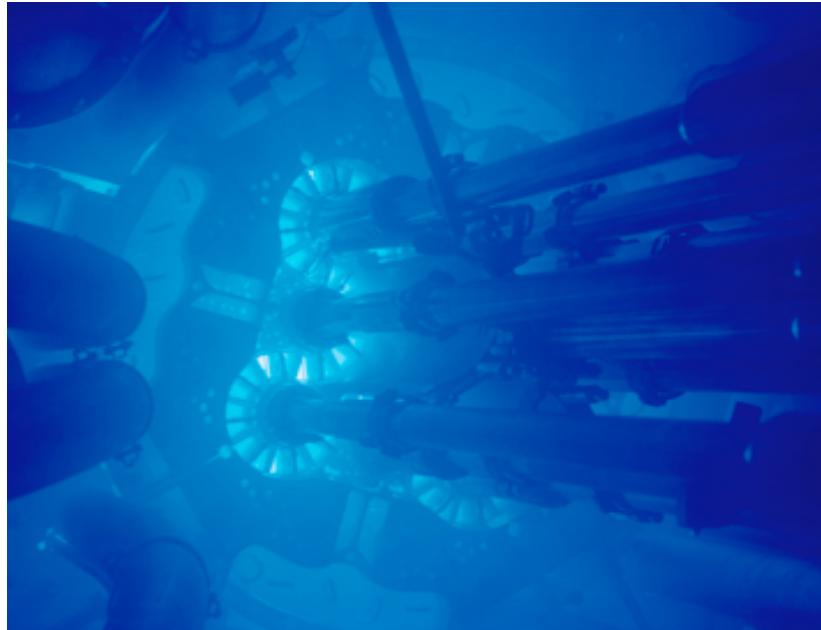
Cherenkov relation

$$\cos \theta = \frac{1}{n\beta}$$

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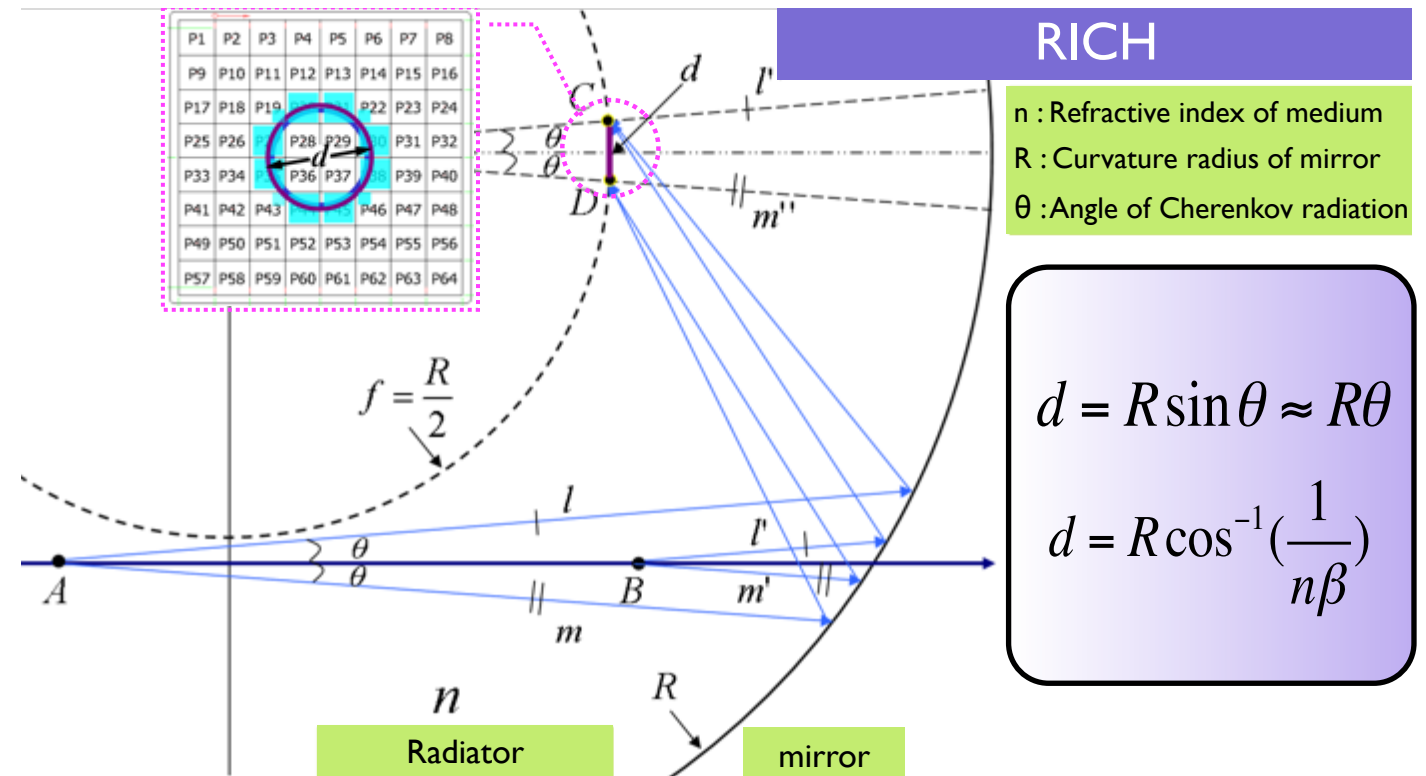
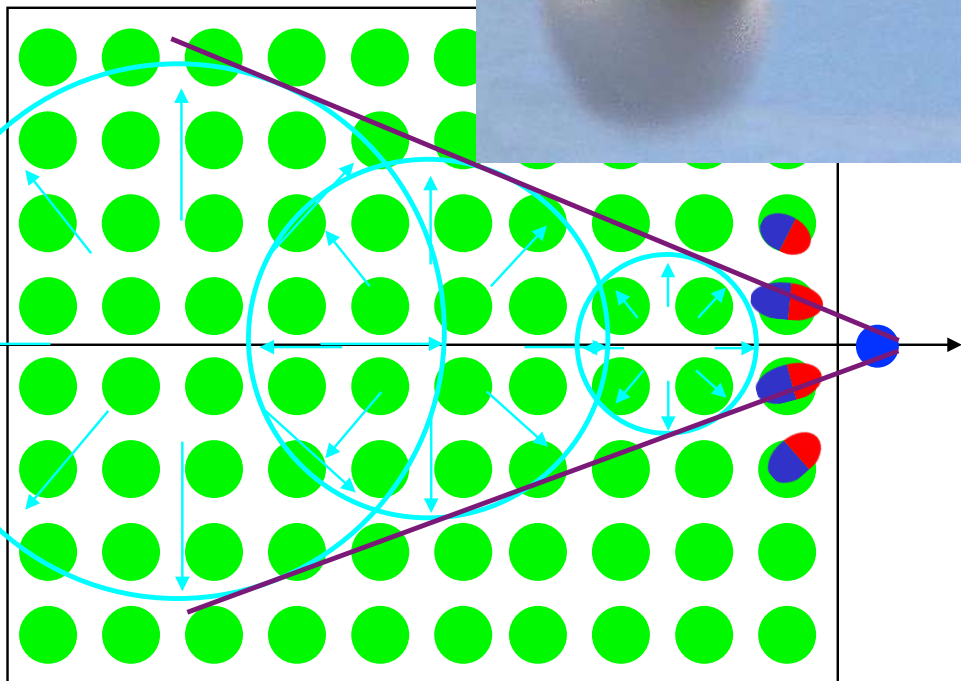
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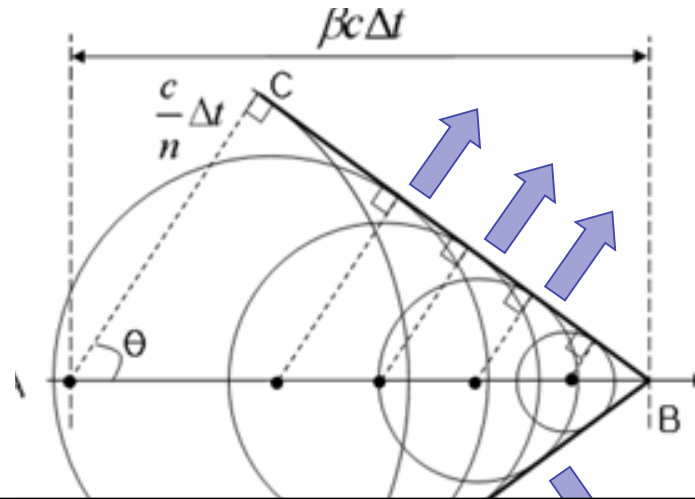
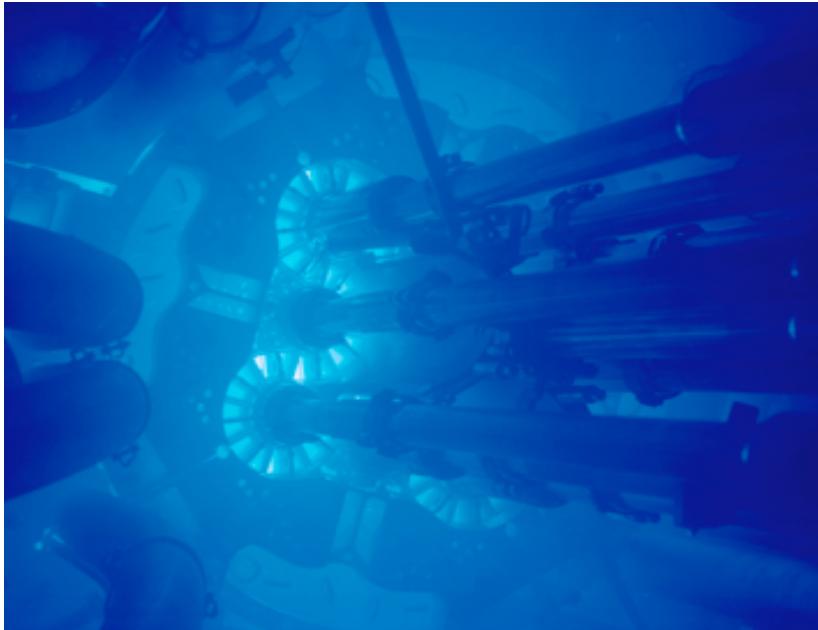
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$$d = R \sin \theta \approx R \theta$$

$$d = R \cos^{-1} \left(\frac{1}{n\beta} \right)$$

Cherenkov radiation

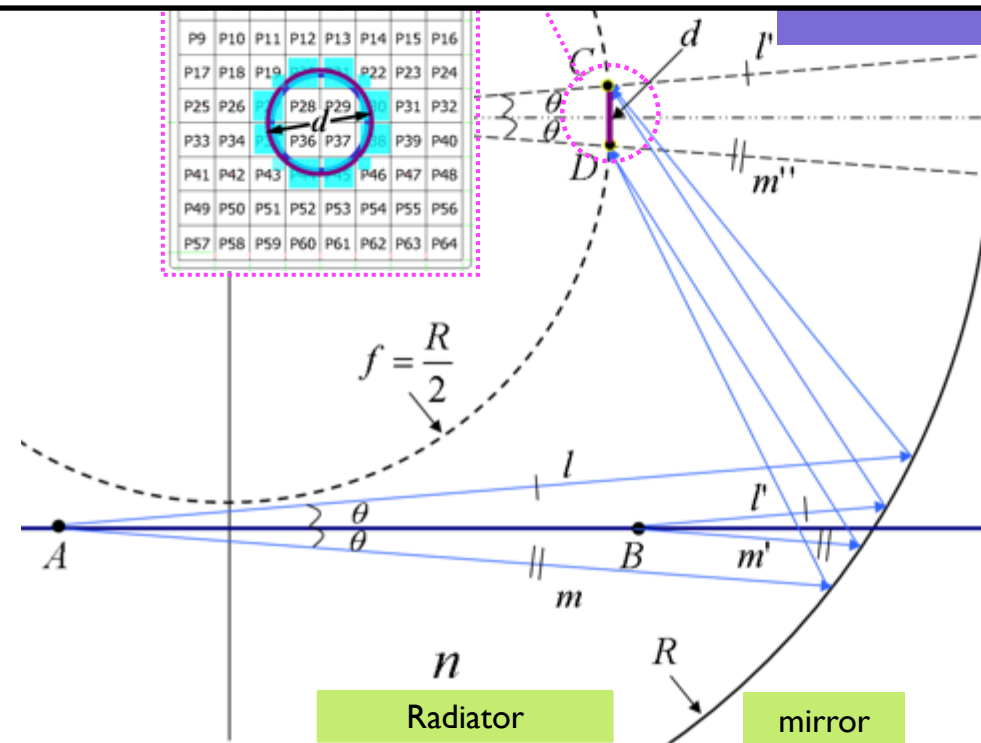
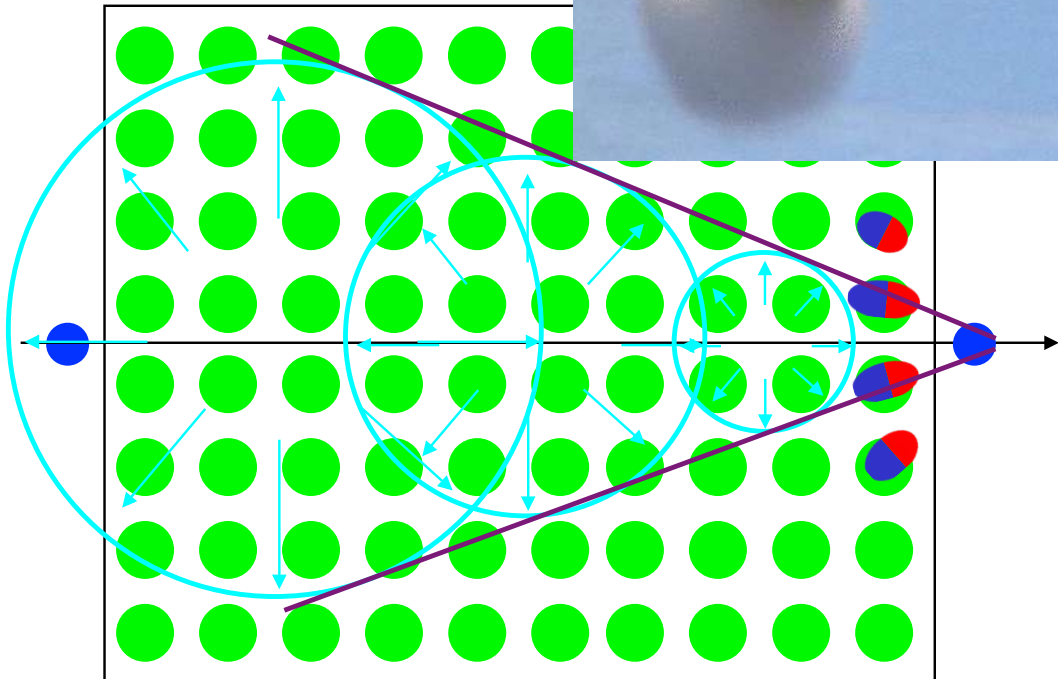


Cherenkov relation

$$\cos \theta = \frac{1}{n\beta}$$

we can figure out the velocity of particle by measuring a diameter of the ring

- Neutral Atom
- ● ↑ Dipole
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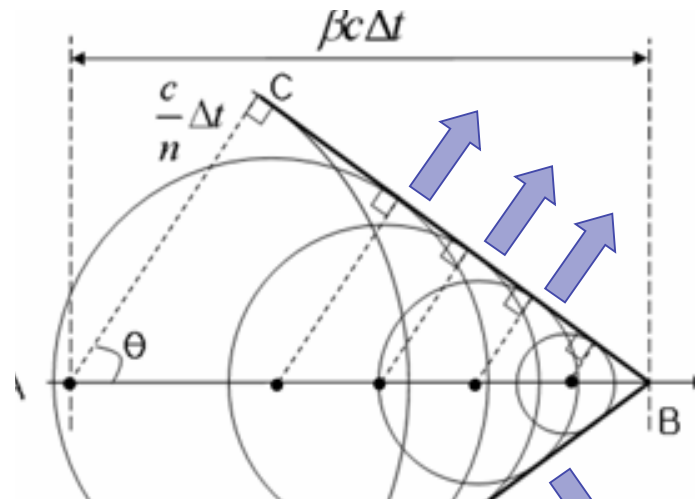
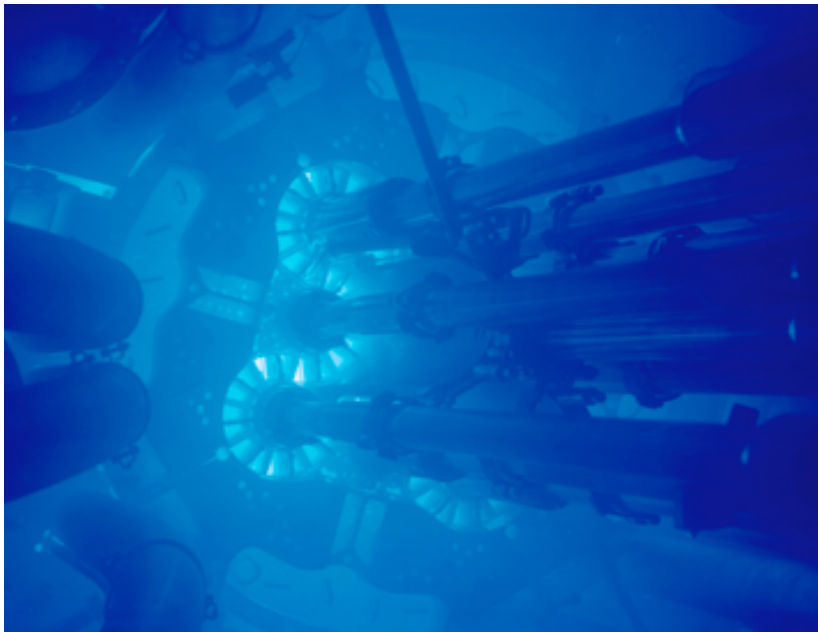


- n : Refractive index of medium
- R : Curvature radius of mirror
- θ : Angle of Cherenkov radiation

$$d = R \sin \theta \approx R\theta$$

$$d = R \cos^{-1} \left(\frac{1}{n\beta} \right)$$

Cherenkov radiation

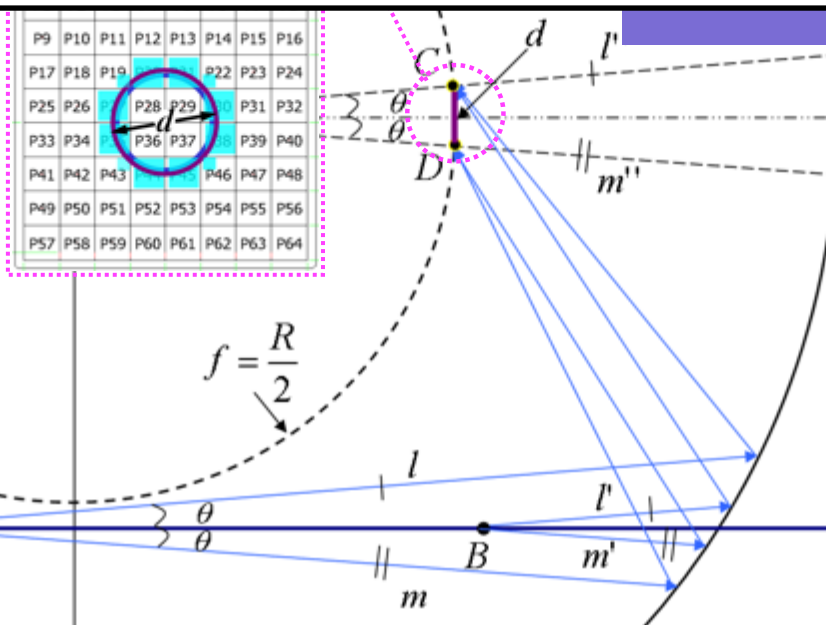
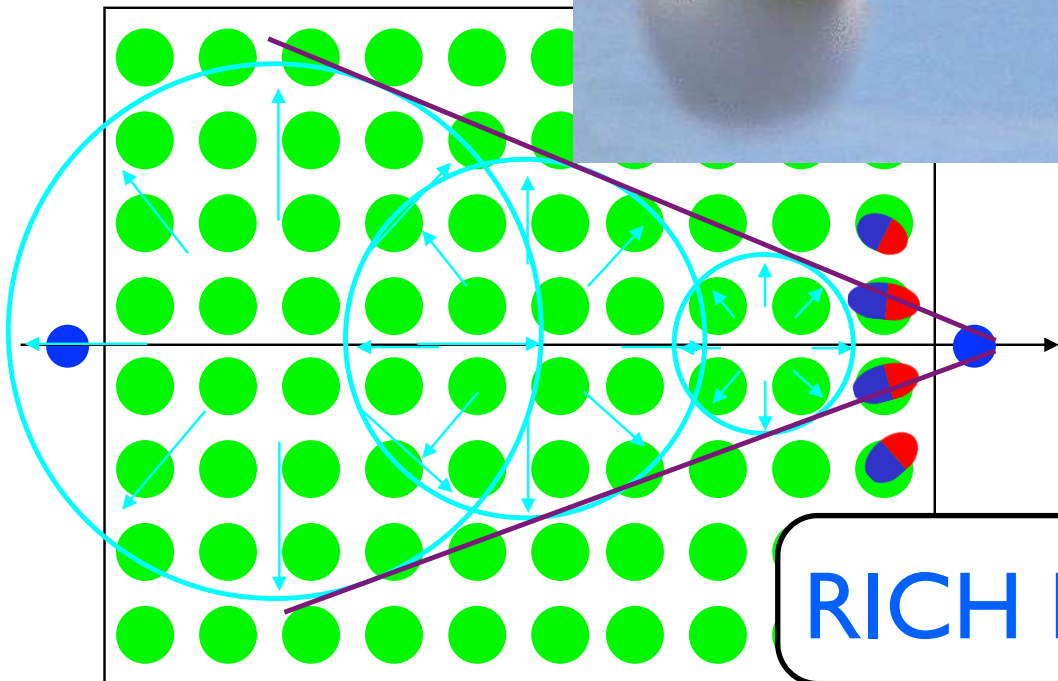


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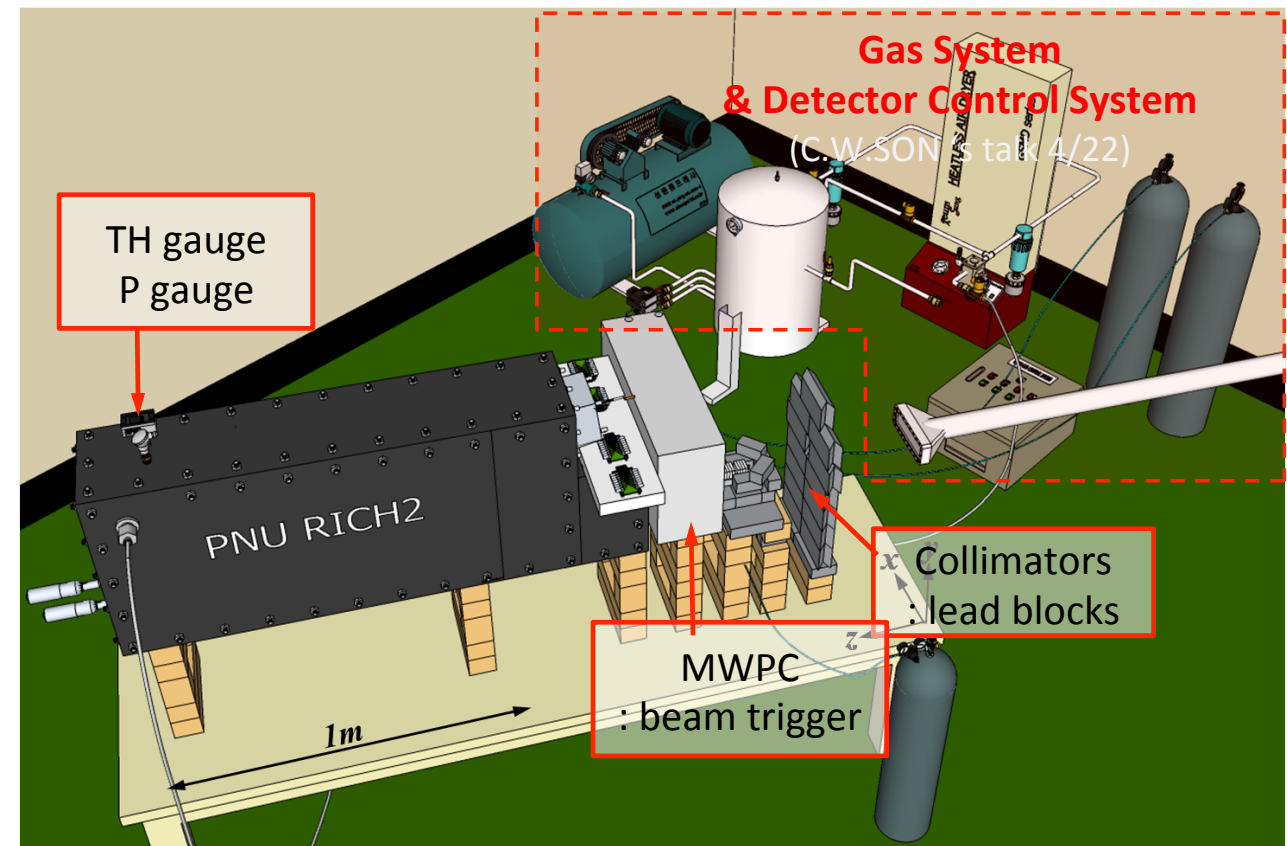
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RICH keypoint: n(matter), R(mirror), d(detector)

PNU-RICH 2.0: CBM RICH prototype




HAMAMATSU MAPMTs

- H8500C(Borosilicate glass)
: Q.E : >10% @ 300 ~ 500nm
- H8500C-03(UV glass)
: Q.E : >10% @ 200 ~ 500nm



CBM mirror prototype

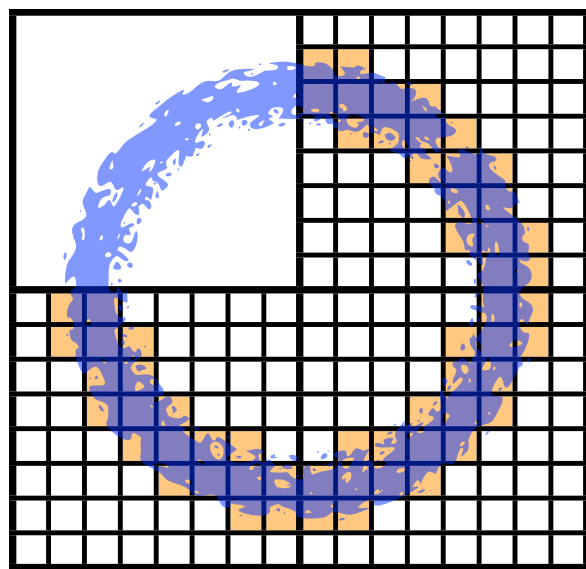
- Reflectivity : >80% in UV
- R = 3.2m, 20 x 20cm²

Specification	
Radiator length(L[m])	*1.75
# of pixels	128(256)
Mirror Curvature (R[m])	3.2
Mirror Reflectivity	≥80%, λ≥200nm
Radiators	N ₂ , CO ₂ & mixed gas
Calculated Ring Dia.[mm]	73.21(N ₂), 91.91(CO ₂)

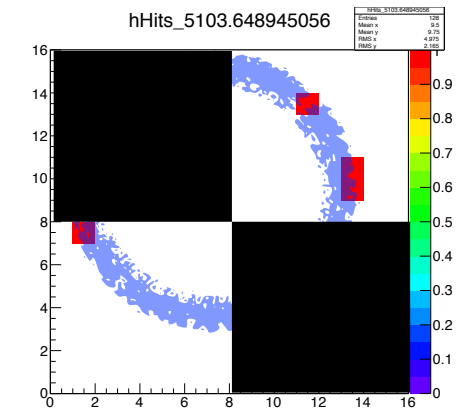
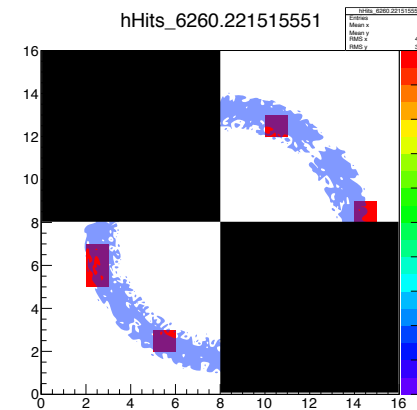
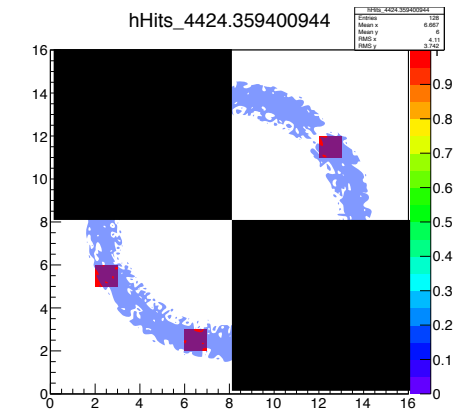
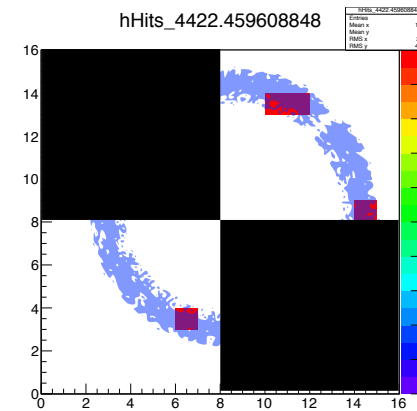
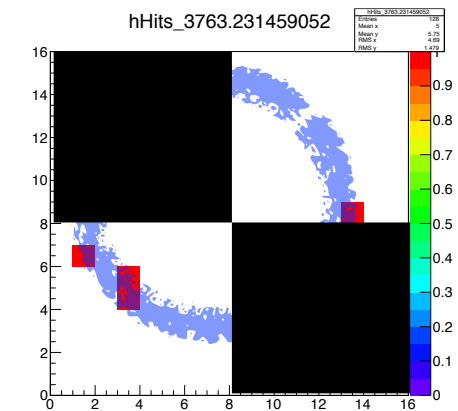
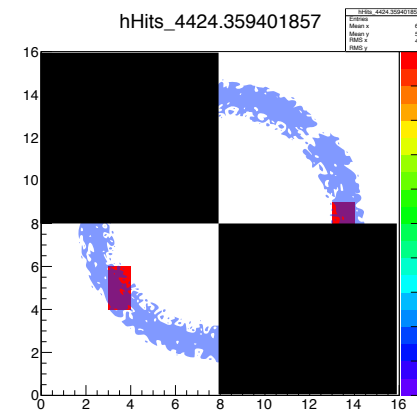
*same dimension as the CBM-RICH detector proposal

RICH2.0: the result

- blue line: expected ring region
- red point: data



- ▶ single event :
3 entries / 1 ns
- ▶ In case that all entries are in orange range, there is a ring image.



Ring is not fully covered!

we need to use more PMTs
to cover the blackout region.



Upgrade: PNU-RICH2.5

What is the difference from RICH 2.0?

1. Addition of PMTs (128ch → 256ch)
2. Upgrade electronics setup(data taking of 256ch)
3. New housing system to reduce the noise

Upg

N

H2.5

What is t

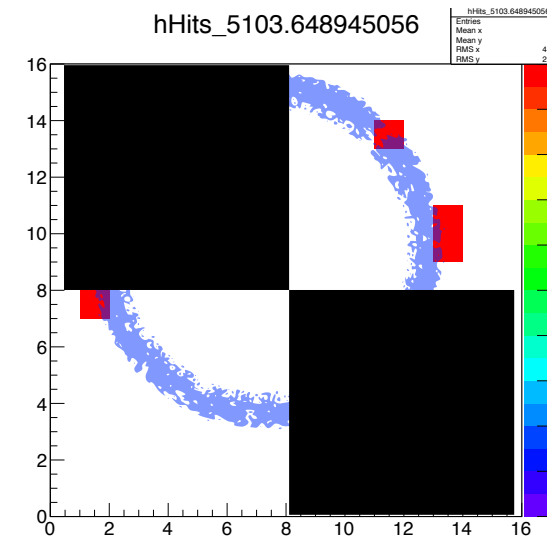
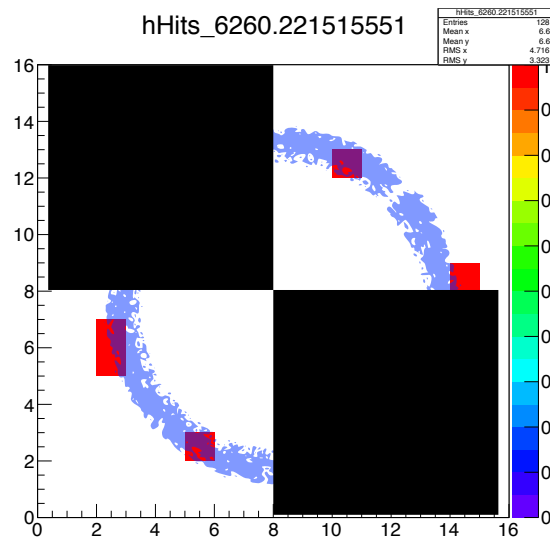
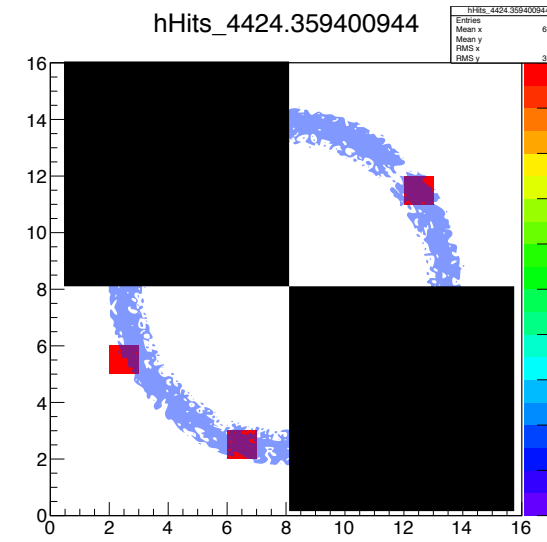
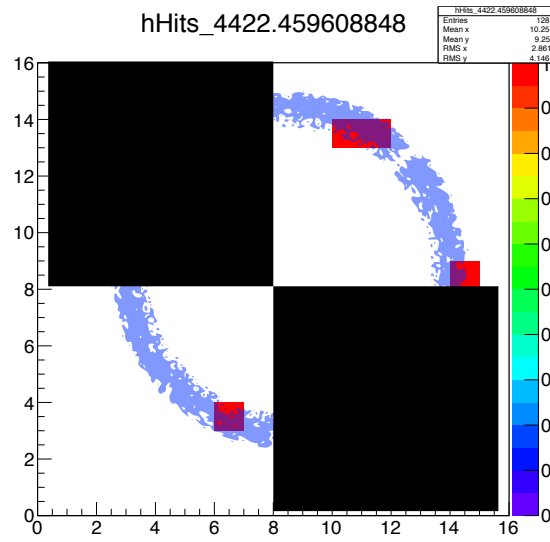
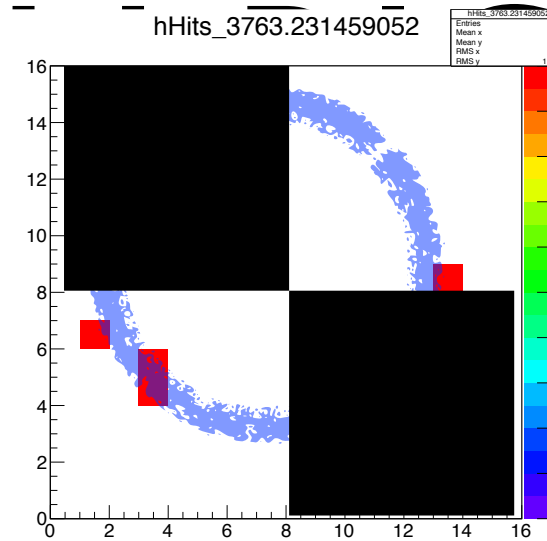
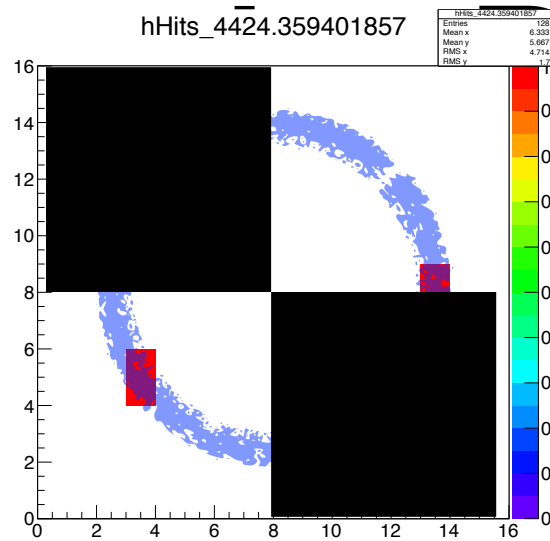
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RICH 2.0?

1. Addition c
2. Upgrade ϵ
3. New hous

8ch setu to r

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Upg

N

H2.5

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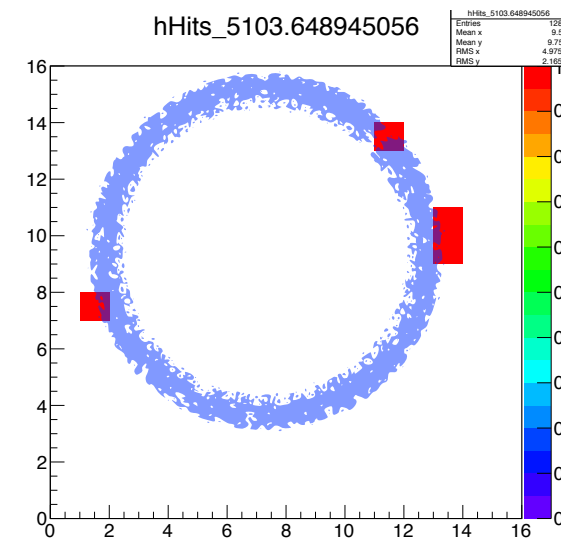
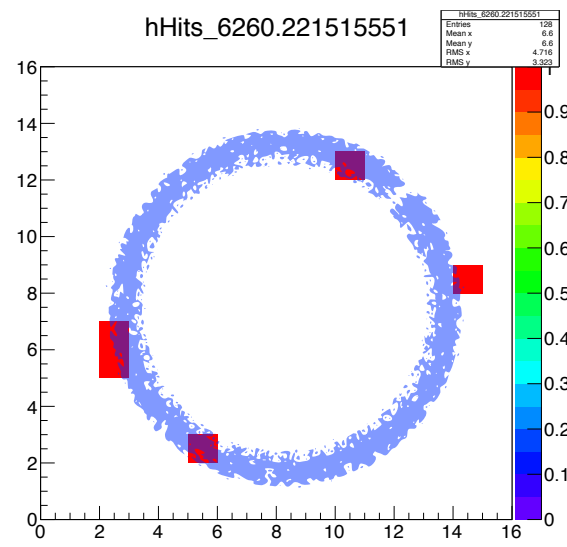
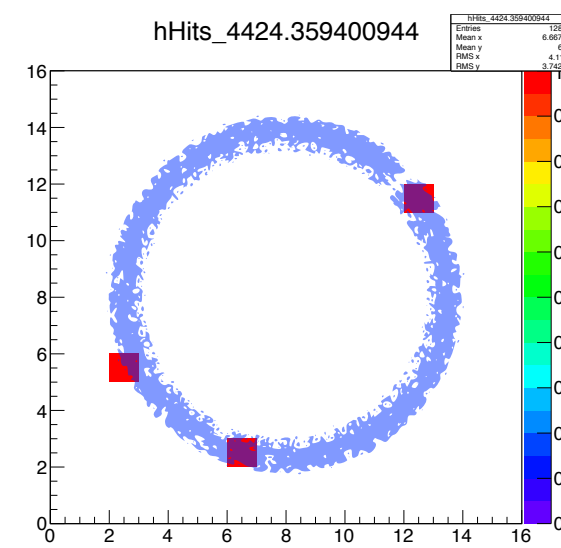
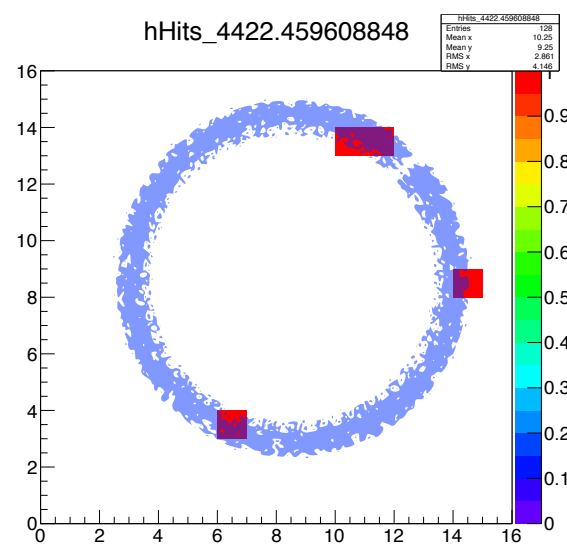
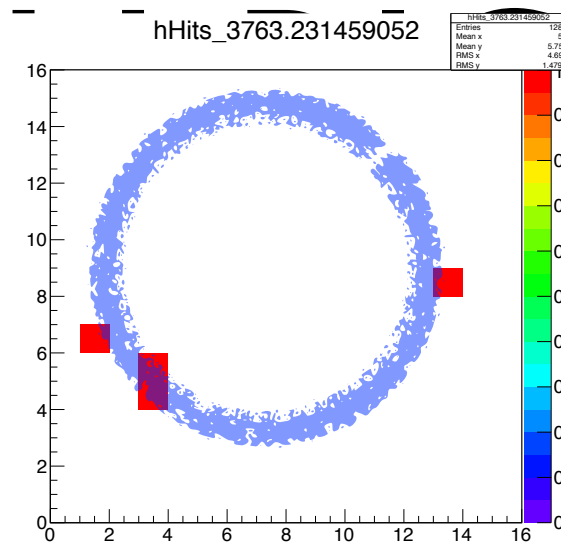
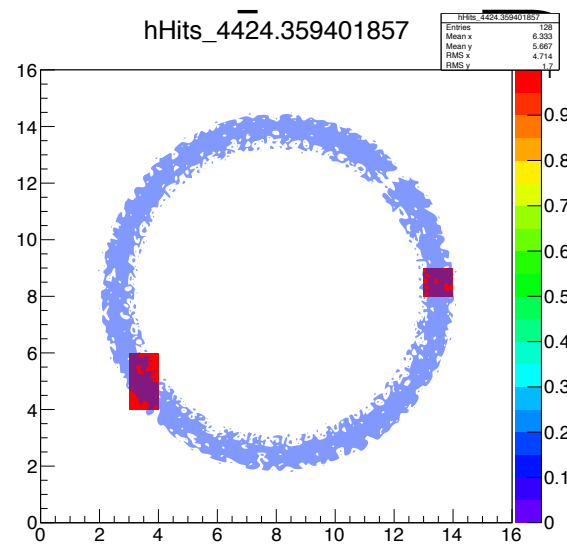
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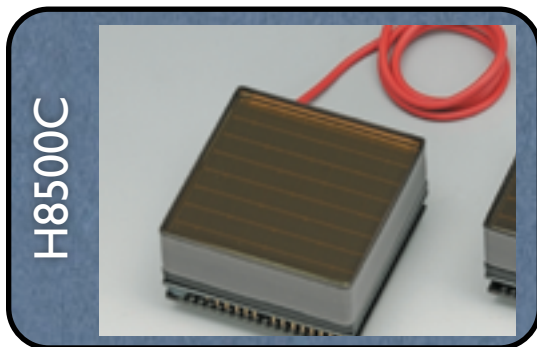
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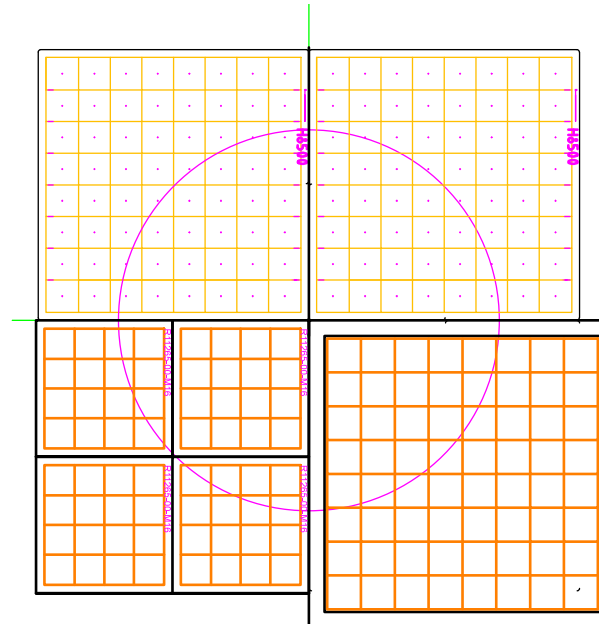


PMT & PMT board

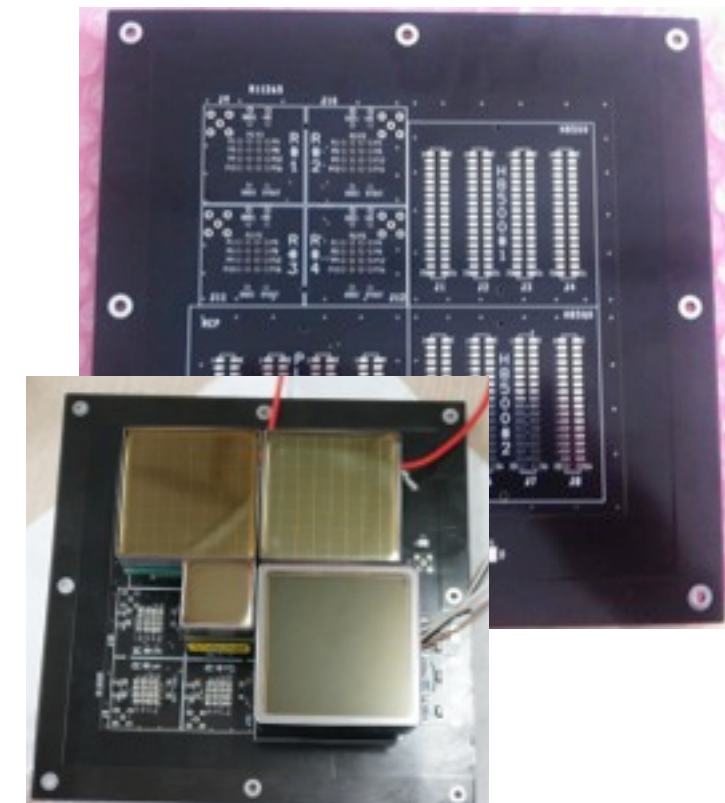
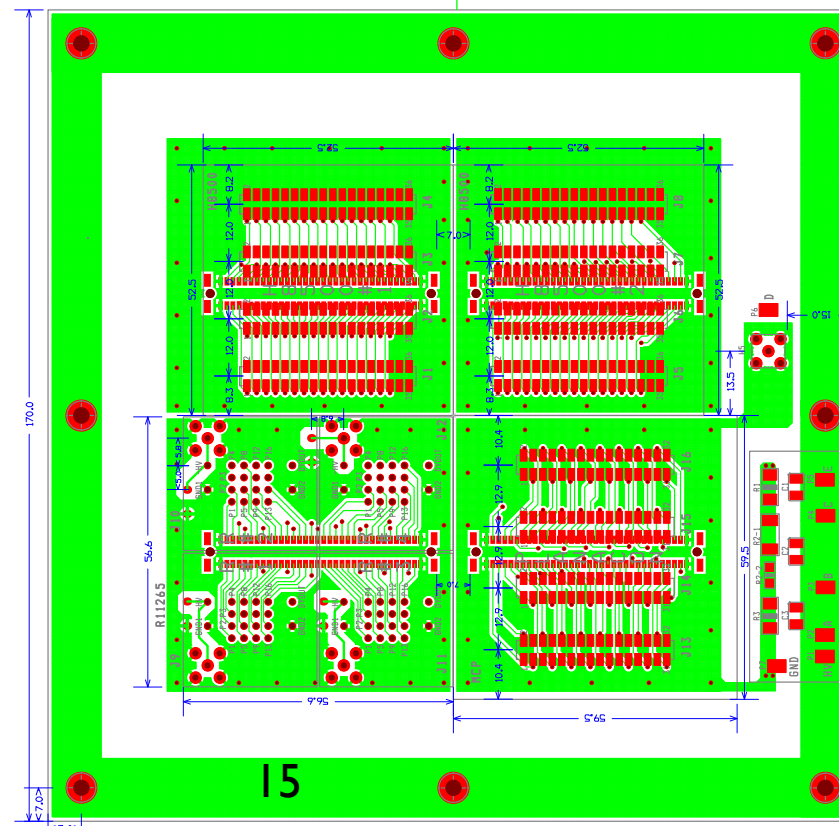
will use the three kinds of PMT



	H8500C	PLANACON	R11265
Pixel array	8 × 8	8 × 8	4 × 4
Pixel size/Pitch	5.8 × 5.8 / 6.08	5.9 × 5.9 / 6.5	5.75 × 5.75 / 6.08
Effective size (mm ²)	49 × 49 (89%)	53 × 53	23 × 23 (78%)
Spectral range (nm)	185 - 650	200 - 650	270 - 650
Quantum Efficiency	24% at 420nm	22% at 380 nm	38% at
Rise/transit time (ns)	0.8 / 6	0.6 /	0.52 / 0.5
Gain	1.5 × 10 ⁶	5 × 10 ⁵	1 × 10 ⁶
Comment	current MAPMT	Strong in mag. field	Good Q.E
status	in HIPEX	in HIPEX	in HIPEX

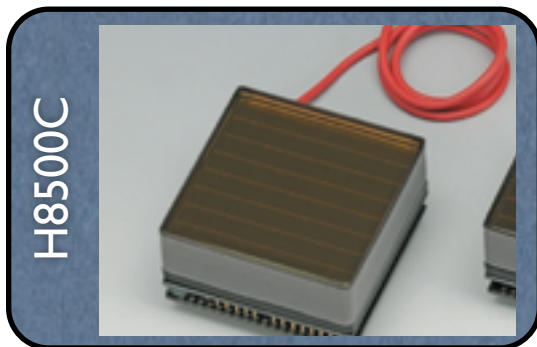


PMT arrangement in RICH v2.5
 - Up : H8500C - 2EA
 - Down : PLANACON(left) -1EA
 R11264(right) - 4EA

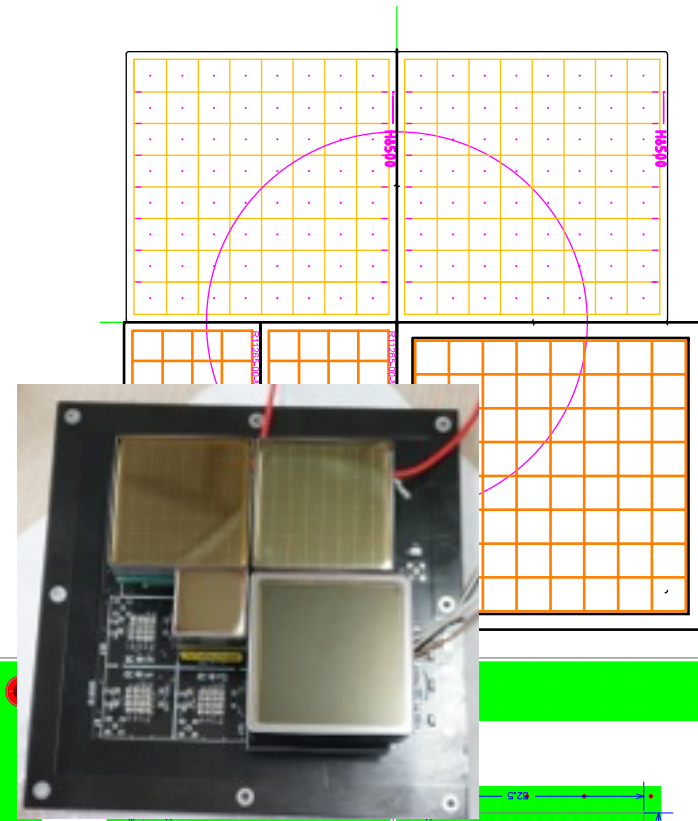


PMT & PMT board

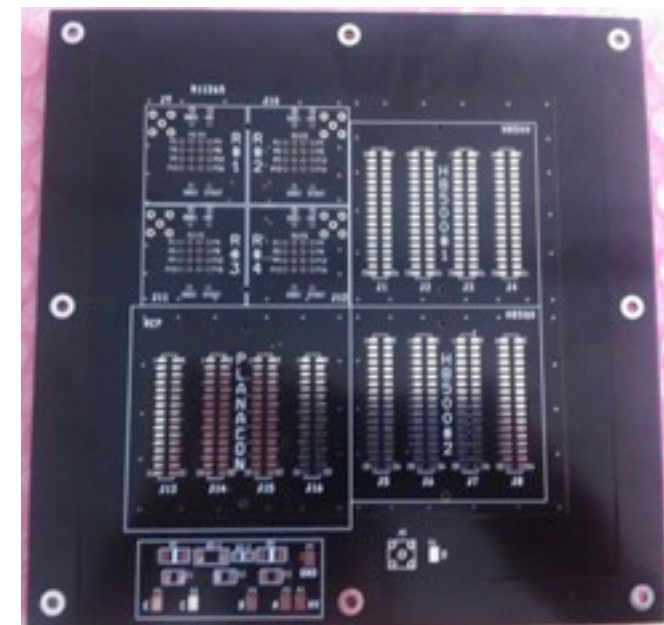
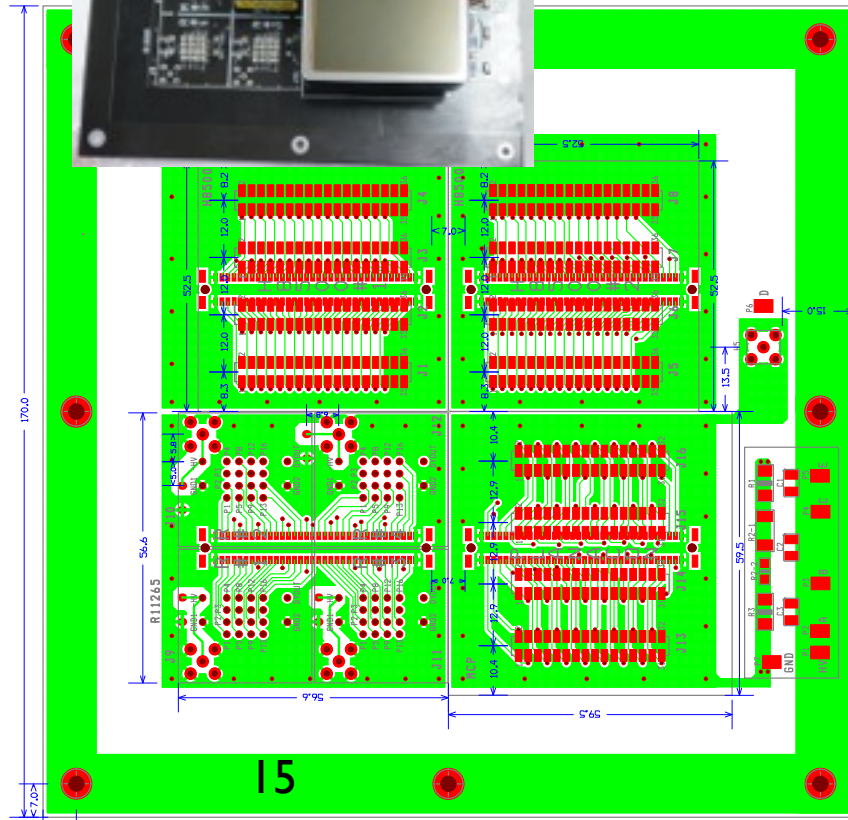
will use the three kinds of PMT



	H8500C	PLANACON	R11265
Pixel array	8 × 8	8 × 8	4 × 4
Pixel size/Pitch	5.8 × 5.8 / 6.08	5.9 × 5.9 / 6.5	5.75 × 5.75 / 6.08
Effective size (mm ²)	49 × 49 (89%)	53 × 53	23 × 23 (78%)
Spectral range (nm)	185 - 650	200 - 650	270 - 650
Quantum Efficiency	24% at 420nm	22% at 380 nm	38% at
Rise/transit time (ns)	0.8 / 6	0.6 /	0.52 / 0.5
Gain	1.5 × 10 ⁶	5 × 10 ⁵	1 × 10 ⁶
Comment	current MAPMT	Strong in mag. field	Good Q.E
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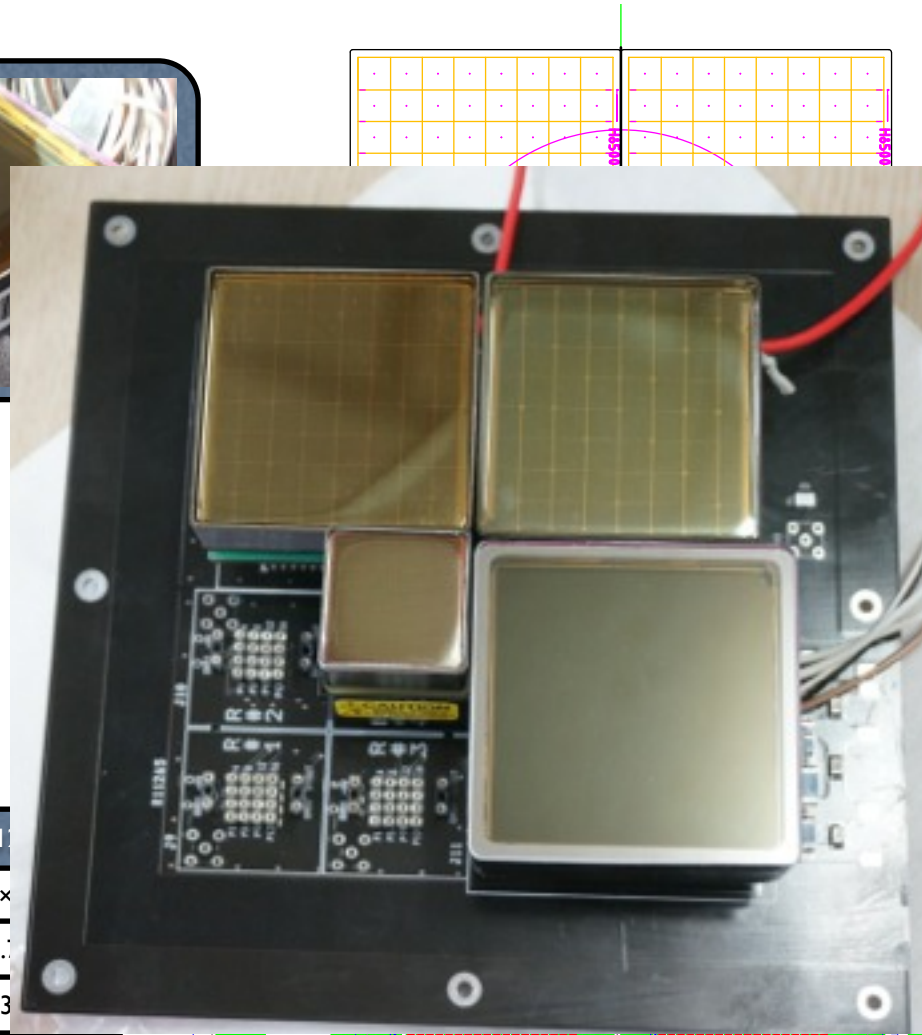
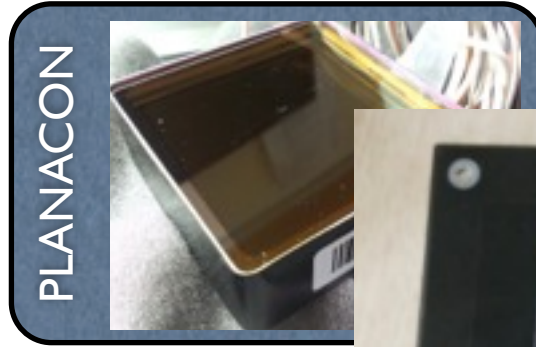
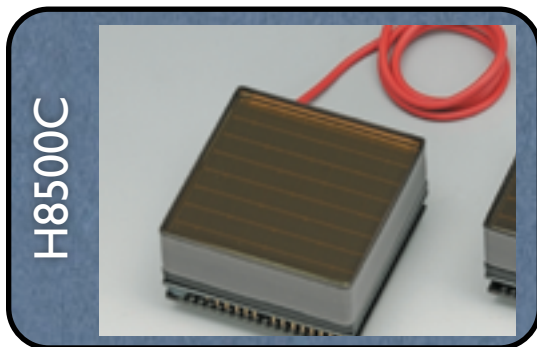


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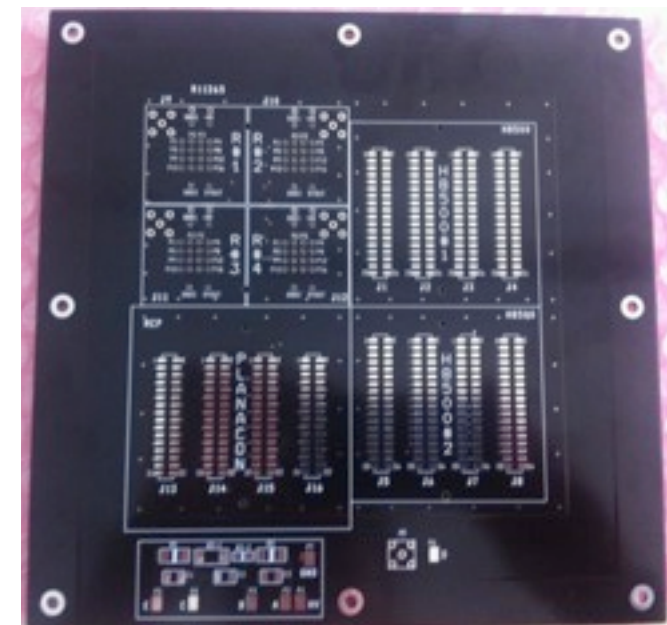
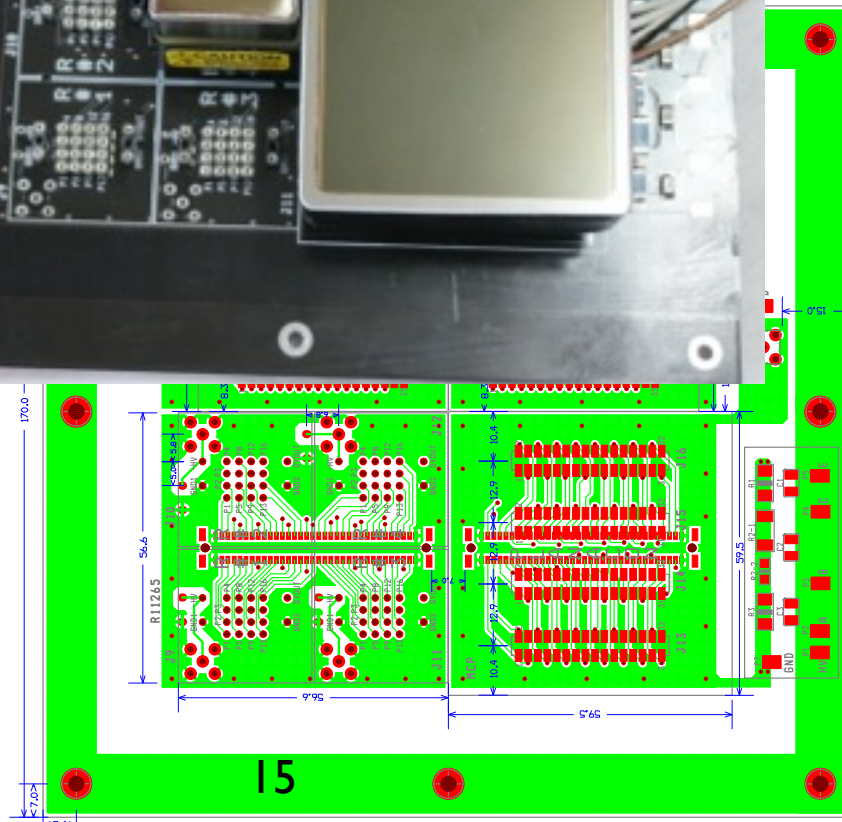
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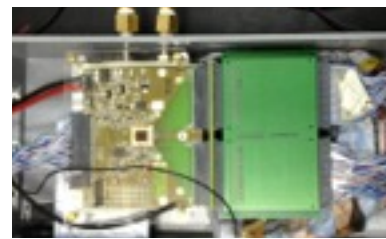
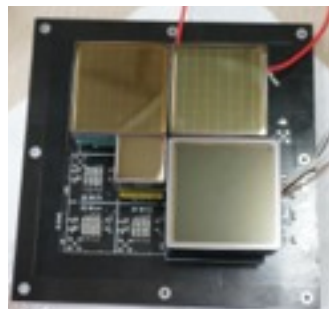
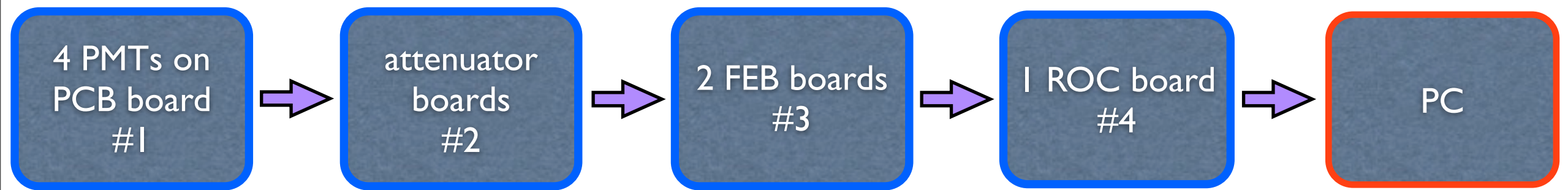
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DAQ system

▶ hardware

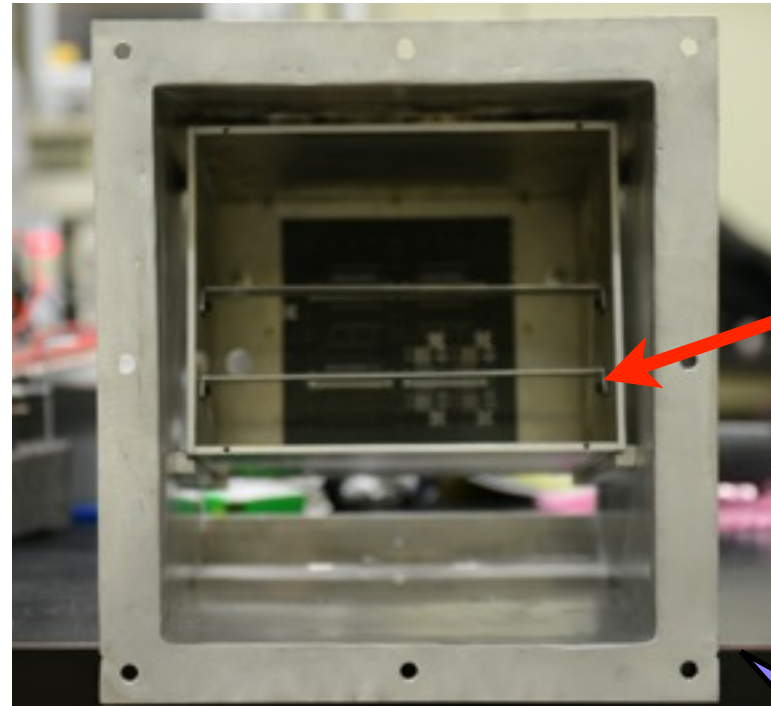
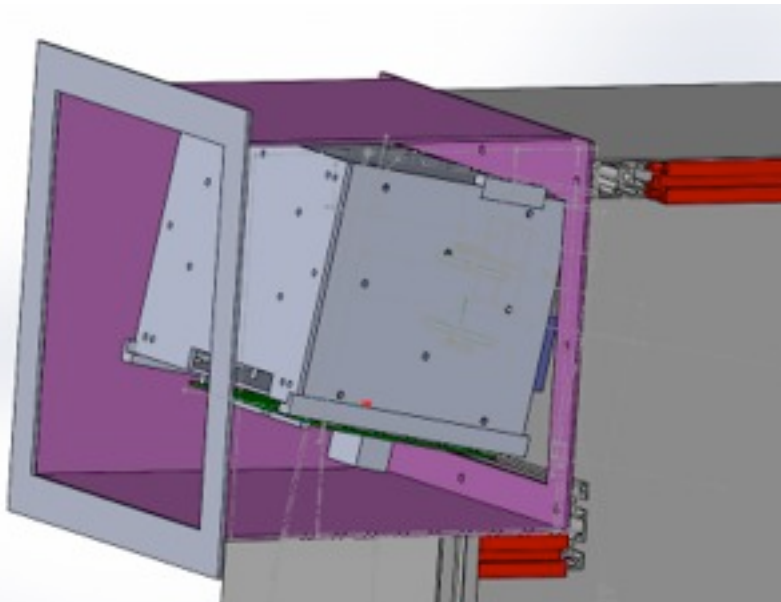


- Simultaneous data taking of 256ch
- 1 ns time resolution

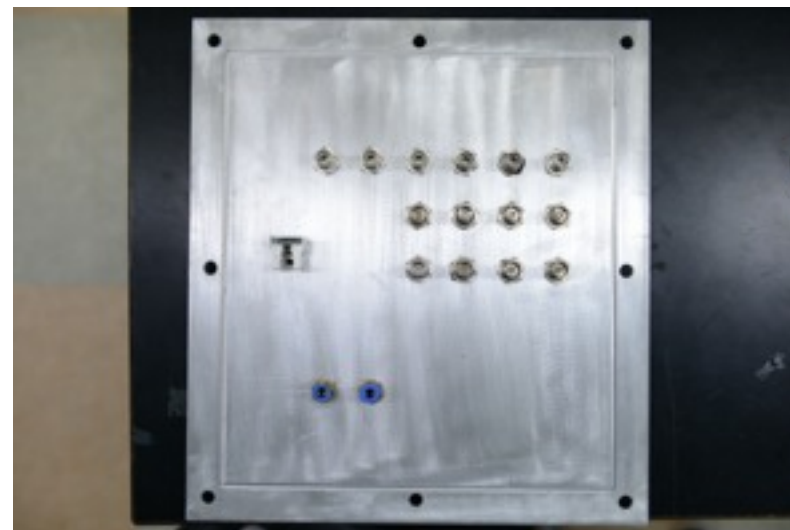
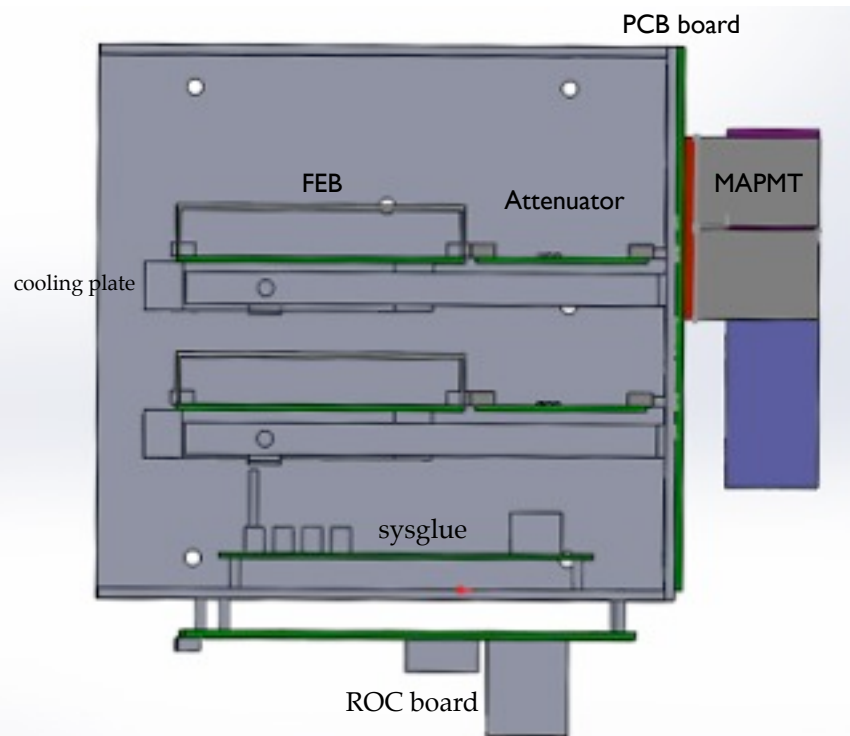
- #1: PMT signal
- #2: the PMT signal size down for FEB
- #3: Analog to digital converter(ADC)
- #4: Read out controller, Control the external trigger

**Very powerful
DAQ system!**

New Housing



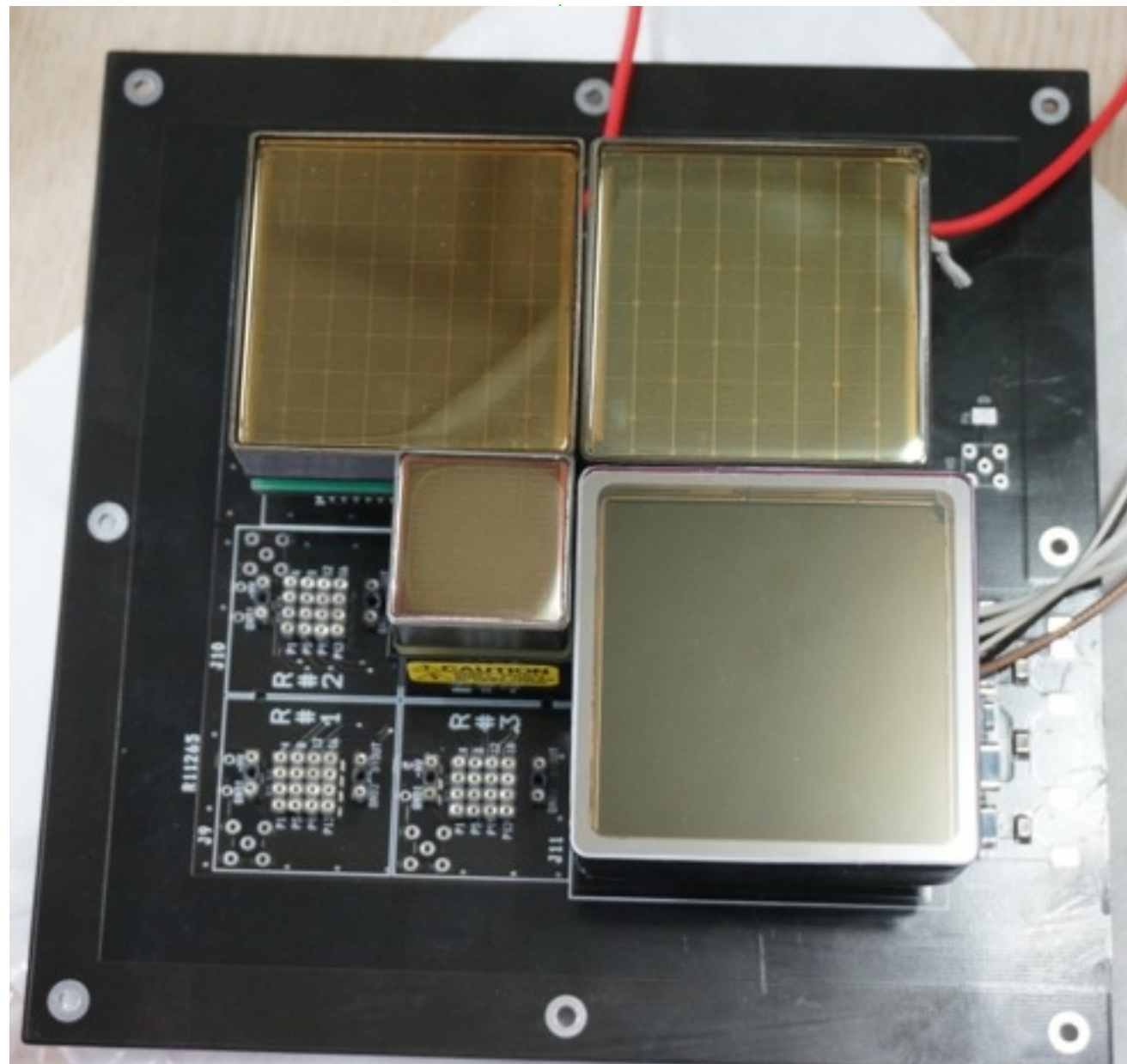
devices	ea
PMTs	7
attenuator	2
FEB board	2
ROC board	1
sysglue	1
SHV connector	7
cool connector	2
low sig	8
LAN connector	1
board / connector	13 / 18



- Protect electronics
- Reduce noise

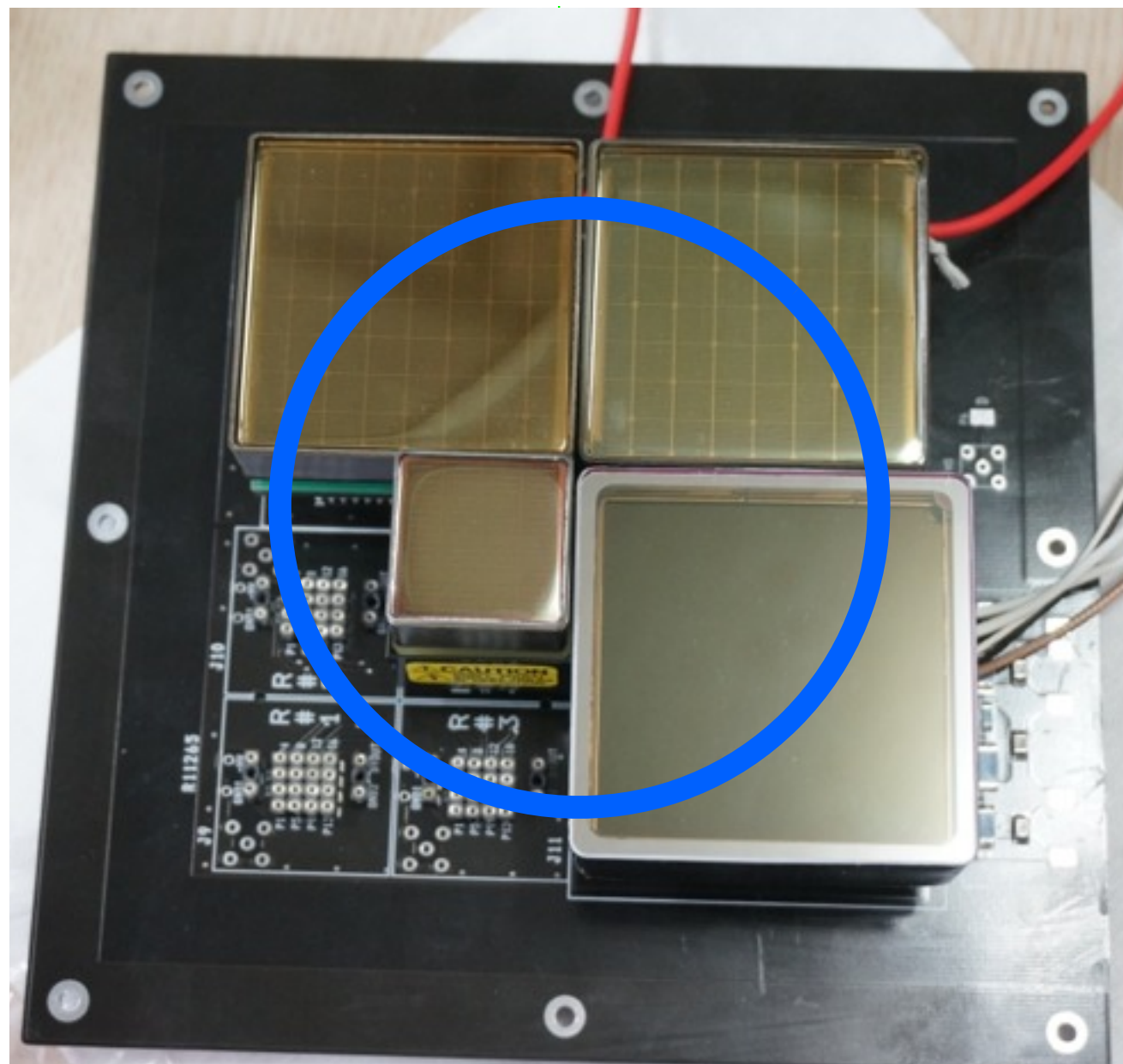
Experiment plan

Beam-time period: July 17 ~ 25, 2013 (about 2 weeks later)



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Beam-time period: July 17 ~ 25, 2013 (about 2 weeks later)





THANK YOU