Large Crystal Nuclear Emulsion for Cosmic-ray Radiography

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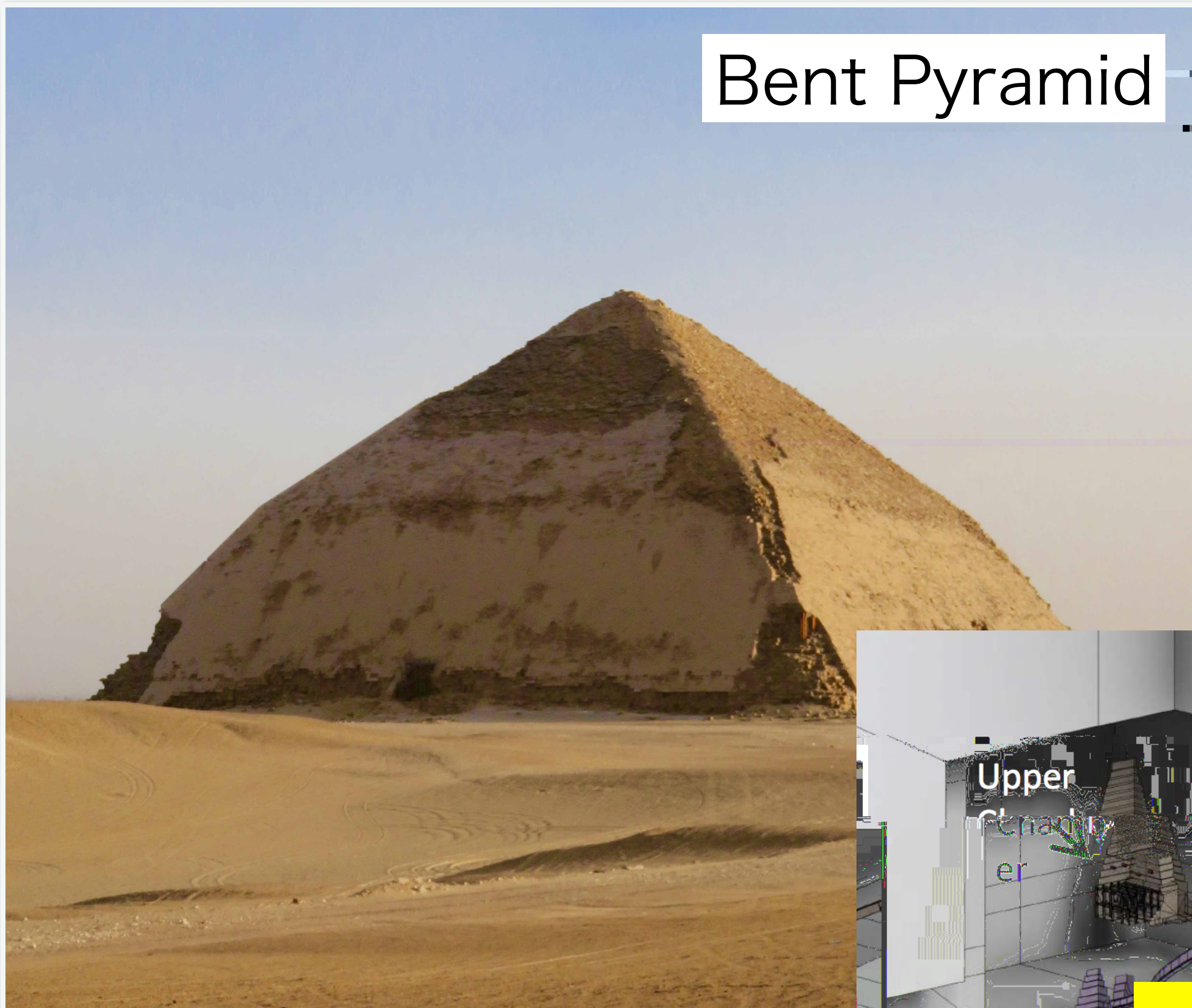
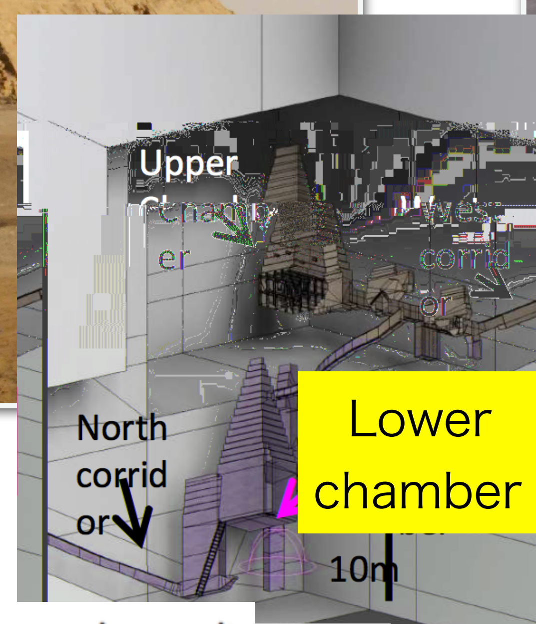
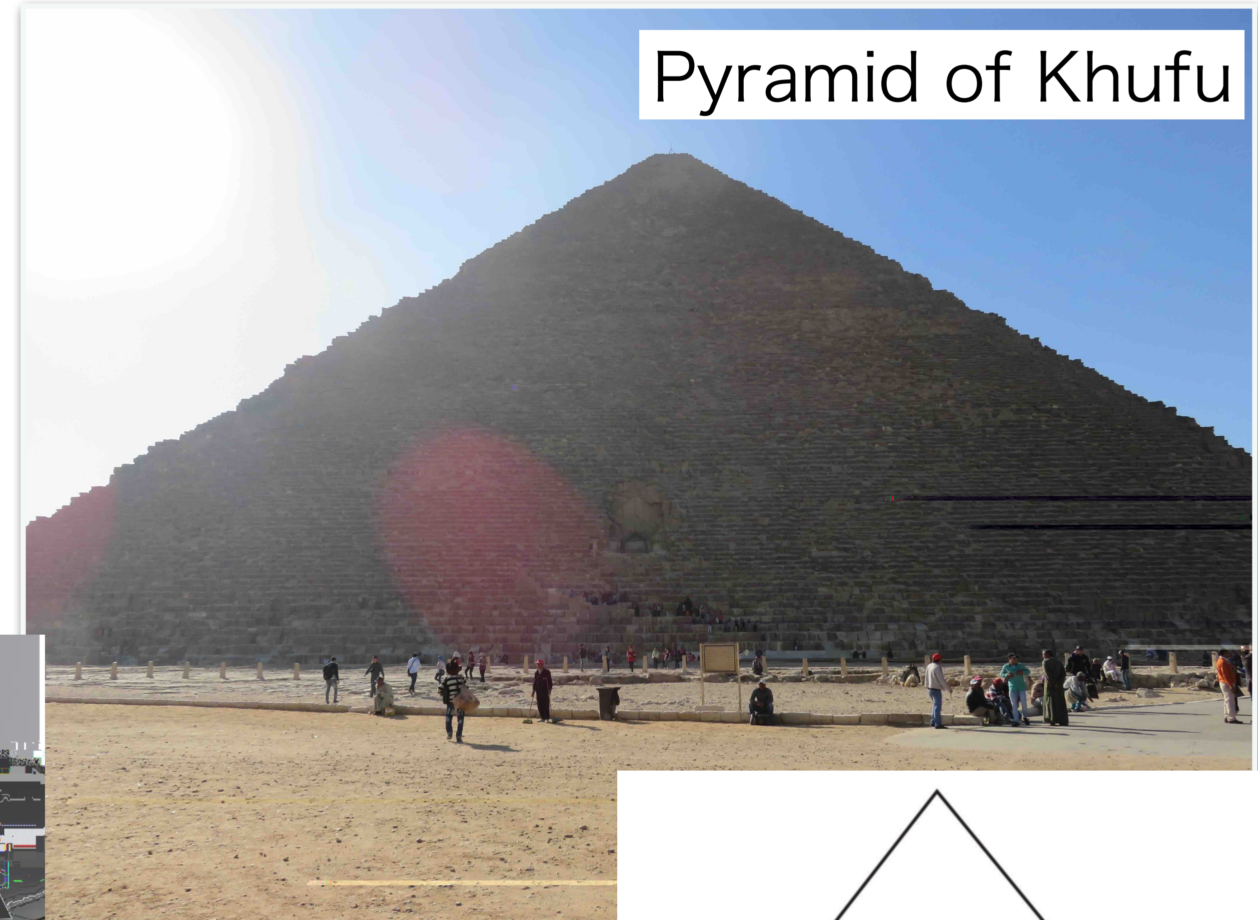
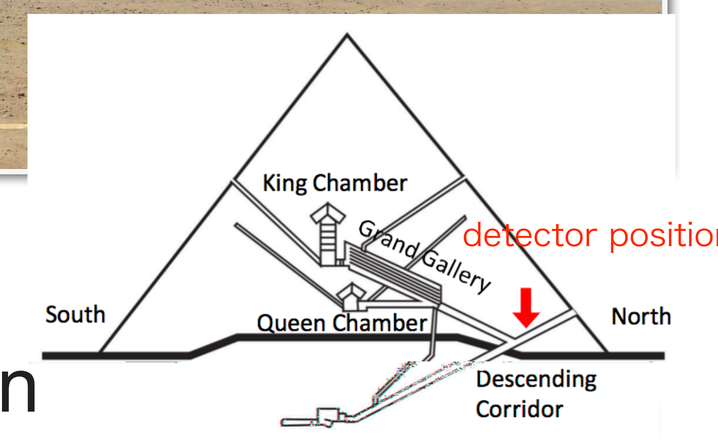
ICMaSS 2017

Investigation of Pyramids using cosmic-ray

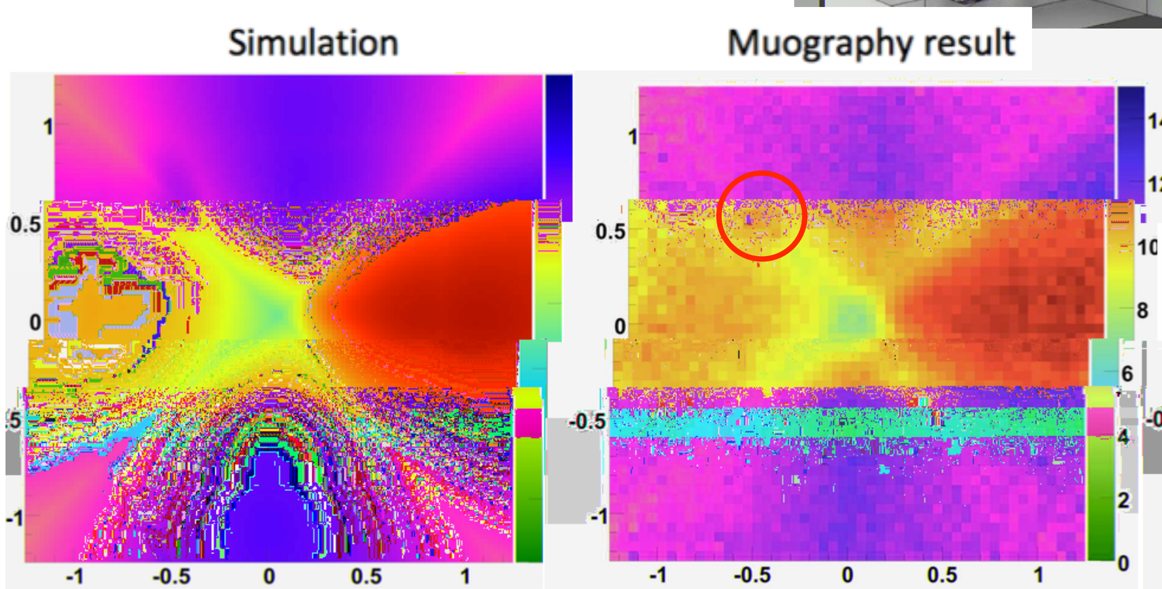




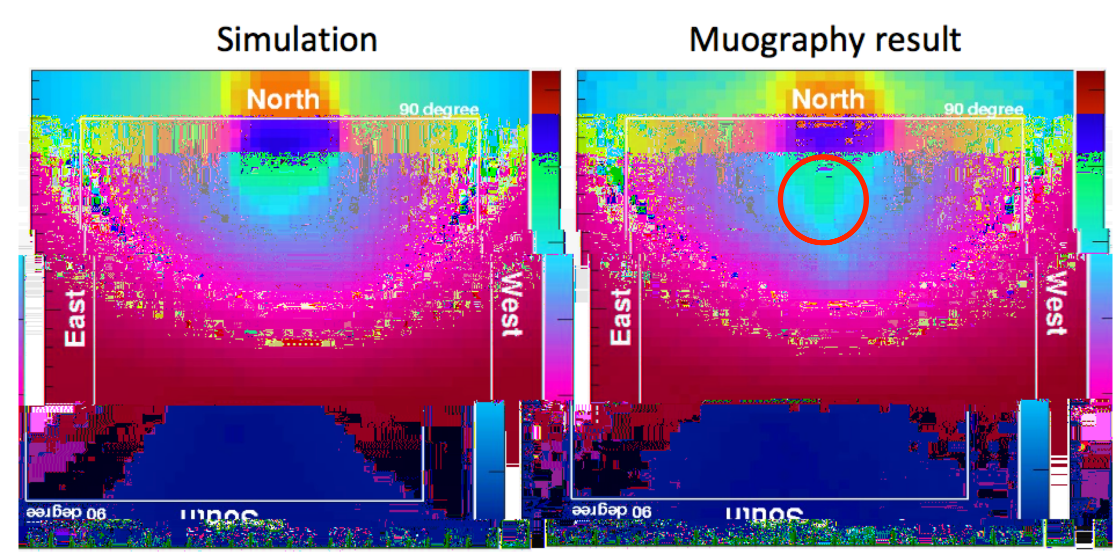




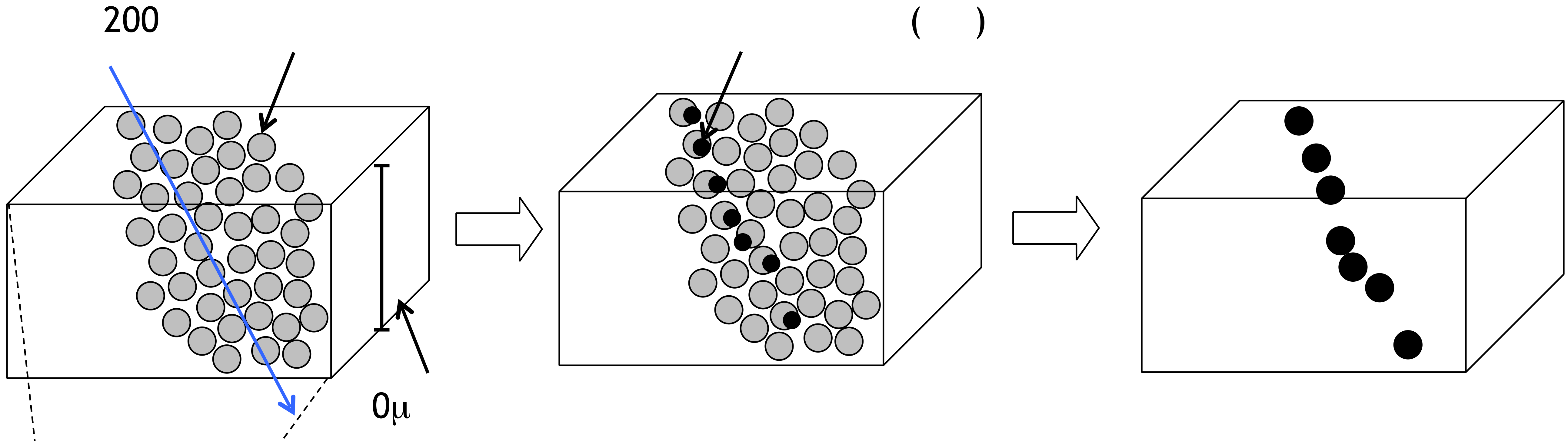
Principle confirmation

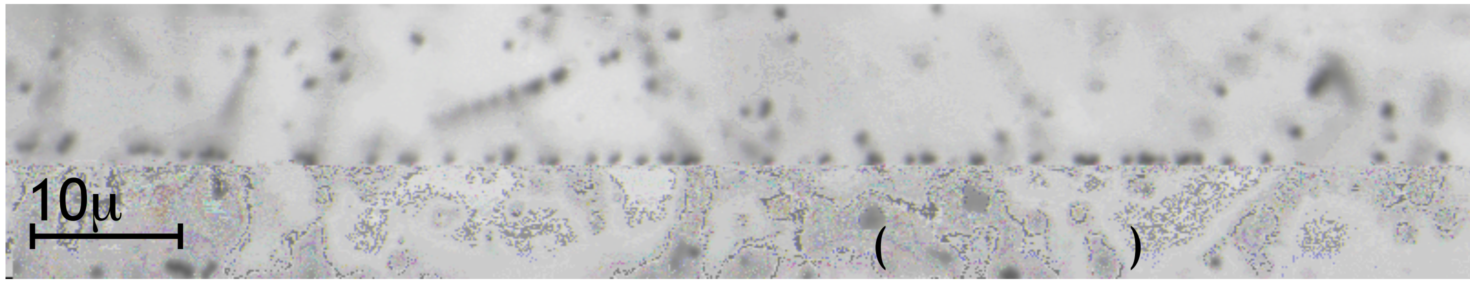


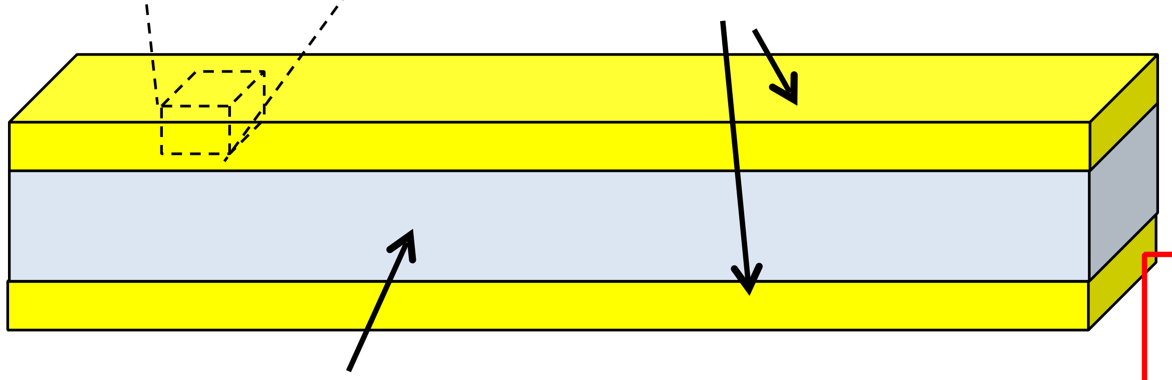
Anomaly region



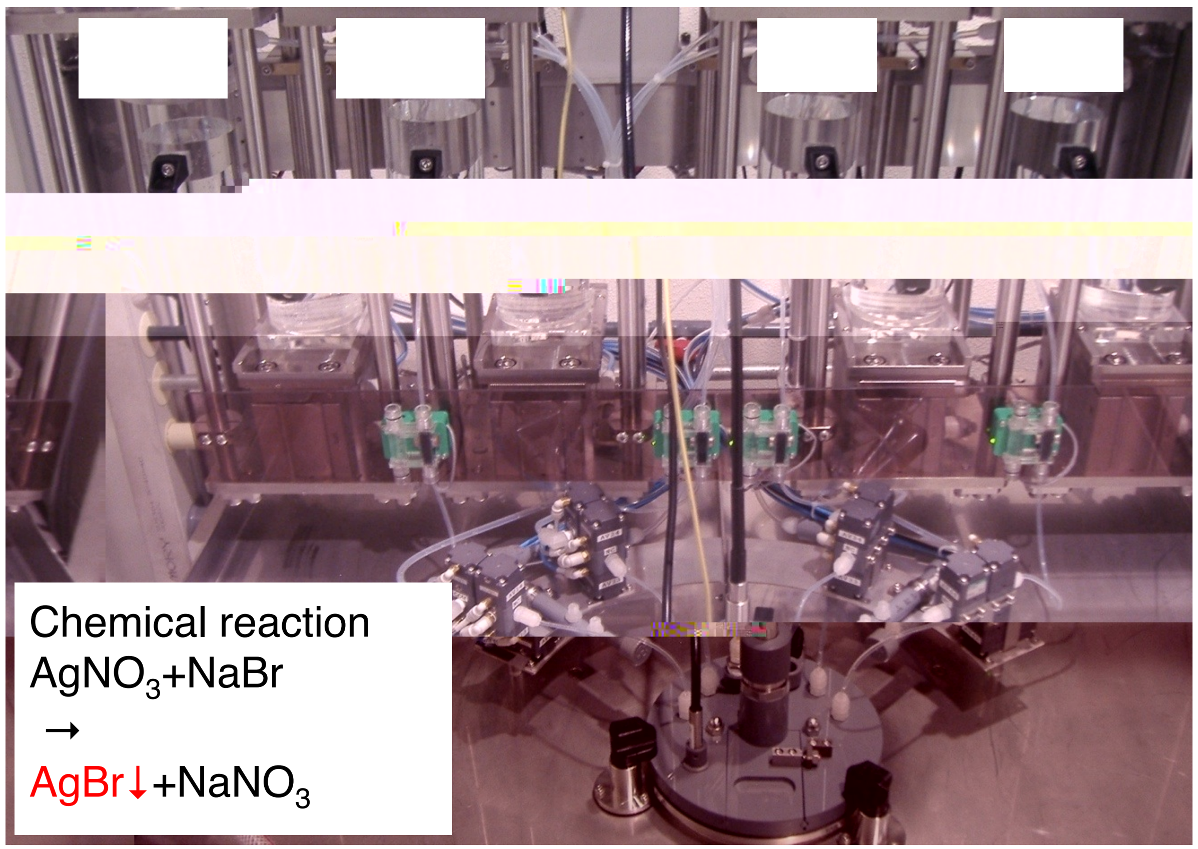
Nuclear emulsion detector







Development of nuclear emulsion in Nagoya University



~2010
Emulsion gel manufacturing machine was installed in Nagoya University (cooperation with FUJI FILM)

nuclear emulsion development by ourselves was started

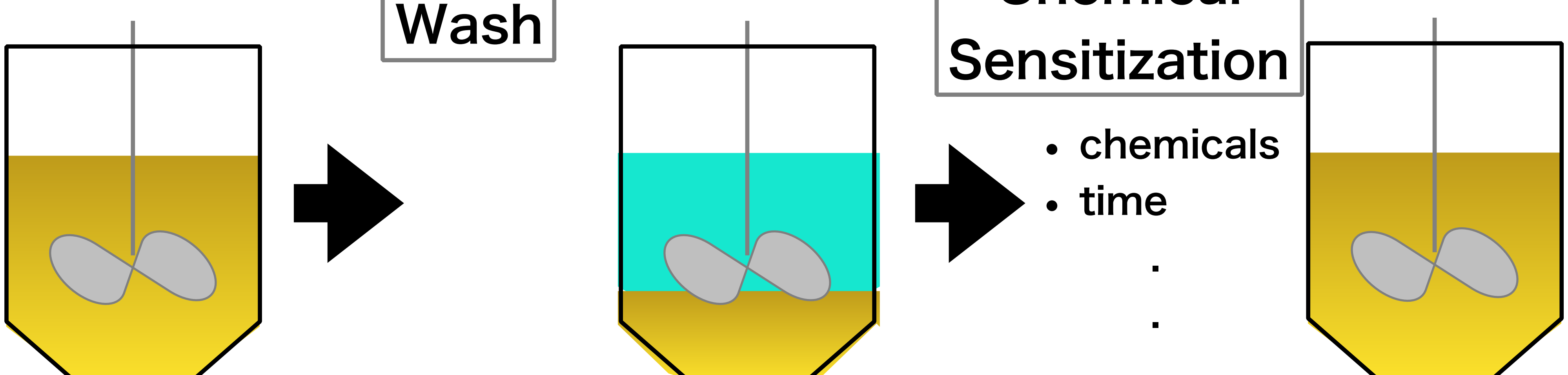
Crystal formation

- temperature
- speed
- chemicals
- .
- .

Wash

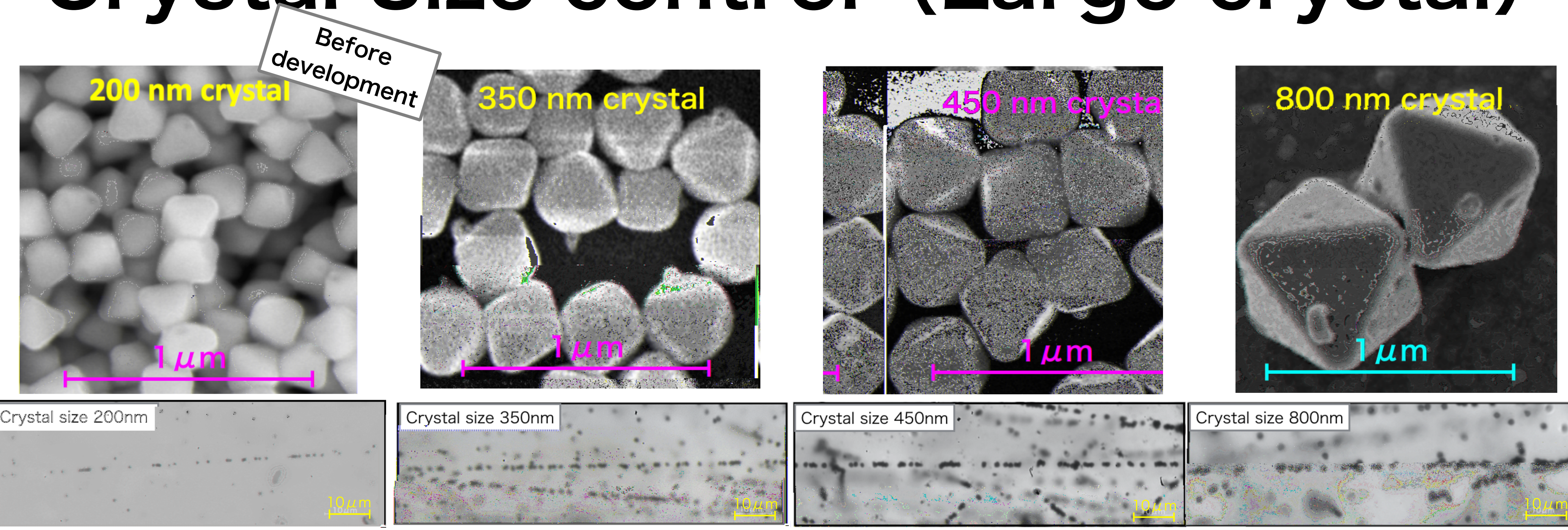
Chemical Sensitization

- chemicals
- time
- .
- .



Control crystal size and shape — Remove extra ion — Sensitivity and Stability control

Crystal Size control（Large crystal)



G.D = 33.6 ± 2.6　　G.D = 42.0 ± 2.9　　G.D = 46.6 ± 3.1　　G.D = (34.1 ± 3.8)

Sensitivity：Grain Density(G.D) = number of developed crystals/100μm

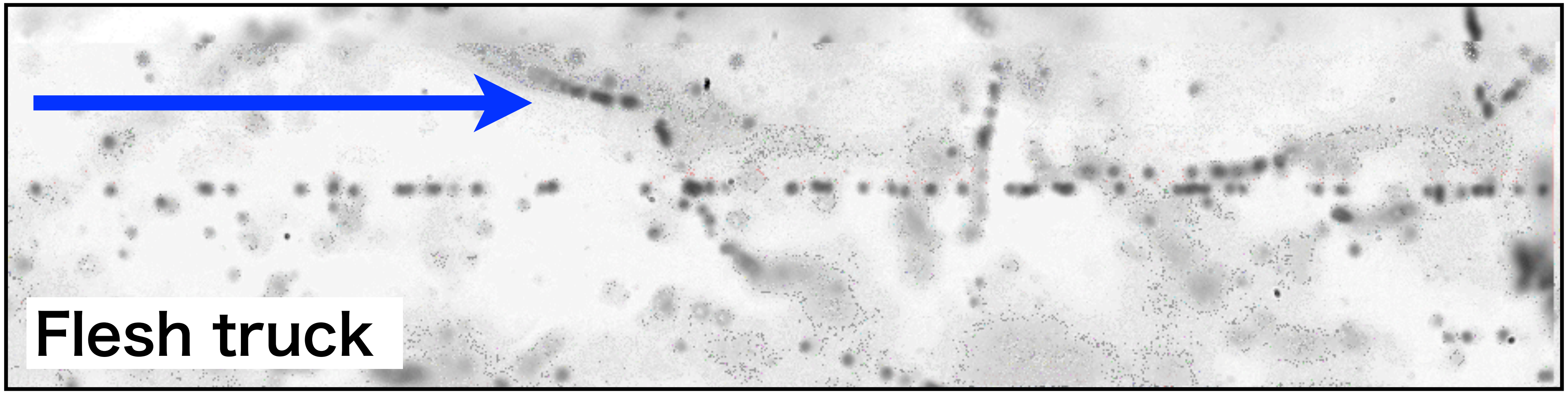
Achievements

- Sensitivity for MIP is maximum when Crystal Size is 300 ~ 500nm
- Contrast of truck is improved
  (vision: high speed track selection in large field of view)
- Characteristic of latent image fading ←**report new result in this talk**

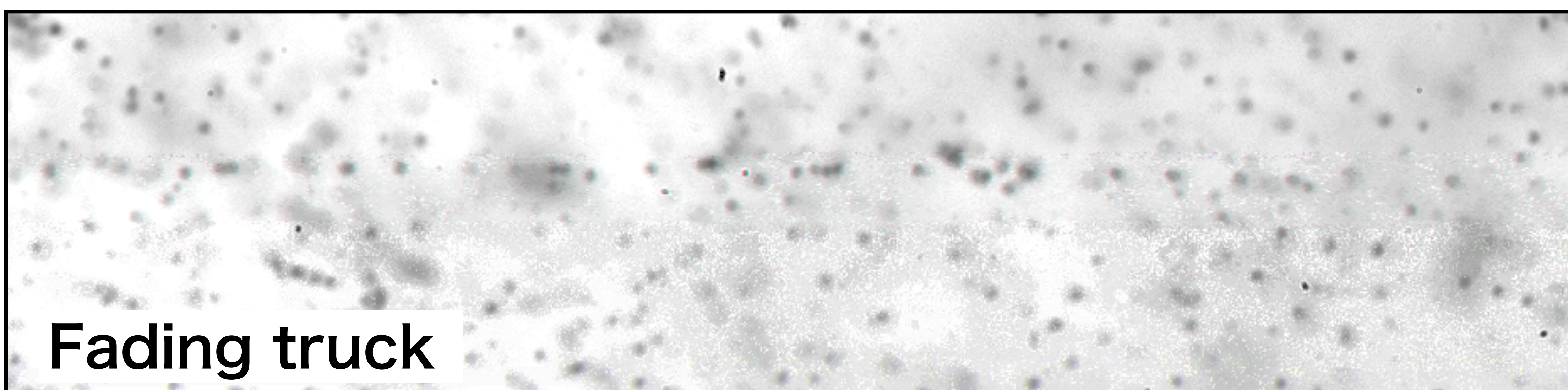
Latent image fading

~100MeV electron truck

is phenomenon that once recorded track as latent images are fading before chemical development.



after storage for 60days in 30℃ (RH30%)



Observation period is limited

- Experiment(1):
  Crystal Size dependence of
  Latent image fading

- Experiment(2):
  Chemical dependence of
  Latent image fading

- Experiment(1):
  Crystal Size dependence of
  Latent image fading

- Experiment(2):
  Chemical dependence of
  Latent image fading

⑴:Crystal Size dependence of Latent image fading

Experimental method

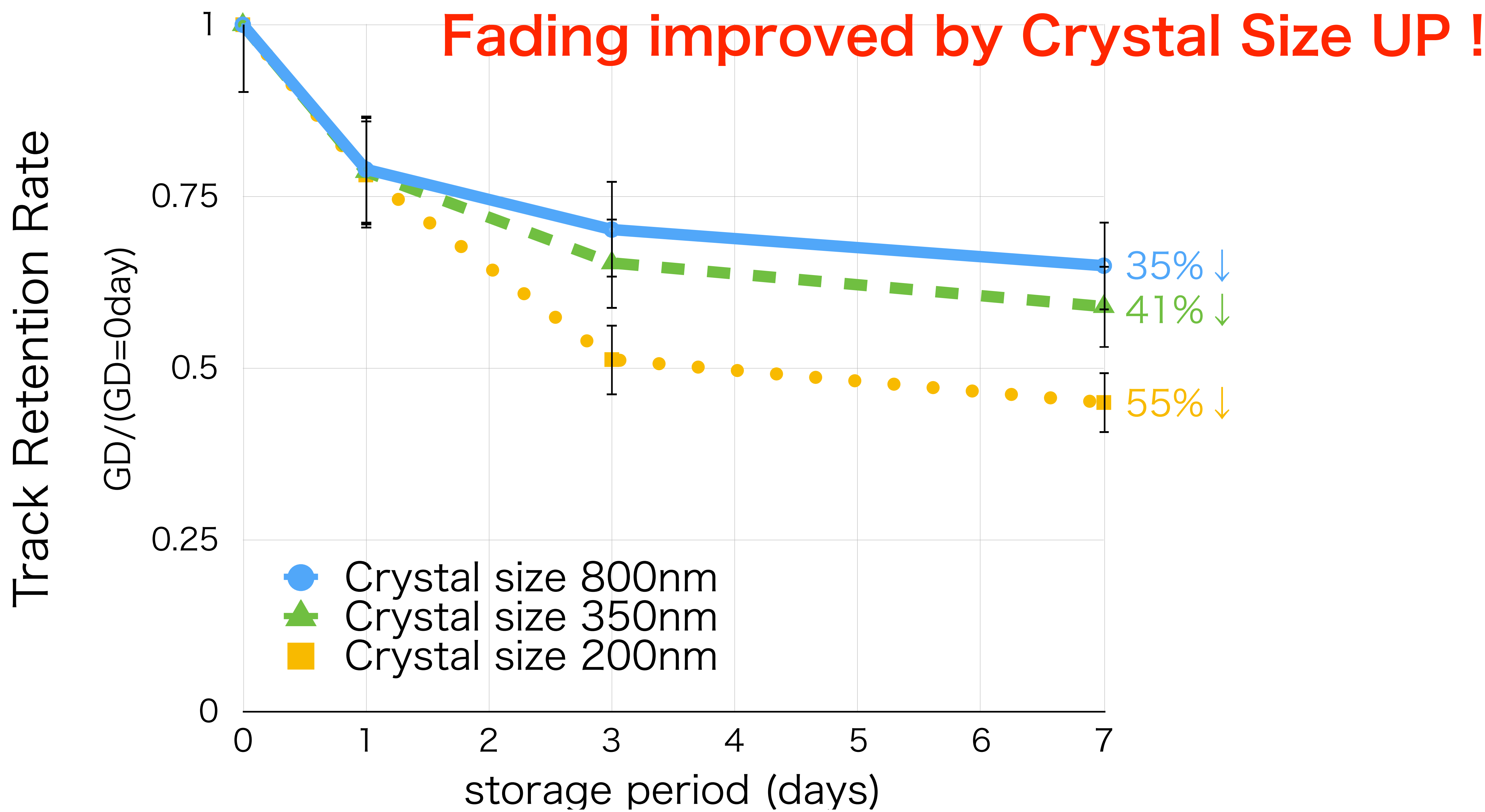
1. Production of emulsion gel which crystal size different
2. Pouring the emulsion gel on base
3. Humidity conditioning of the emulsion film
4. Put the conditioned sample in aluminum laminated bag and vacuum pack(to keep humidity constant)
5. Electron exposure（~100MeV)
6. Storage in constant-temperature bath
7. Development
8. Grain Density evaluation

Condition
Crystal Size : 200,350,800nm
Volume occupancy AgBr : 30%
Humidity : RH60%
Temperature：32℃

⑴:Crystal Size dependence of Latent image fading

＜Initial G.D＞

800nm : 350nm: 200nm = 22.8 : 34.6 : 32 [/100μm]



Condition：３２℃　RH６０％

- Experiment(1):
  Crystal Size dependence of
  Latent image fading

- Experiment(2):
  Chemical dependence of
  Latent image fading

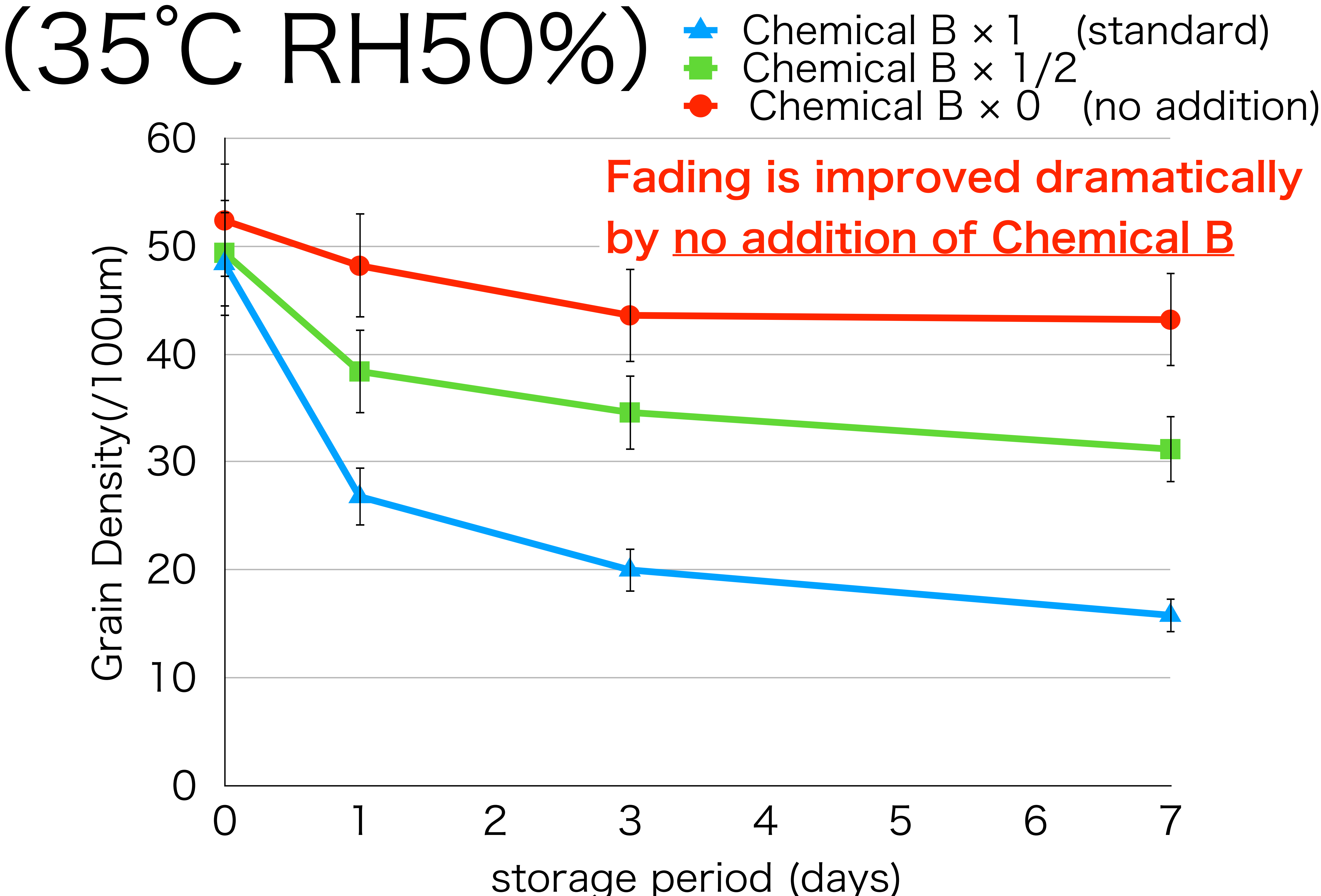
⑵:Chemical dependence of Latent image fading

Experimental method

1. Production of emulsion gel which chemical amount different
2. Pouring the emulsion gel on base
3. Humidity conditioning of the emulsion film
4. Put the conditioned sample in aluminum laminated bag and vacuum pack(to keep humidity constant)
5. Electron exposure（~100MeV)
6. Storage in constant-temperature bath
7. Development
8. Grain Density evaluation

Condition
Crystal Size : 350nm
Volume occupancy AgBr : 40%
Humidity : RH50%
Temperature：35℃

⑵:Chemical dependence of Latent image fading



Chemical B(standard)

Chemical B(no addition)

[redacted]

[redacted]

Initial

35℃
RH50%

storage
7days

[redacted]

[redacted]

Summary

- **We found two factor which improve latent image fading in experiment**

① Fading is improved by large crystal size emulsion
(Condition：32℃,RH60%,200,350,800nm crystal)

② Fading is improved dramatically by <u>no addition of Chemical B</u>
(Condition：35℃,RH50%,350nm crystal, Chem B＝×1,×1/2,×0)

“Thank you for your kind attention”