Basic properties of the Emulsion Film

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(Nagoya Univ.)

2002/3/17

- Short history
  Fuji – Japanese Physicist Collab.
- Basic properties of Emulsion Film
- Special property of Emulsion Film
  = 「Refresh」

Fuji-Japanese Physicist Collaboration

1st Achievement!

1957 Oct 16th

News paper "Mainichi Shinbun" reported the achievement of the collaboration.

"High quality nuclear emulsion (made in Japan): Possible to export to the world."

Compatible to Ilford G5

Fuji Electron Sensitive Nuclear Emulsion ET7A

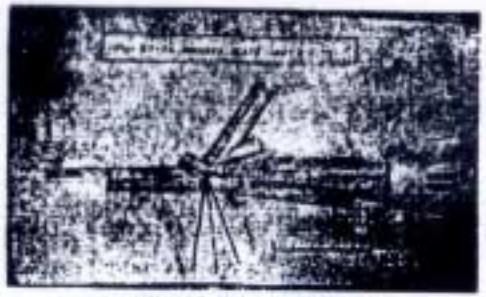
毎日新聞 1957年 (1957)

脚光浴びる国産原子核乾板

16日の日本物理学会へ発表

世界に誇る高性能

輸出の夢も実現しそう



Presented by Prof.Kazuno of Toho univ. in the 1st Emulsion Workshop

⇒ See proceeding

ET7A→ET7B(1957→1997)

Used in many **Balloon/Airplane Experiment** **Discovery of X-particles**

Used in many Accelerator experiment:

Fermilab: E531, E653

CERN: WA75, **CHORUS**

KEK: E176

'94 Seminar by Dr. Tani about Ag Br Device

Learn the current Photographic Emulsion Technology

ET7C (1996-)

Better grain size control

Higher intrinsic resolution : ~60 nm (0.06μm) (←→ ET7B 75nm (0.075μm))

Used in **DONUT** **Discovery of Tau neutrinos**

Emulsion Film (R&D for OPERA from 1998)

ν_τ Appearance exp.

SK ν_μ deficit

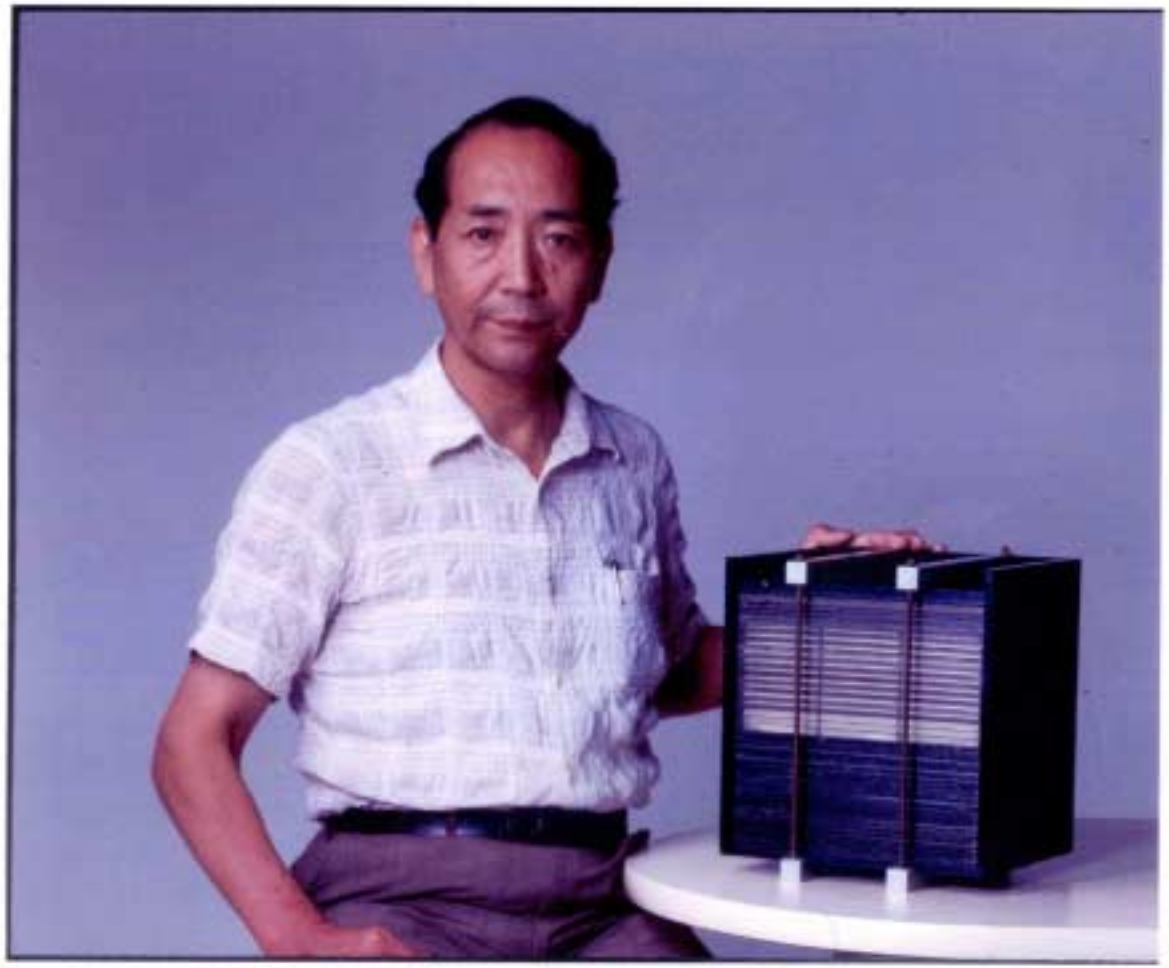
New gel with higher senisitivity

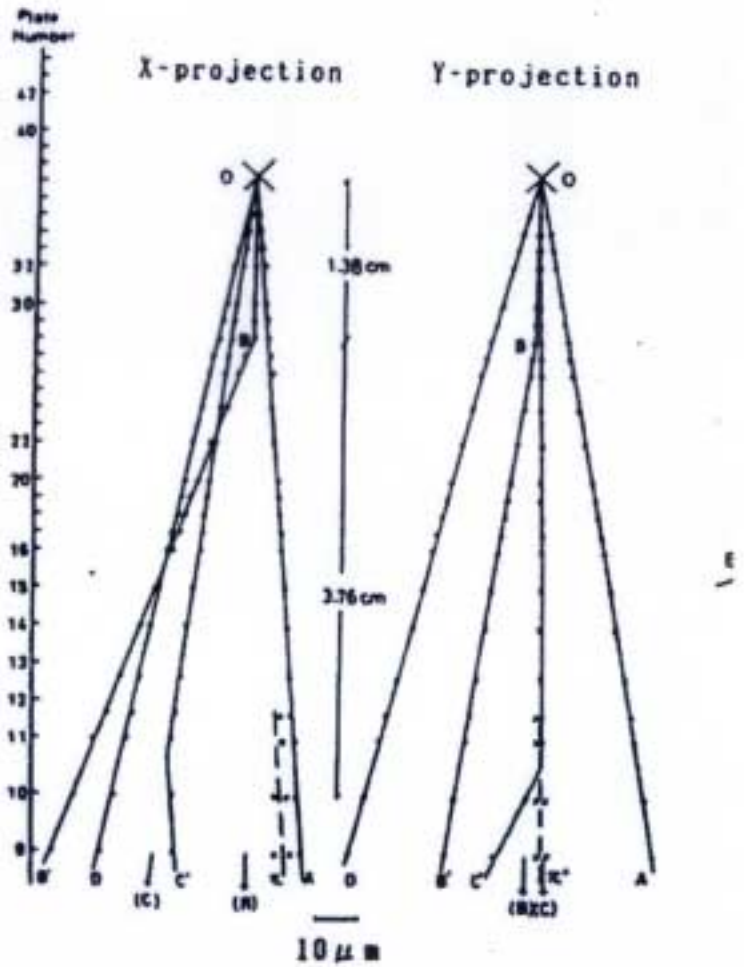
higher resolution: 45 nm (0.045μm)

Coated by machines for the commercial film production

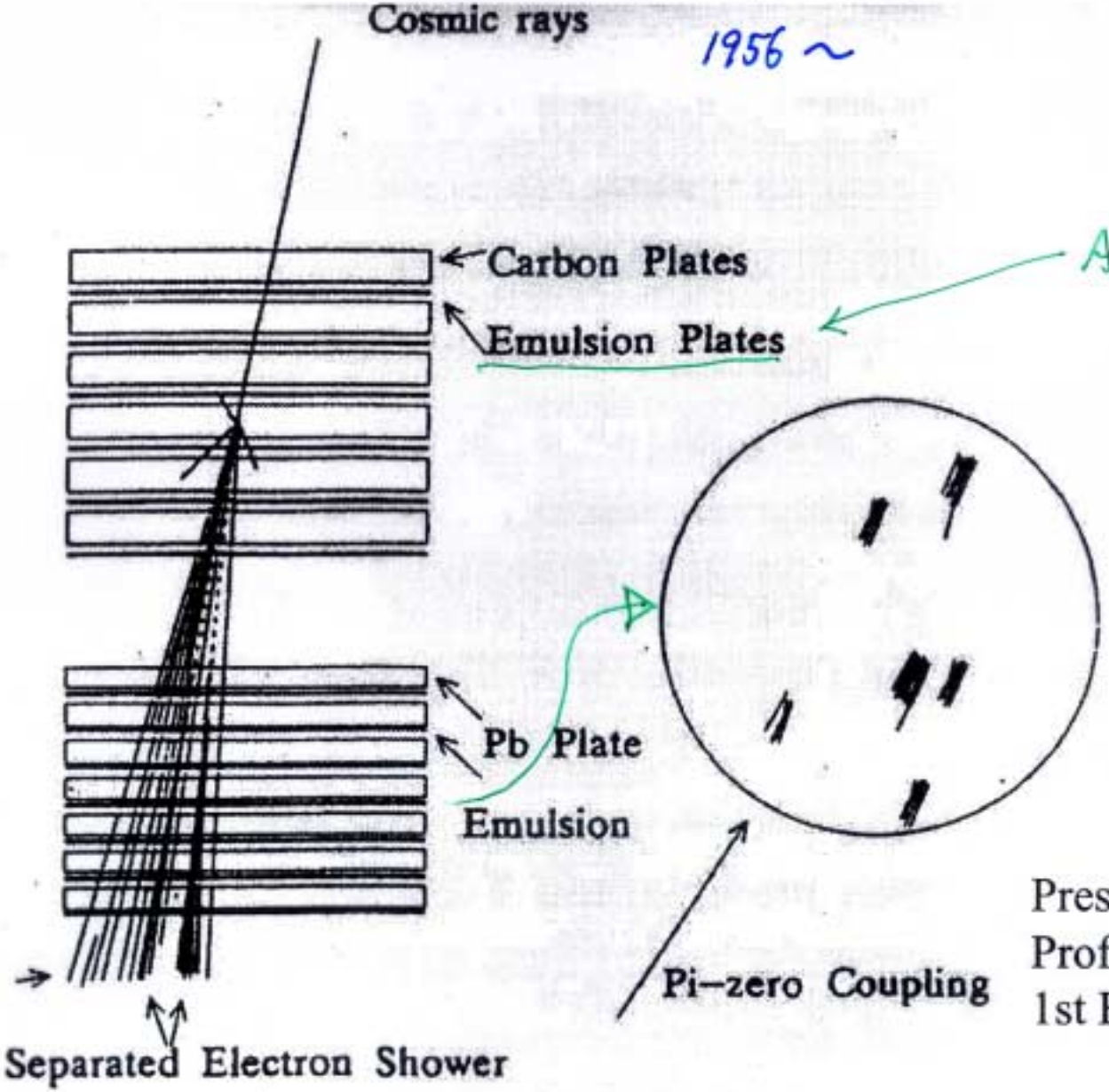
Discovery of X particles (Current Charm) in Cosmic-ray exposure

1971 by Prof.K.Niu



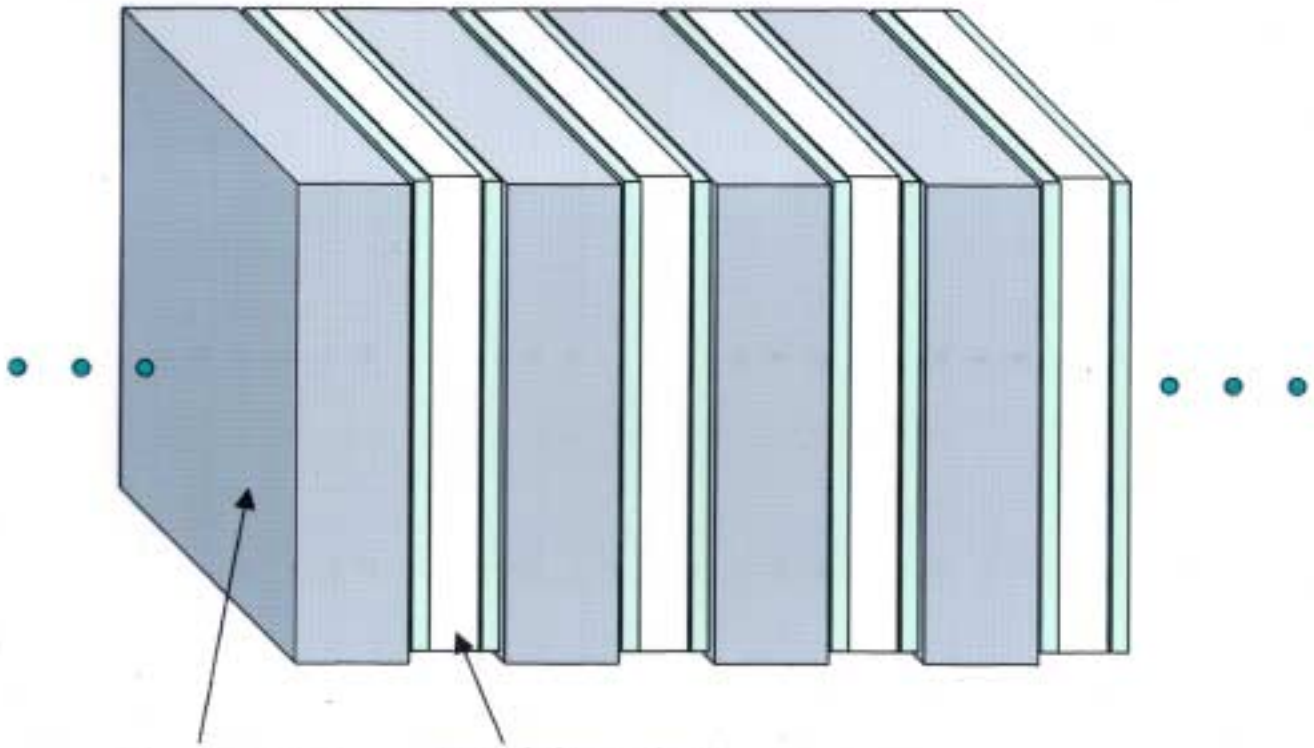


ECC used in the Cosmic ray experiment(Schematic View)



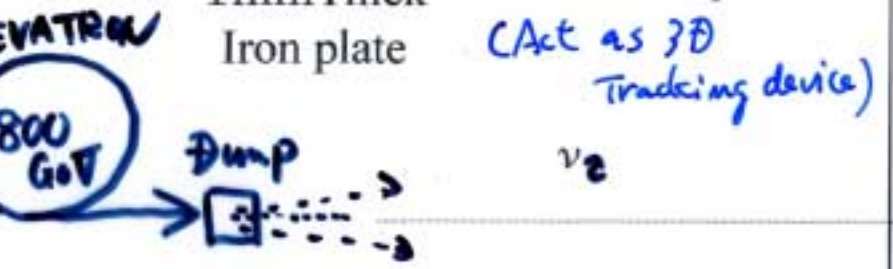
Presented by
Prof.Nishimura in the
1st Emulsion Workshop

DONUT·ECC (Emulsion Cloud Chamber)

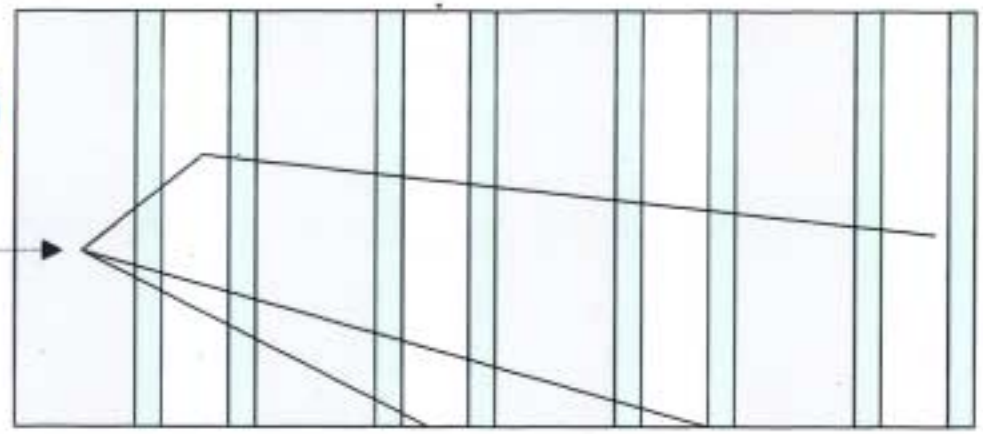


1mmThick Iron plate

Emulsion plate (Act as 3D Tracking device)



ν_e



Gel : ET7C

Dr.NONAKA **Dr.OKADA**

NETSCAN Inventor

2nd Event

2000 Feb. 14

ICHEP2000 at Osaka

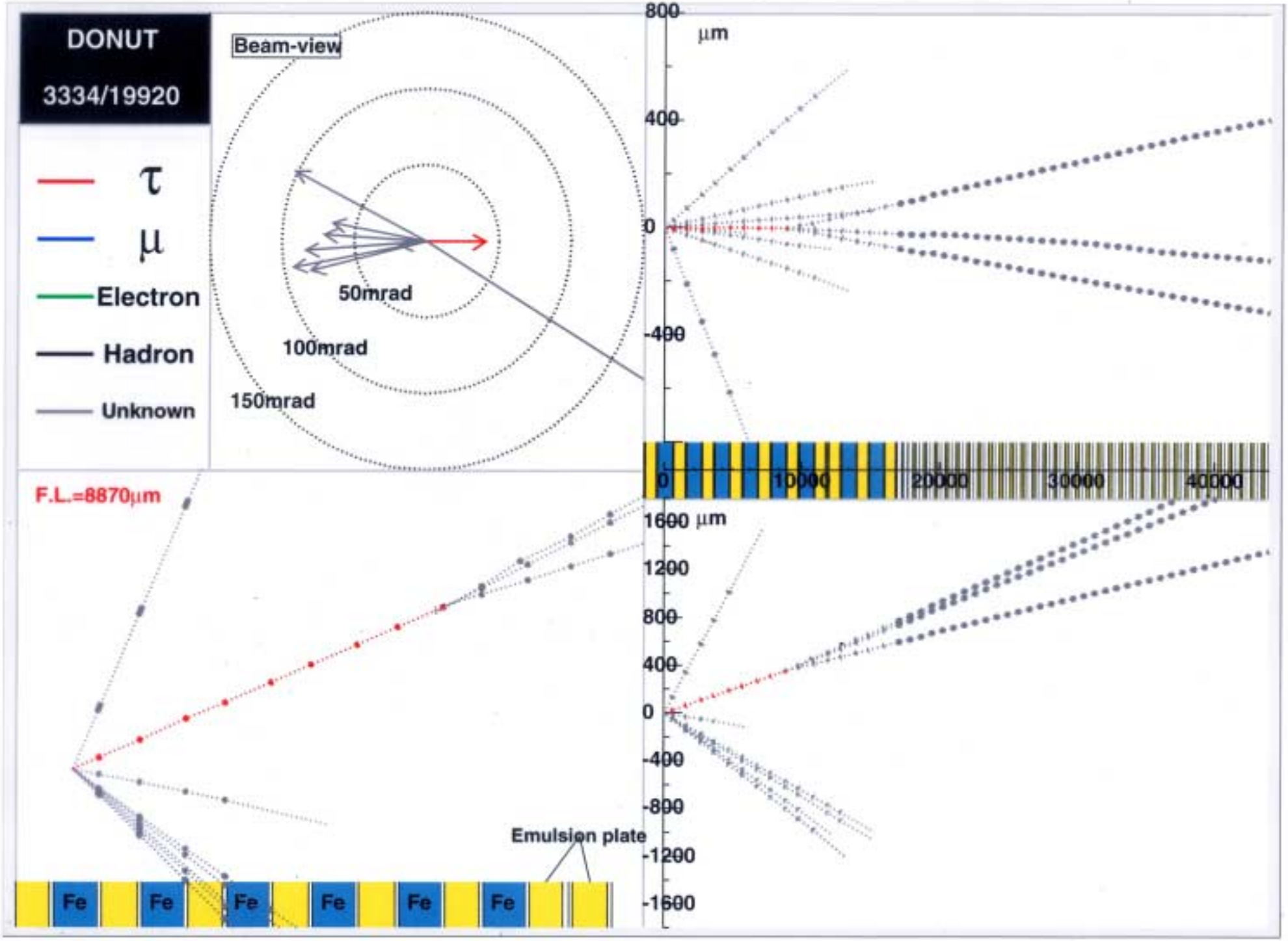
UTS (Nakano) NETSCAN (NONAKA)

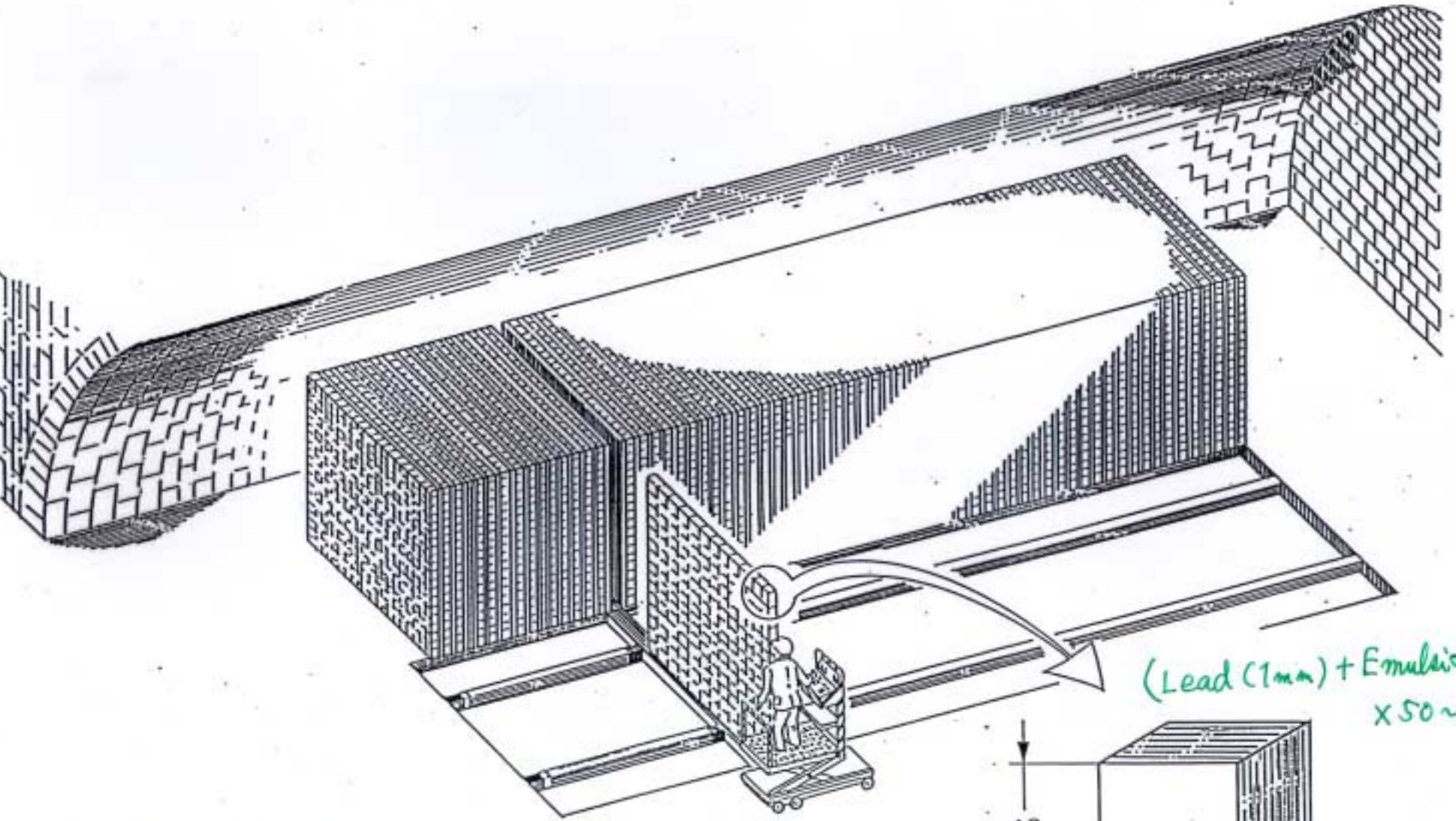
1st Event

1998 May 23

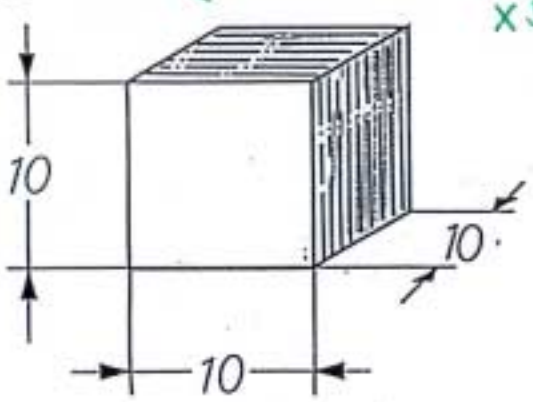
ν98 at Takayama

⇒ At Prosent 7 events.


DONUT
3334/19920
τ
μ
Electron
Hadron
Unknown
Beam-view
50mrad
100mrad
150mrad
F.L.=8870μm
Emulsion plate
Fe
Fe
Fe
Fe
Fe
Fe
800
μm
400
0
-400
0
10000
20000
30000
40000
1600 μm
1200
800
400
0
-400
-800
-1200
-1600

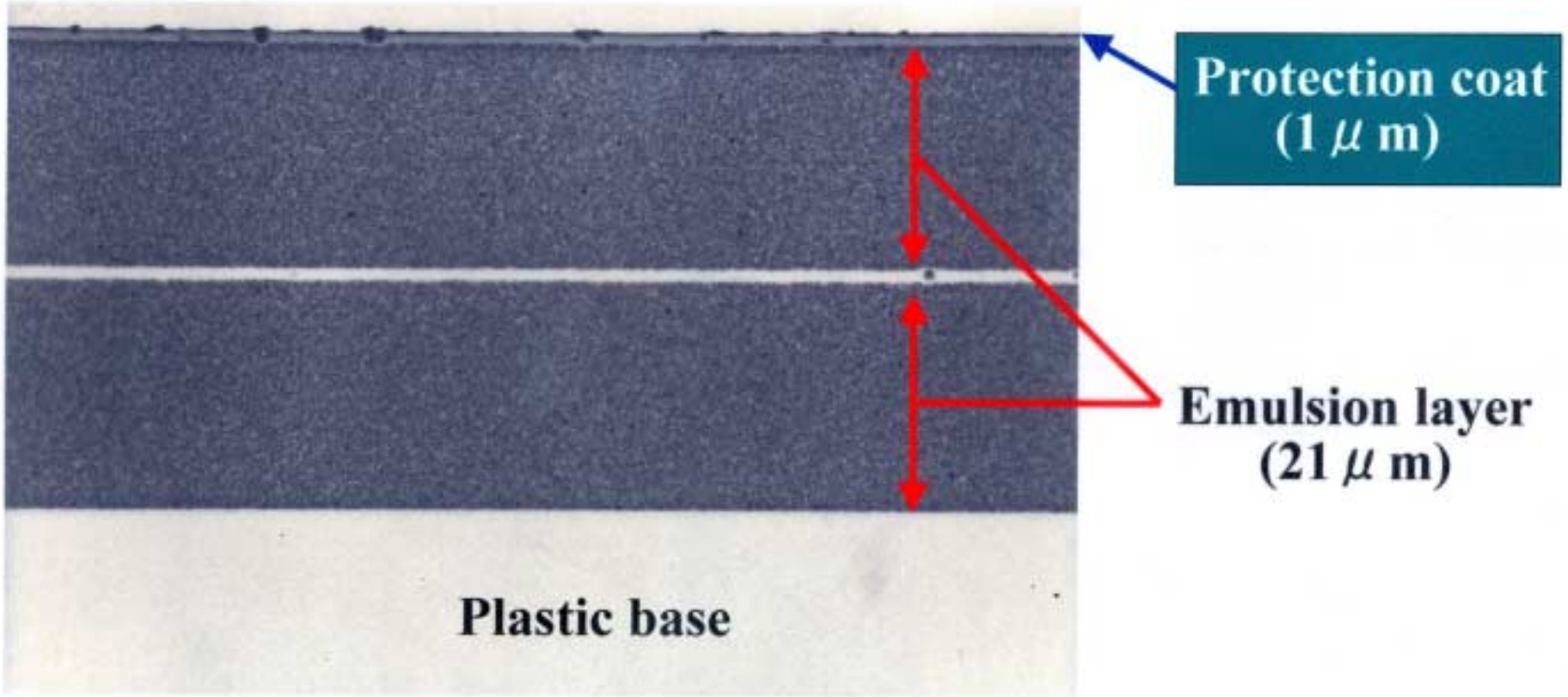


(Lead (1mm) + Emulsion plate)
×50~100



nitial Image of
1 kton ECC detector
@ Soudan mine or @ Gran Sasso. ['96]

⇒ required film ~ 100,000 m² (!) ⟺ CHORUS 500 m²



Protection coat ~~can be possible to~~ allow direct contact with lead

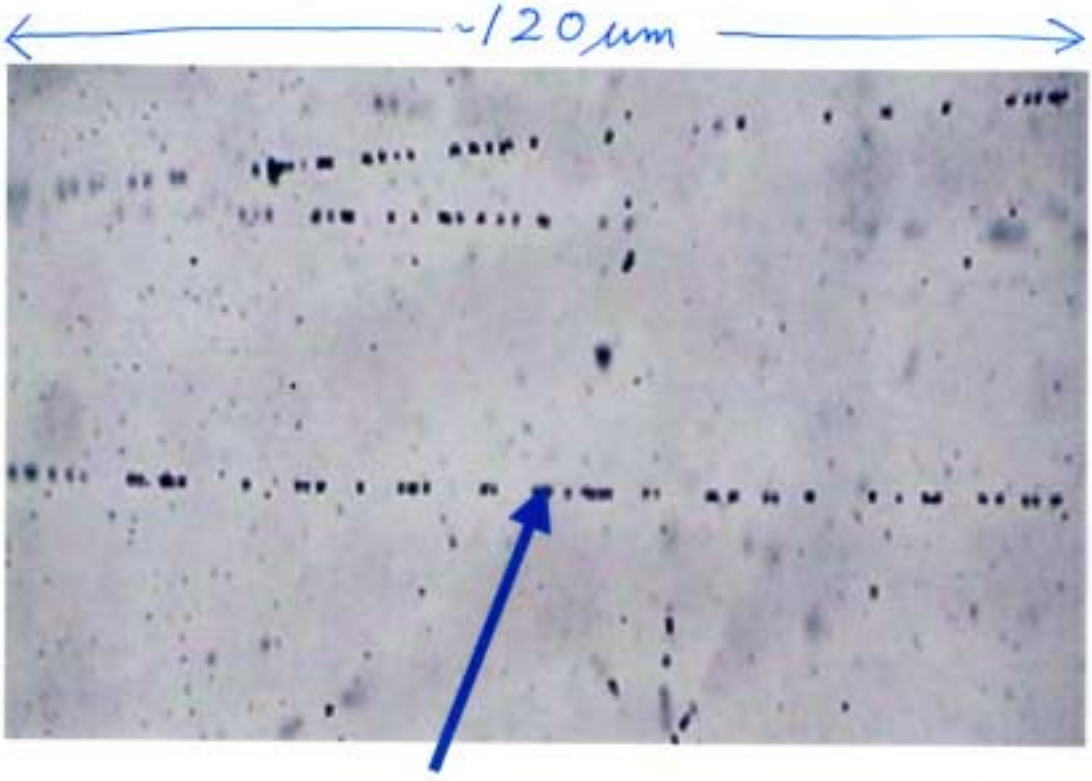
Performance of OPERA emulsion

Initial sensitivity

Production

Beam exposure

Development



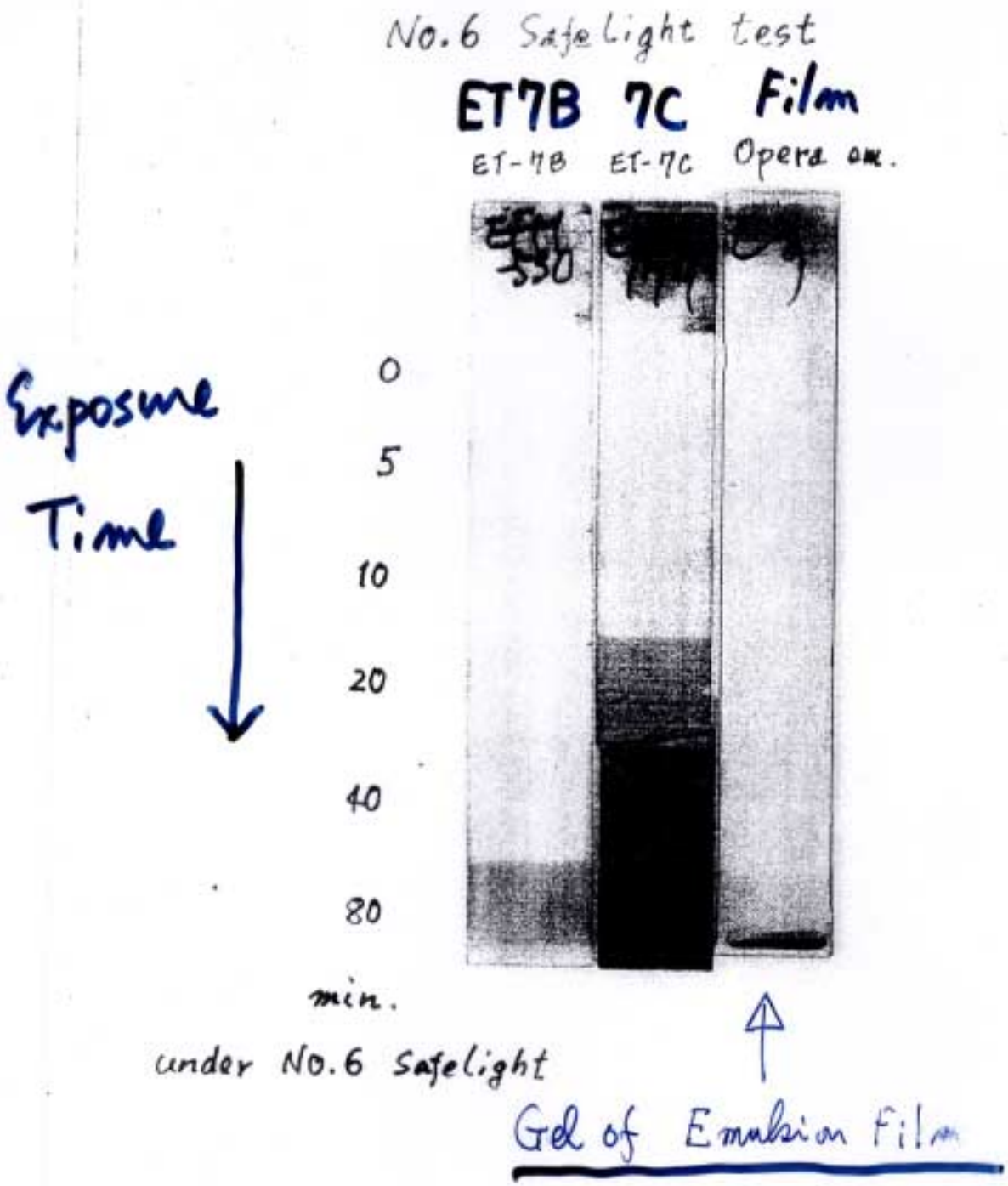
GD 36/100 μ m FD 1.3/1000 μ m^3

	Emulsion Film		ET7B
Grain Diameter			
Average	0.20		0.24 [micron]
RMS	0.02		0.08 [micron]
Volume Occupancy			
of AgBr	0.31	<	0.5
Observed Grain			
density	36	≒	36
λtotal	29	>	24 [cm]
λinel	41	>	37 [cm]
λel	92	>	74 [cm]
Xo	5.0	>	3.4 [cm]

* Less interaction in Emulsion

⇒ suited for Tracking purpose.

Safety Light Properties



⇒ Easy to handle in a "dark" room.

Refresh

"Erasing unwanted tracks accumulated during the production & transportation."
before the experiment

- Full utilization of low BG environment of underground lab (~1 CR/m²/h)
  (G.S.)
- Energy measurement of $e^{\pm}$, γ ..
  by shower counting.

Mechanism

Destroy the Latent image by a kind of Oxidation.

$$Ag_4 + O_2 + 2H_2O \rightarrow 4Ag^+ + 4OH^-$$

(Latent Image)

⇓

Method

Humidity + Temperature.

RH 90 ~ 98% 20 ~ 40 °C

Characteristic of refreshing
(after refreshing)

Production

↓

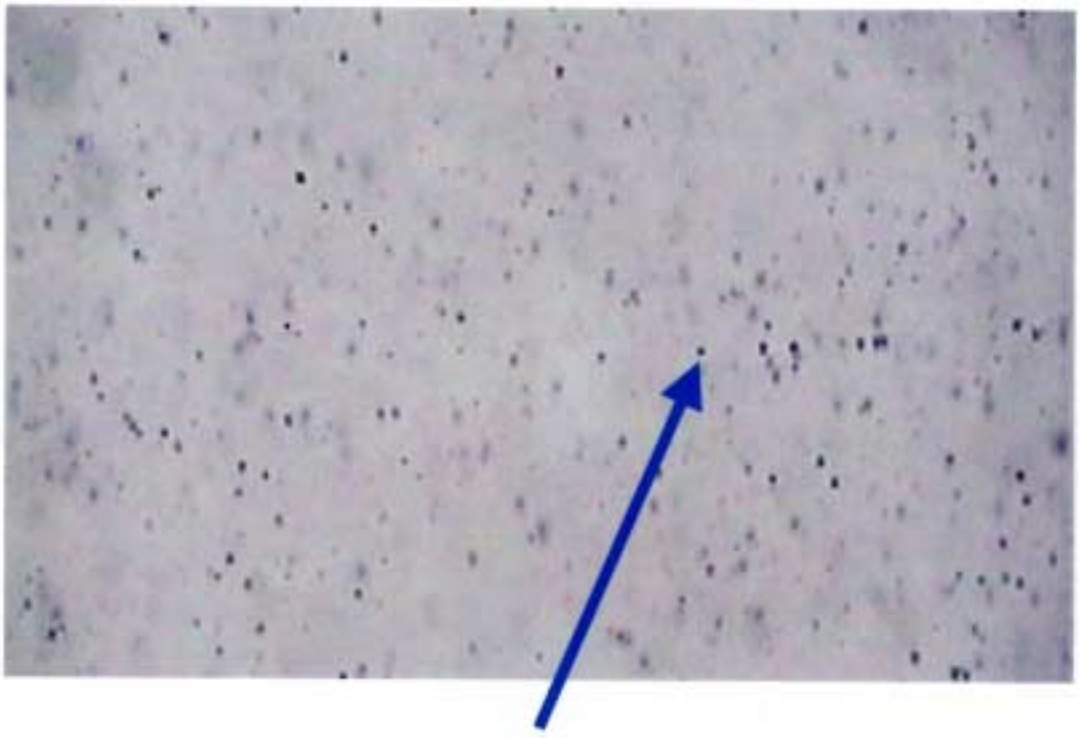
Beam exposure

↓

Refreshing　30°C. 98%RH. 3days

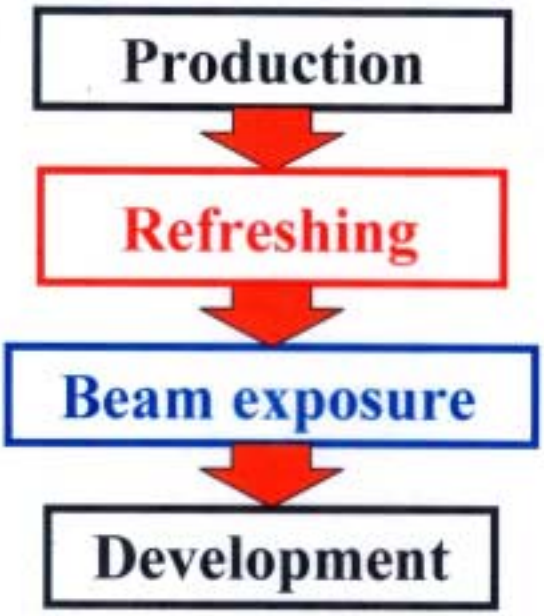
↓

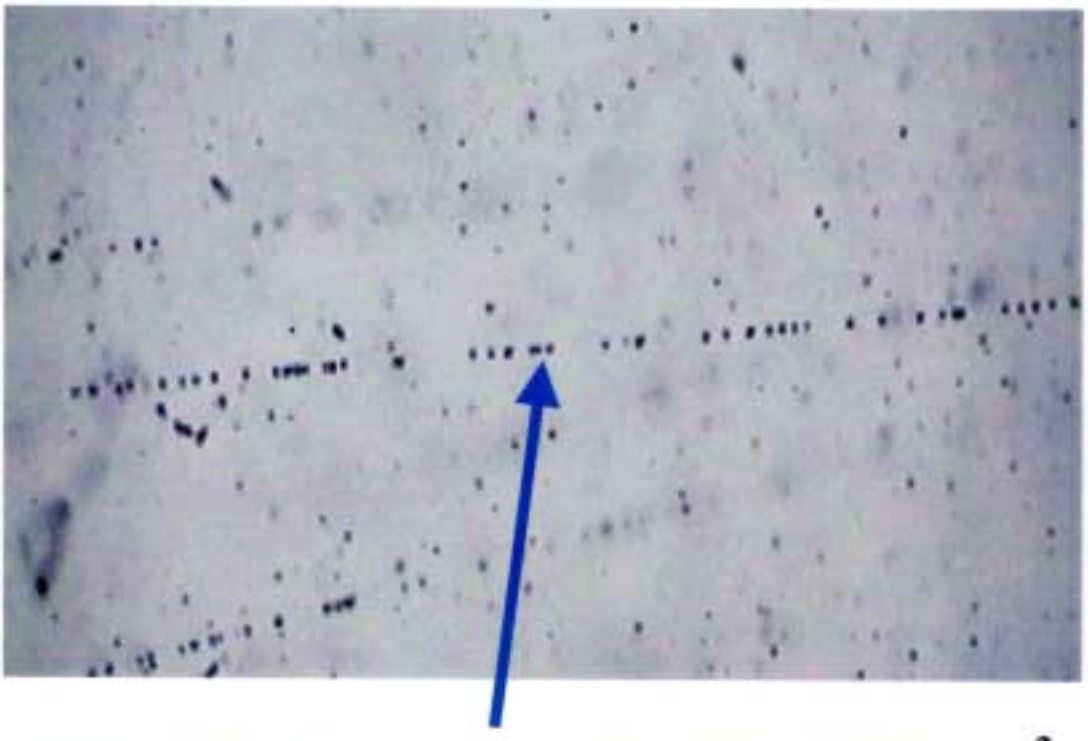
Development



GD Under 8/100 μ m　　FD 2.1/1000 μ m^3

Sensitivity of refreshed film

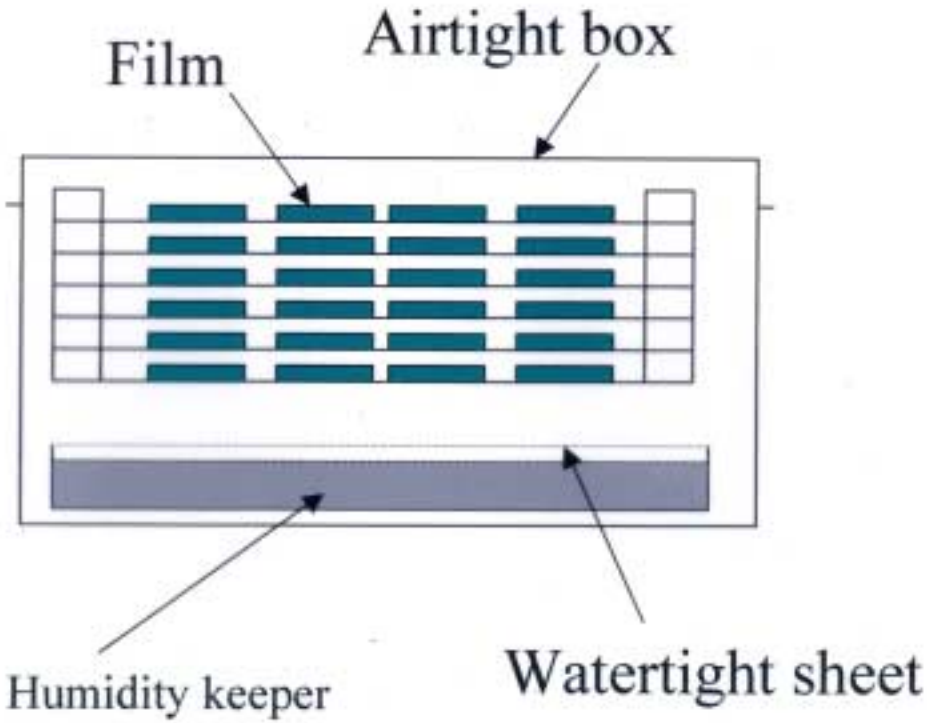




GD 35/100 μ m FD 1.5/1000 μ m^3

No degradation !

Refresh unit



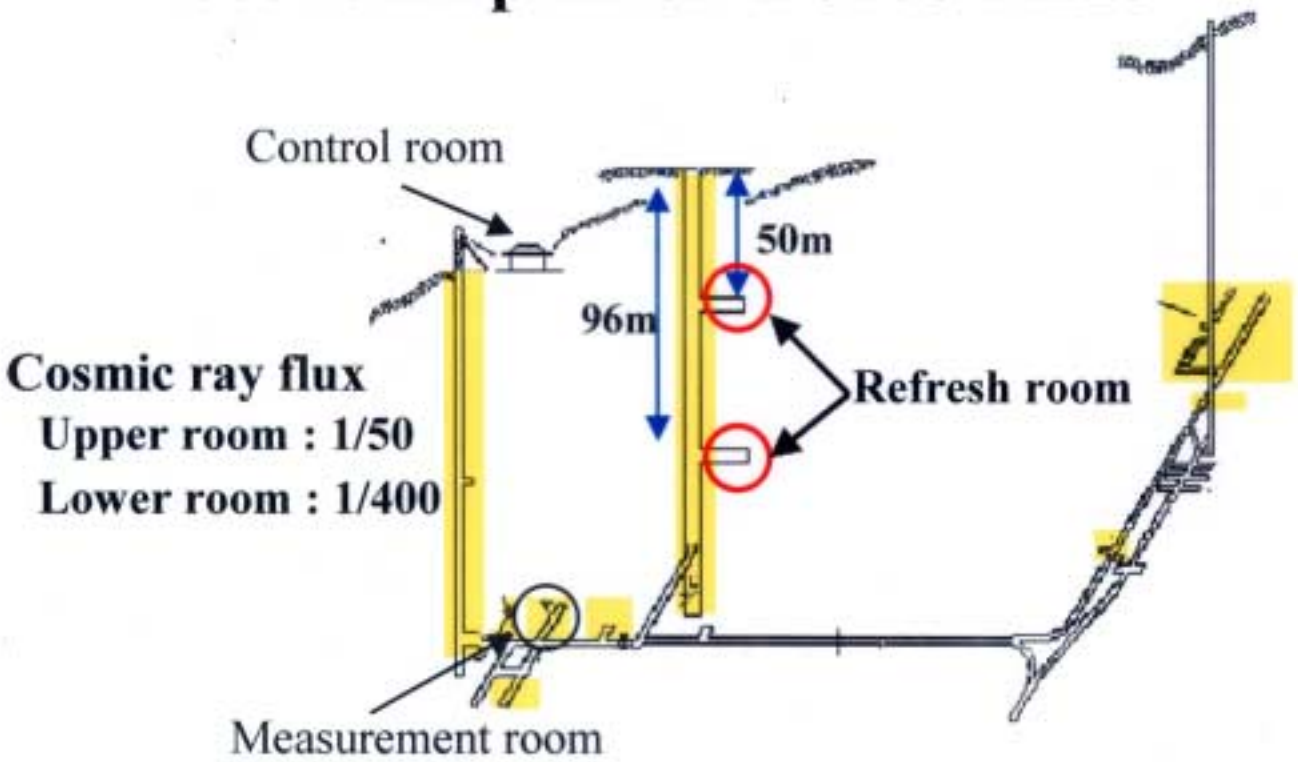
⇒ Keep at 25 ~30°C
four days.

Test of the prototype Refresh unit

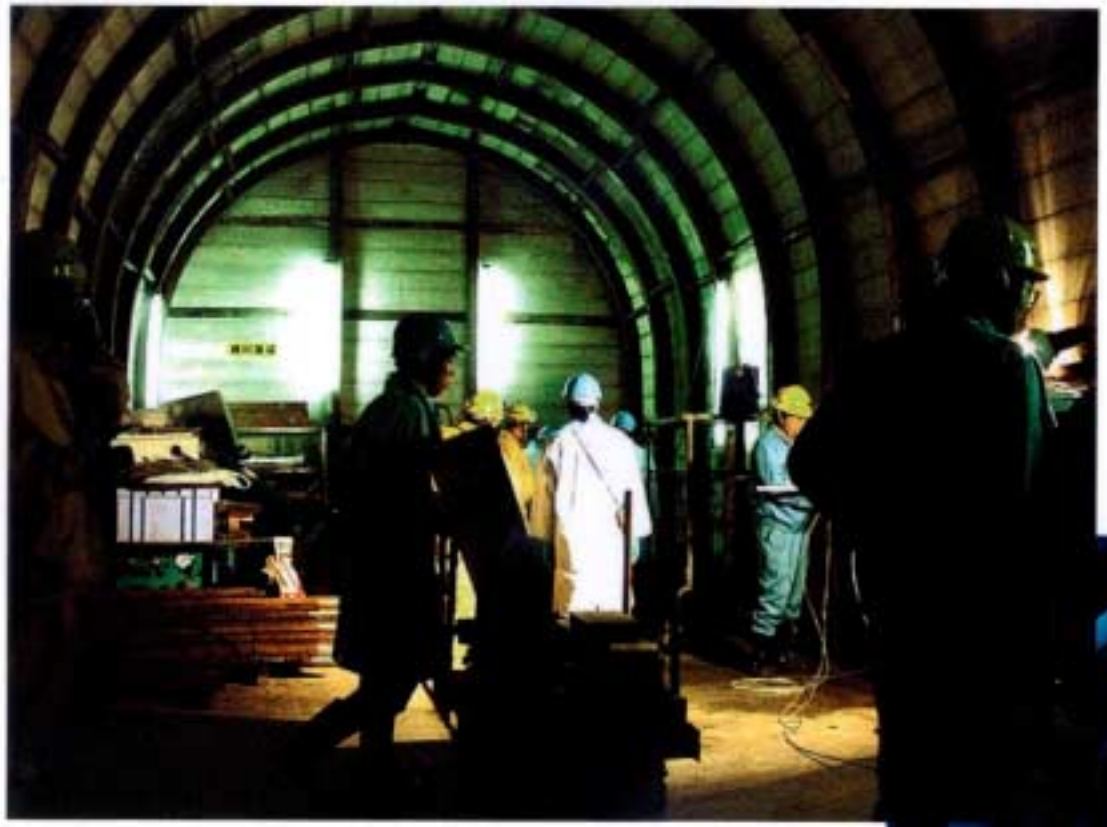
T.Uetake

TONO Mine / Toki

Sectional plan of TONO Mine



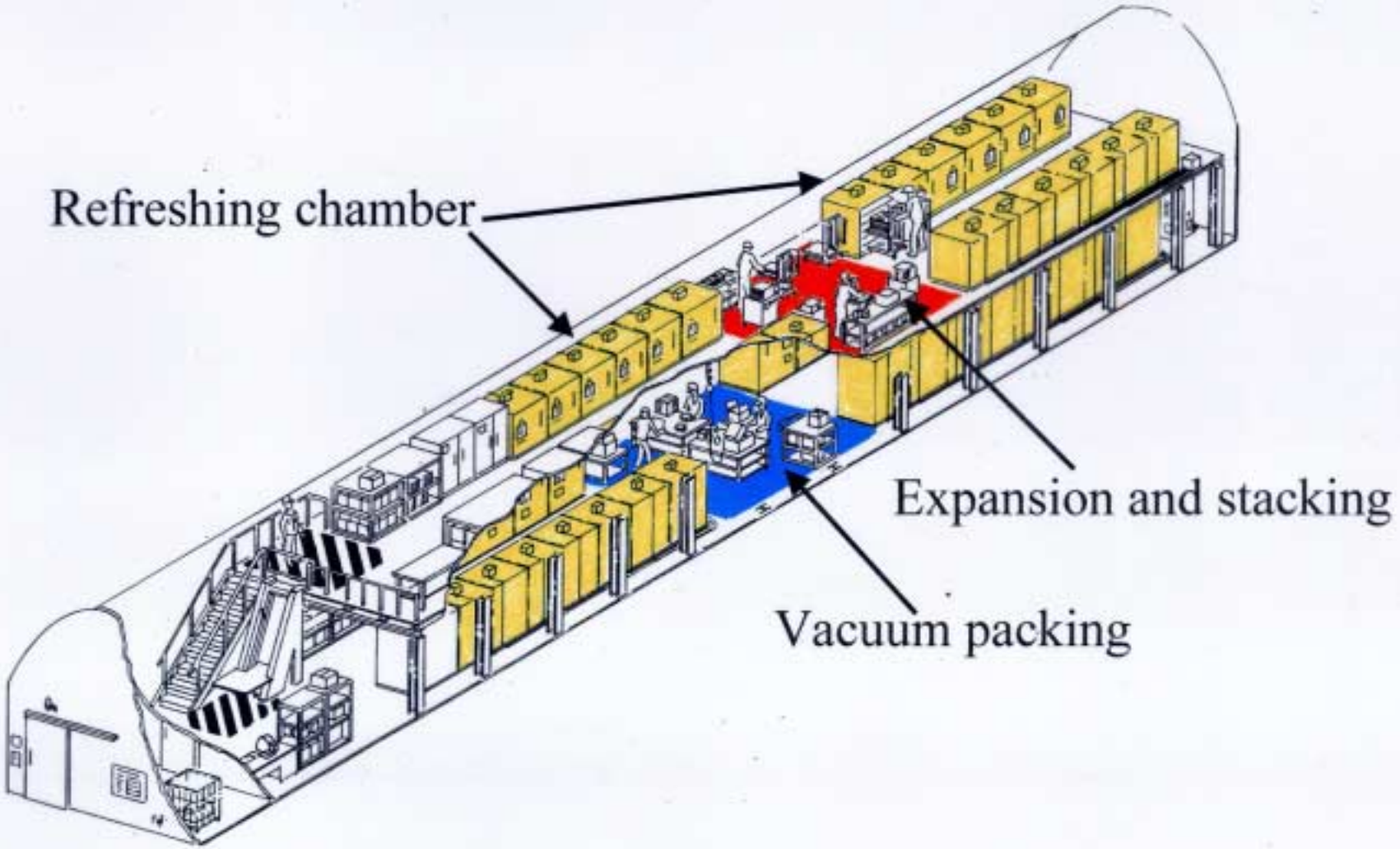
TONO Mine underground Refresh Facility



Room size
4.5m × 4.5m × 20m

Place in preparation

Refresh facility (schematic view)



2002.03.06 松田

Summary

1. New Gel ⟷ New Result

2. Emulsion Film
   = Tracking-oriented Emulsion Plate

3. Refreshing
   - Succeed to realize stable erasing.

4. Application.
   - OPERA
   - ⋮