

Digital Archives for Nuclear Emulsion Data

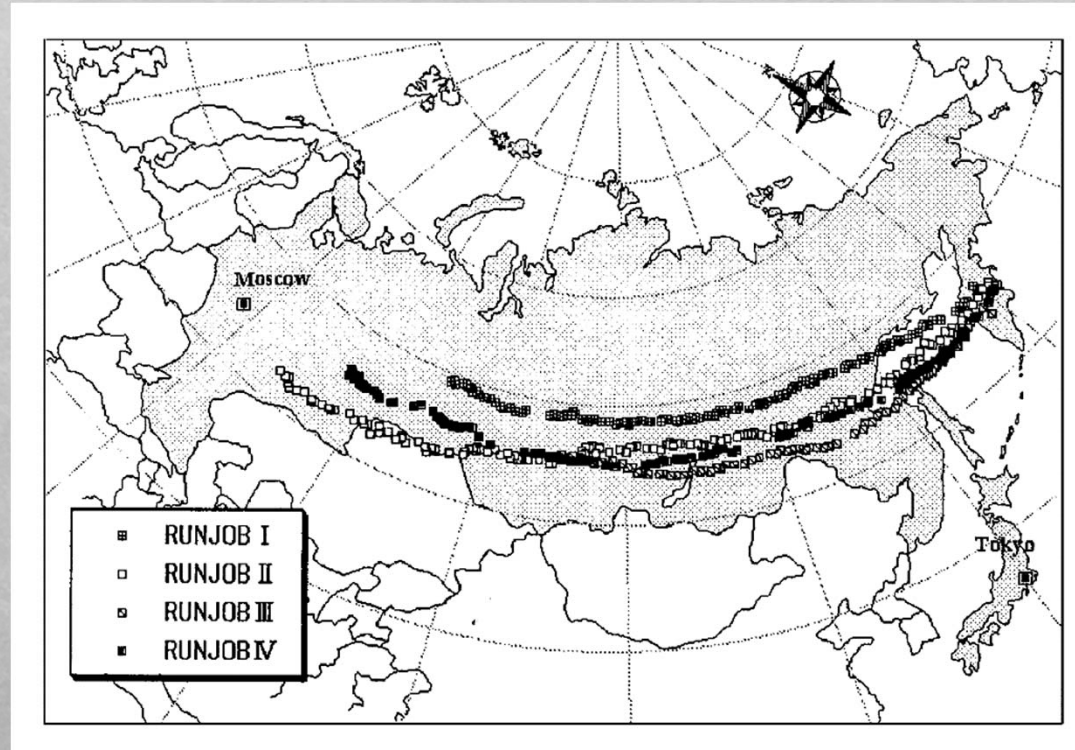
- past experiments in cosmic-ray and accelerator physics -

- HTS runs at $\sim 0.5\text{m}^2/\text{h}$ read-out speed.
- In past emulsion experiments, **NOT ALL phenomenon** recorded in emulsion was studied, especially those did not match their physics purposes.
- It will be interesting to **try to understand everything recorded** in those emulsions ... which is being possible by HTS.
 - **RUNJOB** in cosmic-ray experiment (**our primary target**)
 - DONUT in neutrino experiment
 - NA34-emulsion, EMU09 in high energy heavy ion experiment ...
- A scheme to share those emulsion data → **Digital Archives**

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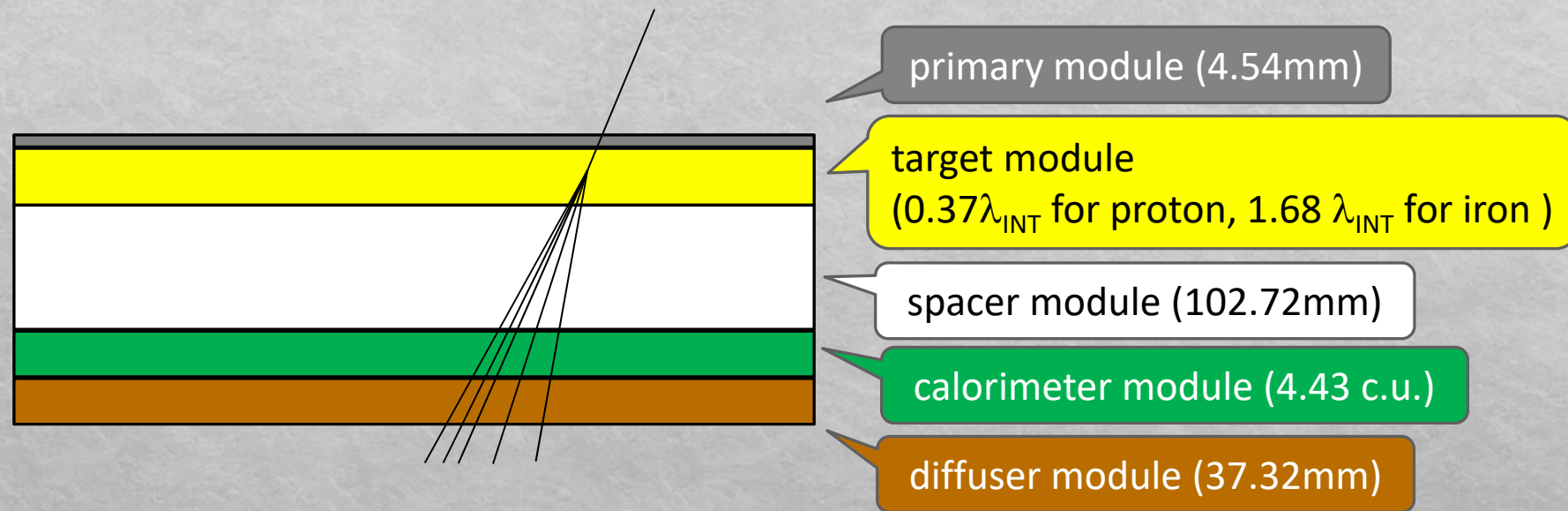
RUNJOB

RUssia-Nippon JOint Balloon-program



- 10 successful flights (1995~1997,1999)
 - Each flight was ~140 hours at mean altitude of $\sim 10\text{g/cm}^2$ (30~35km)
- HTS scanning done for the chamber V-A of 1997 flight.

RUNJOB chamber structure (1997 flight)

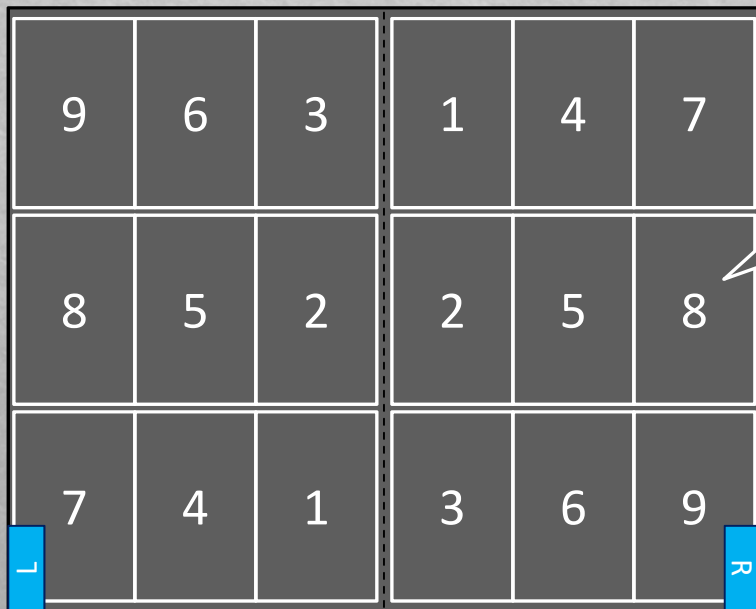


- The chamber consists of two identical blocks and each block has 41 emulsion plates of 50cm×40cm \Rightarrow 8.2m².

Materials (iron plates, Xray films, lead plates ...) are interleaved among emulsion plates.

MicroTrack read-out by HTS

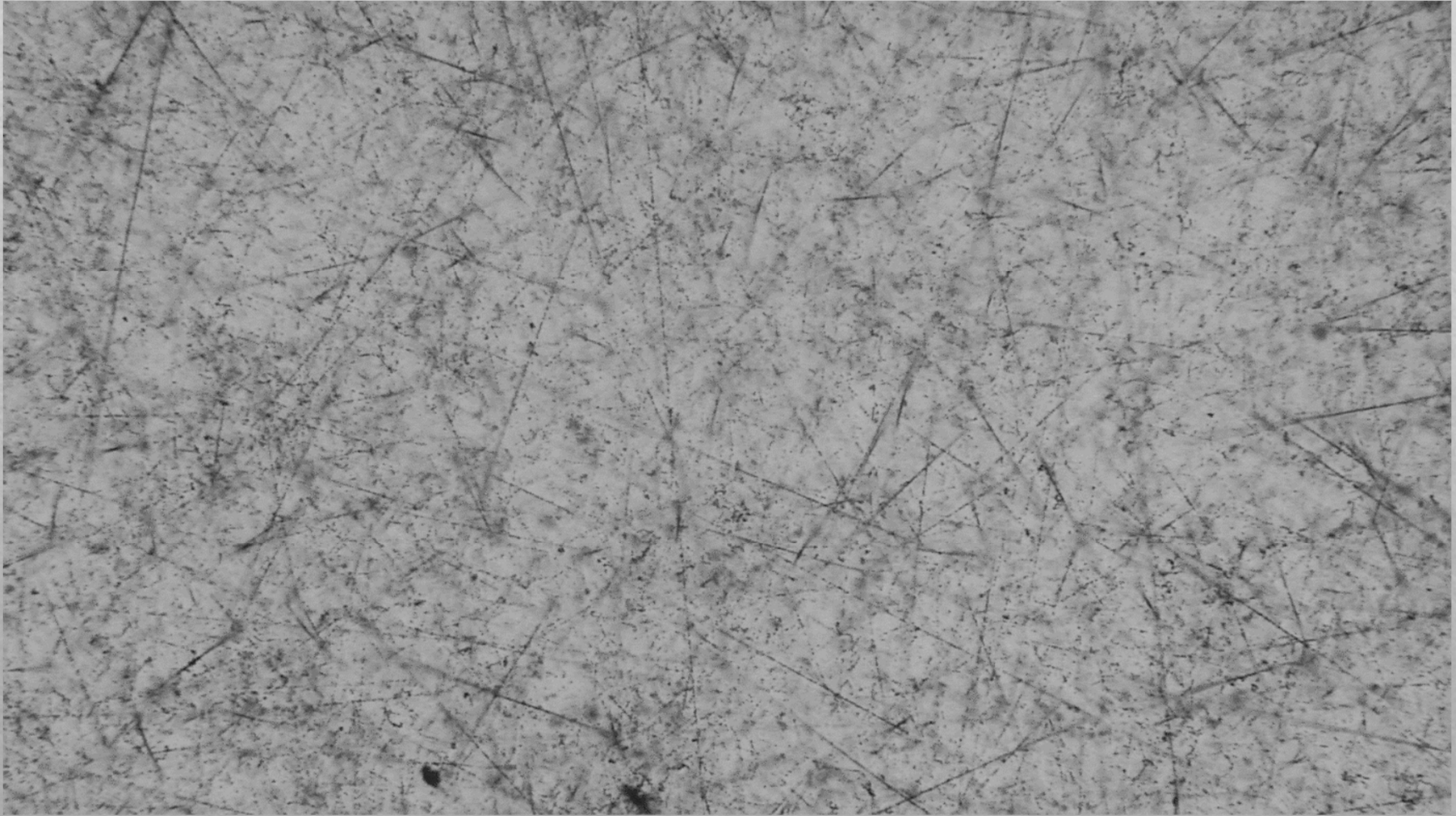
- To fulfill requirements for HTS scanning ...
 - **swelling** to expand emulsion layer thickness $> 60\mu\text{m}$
 - cut each plate (40cm \times 50cm) in 2 pieces (40cm \times 25cm)



Each half plates are scanned by sub-dividing into 9 zones.

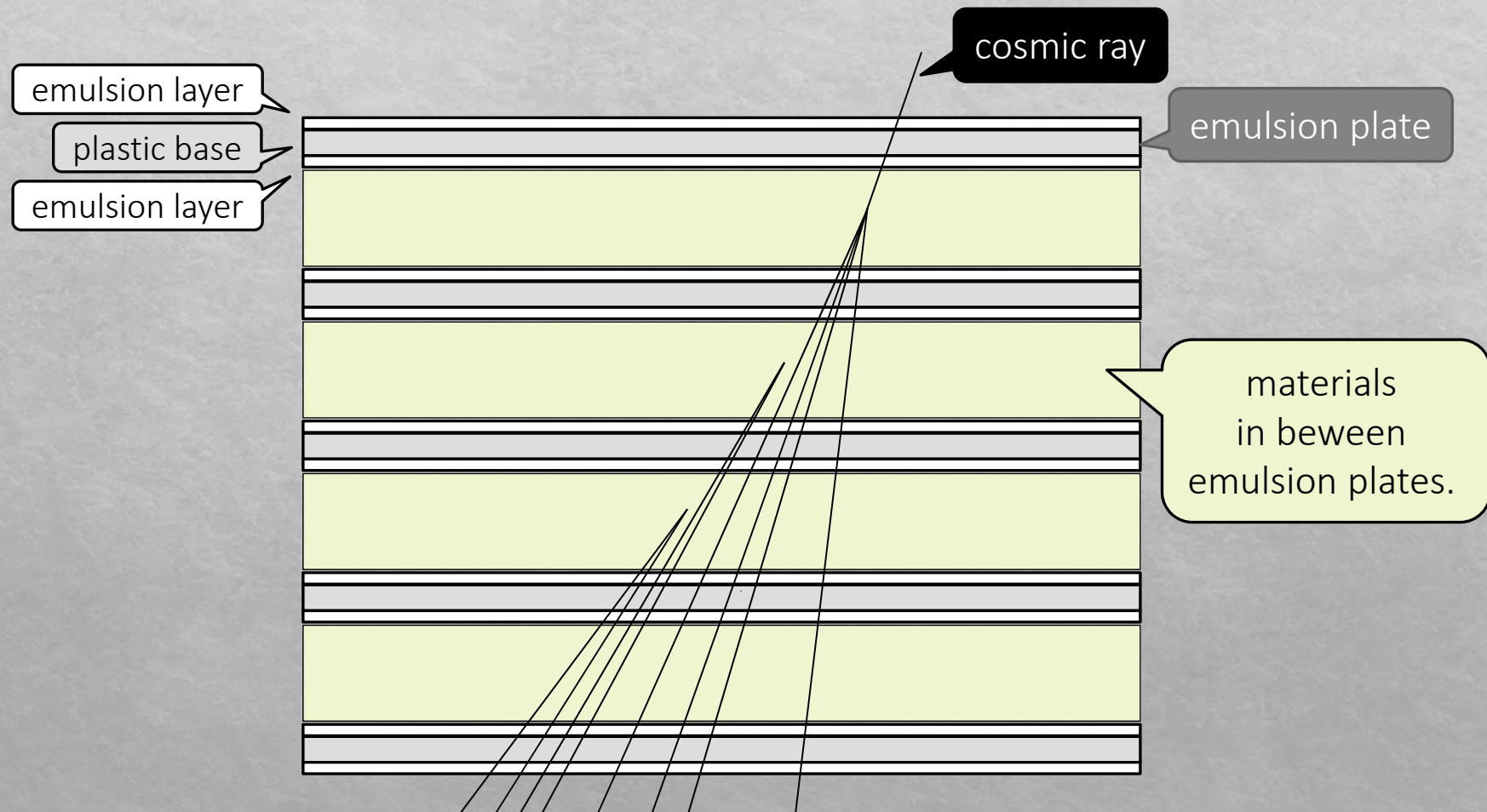
RUNJOB emulsion plate 40cm \times 50cm

Microscope image of RUNJOB emulsion

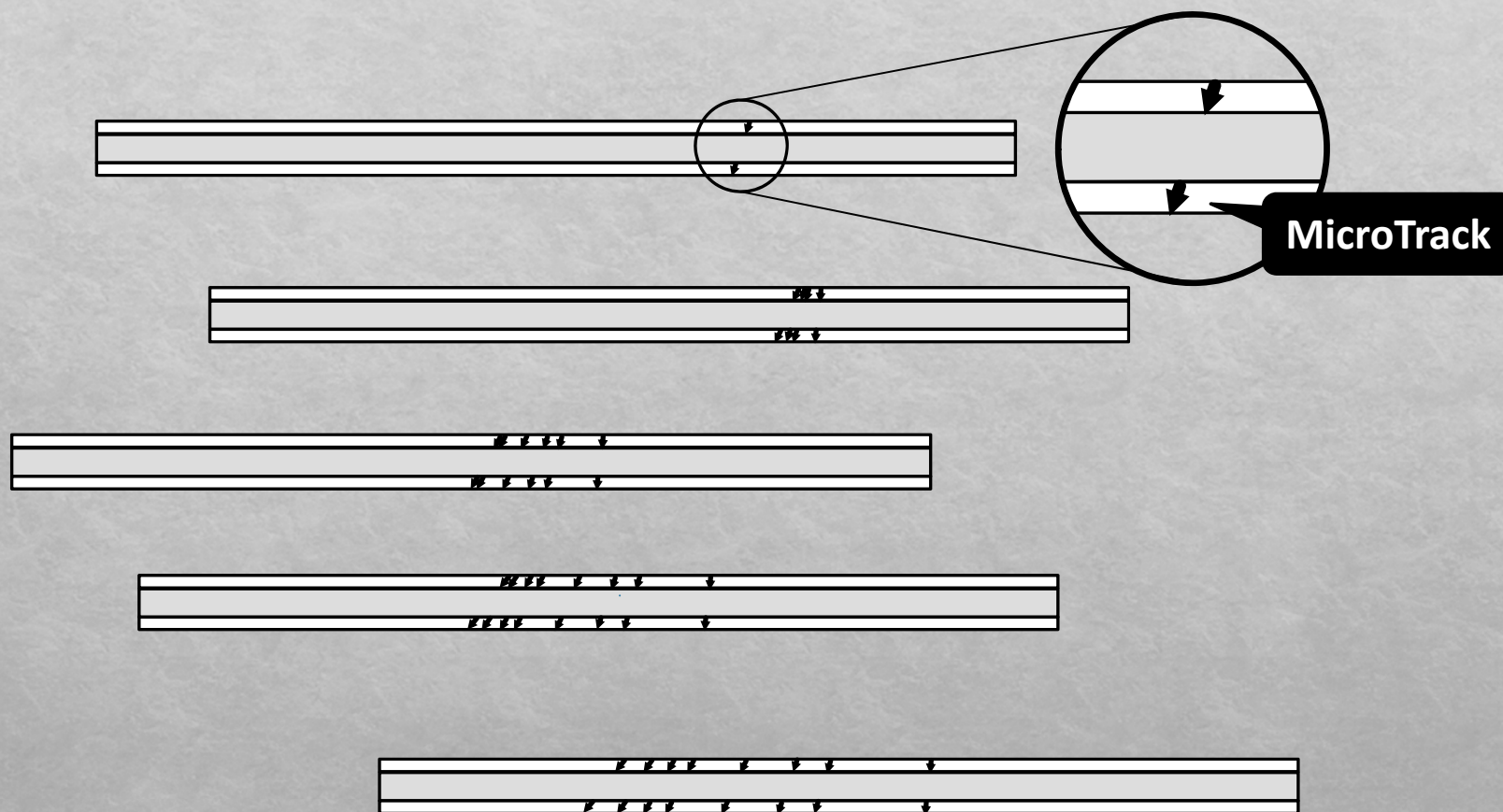


← ~0.7mm →

Schematic view of an interaction in emulsion chamber

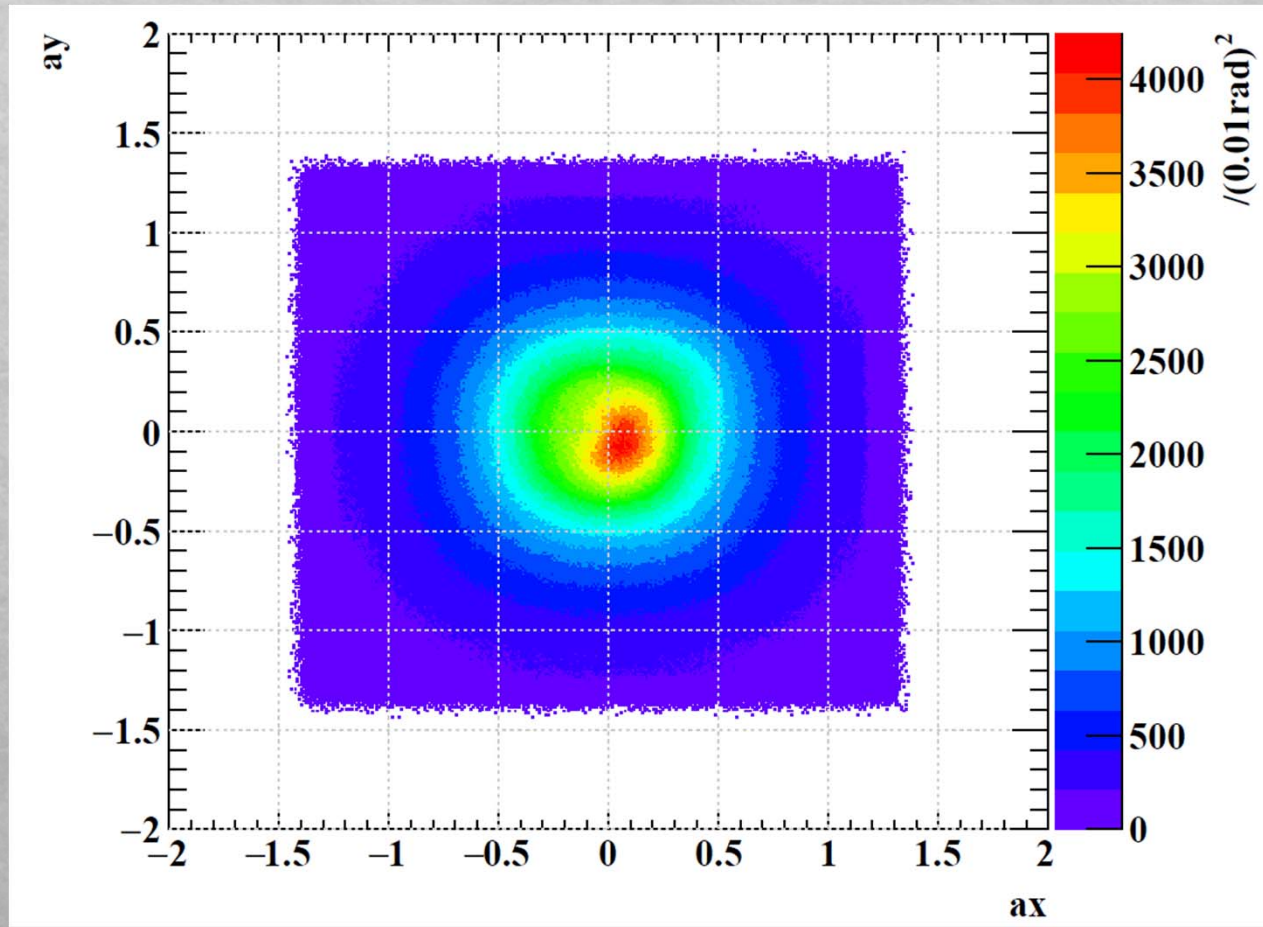


Emulsion tracking data actually read-out



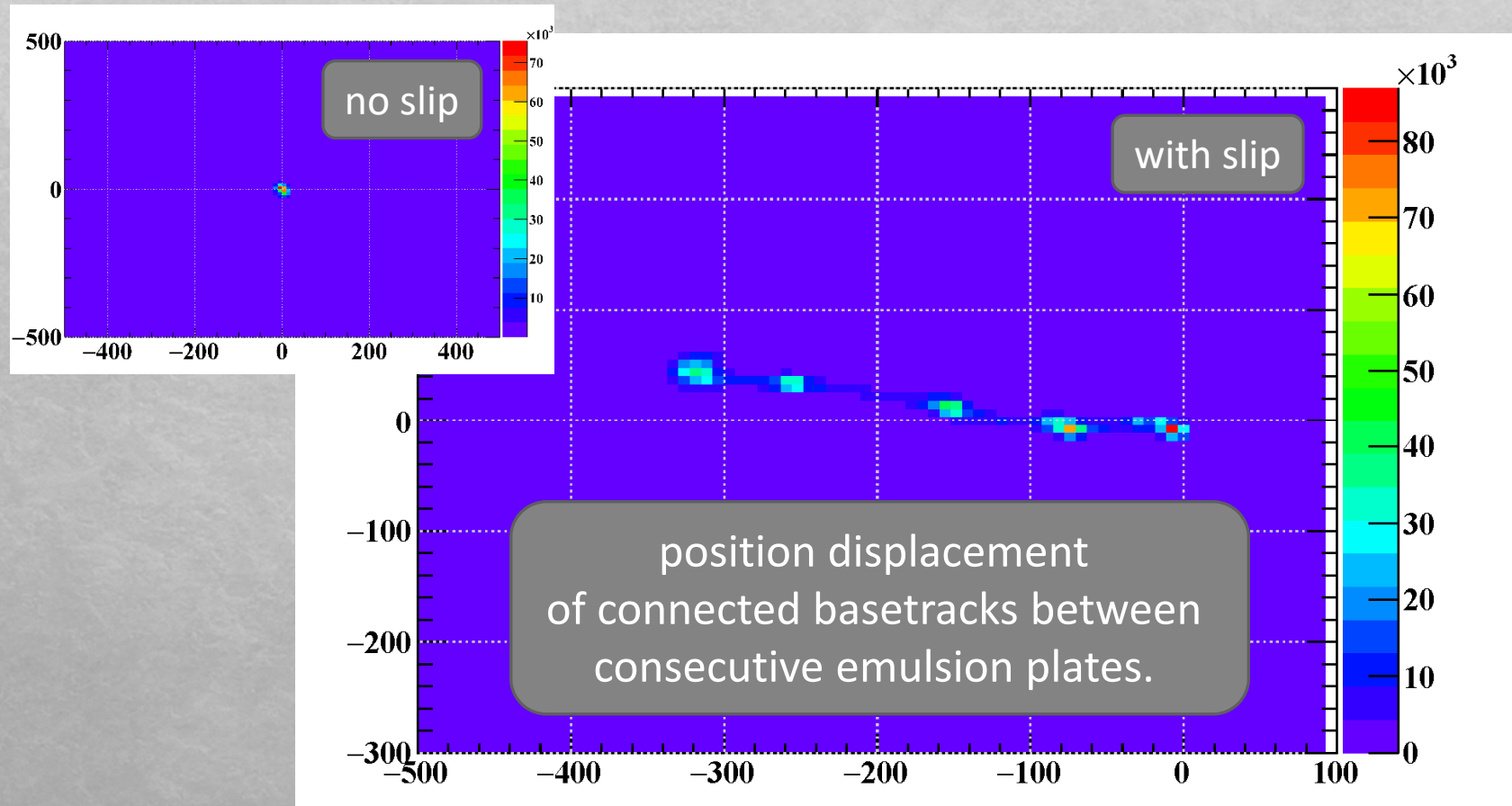
Emulsion Chamber is de-packed to develop emulsion plates ...
thus precise relative positioning among those plates are lost.
First step of analysis is to re-construct those positioning.

Angle acceptance of HTS scan



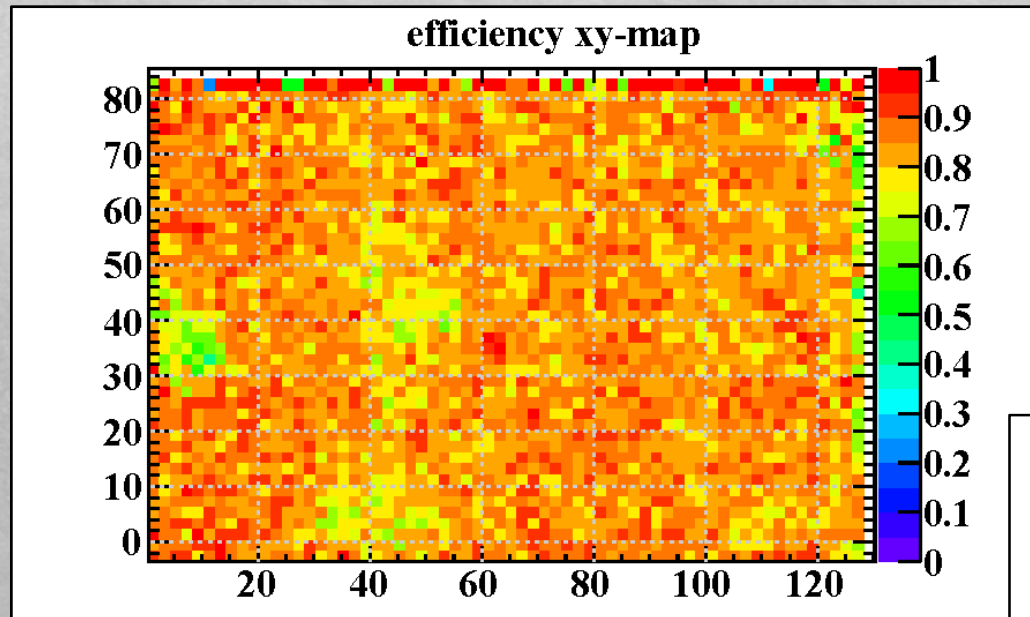
BaseTrack angle distribution of RUNJOB scanning is $\tan\theta \leq 1.4$

“SLIP” emulsion plate moves ! while in flight ?



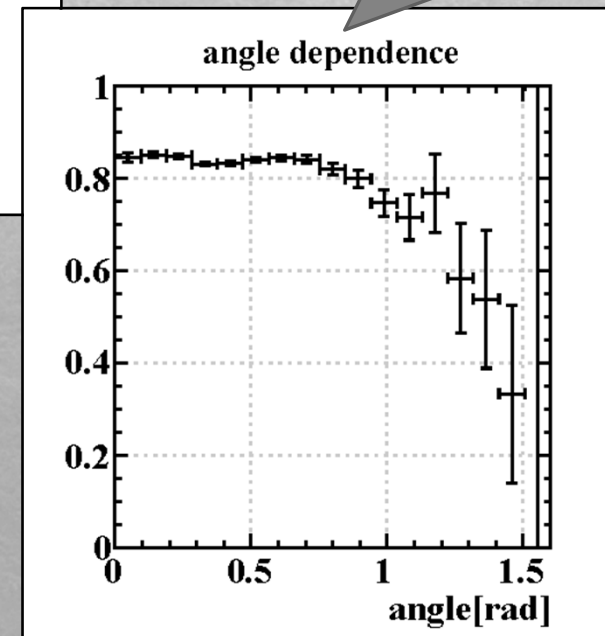
Those “SLIPs” should be taken into account properly
in reconstructing tracks and vertices.

Track recognition efficiency



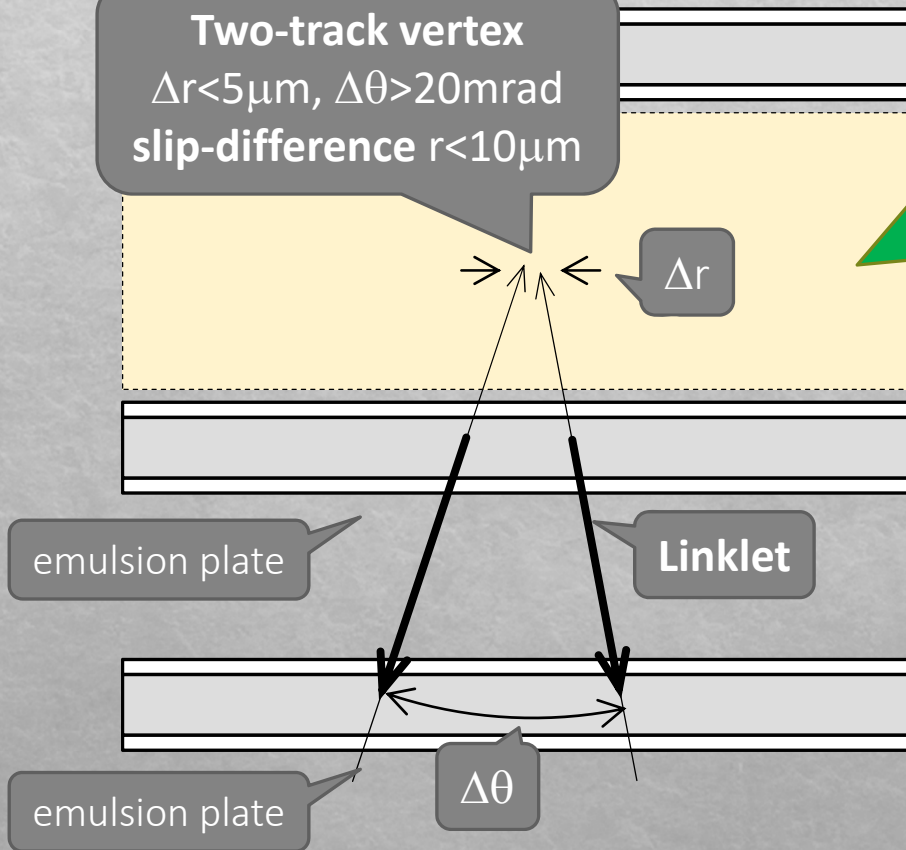
efficiency depends
on track angle

Track recognition efficiency ~ 0.82
for plate #5, zone=5.
... depends on plate quality.

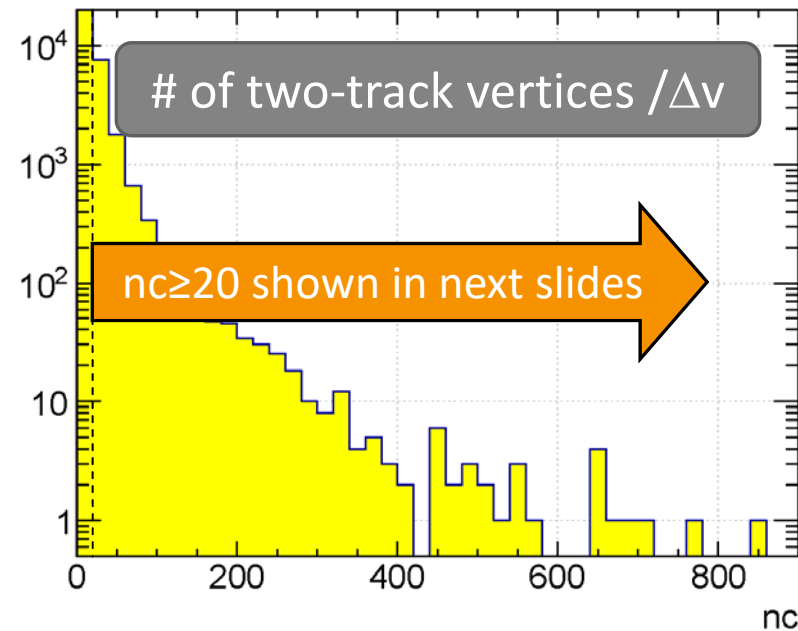


Search for vertices/interactions in the target module

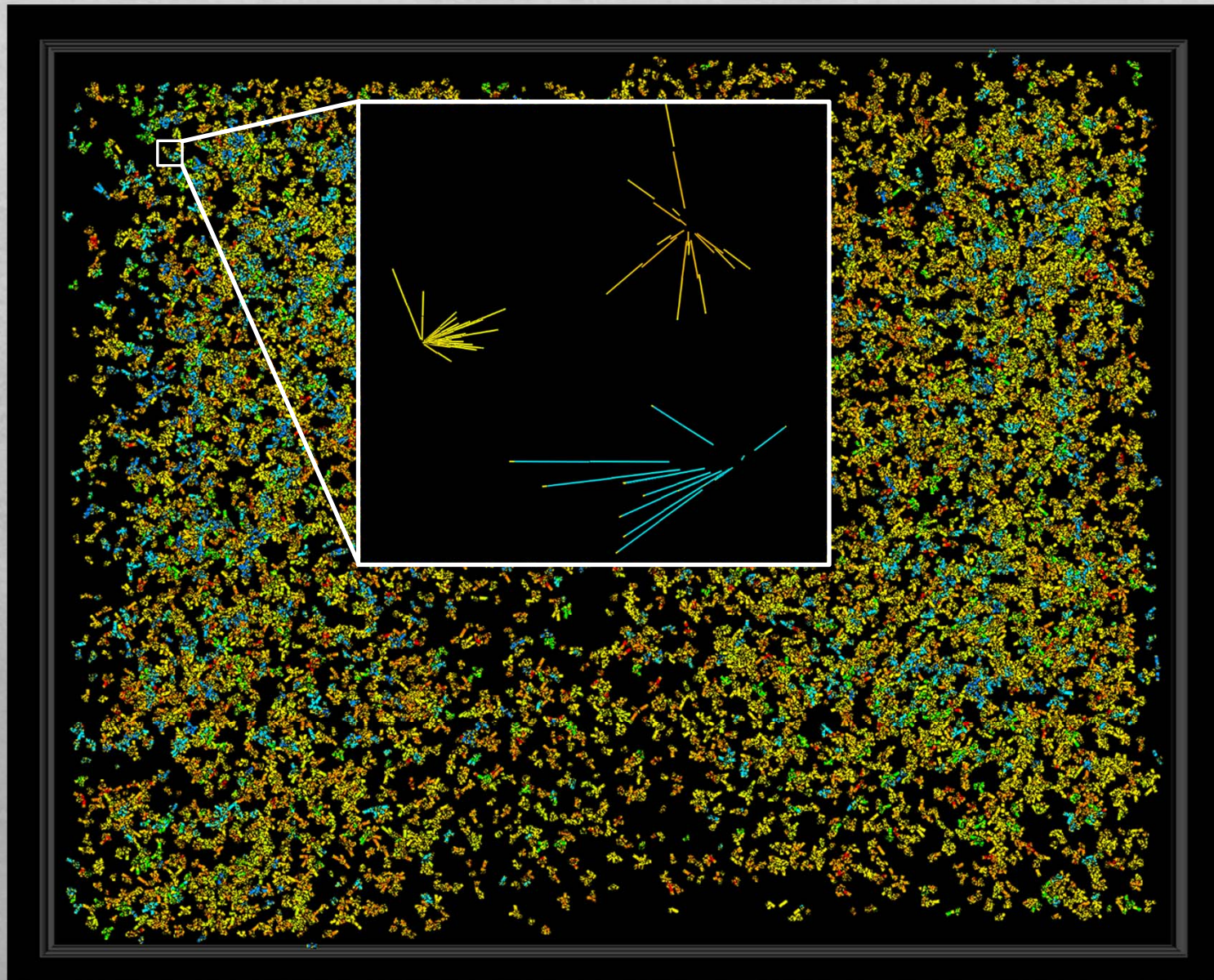
Two-track vertex
 $\Delta r < 5\mu\text{m}$, $\Delta\theta > 20\text{mrad}$
slip-difference $r < 10\mu\text{m}$



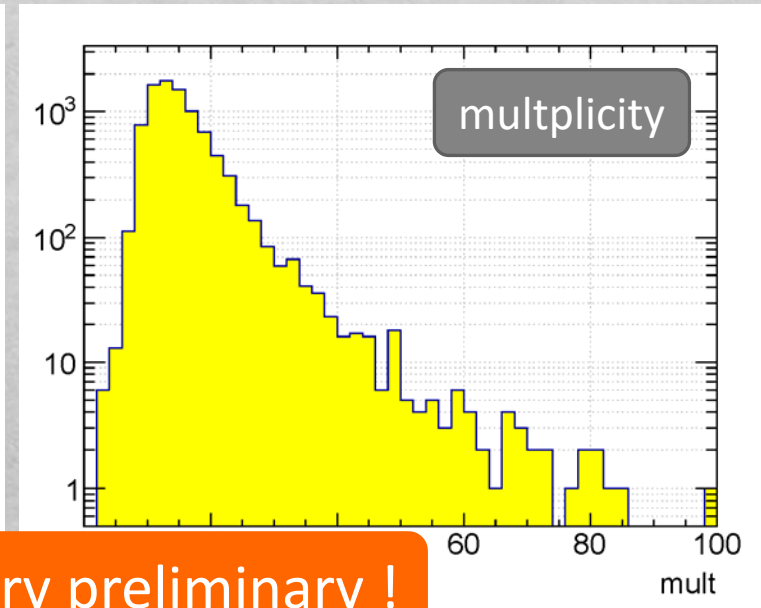
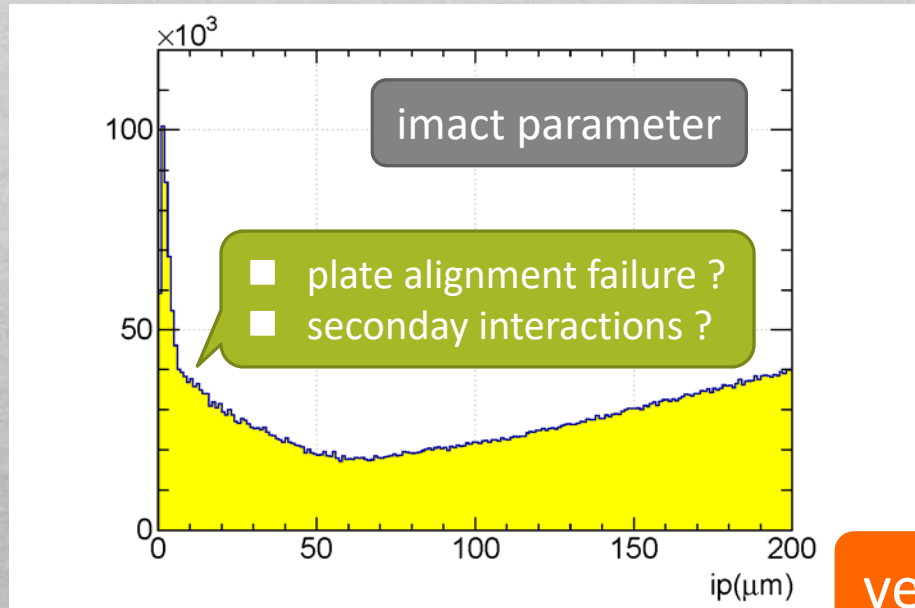
Using all pair of Linklets,
find small regions of
 $\Delta v = 20\mu\text{m} \times 20\mu\text{m} \times 40\mu\text{m}$ (vertical),
where two-track vertices
are concentrated,
in this yellow volume.



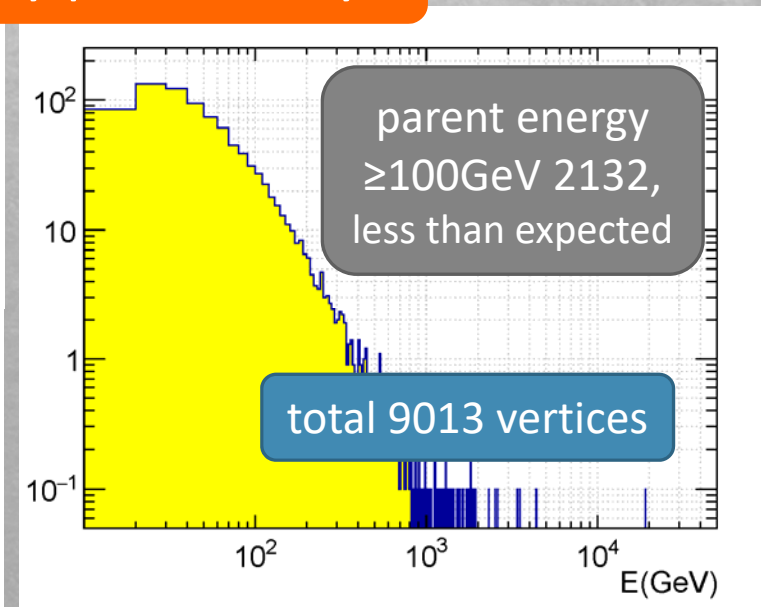
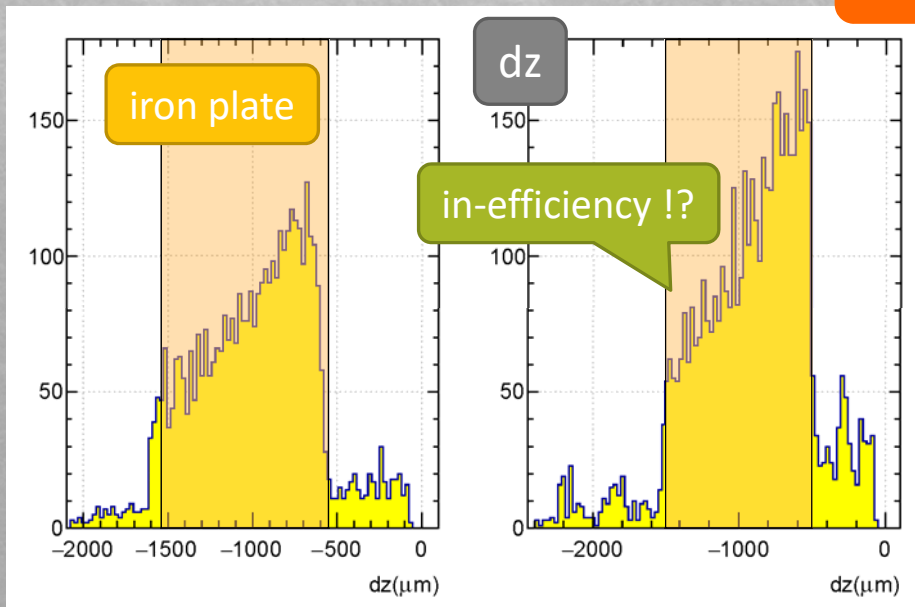
Selected vertices/interactions in the target module



Selected vertices/interactions in the target module

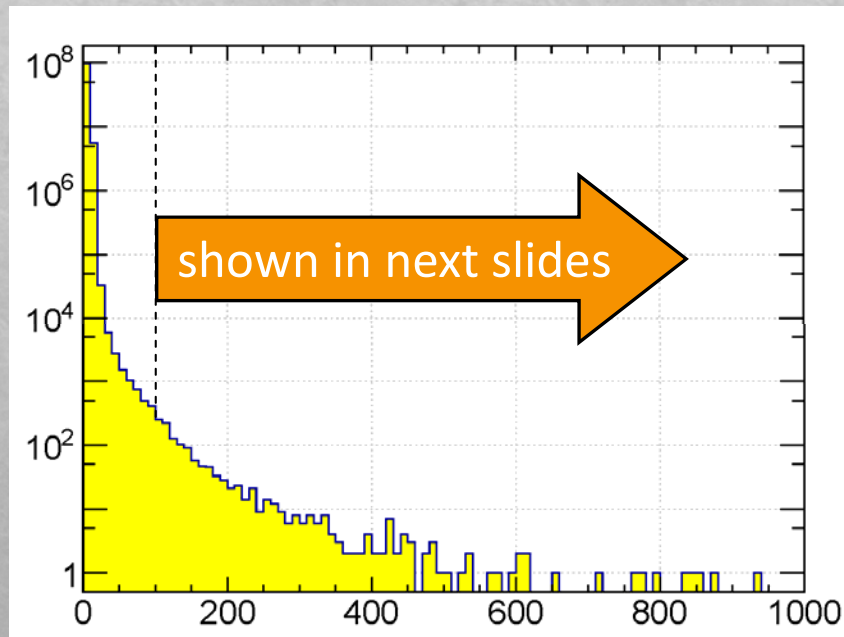


very preliminary !



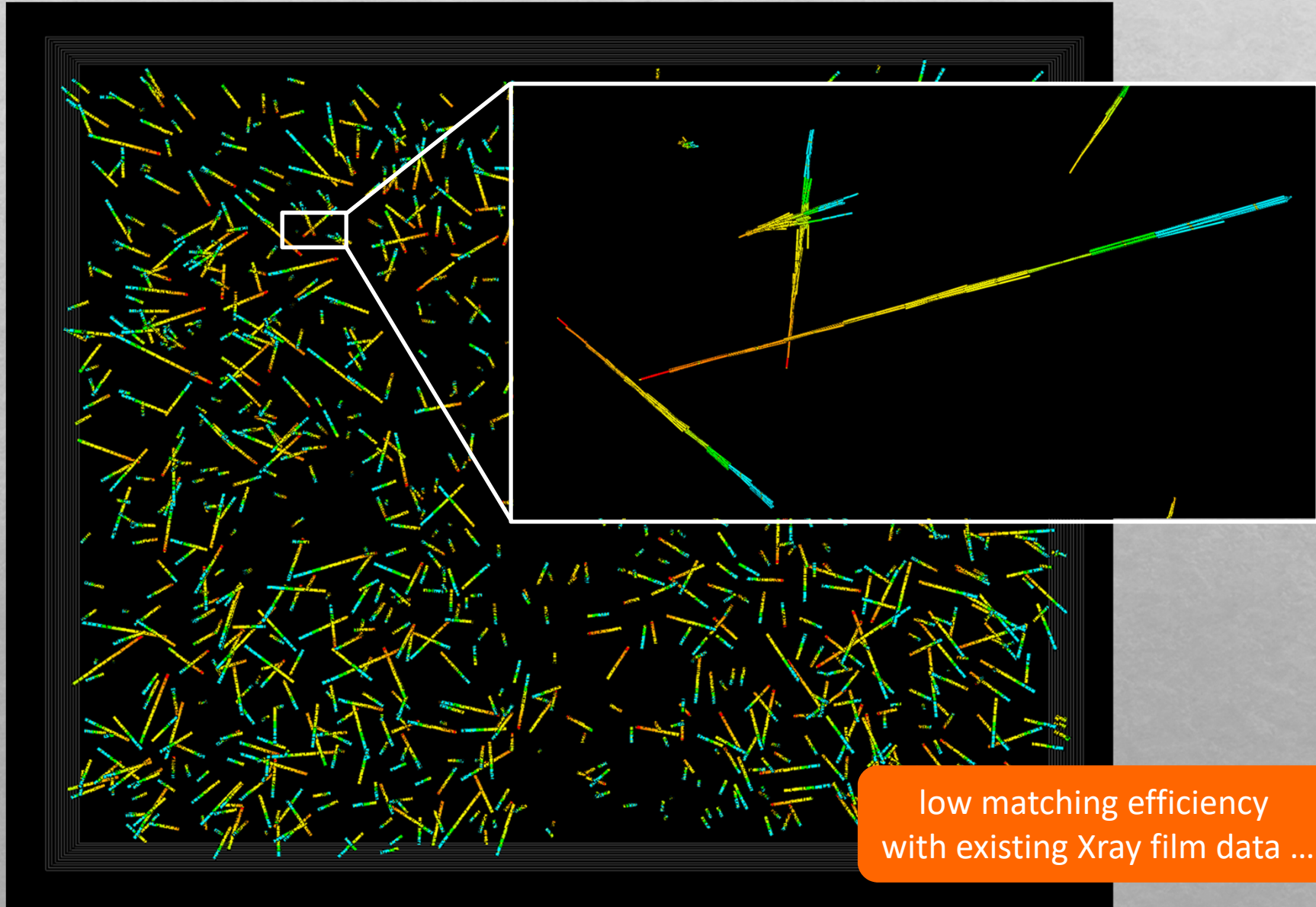
Selection of showers in the calorimeter module

- cascade showers tends to have many parallel tracks/electrons.
- tracks (i.e. trajectories of each electrons) will be corss connected.
- they could be selected as **ChainGroups** having large number of **basetracks**.



of BaseTracks in each ChainGroups

Selected showers in the calorimeter module



Summary

- Minimum bias re-analysis of past emulsion experiments could be possible.
 - RUNJOB (our primary target), JACEE, DONUT, EMU09-emulsion etc.
 - HTS would be able to read all emulsion tracks and topologies found in data can be checked in emulsion (navi).
- Half of RUNJOB 1997 flight had been finished HTS scanning.
 - A size of full set data is about 10Tbytes.
 - Data quality is being checked ... by analyzing vertices in the target module and showers in the calorimeter module ... problems to be understood.