

Boundary study using particle physics and archeological technics and samples

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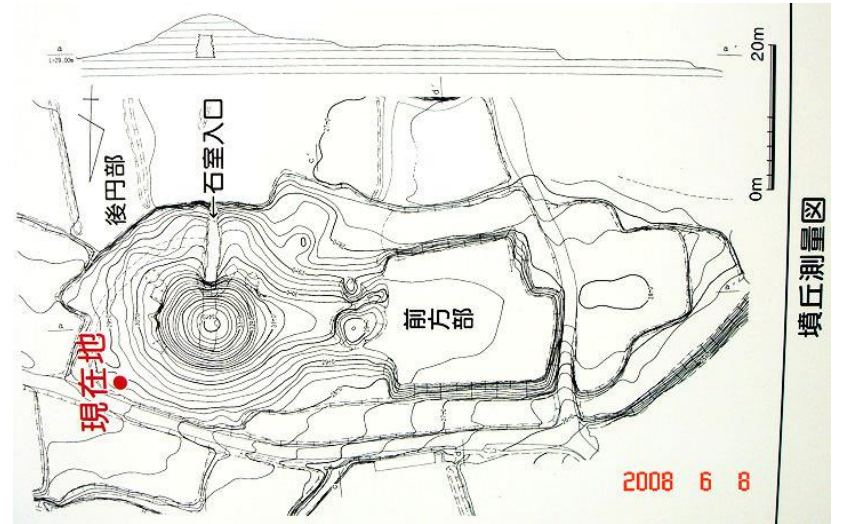
1 kashihara archeological institute of Nara

2 Nagoya university

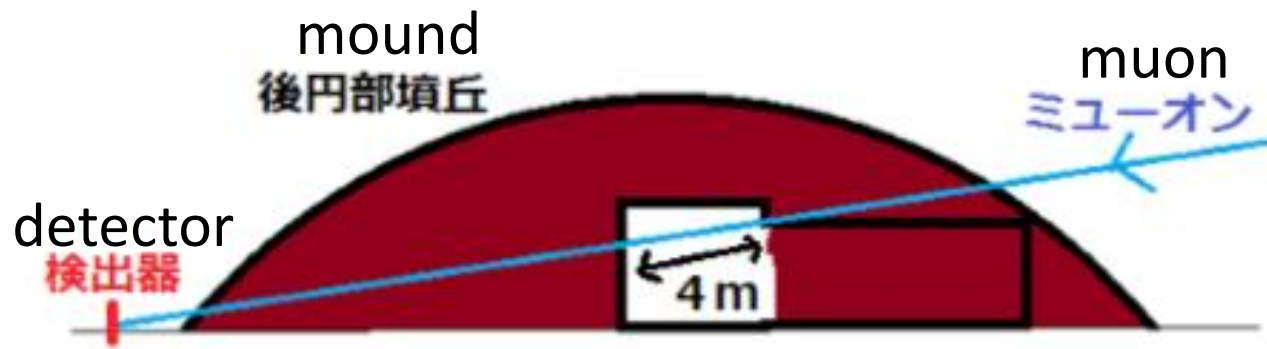
近くの馬越長火塚古墳 (makoshinagahiduka tumulus)



6世紀末葉(last leaf of 6C)
~70m 前方後円墳(key hole shape)



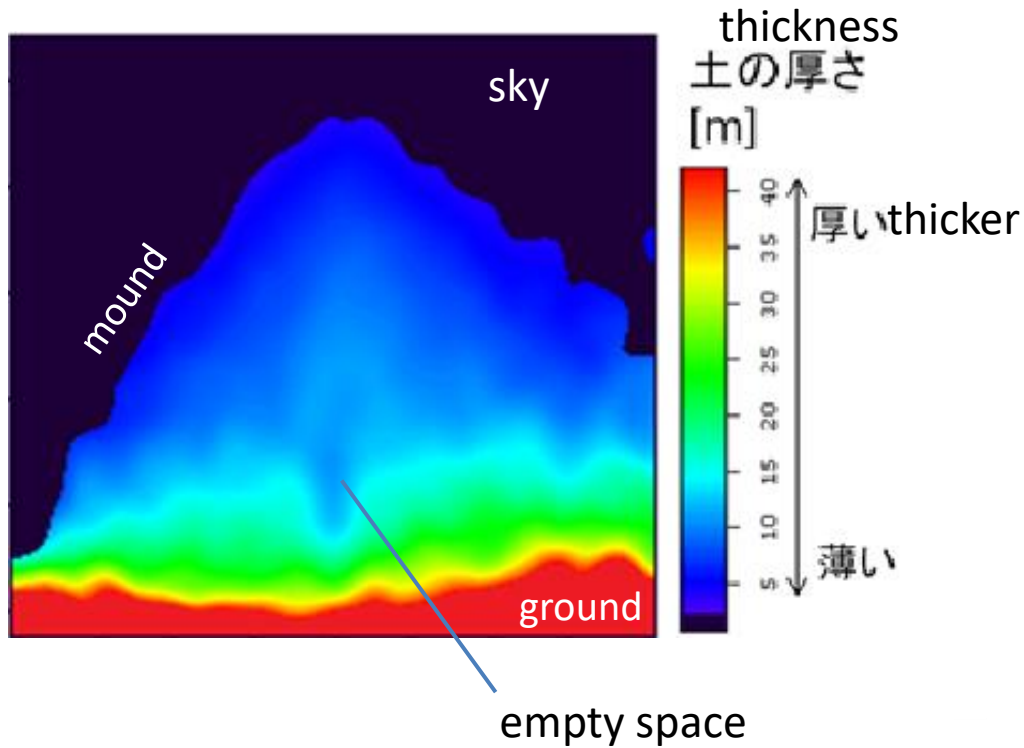
嵩山蛇穴(snakehole Suse)
ruin BC10000~4000
one OB of F lab was
keeper



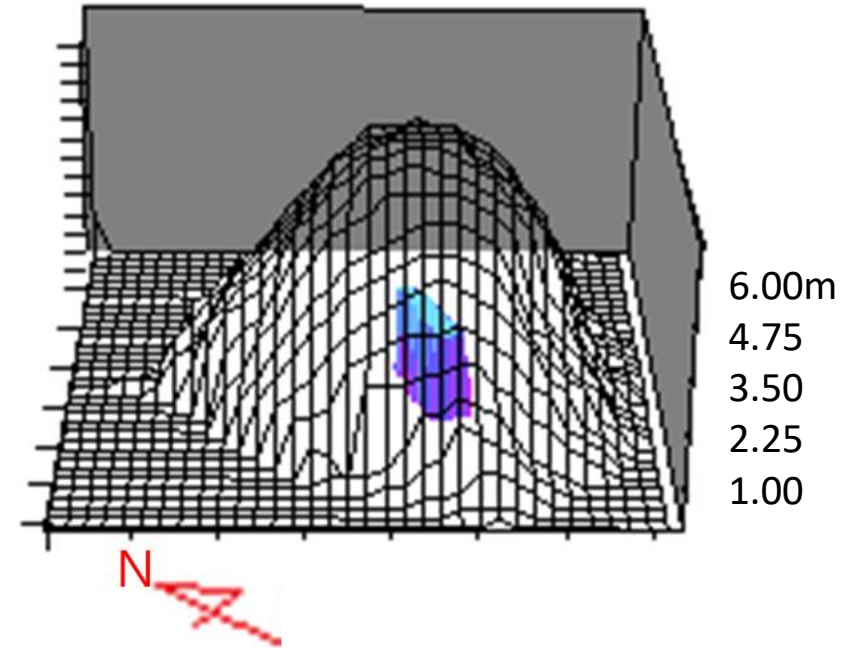
Room exist 20m soil → ~54% muon penetrate
If not exist 24m soil → ~47% muon penetrate

Possible to detect

Kasuga tumulus imaging

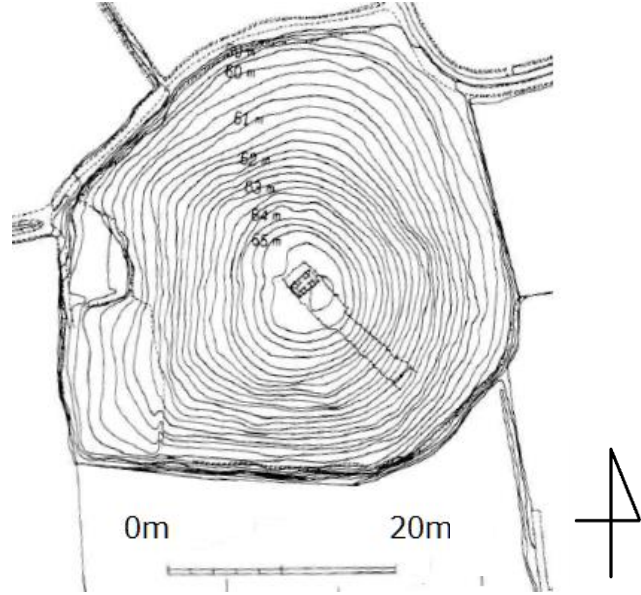


~30m
beginning of 7C

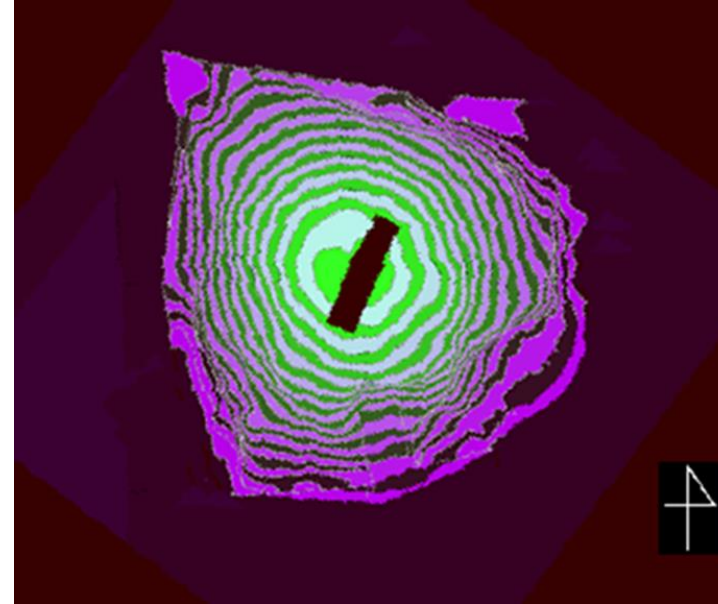


- 6.1 ± 0.5 m less thickness, center direction, low position part
- empty space should exist

となりの藤ノ木古墳との比較 (compare with Fujinoki tumulus build before Kasuga tumulus)



Fujinoki tumulus



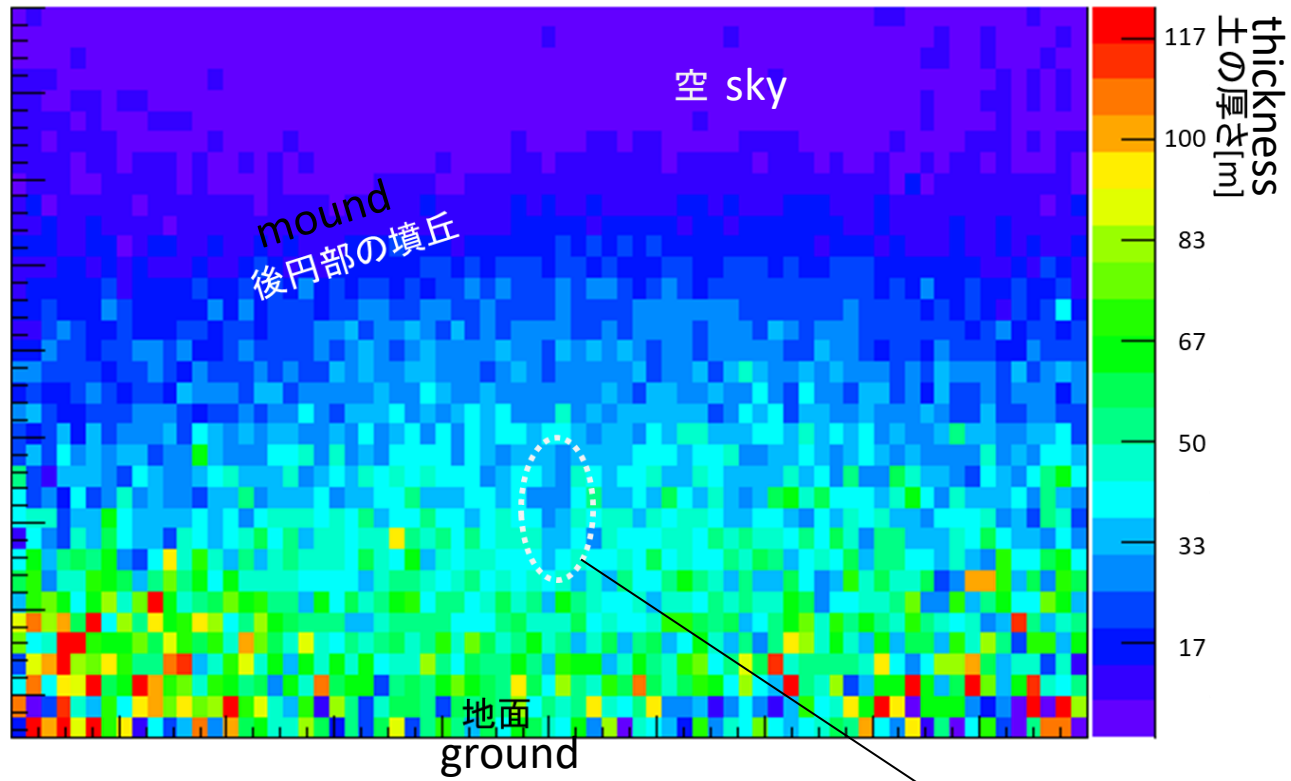
Kasuga tumulus

藤ノ木古墳は穴穂部皇子(欽明天皇の皇子、聖徳太子の叔父)、宅部皇子の暗殺による権力者交代を示している可能性があり春日古墳では大きく石室が変えられている可能性が考えられた

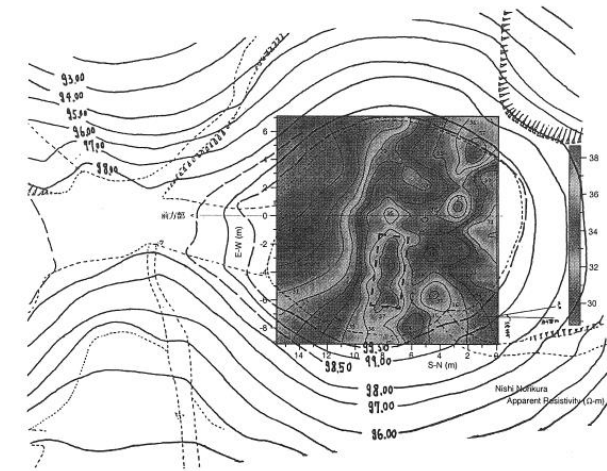
ラジオグラフィーの結果からも方向が変えられて作られており、石室が中心を超えて作られている可能性もある

Fujinoki tumulus is probably tomb of Anahobe prince killed by Soga family, so next Tomb form should be changed on purpose Truly, detected room direction is changed, room position located over center of tumulus.

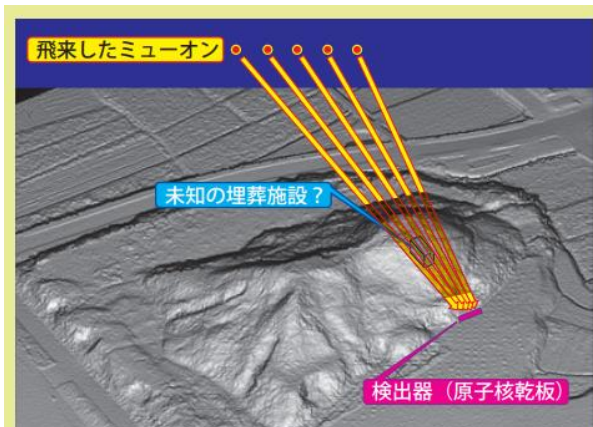
Nishinorikura tumulus imaging



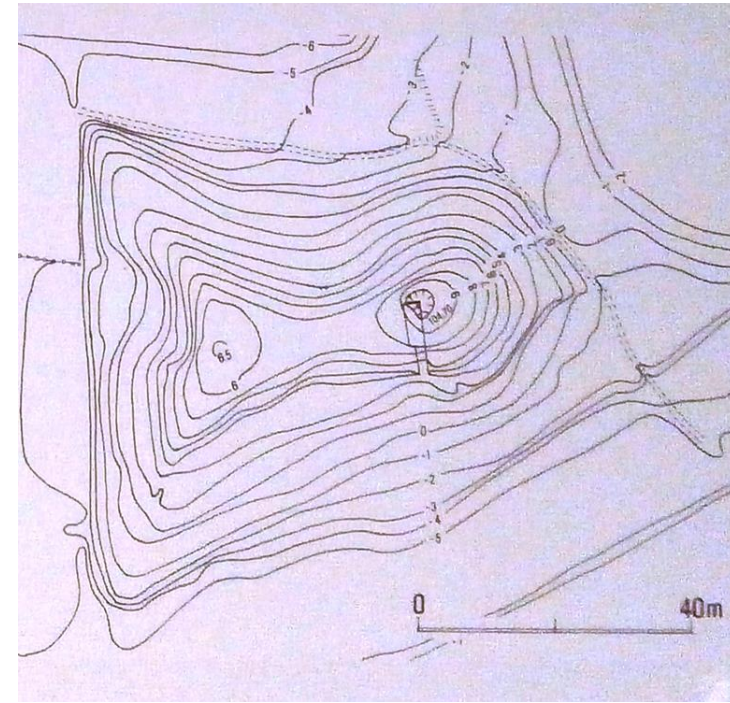
~118m
Mononobe
Family tomb
After half of 5C



地磁気電流法探査
MT method



Compare with nearby
Higashinorikura tumulus
first half of 6C
~83m

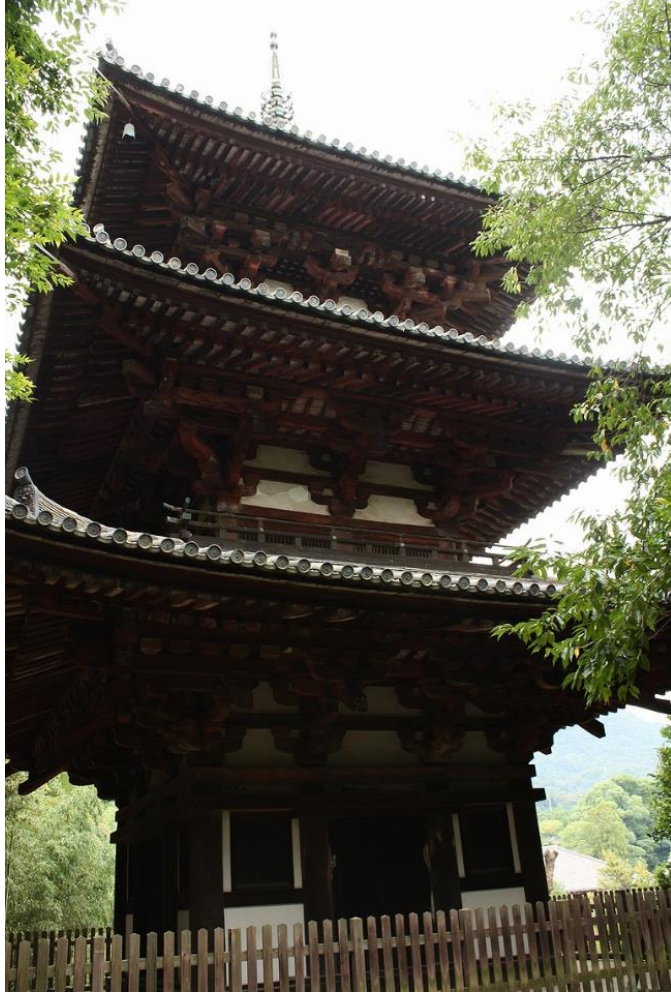


Room form is similar with Nishinorikurakofun
Mononobe Family kept power after even Soga Family appeared



study of Underground imaging by CR

study of Underground imaging by CR



west tower of
temple

心柱 center pillar

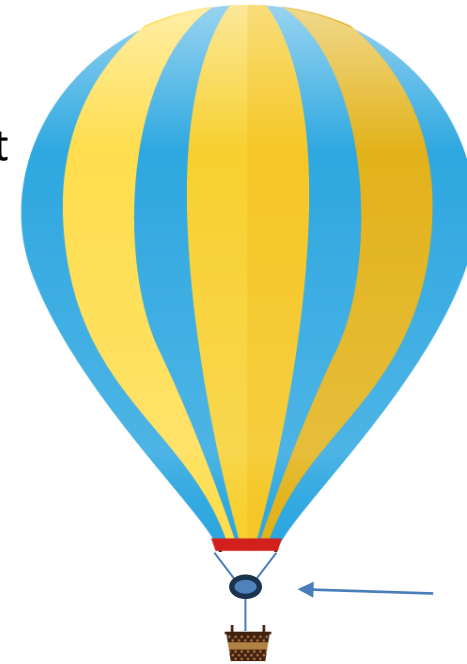
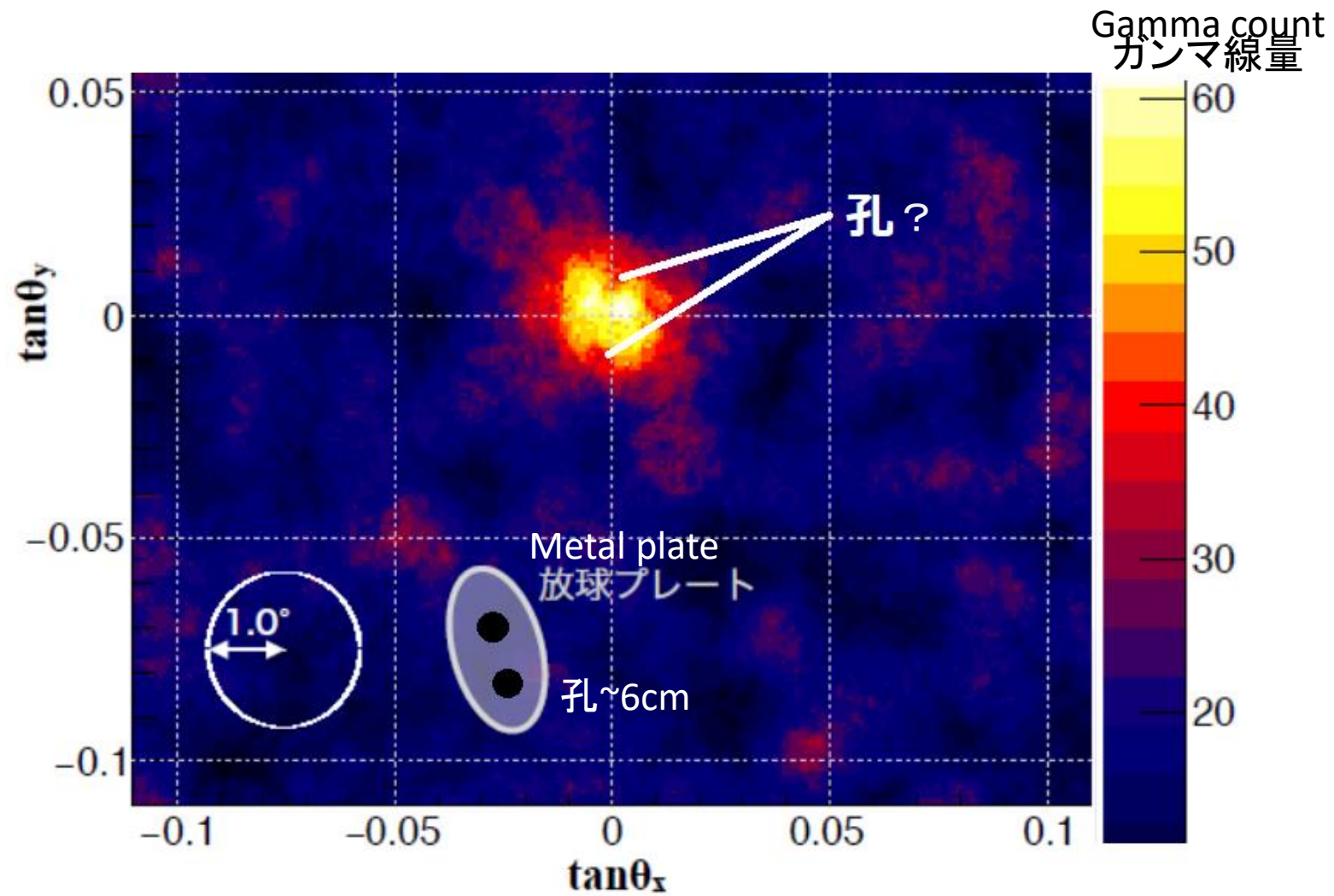


藤原京本薬師寺跡 under pillar of ruined temple

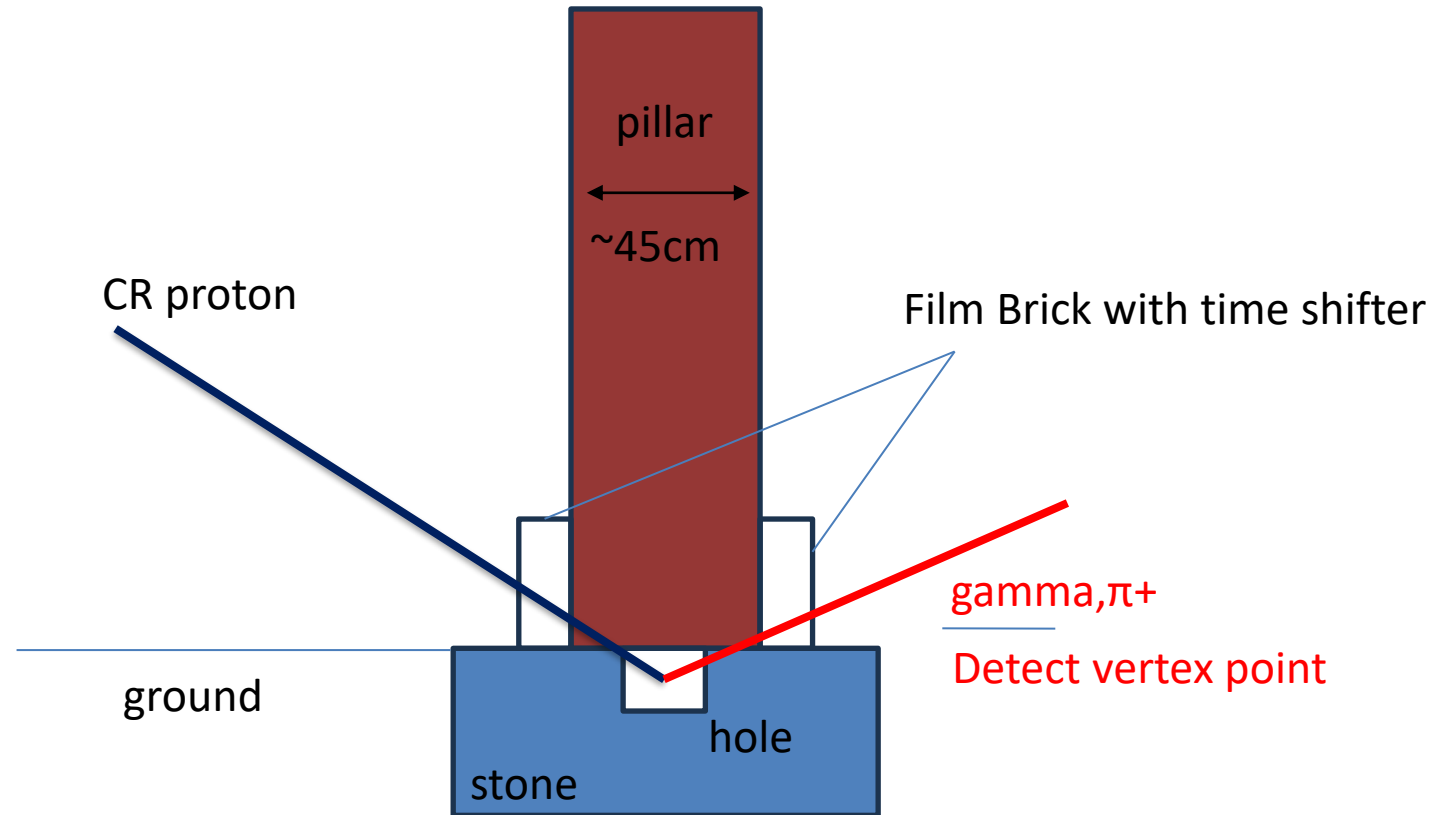


Hole to put bone of Buddha(actually jelly)

from GRAINE



Is there hole or stone?



If vertex is made in the area , hole for bone is not made
We should search top of pillar

survey

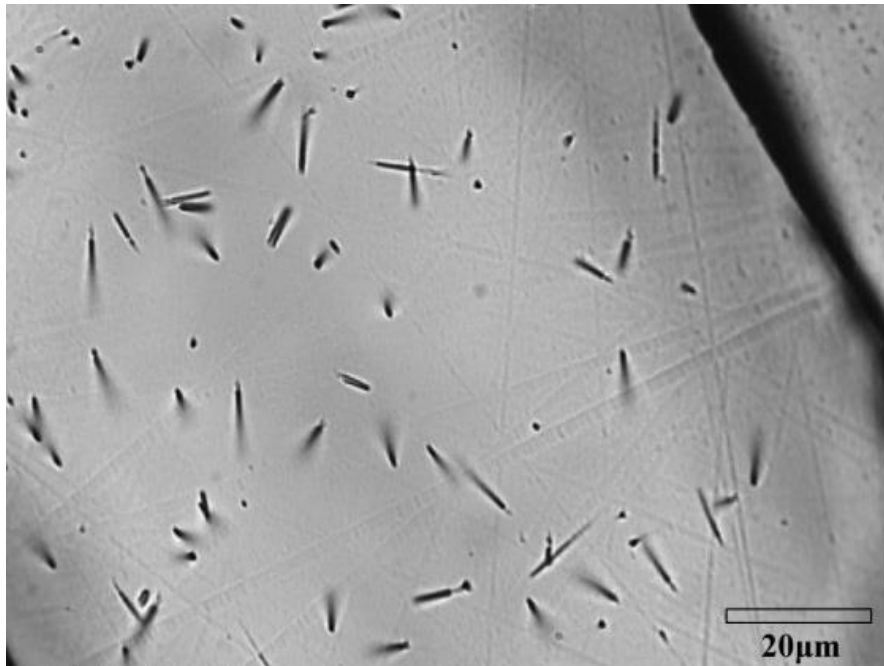
- On the ground, 1~ few GeV proton is about 1% of muon
 - about half of interaction make kink topology by interaction
 - e-pair can be also used
- ~35% of daughter is emitted toward sky
 - about 1~2 interaction/hour should be detected by film

Only one event could solve the question ,so it can be used.

Other study using archeological samples

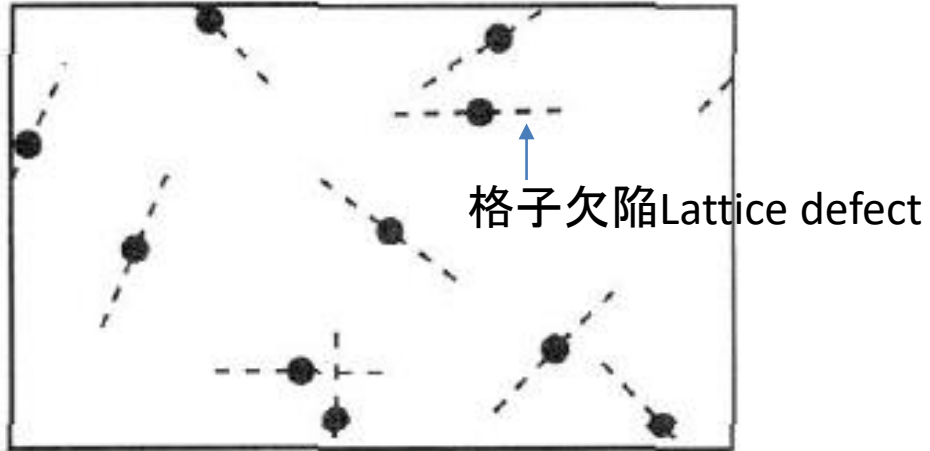
Fission tracks

^{238}U fission track number is used for detecting era(dating)

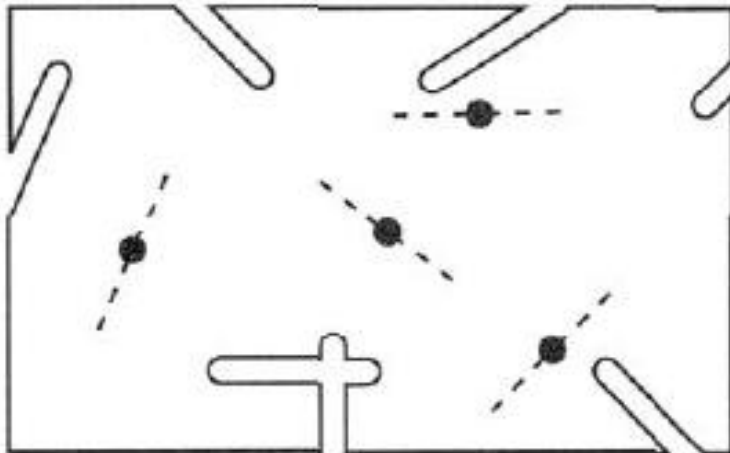


Fission track of old stone

鉱物の自発トラック



↓ **etching**



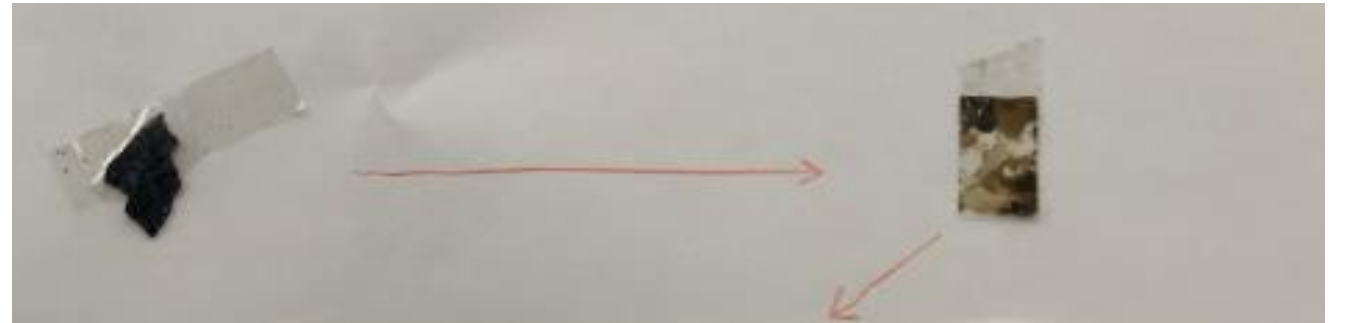
longer than about 5micro meter as fission track

Long track is well studied in Japan , America for archeology

Aim to search short length track as dark matter search

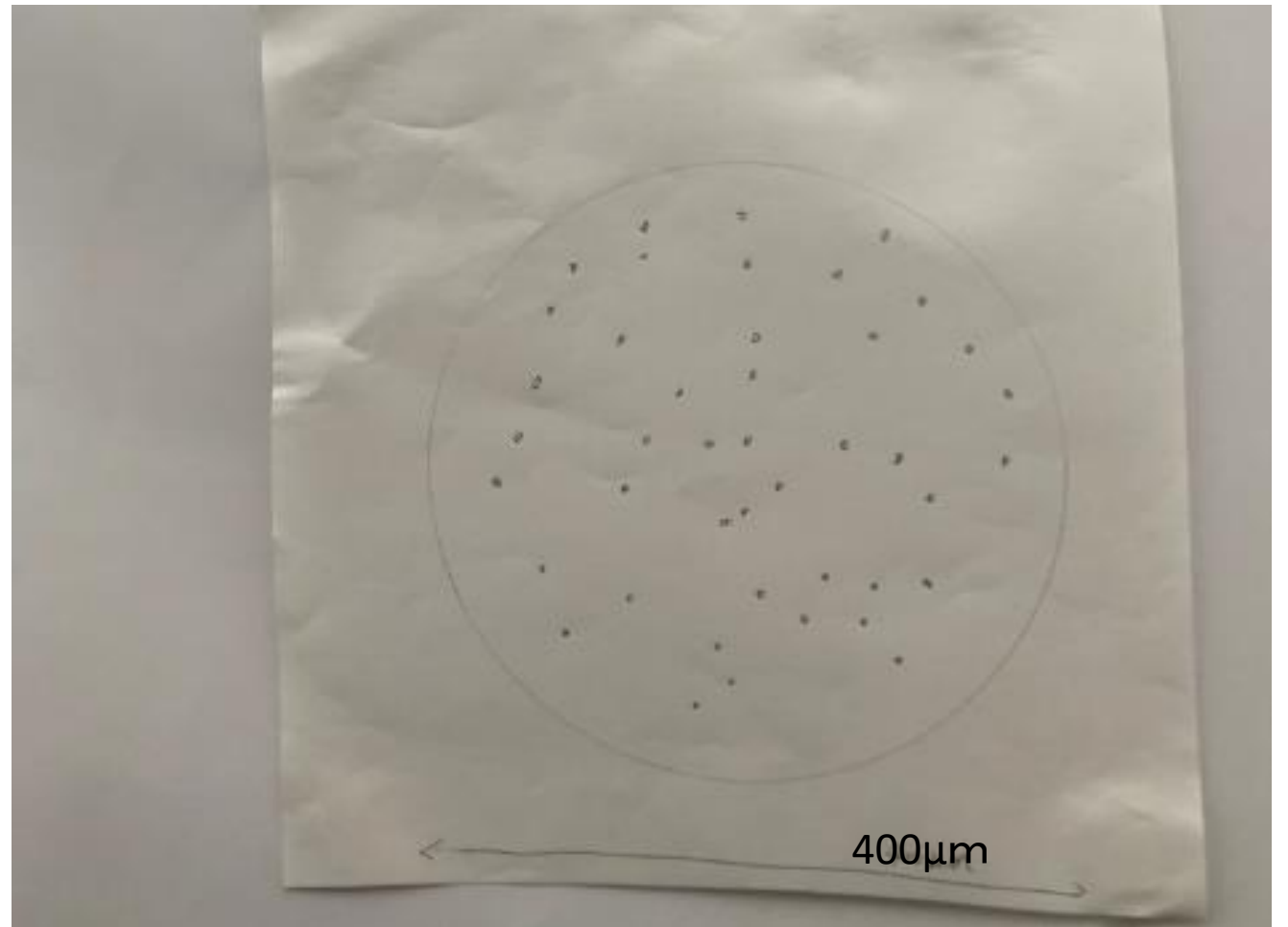
-
- For 10~100GeV darkmatter, about 1 μ m length track is made as recoil track

- Studied using Black mica ◦
- Two pieces of near by mica (Canada, ontario) but different angle toward horizon or Sun
- Dip strong solid for 90second
and count tracks by microbe ($5.0 \times 10^4 \mu\text{m}^2$)



Counted shorter than $2\mu\text{m}$

Direction is not recorded because some of them is not clear



- result

Sample1 93 ± 10 tracks

Sample2 43 ± 6 tracks

sample 1 is larger

Consideration and Views

▪ We think different angle toward Sun can make difference of track number

To make it clear

- Study using stones at polar site of fitting tracks VS latitude
- Understand tracks by α decay reaction ($\sim 10\text{nm}$)

conclude

- muon radiography is used for tumulus
- Underground CR imaging can be useful
- tracks number inside 2black mica is counted to make difference