



NEWAGE

Mar 17-19, 2008
The Advances
in Cosmic Ray Science

~Direction Sensitive Direct Dark Matter Search~

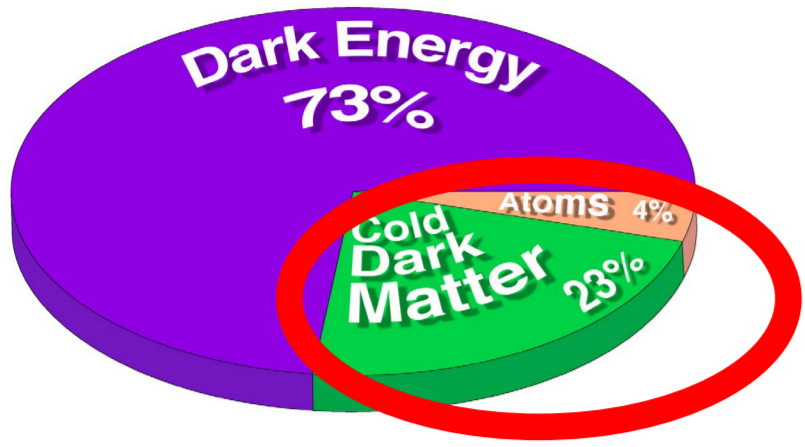
Kyoto University Hironobu Nishimura

nisimura@cr.scphys.kyoto-u.ac.jp

T.Tanimori H.Kubo K.Miuchi S.Kabuki A.Takada K.Hattori K.Ueno S.Kurosawa T.Ida S.Iwaki

Abstract: NEWAGE is a project of direction sensitive direct dark matter search. We are developing and operating a direction sensitive detector based on μ -TPC. We report on the performance of our detector and its first result.

1. Dark Matter



- Promising candidate of dark matter as an elementary particle
 - WIMP (neutralino)
 - Axion

Dark Matter search

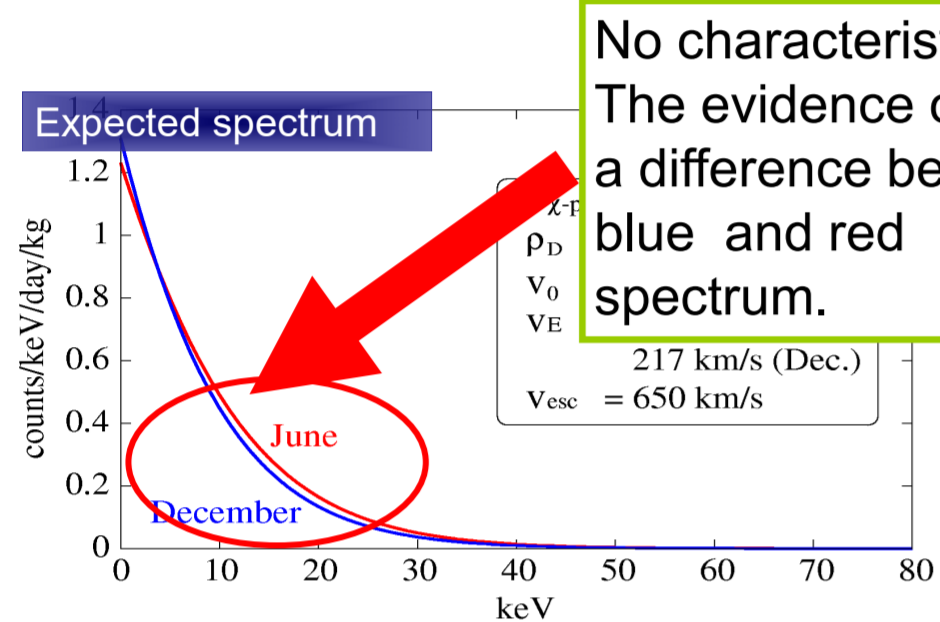
- Direct search:** To detect interaction between DM and nuclei on the earth
- Indirect search:** To detect γ , antiproton, e^+ and so on produced by DM pair creation in the galaxy.

Observation In underground
Observation For sky

2. Direct Dark Matter Search

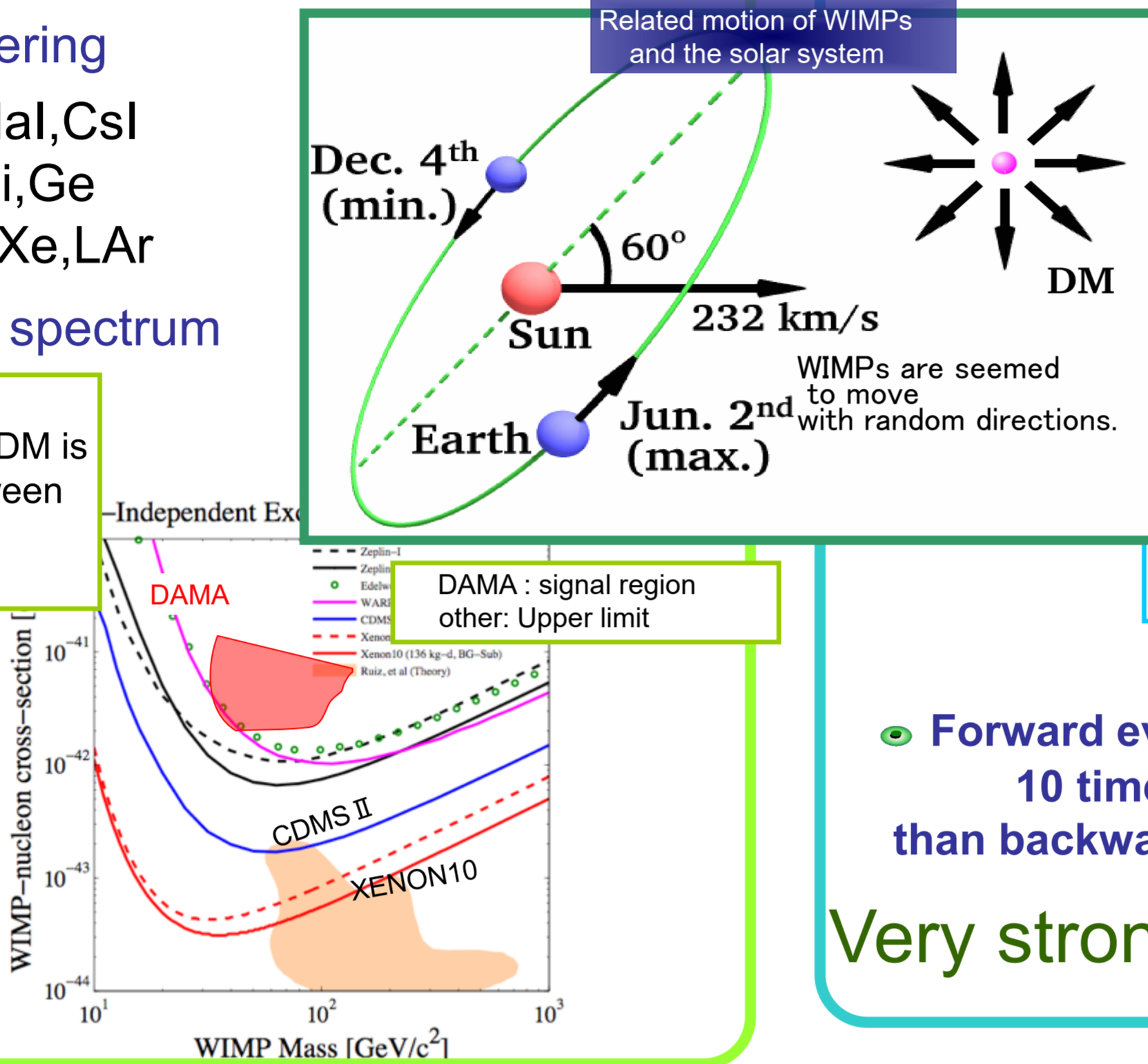
- DM \rightarrow Nuclei Elastic scattering
 - Large mass
 - Low background
 - High energy resolution
- Conventional method: NaI, CsI, Si, Ge, LXe, LAr

using energy spectrum



No characteristic evidence of DM is a difference between blue and red spectrum.

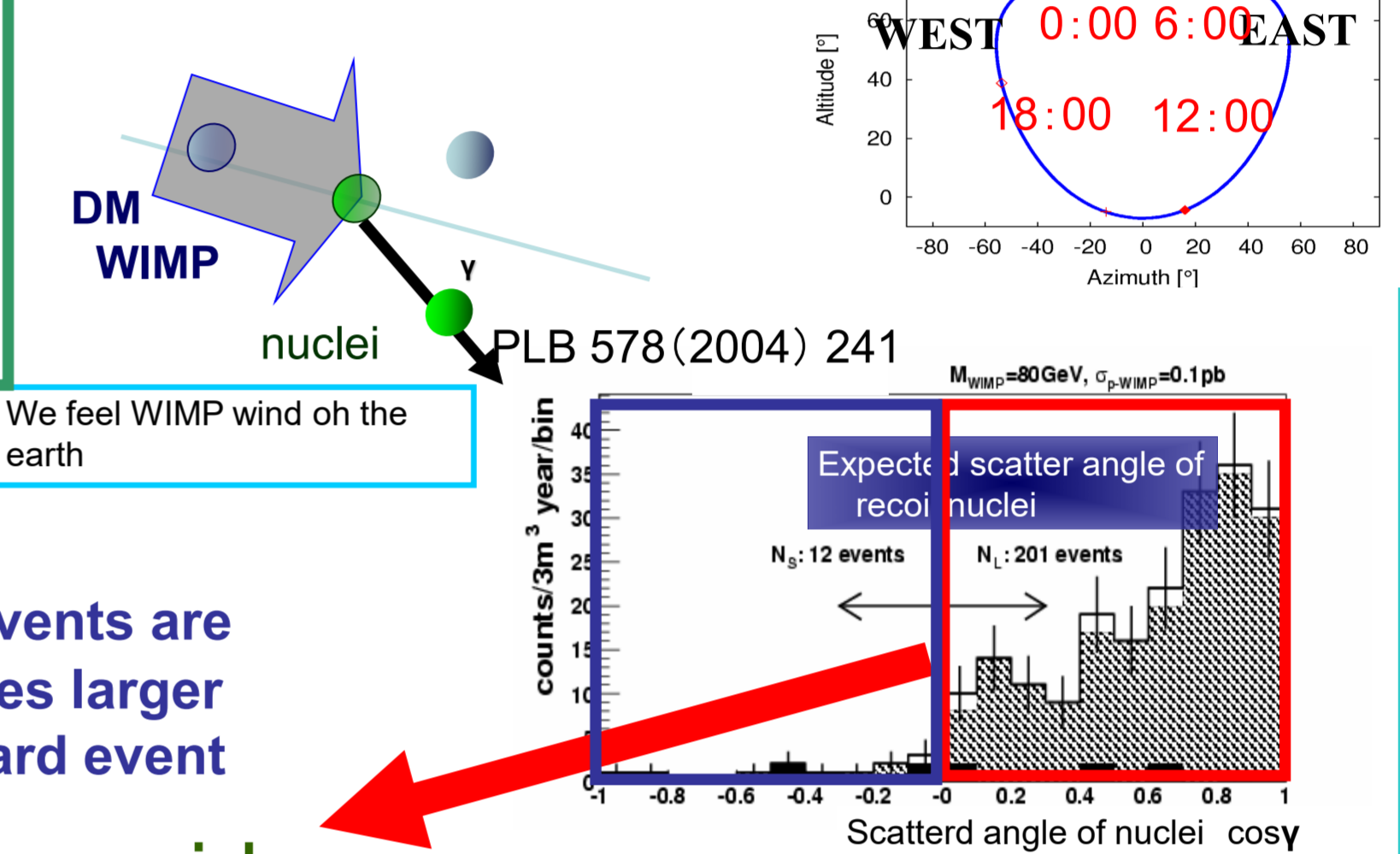
Relay on the annual modulation
Few % of the total events.
Not enough.



3. Direction Sensitive Direct Dark Matter Search

- To detect WIMPs wind on the earth
- WIMPs wind: relative motion between WIMPs and solar system
- Recoil nuclei scattered forward

A track of the direction of WIMPs wind



- Forward events are 10 times larger than backward event

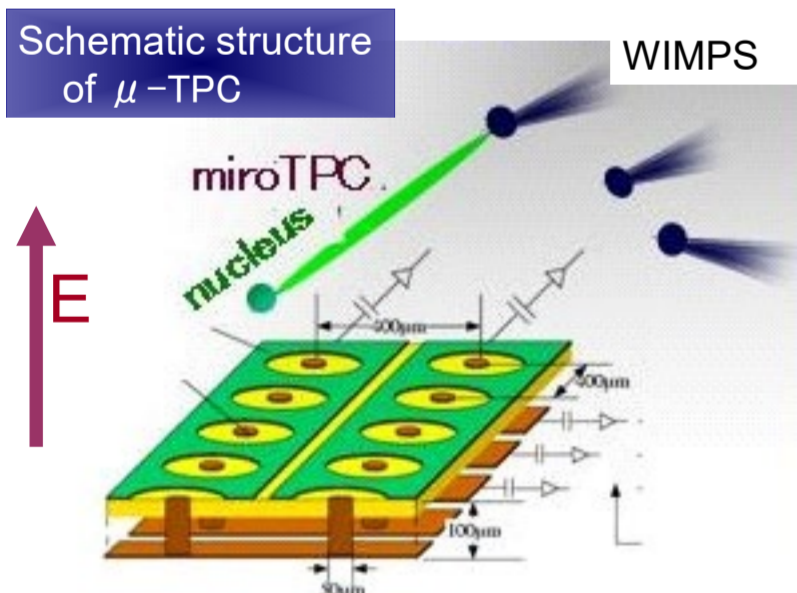
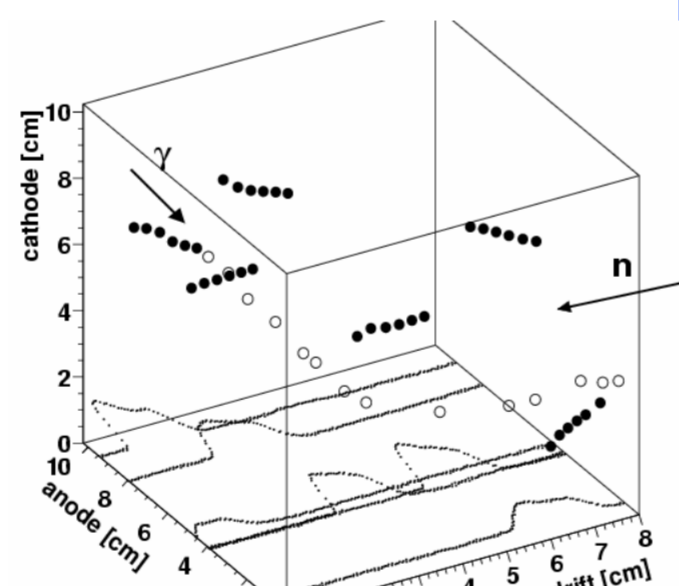
Very strong evidence

Simulation with neutron background in Kamioka mine

4. 3D-Tracking Detector for recoil nuclei

- μ -TPC micro Time Projection Chamber
- μ -PIC 2D gas detector 400 μ m pitch gas gain $10^3 \sim 10^4$ 30 x 30 cm
- 100MHz readout system

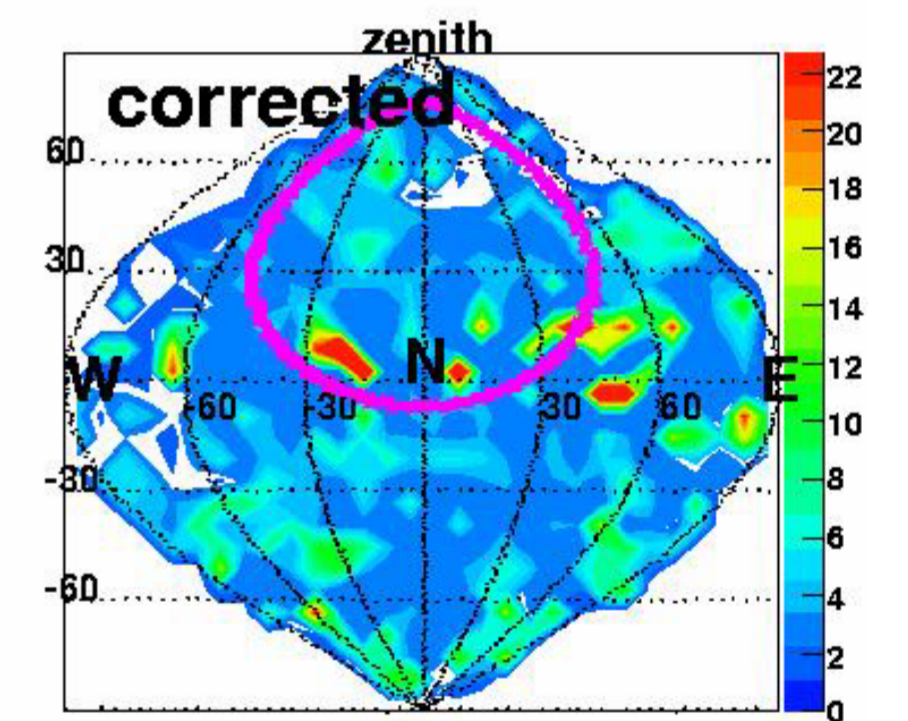
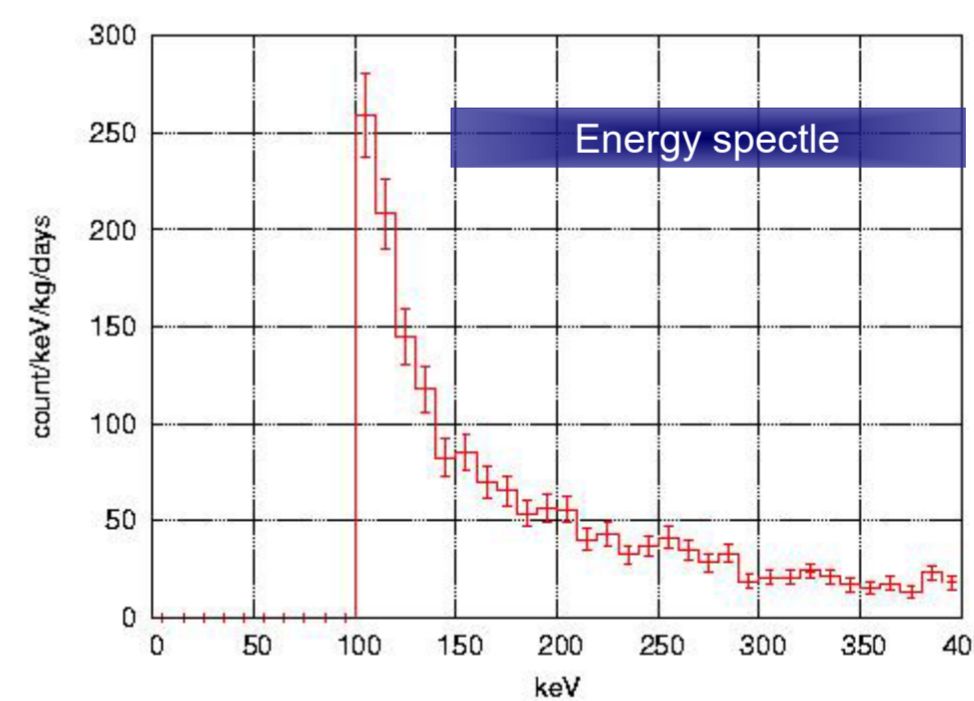
Ex. Track of recoil nuclei scattered by neutron



- 3D tracks with the resolution of **sum-mm**
- Energy resolution of **40% @5MeV**
- Particle discrimination by dE/dx
- $\rightarrow \gamma$ -ray rejection power $< 10^{-4}$

5. Direction Sensitive DM Search on Surface

- Surface run in the laboratory of Kyoto university
- Nov 1-27, 2006 0.15kg \cdot days
- N 35.03 E 135.783**
- Gas: **CF₄ 0.2atm**

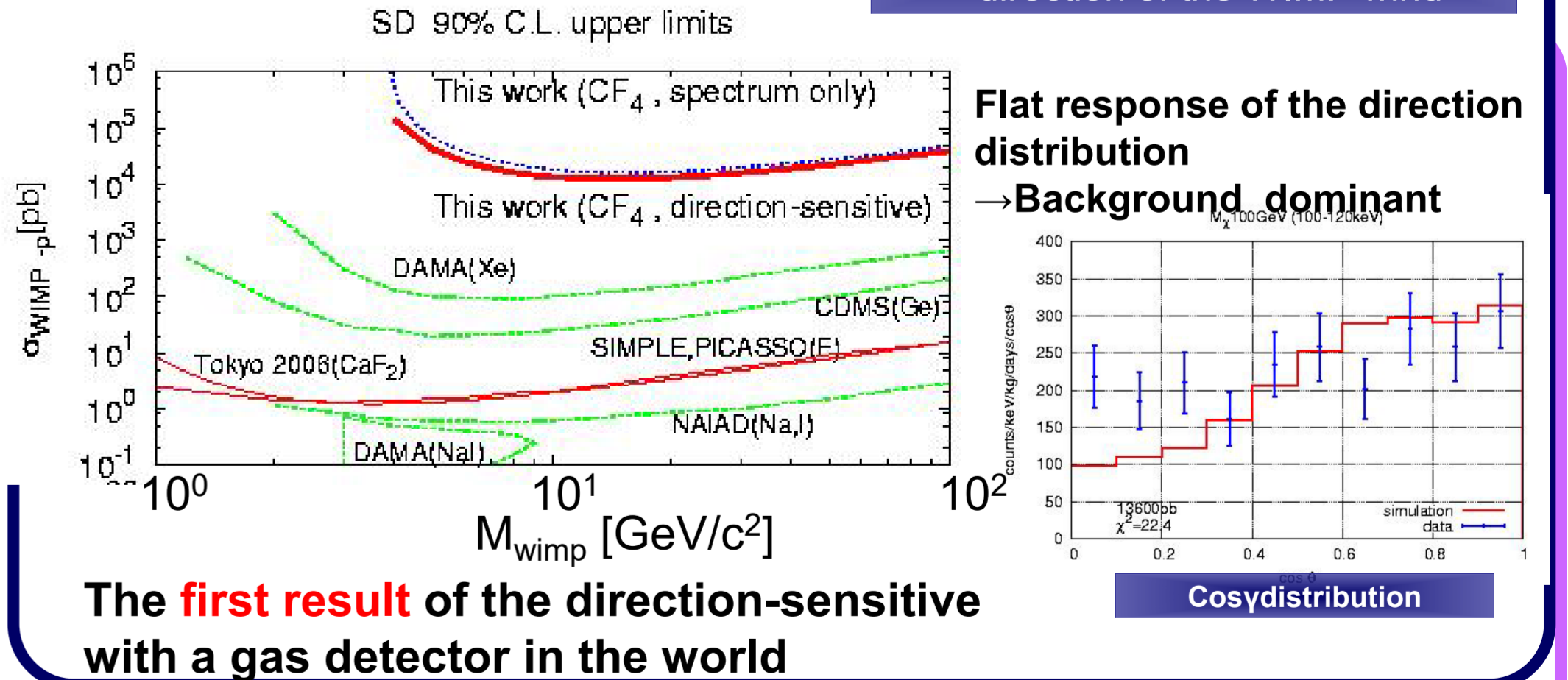
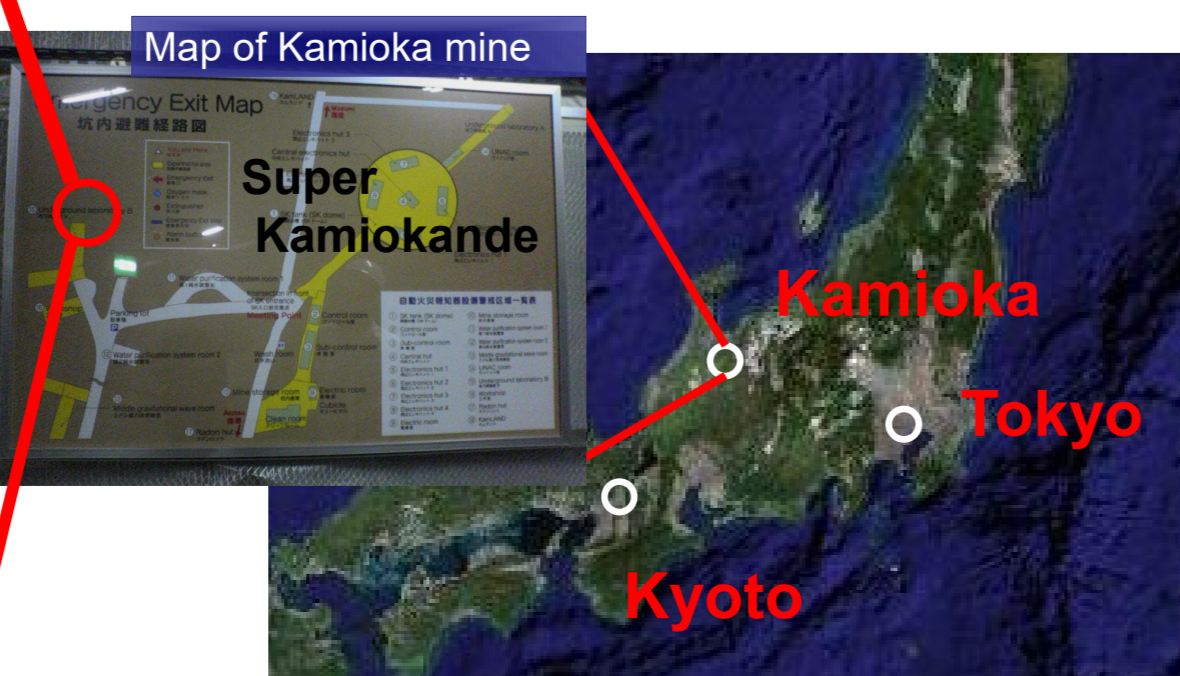
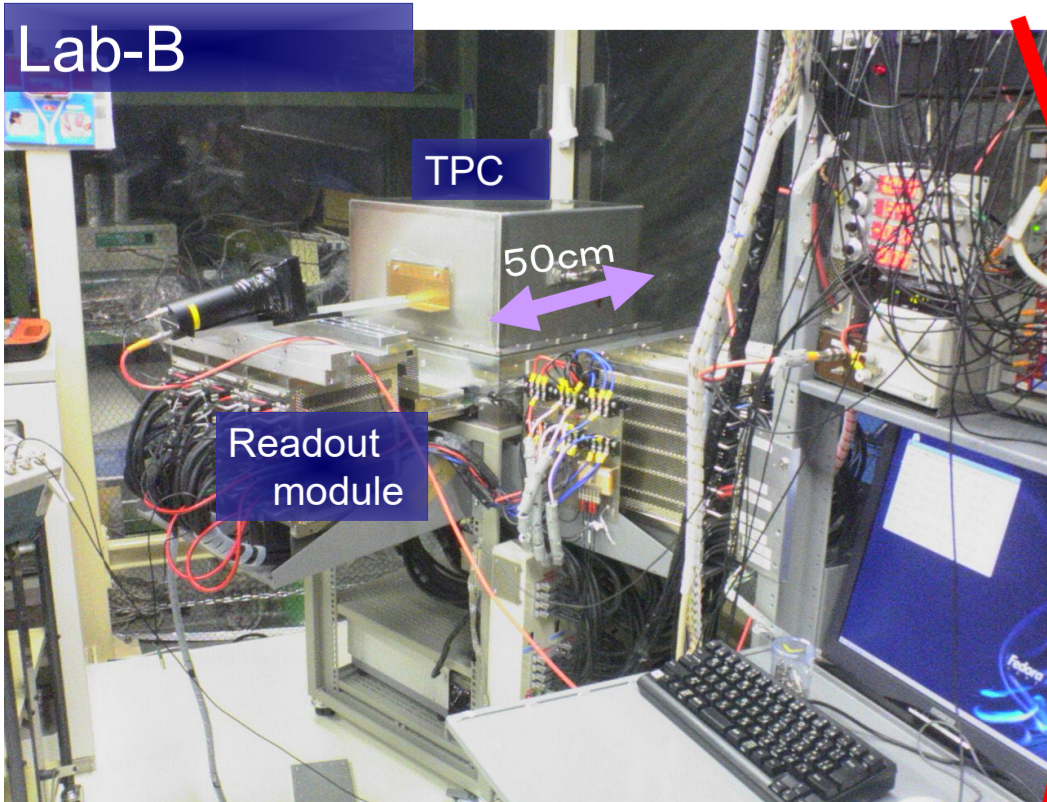
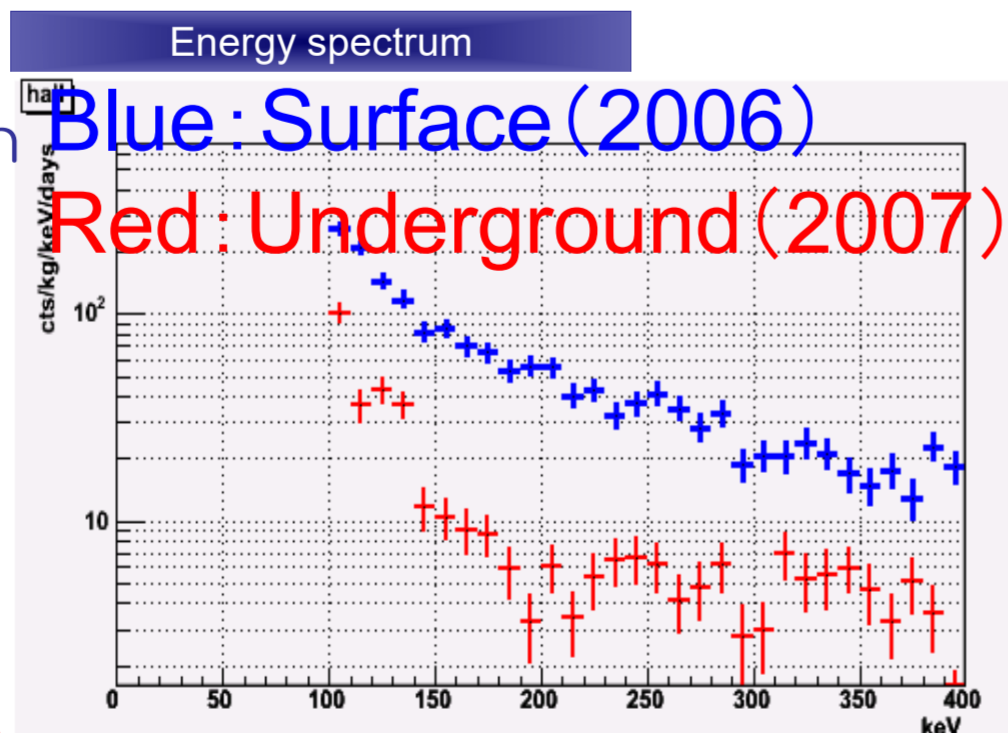


Color: The distribution of directions of recoil nuclei
Purple line: Expected tracks of the direction of the WIMP wind

6. Operation in Kamioka mine

- less environmental background
- Kamioka mine 2700 w.e. depth
- Jan. 2007 Operation Start!!

Background decrease to 40% of surface run.



The first result of the direction-sensitive with a gas detector in the world

Flat response of the direction distribution \rightarrow Background dominant

Future work

- Low BG detector
- Larger volume
- lower pressure
- 2010~:

With 1m³ detectors NEWAGE will reach the frontier of the direct dark search and SUSY region.

