Readout system in japan

Nagoya University
Atsuhiro UMEMOTO

Purpose

NEWS is a directional search of WIMPs by nuclear emulsion

But it is much different from the past emulsion experiment

Detector (NIT)
:Need submicron track detection and high statics

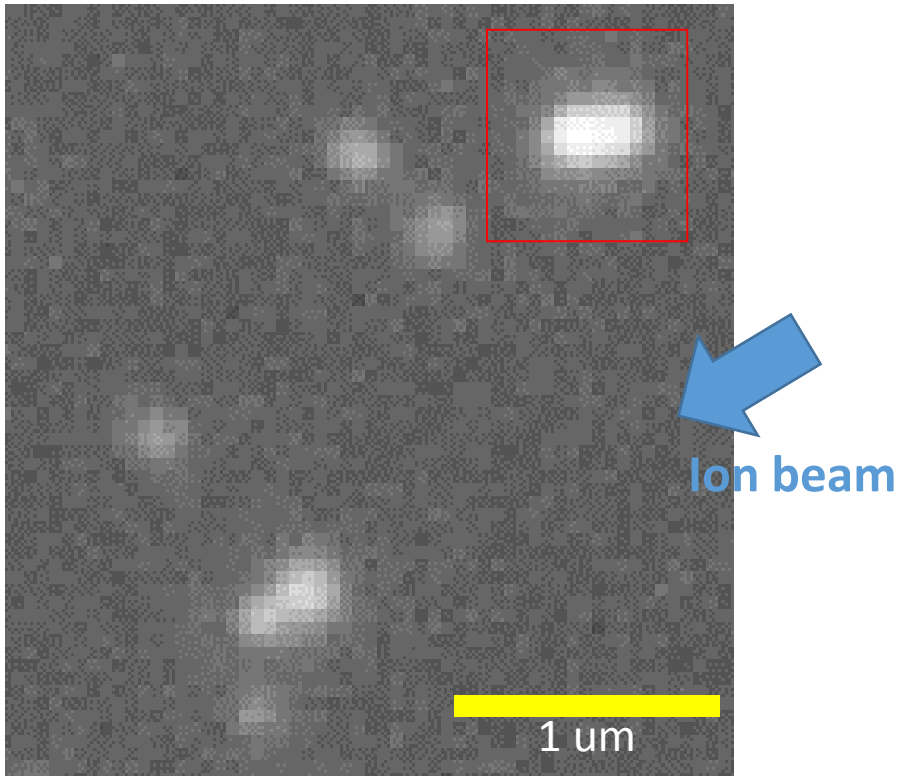
Readout system
:Need nanometric resolution and high scanning speed

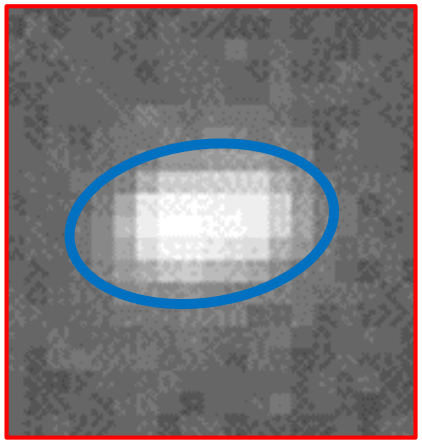
share our scanning concept, strategy and future plan

Elliptical analysis

Our basic analysis is to get the shape of optical image

Optical image of Carbon track (Ek=60keV)



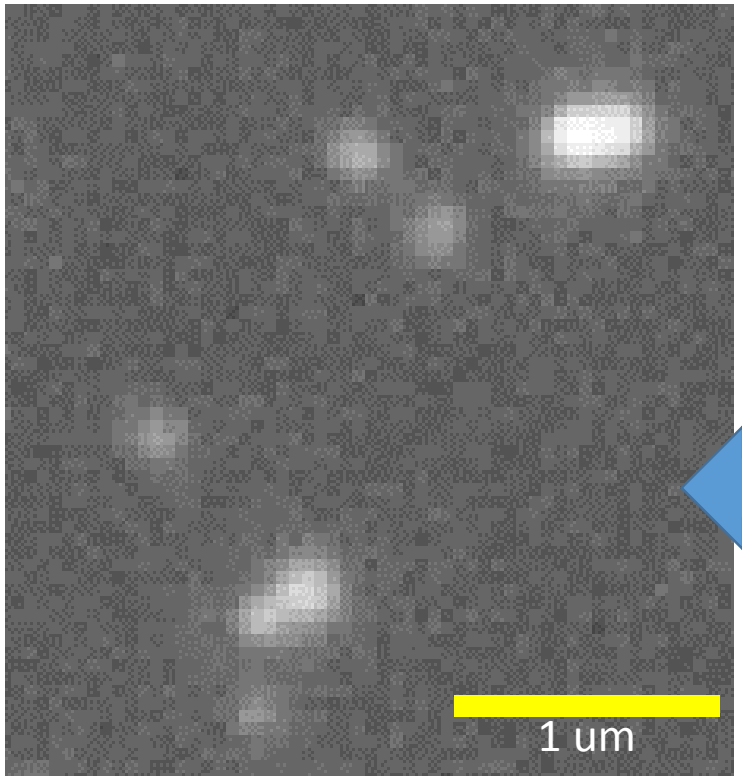


Get direction and length of track

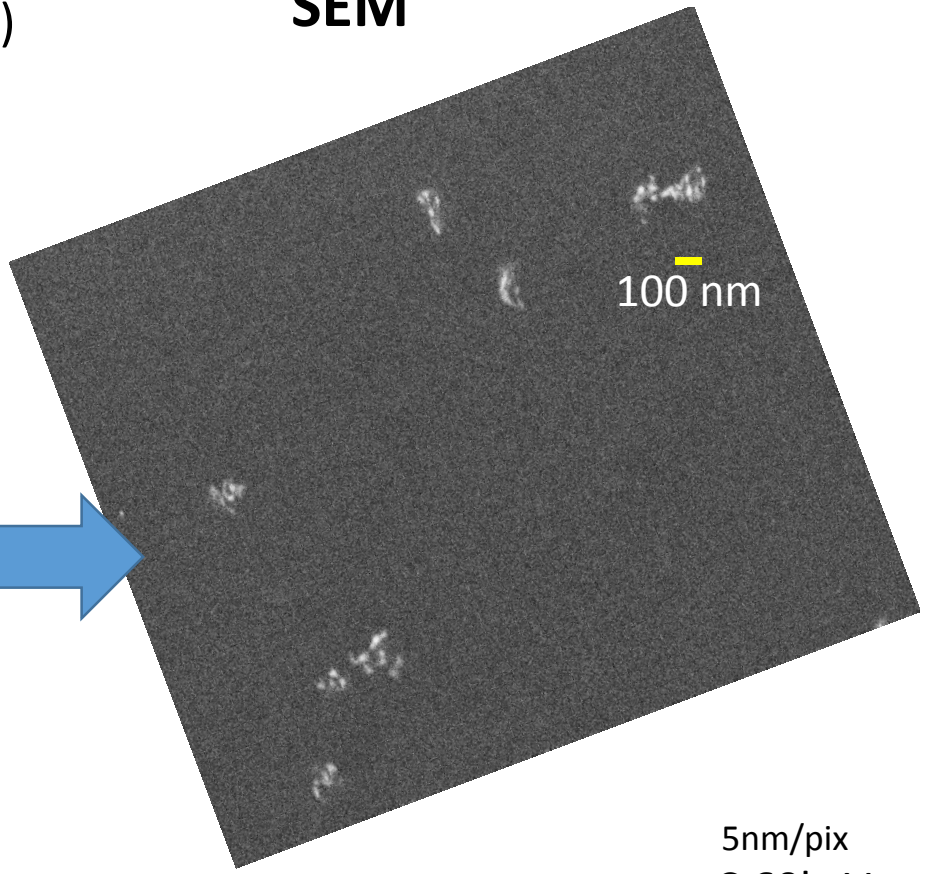
Beyond the optical resolution

Want to get the information about inside of optical image

Optical image of Carbon (Ek=60keV)

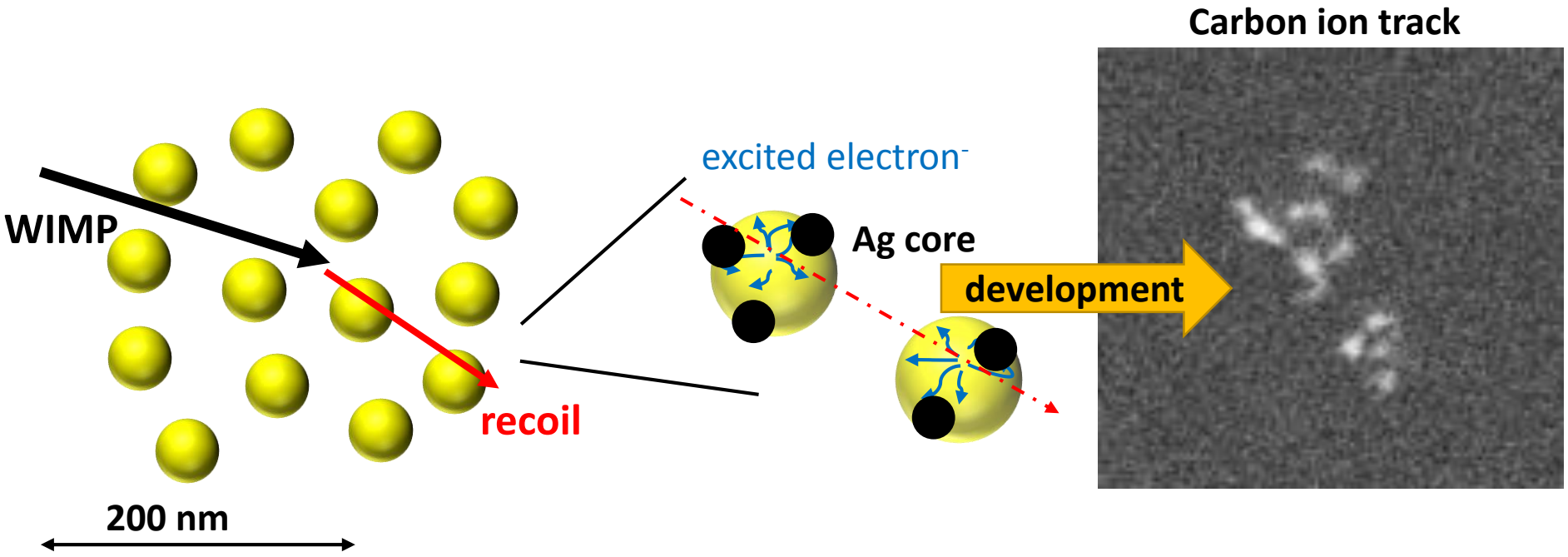


SEM



5nm/pix
C 60keV

Property of NIT



This very complicated shape is much useful for noise discrimination

- **The number of Ag core is decided by an energy loss of the particle**
  → e.g. electron does not make many Ag core

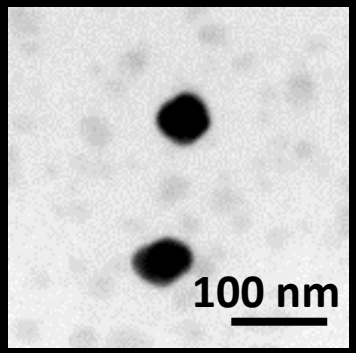
- **this shape should be made only by the development process**
  → An impurity of NIT called "dust" should not be same shape

Plasmon resonance effect

Localized Surface Plasmon Resonance is the optical response of nano Ag and Au

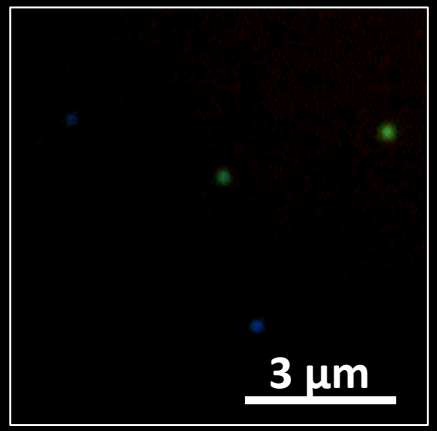
- **Size effect**

TEM image of Ag



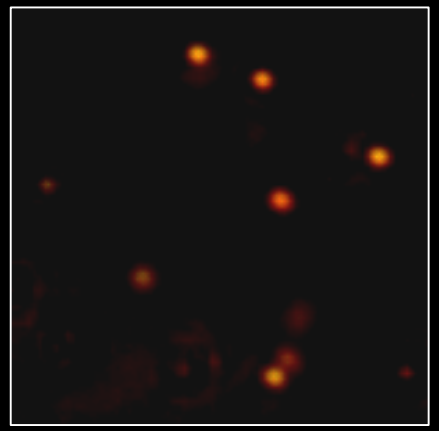
diameter = 60nm

Optical image taken by color camera



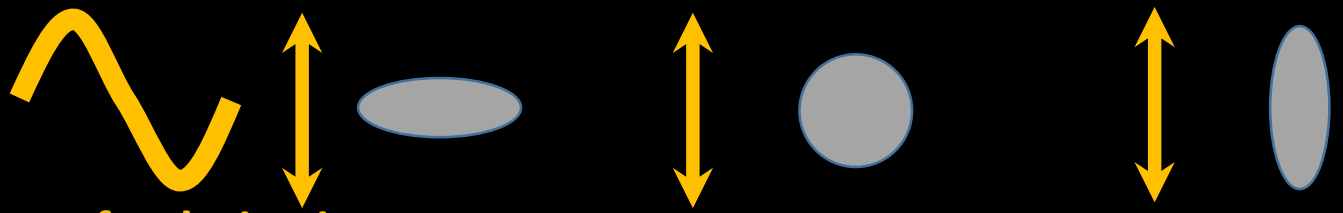
diameter = 40nm

diameter = 60nm



diameter = 85nm

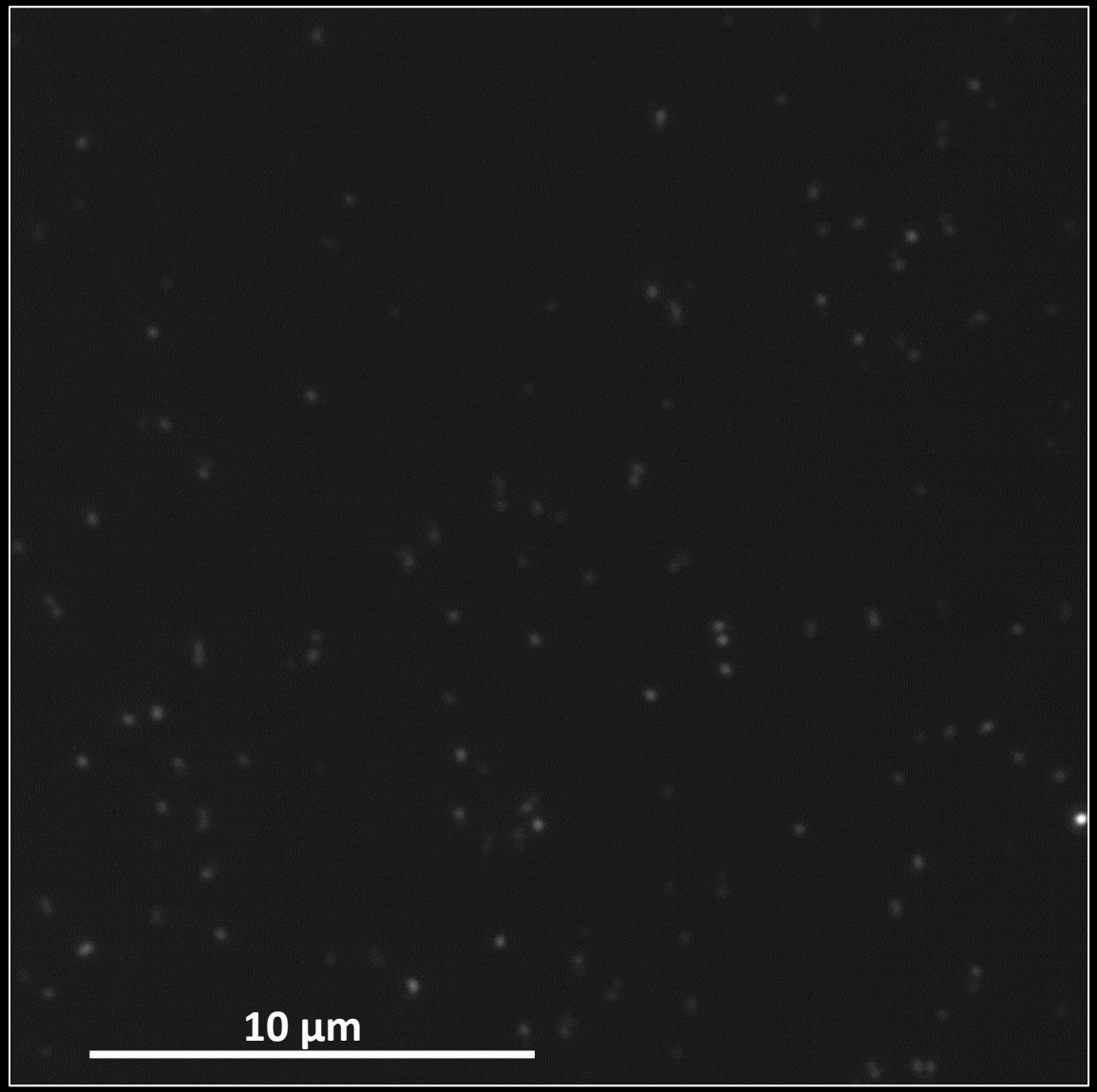
- **Shape effect**



The direction of polarization

short λ_r **long**

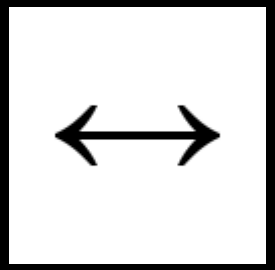
Optical image of Carbon track (Ek100keV)



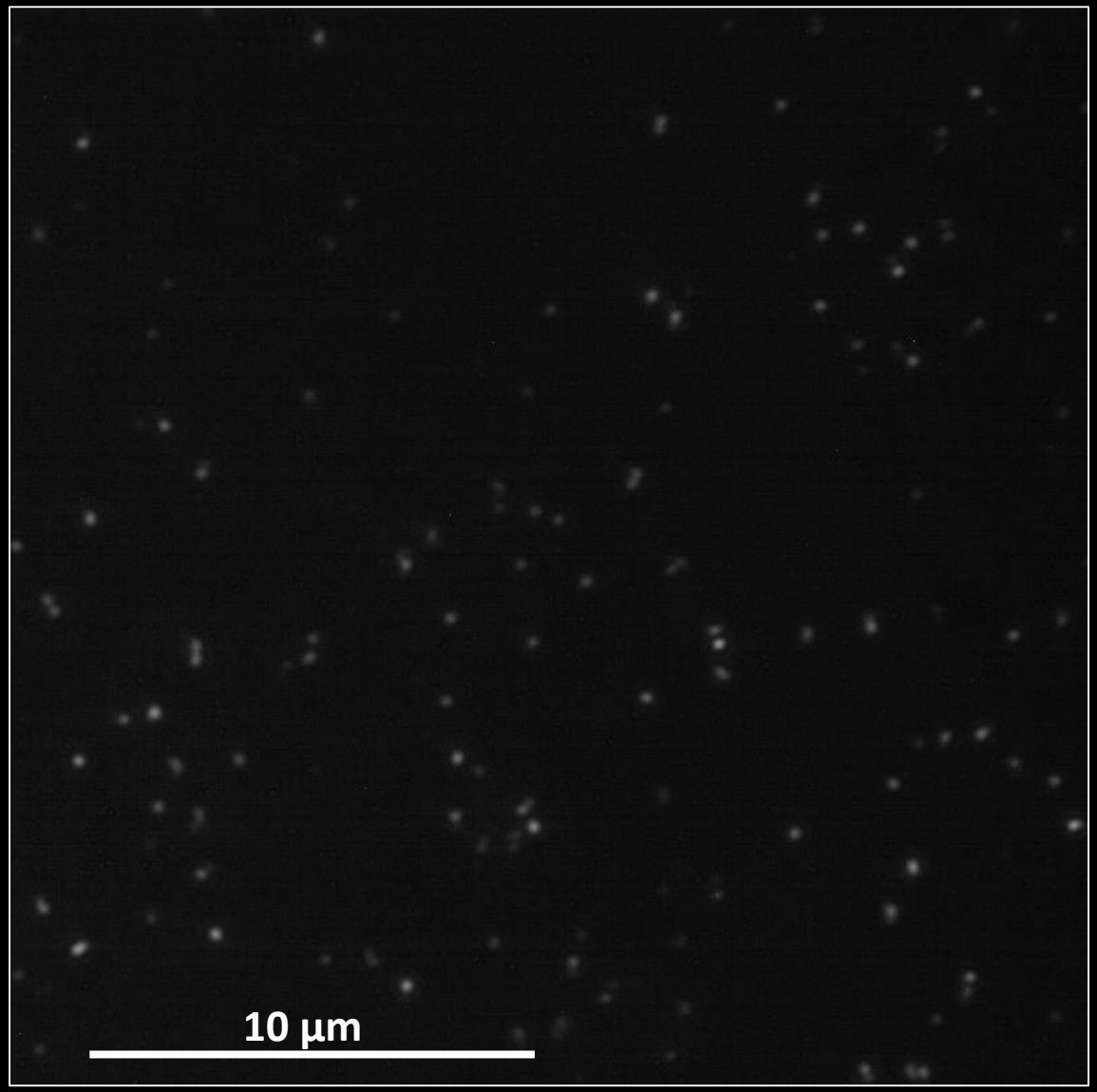
λ= 450nm

Polarization effect

Polarizer angle

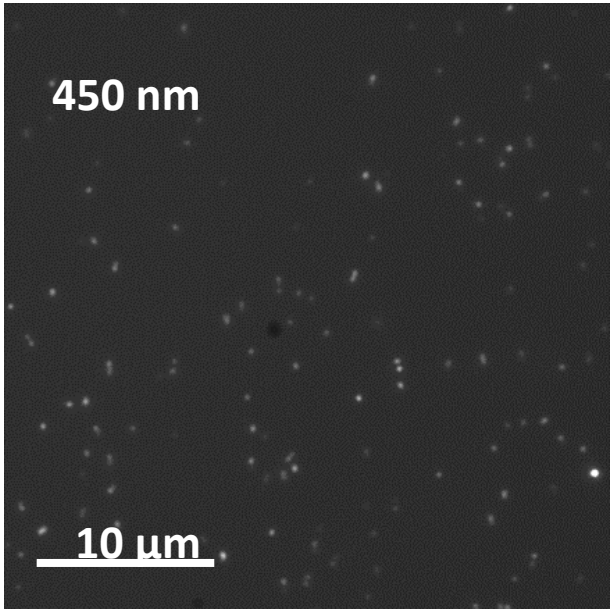


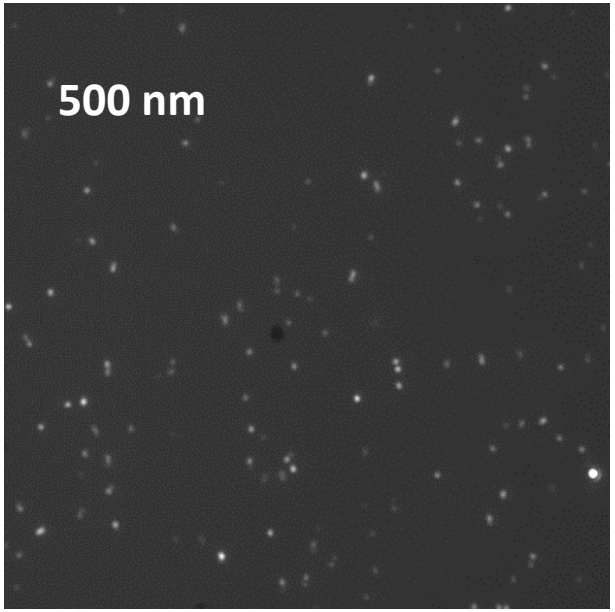
Taken at Napoli

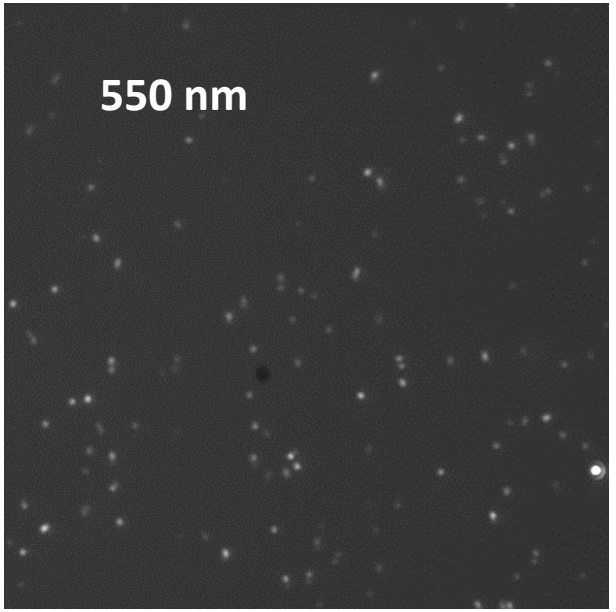


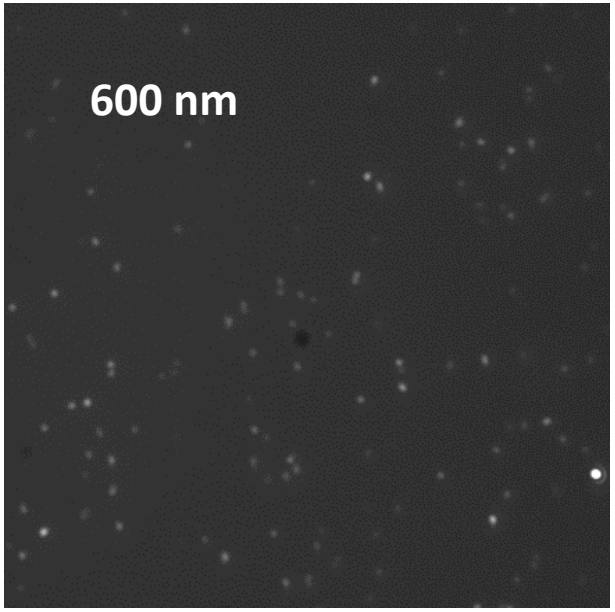
λ= 450nm

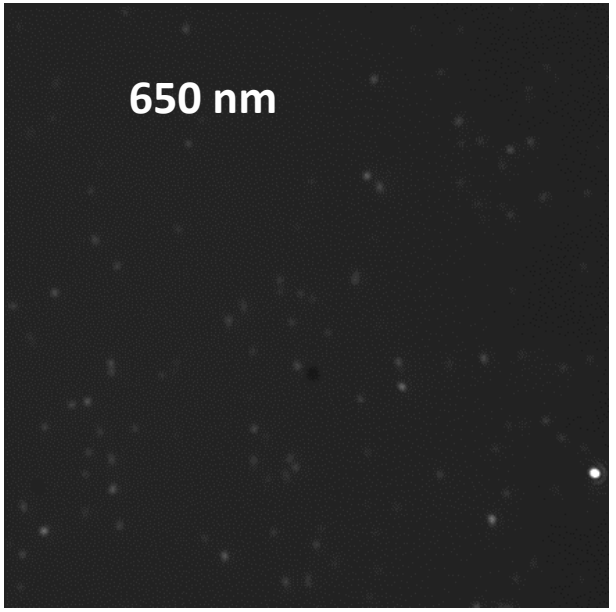
Plasmon analysis by multi wavelength











Scanning strategy

1st selection ～elliptical analysis

Full volume scan

Select signal candidate

2nd selection ～elliptical analysis again

1 % of Sphere image accidentaly has high Elliptyiity

Rescan 1st selection candidates

3rd selection ～super resolution analysis

Use a nanometric information beyond the optical image by plasmon and neural network

Decide signal

Scanning strategy

1st selection ～elliptical analysis

Full volume scan

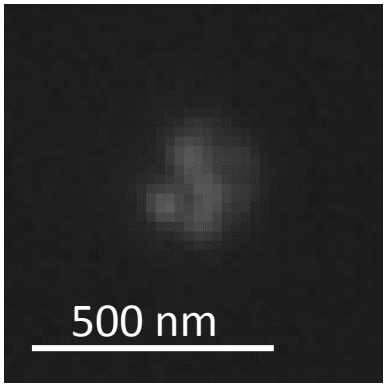
2nd selection ～elliptical analysis again

Rescan 1st selection candidates

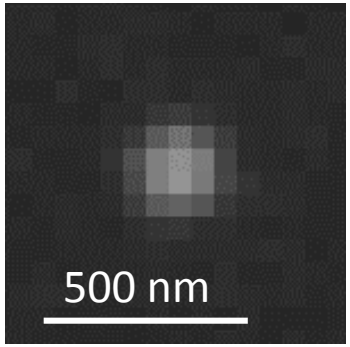
3rd selection ～super resolution analysis

Decide signal

Obvious dust

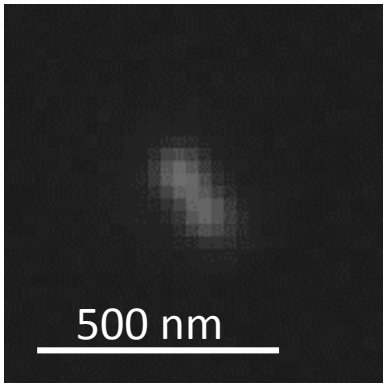


fog



Reject by shape analysis

dust



Reject by plasmon effect

Japanese readout system for NEWS

☐**Set up**

- **High N.A Objective lens: N.A = 1.45 (x100)**

- **4M pixel Camera, 180 fps**
  View: $(112.6\ \mu m)^2$/view
  55 nm/pix (measured)

- **Xenon-Mercury lump**
- **High-path filter: λ < 500 nm**
- **Spatial resolution: $\delta x = 233$ nm (measured)**

- **Stage is moved by stop and go**

current speed of 1st scanning ~ 1 g/ 10 days

Plan for upgrade of 1st scanning

First goal of Scanning speed

1 g /10 days ⇒ 3 g/10 days

- stage speed

move X and Y stage with very low speed to reject the vibration now

⇒ will tune the best condition

- position accuracy of Z direction

Sometime miss the surface

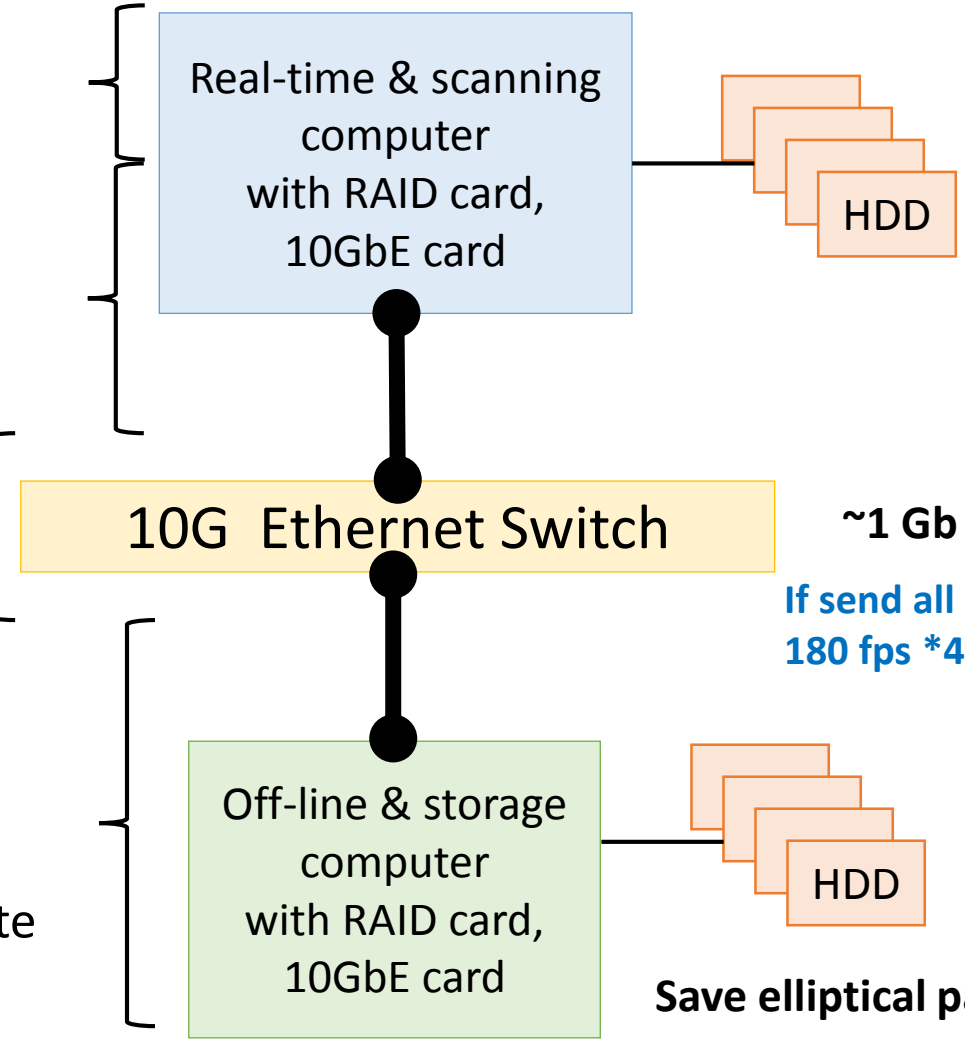
⇒ use a piezo for smooth moving and better position resolution

Near future system of scanning system

Will separate tasks to 2 PC for parallel analyzing

- Stage control
- Camera control

- Image filter
- Surface recognition



Send only fiducial images after surface recognition

- Elliptical analysis
- Best focus selection
- Select signal candidate

Set up of Plasmon analysis

Task

- scanning algorithm to see same event after 1st scan
- high speed scanning

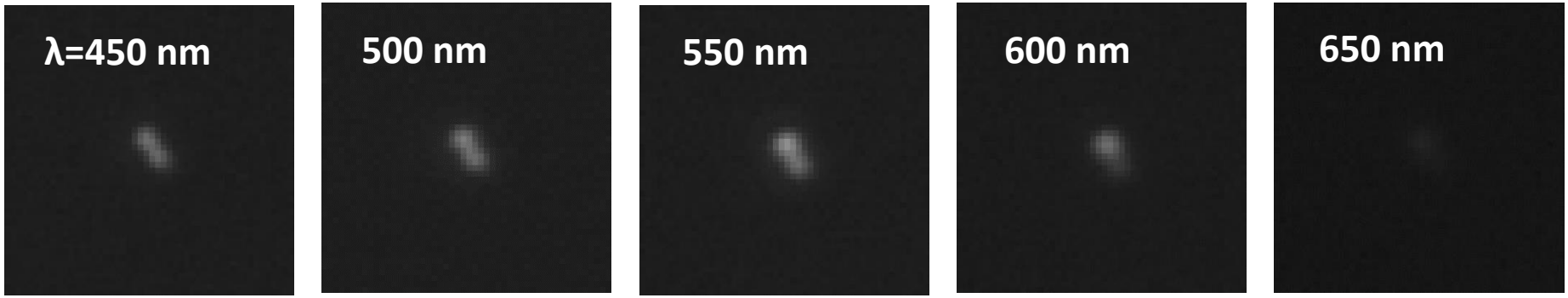
- Polarization system in Napoli
  being constructed by Andrey

- Multi wavelength analysis system in Japan
  bandpass filter is changed by my hand now
  ⇒ think about automatic system

Plasmon analysis about Dust

- Multi wavelength analysis has done about several events

- Sometime dust has optical change depended on the wavelength



But maybe the value of shift of brightness is difference from the signal one
⇒should be checked after meeting

e.g. parameter of Double Gaussian fitting of brightness distribution
displacement of brightness point

Also combination multi wavelength and polarization effect is much strong

Conclusion

- Readout system the nanometric resolution and scanning speed

- Scanning strategy is :

  reject sphere noise and strange shape dust by Elliptical analysis at first, then select signal by using detail information by plasmon

- Readout system need to be improved for high scanning speed and high S/N ratio in JP and Italy