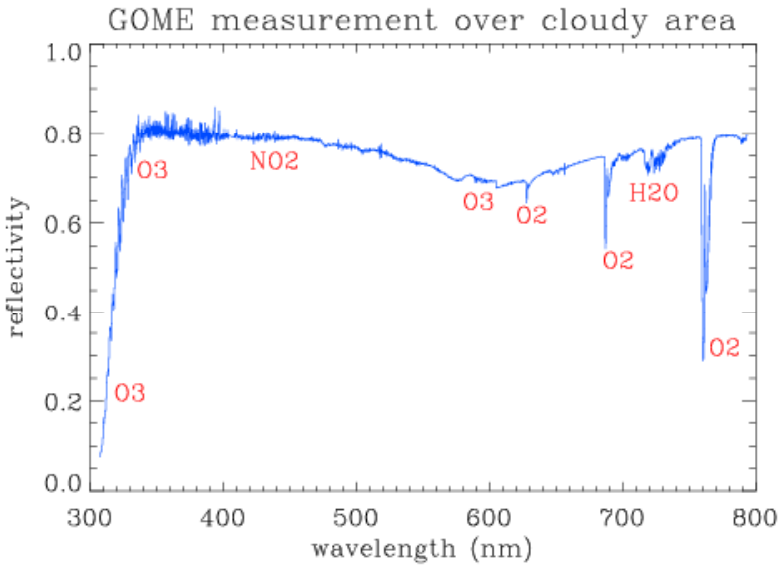
Spectral Range Expansion to 630nm : Impacts on GEMS Design

KARI

Spectral Range

Chappuis Band

- Absorption of light by ozone in visible range of spectrum
- Ozone absorbs visible light at about 602nm wavelength



http://disc.sci.gsfc.nasa.gov/oceancolor/additional/science-focus/ocean-color/science_focus.shtml/ozone.shtml

Spectral Range

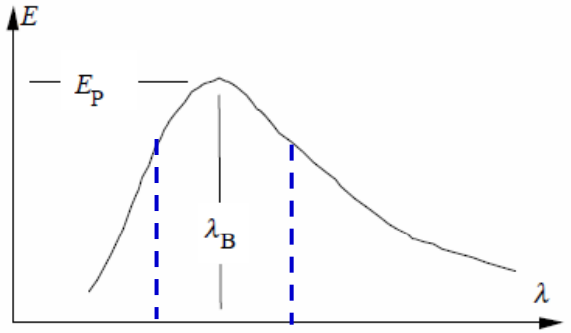
- Current Requirement : 300 – 500nm
- Extended Requirement : 300 – 630nm

Impacts on the GEMS design & performances

Impacts on the GEMS design

SNR

- Current spectrometer design, especially grating, is optimized for the 300-500nm spectral range
- SNR could dramatically decrease in 500-630nm without spectrometer design change



Typical efficiency curve according to the wavelength

Diffraction order overlapping

- Diffraction order overlapping in the 600-630nm range
- Order sorting filter is required to distinguish the diffraction order
- Additional filter induces the decrease of transmittance and also SNR

Impacts on the GEMS design

MTF

- Current optical design is optimized for the 300-500nm
- MTF could dramatically decrease in 500-630nm without optical design change

Data rate

- Current Data rate requirement : < **10Mbps** (TBC)
- Data increase : (630-300)/(500-300) = 1.65 times
- Data compression rate increase or on-board data processing
- Data rate budgeting to S/L should be revisited

Impacts on the GEMS design

Detector constraint

- Required spectral pixel number : (630-300)nm/0.2nm = 1650
  (0.2nm spectral sampling assumed)
- For the 1k column detector design
  – extra FPA or extra spectrometer
  ➔ Volume & Mass increase

- For the 2k column detector design
  – Detector readout speed decrease
  ➔ FPA electronics design change

※ Current design constraint :
1k×1k or 2k×2k detector

Summary

Issues	Mitigation	Impacts
SNR decrease	Imaging time increase Spectrometer design change	--
MTF decrease	Optics design change	--
Data rate increase	Data rate rebudgeting (IF to S/L) Data compression/on-board data processing	--
Order overlapping	Filter adding	-
Detector constraint	Extra FPA or Spectrometer Mass & Volume increase (IF to S/L) FPA electronics design change	---/--

Projected FOV, GSD & ROI

KARI

FOV, ROI & GSD

- **FOV Requirement :**

  > 5,000km(EW)×5,000km(NS)

- **ROI (Region of Interest) : 75°E~145°E, 5°S~55°N**
- **GSD Requirement :**

  < 5km(EW) × 5km(NS) at Seoul (baseline)

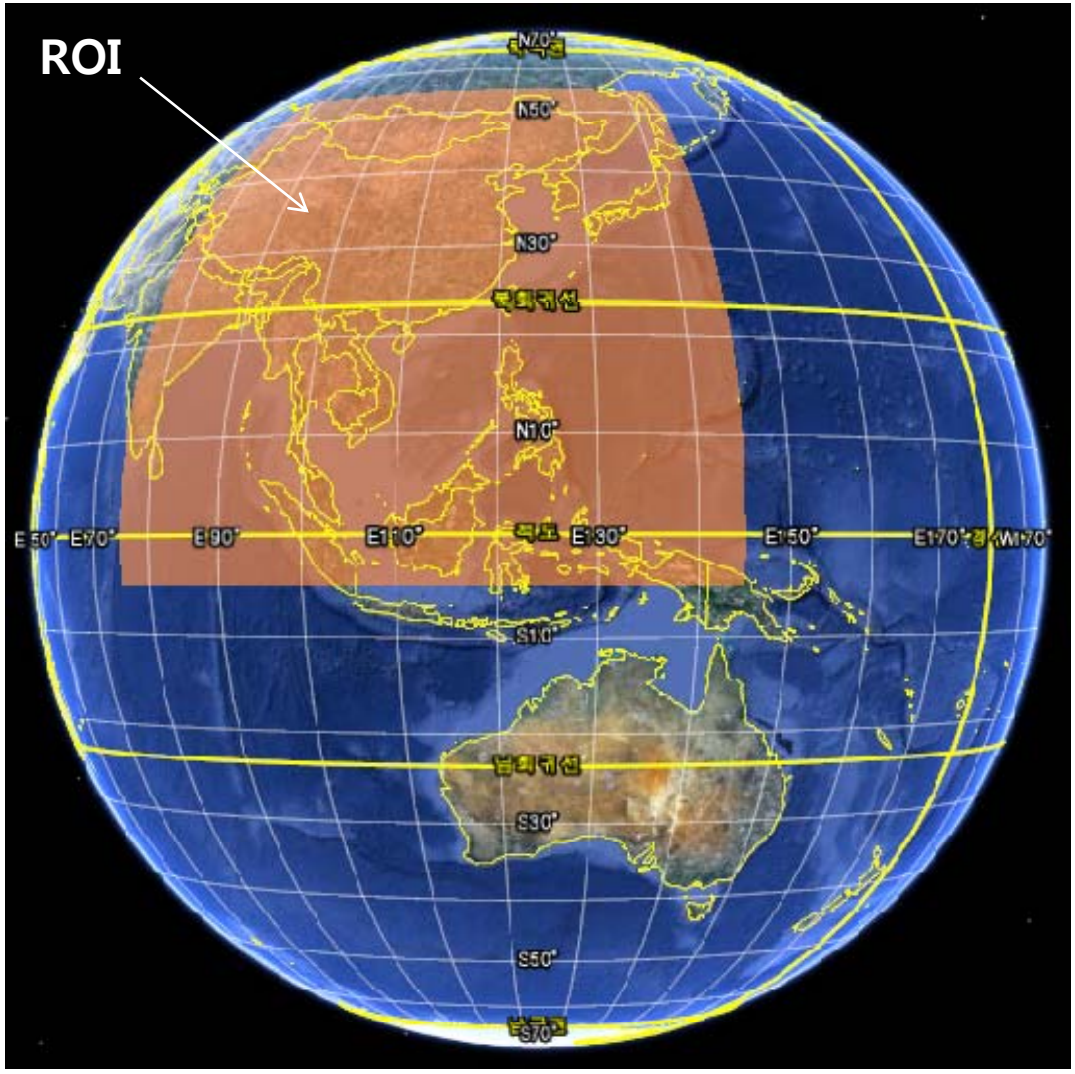
- **Current Design Constraint**
  - **1-D Scan (Step & Stare Scan or Continuous Scan)**
  - **EW direction scan**
  - **NS direction sampling : 1000**
    - **1k pixel or 2k pixel with binning**

Geostationary View of ROI

S/L position : 128.2°E

Altitude : 36,000km

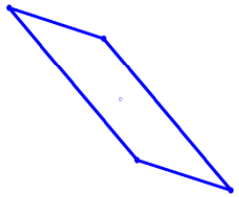
ROI : 75°E ~ 145°E
5°S ~ 55°N



Magnification ratio of Earth projected IFOV

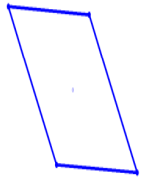
S/L position : 128.2E
Target center : 110E, 25N

(75E, 55N)



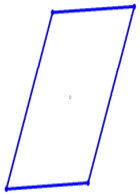
2.87(EW)×3.03(NS)

(110E, 55N)



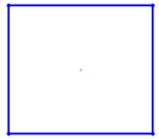
1.19(EW)×2.40(NS)

(145E, 55N)



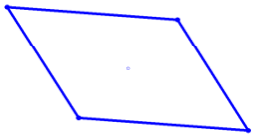
1.16(EW)×2.39(NS)

GEO altitude,
normal projection



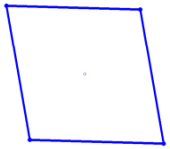
1(EW) × 1(NS)

(75E, 25N)



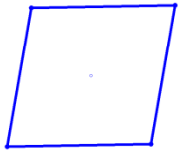
2.28(EW)×1.29(NS)

(110E, 25N)



1.11(EW)×1.18(NS)

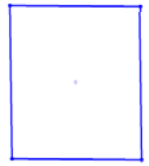
(145E, 25N)



1.08(EW)×1.17(NS)

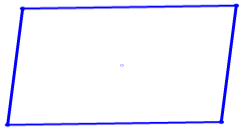
Seoul

(127E, 37.5N)



1.04(EW)×1.43(NS)

(75E, 5S)



2.19(EW)×1.08(NS)

(110E, 5S)

1.08(EW)×1.01(NS)

(145E, 5S)

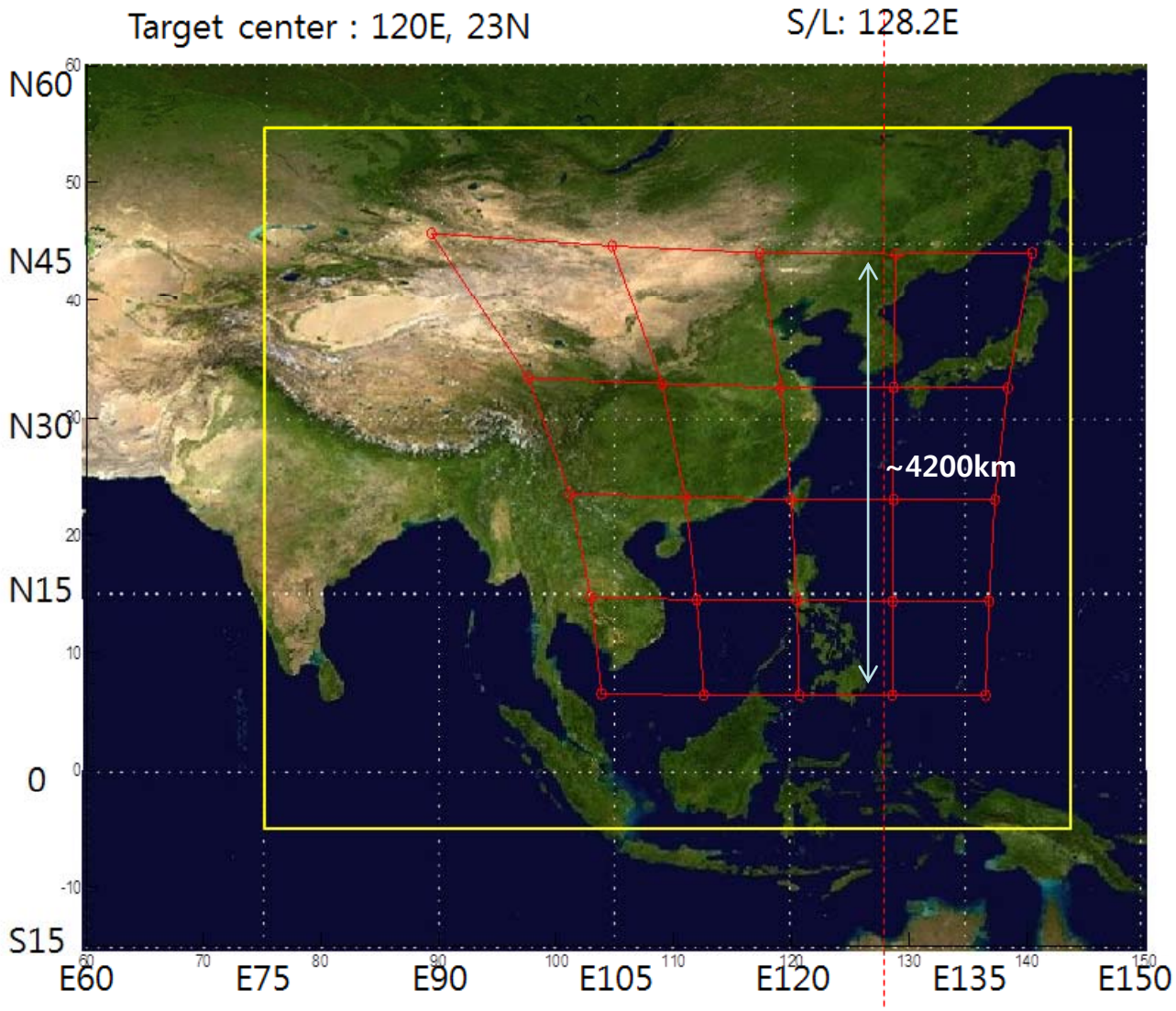
1.06(EW)×1.00(NS)

Case A - Hypothesis

- Target center : 120E, 23N (Taiwan)
- Satellite longitude : 128.2E
- No. of sampling in NS direction : 1000
- Geo altitude, normal projected NS GSD = 3.5km
- Geo altitude, normal projected EW GSD = 3.5km (assumed)
  (depends on H/W)

- NS GSD @ Seoul = 5.0km
- EW GSD @ Seoul = 3.6km
- NS swath = 4200km (< 5000km)
- EW direction scan : 1000 step (assumed)
  (Imaging time depends on H/W)

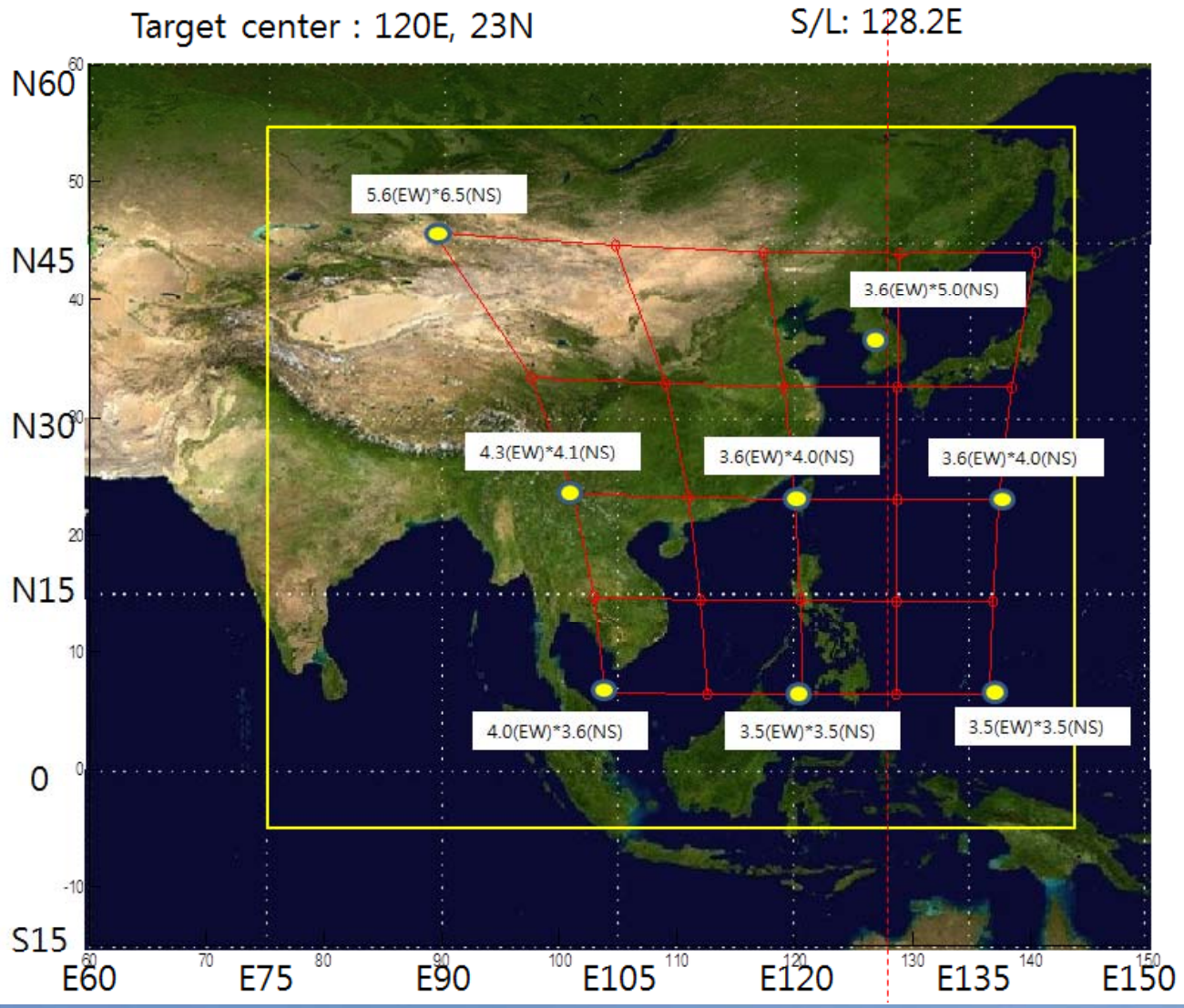
Case A - Projected Field of View



Projected FOV

Region of interest

Case A - Projected GSD



Projected FOV

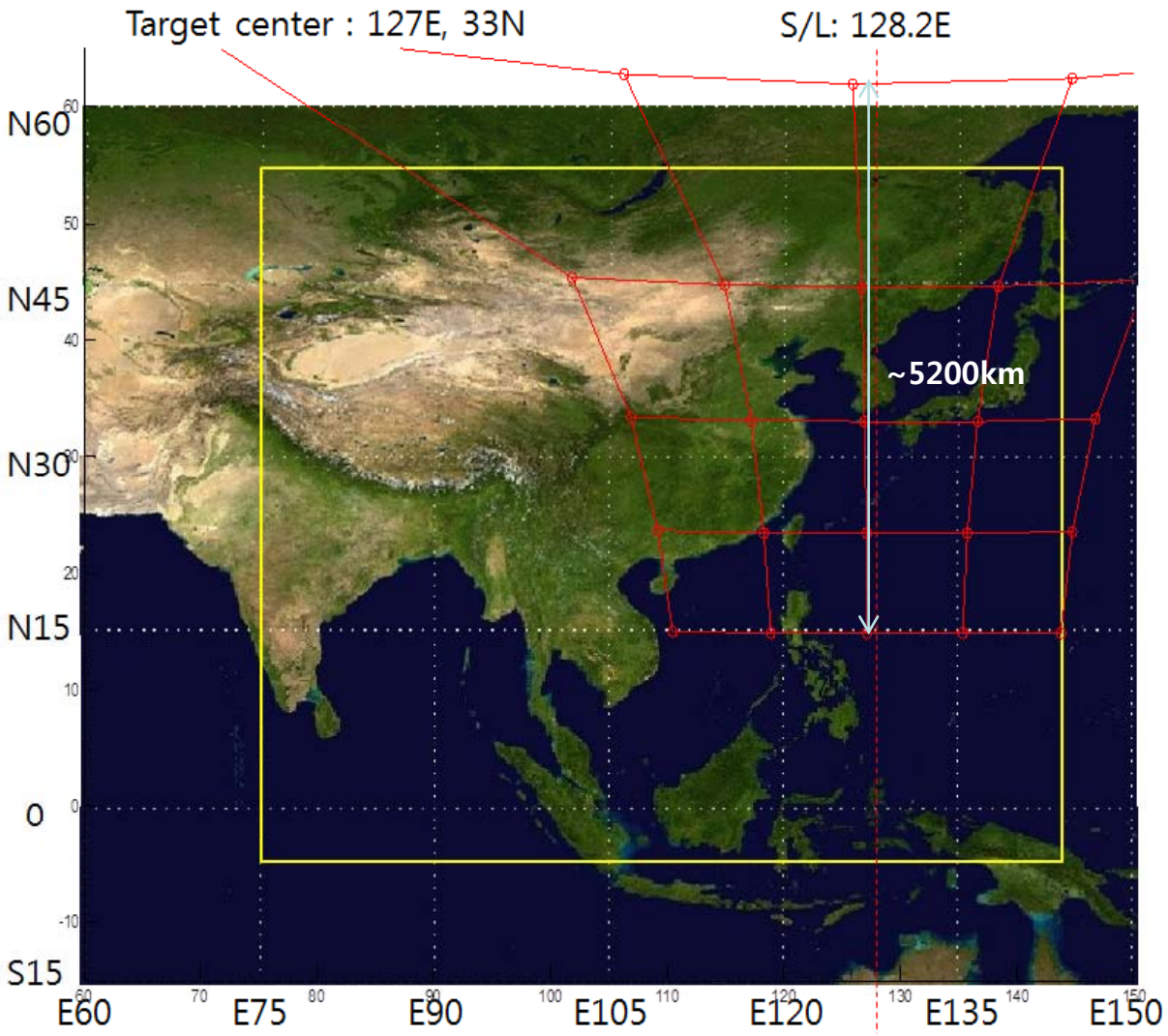
Region of interest

Case B - Hypothesis

- Target center : 127E, 33N
- Satellite longitude : 128.2E
- No. of sampling in NS direction : 1000
- Geo altitude, normal projected NS GSD = 3.5km
- Geo altitude, normal projected EW GSD = 3.5km (assumed)
  (depends on H/W)

- NS GSD @ Seoul = 5.0km
- EW GSD @ Seoul = 3.6km
- NS swath = 5200km (> 5000km)
- EW direction scan : 1000 step (assumed)
  (Imaging time depends on H/W)

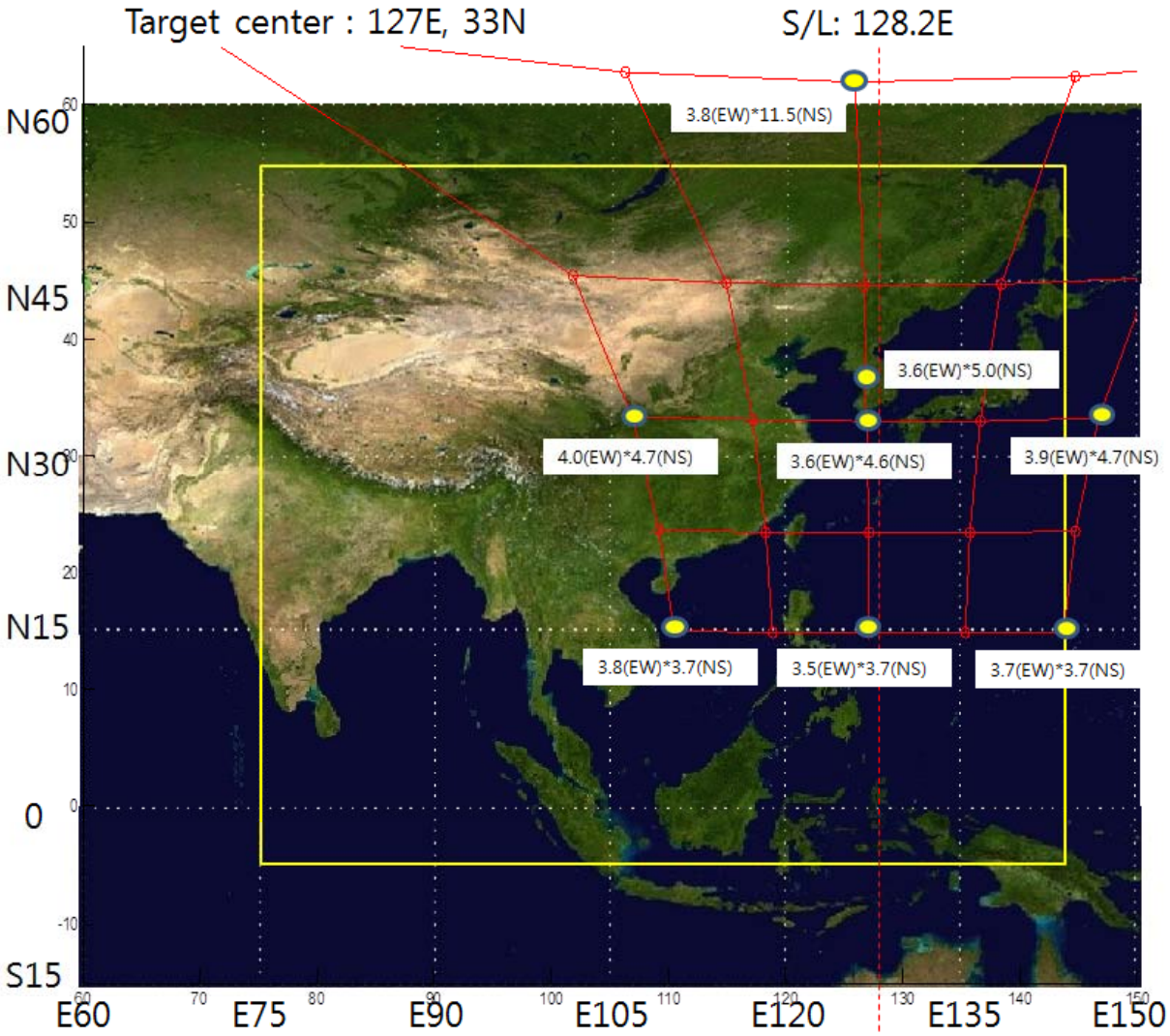
Case B - Projected Field of View



Projected FOV

Region of interest

Case B - Projected GSD



Projected FOV

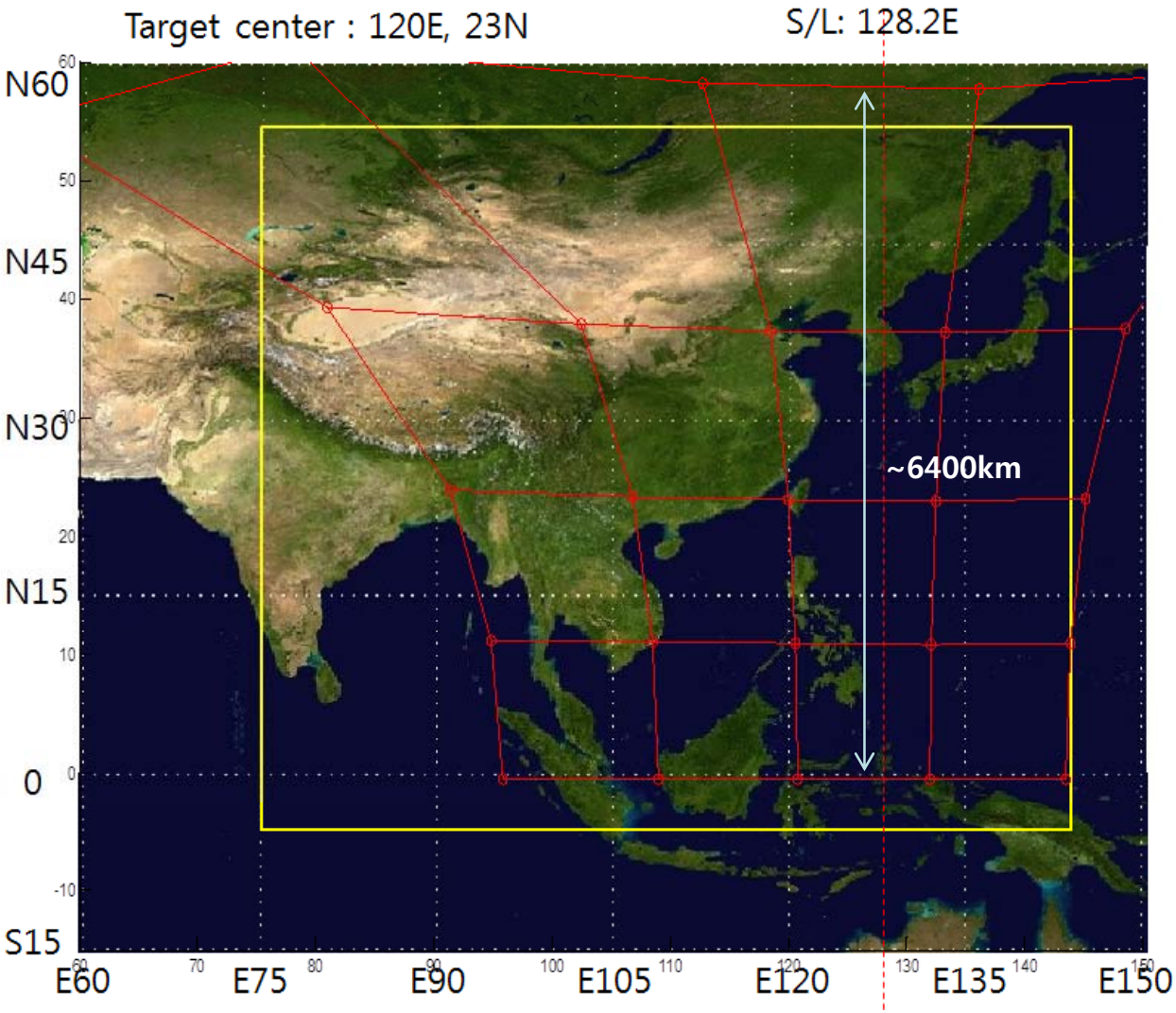
Region of interest

Case C - Hypothesis

- Target center : 120E, 23N (Taiwan)
- Satellite longitude : 128.2E
- No. of sampling in NS direction : 1000
- Geo altitude, normal projected NS GSD = 5.0km
- Geo altitude, normal projected EW GSD = 5.0km (assumed)
  (depends on H/W)

- NS GSD @ Seoul = 7.2km
- EW GSD @ Seoul = 5.2km
- NS swath = 6400km (> 5000km)
- EW direction scan : 1000 step (assumed)
  (Imaging time depends on H/W)

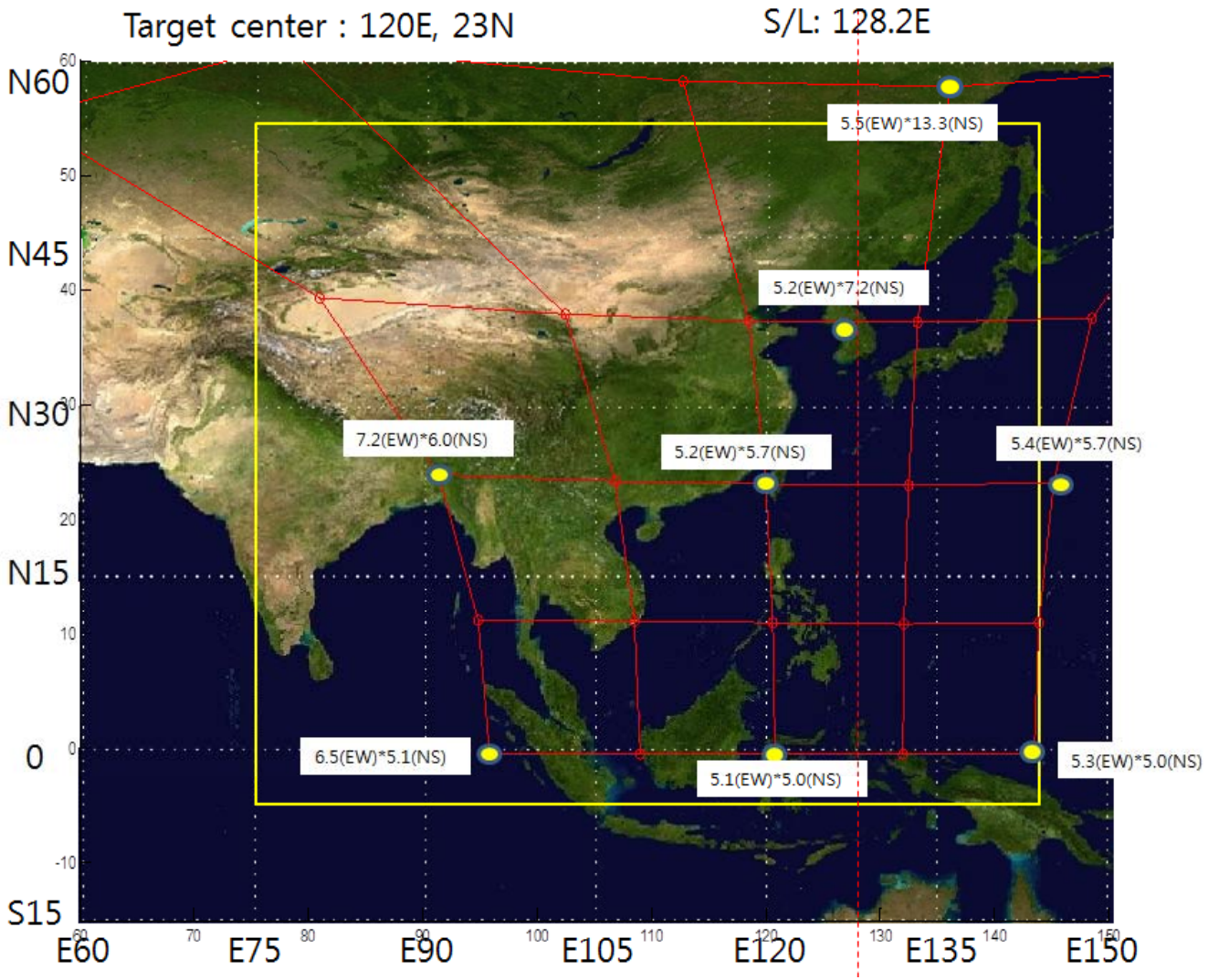
Case C - Projected Field of View



Projected FOV

Region of interest

Case C - Projected GSD



Projected FOV

Region of interest

Comparisons

	Target Center	Geo altitude normal proj. NS GSD	NS GSD @ Seoul	NS swath
Case A	120E, 23N (Taiwan)	3.5km	5.0km	~4200km
Case B	127E, 33N	3.5km	5.0km	~5200km
Case C	120E, 23N (Taiwan)	5.0km	7.2km	~6400km

Summary

- To cover all ROI under the condition of 5km NS GSD at Seoul, at least 1,500 sampling is required in NS direction
  ➔ conflict to current design constraint
- If target center is below about 30°N, NS swath will be smaller than 5,000km (Case A)
- If target center is above about 30°N, NS swath will be larger than 5,000km (Case B). However, in that case, it is difficult to cover South-East Asia & Indo-China Pen. area.
- If the GSD requirement at Seoul is relaxed, NS swath can be enlarged to cover most of ROI region (Case C)
- *Trade-off between ROI, FOV & GSD requirements has to be performed*