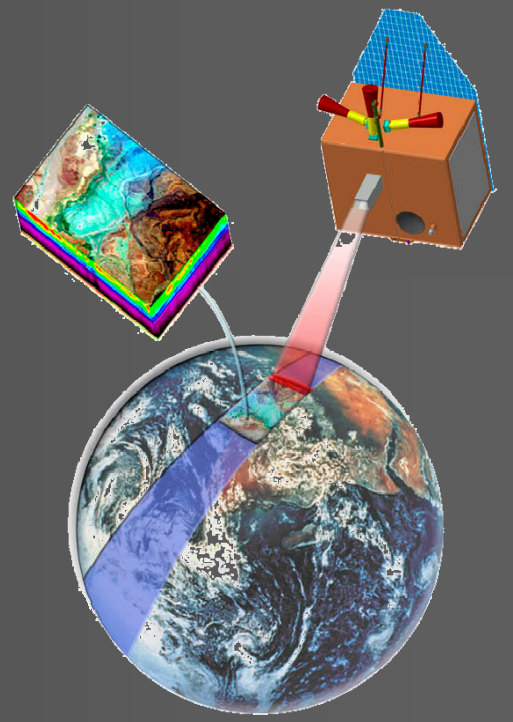
Abbildende Spektrometrie



EnMAP

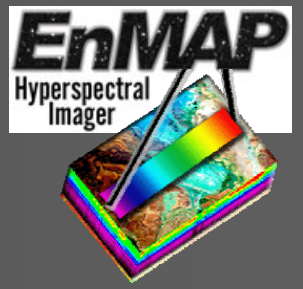
Environmental Mapping and Analysis Program

ARES

Airborne Reflective Emissive Spectrometer

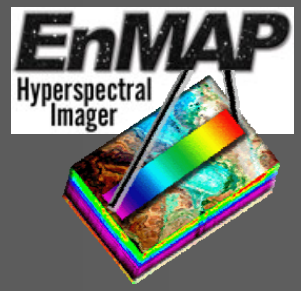
Kaufmann et al., 2006

Announcement of Opportunity



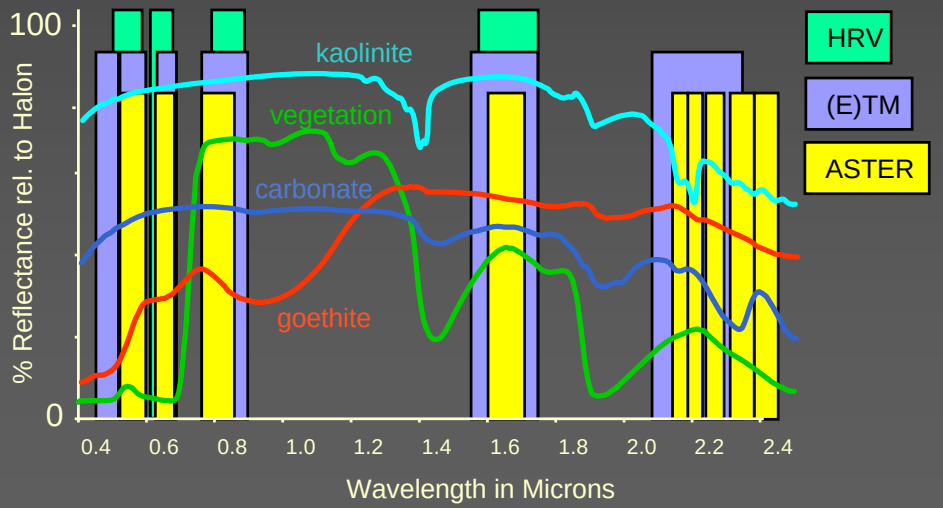
- In 2003 DLR-Agency started a selection process for a future Earth observation mission
- 15 announced; 9 different missions have been proposed
- 2 proposals have been selected for a phase A study:
  - EnMAP: Hyperspectral Mission
  - TanDEM-X: SAR Interferometry Mission
- Phase A studies for both started in September 2004
- Study duration 9 (12) month
- After finalization, DLR-Agency selects 1 proposal for a phase B/C/D in fall 2005

Overall Objectives



- To provide high-spectral resolution observations of bio-geochemical and geophysical variables
- To observe and develop a wide range of ecosystem parameters encompassing agriculture, forestry, soil/geological environments and coastal zones/inland waters
- To enable the retrieval of presently undetectable, quantitative diagnostic parameters needed by the user community
- To provide high-quality calibrated data and data products to be used as inputs for improved modeling and understanding of biospheric /geospheric processes

EO Scenario – 30 years of Tech. Development



Spatial Resolution

MSS (80m) -> Quick Bird (61 cm)

More details discernable

Benefits: pattern recognition/DTMs

Spectral Resolution

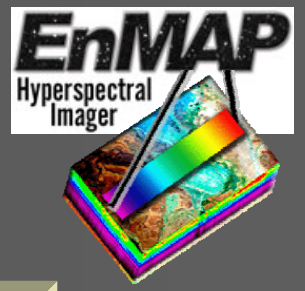
SPOT/HRV (3/5 opt. bands)

-> Landsat/TM (6 opt. bands)

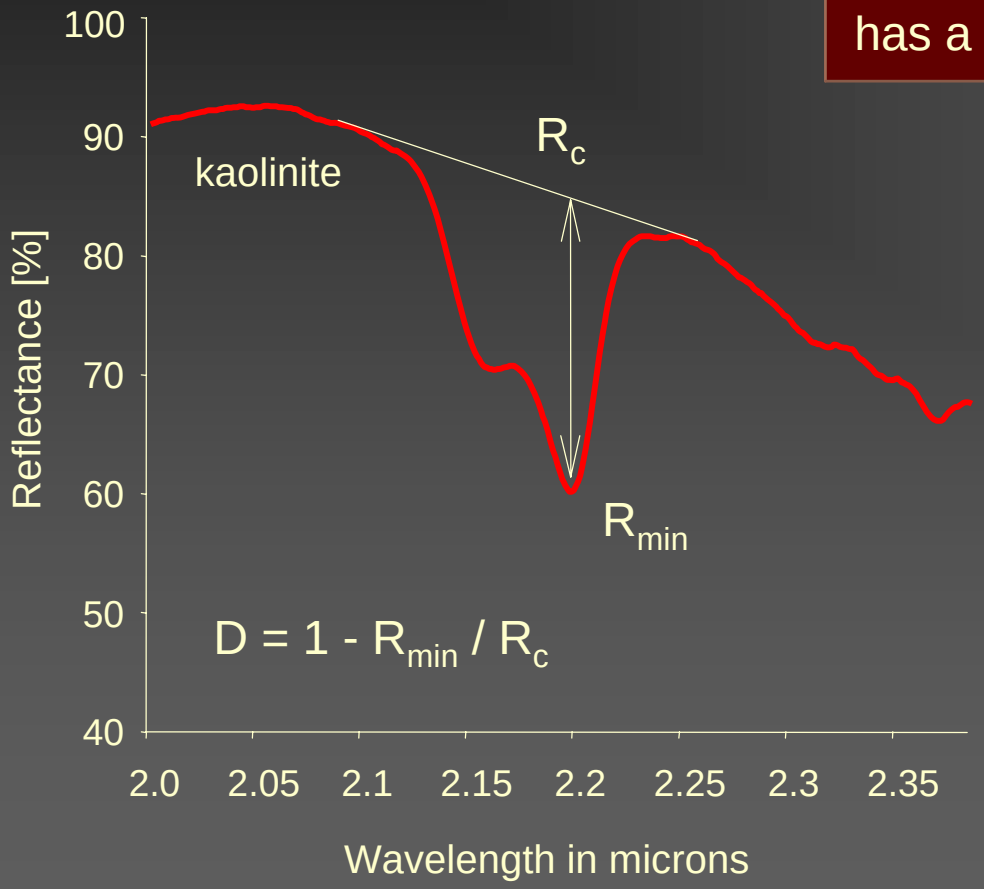
-> ASTER (9 opt. bands)

Not sufficient for identification of most surface materials

Identification – Quantification => Diagnosis



Each material on the Earth´s surface has a unique spectral characteristic



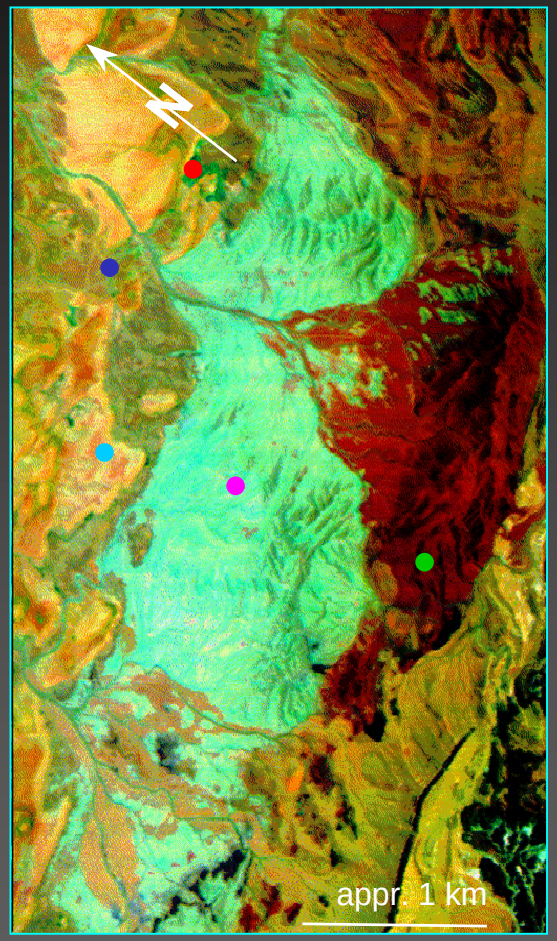
Individual Absorptions

of pigments, minerals, man made objects

Shape
Position
→ Identification

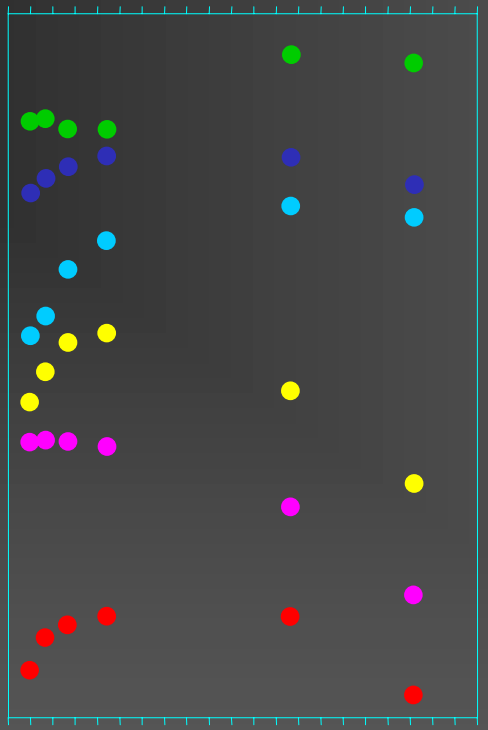
Depth → Quantification

Multi- versus Hyperspectral / Potentials

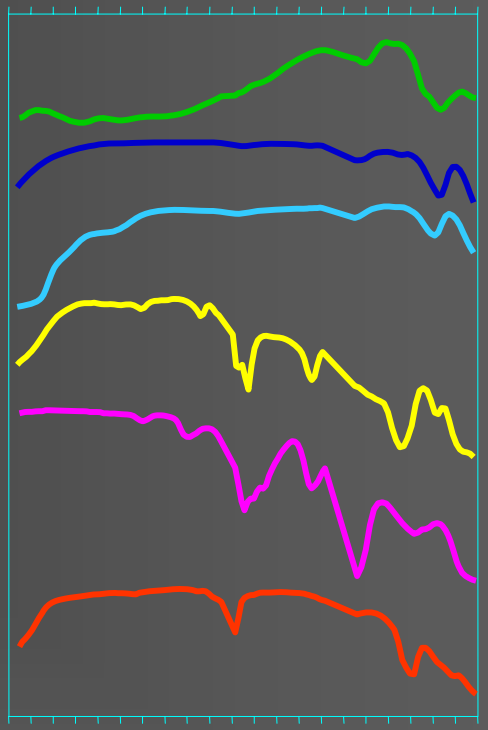


Makhtesh Ramon/Israel
color composite of bands 1, 20, 48

multispectral



hyperspectral



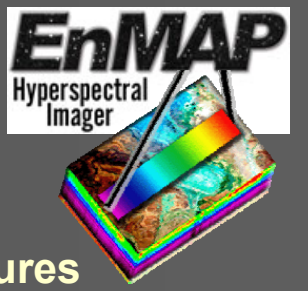
Few fixed bands

- minimum identification
- low confidence
- field knowledge and lab-analysis required

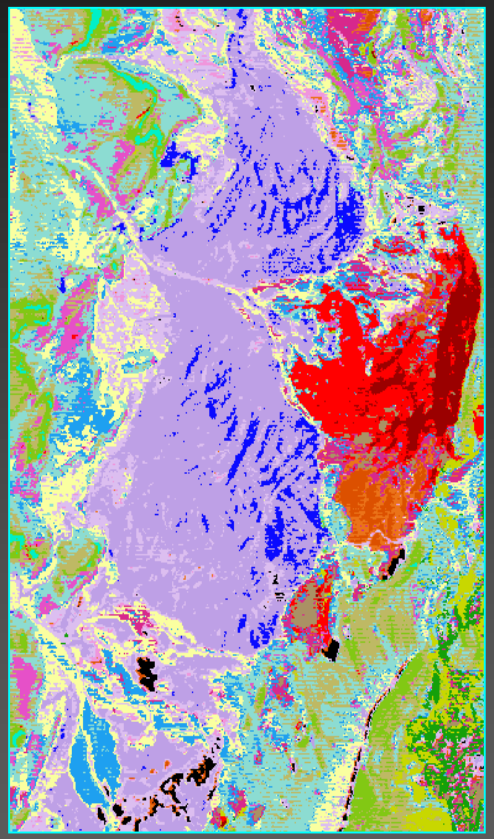
Contiguous bands

- maximum identification
- high confidence
- data base usable
- spectral unmixing

Multi- versus Hyperspectral / Identification



INDIRECT – field knowledge

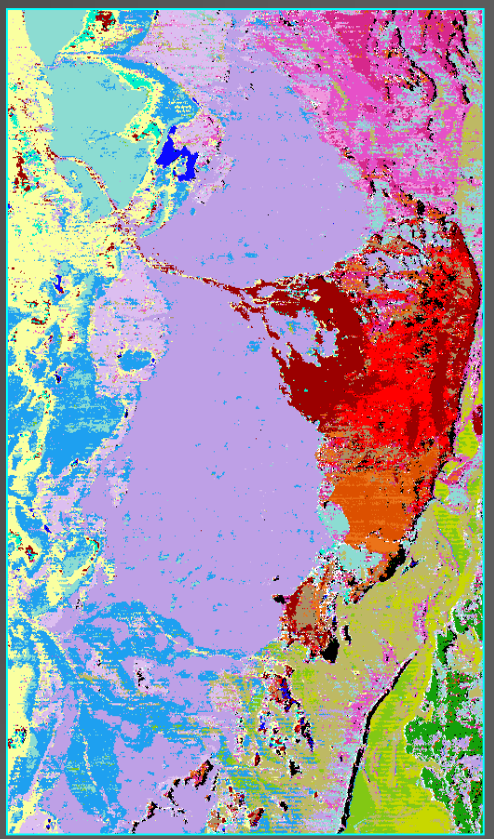


MS – 6 bands

average producer
accuracy: 71%

class 1	calcite 1
OH-indicated	kaolinite/chert 1
class 3	dolomite 1
class 4	dolomite 2
Fe-indicated	Fe-sandstone
Fe-indicated	Fe-sandstone 2
class 7	dolomite 3
OH-indicated	kaolinite 2
class 9	dolomite 4
OH-indicated	kaol./gibbsite
class 11	calcite 2
OH-indicated	gypsum
class 13	calcite 3
class 14	calcite 4
OH-indicated	illite
class 16	pyroxene
class 17	arfvedsonite
OH-indicated	chlorite
OH-indicated	kaolinite 3
Fe-indicated	K-feldspars/Fe

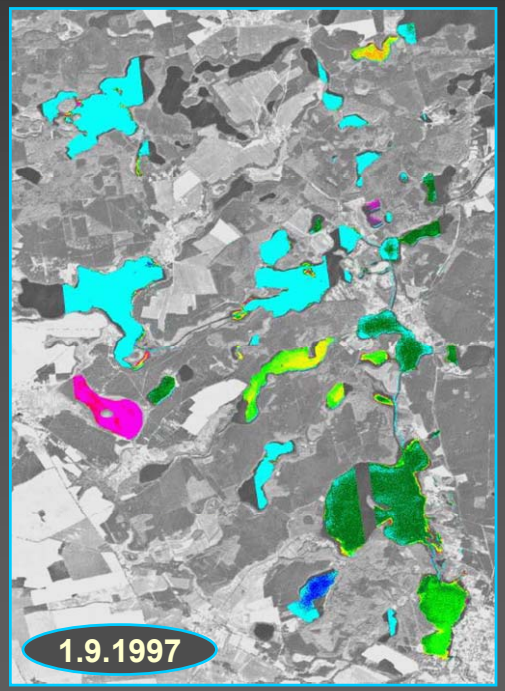
DIRECT – spectral features

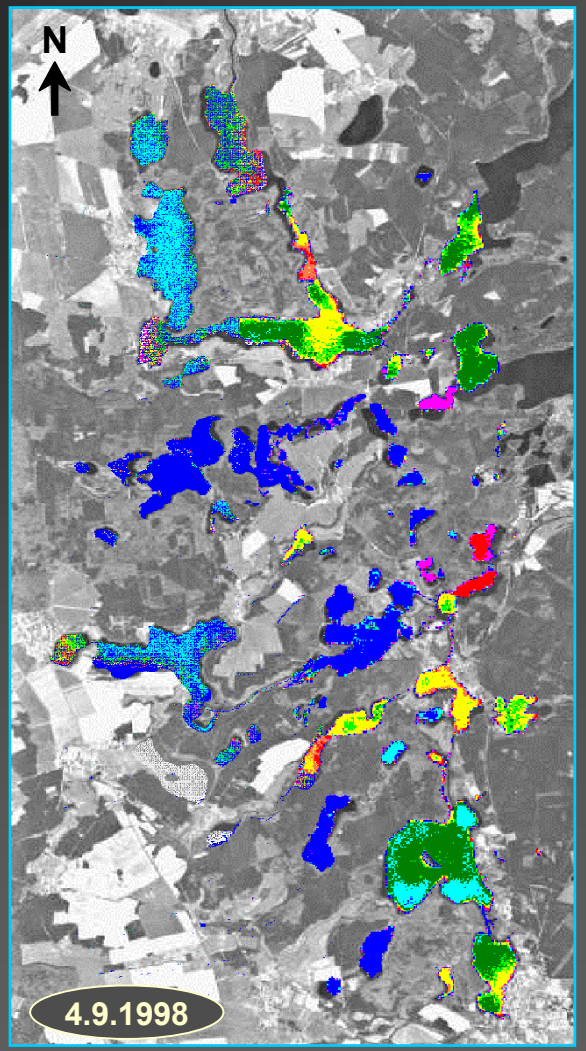


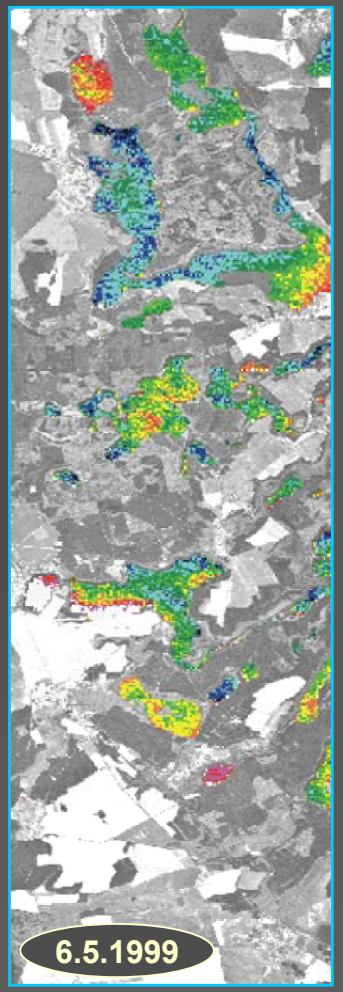
HS – 72 bands

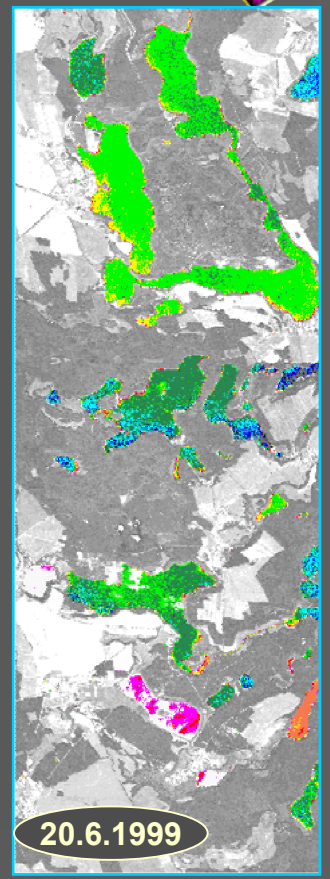
average producer
accuracy: 96%

Chlorophyll-a Derived from Airborne Data (HyMap)







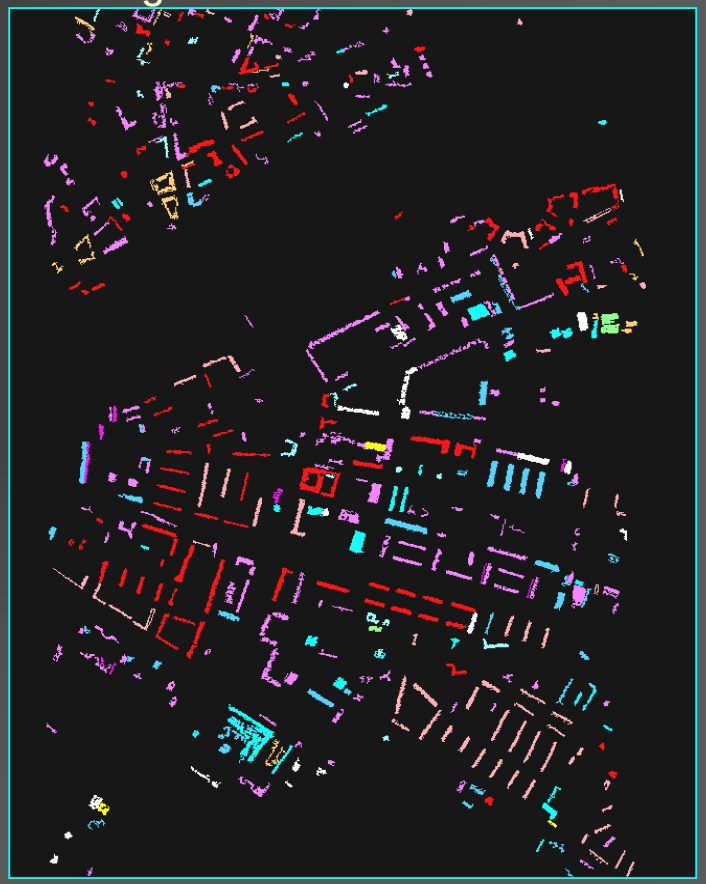


Mecklenburg Lake District

Hyperspectral Identification of Roofing Materials

HyMap RGB (14/8/3)

Roofing materials



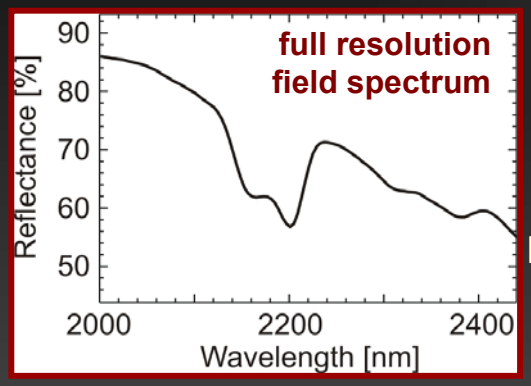
City of Dresden

N

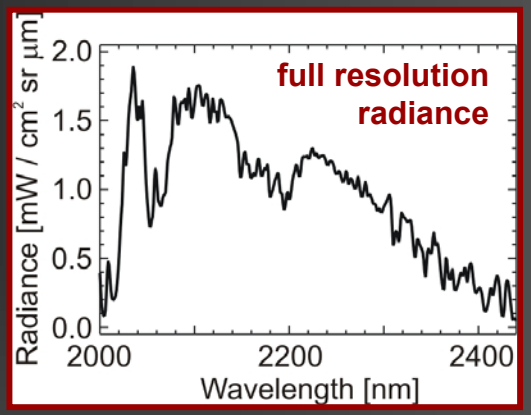
400 m

- tiles new
- tiles old
- concrete
- aluminium
- zink
- copper
- pvc
- polyethylene
- glass
- bitumen & tar-paper
- schist
- vegetation
- gravel
- facade
- other

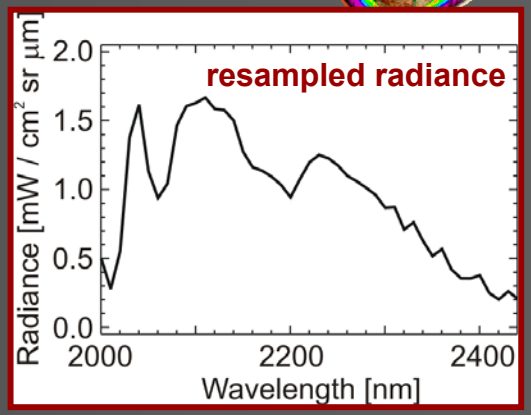
Simulations for Optimum Band Design & SNR



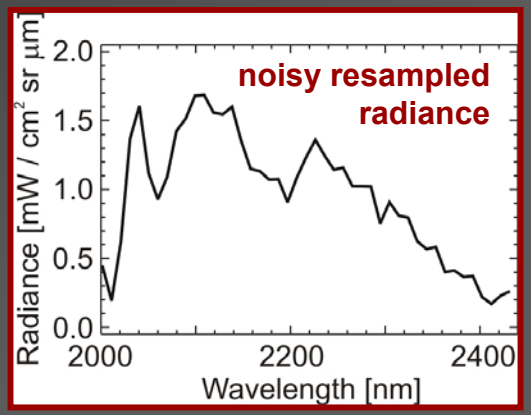
MODTRAN



Spectral
Response
Function



Noise Model



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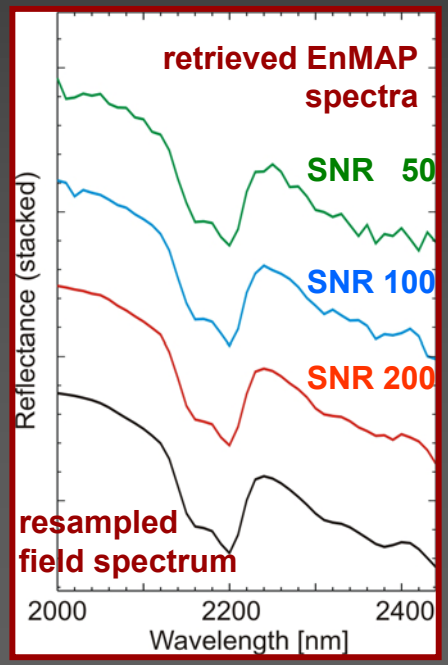


Spectral
Response
Function

EnMAP Technical Outline

Instrument Outline:

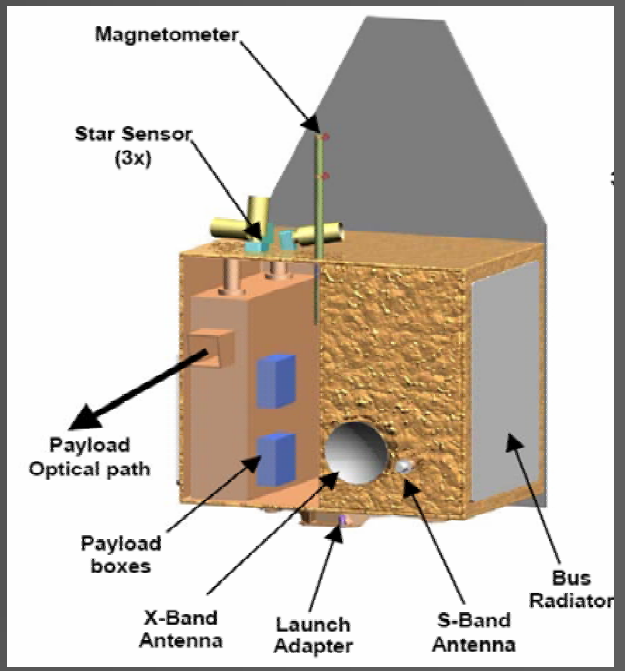
- Dedicated imaging pushbroom hyperspectral sensor mainly based on modified existing or pre-developed technology
- Broad spectral range from 420 nm to 1030 nm (VNIR) and from 950 nm to 2450 nm (SWIR) with high SNR in both spectral ranges
- High spectral resolution of 5/10 nm at SNRs >500:1 (VNIR) and >150:1 (SWIR); up to 218 channels
- Swath width 30 km at high spatial resolution of 30 m and off-nadir (30°) pointing feature for fast target revisit (4 days)
- Sufficient on-board memory to acquire 1,000 km swath length per orbit and a total of 5.000 km per day (based on one ground station)

Platform:

- EnMAP will be carried by a dedicated small satellite based on existing state-of-the art bus technology

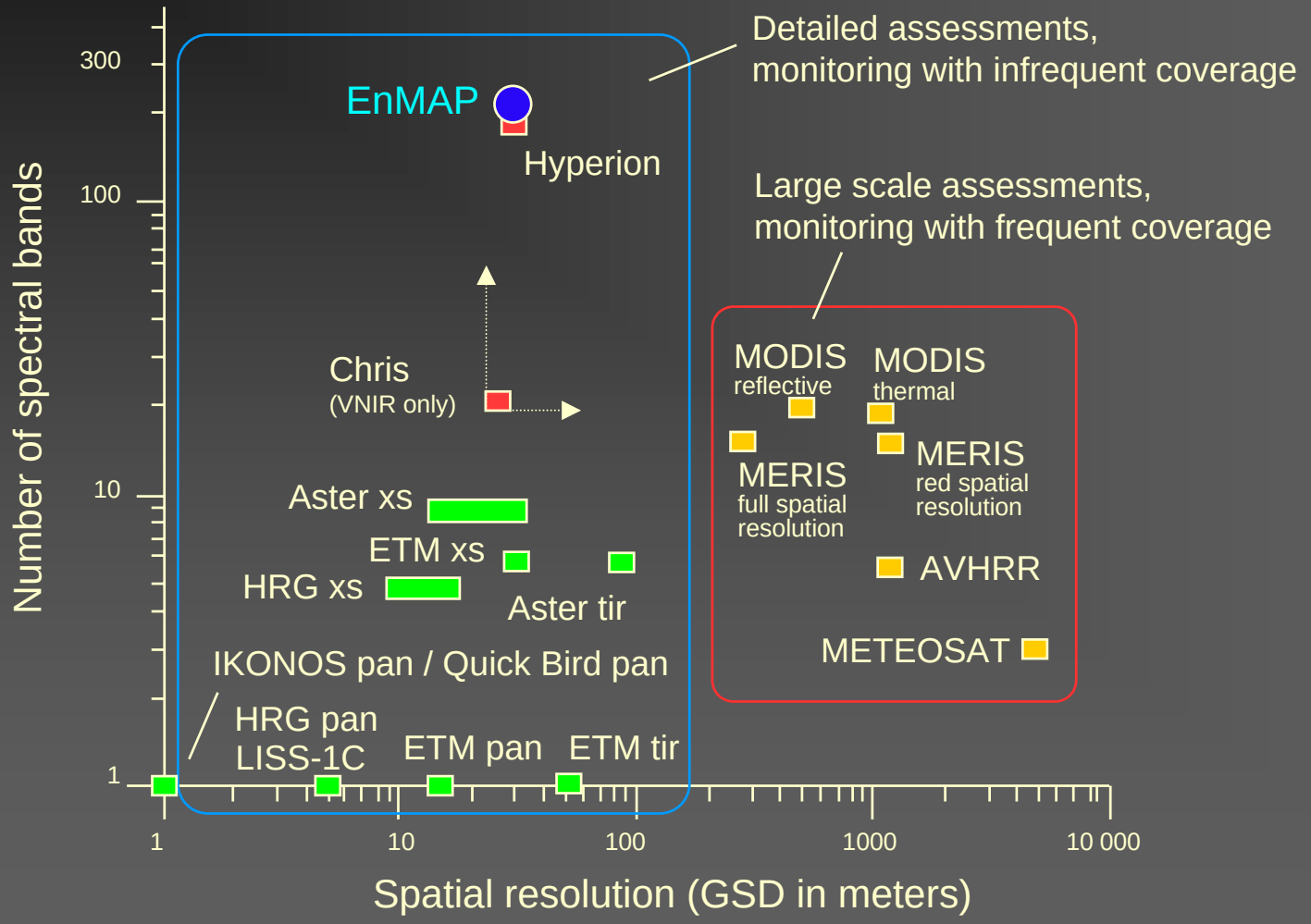
Launcher:

- DNEPR, KOSMOS, Eurockot, PSLV; all compatible to EnMAP



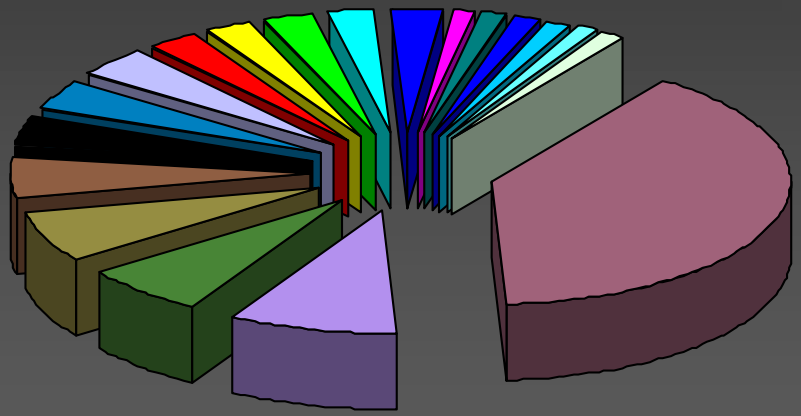
Context to present optical EO-Sensors

plot of spatial resolution versus number of spectral bands



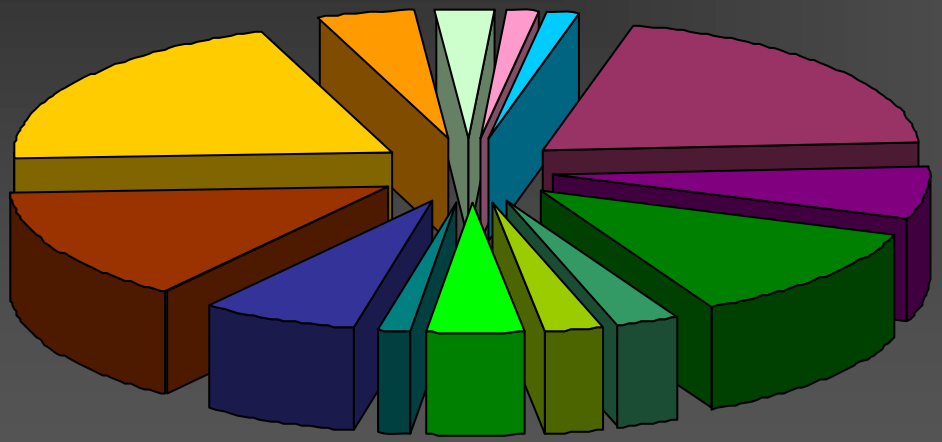
Participating Countries

At present, scientists, research institutions, governmental agencies and companies of 19 countries support the EnMAP initiative



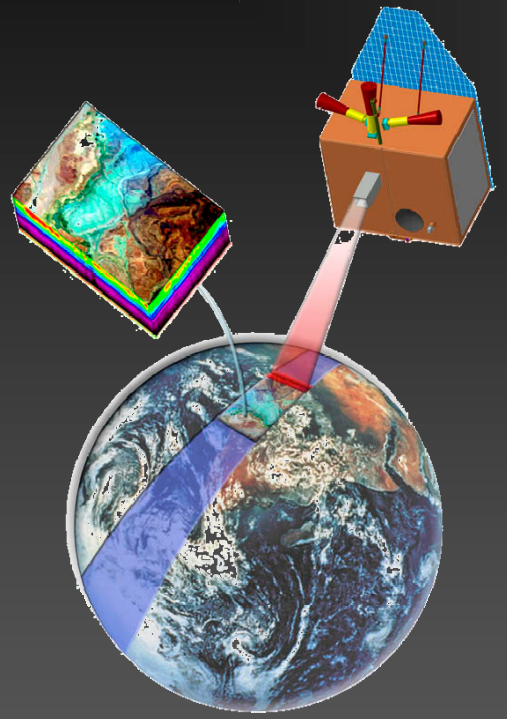
- Germany
- India
- France
- USA
- Israel
- South Africa
- Italia
- Sweden
- Hungary
- Denmark
- Canada
- Spain
- Australia
- Netherlands
- China
- Poland
- New Zealand
- Switzerland
- Finland

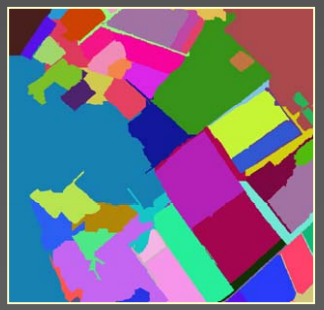
Represented Disciplines



- Agriculture/Forestry
- Biodiversity
- Ecology
- Wetlands
- Climate Change
- Water
- Soils/Landdegradation
- Geology/Mineralogy
- Arid Zones
- Cartography
- Urban
- Fisheries
- Meth. Development
- Cal./Val.

Science Program

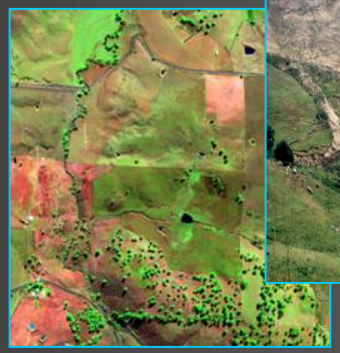




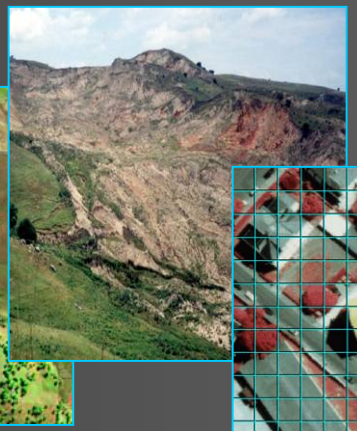
parameter extraction and modeling

Co-operative International Network

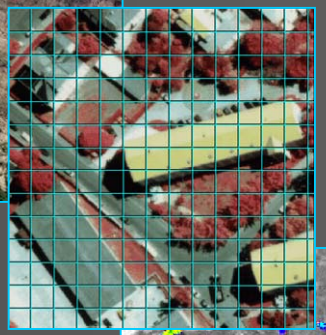
management of agricultural and forest ecosystems



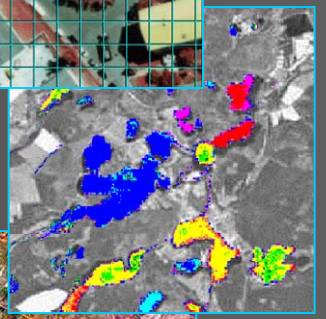
hazard assessment



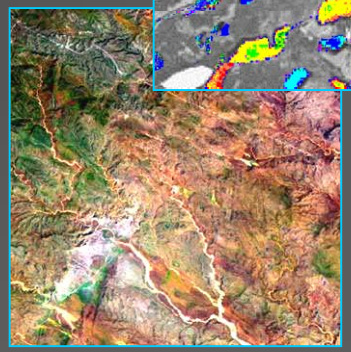
urban develop-ment



inland water



dry-land degradation

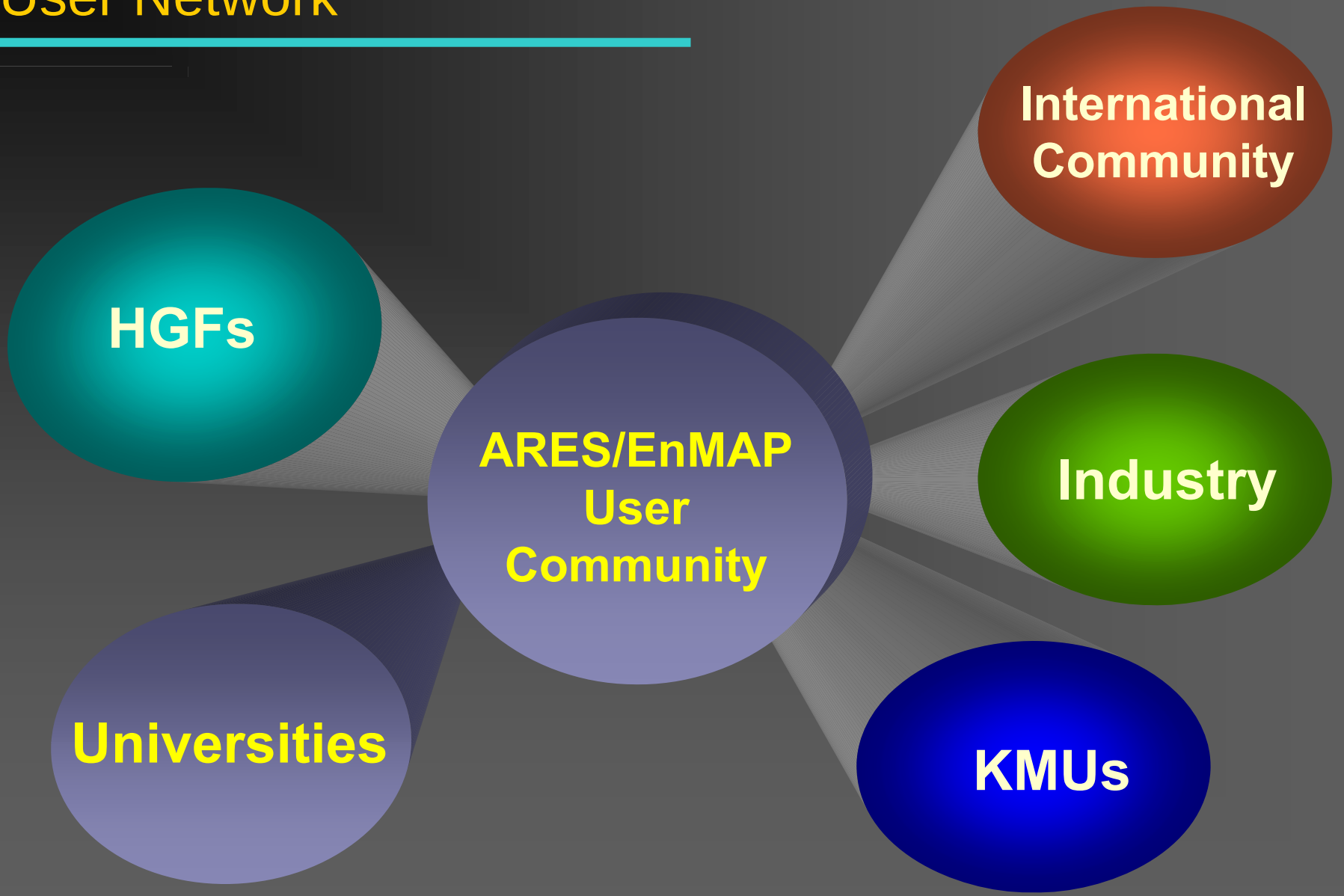


ARES - System Parameters (Design Specs)

- Scan Principle — Whisk-Broom
- FOV — 65°
- IFOV — 2.0 mrad
- Oversampling — 1.43
- Ground Sampling Distance — 2.5 -10 m
- No. of Pixel — 813
- No. of Bands — 151 (121+30)
- Rad. Resolution — 14 bit
- Co-Registration (refl.) — < 0.05 pixel
- Co-Registration (em.) — < 0.05 pixel
- Co-Registration (refl. - em.) — < 0.1 pixel

Wavelengths	No. of Bands	Spec. Sampl. Interval	Band-Width (FWHM)	Rad. Requirements [W m^{-2} sr^{-1} μm^{-1}]
470 - 890 nm	32	15-13 nm	15-13 nm	0.09 NER
890 - 1350 nm	29	18-16 nm	16-14 nm	0.04 NER
1360 - 1800 nm	30	16-14 nm	14-13 nm	0.03 NER
2020 - 2420 nm	30	15-13 nm	14-12 nm	0.02 NER
8.1 - 12.1 µm	30	147-131 nm	130-117 nm	0.1-0.3K NEΔT

User Network



Funding Possibilities