

# MERIS US Workshop

## 14 July 2008

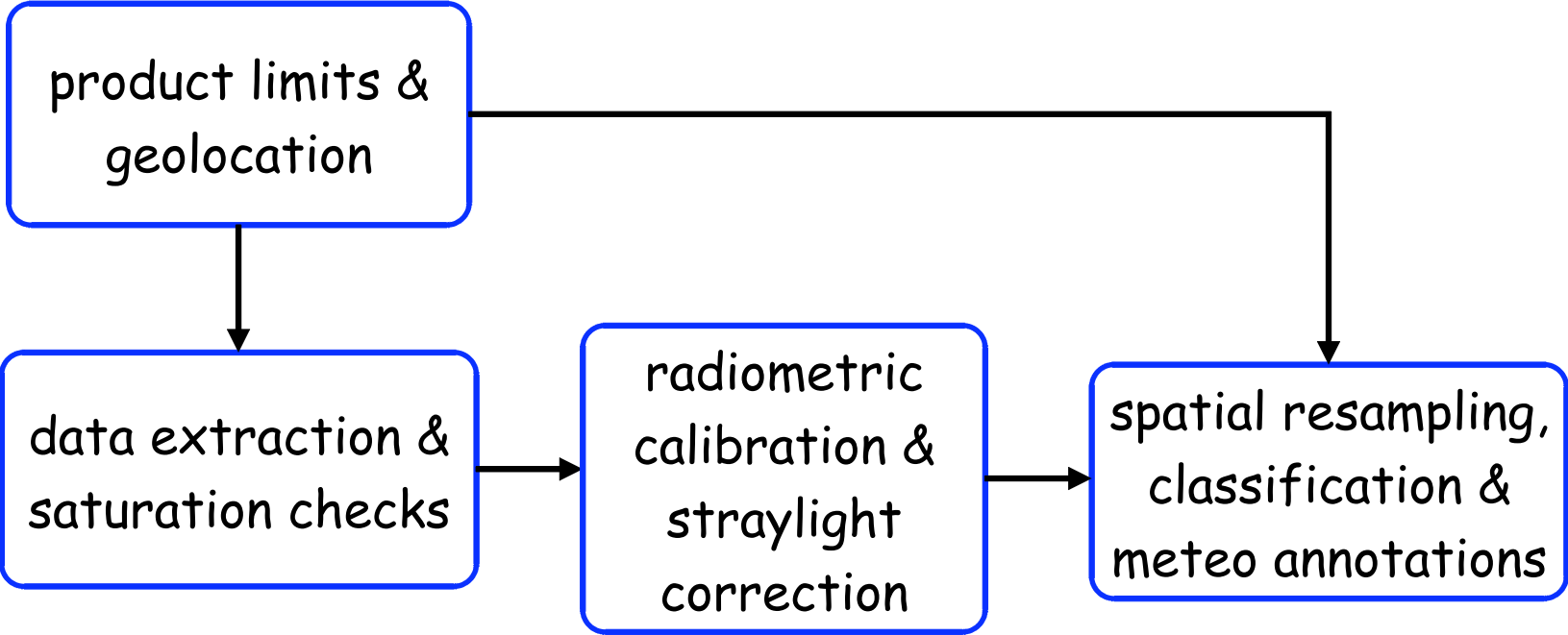
MERIS Level 1b processing

Ludovic Bourg

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## Functional Breakdown

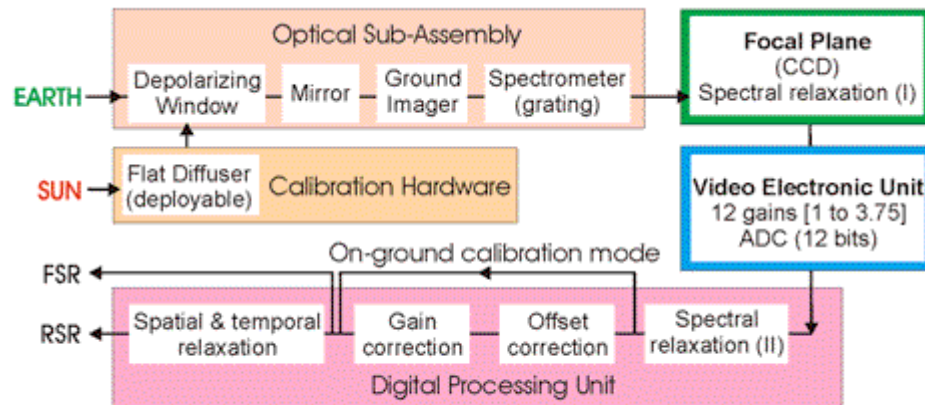


## Data Extraction & Saturation Checks

- data is extracted from L0 according to products limits computations
- time continuity is checked, overlaps removed and gaps filled (if any)
- each sample is checked for saturation and flagged

## Radiometric Model

$$X_{b,k,m,f} = \text{NonLin}_{b,m} \left[ g(T_f^{\text{VEU}}) \cdot \left[ A_{b,k,m} \cdot (L_{b,k,m,f} + \text{SL}_{b,k,m}(L_{*,*,m,f})) \right] + \text{Sm}_{b,k,m,f}(L_{b,k,m,*}) + g_c(T_f^{\text{CCD}}) \cdot C_{b,k,m} \right] + \epsilon$$



FSR = Full Spatial Resolution data [260 m x 300 m at nadir]  
 RSR = Reduced Spatial Resolution data [1040 m x 1200 m at nadir]

- L: incoming radiance
- X: raw counts
- b,k,m,f: band, pixel, camera, frame
- A: instrument gain
- C: dark signal
- Sm: smearing effect
- SL: stray-light (within spectrometer)
- g, g<sub>c</sub>: temperature dependency of gain and dark signal
- NonLin: non-linearity

## Radiometric Calibration

Invert radiometric model using:

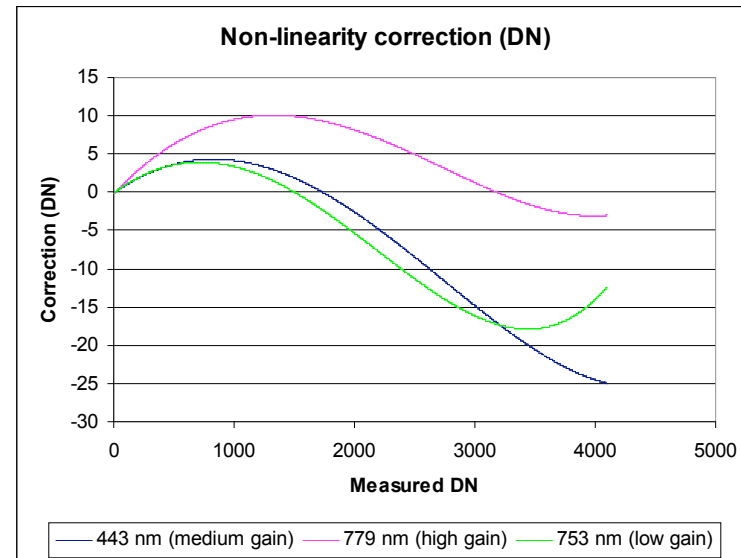
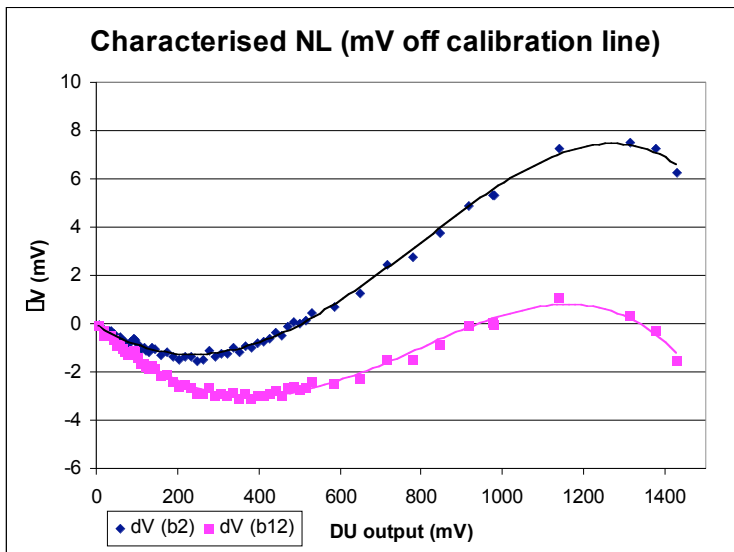
- $S_m$  from dedicated virtual band
- NonLin from on-ground characterisation
- C & A from on-board measurements
- $g, g_c$  from on-ground characterisation

Provides

$$L_{b,k,m,f} + SL_{b,k,m}(L_{*,*,m,f})$$

## Non-linearity look-up tables

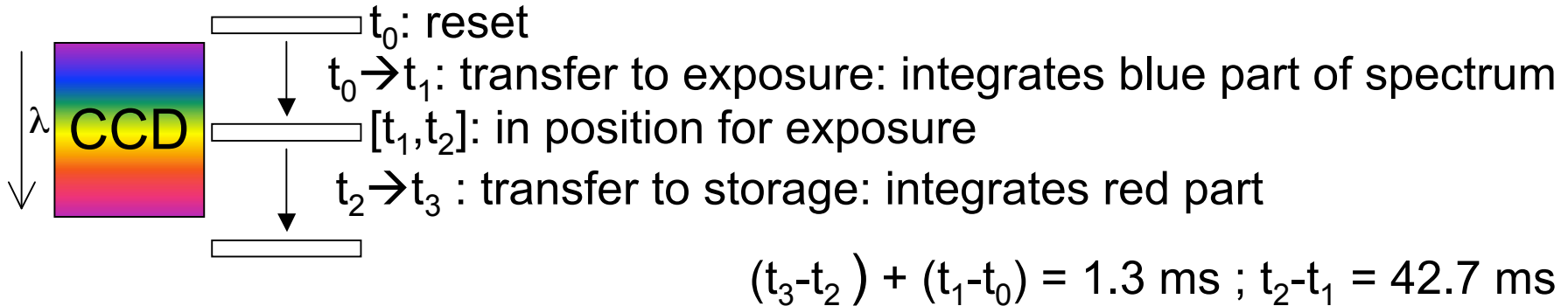
- Non-linearity is significant at CCD output
- It has been characterized as  $V=f(E)$
- Converted into  $dV=g(V)$  using calibration line drawn between null illumination and the calibration point (on-orbit data) and modeled
- Scaled to counts using actual gain and band settings



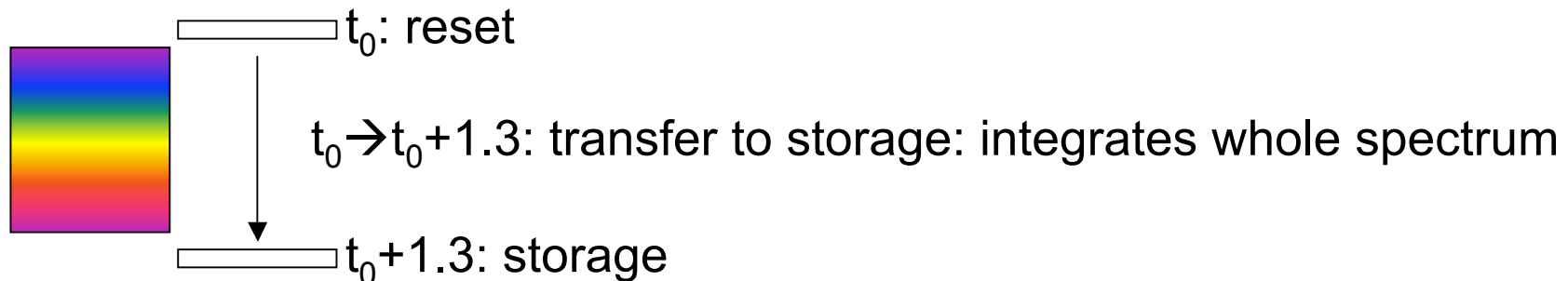
## Smearing effect

- Smearing : continuous sensing during charges transfer between CCD image (exposed) to storage (masked) zones.

Actual channel:



Virtual smear channel:





# Smearing effect and correction

## Acquisition timeline:

- The virtual smear band integrates spectra acquired at  $\sim t_1$
- Each actual channel of wavelength  $\lambda$  integrates during transfer:
  - From UV to  $\lambda$  at  $\sim t_1$  (start of exp.)
  - From  $\lambda$  to NIR at  $\sim t_2$  (end of exp.)
- The (next) virtual smear band integrates spectra acquired at  $\sim t_2$

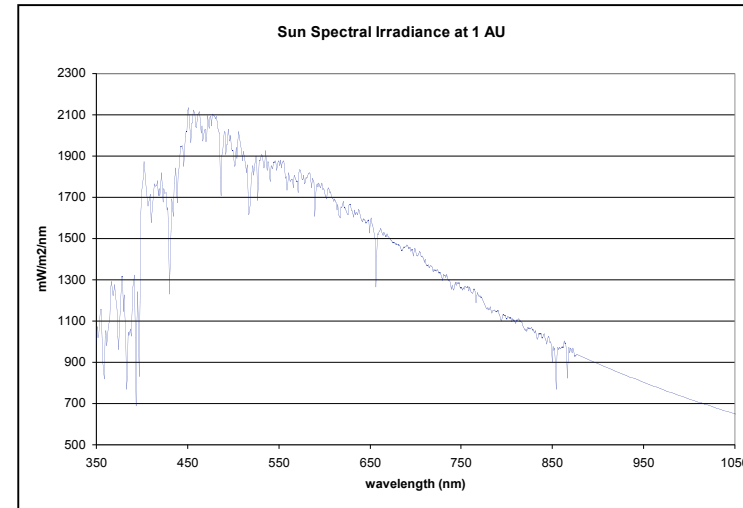
## Correction scheme:

- Each actual channel is corrected by a weighted average of smear channel values at  $t_1$  and  $t_2$ , weights being derived according to channel wavelength:

$$Sm(b, t_1) = \frac{X_{Sm}(t_1) \cdot (\lambda_b - 390) + X_{Sm}(t_2) \cdot (1040 - \lambda_b)}{1040 - 390}$$

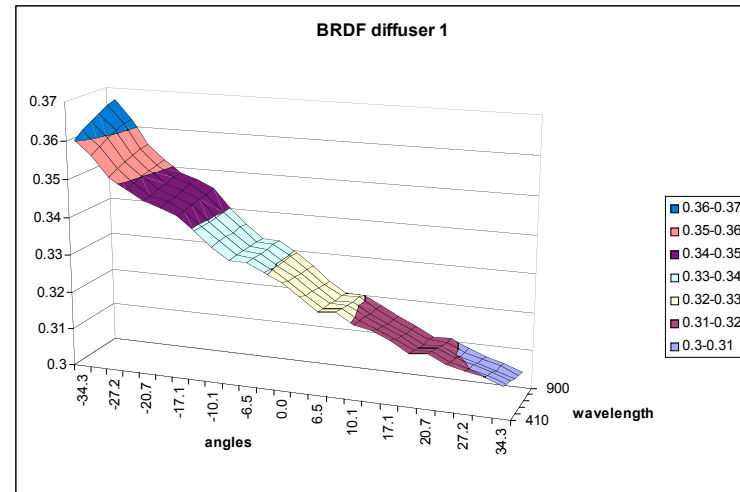
Instrument gain includes:

- **Solar Irradiance model**
- Absolute characterization of reference diffuser reflectivity (on-ground)
- Instrument spectral model from on-ground + on-orbit spectral characterization
- On-board diffuser measurements



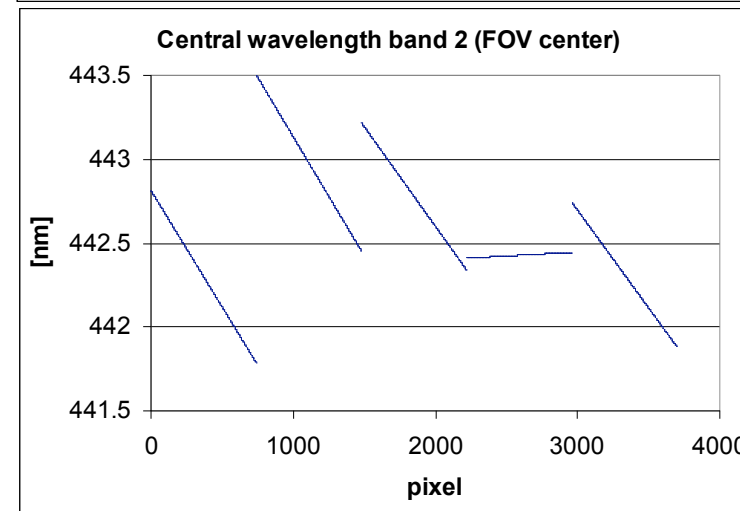
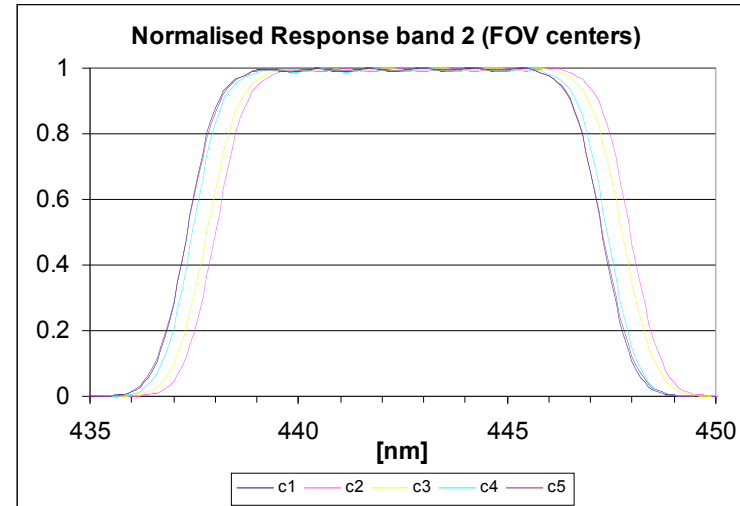
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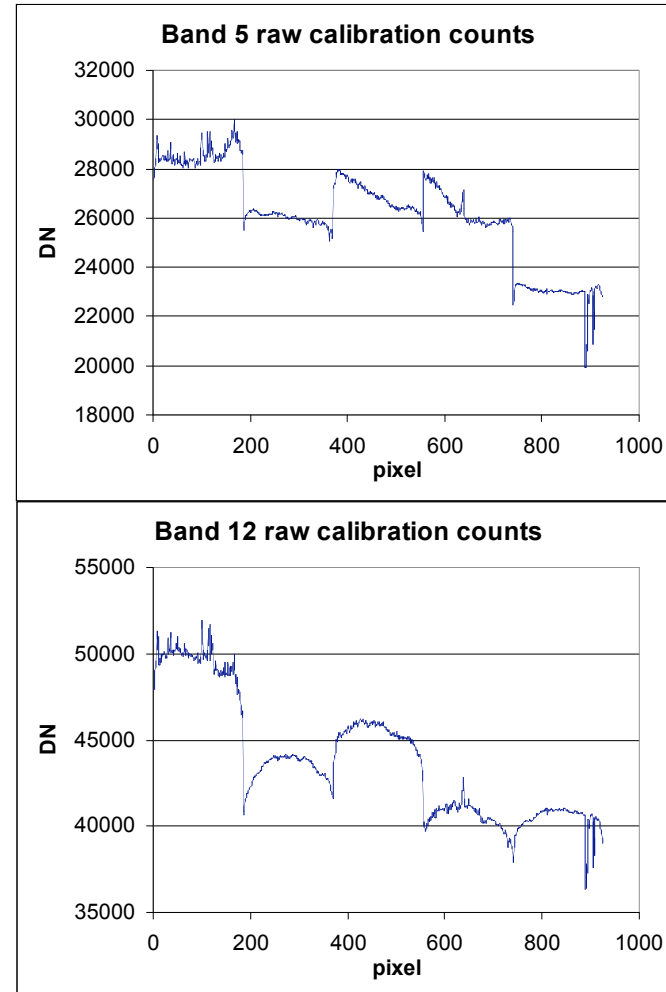
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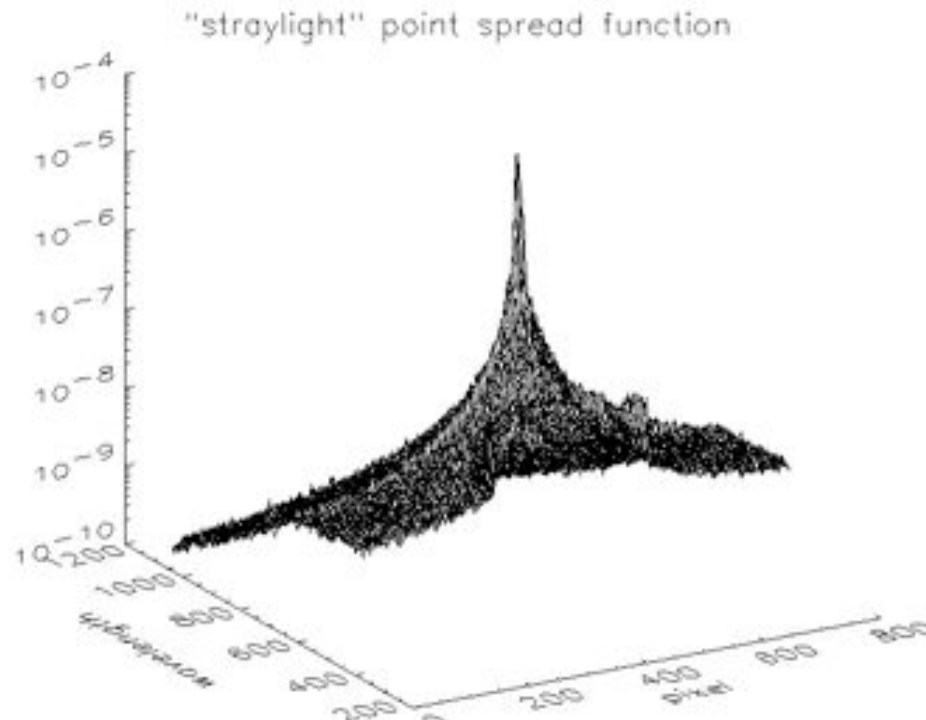
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## Straylight Correction

- Source is scattering & reflection within spectrometer
- Small contribution → can be estimated from degraded signal
- Can be modelled as a point spread function → convolutive process
- Correction using modelled PSF and approximate deconvolution



## Product Grid and Geolocation

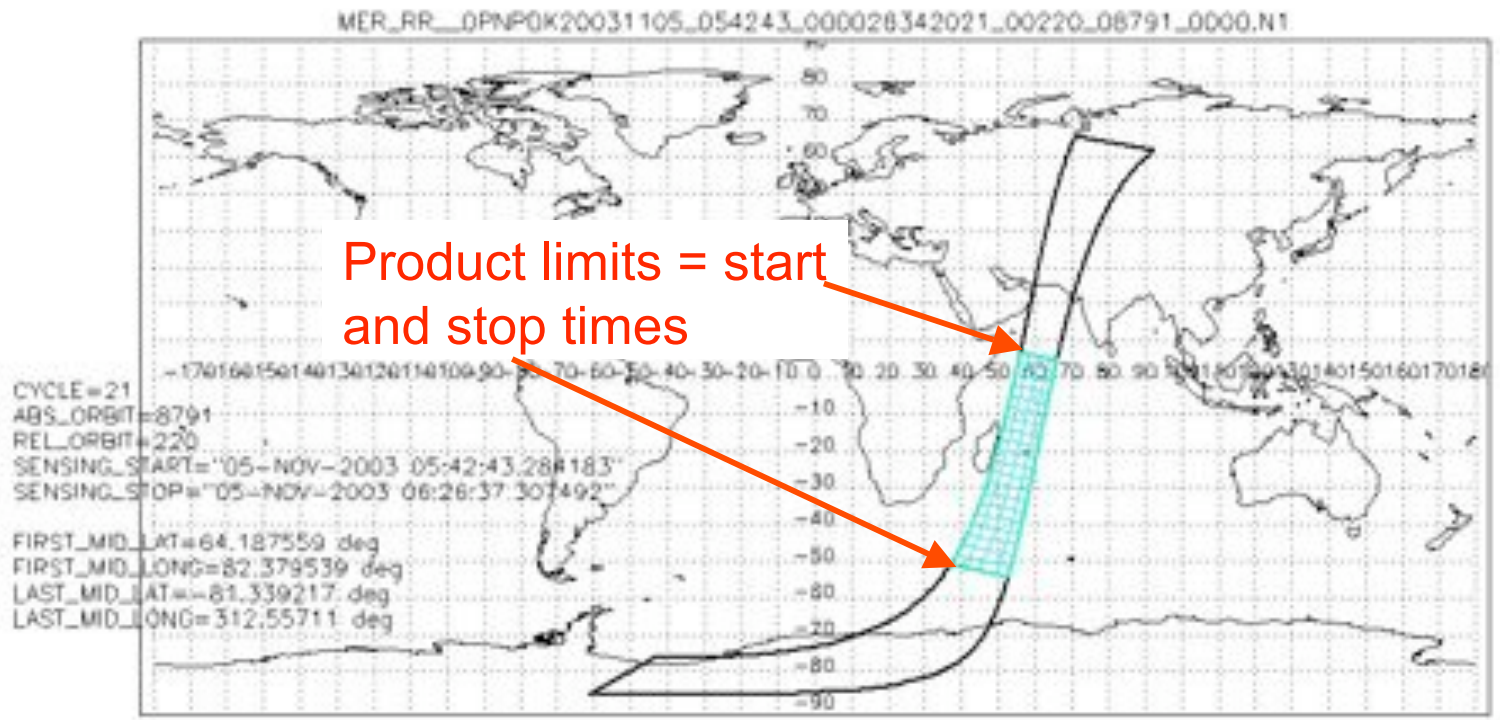
### Product grid definition: re-built “ideal instrument” swath

- Across-track: perfectly aligned cameras along  $\perp$  to track, inter-camera overlaps removed, regular on-ground distance sampling (geodesic at WGS-84 ellipsoid surface)
- Along-track: instrument time sampling, gives quasi-regular distance

### Geo-location:

- At **Tie Points**: every 16 pixels in RR, 64 in FR, in both directions (17 x 19 km)
- Geo-location (longitude, geodetic latitude) at ellipsoid surface (WGS-84)
- Altitude and its variability ( $h$ ,  $\sigma_h$  from GTOPO-05/GTOPO-30)
- Illumination and observation geometry: SZA, SAA, VZA, VAA
- Approximate parallax correction provided over land

# Product limits: RR & FR segments

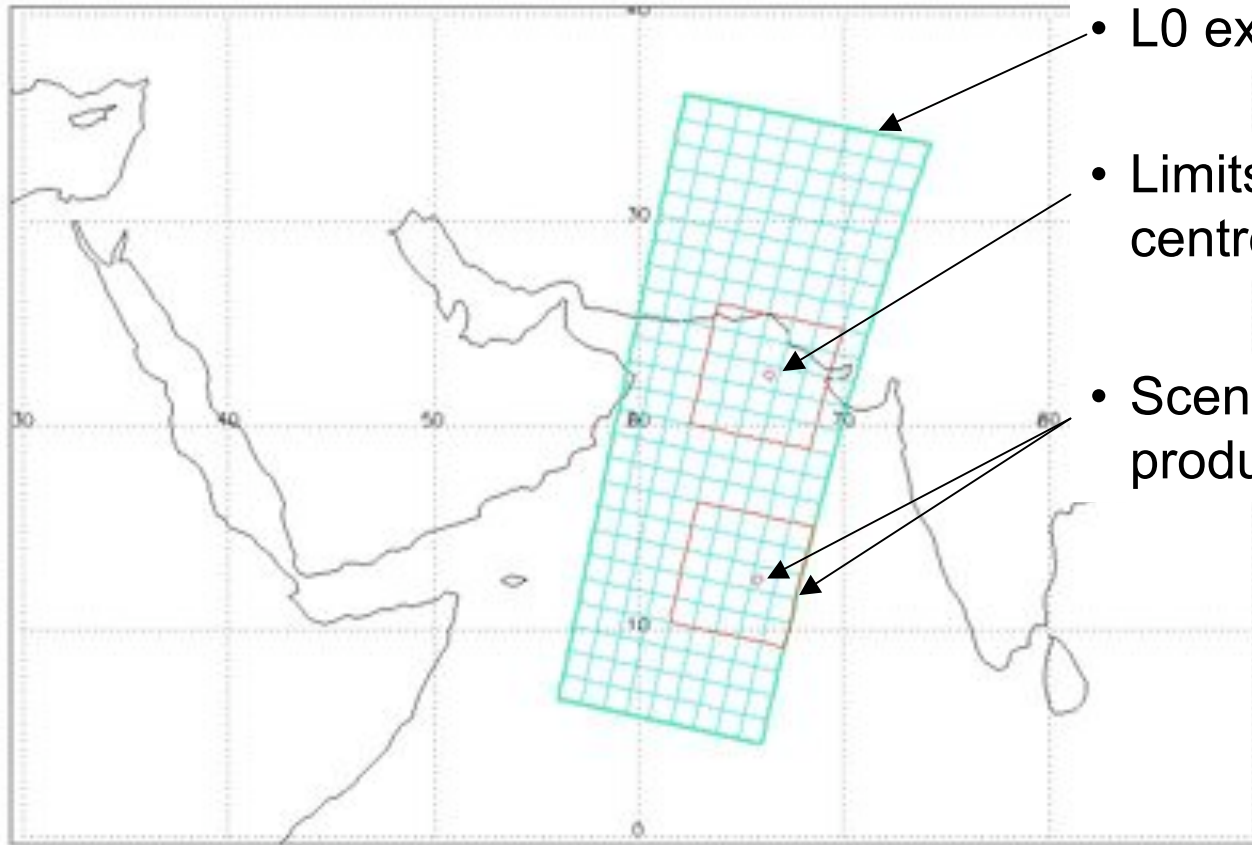


MER\_RR\_1/2P

MER\_FRS\_1/2P



## Product limits: ED Scene

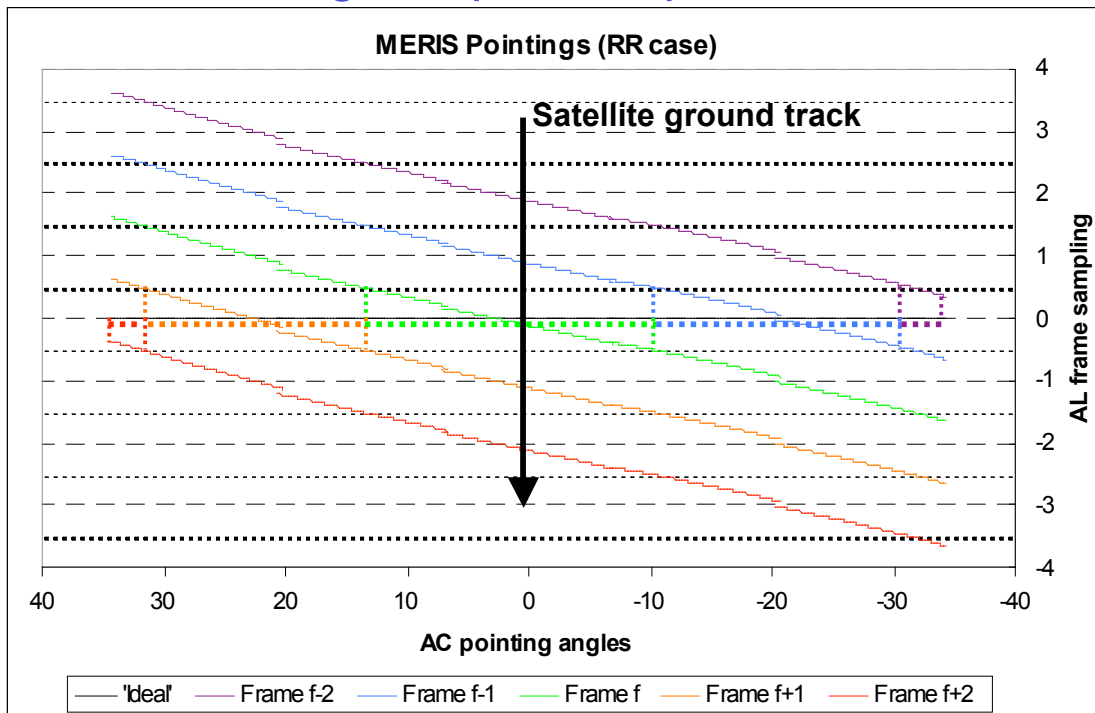


- L0 extent defines TP grid
- Limits based on scene centre but fits TP grid
- Scene remains within product

MER\_FR\_1/2P

## Spatial Re-sampling

- Re-builds ideal swath from actual MERIS FOV: slightly misaligned plane + inter-camera dispersion (see figure)
- Keep instrument measurements: nearest neighbour
- To fill-in a given product pixel:



- Across-track: detector column selected comparing across-track pointing angles
- Along-track: frame offset determined from known de-pointing of selected column

## Pixels Classification

- **Land/water** and **coastline** based on an atlas
- **Bright** based on radiometry (geometry dependant threshold on reflectance at 443 nm)
- **Glint risk** based on angular distance to Sun specular reflection direction
- **Invalid** when no data available (out of swath, gap, all bands saturated)

## Meteo Annotations

Are added to geolocation annotations:

- u & v wind components at 10 m
- mean sea level pressure
- Relative humidity at 1000 hPa
- Total column ozone

Interpolated at TP location from ECMWF data  
(1x1 degree regular grid)

## Level 1b product summary

- Calibrated in-band radiances at 1x1.2 km (0.25x0.3 in FR)
  - ① At actual instrument wavelength: no "smile" correction
- 1121 pixel wide (1300 km) wide, up to 15000 pixels long (2241x2241 pixels or 560x670 km for FR scenes, 4481 pixels wide, up to 12800 long for FR segment)
- Classification and quality flags provided at each pixel
- Detector index provided at each pixel
- Geolocation and meteo provided on a 16x16 sub-grid (64x64 sub-grid in FR)

# Accurate geo-referencing for MERIS

- Land community expressed concerns about geo-location accuracy
- A specific post-processing tool was developed to respond to this need: **AMORGOS**, that adds to MERIS FR per pixel geo-location accounting for Earth surface elevation
- Inclusion in operational processing is considered

