

Instantaneous Field of View and Along-track Pixel Size in pushbroom hyperspectral cameras

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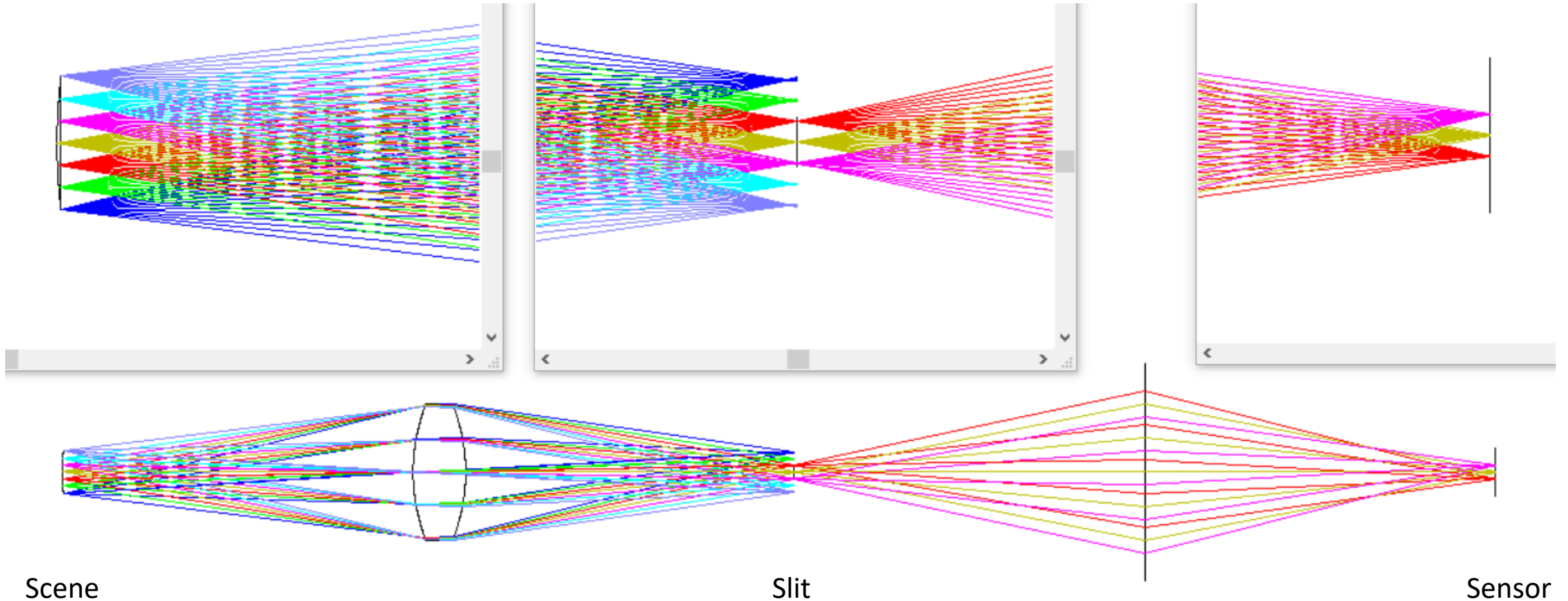
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The current standard draft

The current version of the standard says that, for a pushbroom camera, the projection of the slit width onto the scene is the instantaneous field of view (iFOV), and that the projection of the slit width:

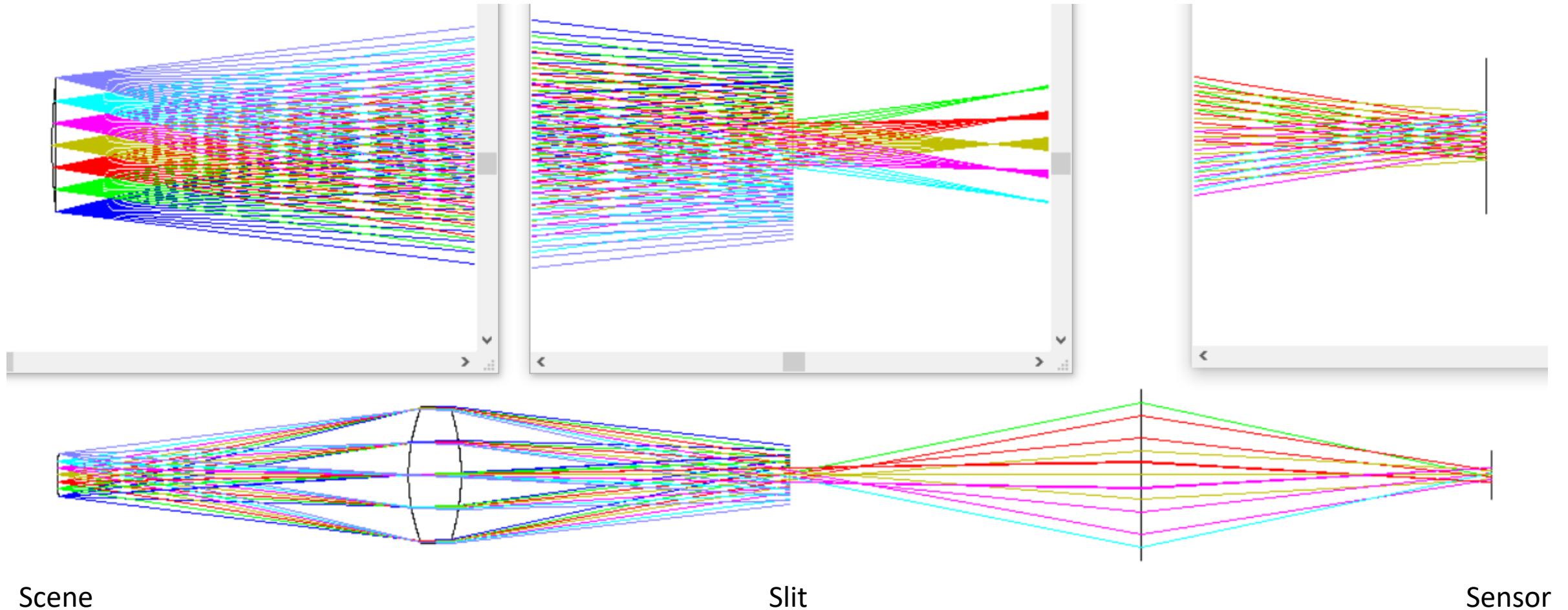
1. Directly affects the amount of light that the camera sensor receives, Correct
2. Is equal to the width of the area that the camera sees in the along track direction at a given moment in time, Incorrect
3. Is equal to the pixel size in the along track direction. Incorrect

2. IFOV (perfect foreoptics)



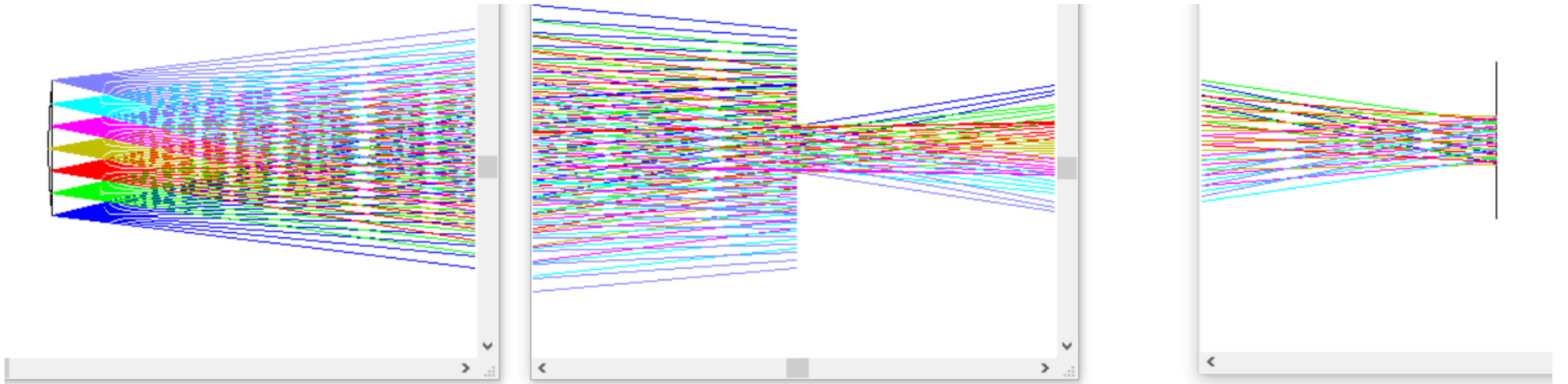
Light from 3 scene objects reaches the sensor pixel. The rest of the scene is blocked by the slit.

2. IFOV (blurry foreoptics)



Light from 5 scene objects reaches the sensor pixel. The rest of the scene is blocked by the slit.

2. IFOV (very blurry foreoptics)



Scene

Slit

Sensor

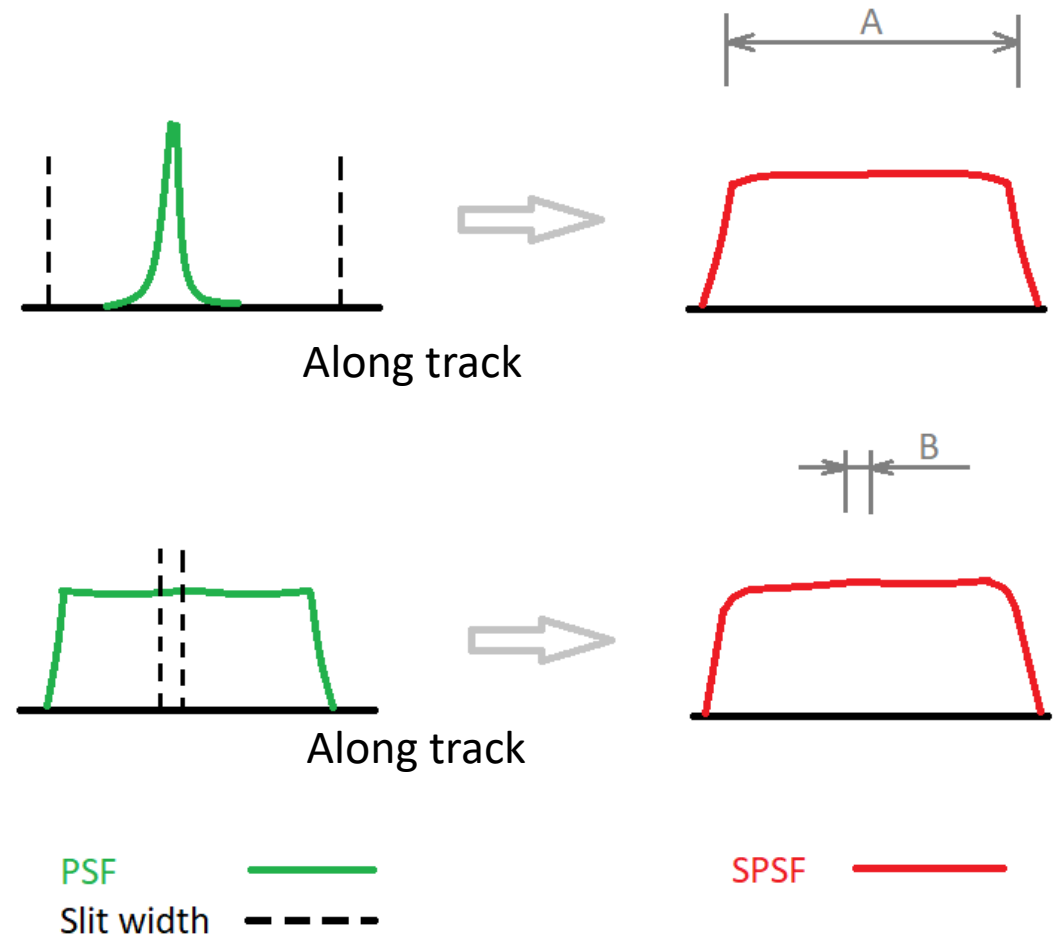
The slit now partially blocks the light from all 7 objects. This is why the radiometry is still correct despite significantly wider iFOV.

Light from all 7 scene objects reaches the sensor pixel. The rest of the scene is blocked by the slit (not shown).

2. IFOV (very different slit widths but the same along track SPSF)

Here another example why it is incorrect to use the slit width as the definition of IFOV in the along track direction. These are two cameras with very different slit widths but the same along track SPSF.

Note that the along track SPSF defines how large area of the scene is visible to the camera in the along track direction, i.e., SPSF FWHM is IFOV in the along track direction.

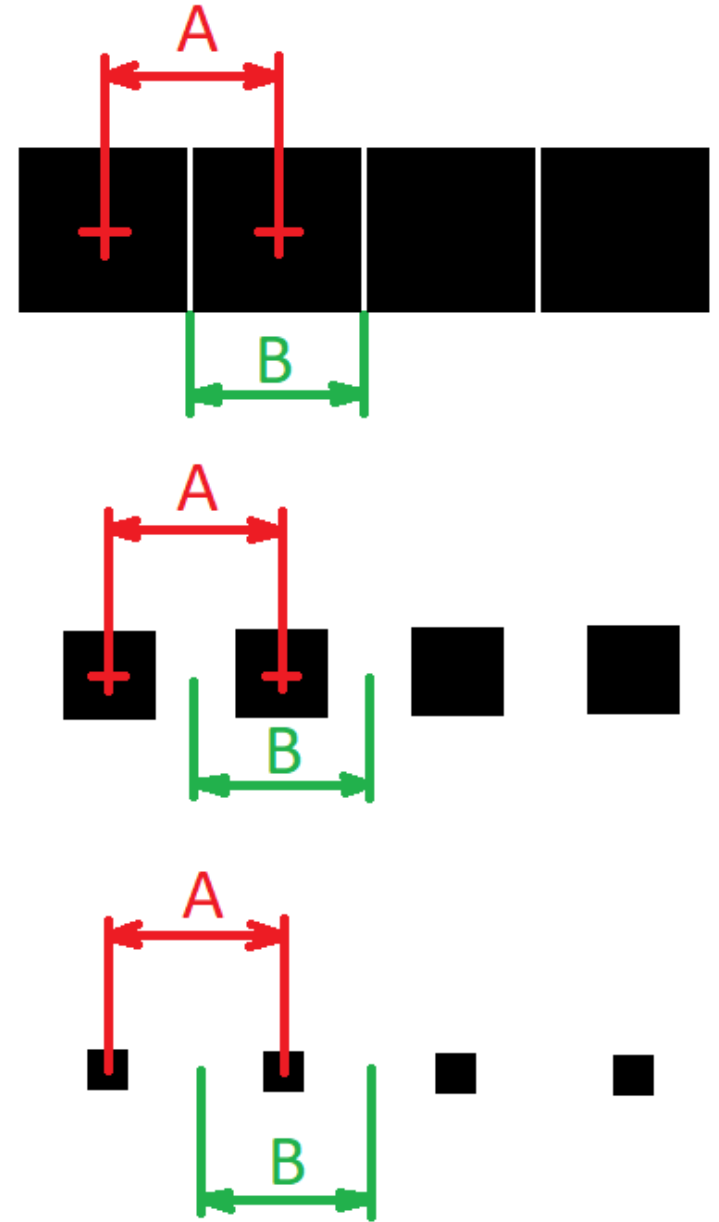


2. IFOV (conclusion)

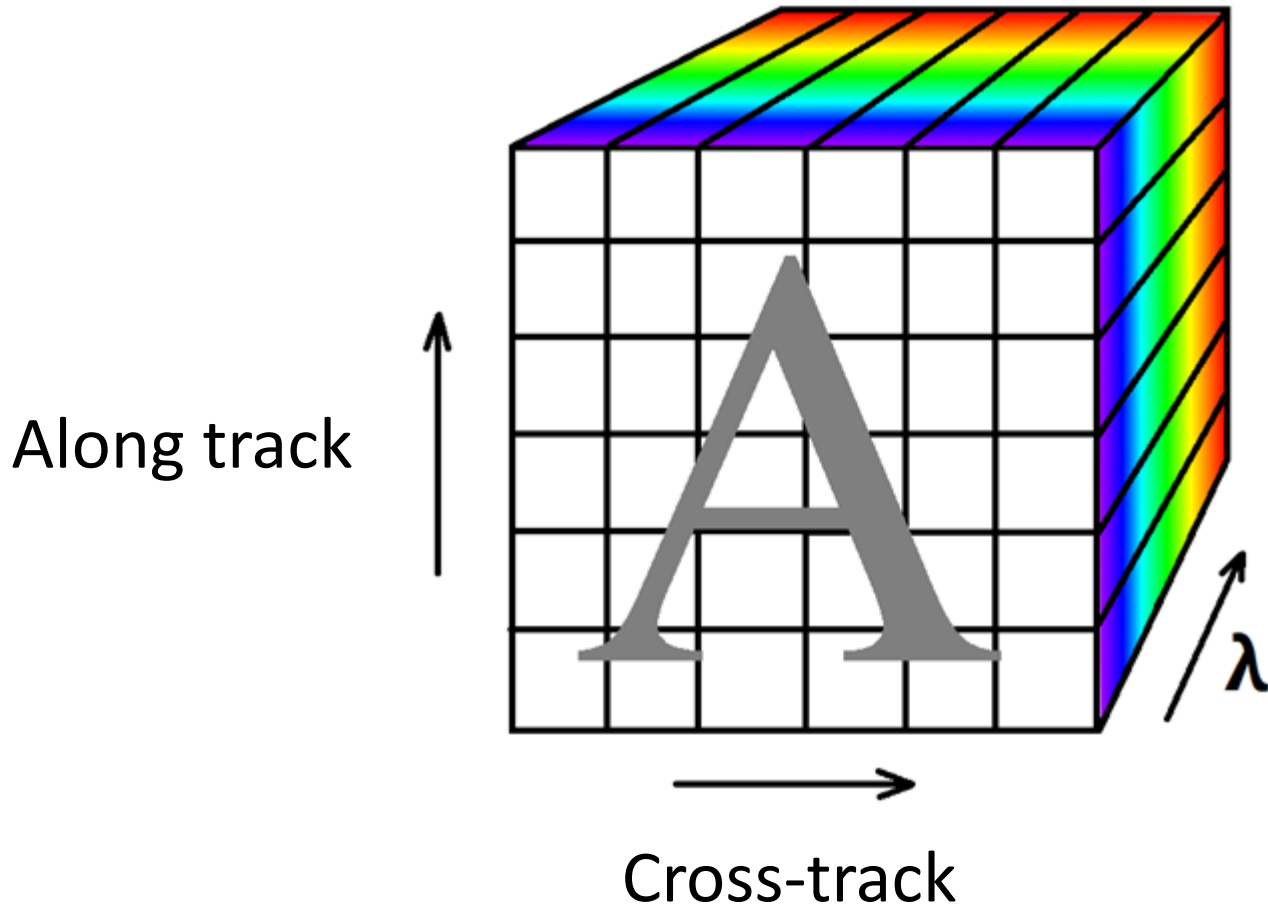
- IFOV is determined by the SPSF width in the along track direction
- Since the SPSF is what a pixel “sees” on the scene, SPSF is IFOV by definition

3. Pixel size

The current version of the standard defines cross-track pixel size B from pixel pitch A. This is a good assumption. Here is an illustration how this assumption works in the cross-track direction for different fill-factors.

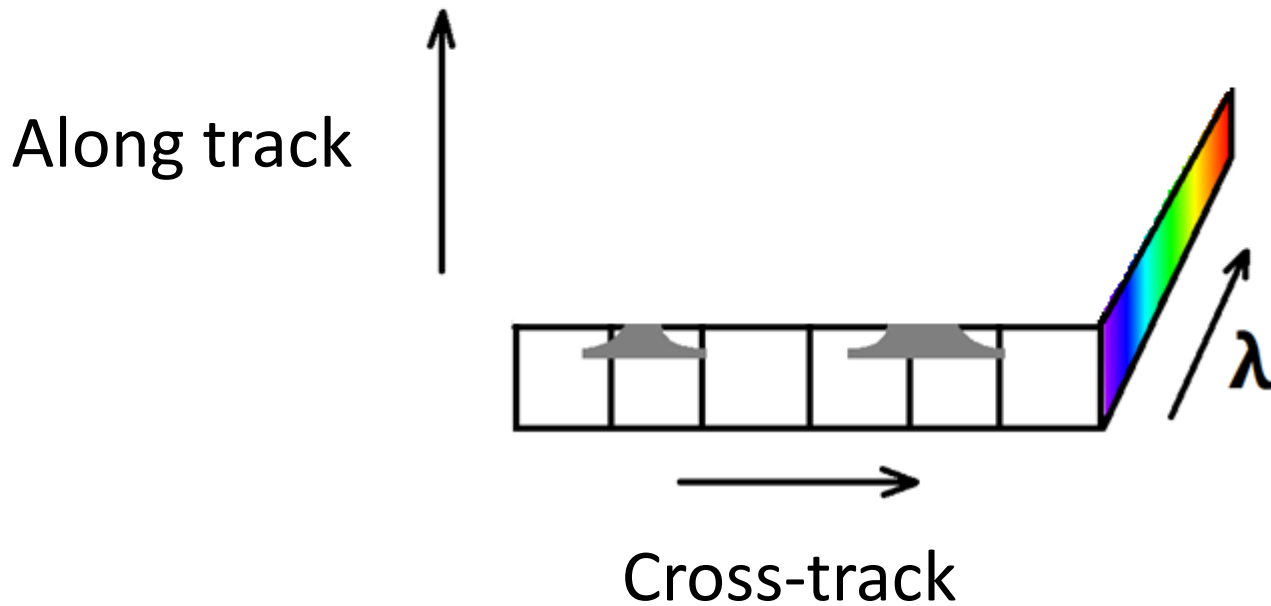


3. Pixel size



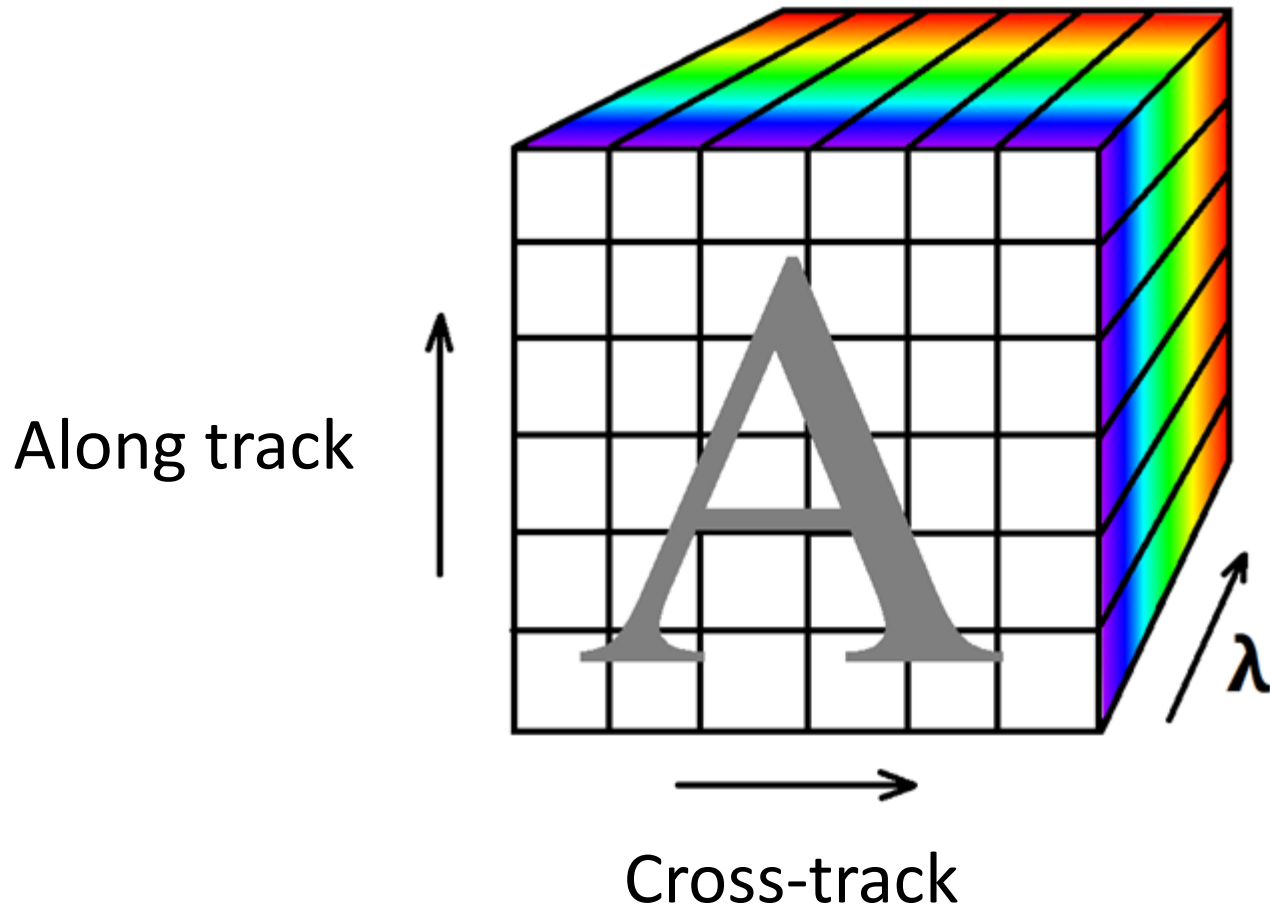
- For a single frame, pixel pitch in the along track direction is undefined

3. Pixel size



- For a single frame, pixel pitch in the along track direction is undefined
- This is the reality
- Most users prefer (even expect) square pixels in the datacube
- There are special cases when a camera is designed to output non-square pixels

3. Pixel size (proposal for the standard)



- For a single frame, pixel pitch in the along track direction is undefined
- When quantifying spatial specs (SPSF FWHM), pixel size in the along track direction is assumed to be the same as in the cross-track direction,
- ...unless explicitly specified otherwise by the camera manufacturer.

Proposed changes to the draft

1. iFOV for radiometry is determined by the projection of the slit width onto the scene
 - This is the same as in the current version of the standard
 - The term iFOV for radiometry should be changed to something else
2. iFOV for spatial (what objects are visible to the camera at a given moment in time) is determined by SPSF FWHM in the along track direction.
3. For a single frame, pixel size in the along track direction is undefined. When quantifying spatial specifications of a camera (SPSF FWHM), pixel size in the along track direction is assumed to be the same as in the cross-track direction,
 - ...unless explicitly specified otherwise by the camera manufacturer.

Benefits

- Slit width, being a design parameter that may be just a minor contributor to the along track IFOV, no longer defines pixel size in the camera specs. This allows the designer to optimize the slit width for the optimum combination of light throughput, spatial resolution, and spectral resolution – without affecting the formal “pixel size” specification on the camera’s spec sheet.
- For spatial IFOV, the literal meaning of the term now corresponds to what the term attempts to define: (spatial) instantaneous field of view is what camera sees in the along track direction at a given moment in time.
- Some discrepancies in specifications between pushbroom and other camera types are removed.
- Some discrepancies between the pixel size definitions for along- and cross-track directions are removed.