Report 04/23/2020

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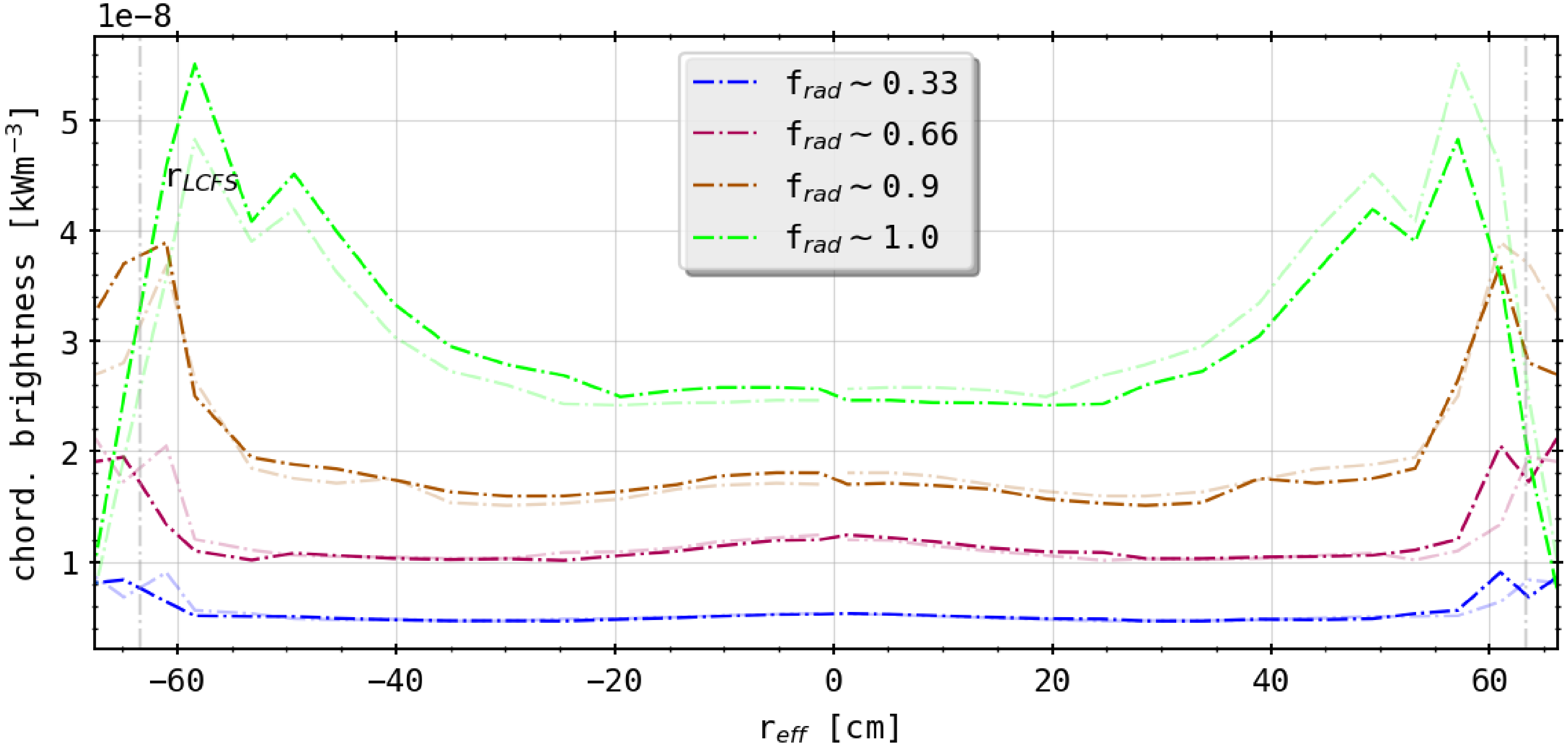
Previously on: Why is a STRAHL Profile Asymmetric?

➢ **forward integral on Bolometer lines of sight from intrinsically symmetric radiation profile in STRAHL yields asymmetric chordal brightness profile**



(forward integration of STRAHL simulations)

Agenda: Line of Sight Geometry and Local Emissivity

- **investigate intrinsic dependency of chordal profile to line of sight (LoS) geometry**

- **therefore deliberately change detector arrangement/geometry in pre-processing:**

1. **fixing possible non-planar distribution; relative to plane created by one side of detector fan and aperture normal vector (only HBCm possible, aperture centered)**
2. **transforming detector fan from tilted plane in toroidal direction to vertical arrangement at 107.94° (tor. angle)**
3. **tilting detector fan in poloidal direction up/down by -1.0° <-> 5.0°**

- **changes in geometry matrix from LoS geometry used in forward integration of poloidally symmetric STRAHL simulation results (line radiation of impurity carbon)**

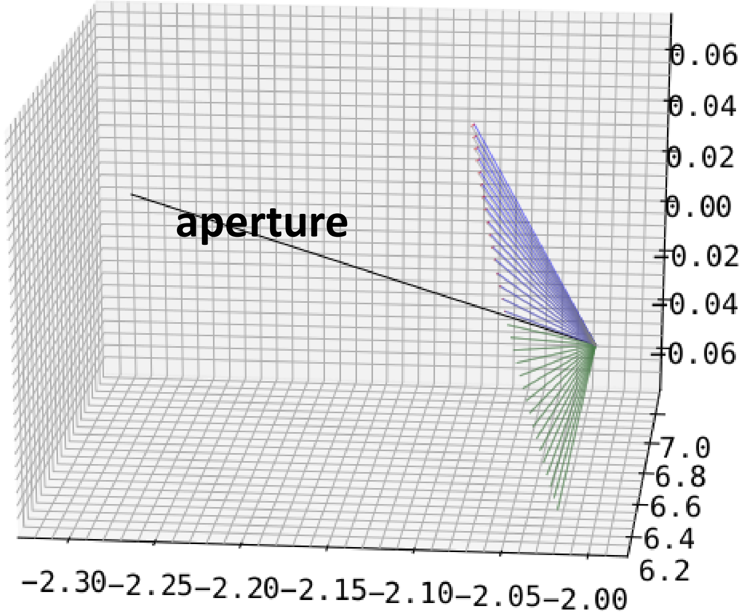
1.: 'Fix' Bolometer Planar Error

- guided by lower half of detector array (green)

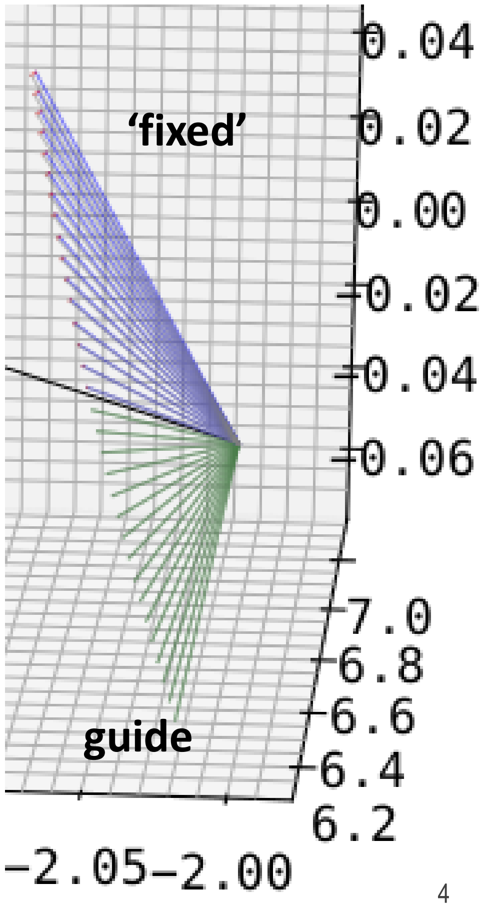
- observe difference (red) between opposite channel (e.g. CH#0 <-> CH#31) through rotating around aperture normal by 180° and measuring angle

- transforming second channel through rotating it by angle from before (blue)

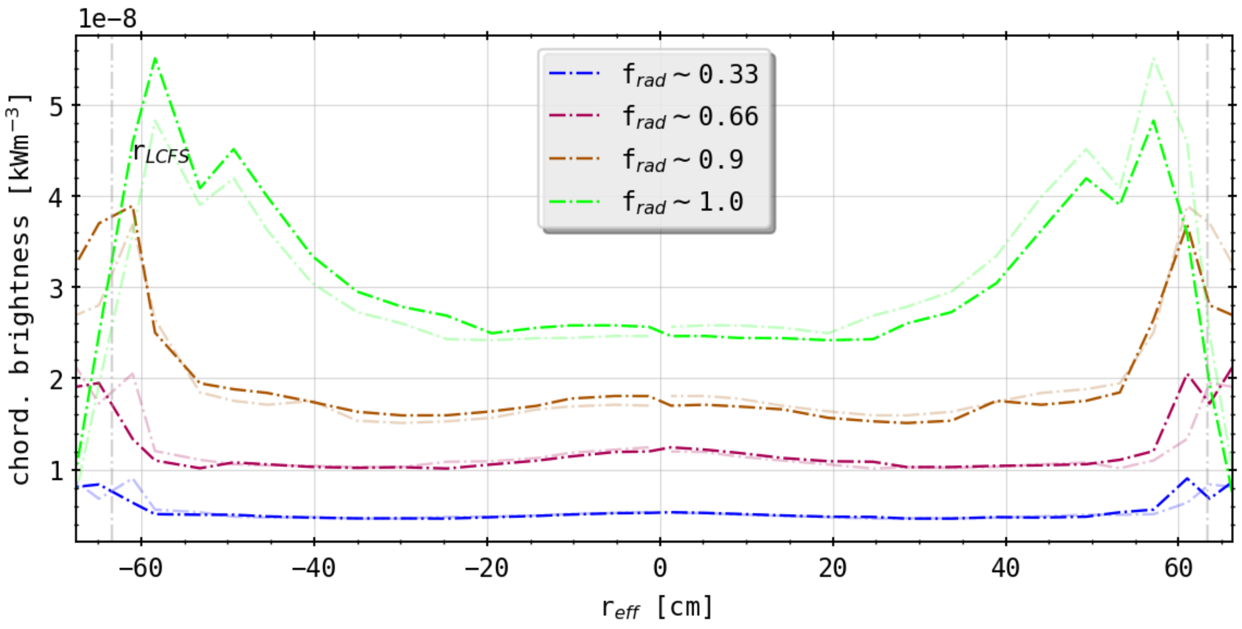
- only really easy for HBCm, because central aperture axis alignment; VBC cameras not possible



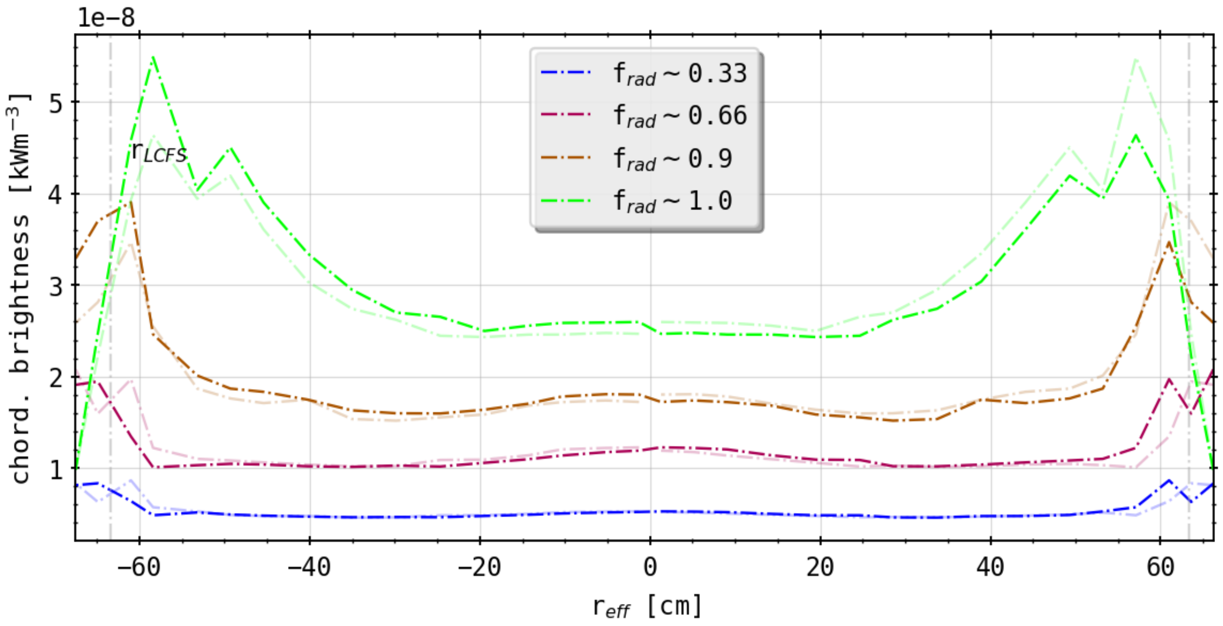
HBCm



‘Standard’ Case vs. Planar Fix



(forward integration of STRAHL simulations)

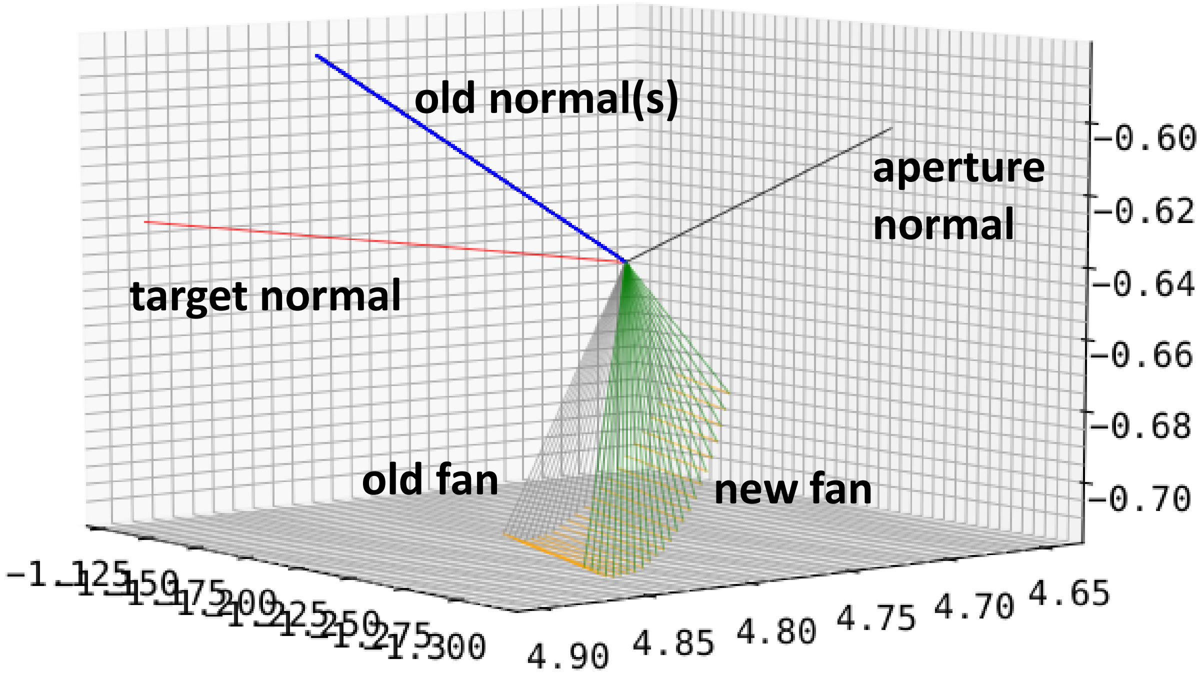


(forward integration of STRAHL simulations with ‘fixed’ LoS)

➢**virtually no changes?**

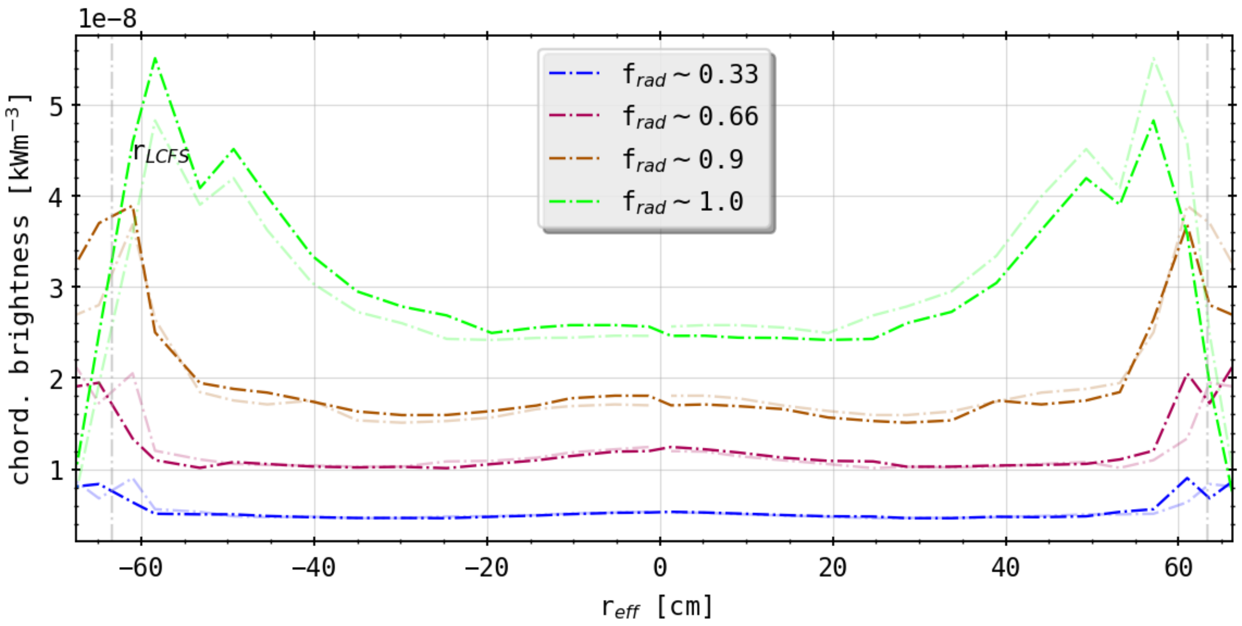
2.: Toroidal Transformation to Axis Plane

- guide is normal of plane constructed by detector fan (blue)
- transforming all channels so that normal points in/at toroidal direction (red)
- transformation for each channel individual (see previous argument (1.)) (orange)
- done for all cameras individually

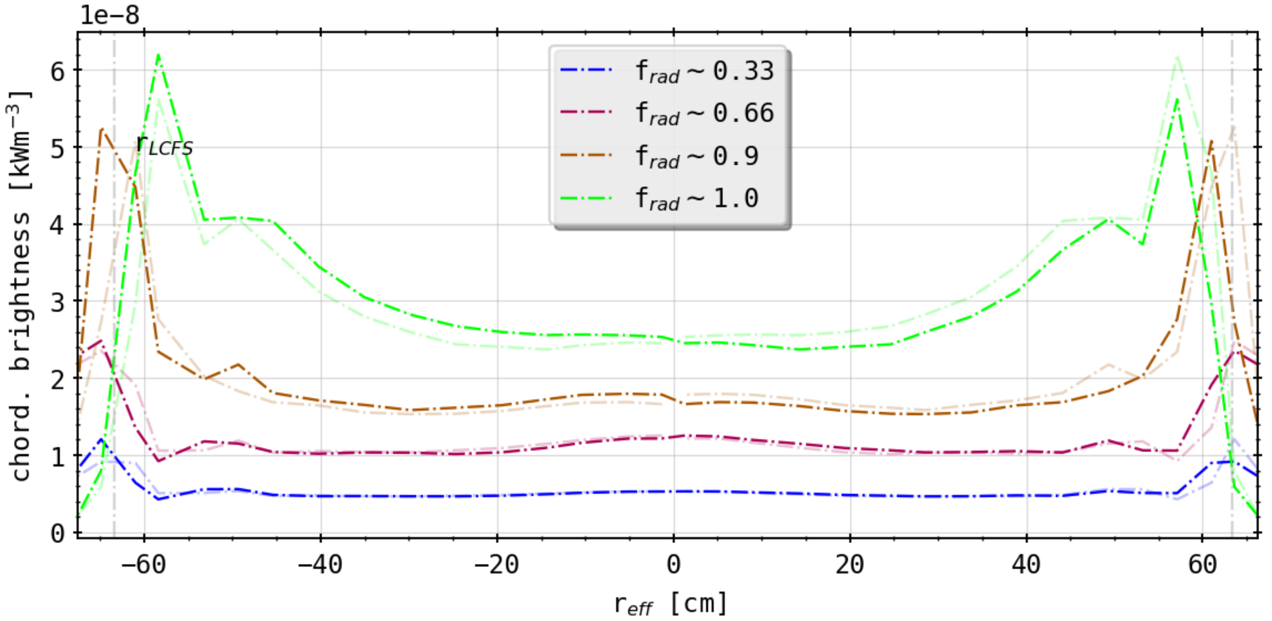


VBCr

‘Standard’ Case vs. Toroidal Transformation



(forward integration of STRAHL simulations)

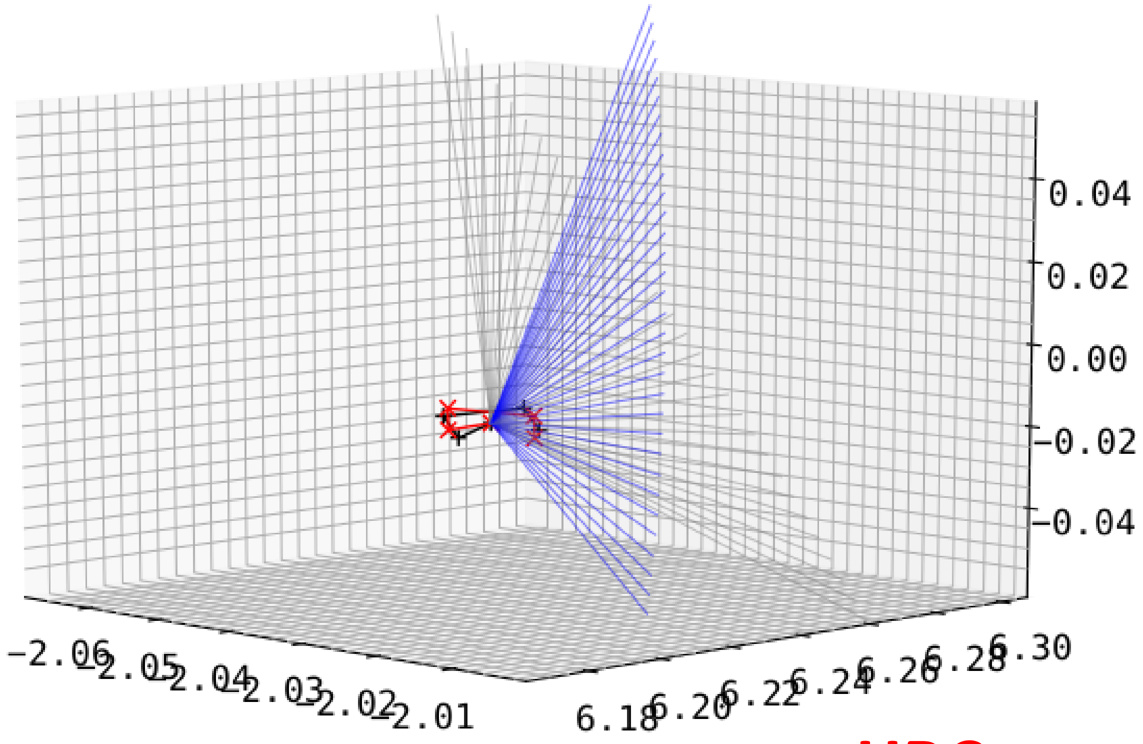


(geometry matrix in Bolometer plane at 108° with symmetric LoS orientation)

- qualitatively small changes: SOL radiation zones now more peaked
- radially no shift/difference in forward calculation
- comparatively same level of asymmetry remains (fault in own calculation?)

3.: Tilting the Detector Fan Up/Down

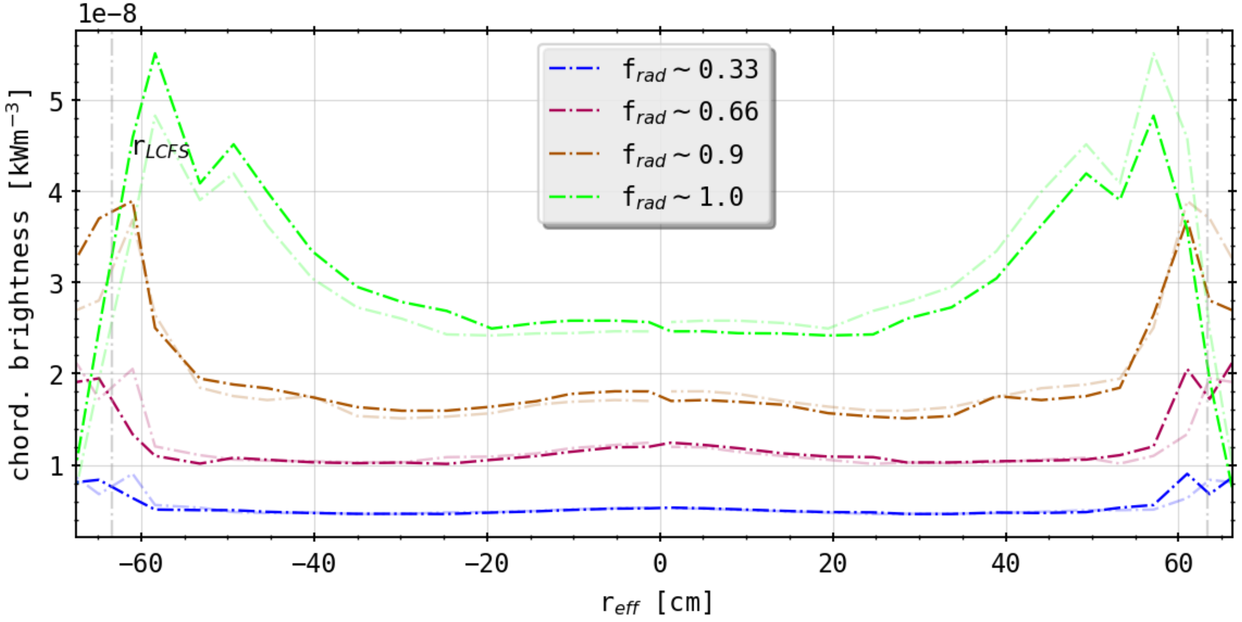
- take results of (2.) and tilt the entire fan including the aperture poloidally (grey to blue and black to red)



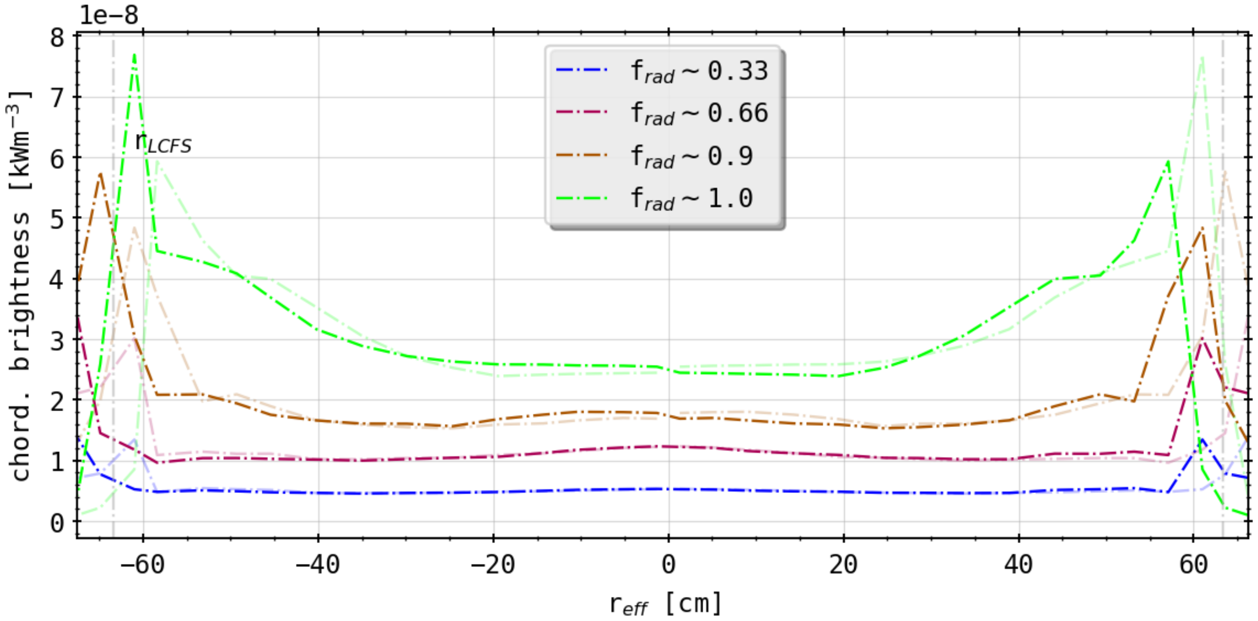
(results for (2.) with aperture change included)

HBCm

‘Standard’ Case vs. Toroidal Transformation and Tilt



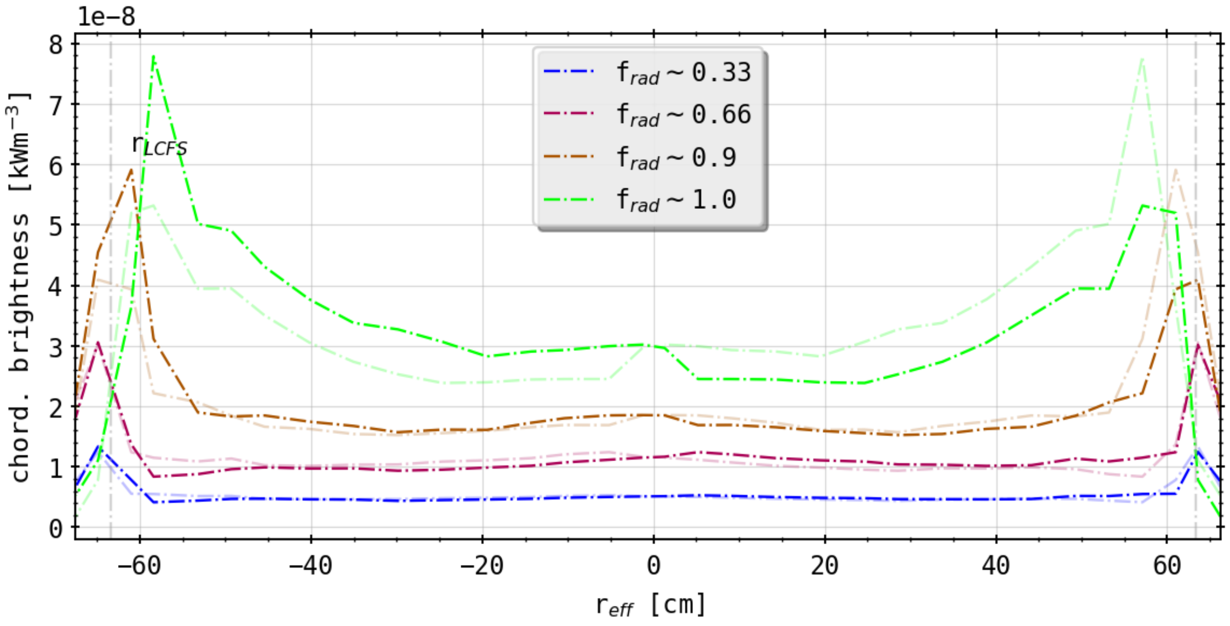
(forward integration of STRAHL simulations)



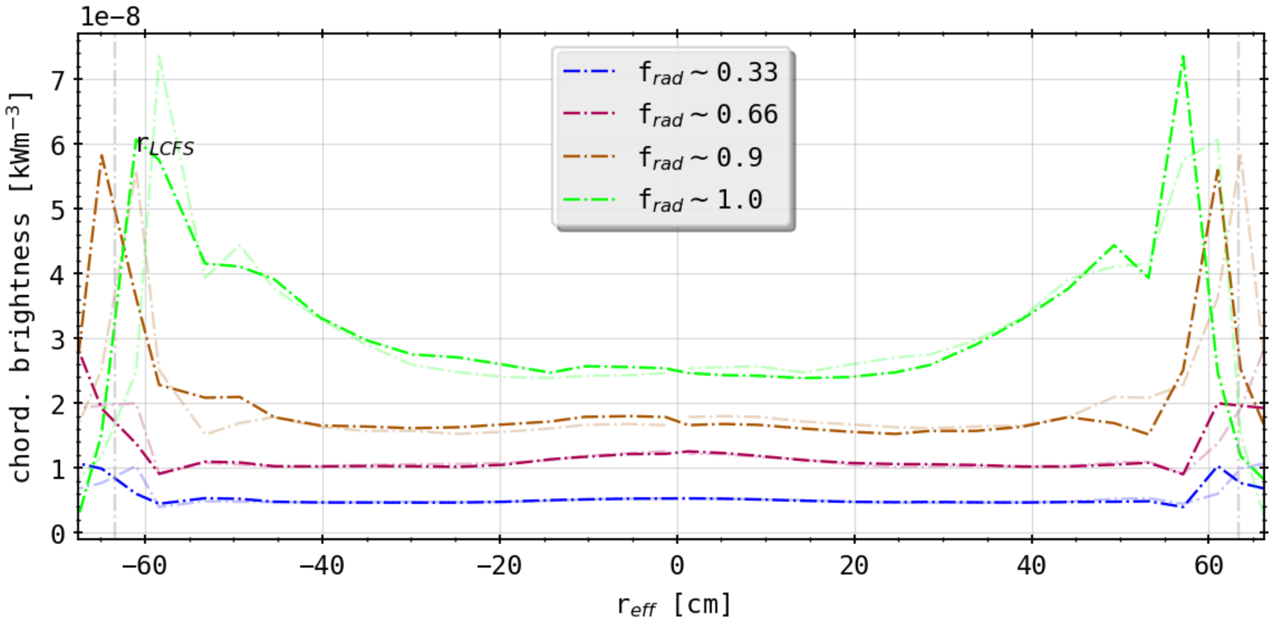
(geometry matrix in Bolometer plane at 108° with symmetric LoS orientation and -1.0° tilt (up))

- asymmetry becomes stronger
- left hand side or brightness for ‘negative’ radii more peaked
- alignment with fluxsurfaces better
- also radial movement of radiation peaks further out (instead of inwards)

Different Tilts



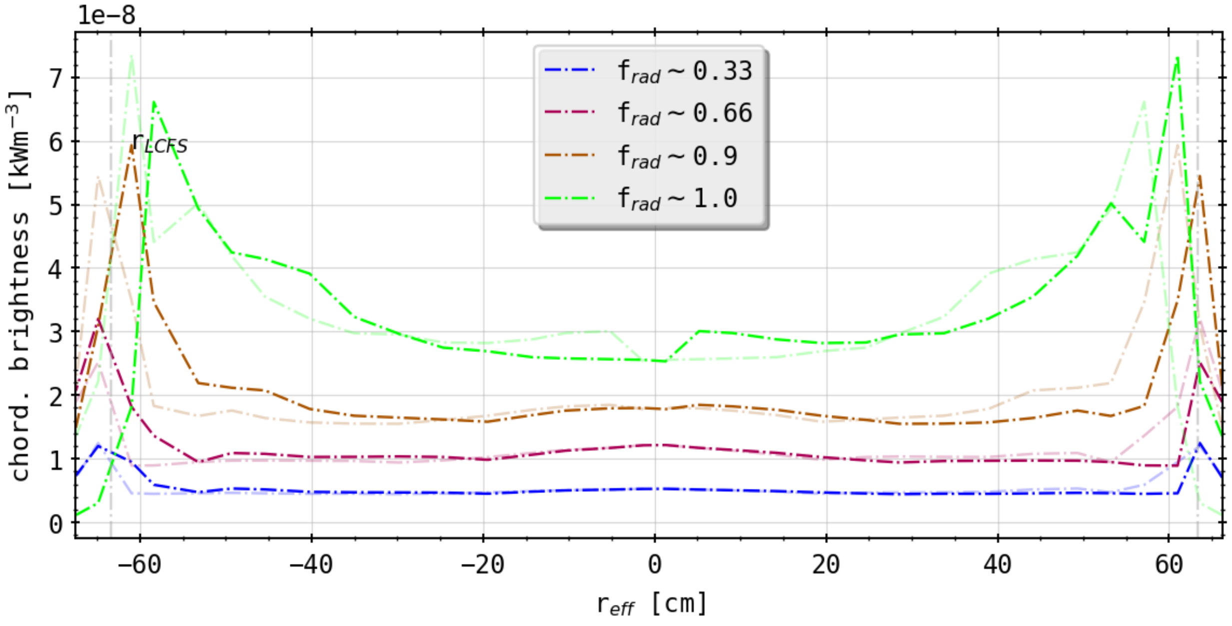
(0.5° tilt (down))



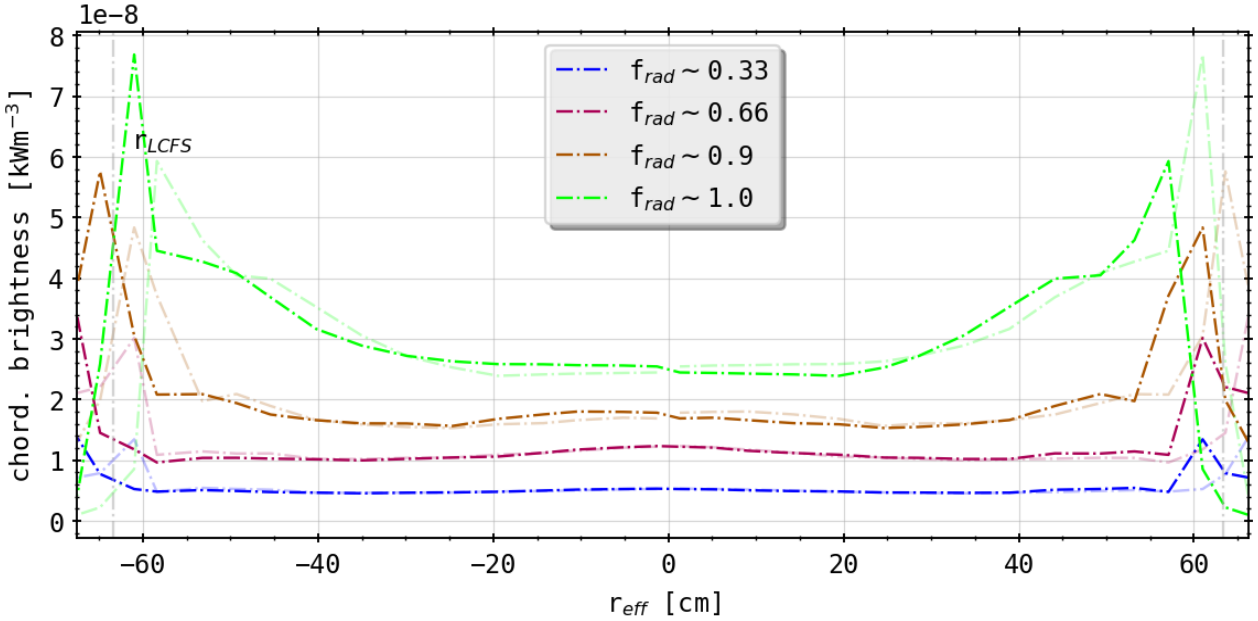
(-0.5° tilt (up))

- asymmetry switched around
- alignment better now upside (tilt down!)
- likewise radial movement as before!

Different Tilts

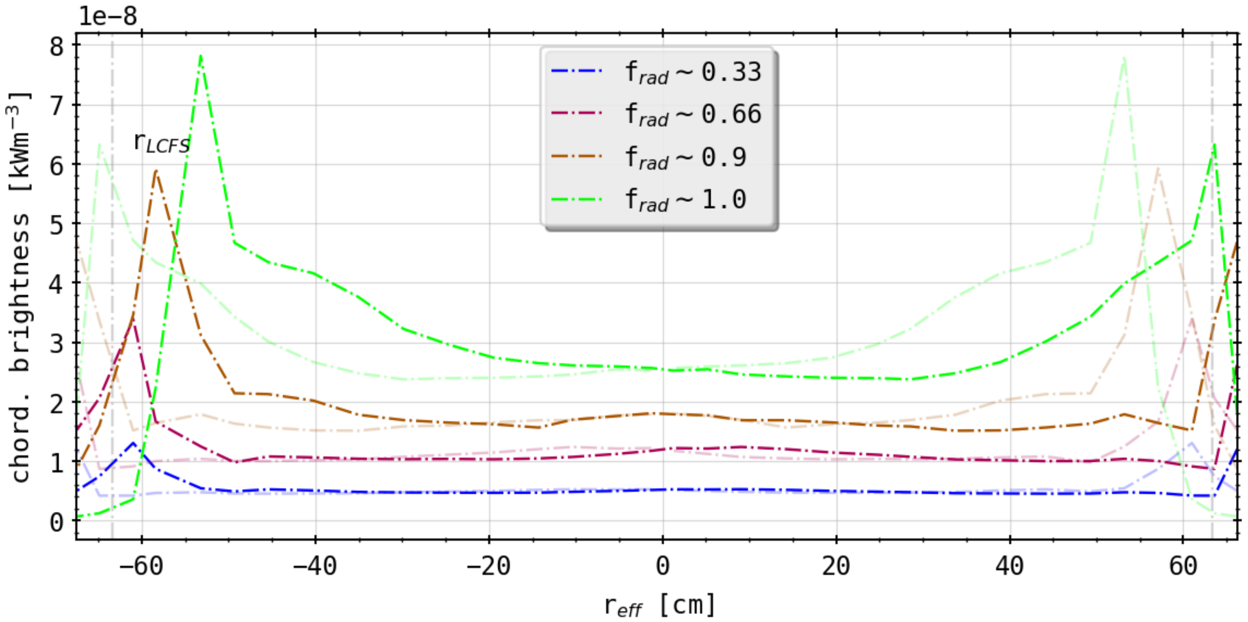


(1.0° tilt (down))

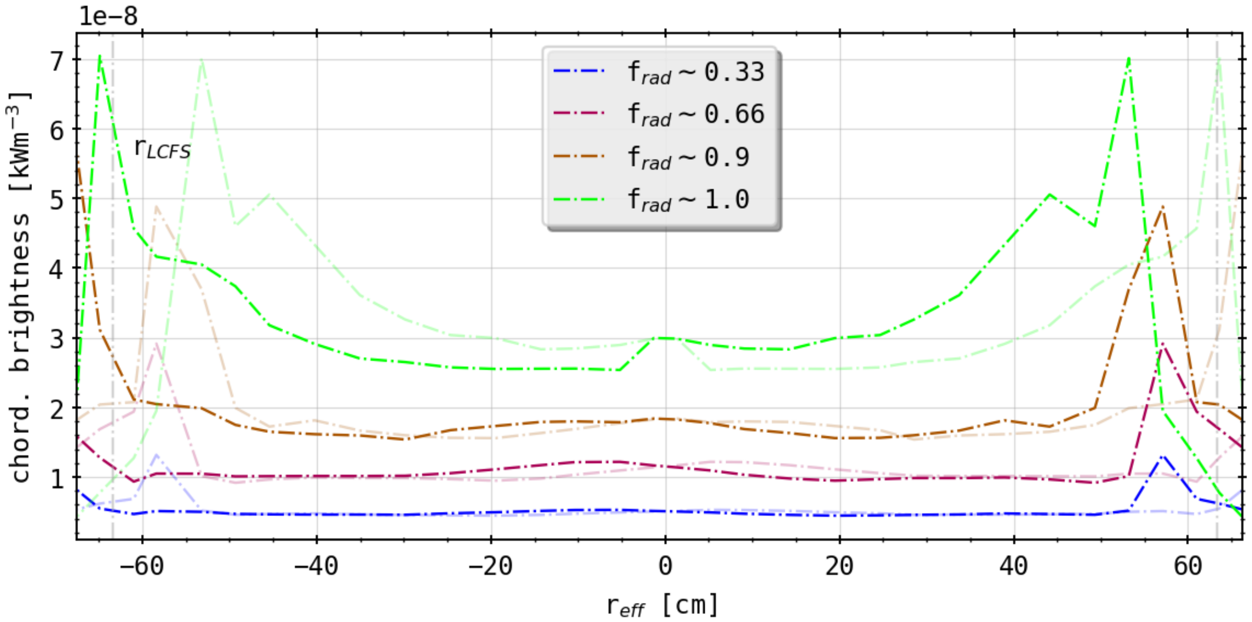


(-1.0° tilt (up))

Different Tilts



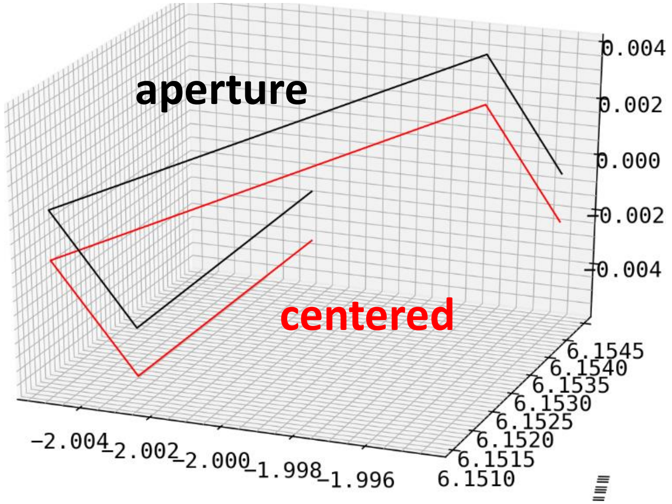
(2.5° tilt (down))



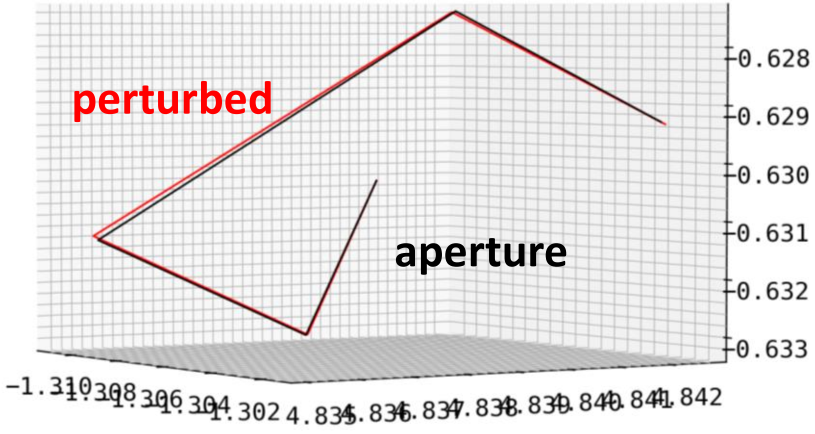
(-2.5° tilt (up))

Centering of Aperture and Random Error

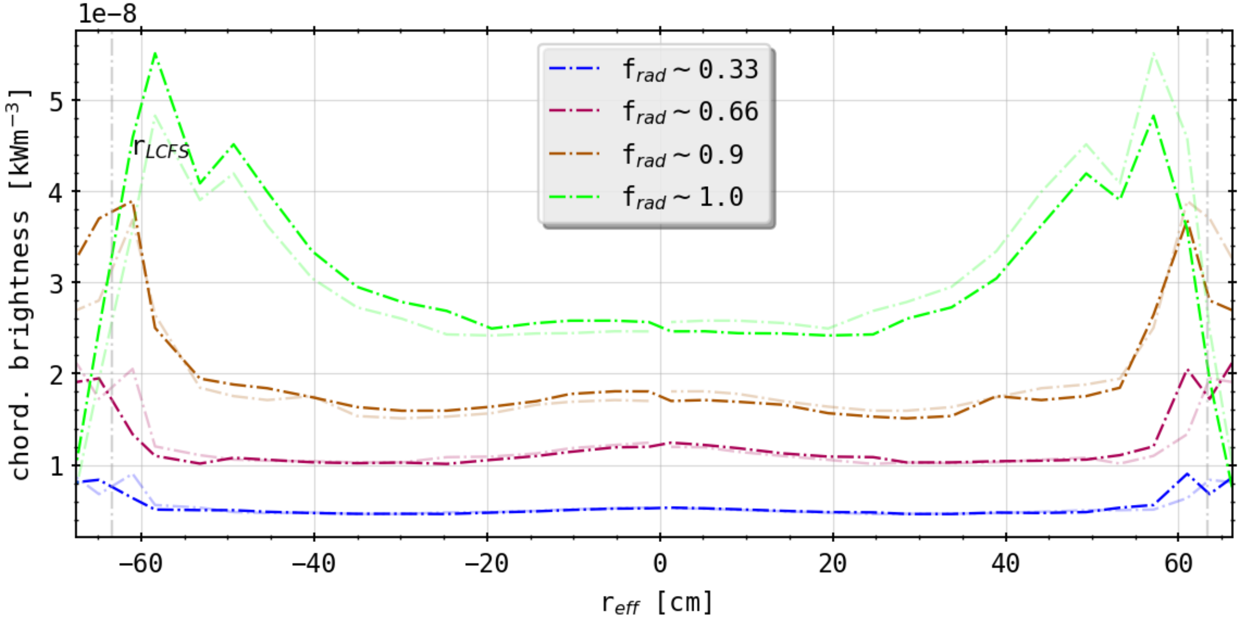
- center the aperture center (black) on z = 0 axis and shift entire array accordingly to red



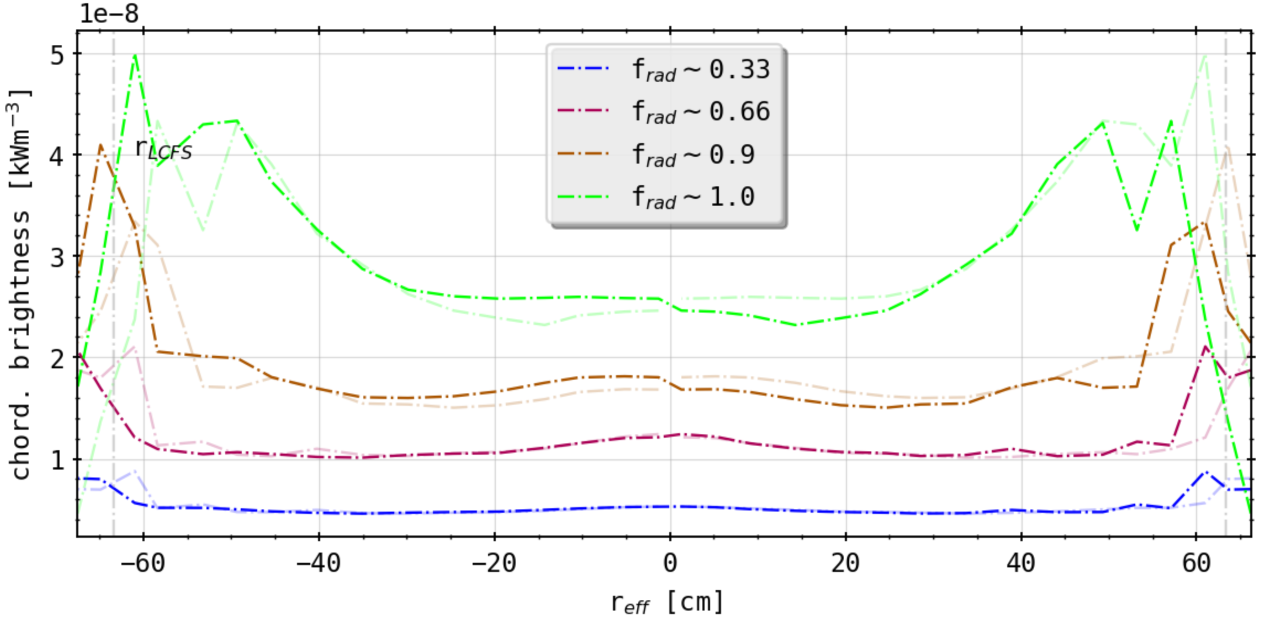
- introduce measurement error to aperture and detector positions of maximum 0.1mm (randomly distributed) and see resulting tilt in camera fan
- degree of tilt 0.5° - 2.0°, but omnidirectional



Standard v. Centered Aperture



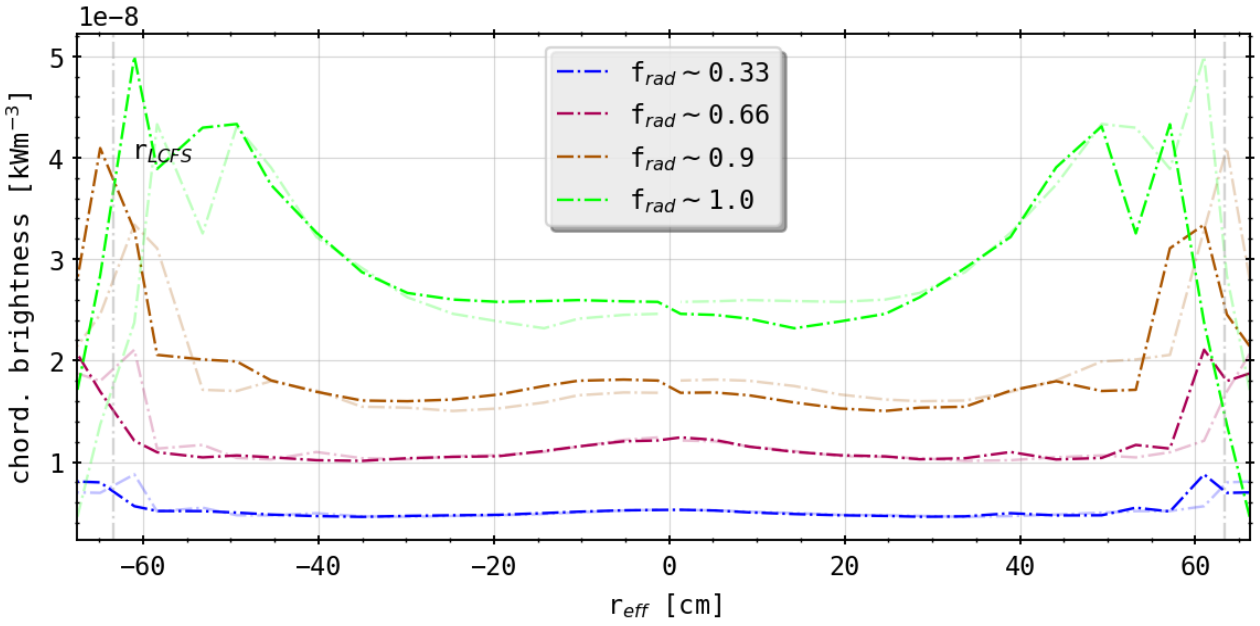
(standard case)



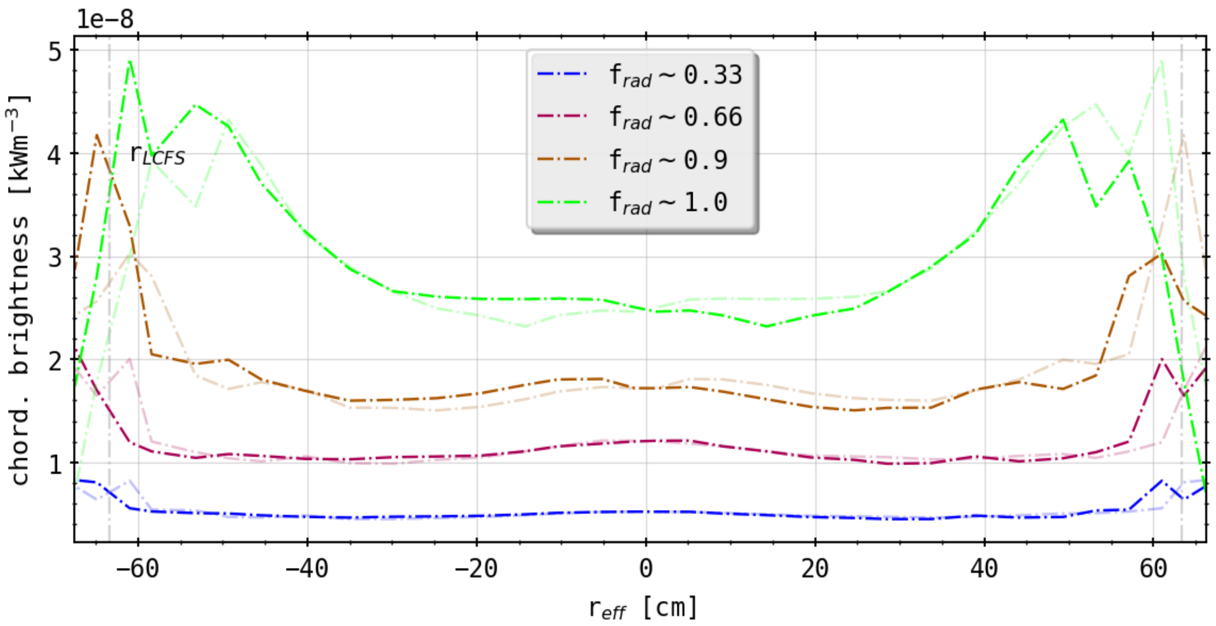
(centered aperture)

- introduction of some more asymmetry close to SOL
- possibly resolvable by one of earlier transformations

Standard v. Centered Aperture



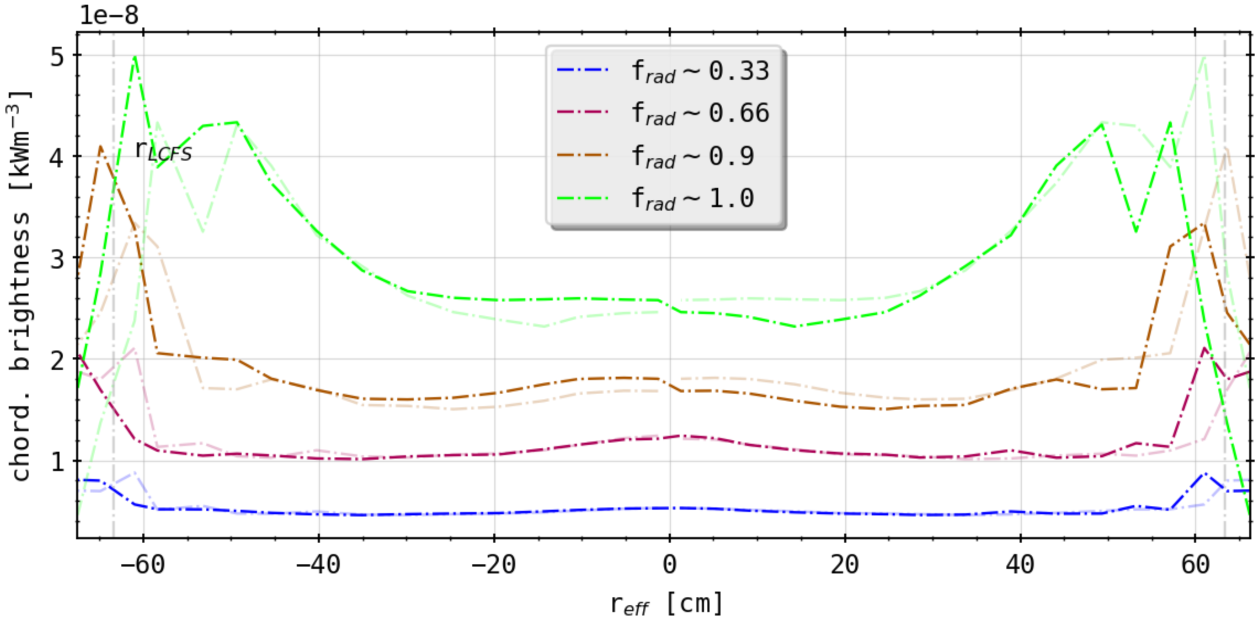
(centered aperture)



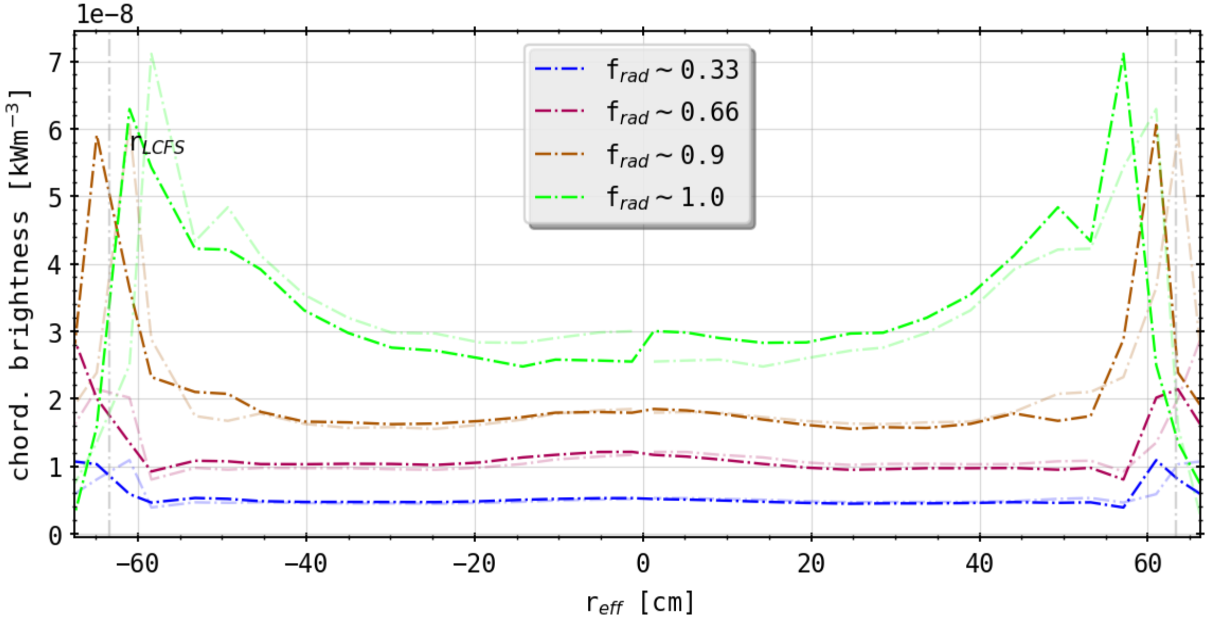
(centered aperture and ‘planar fix’)

- still not symmetric, aperture normal and LoS fan tilted still

Standard v. Centered Aperture



(centered aperture)

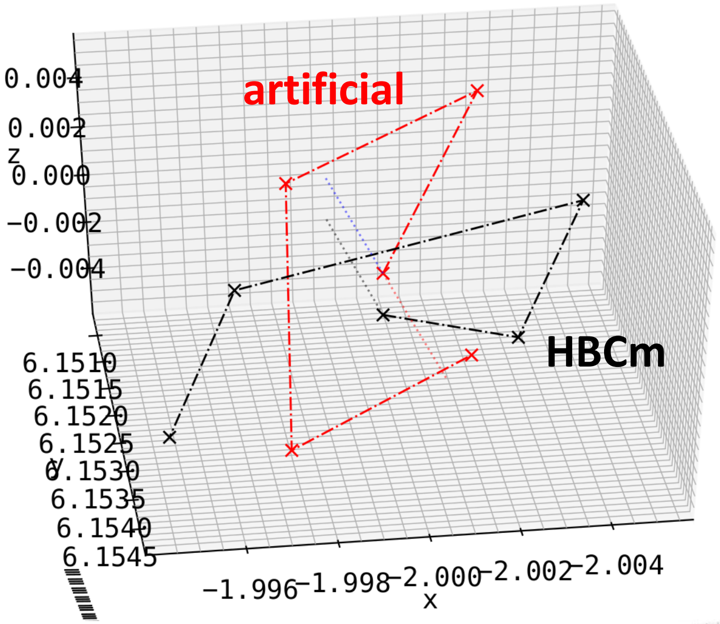


(centered aperture and toroidal transformation)

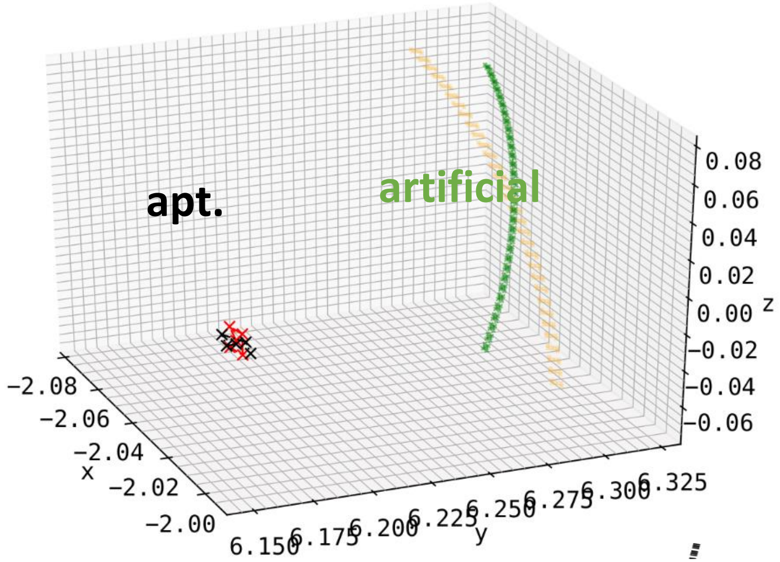
➢ ???

Setup

- creating symmetric, upright, rectangular aperture at location of old one (HBCm) with plane normal exactly pointing at (0.0, 0.0, 0.0)



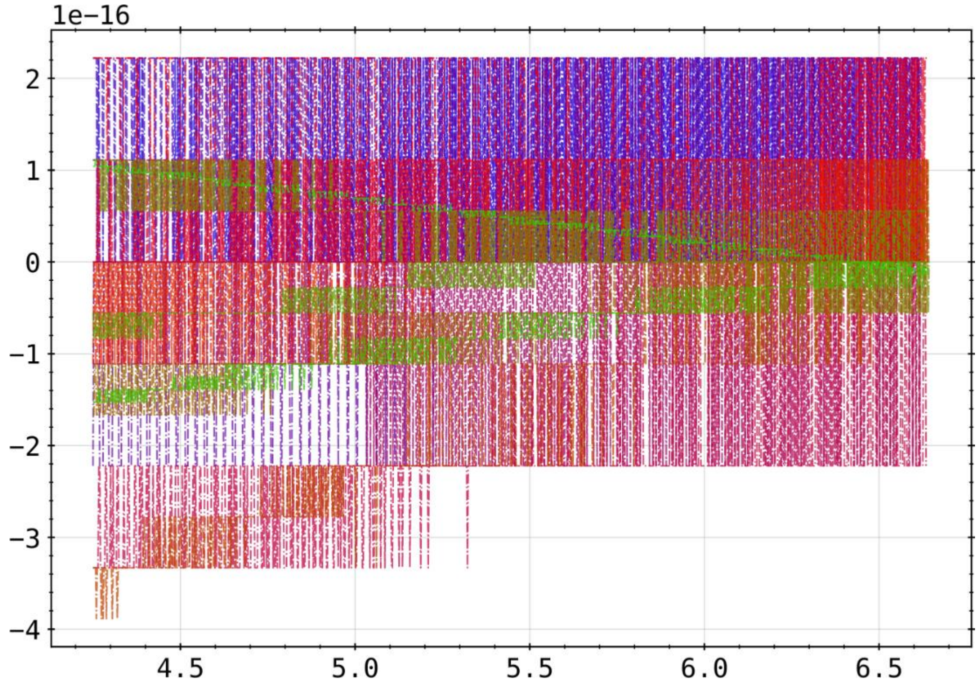
- detector array equidistant to aperture and to each other behind pinhole and in-line with plane normal



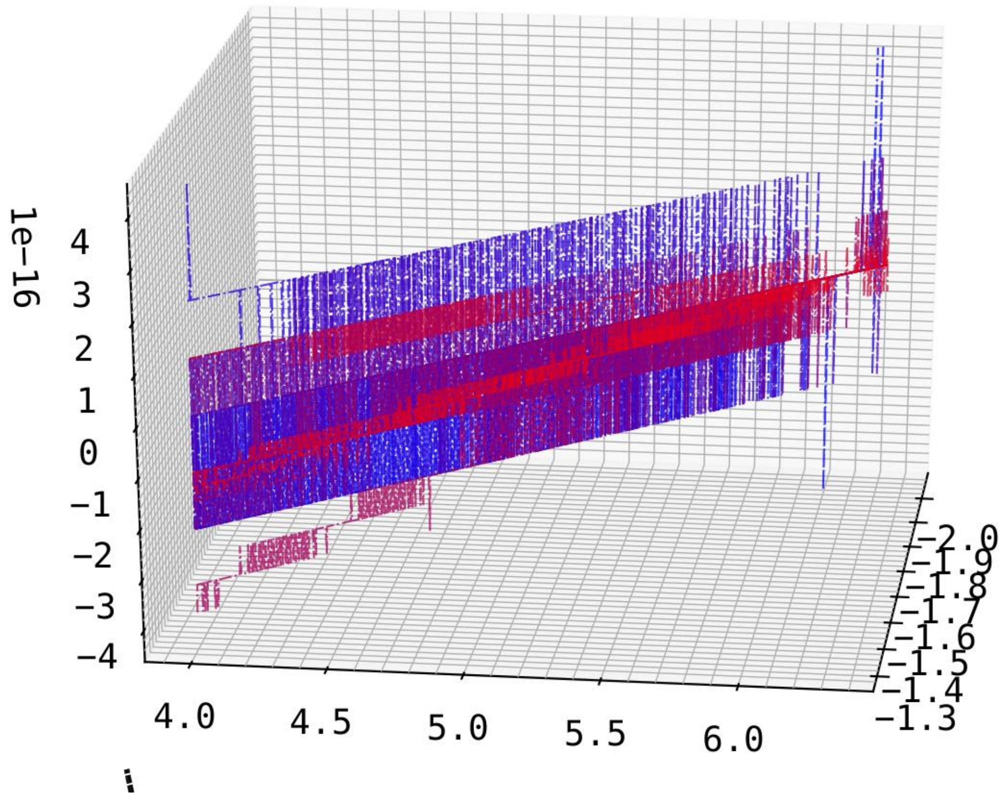
- detector plane normal has no angle with pointing vector between aperture and center

Setup

- ➢ **Lines of sight from this configuration are symmetric (top-bottom) down to the numerical accuracy of a 53 bit encoded double precision float**

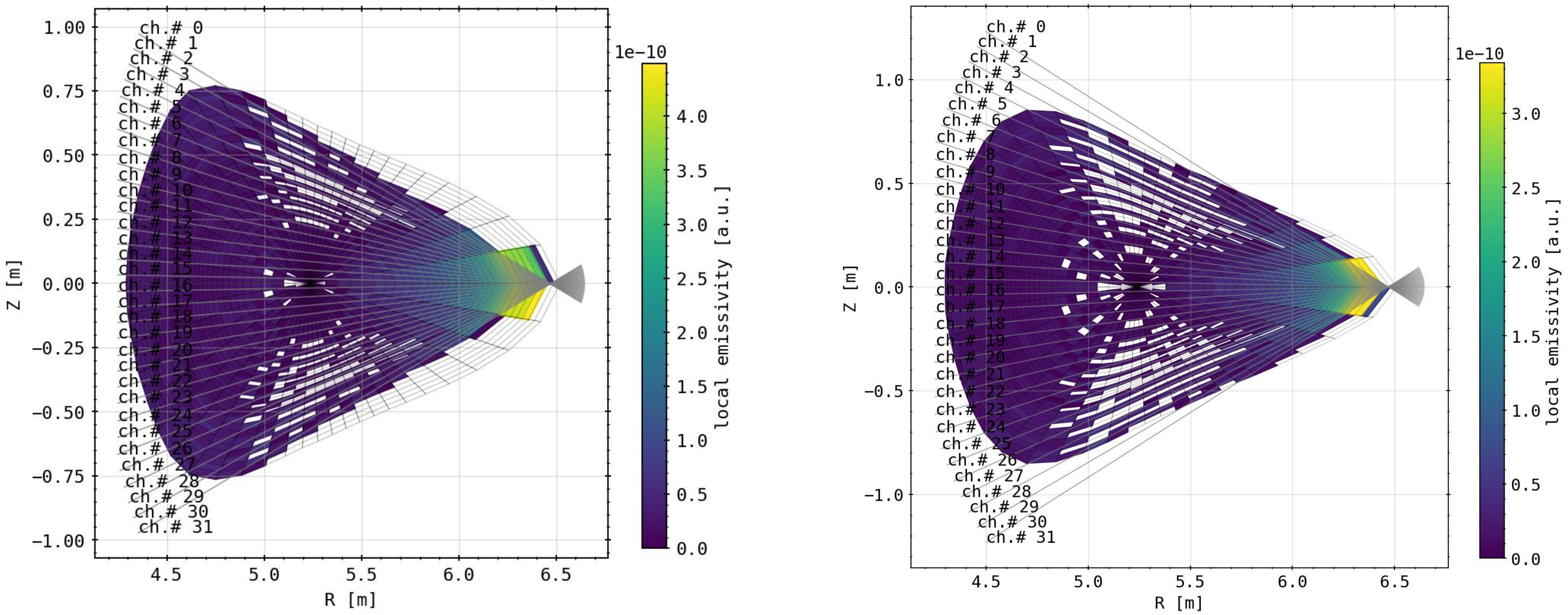


sum of channels (0-31, 1-30 ,…) in (r,z)-space



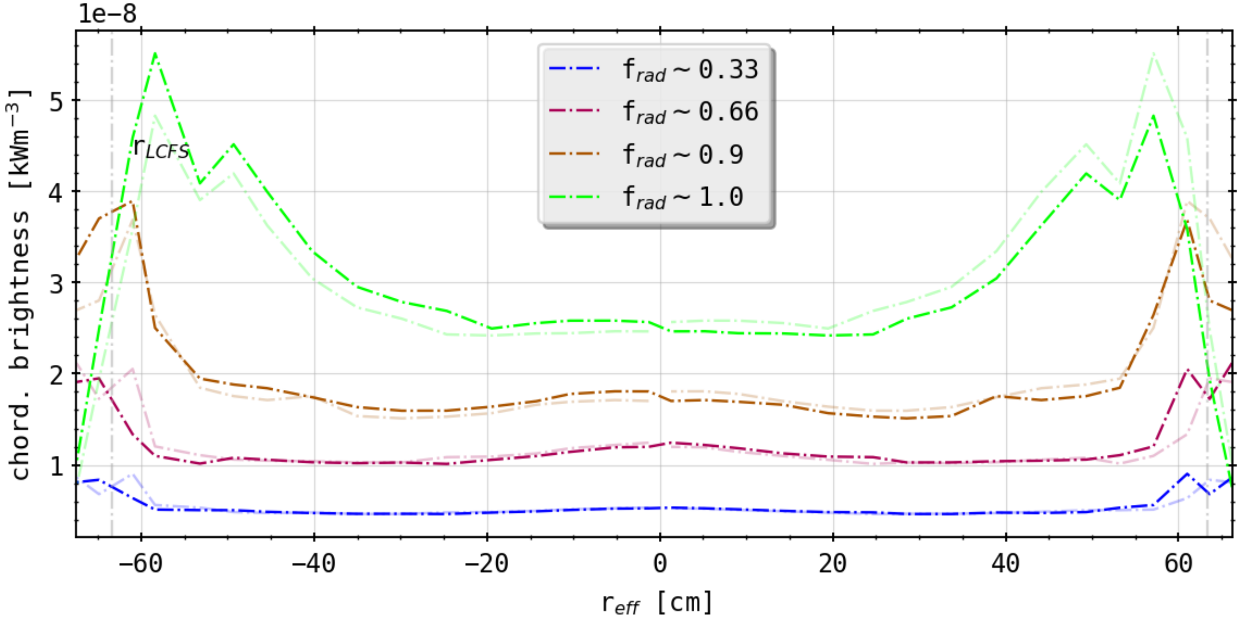
sum of opposing channels (0-31, 1-30 ,…) in (x,y,z)-space

Emissivity on Fluxsurface Cells

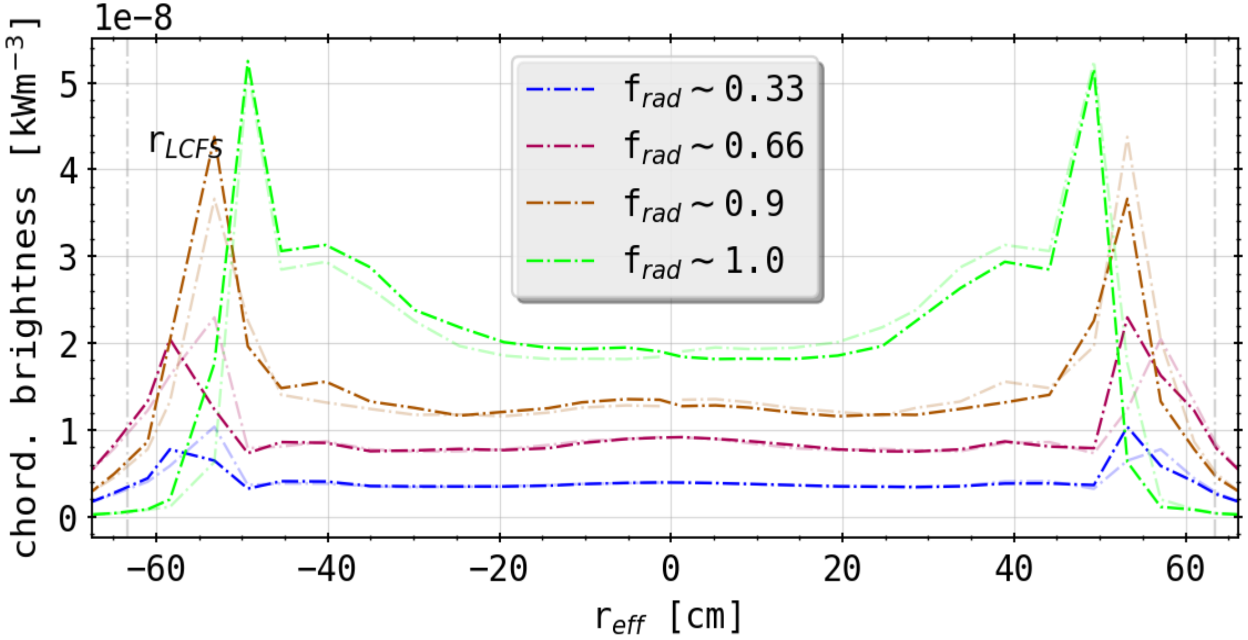


- almost entirely symmetric emissivity distribution on fluxsurfaces, except artifact in front of aperture
- slightly wider opening angle on line of sight-fan

Forward Integral: Standard Case vs. Artificial Array



(forward integration of STRAHL simulations)

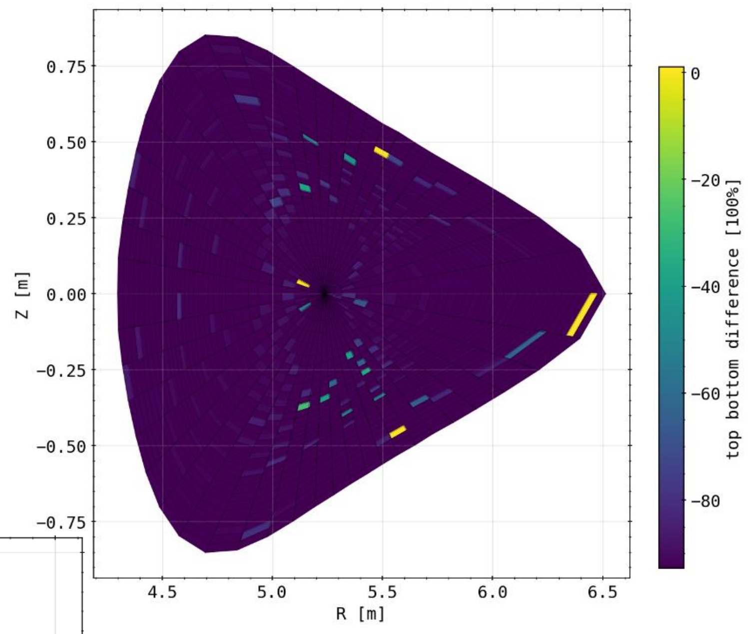


(forward integration of STRAHL simulations of artificial, fully symmetric horizontal camera array)

- still not entirely symmetric, deviance in fluxsurface geometry? (pinhole is located not exactly at 108 degrees, but rather 107.9)
- geometrically very different to ‘standard’ case
- more peaked towards edge
- far inside the LCFS even for low radiation fraction cases

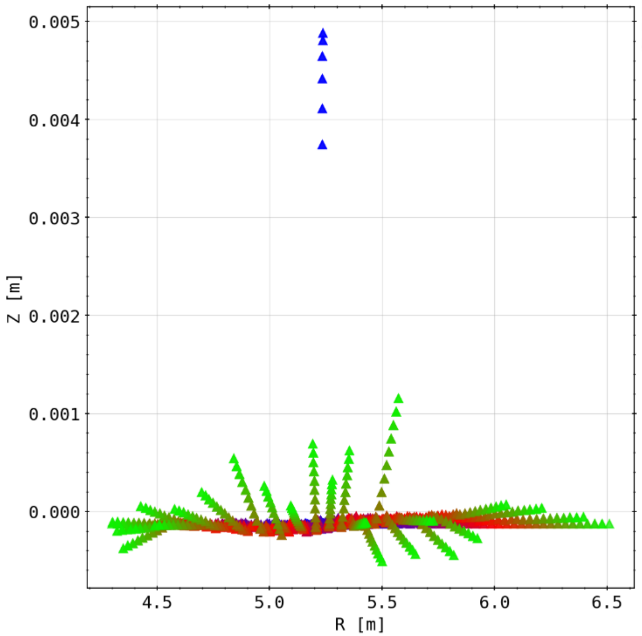
Symmetry of Emissivity Matrix and Mesh

- checking the symmetry (read: top-bottom congruence) of the emissivity matrix
- slight deviances overall, especially some cells not touched by channels at all (equaling 100% difference here)



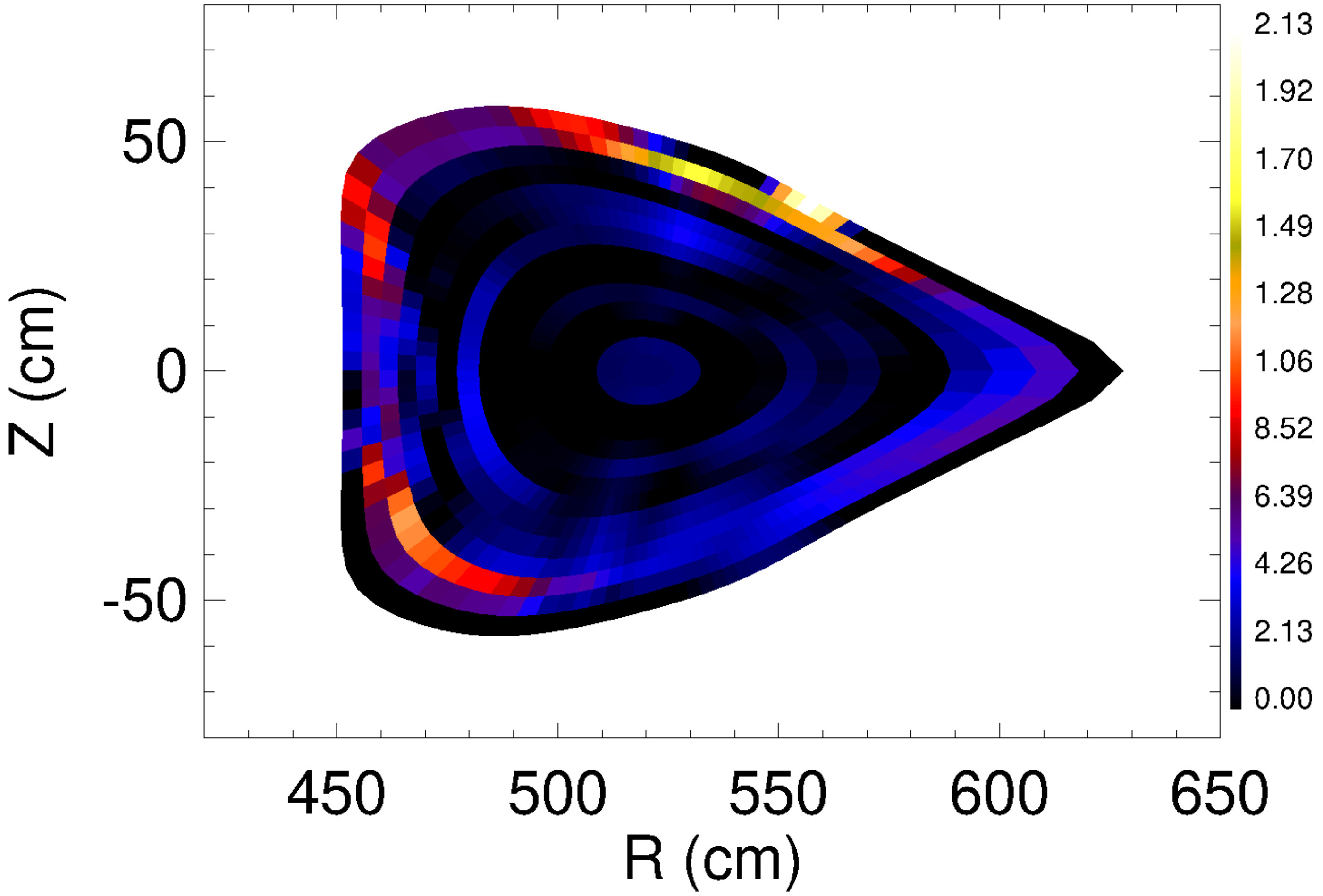
- checking symmetry mesh matrix
- blue to red to green means further outside the magnetic axis, i.e. 'larger' fluxsurfaces/fluxtubes

- entire mesh dispositioned below (still oriented around magnetic axis)
- increasing deviance with distance



2D Tomography: First Results

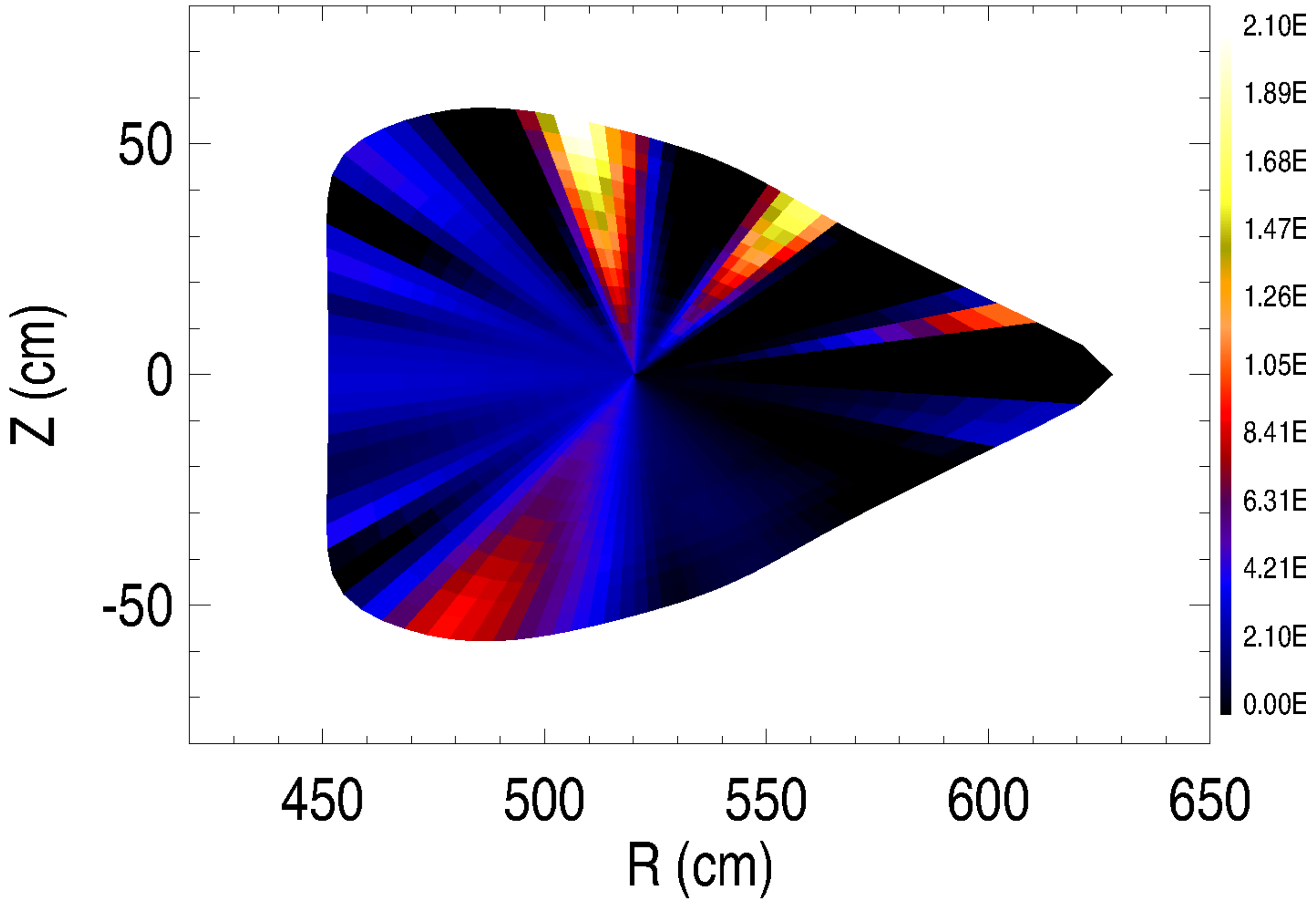
- ➢geometry files are now being read correctly
- ➢anisotropy factors set to 1.5 for divertor (?) or island and 0.8 for core-like regions
- ➢ t = 3.421s <-> frad=100%



2D Tomography: First Results

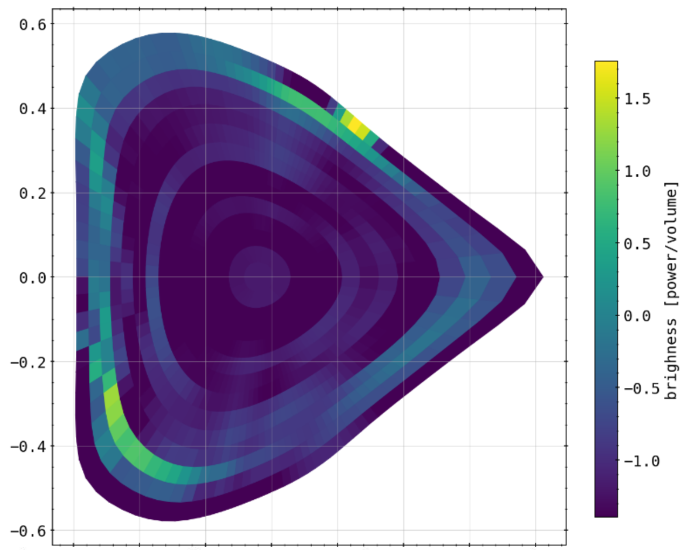
- anisotropy factors set to 1.0 and 1.0

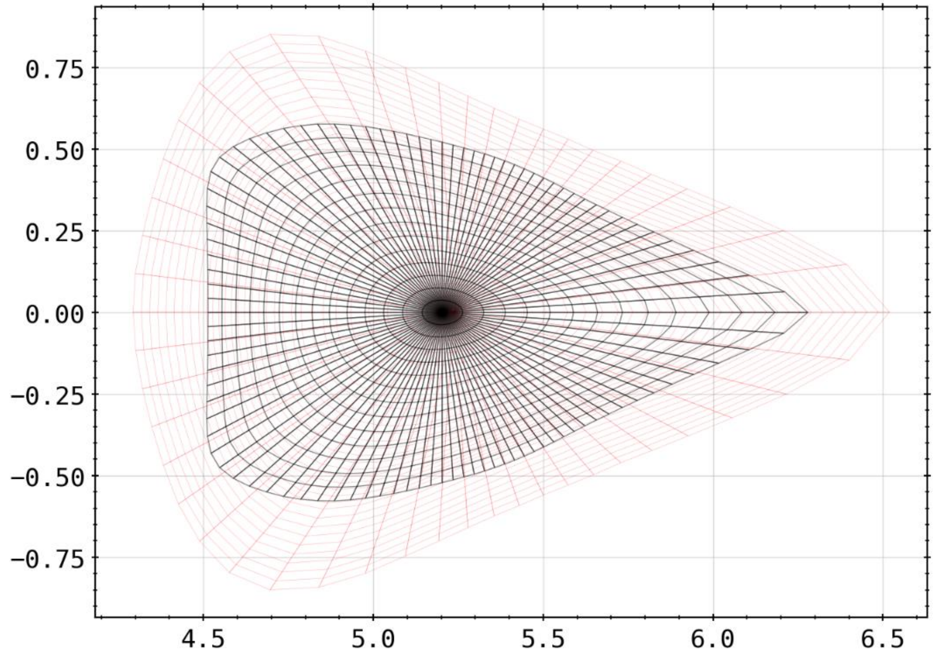
- again: t = 3.421s (frad=100%)



Forward Calculations Towards Phantom Tests

- ➢now reading from MFR tomography and adapting to different geometry
- ➢next step: set up forward calculation of chordal brightness profile from the 2D results of tomography as shown before





Agenda

Not in order:

- **start to finish RSI paper (for internal reviewing)**
- **understand anisotropy factor, hence structure of tomogram**
- **create and feed phantom radiation profiles to inversion method using that knowledge**