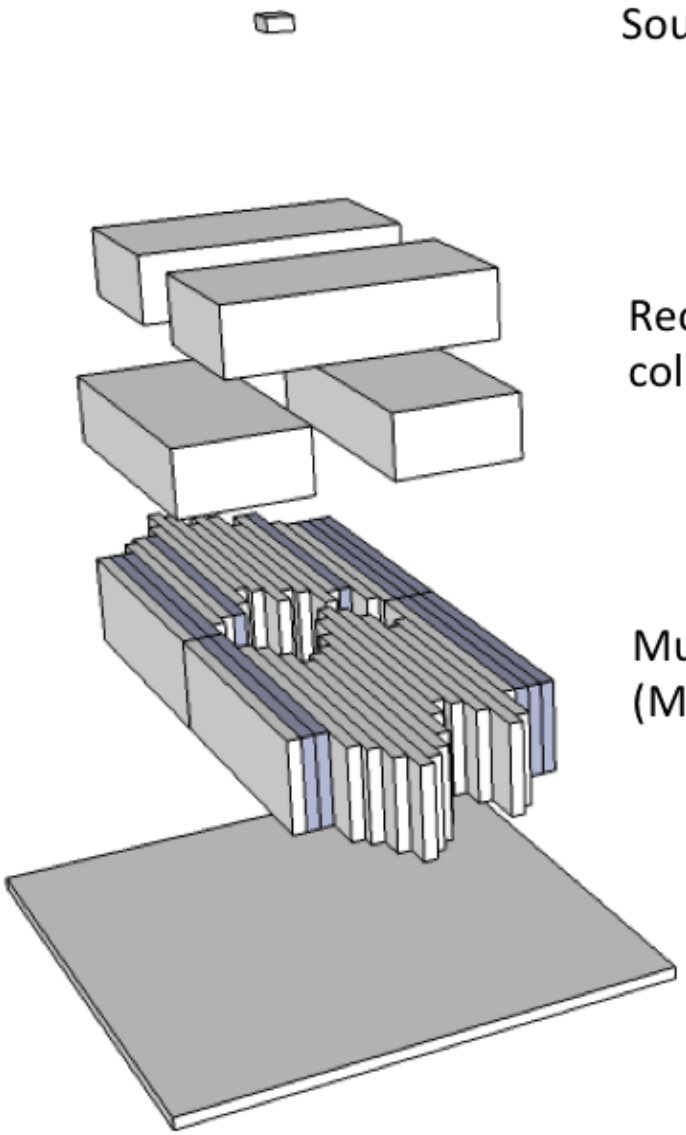
Beam collimation using MLC

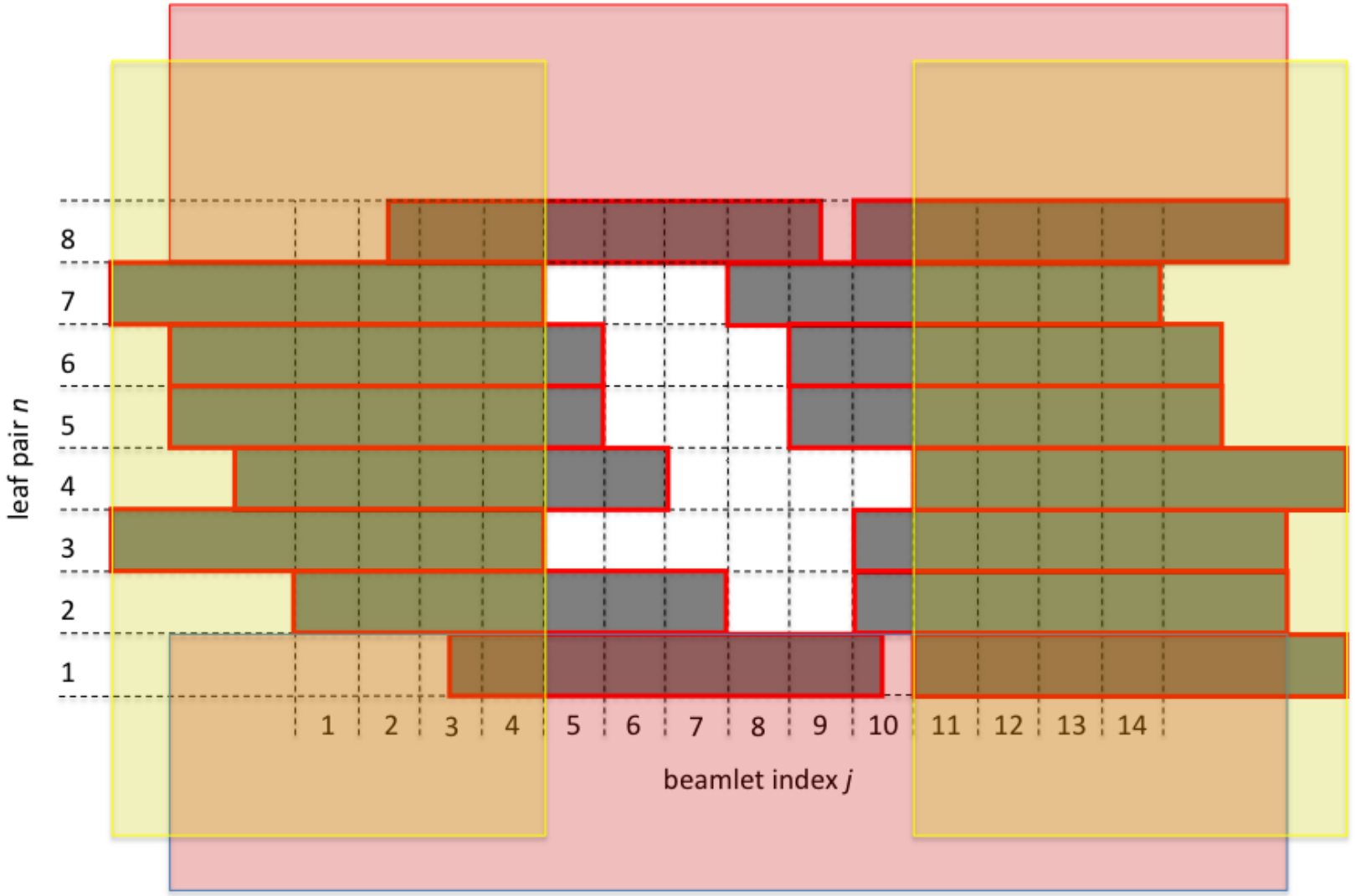


Source

Rectangular field collimator (Jaws)

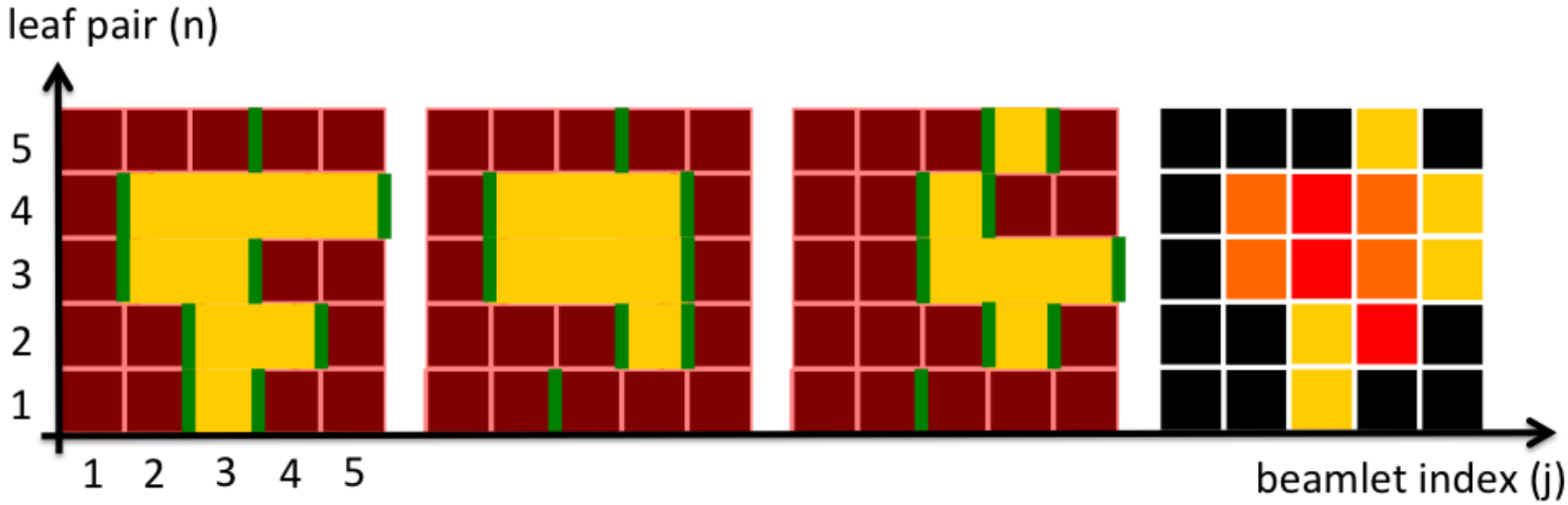
Multileaf collimator (MLC)

Beam collimation using MLC



Leaf sequencing

Superposition of multiple apertures yields an IMRT field



Leaf sequencing is the inverse problem

Find a set of MLC apertures that deliver an optimized fluence map

Leaf sequencing

- Leaf sequencing does not have a unique solution
  (trivial solution: deliver each beamlet individually)

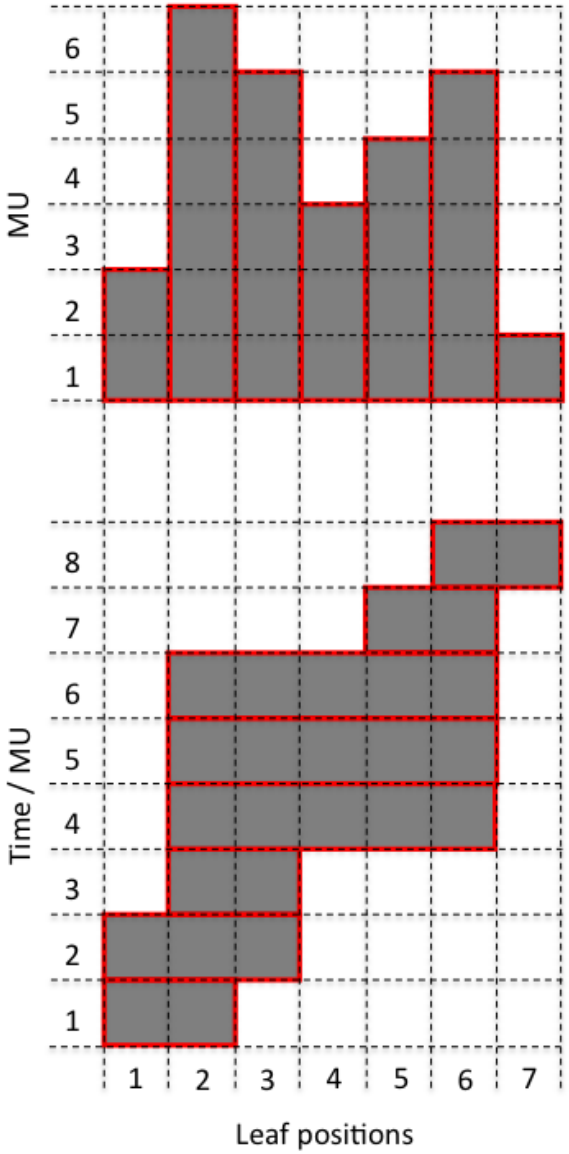
Goal: Find an efficient solution

- reproduce fluence map faithfully
- minimize number of apertures
- minimize total number of monitor units

Constructive method: Sliding window (minimizes total MU)

Discrete optimization methods: aim to minimize number of apertures

Sliding window sequencing



- consider discretized fluence map
- consider one MLC leaf pair

- leaves move uni-directionally

- left leaf positions:
  determined by positive gradients
- right leaf positions:
  determined by negative gradients

- total MU = sum of positive gradients

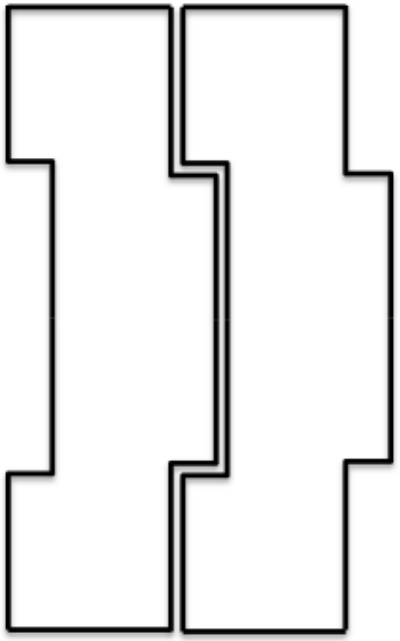
Shortcomings

Limitations of Two-step approach:

- Poor dose calculation accuracy for fluence map optimization
  (use of pencil beam algorithm for Dose-influence matrix)
- Discrepancy between optimized fluence map and sequenced map
  (treatment plan with few apertures)
- discrete leaf positions limited to beamlet boundaries
  (benefit of fine tuning leaf positions at the target edge)
- Inherent limitations of the dose-influence matrix concept
  (example: tongue & groove effect)

Shortcomings

Tongue & Groove design of MLC leaves:



- dose-influence matrix assumes linearity

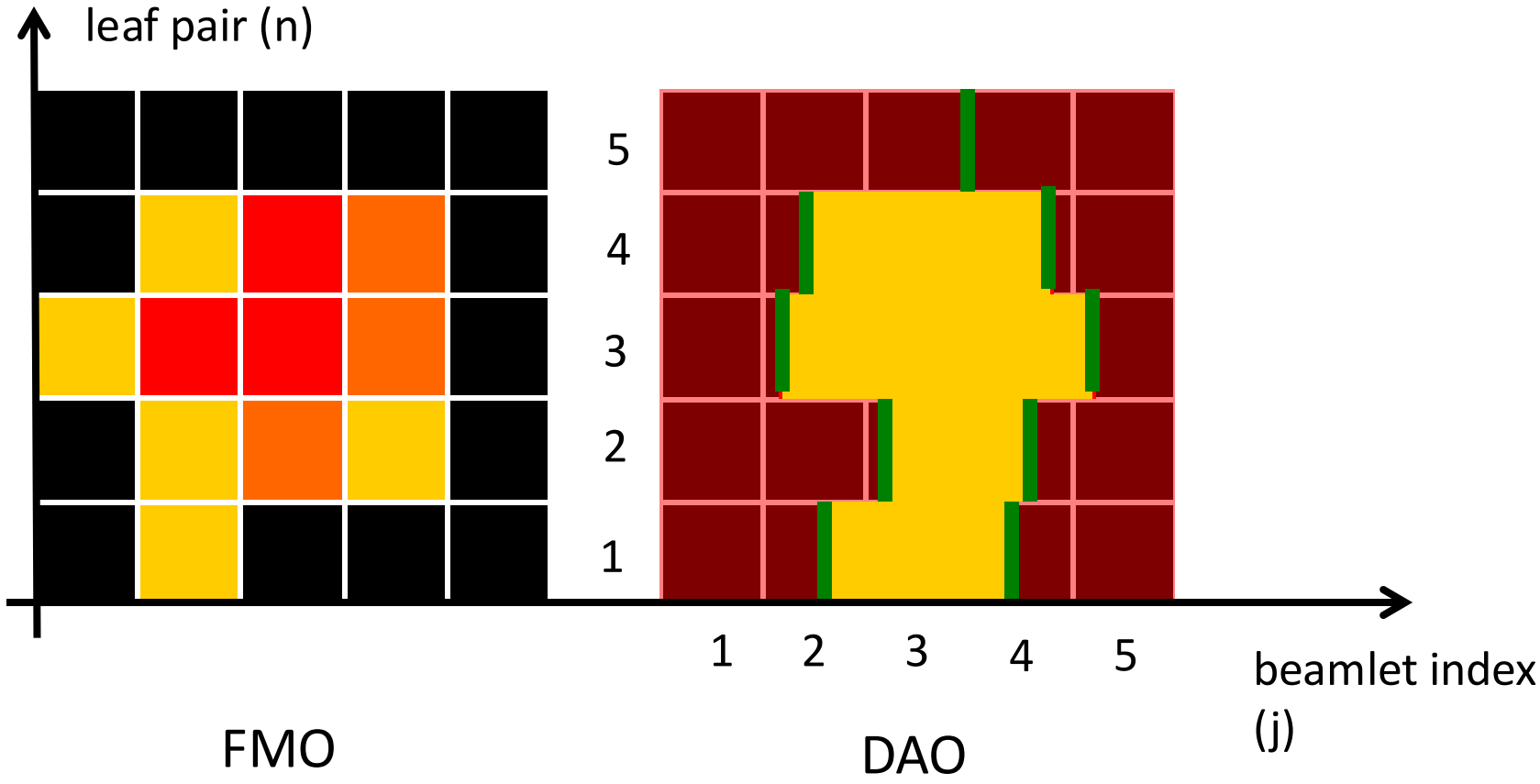
  i.e. dose of beamlets delivered individually equals dose delivered by combined aperture

- not strictly true

center is blocked as soon as one leaf is closed

➔ center is underdosed if beamlets are delivered separately

Direct aperture optimization

Direct aperture Optimization (DAO)

= directly optimize shape and intensity of apertures