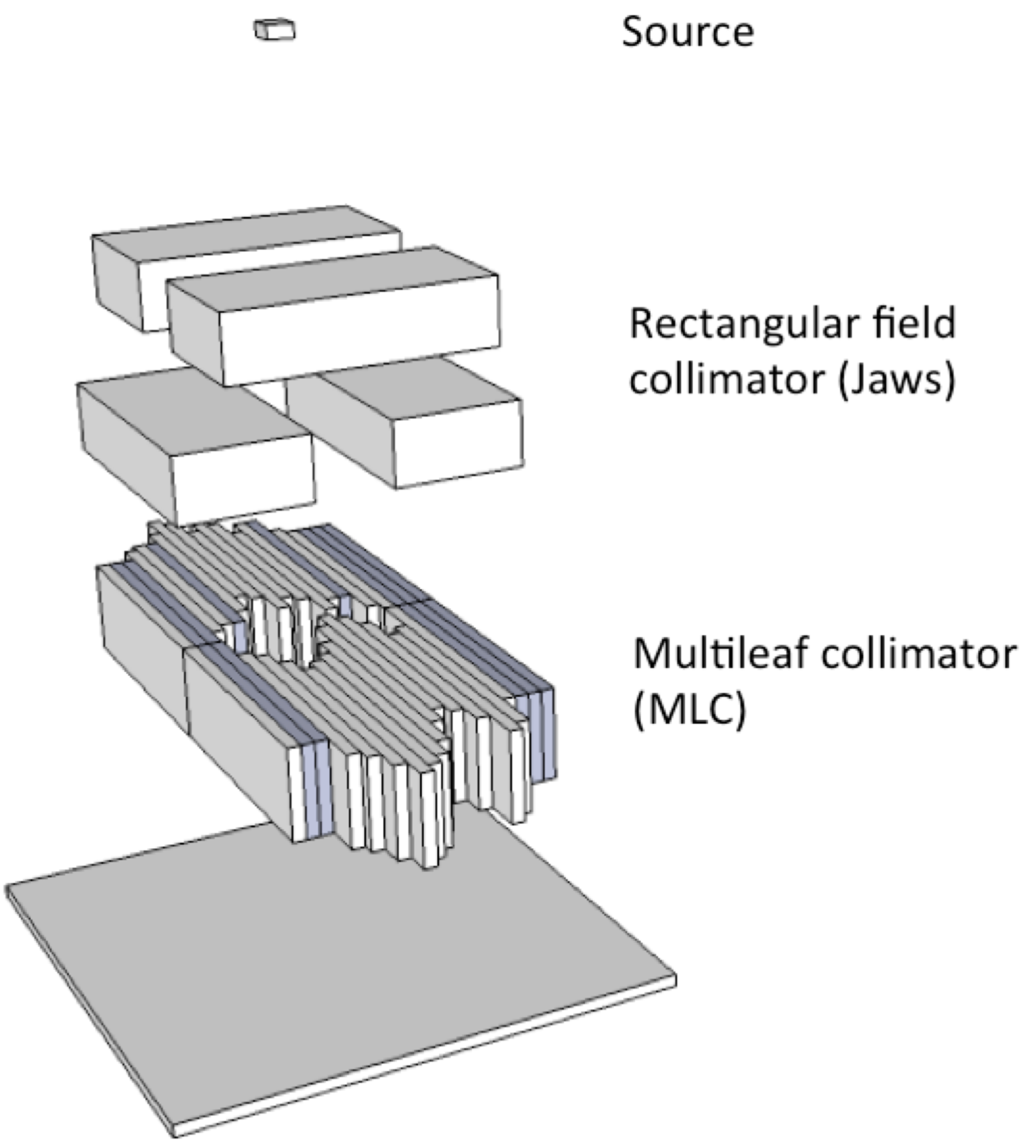
Beam collimation using MLC



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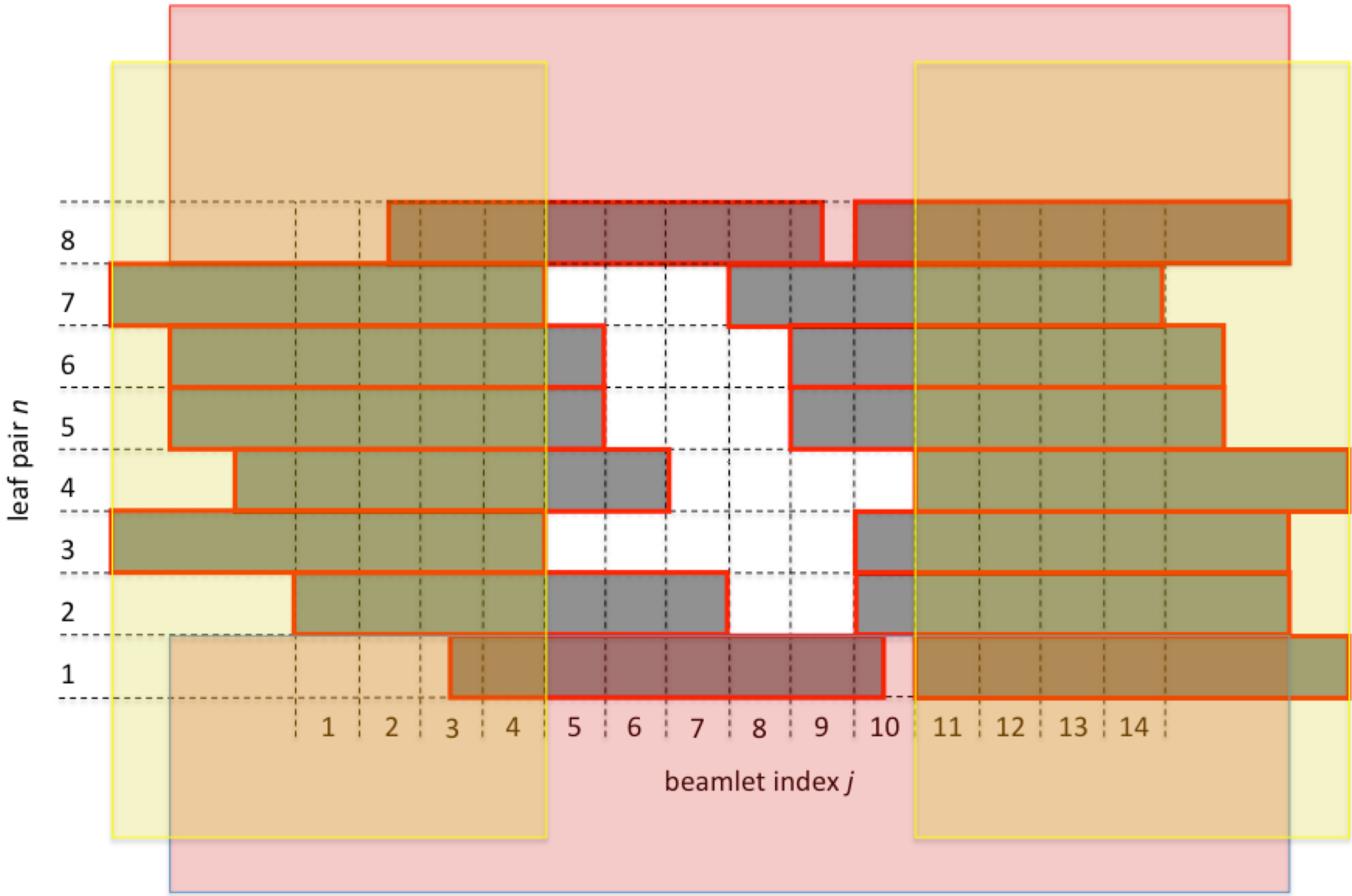
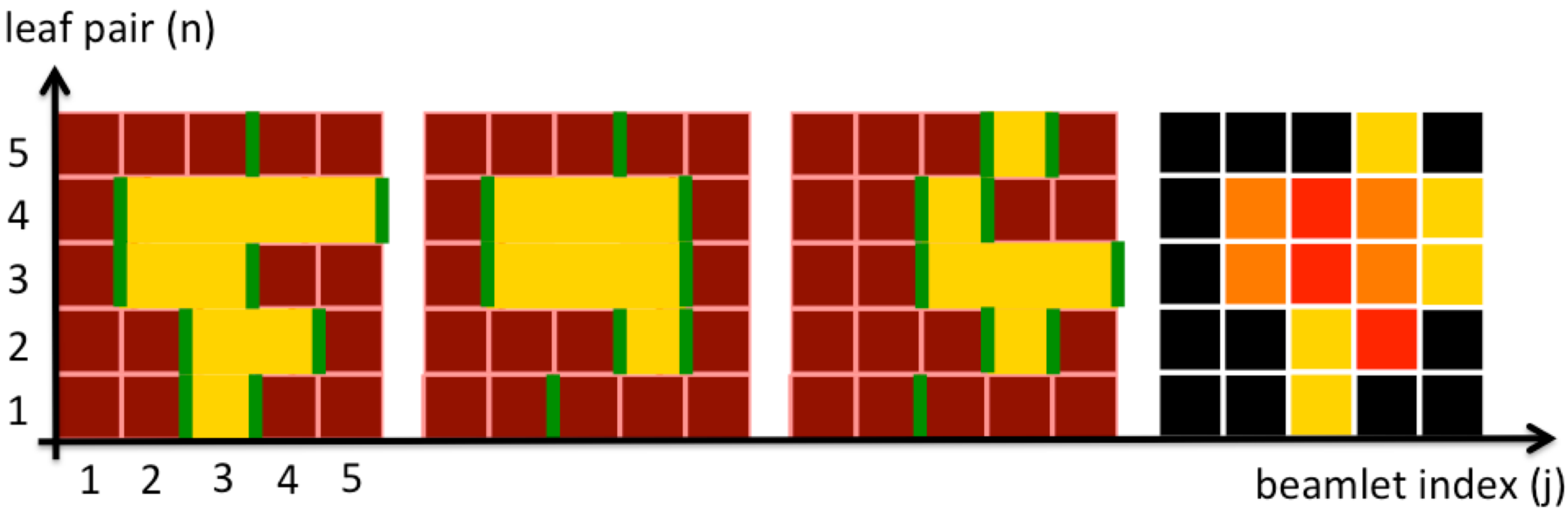


Leaf sequencing

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)

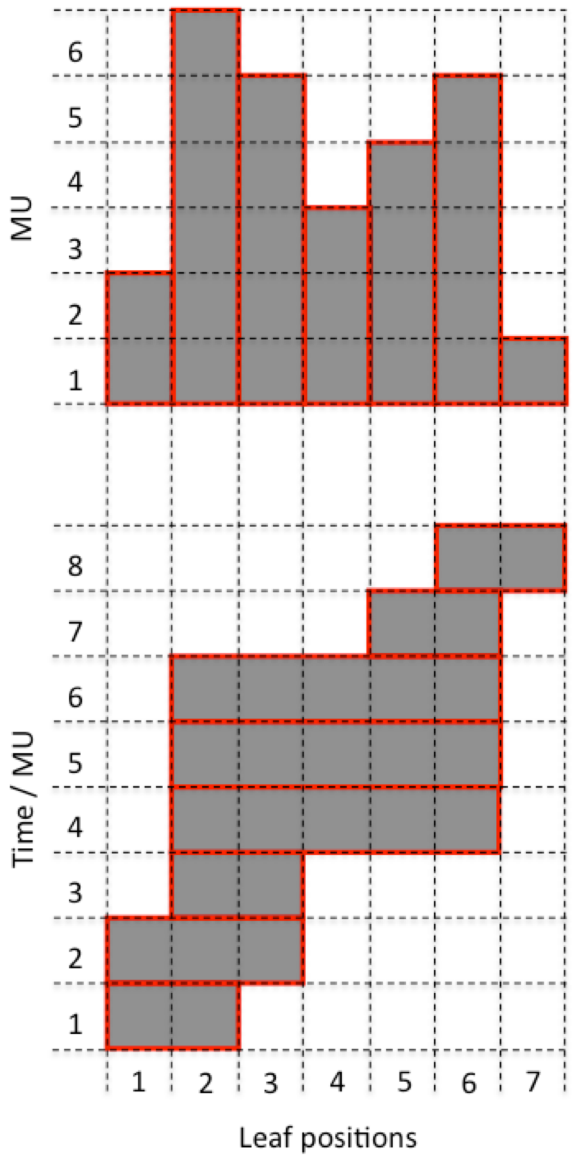
Goal: Find an efficient solution

- 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

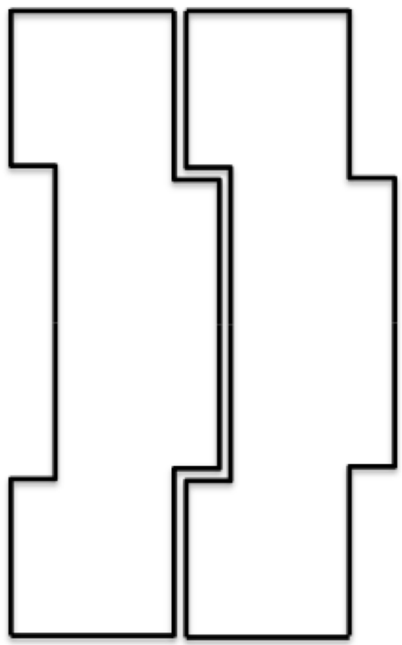
  (benefit of fine tuning leaf positions at the target edge)

- 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