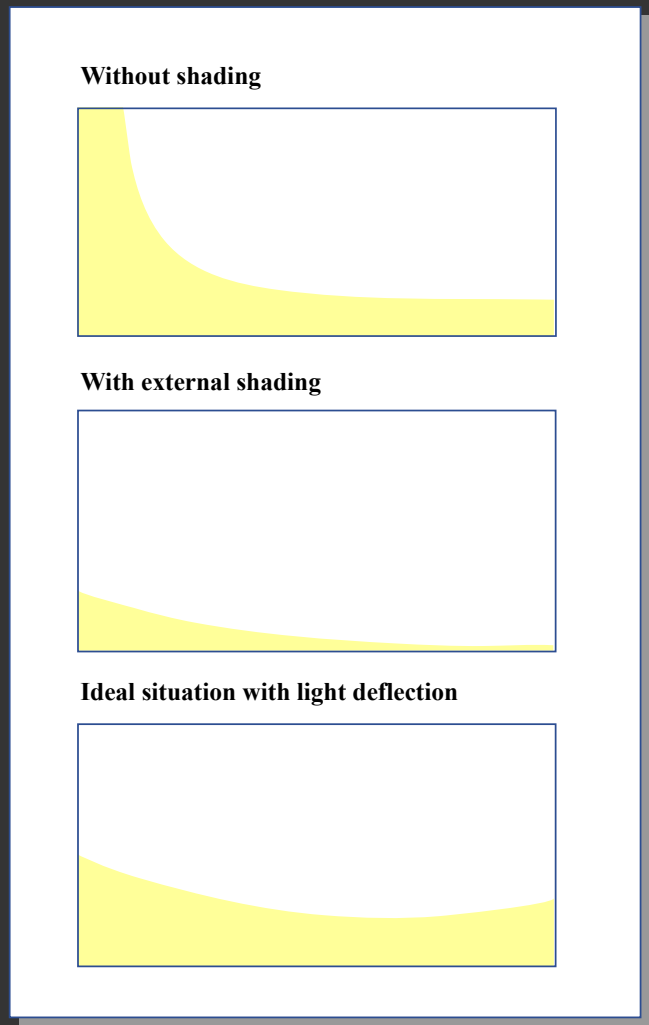
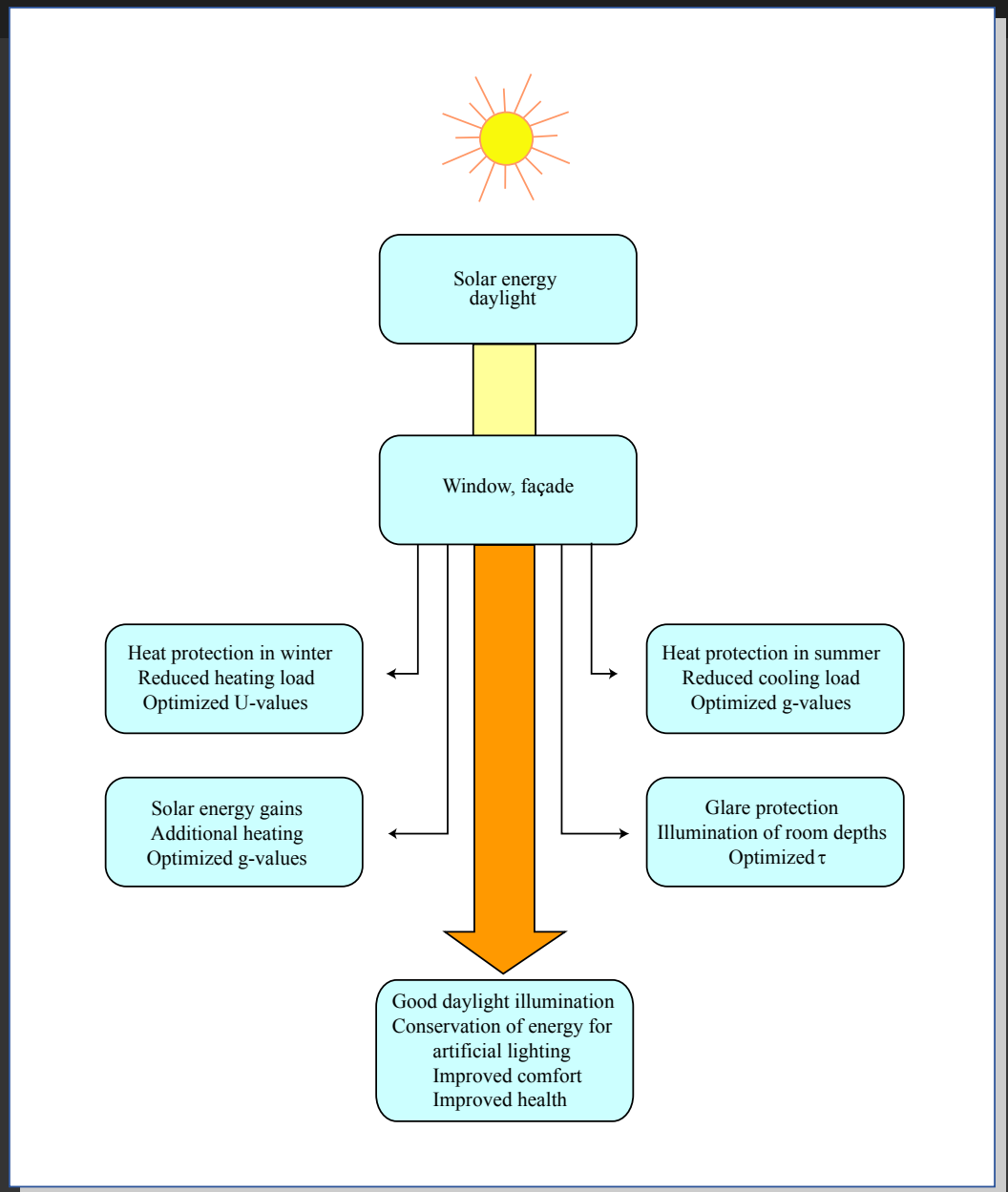
Advanced Lighting Strategies

- Strategy at the building's design level
  - Atrium
  - Skylights
  - Light guiding

Advanced fenestration technologies

- General principle





Figures by MIT OCW.

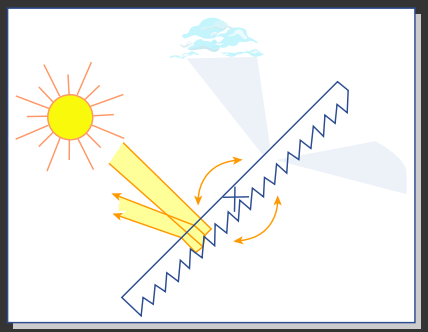
Advanced fenestration technologies

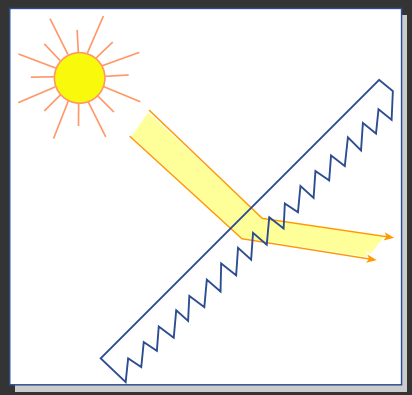
- Theoretical angular selective glazing could achieve:
  - 18% annual cooling energy reduction
  - 15% annual electricity use reduction

relative to spectrally selective glazing

Advanced fenestration technologies

- Classification of CFS
  - with shading
    - diffuse daylight



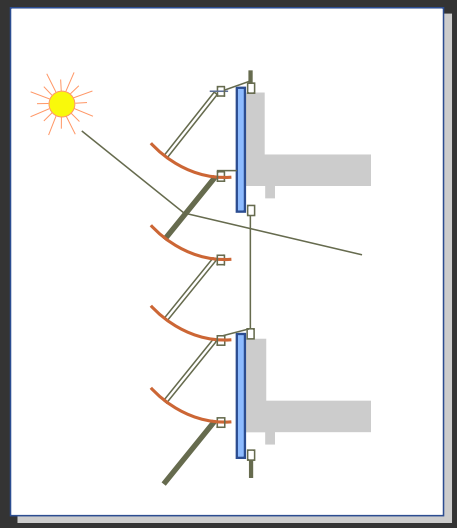


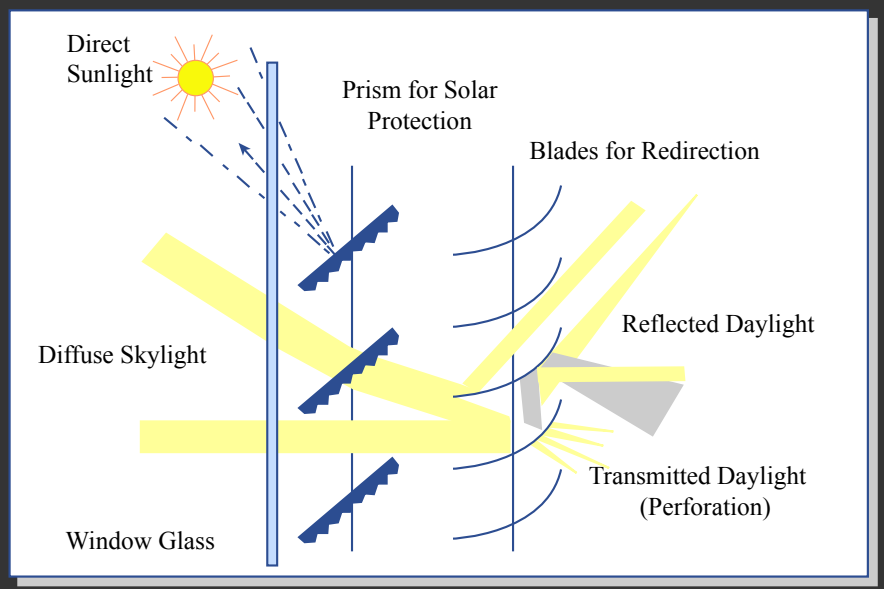
Prismatic panels (→ 4.5)		All climates	Vertical windows, skylights
Prisms and venetian blinds		Temperate climates	Vertical windows
Sun protecting mirror elements		Temperate climates	Skylights, glazed roofs
Anidolic zenithal opening (→ 4.12, 4.13)		Temperate climates	Skylights
Directional selective shading system with concentrating Holographic Optical Element (HOE) (→ 4.11)		All climates	Vertical windows, skylights, glazed roofs
Transparent shading system with HOE based on total reflection (→ 4.11)		Temperate climates	Vertical windows, skylights, glazed roofs

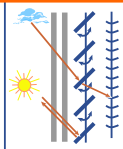
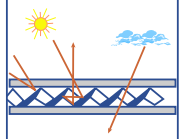
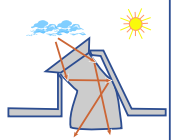
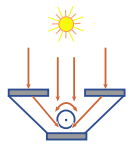
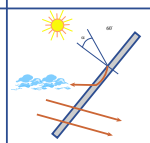
Figures by MIT OCW.

Advanced fenestration technologies

- Classification of CFS
  - with shading
    - diffuse daylight





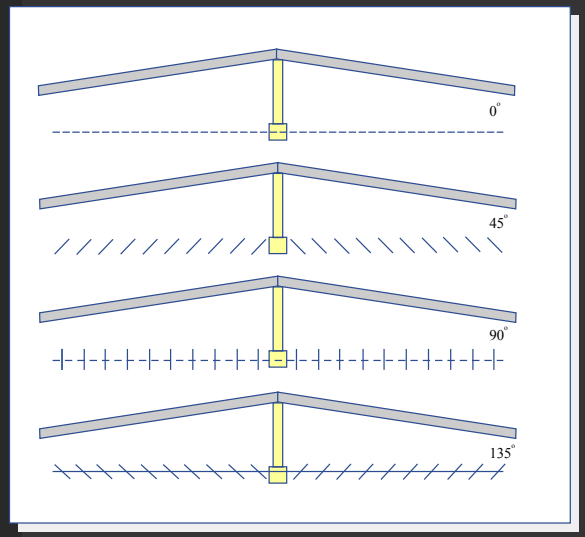
Prismatic panels (→ 4.5)		All climates	Vertical windows, skylights
Prisms and venetian blinds		Temperate climates	Vertical windows
Sun protecting mirror elements		Temperate climates	Skylights, glazed roofs
Anidolic zenithal opening (→ 4.12, 4.13)		Temperate climates	Skylights
Directional selective shading system with concentrating Holographic Optical Element (HOE) (→ 4.11)		All climates	Vertical windows, skylights, glazed roofs
Transparent shading system with HOE based on total reflection (→ 4.11)		Temperate climates	Vertical windows, skylights, glazed roofs

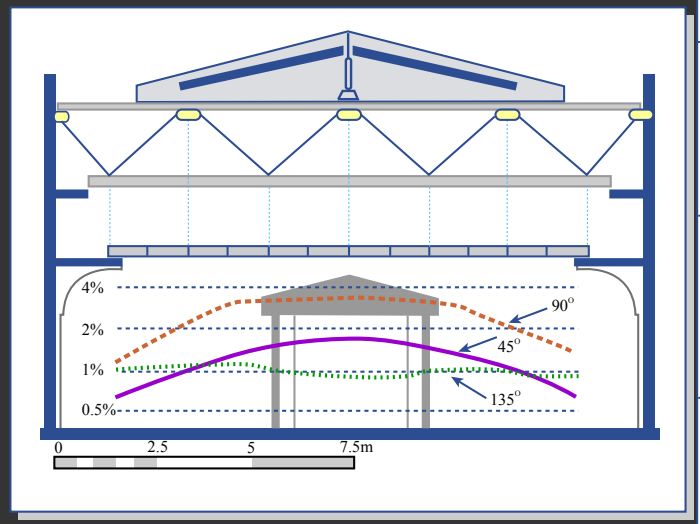
Figures by MIT OCW.

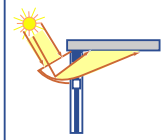
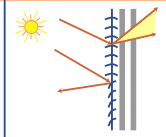
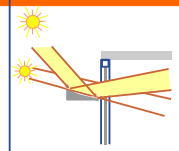
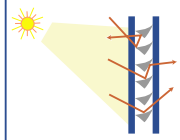
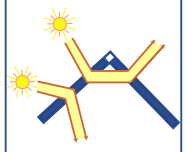
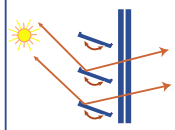
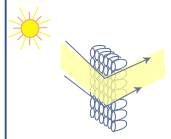
Advanced fenestration technologies

Classification of CFS

- with shading
  - direct sunlight



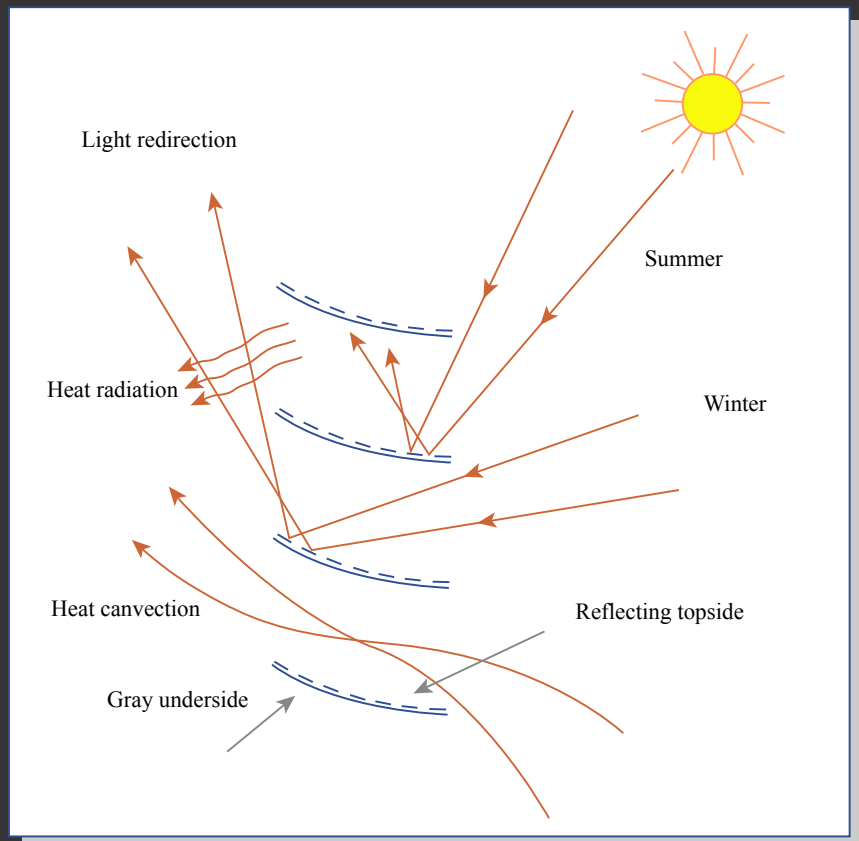


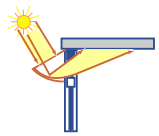
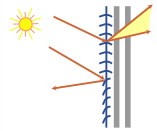
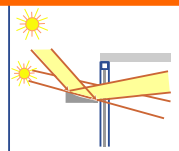
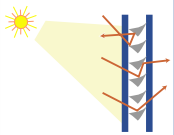
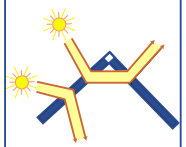
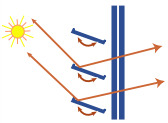
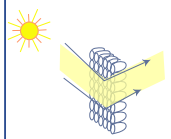
Light guiding shade(→4.7)		Hot climates, sunny skies	Vertical windows above eye height
Louvres and blinds(→4.4)		All climates	Vertical windows
Light shelf for redirection of sunlight (→ 4.3)		All climates	Vertical windows
Glazing with reflecting profiles (Okasolar)		Temperate climates	Vertical windows, skylights
Skylight with Laser Cut panels (LCPs) (→ 4.7)		Hot climates, sunny skies, low latitudes	Skylights
Turnable lamellas		Temperate climates	Vertical windows, skylights
Anidolic solar blinds (→ 4.13)		All climates	Vertical windows

Figures by MIT OCW.

Advanced fenestration technologies

- Classification of CFS
  - with shading
    - direct sunlight



Light guiding shade(→4.7)		Hot climates, sunny skies	Vertical windows above eye height
Louvres and blinds(→4.4)		All climates	Vertical windows
Light shelf for redirection of sunlight (→ 4.3)		All climates	Vertical windows
Glazing with reflecting profiles (Okasolar)		Temperate climates	Vertical windows, skylights
Skylight with Laser Cut panels (LCPs) (→ 4.7)		Hot climates, sunny skies, low latitudes	Skylights
Turnable lamellas		Temperate climates	Vertical windows, skylights
Anidolic solar blinds (→ 4.13)		All climates	Vertical windows

Figures by MIT OCW.

Advanced fenestration technologies

- Classification of CFS
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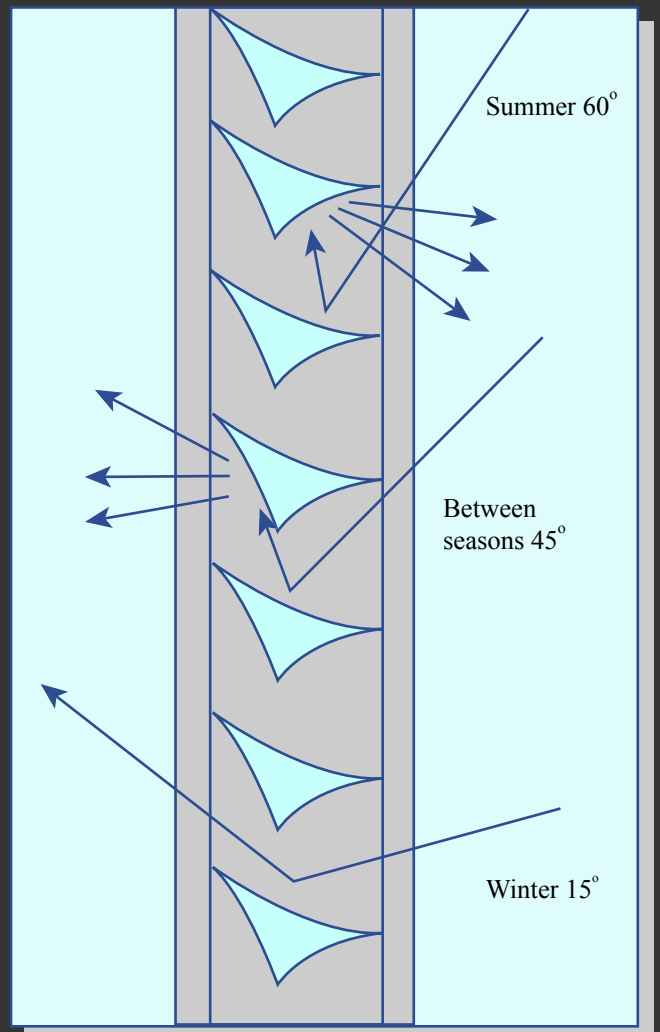
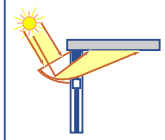
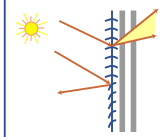
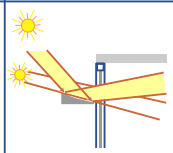
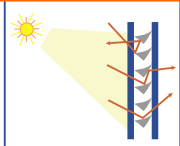
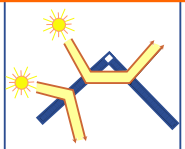
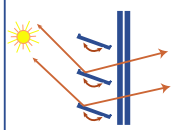
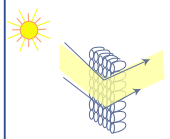


Light guiding shade(→4.7)		Hot climates, sunny skies	Vertical windows above eye height
Louvres and blinds(→4.4)		All climates	Vertical windows
Light shelf for redirection of sunlight (→ 4.3)		All climates	Vertical windows
Glazing with reflecting profiles (Okasolar)		Temperate climates	Vertical windows, skylights
Skylight with Laser Cut panels (LCPs) (→ 4.7)		Hot climates, sunny skies, low latitudes	Skylights
Turnable lamellas		Temperate climates	Vertical windows, skylights
Anidolic solar blinds (→ 4.13)		All climates	Vertical windows

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Advanced fenestration technologies

- Classification of CFS
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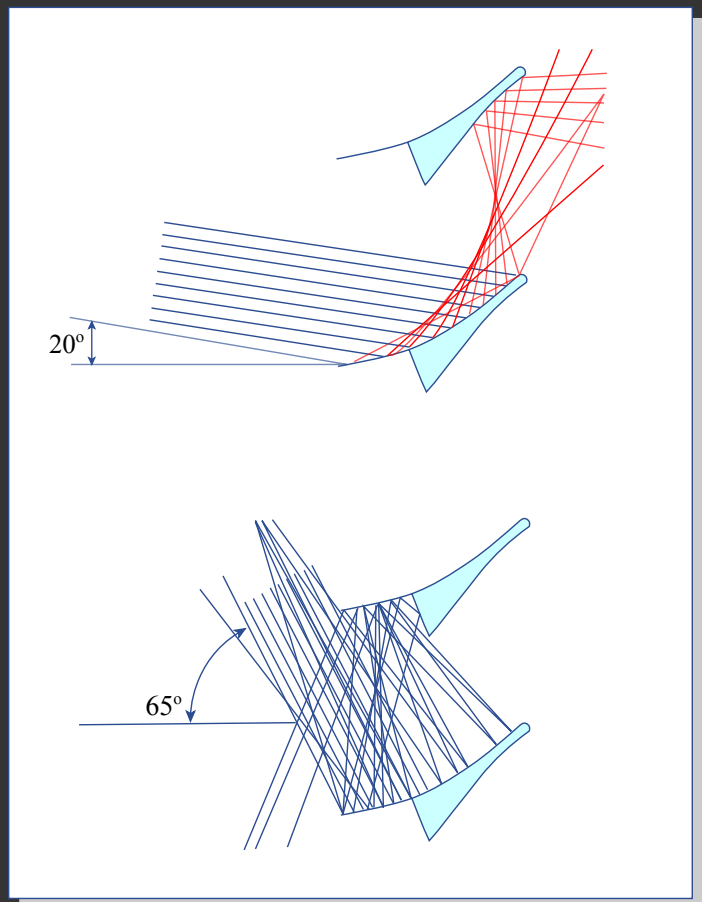
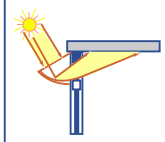
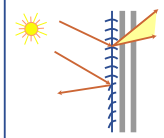
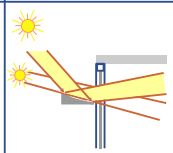
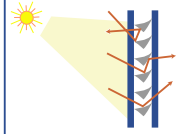
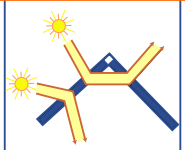
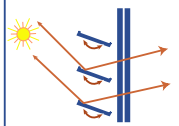
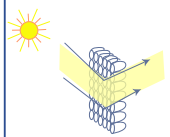


Light guiding shade(→4.7)		Hot climates, sunny skies	Vertical windows above eye height
Louvres and blinds(→4.4)		All climates	Vertical windows
Light shelf for redirection of sunlight (→ 4.3)		All climates	Vertical windows
Glazing with reflecting profiles (Okasolar)		Temperate climates	Vertical windows, skylights
Skylight with Laser Cut panels (LCPs) (→ 4.7)		Hot climates, sunny skies, low latitudes	Skylights
Turnable lamellas		Temperate climates	Vertical windows, skylights
Anidolic solar blinds (→ 4.13)		All climates	Vertical windows

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Advanced fenestration technologies

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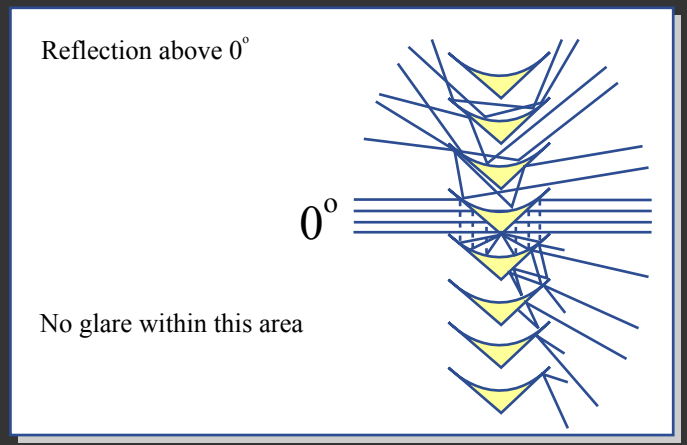
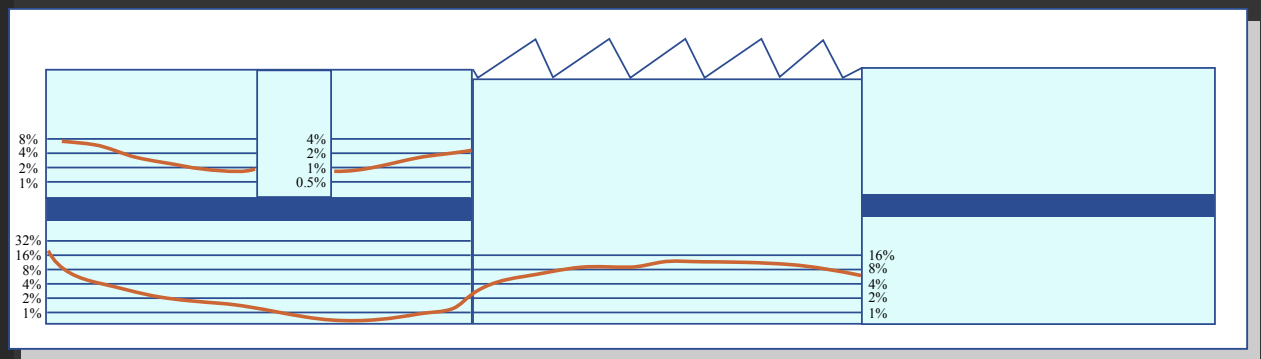
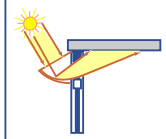
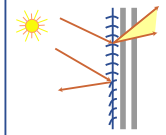
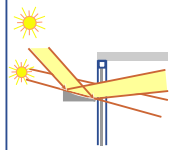
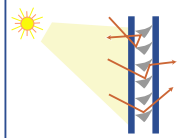
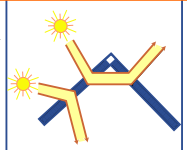
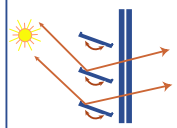
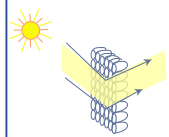


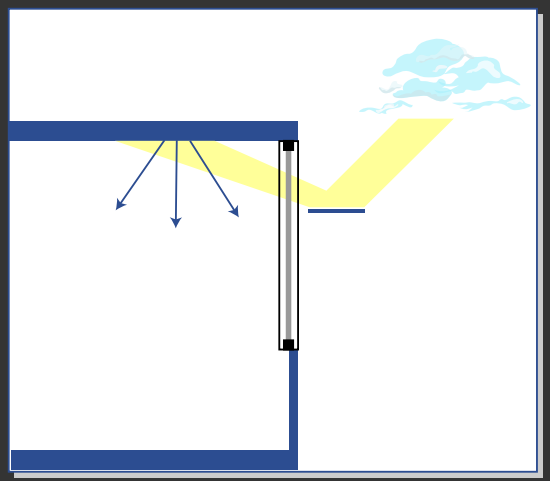


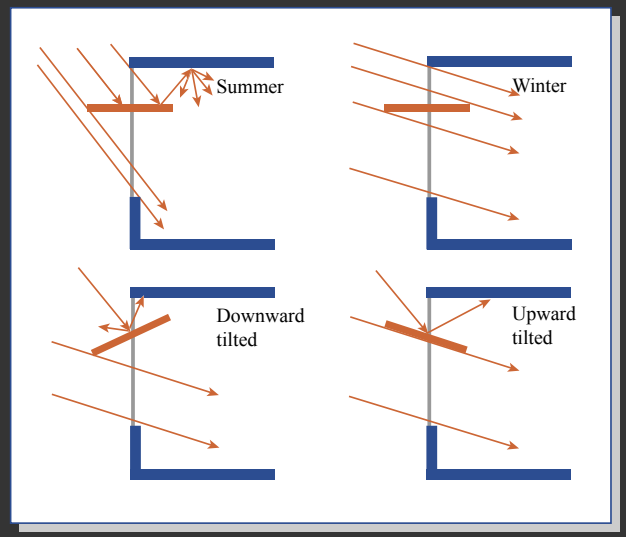
Light guiding shade(→4.7)		Hot climates, sunny skies	Vertical windows above eye height
Louvres and blinds(→4.4)		All climates	Vertical windows
Light shelf for redirection of sunlight (→ 4.3)		All climates	Vertical windows
Glazing with reflecting profiles (Okasolar)		Temperate climates	Vertical windows, skylights
Skylight with Laser Cut panels (LCPs) (→ 4.7)		Hot climates, sunny skies, low latitudes	Skylights
Turnable lamellas		Temperate climates	Vertical windows, skylights
Anidolic solar blinds (→ 4.13)		All climates	Vertical windows

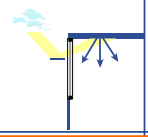
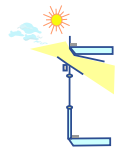
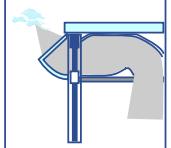
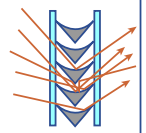
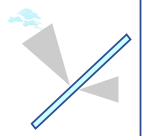
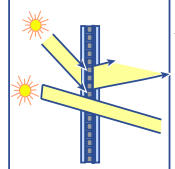
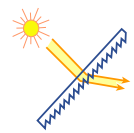
Figures by MIT OCW.

Advanced fenestration technologies

- Classification of CFS
  - without shading
    - diffuse light guiding systems





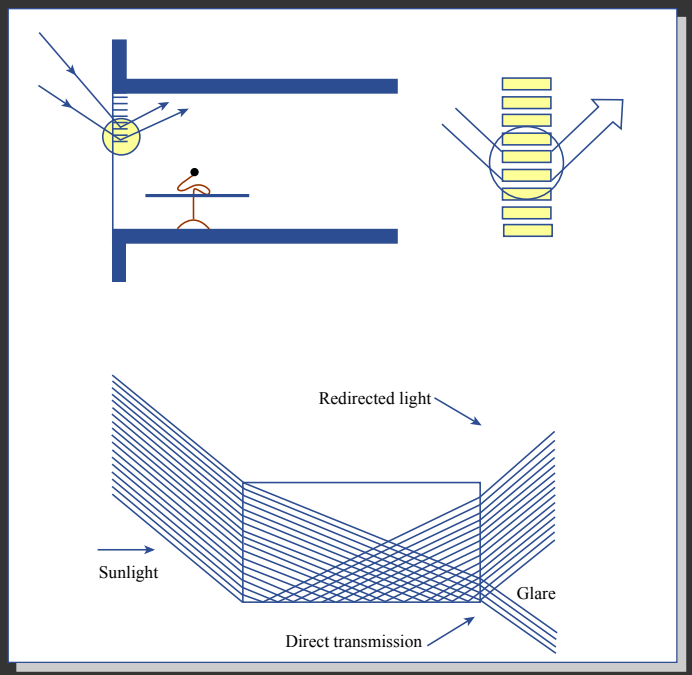
Light shelf (→ 4.3)		Temperate climates, cloudy skies	Vertical windows
Anidolic Integrated System (→ 4.12)		Temperate climates	Vertical windows
Anidolic ceiling (→ 4.12)		Temperate climates, cloudy skies	Vertical facade above view-ing window
Fish System		Temperate climates	Vertical windows
Zenith light guiding elements with HOEs (→ 4.10)		Temperate climates, cloudy skies	Vertical windows (especially in court-yards), skylights
Laser Cut panel (→ 4.6)		All climates	Vertical windows, skylights
Prismatic panels (→ 4.5)		All climates	Vertical windows, skylights

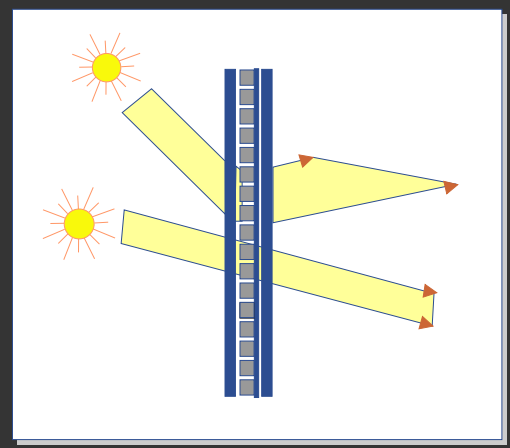
Figures by MIT OCW.

Advanced fenestration technologies

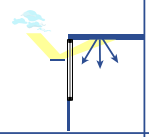
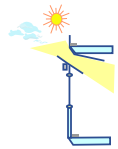
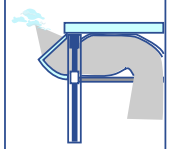
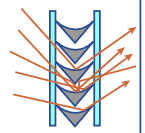
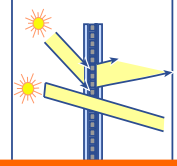
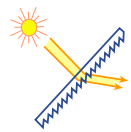
Classification of CFS

- without shading
  - diffuse light guiding systems





Figures by MIT OCW.

Light shelf (→ 4.3)		Temperate climates, cloudy skies	Vertical windows
Anidolic Integrated System (→ 4.12)		Temperate climates	Vertical windows
Anidolic ceiling (→ 4.12)		Temperate climates, cloudy skies	Vertical facade above view-ing window
Fish System		Temperate climates	Vertical windows
Zenith light guiding elements with HOEs (→ 4.10)		Temperate climates, cloudy skies	Vertical windows (especially in court-yards), skylights
Laser Cut panel (→ 4.6)		All climates	Vertical windows, skylights
Prismatic panels (→ 4.5)		All climates	Vertical windows, skylights

Advanced fenestration technologies

- Classification of CFS
  - without shading
    - direct light guiding systems
    - light scattering/diffusing systems

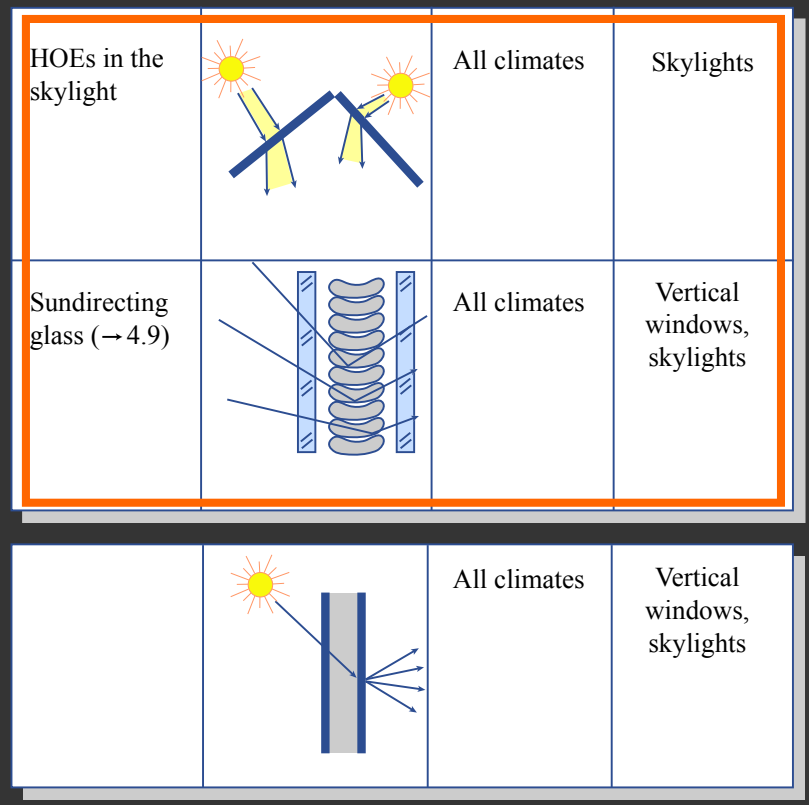


Figure by MIT OCW.

Advanced fenestration technologies

- Classification of CFS
  - without shading
    - light transport systems

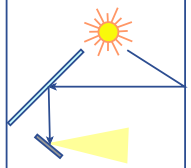
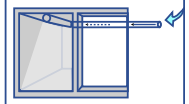
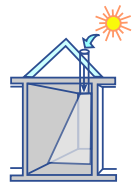
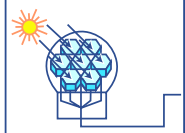
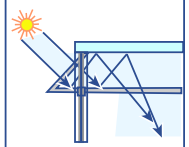
Heliostat		All climates, sunny skies	
Light pipe		All climates, sunny skies	
Solar Tube		All climates, sunny skies	Roof
Fibres		All climates, sunny skies	
Light-guiding ceiling		Temperate climates, sunny skies	

Figure by MIT OCW.

Advanced fenestration technologies

- Arbed-Stahl HQ, Luxemburg
  - Gottfried Boehm

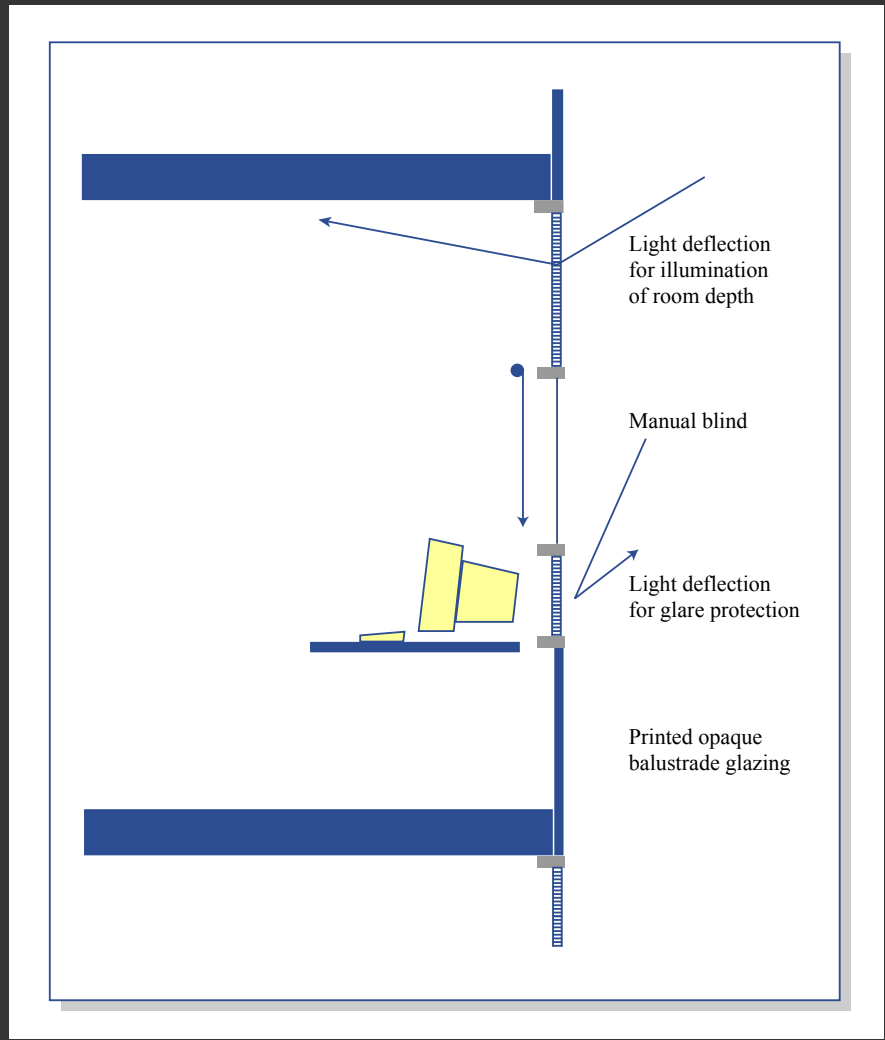


Figure by MIT OCW.

Advanced fenestration technologies

- "ag4 Mediatecture" company, Cologne
  - TIM façades

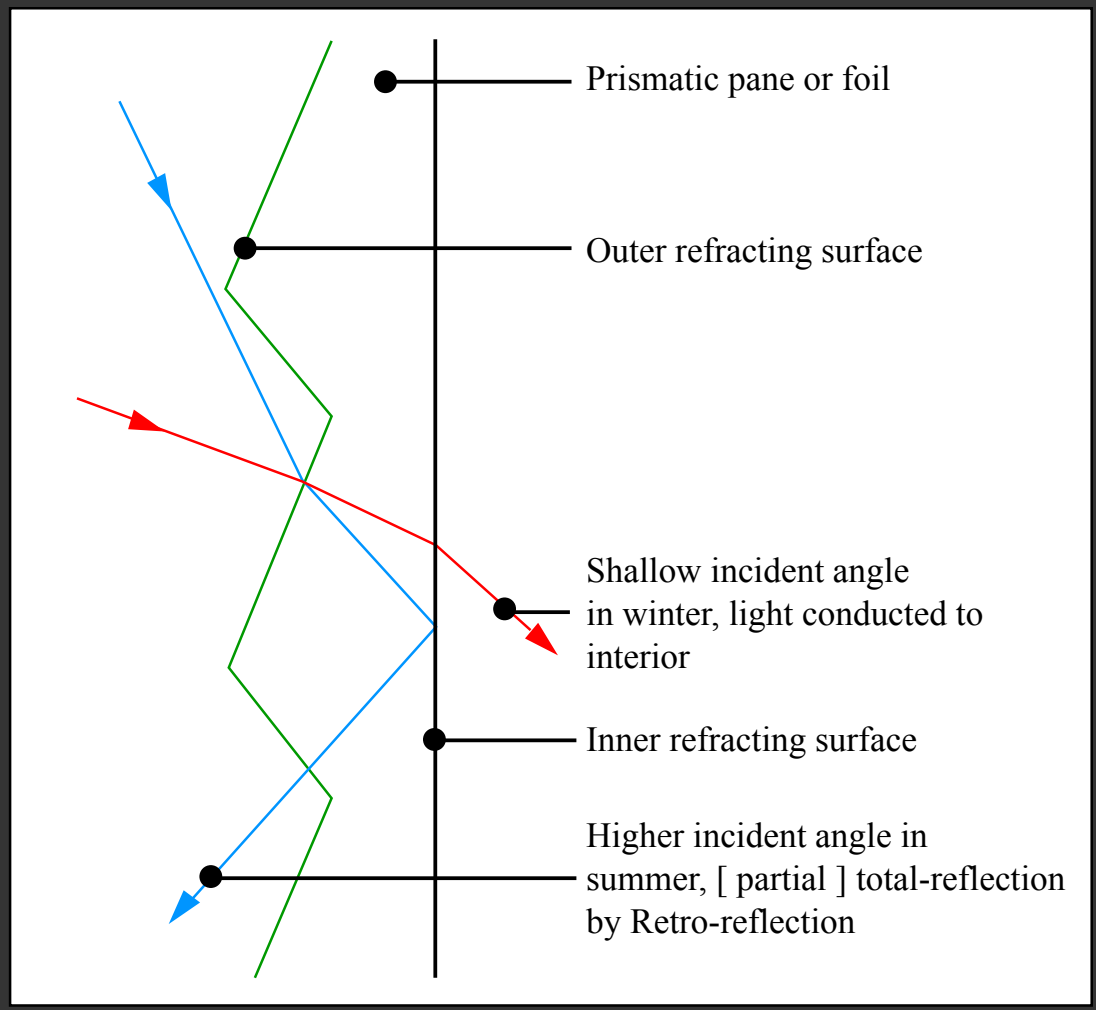
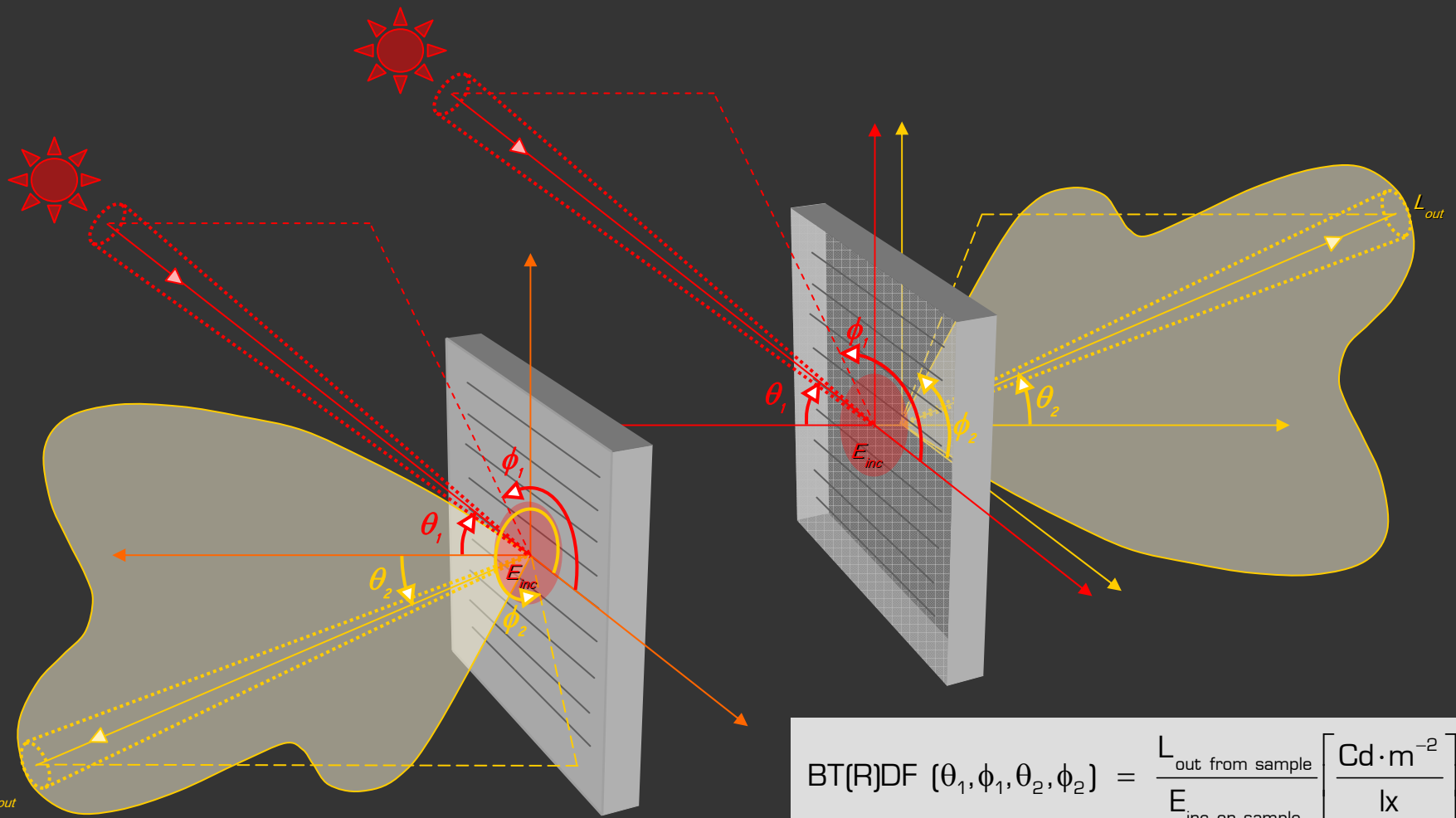


Figure by MIT OCW.

Characterization of CFS

- Bidirectional Transmission/Reflection Distribution Function



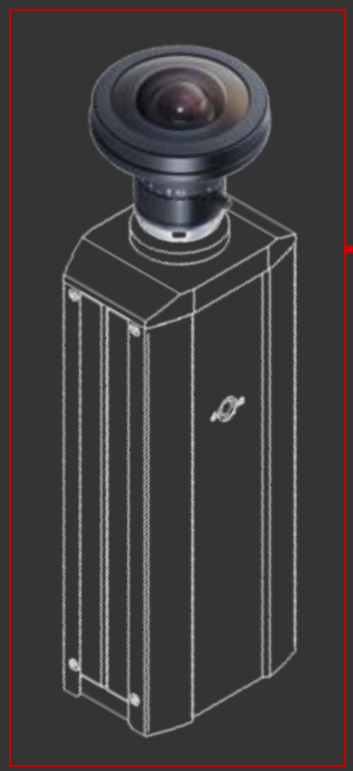
$$BT(R)DF\ (\theta_1, \phi_1, \theta_2, \phi_2) = \frac{L_{out\ from\ sample}}{E_{inc\ on\ sample}} \left[\frac{Cd \cdot m^{-2}}{lx} \right]$$

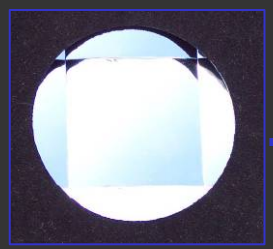
Characterization of CFS

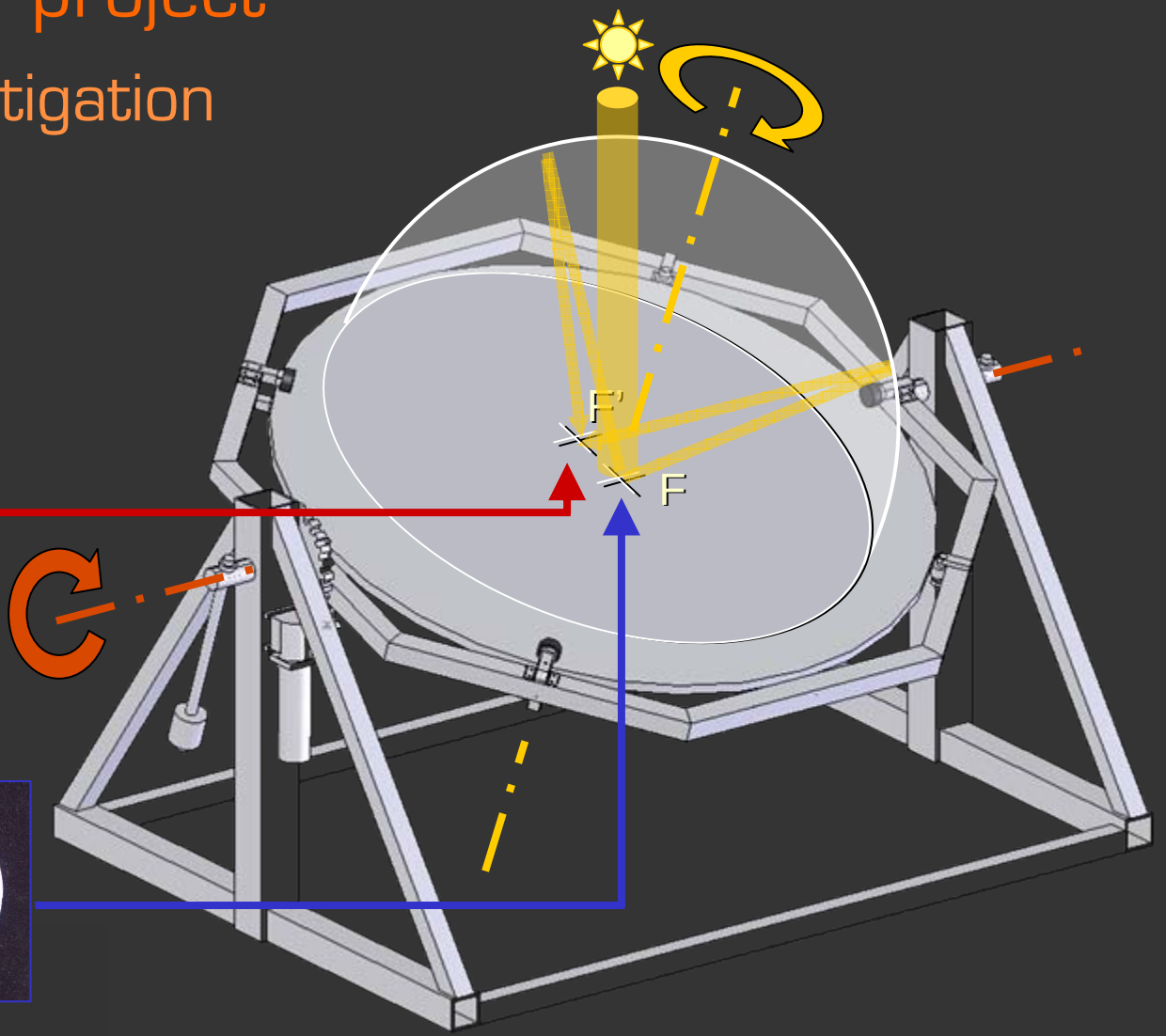
- BT(R)DFs for different components
  - Diffusing elements
    - opalescent glass or panels, LMT paint
  - Sunlight redirecting systems
    - LCP, Lumitop, HOE, serraglaze, mirrors
  - Prismatic panels
    - Siemens prisms, 3M film
  - Fabric blinds
    - Baumann-Hüppe & REVIS prototypes
  - Venetian blinds
    - Okasolar; mirrored, metallic, Köster blinds

Characterization of CFS

- The “HelioDome" project
  - continuous investigation
  - time-efficiency







Characterization of CFS

- The “HelioDome" project
  - continuous investigation
  - time-efficiency
  - wavelength-dependent investigation (& color camera)
  - BT&RDF over visible and NIR
    - ~½ solar gains due to NIR
    - visual and thermal comfort

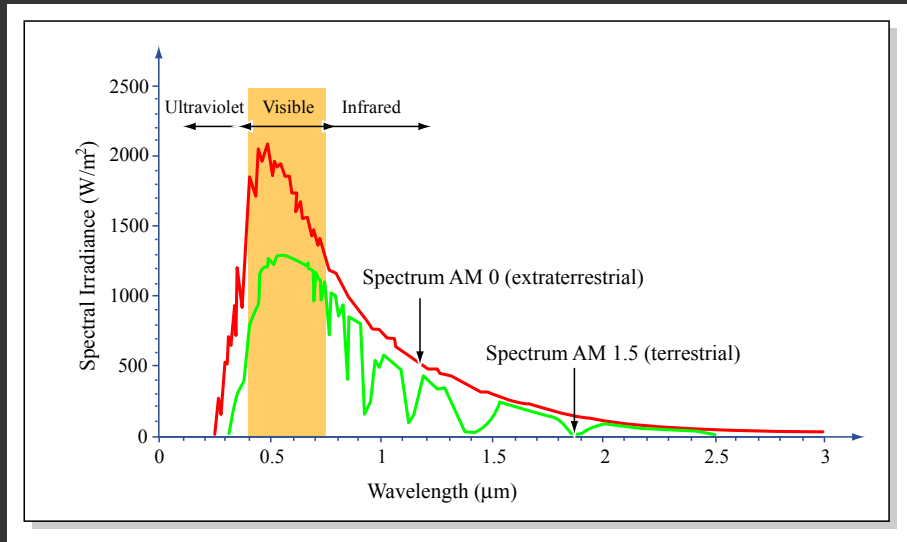


Figure by MIT OCW.

The HelioDome's older brother