Innovative Daylighting Systems

MSc Architecture, Energy & Sustainability
Module ADP033
Daylighting & Energy Efficient Artificial Lighting

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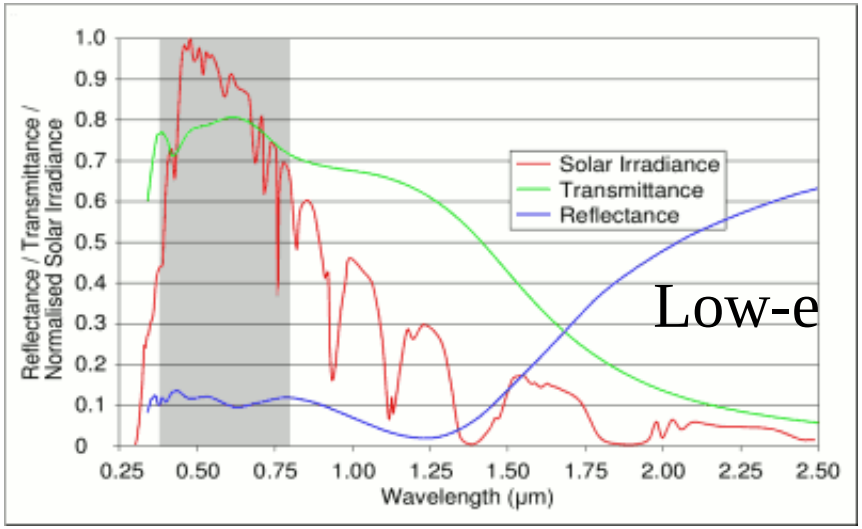
2012/13

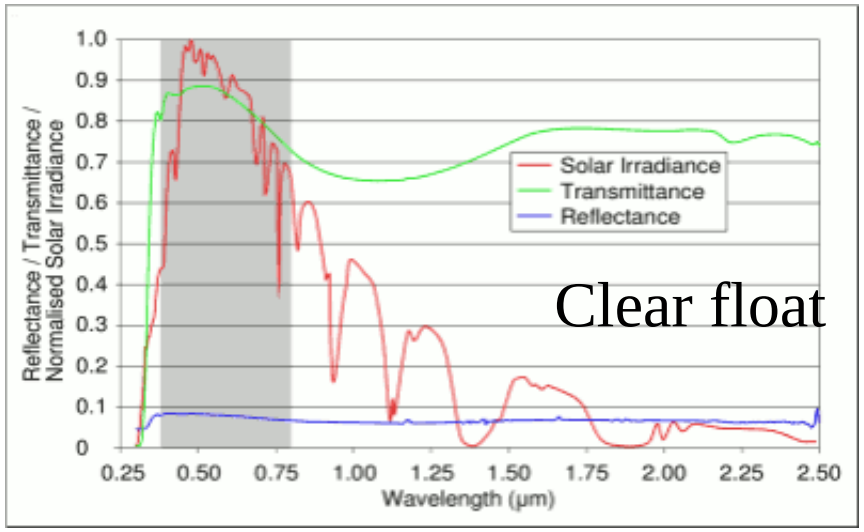
Structure

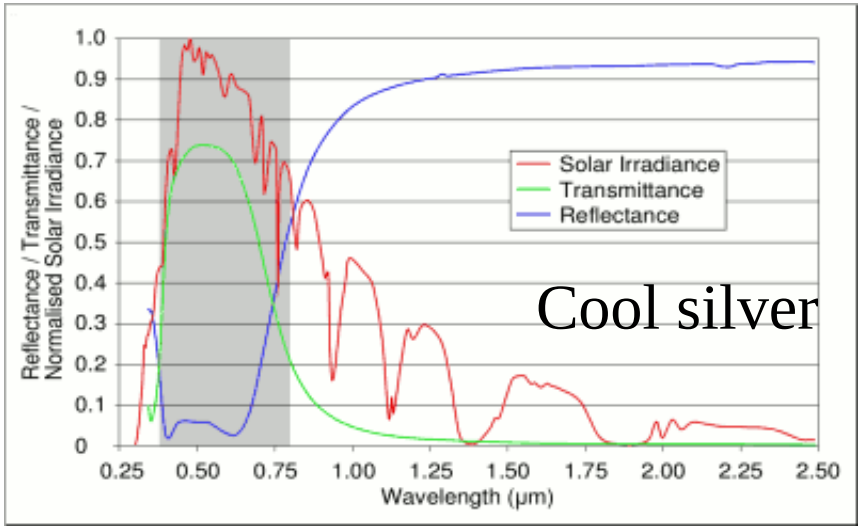
- Light shelves
- Louvres and blinds
- Light transport
- General thoughts

A Quick Reminder

- Modern glass coatings can ensure low solar heat gains (g-value) and a high visible transmittance (τ)
- A high g-value might be desirable for passive solar buildings so that the sun's energy can be harvested in winter. Beware of low-angle solar glare.







John Soane's Museum

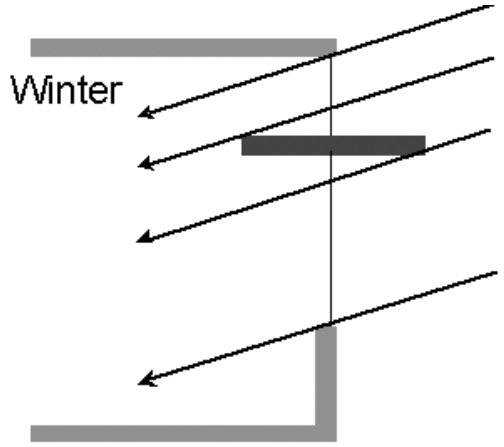
Sir John Soane's Museum, London

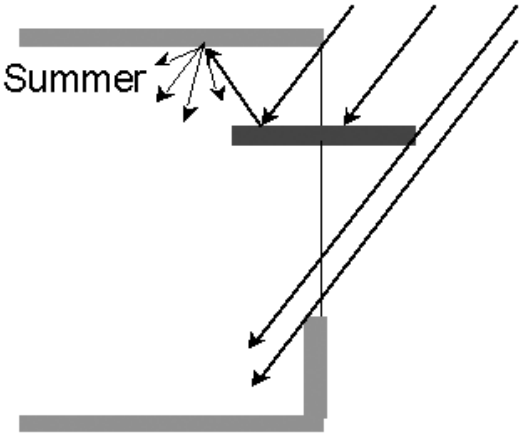
Light Shelves

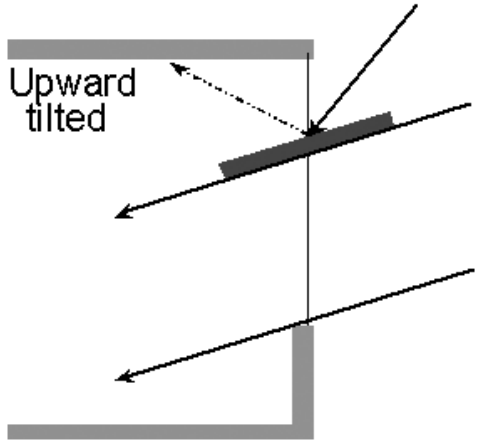
- Used to even out levels of daylight in a room
- Illuminance near the window is reduced, but illuminance at the back of the room is increased
- Like all daylighting systems, they need to be optimised for the predominant sky condition:
  - Overcast: outside, sloped, reflective
  - Sunny: inside or outside (doubles as shading), horizontal, diffuse (to avoid glare)
- Light shelves are often seen as the solution to any daylighting problem. They never are...

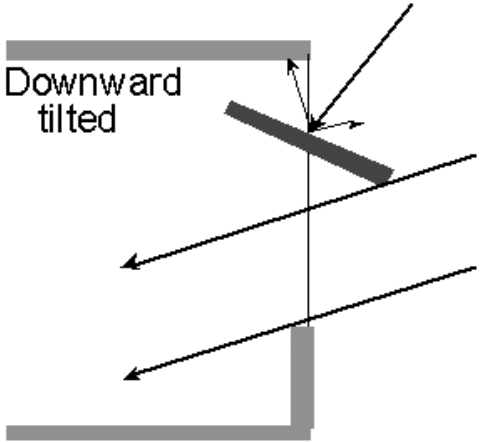
Light Shelves

- The ceiling becomes an important part of the system
- LS are only viable with sufficient ceiling height. This is not usually given in the UK.



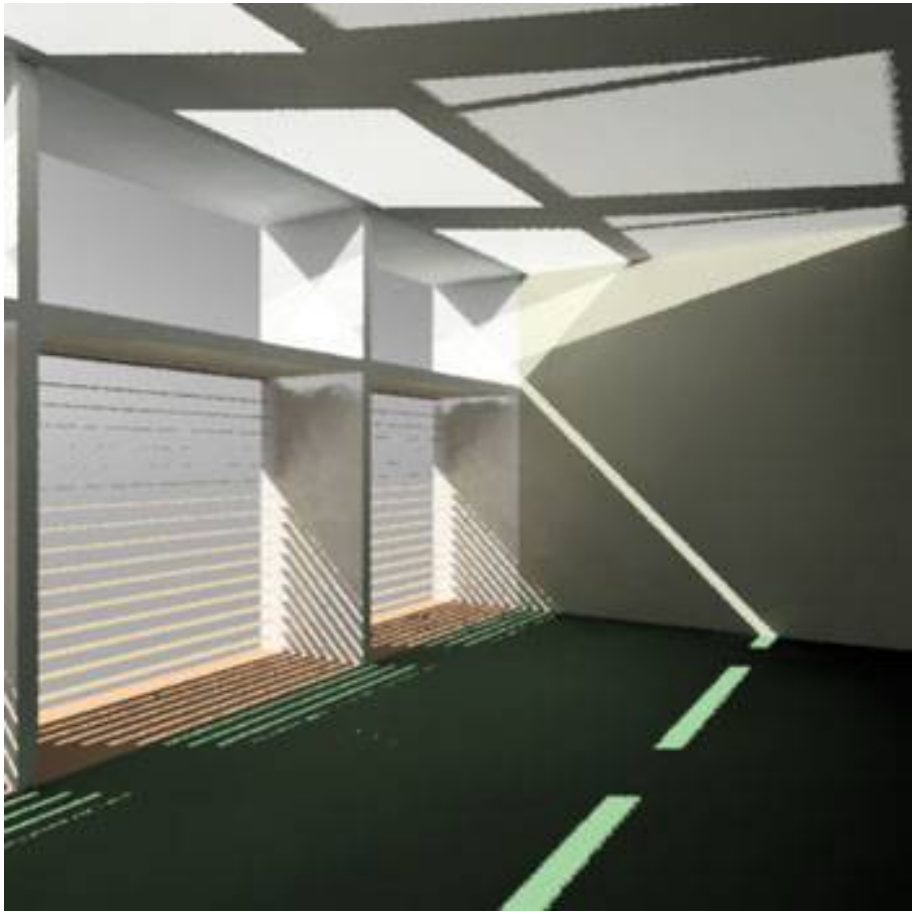






Light Shelves

For overcast skies



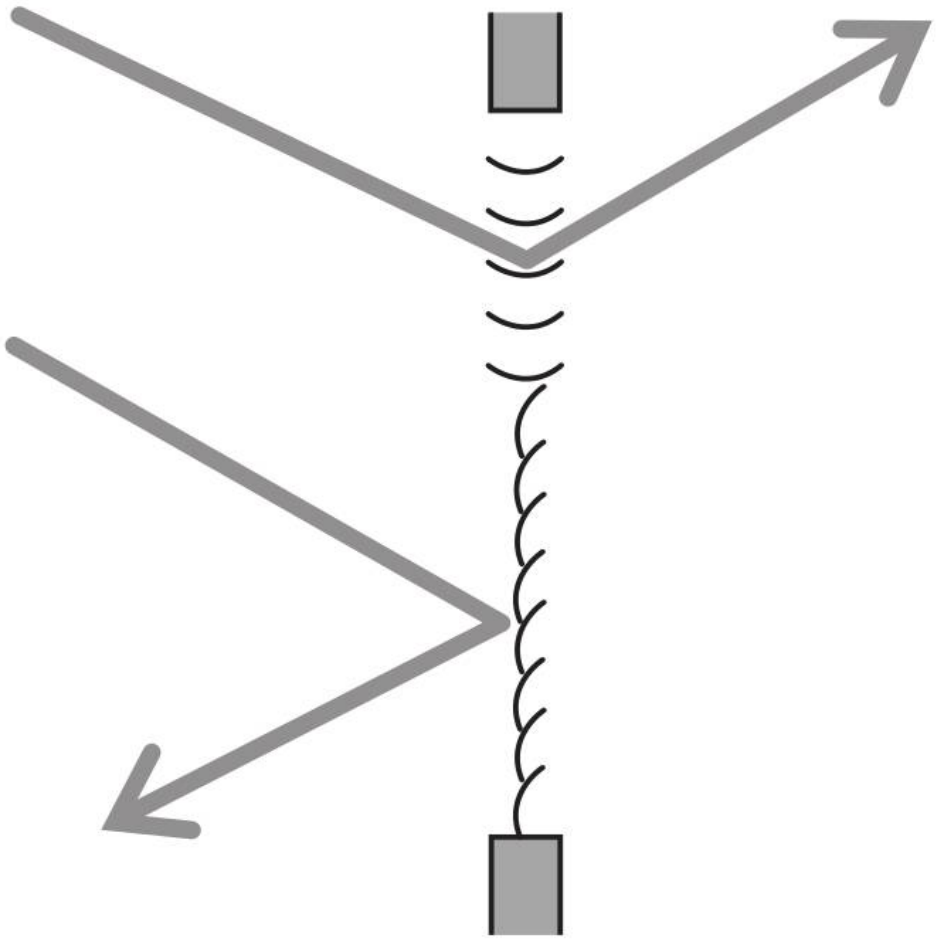
For clear skies

http://www.new-learn.info/learn/packages/clear/visual/buildings/elements/exterior/lightshelf.html

Louvres and Blinds

- May obstruct, absorb, reflect and/or transmit solar radiation (diffuse and direct) to a building's interior
- Position: exterior, interior or mid-pane
- Slats can be flat or curved
- Effect such as view out, glare, redirection of sunlight are highly dependent on slat angle

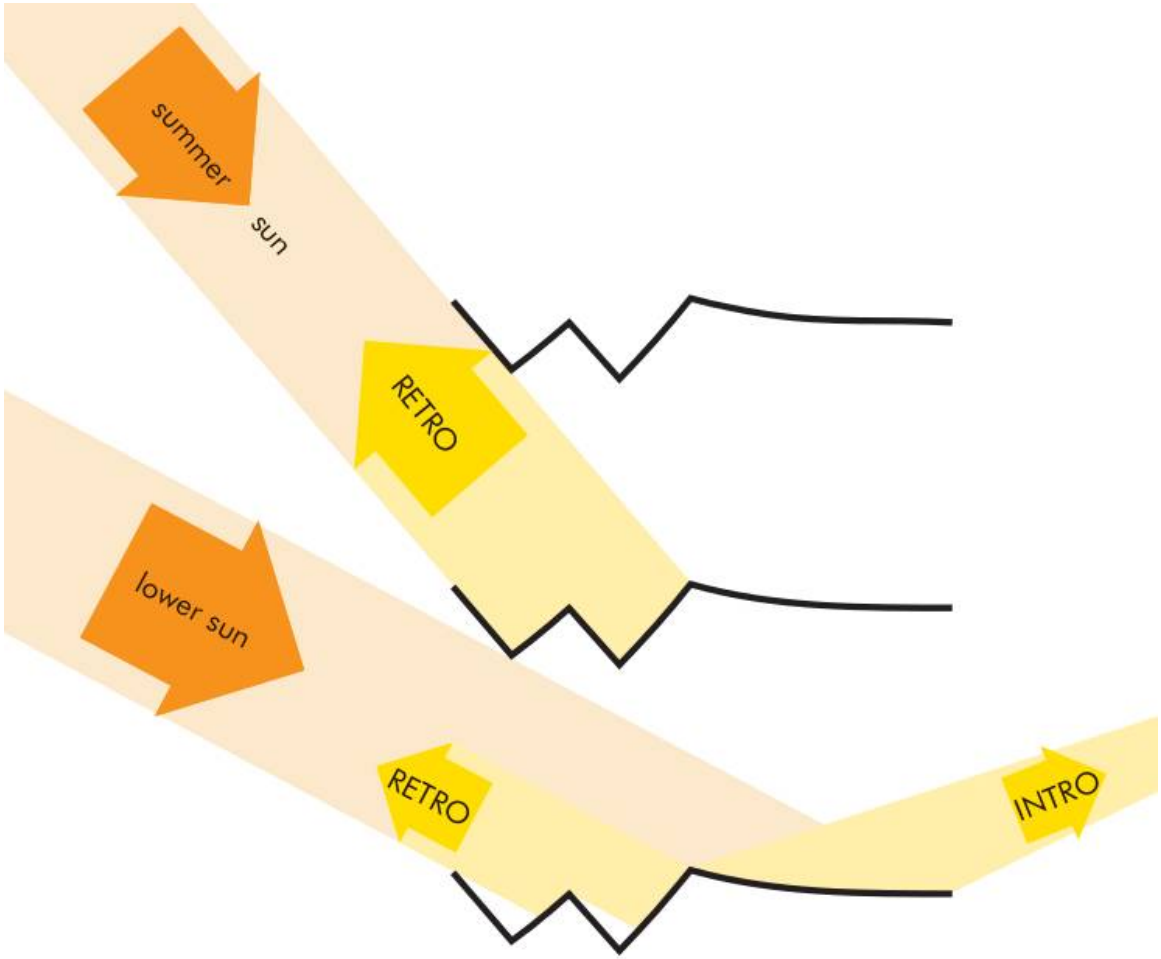
Dual-slat angle reflective blinds

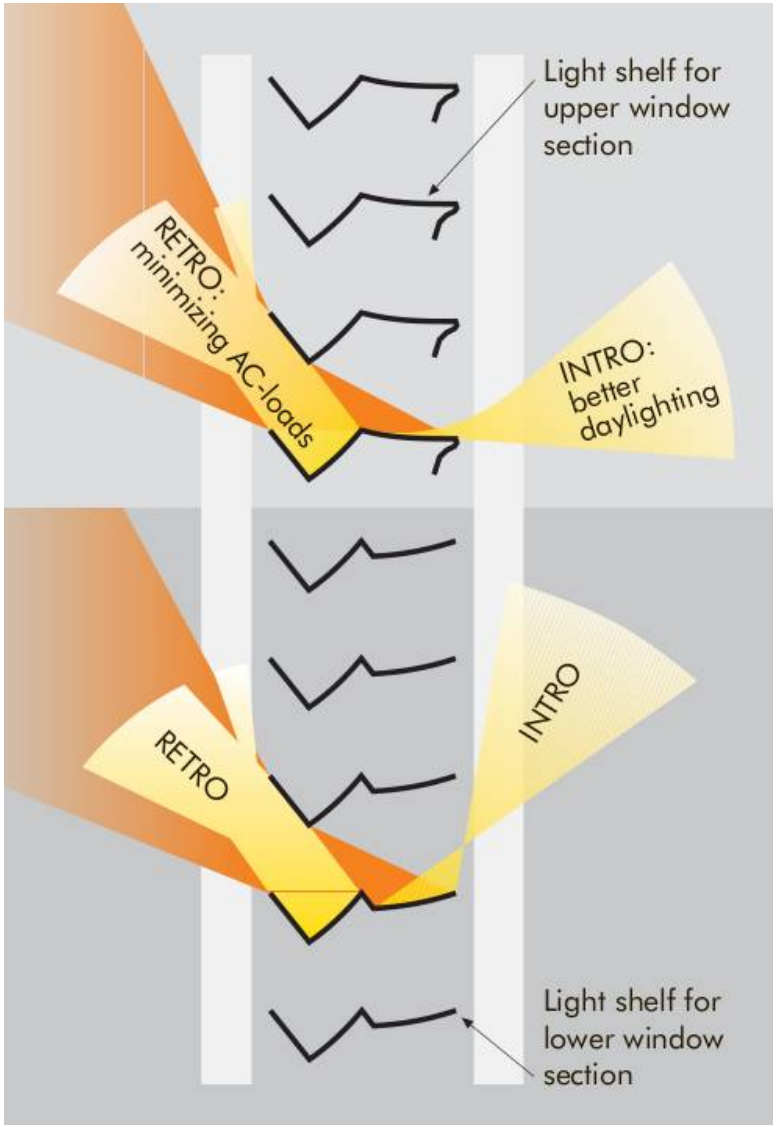


Dual-slat angle reflective blinds

- Separate treatment for upper and lower part of the window
- Lower part – view: like normal Venetian blinds, can be raised/lowered and tilted to prevent glare
- Upper part – daylight: Lamellae are curved upward and highly reflective. When lower part is closed under sunny conditions, the upper part remains open and reflects sunlight onto the ceiling.
- Avoids the sun-out blinds-down lights-on effect.

Light Re-directing Louvres





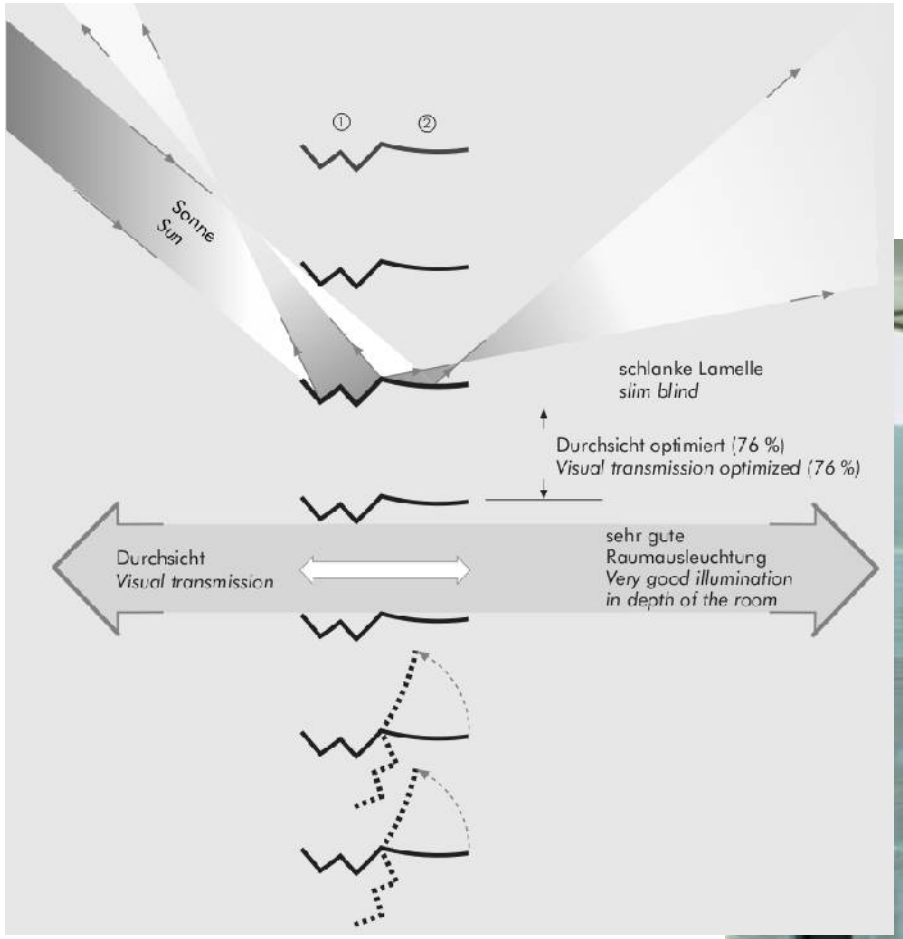
[Retrosolar]

Light Re-directing Louvres

- High angle sun and the associated heat is reflected back out – 'retro-reflection'
- Upper window: Light is reflected into the room – 'intro-reflection'
- Lower window: Light is reflected upwards onto the ceiling

- High diffuse transmittance and view out are maintained

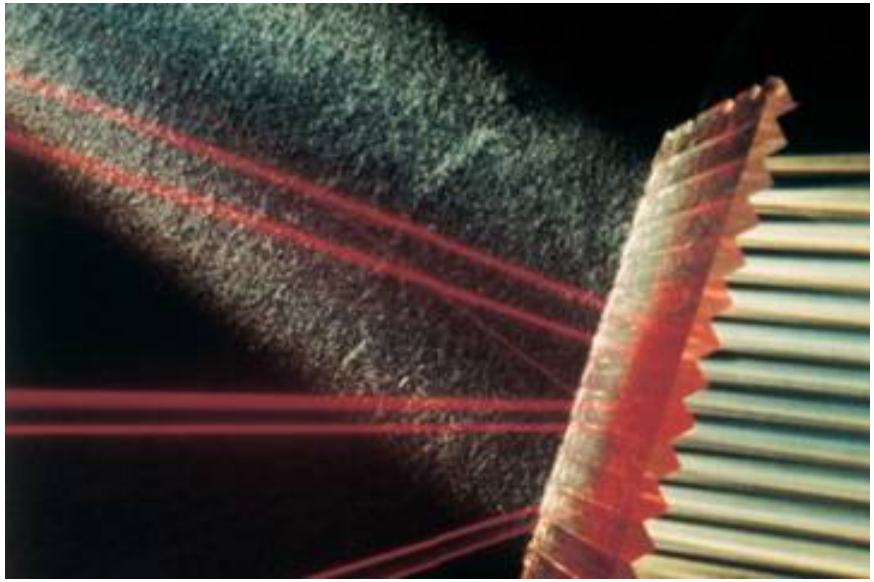
Light Re-directing Louvres

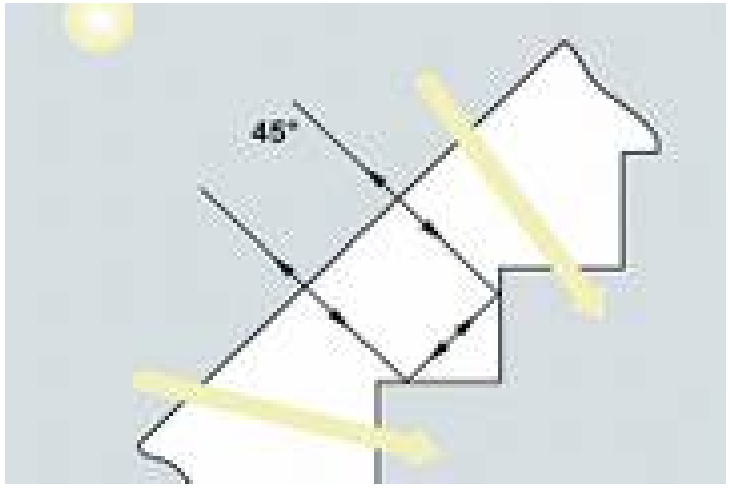


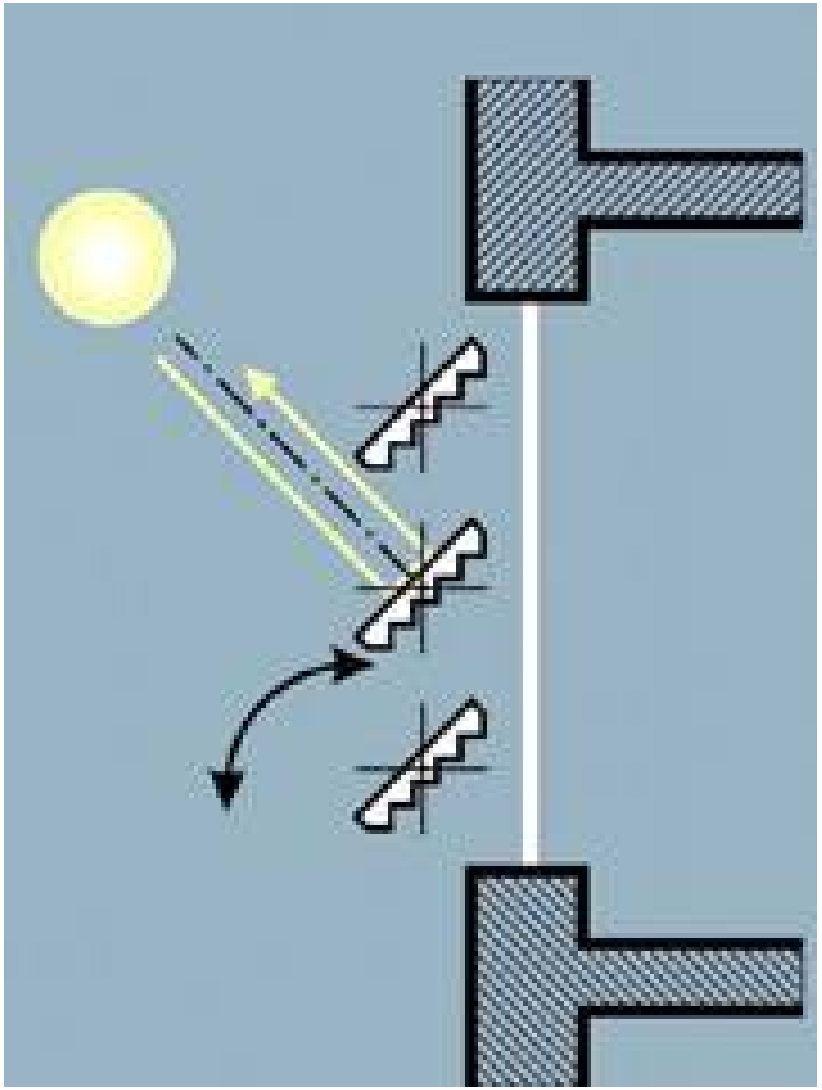
Prismatic Louvres

- Work like a cat-eye (corner reflector) through total inner reflection
- Unlike cat-eyes, they only reflect in the normal direction, other (diffuse) light is transmitted
- PLs work best with elevation-tracking of the sun

Prismatic Louvres



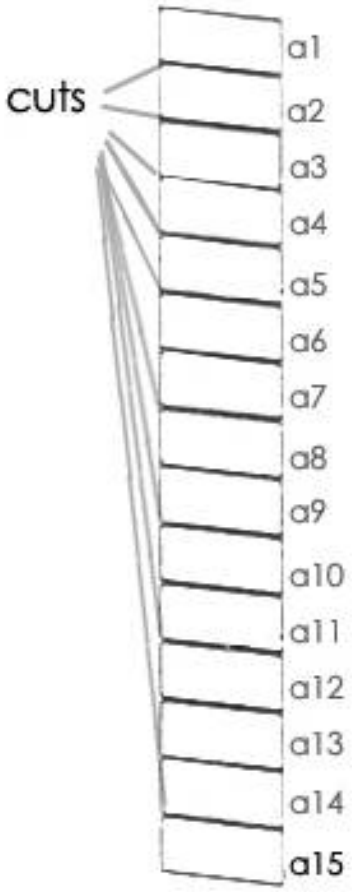




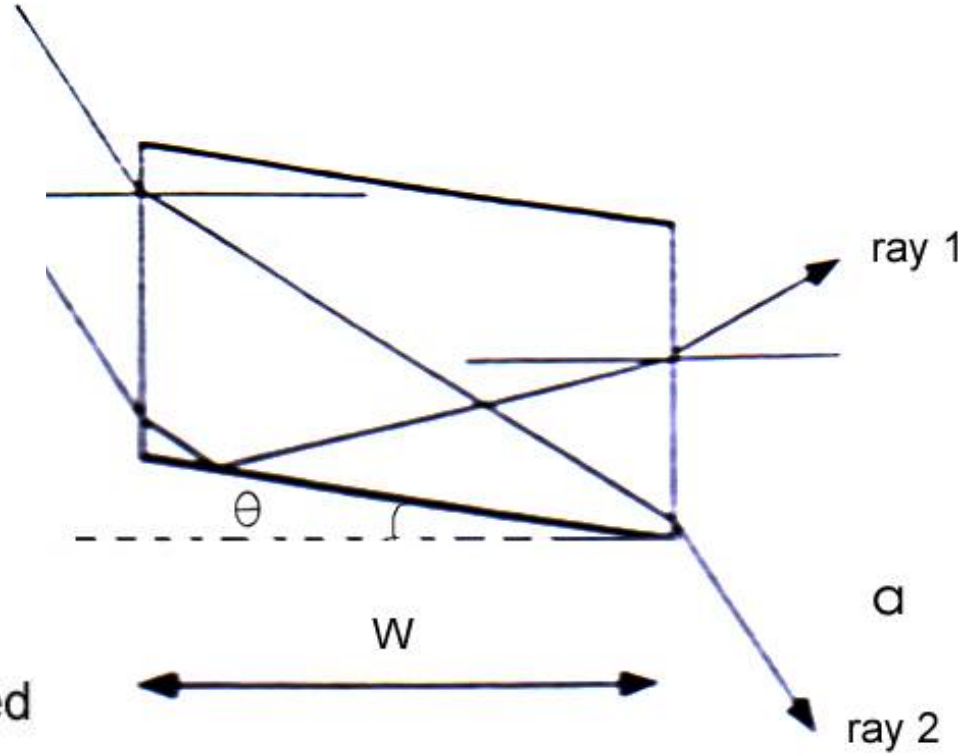
Laser-cut Panels

- Fine laser cuts in a thin acrylic sheet
- Designed to replace glass in clerestory windows and atria to improve the distribution and penetration of daylight in rooms
- Incoming ray is split into two components: one continues to travel in the same direction, the other is deflected

Laser-cut Panels

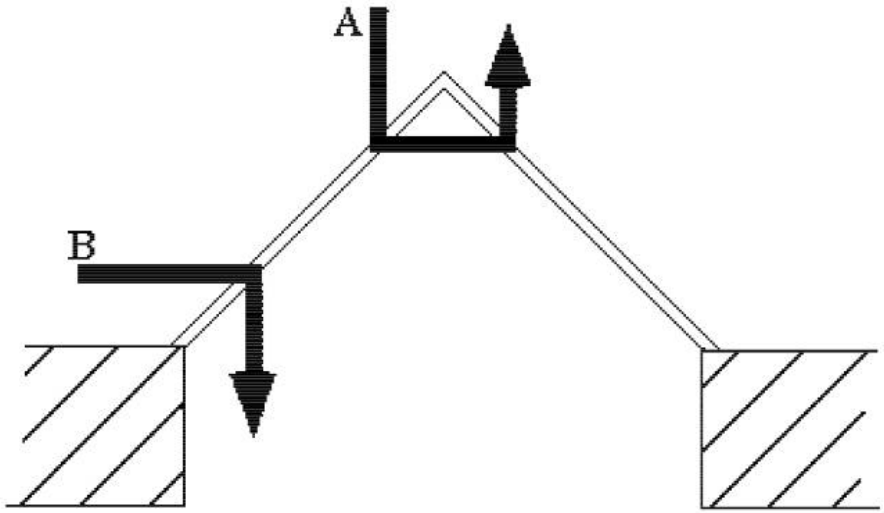


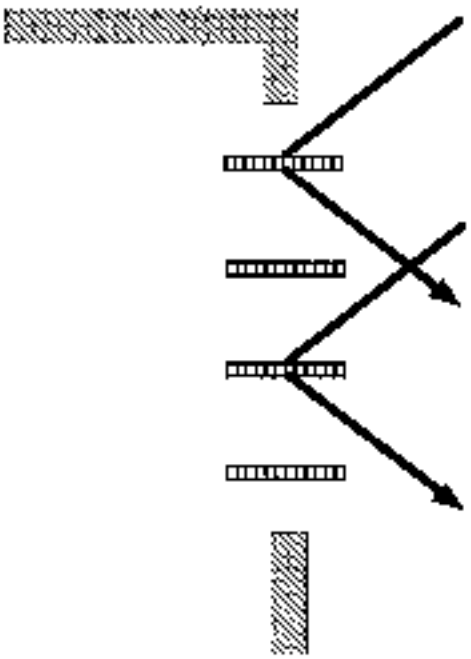
rectangular parallelepiped elements are produced by laser cutting an acrylic plastic

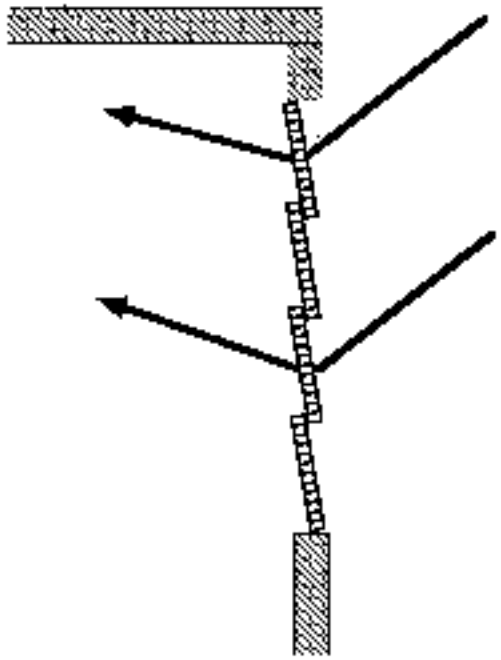


Laser-cut Panels

Laser-cut Panels





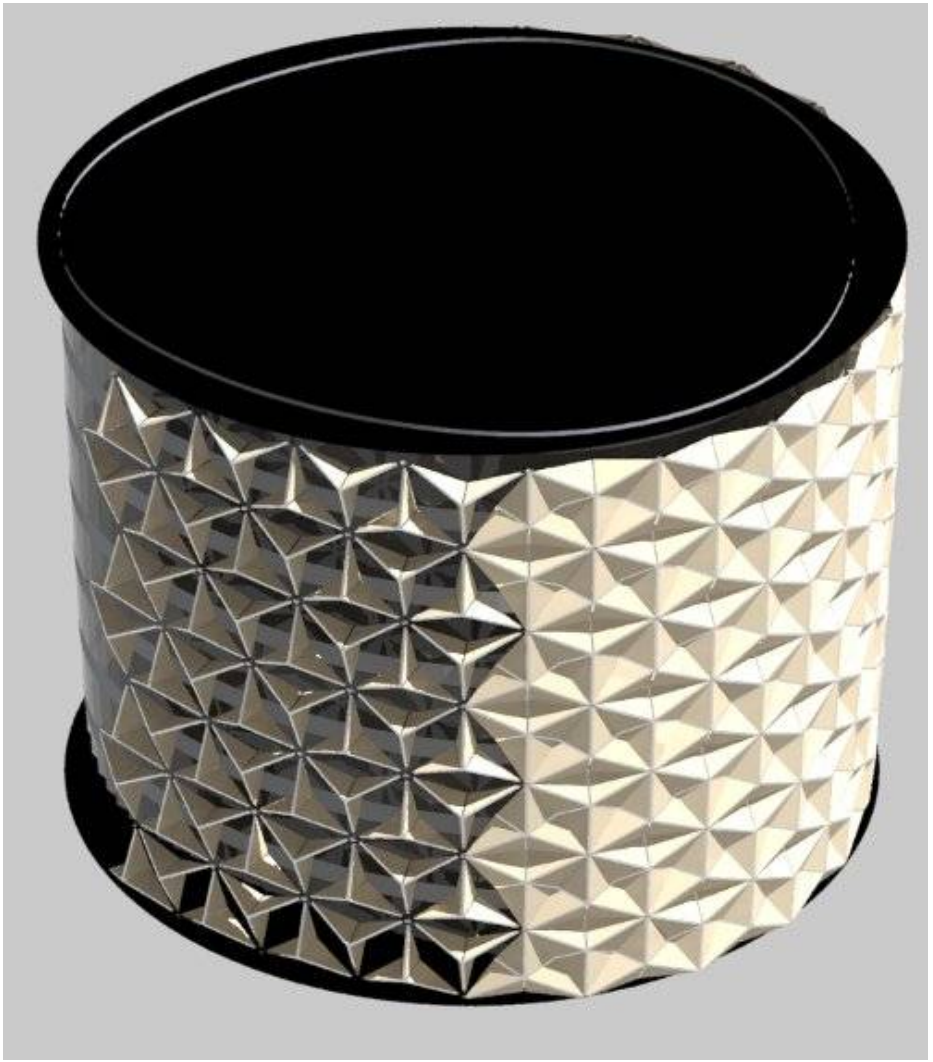


Serraglaze

- Two very thin sheets of acrylic incorporating micro-replicated prisms, bonded together to create microscopic air pockets
- Those lamellae act as light shelves set perpendicular to the faces of the sheet.
- When applied to a window, prevents high incidence sky light from passing directly down to the floor, thus reducing glare and acting as a sunshade
- Similar to LCP

Translucent Shading – Fabric

- Umbrella-like frames with translucent fabric
- Shading follows the sun, opens and closes to provide optimum protection, but only as long as needed
- The fabric, when hit by direct sunlight might itself turn into a source of glare
- Internal blinds still needed for glare protection

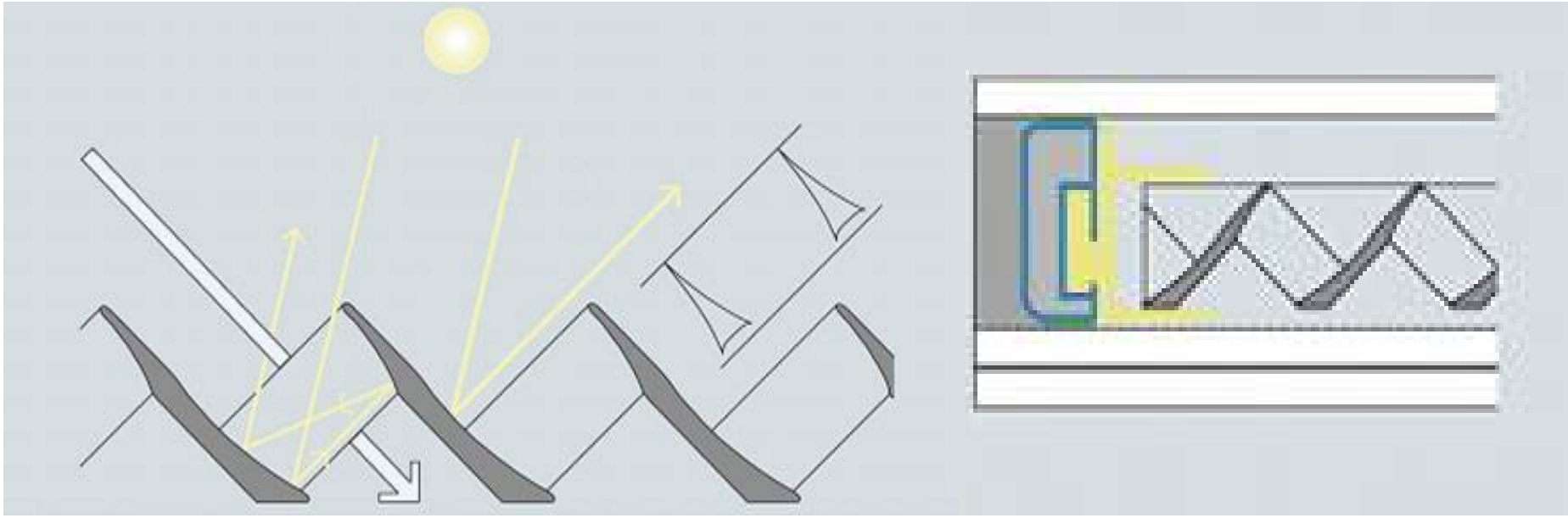


Translucent Shading – Ceramic

Lee and Selkowitz: The New York Times Headquarters daylighting mockup: Monitored performance of the daylighting control system, E&B 38 (2006)

Micro Louvres

- Allow diffuse DL to pass, but reflect direct sunlight back
- Need to be in sealed units for protection
- Careful alignment is necessary

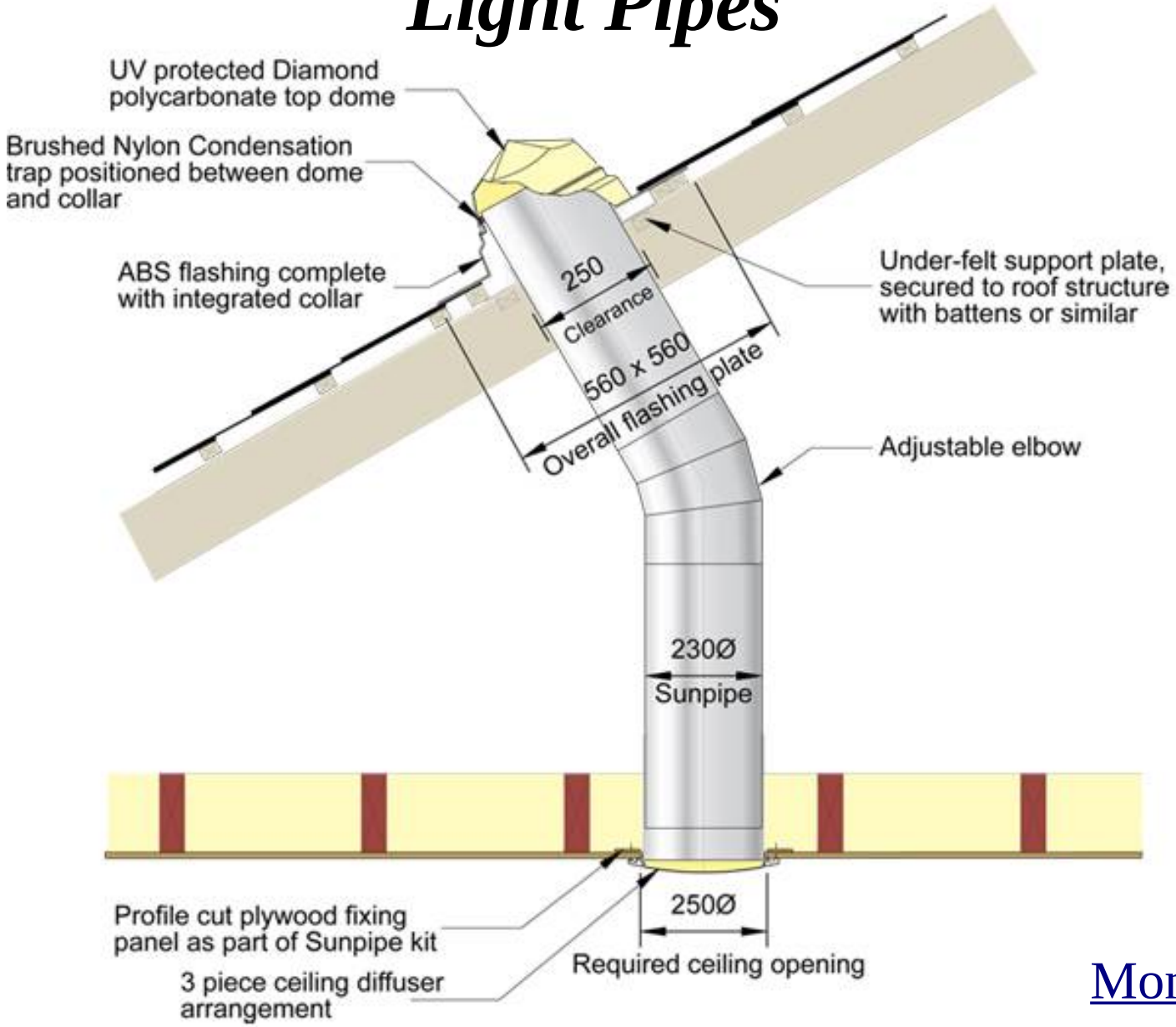


Light Pipes

Light Pipes

- Affordable systems for top-floor daylighting
- Aluminium tube with highly reflective inner coating
- Come in different diametres
- Can accommodate bends, but loss of transmittance
- Increasingly used, e.g. in supermarkets
- The don't 'funnel' light into the building—they are simply openings with low reflection losses.

Light Pipes



Monodrought

Light Pipes

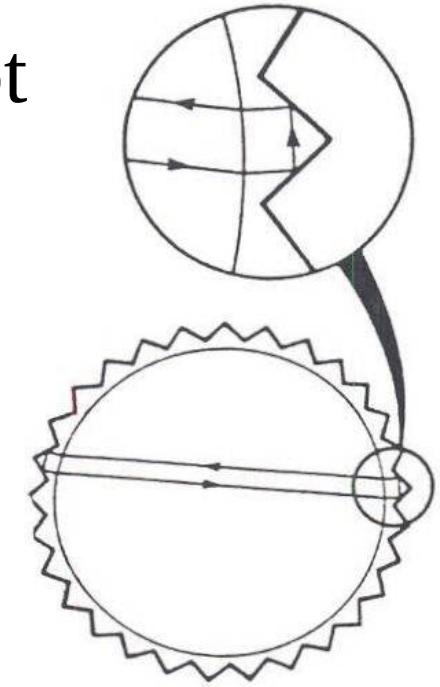
Olympic hand ball arena: 88 large-diamer light pipes

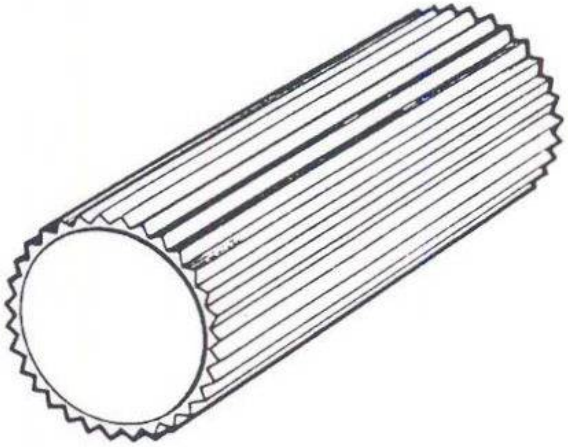
Light Pipes

Berlin, Potzdamer Platz Station

Hollow Light Guides

- Like fibre optics, they are based on total inner reflection
- Unlike FO, they are hollow
- Part of the light is not reflected and leaks out, giving a glow appearance

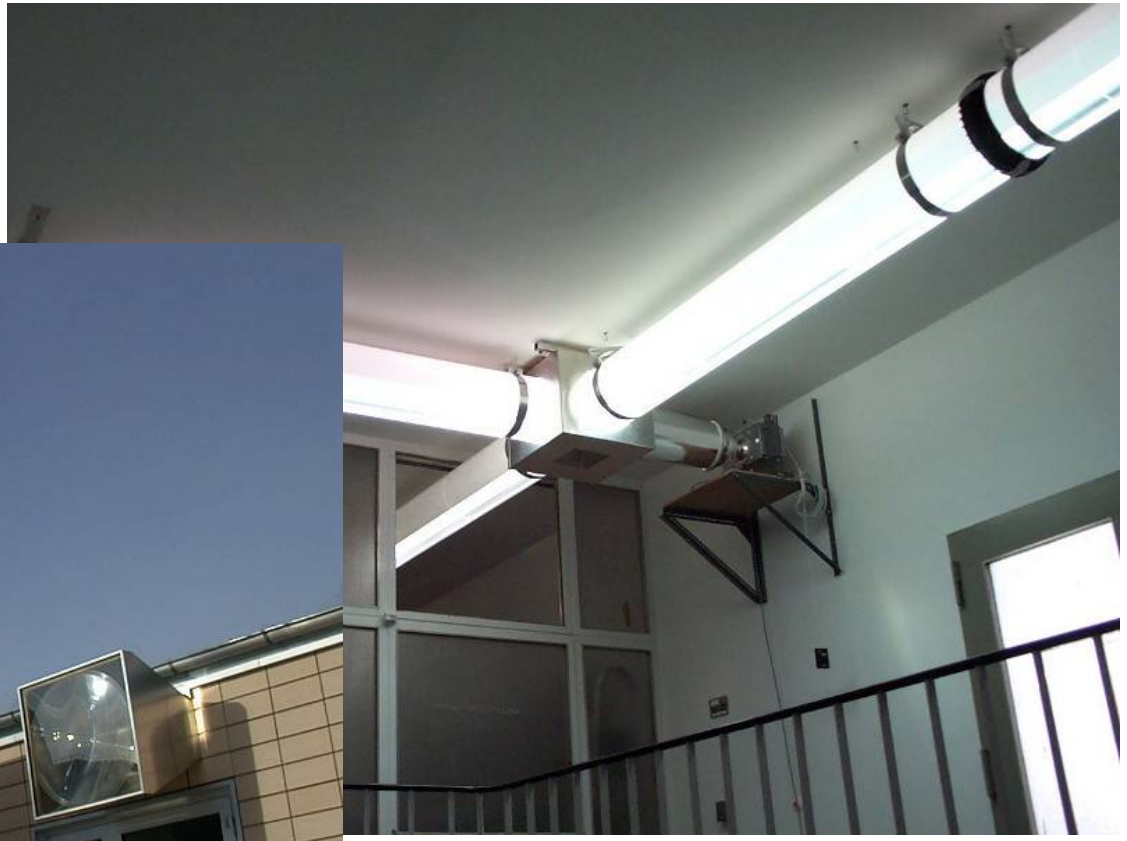




Hollow Light Guides

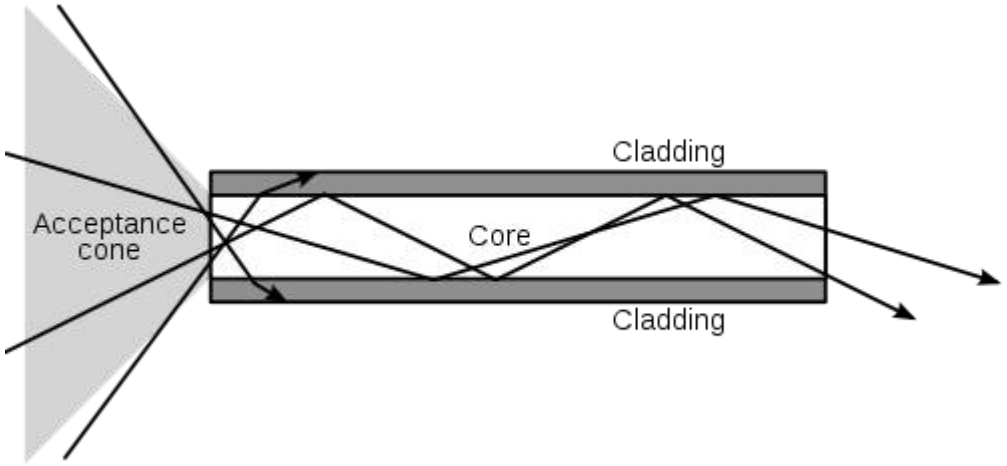
Arthelio project

Hollow Light Guides

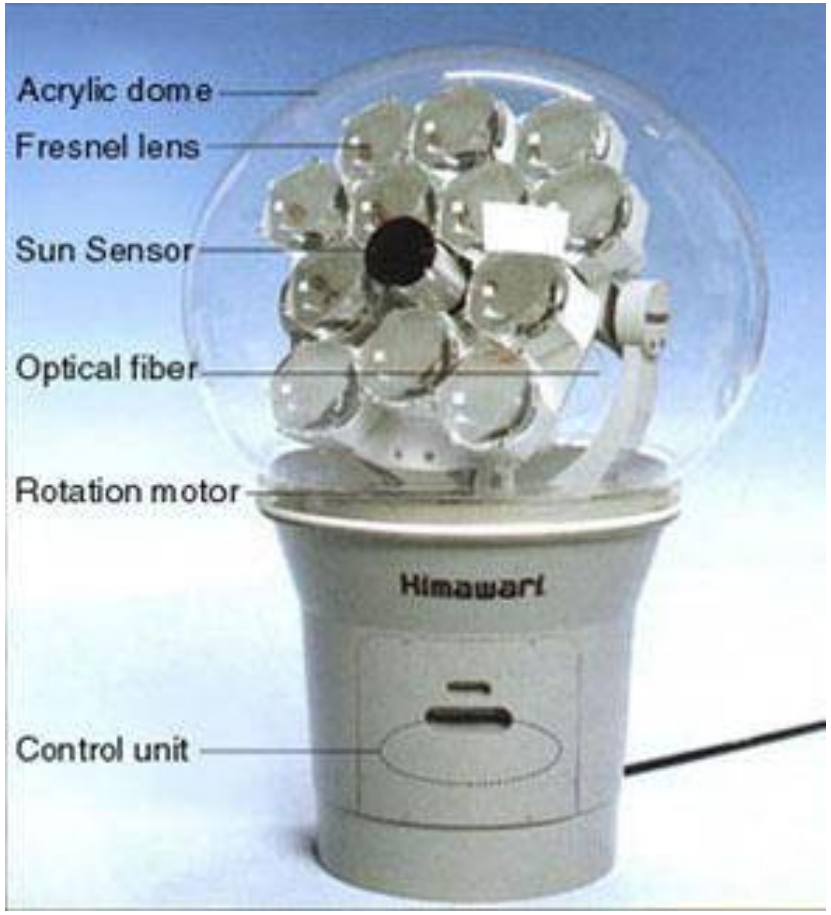


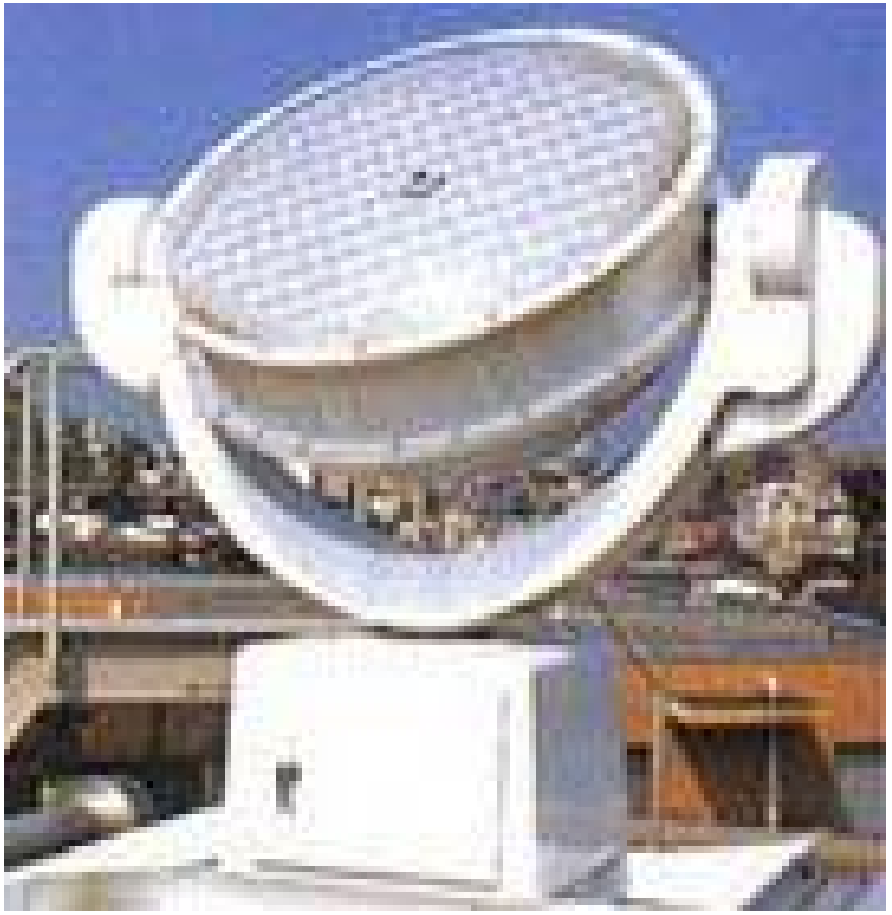
Fibre Optics

- FO can transport light through flexible cables
- Material may be plastic, glass or liquid
- Beware of scorching of the common end, and of hot spots caused by microscopic cracks (fire risk!)

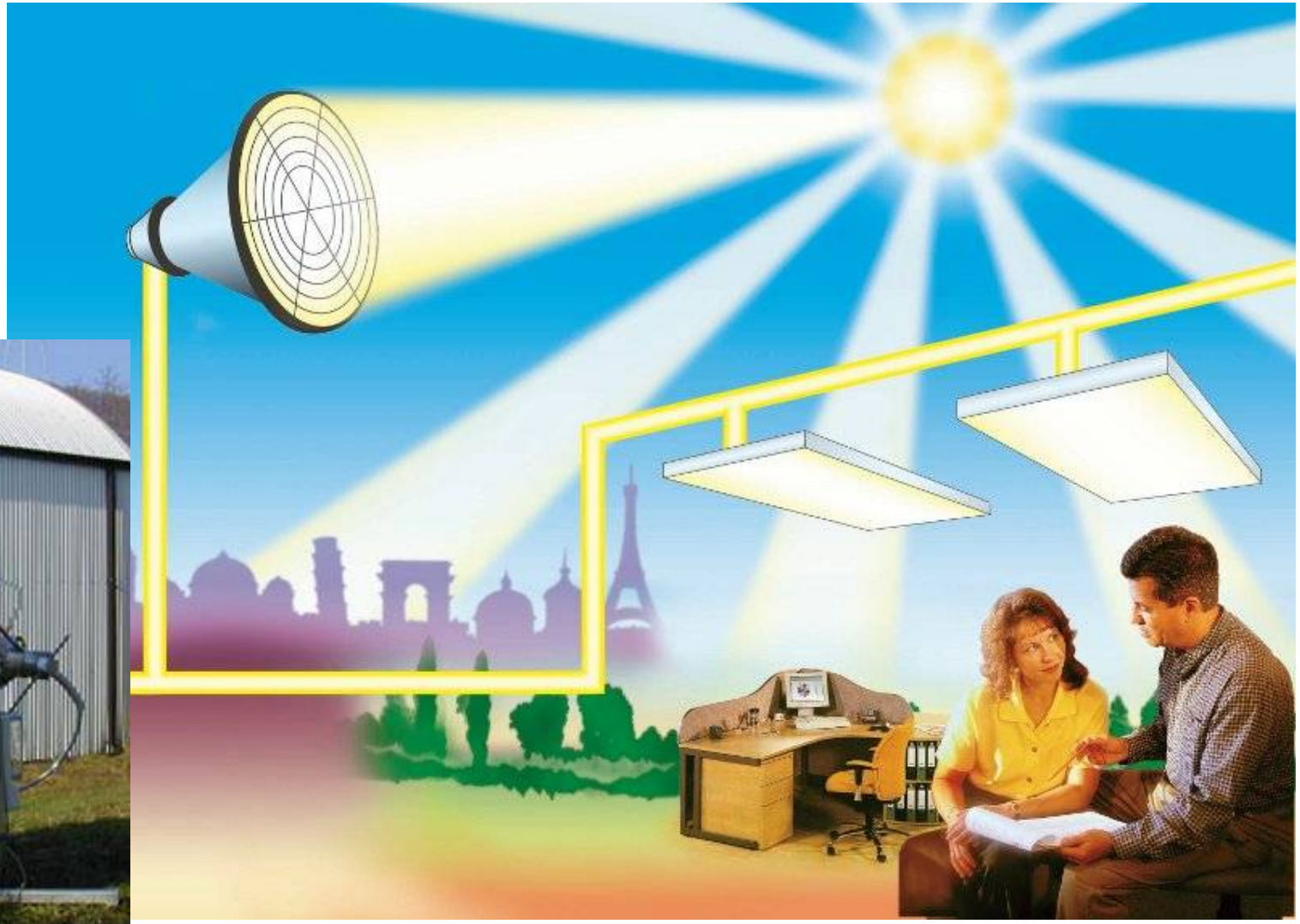


Heliostat


Acrylic dome
Fresnel lens
Sun Sensor
Optical fiber
Rotation motor
Himawari
Control unit

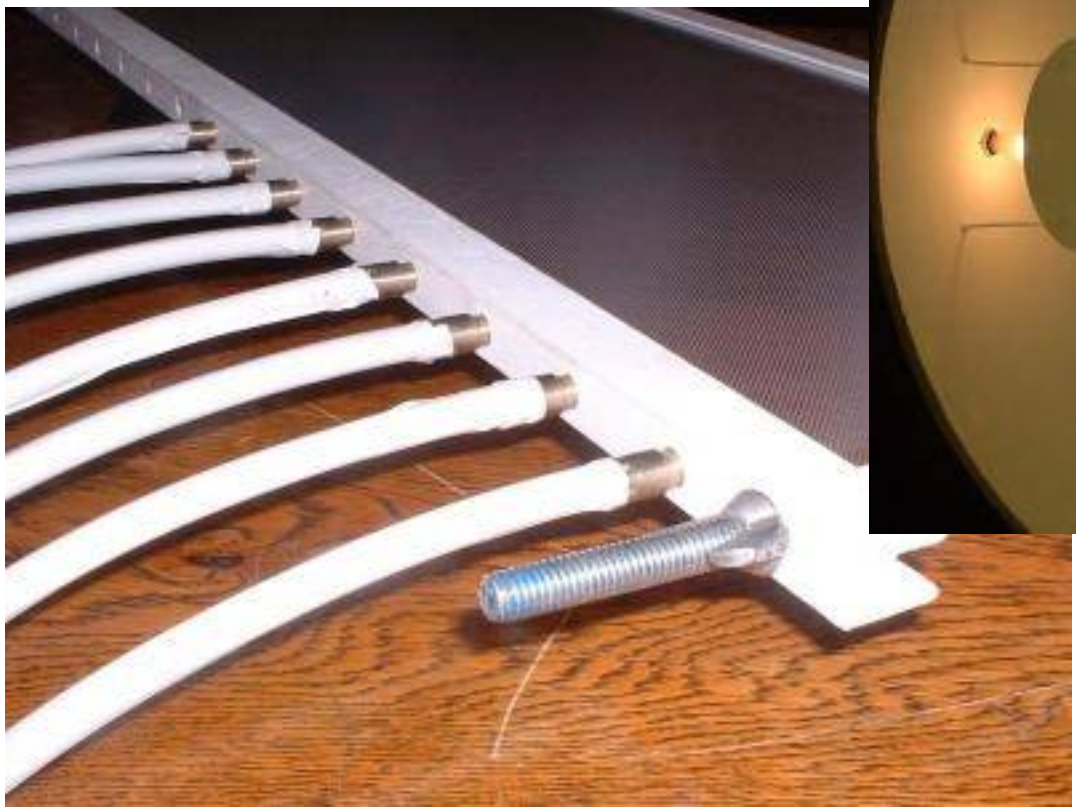


UFO – Heliostat



UFO – Light Source

UFO – Panel



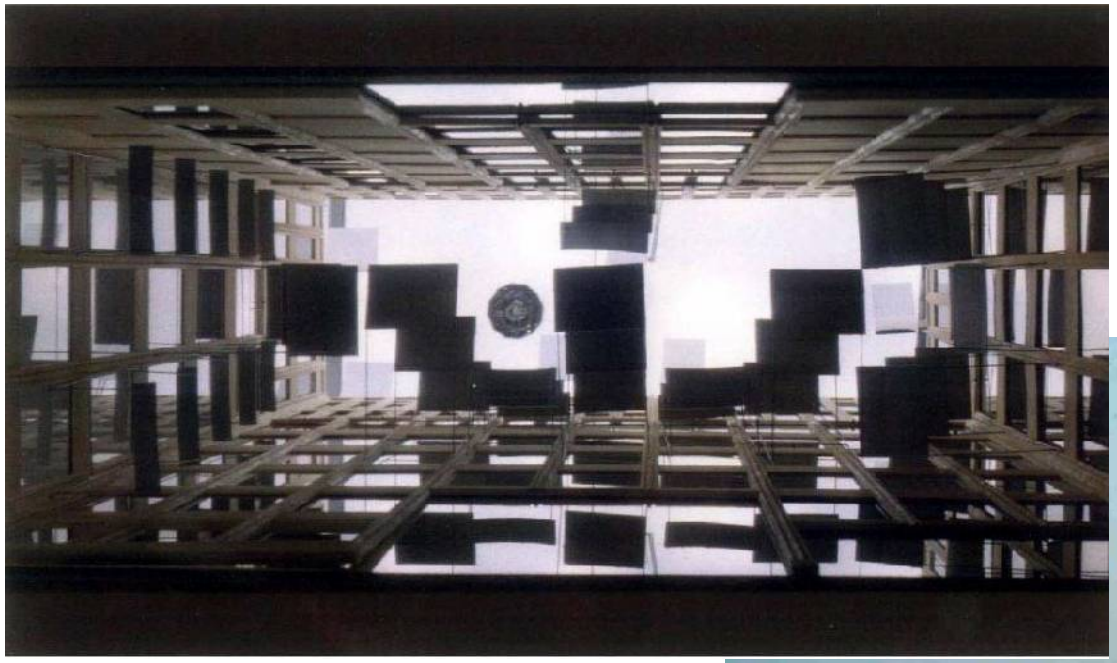
Heliostat

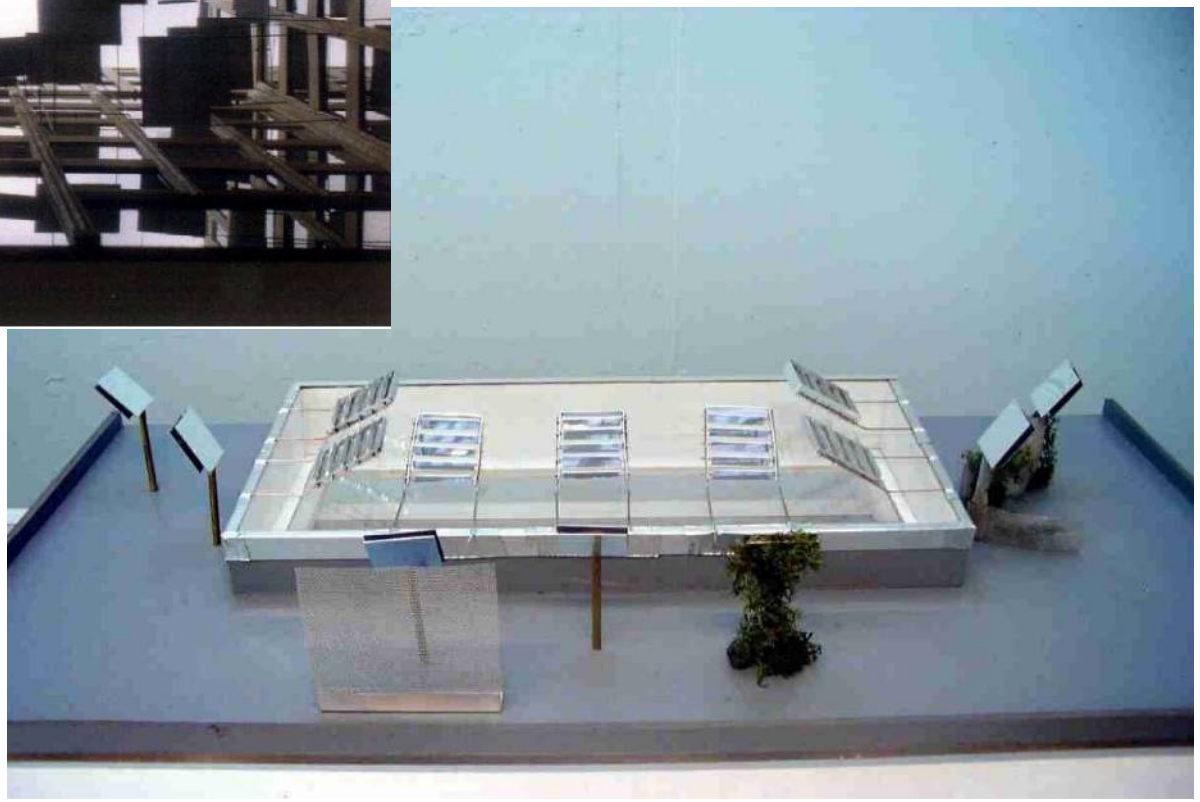
Bartenbach Lichtlabor, Innsbruck, Austria

Mirror Example 1

SynthLight: Courtyard with heliostats in Karl-Scharnagl-Ring in Munich
Concept and design by Bartenbach LichtLabor, Austria

Mirror Example 1





Mirror Example 2

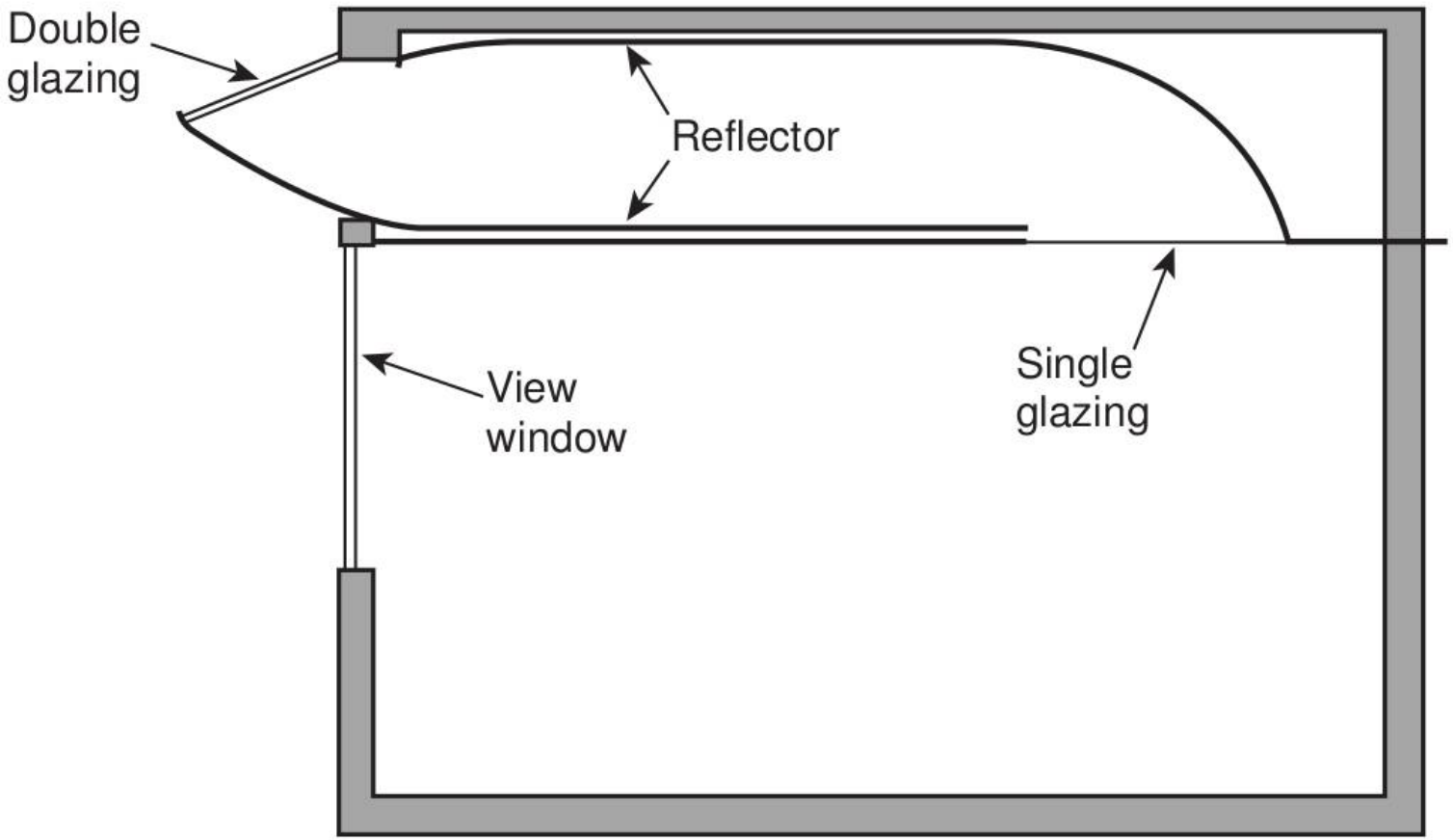
Secondary mirror

Primary mirror, suntracker

Mirror Example 2

Tertiary mirror feeds sunlight into a prismatic light guide.
Sunlight can be topped up with fluorescent light (the boxes below the round light guide).

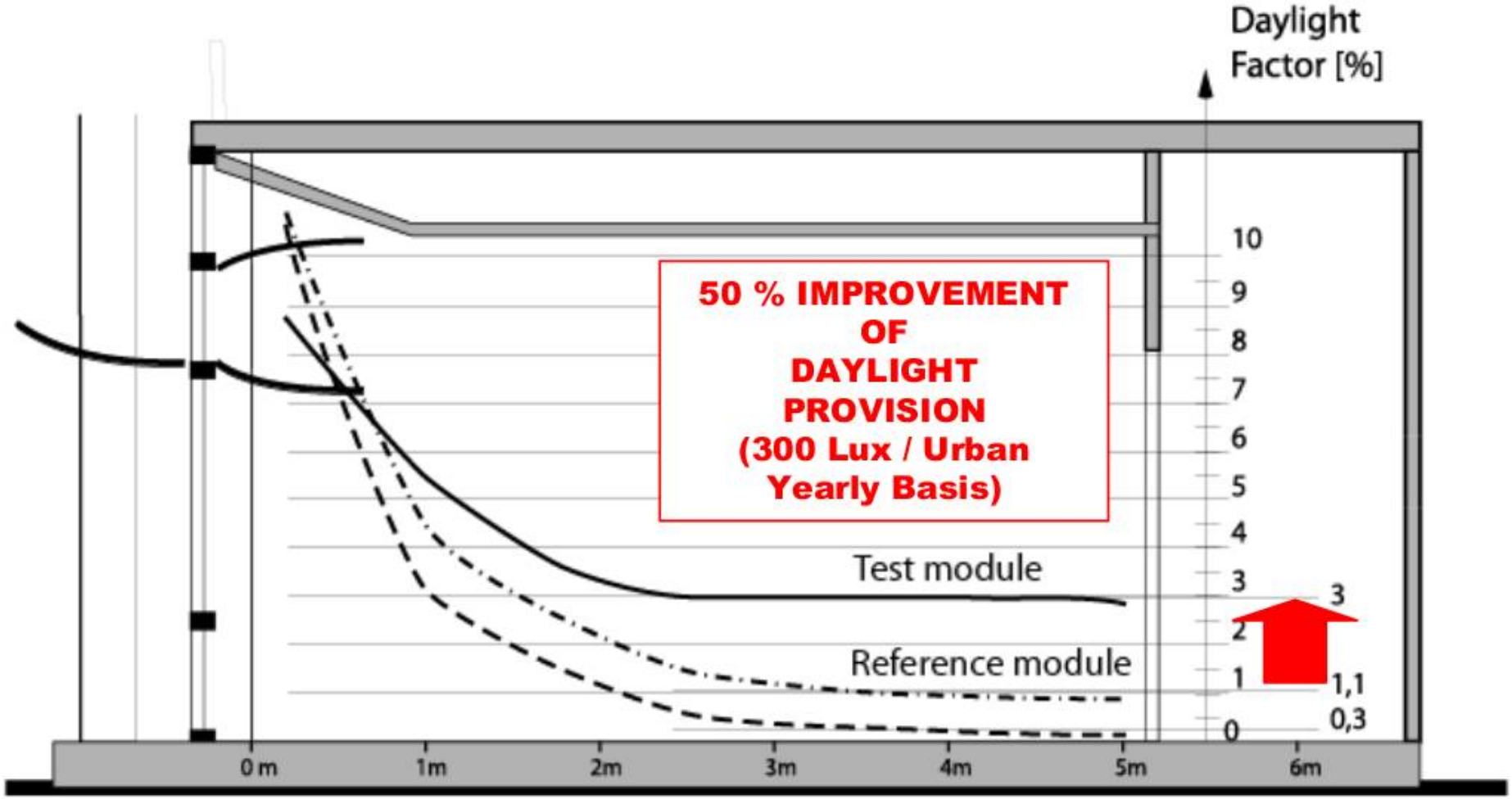
Anidolic Ceiling



About the only DL system that works well with diffuse daylight

Anidolic Ceiling

Anidolic Ceiling



Scartezzini: Innovation and Daylight in Buildings

Anidolic Ceiling

Questions to Ask

- Have I really done what is possible to optimise 'normal' daylighting through windows, rooflights?
- Is it useful to apply an ADLS in my case?
- What kind of problems can I resolve with an ADLS?
- What benefits could I achieve with an ADLS?
- Which system should I choose?

Key Parameters

- Site daylighting conditions: latitude, cloudiness, obstructions
- Daylighting objectives
- Daylighting strategies implied in the architectural design
- Window scheme and function
- Energy and peak power reduction objectives
- Operational constraints: fixed/operable, maintenance
- Integration constraints: architecture and construction
- Economic constraints


Solar Contrtol
Daylighting
Glare Control
Maintenance
Availability
Lifetime
Retrofit
View to Exterior
Internal Blinds
Window Film
Fixed Louvre Sunshades
Motorised Blinds (Internal)
Motorised Sunshades
Lightshelves
Holographic Optical Elements
Electrochromic Glazing
Vacuum Glazing
Reflective Prismatic Elements
Retro-Lamellae
Spectrally Selective Glazing
Low-e Glazing
Sun-Directing Glass

D.LiTE
DATABASE OF LIGHT - INTERACTING TECHNOLOGIES FOR ENVELOPES

ABOUT | SEARCH MATRIX | DIRECTORY | PEOPLE | CONTACT

Help

MAIN FUNCTIONS
- LESS GLARE
- DEEPER LIGHT
- SOLAR CONTROL
- MORE PRIVACY

PLACEMENT
- GLAZING
- SEPARATE LAYER
- SEPARATE SYSTEM

APPLICATION STAGE
- NEW
- RETROFIT

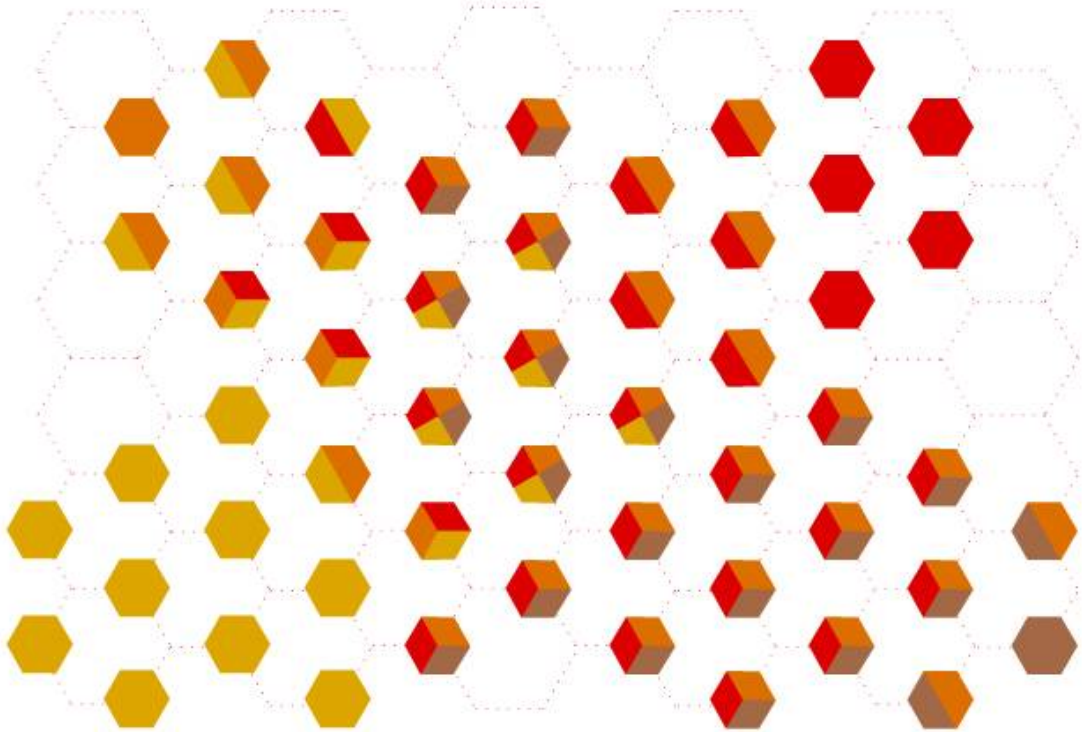
CHARACTER
- STATIC
- DYNAMIC MANUAL
- DYNAMIC AUTO
- DYNAMIC PASSIVE

LIGHT PROCESSING
- REDIRECTING
- SPECTRAL FILTER
- POWER OUTPUT
- BLOCKING

LIGHT TRANSPORT
- THROUGH SKIN
- REMOTE GUIDE
- SIDE LIGHTING
- TOP LIGHTING

PERCEPTION
- CLEAR VIEW
- PARTIAL VIEW
- OUT OF VIEW
- COLOUR FREE

DEVELOPMENT STAGE
- COMMERCIAL
- PROTOTYPE



http://d-lite.mit.edu/dlite_matrix.php

Objectives

- redirecting daylight to under-lit zones
- improving daylighting for task illumination
- improving visual comfort, glare control
- achieving solar shading, thermal control.

Resources

- Siteco Daylighting Systems
- Comfortable Low Energy Architecture, CLEAR
- Daylight in Buildings
- D-Lite database