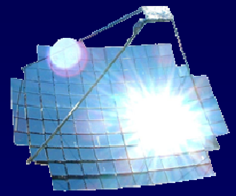
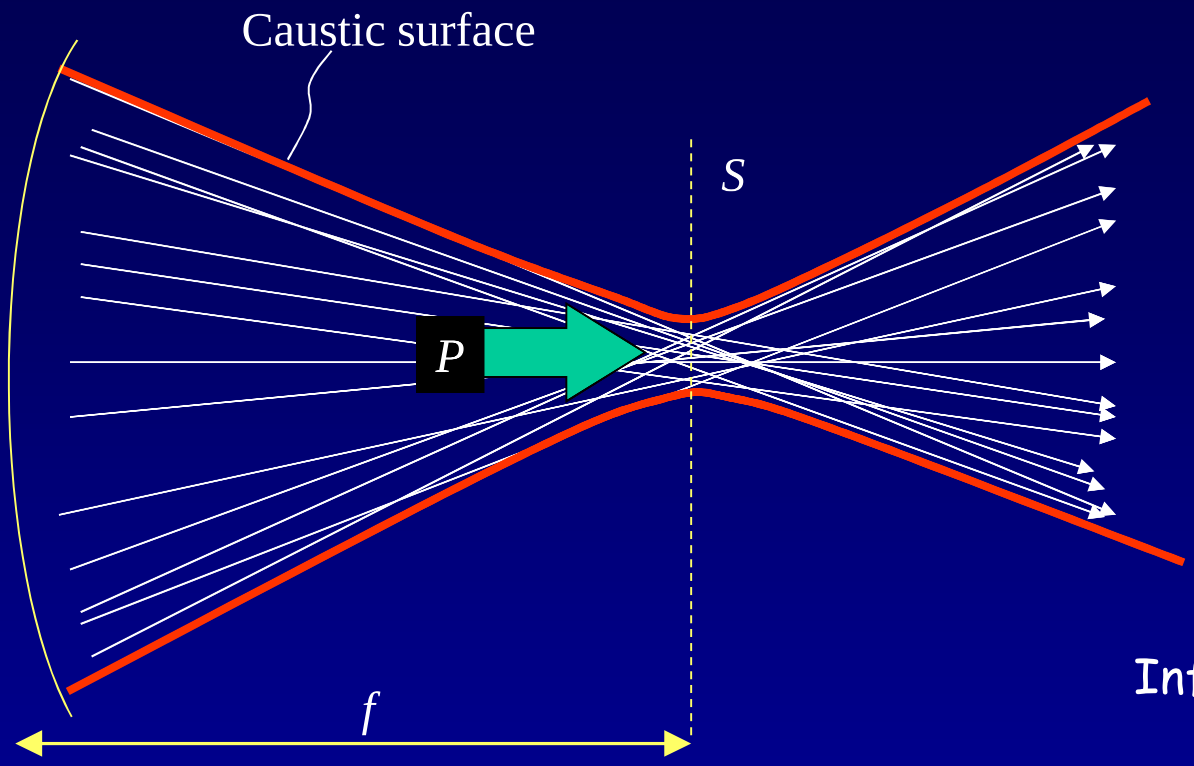
International School on Concentrated Photovoltaics, Ferrara 2-6 September 2006



"CHARACTERIZATION OF CONCENTRATED LIGHT BEAMS WITH APPLICATIONS TO SOLAR CONCENTRATORS"

Antonio Parretta
ENEA – Bologna

RADIOMETRY OF THE BEAM

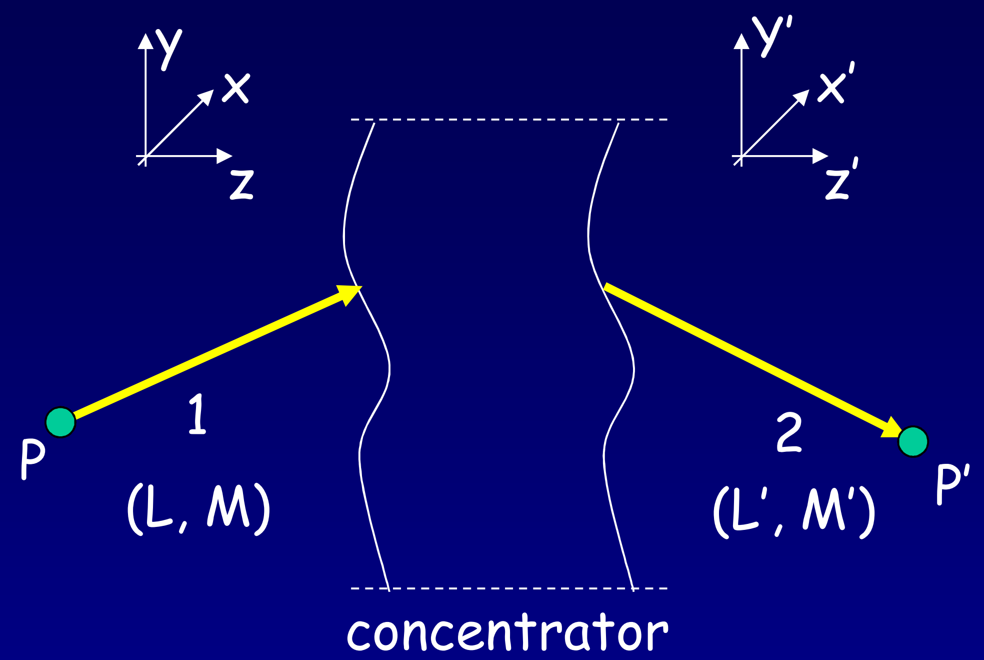


Flux (power): constant
(Generalized étendue)

Information on the beam:

Focal length
Total flux (Power)
Flux distribution in S
...
Divergence

GENERALIZED ÉTENDUE



Generalized étendue:

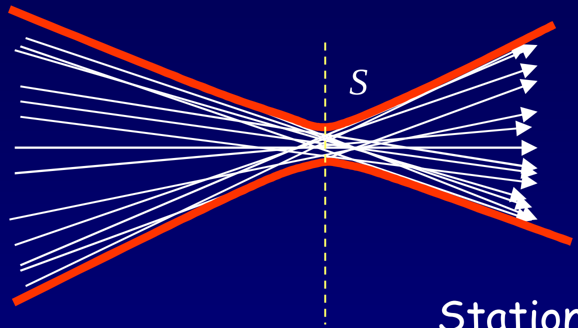
$n^2 \cdot dx \cdot dy \cdot dL \cdot dM = n'^2 \cdot dx' \cdot dy' \cdot dL' \cdot dM'$ Lagrange invariance

$dx \cdot dy \cdot dp \cdot dq = const$ ⇐ Area of phase space = const

$p = n \cdot L$; $q = n \cdot M$ L, M = cosine directors

RADIOMETRY OF THE BEAM

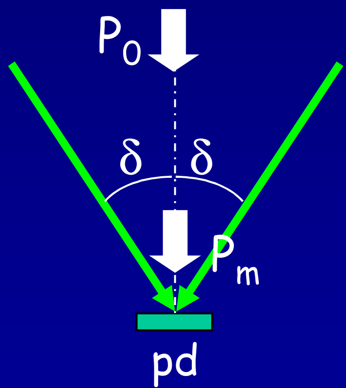
Power measurements by a photodetector



i) High flux density
ii) High divergence

Stationary measurement -→ Temp increase of pd

Pulsed measurement -→ Complex electronics

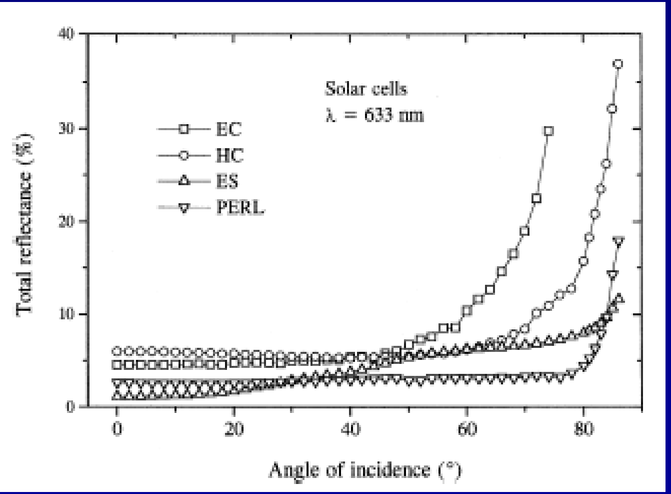


Response depends on δ

$P_m = P_0$

$f_{att} = 1$

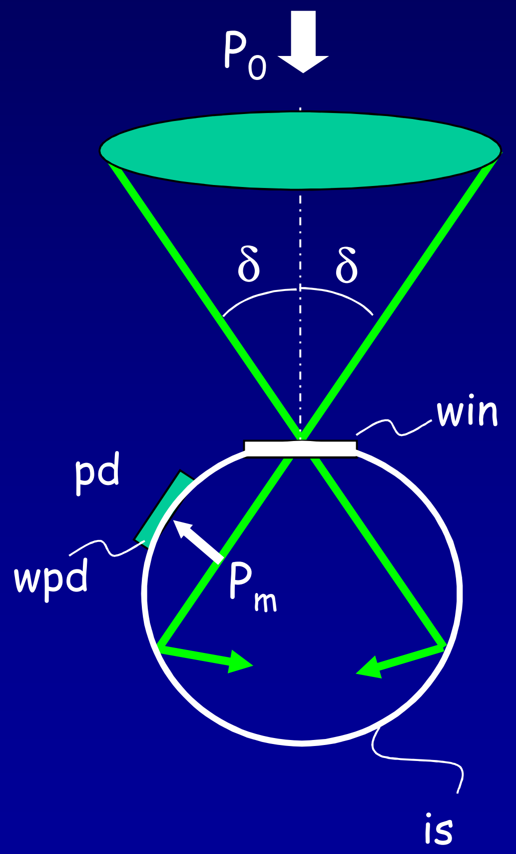
Power measurement by a photodetector



Curves of total reflectance

RADIOMETRY OF THE BEAM

Power measurements by one integrating sphere



i) Low Temp increase of pd
ii) No dependence on δ

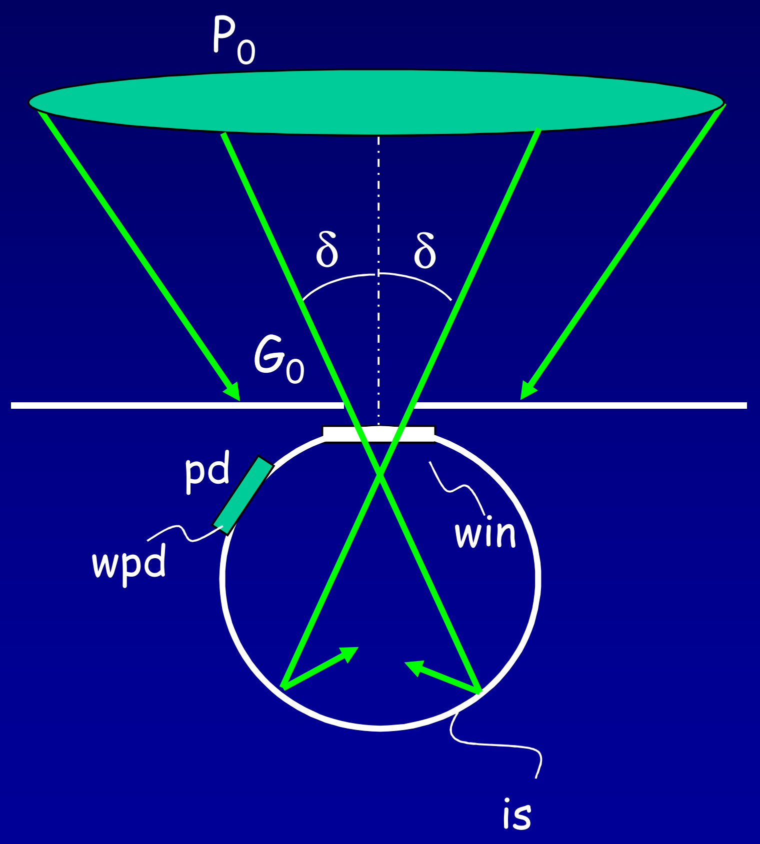
$$P_m = P_0 / f_{att}^P$$

$$f_{att}^P = P_0 / P_m = G_0 \cdot S_{in} / G_1 \cdot S_{pd} \approx \dots$$

$$\dots \approx \frac{[S_{pd}(1-R_{pd}) + S_p(1-R_p)]}{R_p \cdot S_{pd} \cdot (1-R_{pd})}$$

RADIOMETRY OF THE BEAM

Flux density (Irradiance) measurements by one integrating sphere



i) Low Temp increase of pd
ii) No dependence on δ

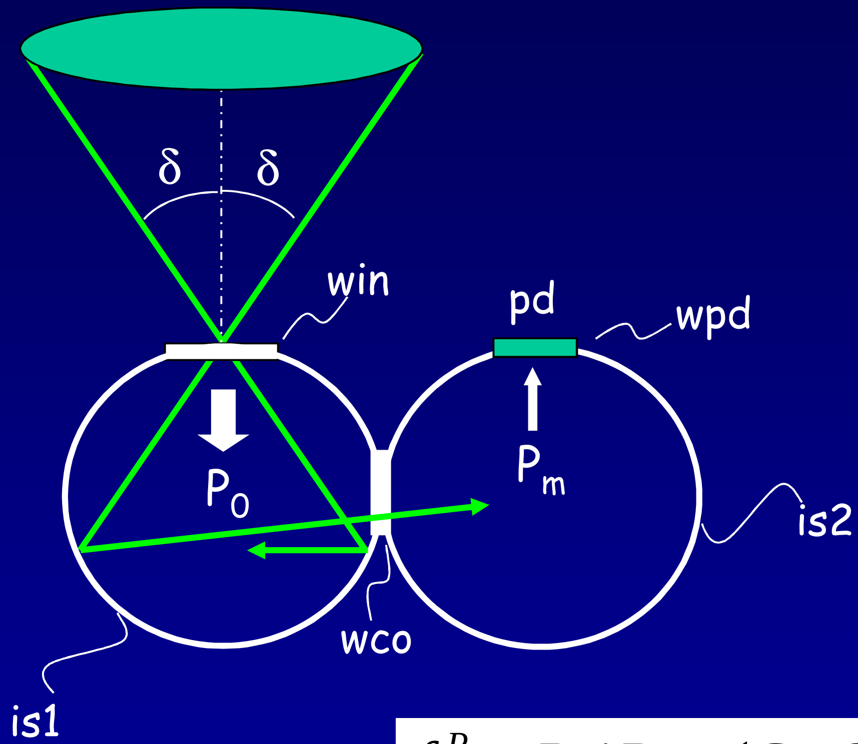
$$G_m = G_0 / f_{att}^G$$

$$f_{att}^G = G_0 / G_m \approx \dots$$

$$\dots \approx \frac{S_{pd} \cdot [S_{pd}(1 - R_{pd}) + S_w(1 - R_w)]}{S_{in} \cdot R_p \cdot S_{pd} \cdot (1 - R_{pd})}$$

RADIOMETRY OF THE BEAM

Power measurements by two integrating spheres



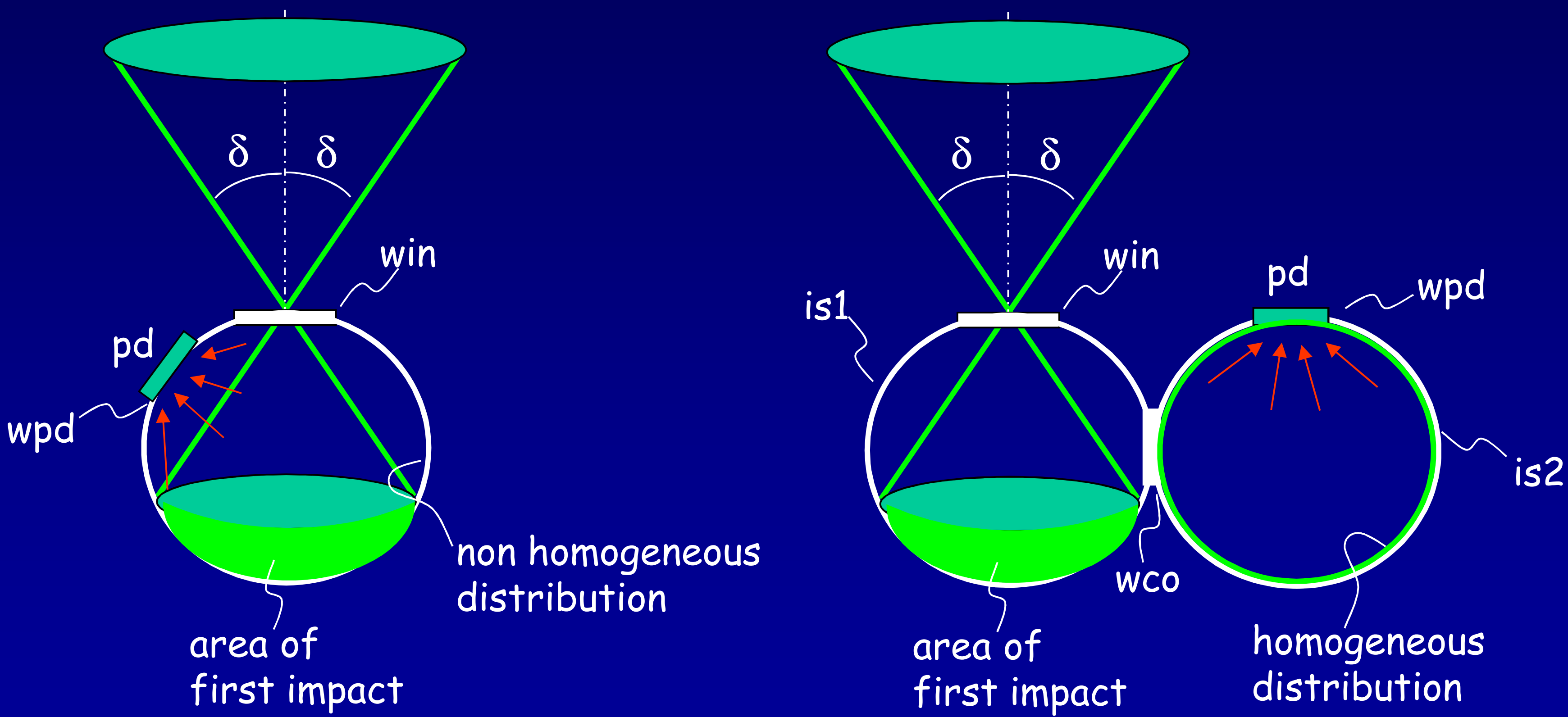
i) Very low Temp increase of pd
ii) No dependence on δ
iii) Better control of attenuation factor through wco
iv) More homogeneous intensity distribution on pd

$$f_{att}^{P} = P_0 / P_m = (G_0 \cdot S_{in}) / (G_m \cdot S_{pd}) = f_{att}^{G} \cdot S_{in} / S_{pd} \approx \ldots$$

$$\approx \frac{[S_{in} + S_{co} + S_w(1 - R_w)] \cdot [S_{pd} + S_{co} + S_w(1 - R_w)] - S_{co}{}^2}{S_{pd} S_{co}}$$

RADIOMETRY OF THE BEAM

Differences in intensity distributions inside the integrating spheres



RADIOMETRY OF THE BEAM

Flux density measurements by the camera-target method