E2: Calcolo numerico dei parametri d’antenna

- Obiettivo di questa esercitazione è di eseguire un calcolo numerico dei parametri di radiazione di una antenna dato il diagramma di radiazione in potenza.
  - Utilizzo del Matab per l’implementazione numerica.

Parametri d'antenna in trasmissione

- *densita` di potenza [W/m²]*

$$\underline{\mathbf{P}}_\infty(r,\theta,\varphi) \equiv \frac{1}{2}\underline{\mathbf{E}}_\infty(r,\theta,\varphi) \times \underline{\mathbf{H}}^*_\infty(r,\theta,\varphi) = \frac{1}{2\eta^*}|\underline{\mathbf{E}}_\infty(r,\theta,\varphi)|^2 \underline{\mathbf{r}}_0$$

- *Intensita` di radiazione [W/sr]*

$$U(\theta,\varphi) \equiv \frac{dW_T}{d\Omega} = r^2 P_\infty(r,\theta,\varphi) \ [\mathrm{W/sr}]$$

- *Angolo solido*

$$d\Omega \equiv dS/r^2 \quad [\mathrm{sr}]$$

$$dS = ds_\theta ds_\varphi = (r d\theta)(r \sin\theta d\varphi) = r^2 \sin\theta d\theta d\varphi$$

- *Potenza radiata [W]*

$$W_T = \int_{4\pi} U(\theta,\varphi) d\Omega = \int_0^{2\pi}\int_0^{\pi} U(\theta,\varphi)\sin\theta d\theta d\varphi \equiv \oint_S \underline{\mathbf{P}}_\infty(r,\theta,\varphi)\cdot \underline{\mathbf{n}}_0 dS$$

- *Intensità di radiazione Normalizzata*

$$U_n(\theta,\varphi) \equiv \frac{U(\theta,\varphi)}{\mathrm{Max}\,[\mathrm{U}(\theta,\varphi)]} = \frac{U(\theta,\varphi)}{U_M} \quad [\mathrm{adim}]$$

- *Angolo solido di radiazione*

$$\Omega_A \equiv \frac{1}{U_M}\int_{4\pi} U(\theta,\varphi)d\Omega = \int_{4\pi} U_n(\theta,\varphi) d\Omega$$

- *Direttività*

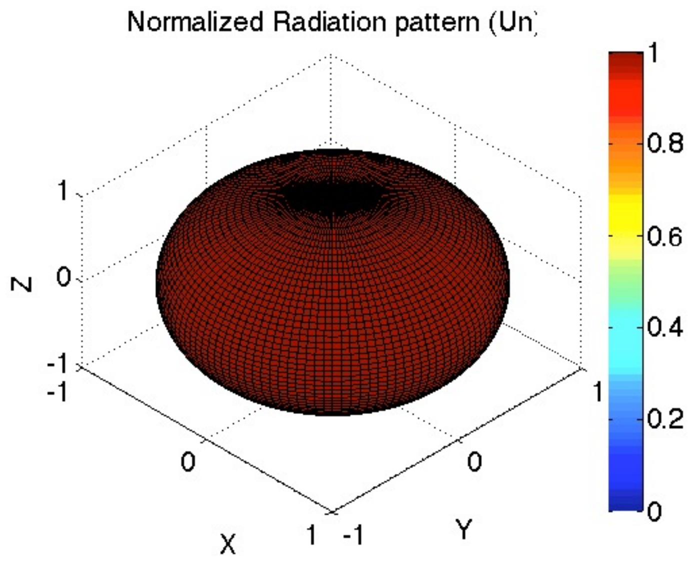
$$D(\theta,\varphi) \equiv \frac{P_\infty(r,\theta,\varphi)}{P_{\infty\,\mathrm{iso}}} = \frac{U(\theta,\varphi)}{U_{\mathrm{iso}}} = \frac{P_\infty(r,\theta,\varphi)}{W_T/4\pi r^2} = \frac{U(\theta,\varphi)}{W_T/4\pi} = 4\pi\frac{U_n(\theta,\varphi)}{\Omega_A}$$

- *Direttività massima*

$$D_M = \frac{4\pi}{\Omega_A}$$

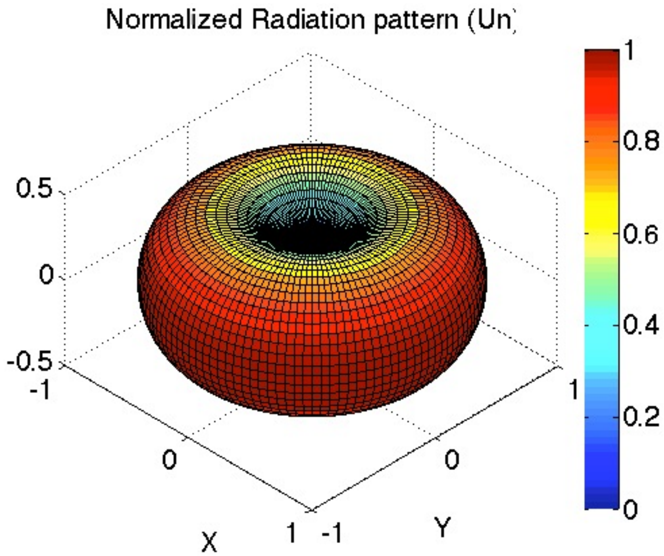
Antenna isotropica

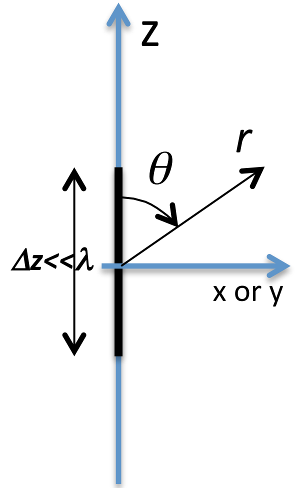
- $U(\theta,\varphi)=1$;
  - $D_M=1$ (0 dBi) [-]
  - $\Omega_A=4\pi\ (=12.56)$ [sr]
  - $W_T=\Omega_A$ [W]
  - θ_{3dB}=Non Definito
  - η_{ML}=Non Definito

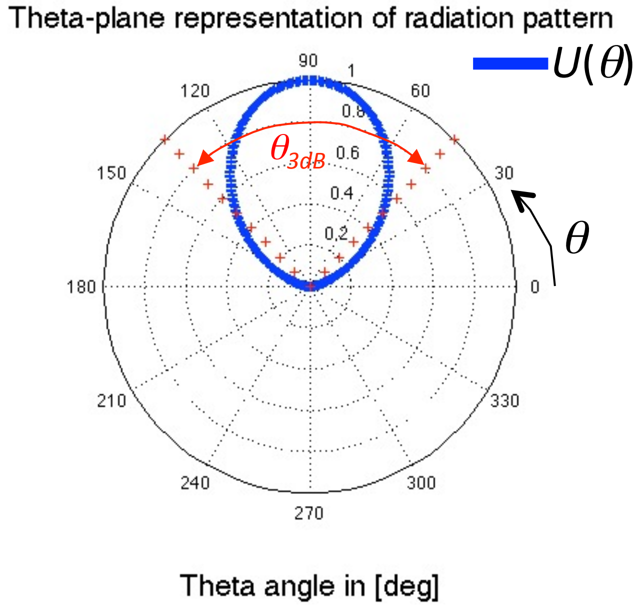


Dipolo elementare

- $U(\theta,\varphi)=A\bullet[\sin(\theta)]^2$;
  - $A=U_M=I_0^2\Delta Z^2/(8\lambda^2)$
  - $D_M=1.5$ [-] (=1.76 dBi)
  - $\Omega_A=8/3\pi$ (=2.667)[sr]
  - $W_T=8/3\pi\bullet U_M$ [W]
  - $\theta_{3dB}=\pi/2$ [rad]
  - $\eta_{ML}=(5/8)\sqrt{2}$ (=0.88)



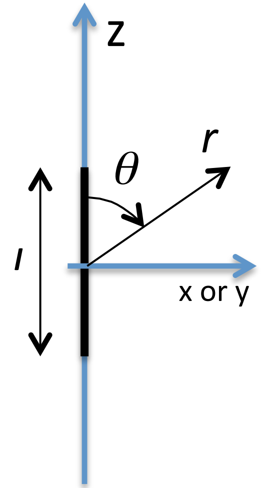




Legenda:
I0= corrente di alimentazione [A]
ΔZ= lunghezza del dipolo
Elementare [m]

Dipolo non caricato lungo l

$$U(\theta,\varphi) = A \cdot \left\{ \frac{\cos\left[\frac{kl}{2}\cdot(\cos\theta)\right] - \cos\frac{kl}{2}}{\sin\theta} \right\}^2$$



$$A = \frac{\eta |I_0|^2}{8\pi^2 \sin\left(\frac{kl}{2}\right)}$$

$$U_M = A \cdot \left[1 - \cos\frac{kl}{2}\right]^2$$

l	kl/2	Sin(kl/2)	Cos(kl/2)	$U(\theta,\varphi)$
λ/2	π/2	1	0	$A\cdot\left\{\cos\left[\frac{\pi}{2}\cdot(\cos\theta)\right]\left[\sin\theta\right]^{-1}\right\}^2$
λ	π	0	-1	$A\cdot\left\{\cos\left[\pi\cdot(\cos\theta)+1\right]\left[\sin\theta\right]^{-1}\right\}^2$
3λ/2	3π/2	-1	0	$A\cdot\left\{\cos\left[3\frac{\pi}{2}\cdot(\cos\theta)\right]\left[\sin\theta\right]^{-1}\right\}^2$
8λ/3	8π/3	√3/2	-1/2	$A\cdot\left\{\cos\left[8\frac{\pi}{3}\cdot(\cos\theta)+\frac{1}{2}\right]\left[\sin\theta\right]^{-1}\right\}^2$

Legenda:

U_M= max Intensita` di radiazione

l= lunghezza del dipolo [m]

λ= lunghezza d'onda del dipolo [m]

I_0= Corrente di alimentazione [A]

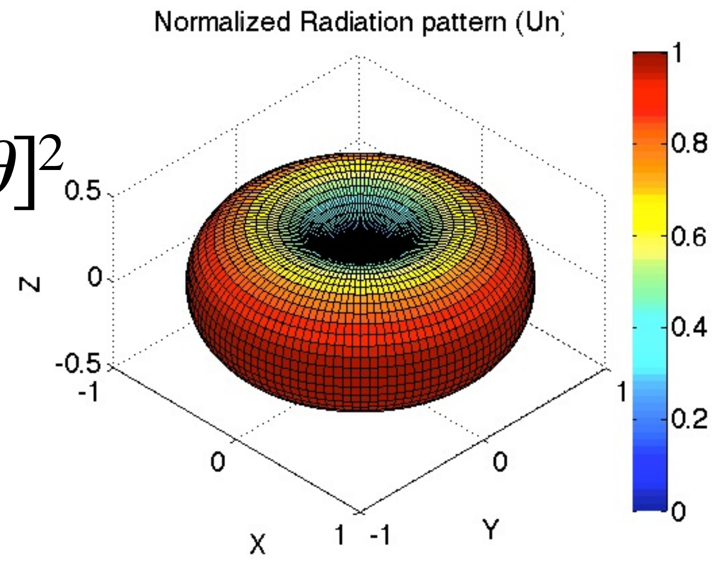
Dipolo non caricato lungo λ/2

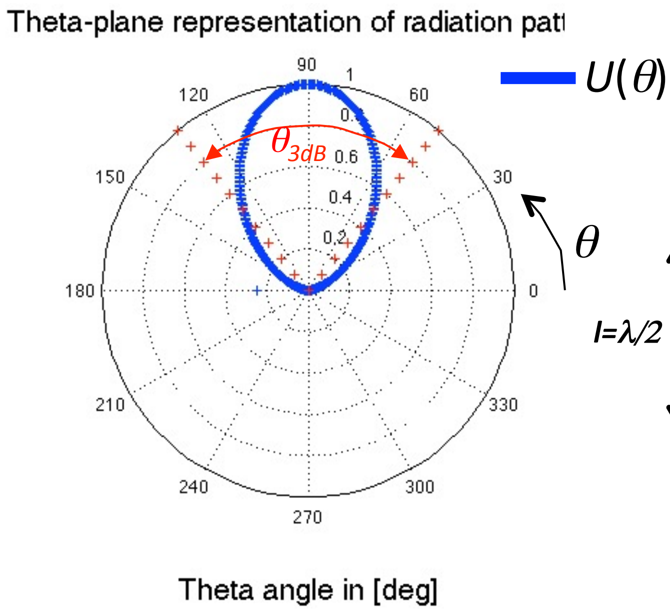
- $U(\theta,\varphi)=A\bullet[\cos(\pi/2\bullet\cos\theta)\ /\sin\theta]^2$

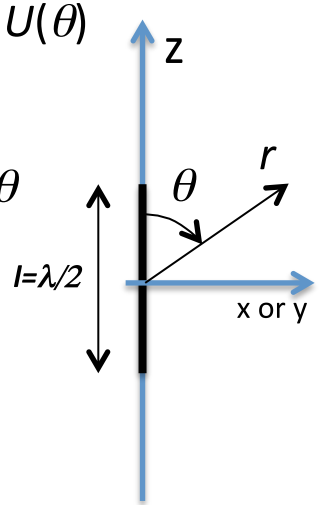
  $$A=\frac{\eta|I_0|^2}{8\pi^2};\ U_M=A$$

  - D_M=1.64 [-] (=2.15 dBi)
  - Ω_A= 2.437π [sr]
  - W_T=2.437π•U_M [W]
  - θ_{3dB}=78 [deg]
  - η_{ML}=0.85
  - R_r=73 [Ω]

<u>Legenda:</u>
I0= corrente di alimentazione [A]
ΔZ= lunghezza del dipolo
Elementare [m]

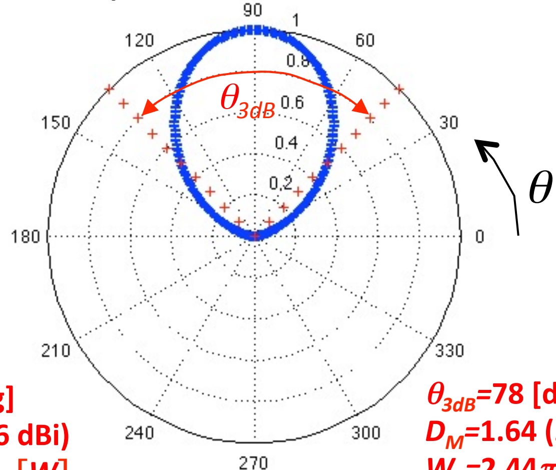






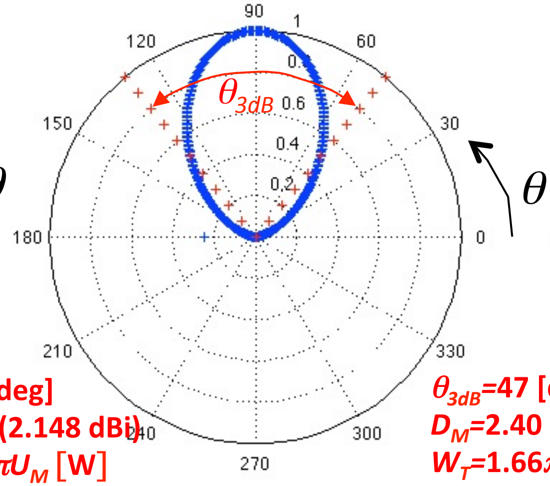
Dipoli: diagramma polare, piano E

Dipolo elementare



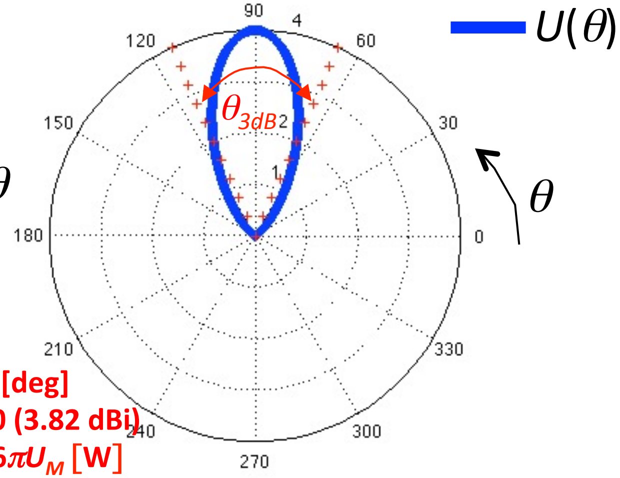
θ_{3dB}=90 [deg]
D_M=1.5 (1.76 dBi)
W_T=2.66πU_M [W]
η_{ML}=88%

Dipolo lungo $\lambda/2$



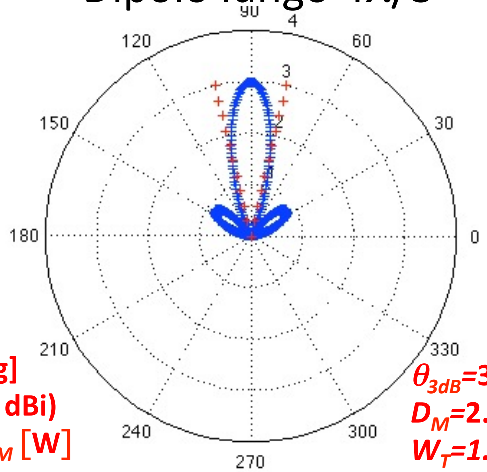
θ_{3dB}=78 [deg]
D_M=1.64 (2.148 dBi)
W_T=2.44πU_M [W]
η_{ML}=85%

Dipolo lungo λ



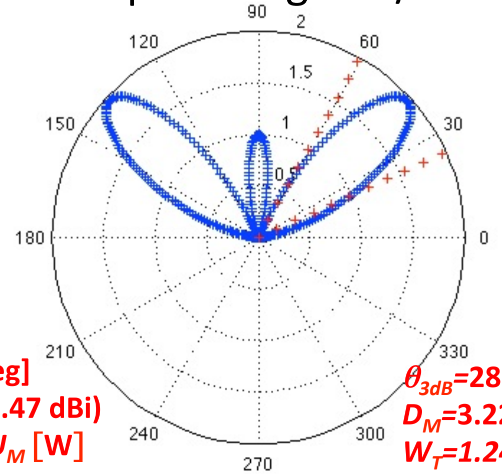
θ_{3dB}=47 [deg]
D_M=2.40 (3.82 dBi)
W_T=1.66πU_M [W]
η_{ML}=79%

Dipolo lungo 4λ/3



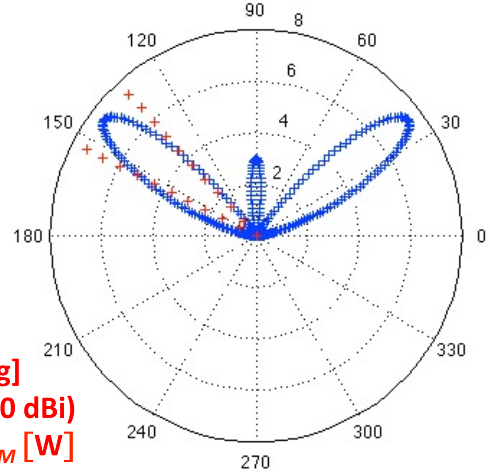
θ_{3dB}=27 [deg]
D_M=3.1 (4.9 dBi)
W_T=1.29πU_M [W]
η_{ML}= 61%

Dipolo lungo 3λ/2



θ_{3dB}=36 [deg]
D_M=2.22 (3.47 dBi)
W_T=1.79πU_M [W]
η_{ML}=36%

Dipolo lungo 8/3λ



θ_{3dB}=28 [deg]
D_M=3.22 (5.0 dBi)
W_T=1.24πU_M [W]
η_{ML}=36%