



# RF design of the $\beta 0.35$ spoke cavity "AMANDA"



**Guillaume OLRÉY**  
Institut de Physique Nucléaire  
*olry@ipno.in2p3.fr*

# Introduction

## European projects

- **XADS** (Transmutation) : CW, I=10 mA ( $\rightarrow$ 40 mA), E=600 MeV ( $\rightarrow$ 1 GeV)
- **EURISOL** (Radioactive ions beams) : CW, I=5 mA, E=1 GeV ( $\rightarrow$ 2 GeV)

## Study of spoke cavities

$$5...10 \text{ MeV } (\beta_p \sim 0.1) < E_{\text{proton}} < 80...100 \text{ MeV } (\beta_p \sim 0.5)$$

IPHI injector

ECR source + RFQ

Elliptical cavities

5-cell, 700MHz

# RF design

## Main parameters

- **Frequency: 352 MHz**  
IPHI frequency  
Large beam tube aperture
- **2-gap cavity**  
Fabrication cost  
Higher energy acceptance/multi-gap cavities
- **$\beta_g = 0.35$**   
Transition with  $\beta_{0.47}$  elliptical cavities ( $\sim 85$  MeV)

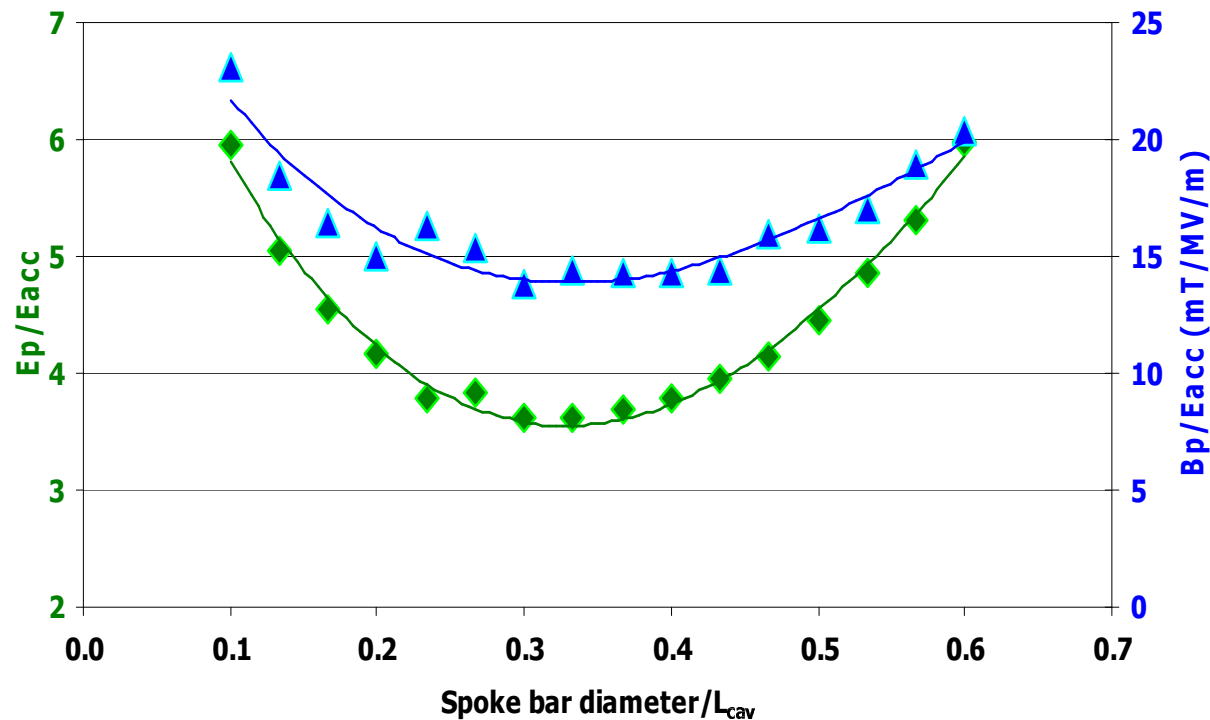
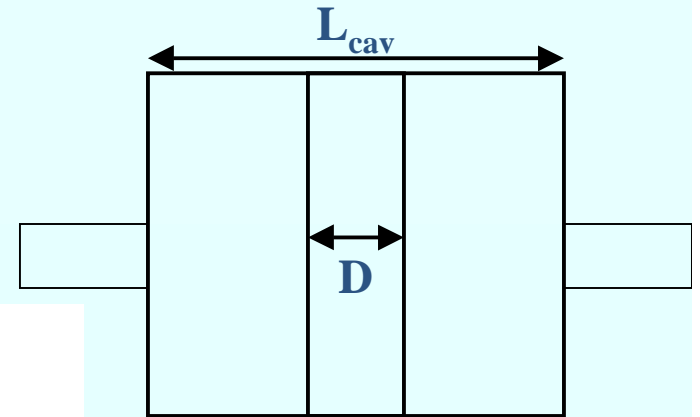
## Geometry optimization

- Many parameters  
Spoke bar shape (base & center)  
End walls
- **Minimize  $E_p/E_{acc}$  &  $B_p/E_{acc}$**
- **Maximize  $E_{acc}$  and  $T$**
- "Simple" final geometry  
Feasibility  
Fabrication cost

# RF design

Starting point : pillbox cavity with cylindrical spoke bar

- Variation of the spoke bar diameter ( $L_{cav}$  fixed)
- $L_{cav}=300$  mm, Cavity diameter=300 mm


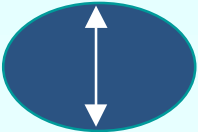



Minimum  
for  
 $D/L_{cav}=1/3$

# RF design

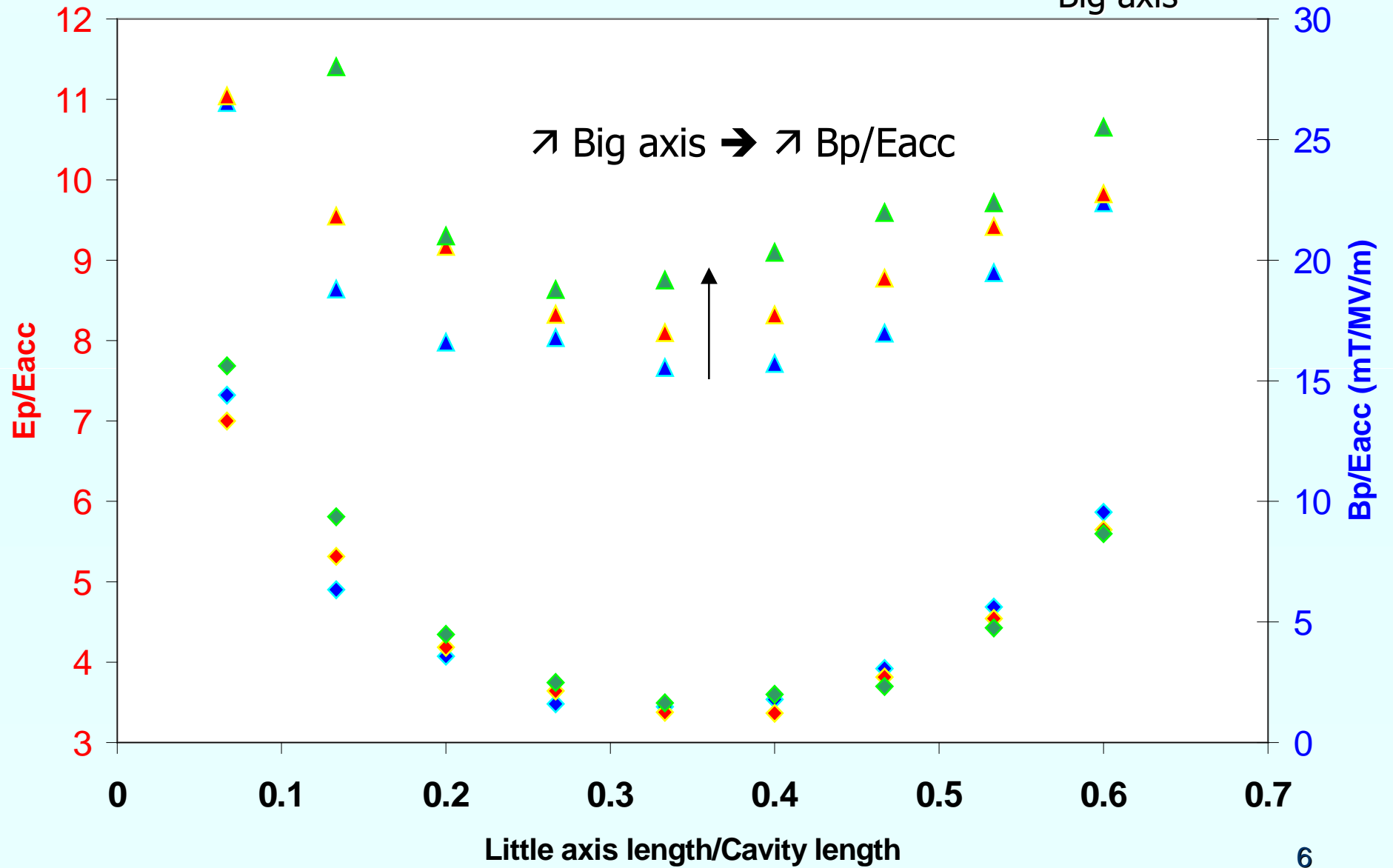
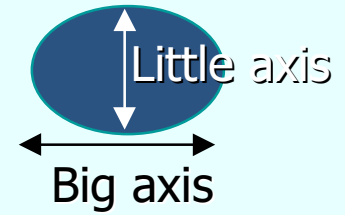
*Comparison : cylindrical, elliptical and racetrack spoke bar shape*

- Mesh points : 1 000 000, mesh size : 2 mm

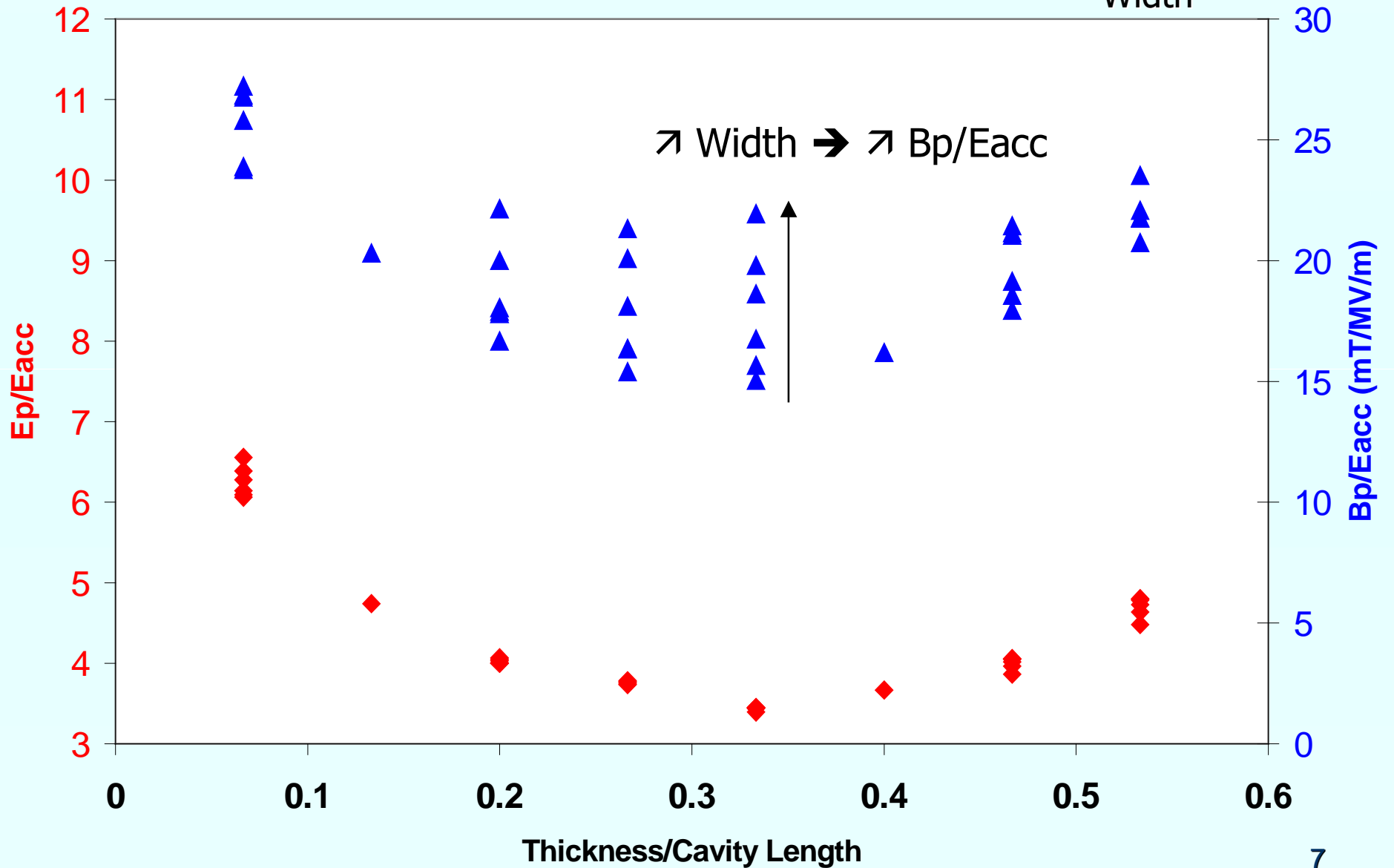
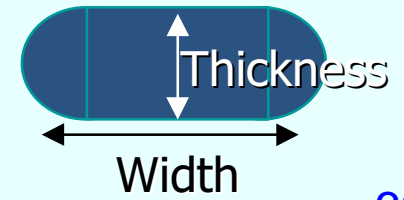
	Ep/Eacc	Bp/Eacc (mT/MV/m)
	3.60	13.8
	3.40	15.5
	3.40	15.0

Minimum  
for  
 $D/L_{cav} = 1/3$

# Elliptical spoke bar



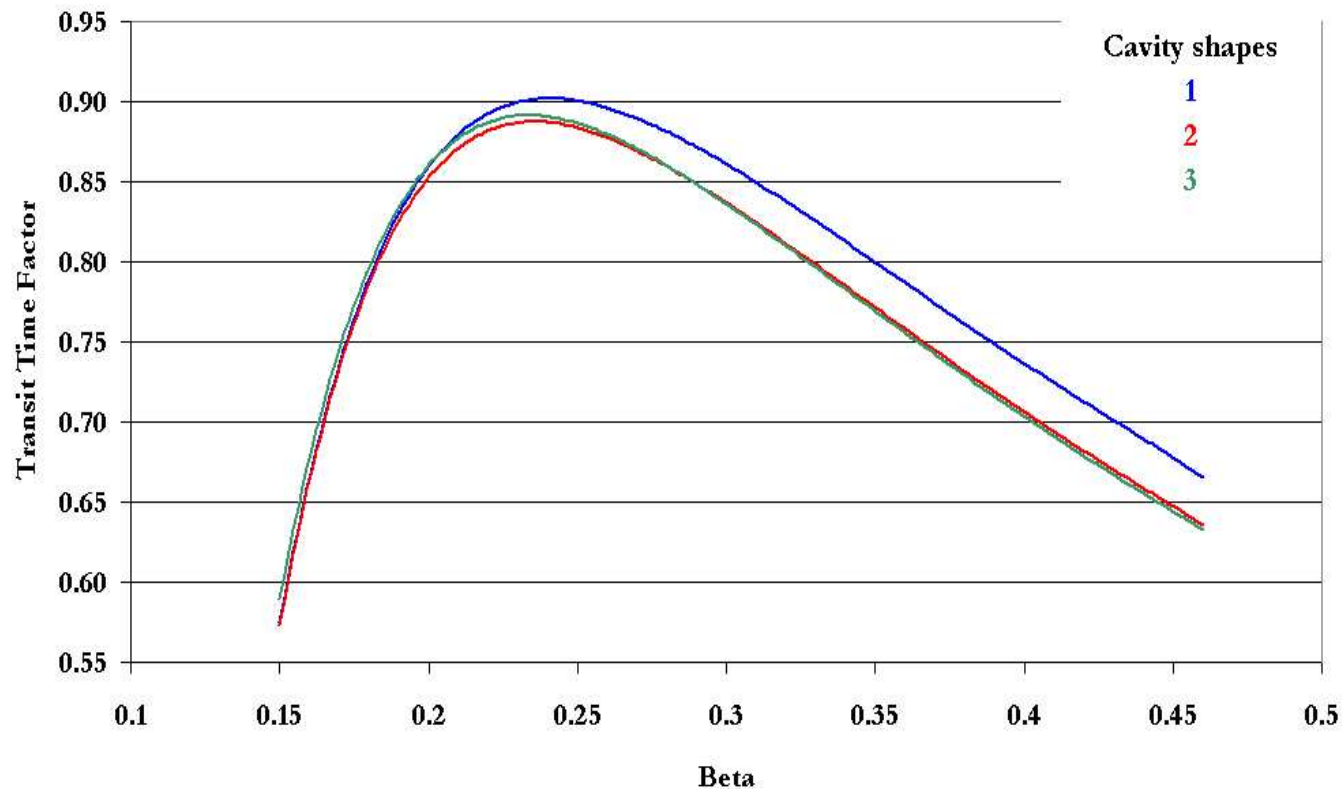
# Racetrack spoke bar



# RF design

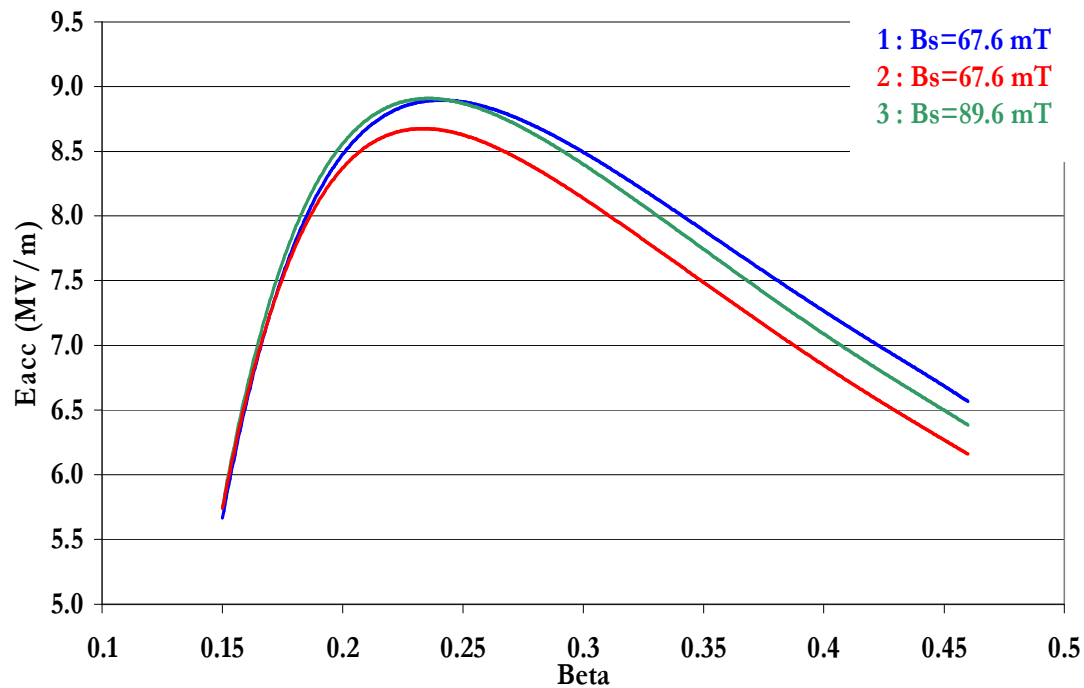
*Comparison : 3 types of cavity (f=320 MHz,  $\beta_g$ 0.24)*

- 1 Cylindrical spoke base + racetrack spoke center & reentrant end walls
- 2 Cylindrical spoke bar & reentrant end walls
- 3 Pillbox with cylindrical spoke bar

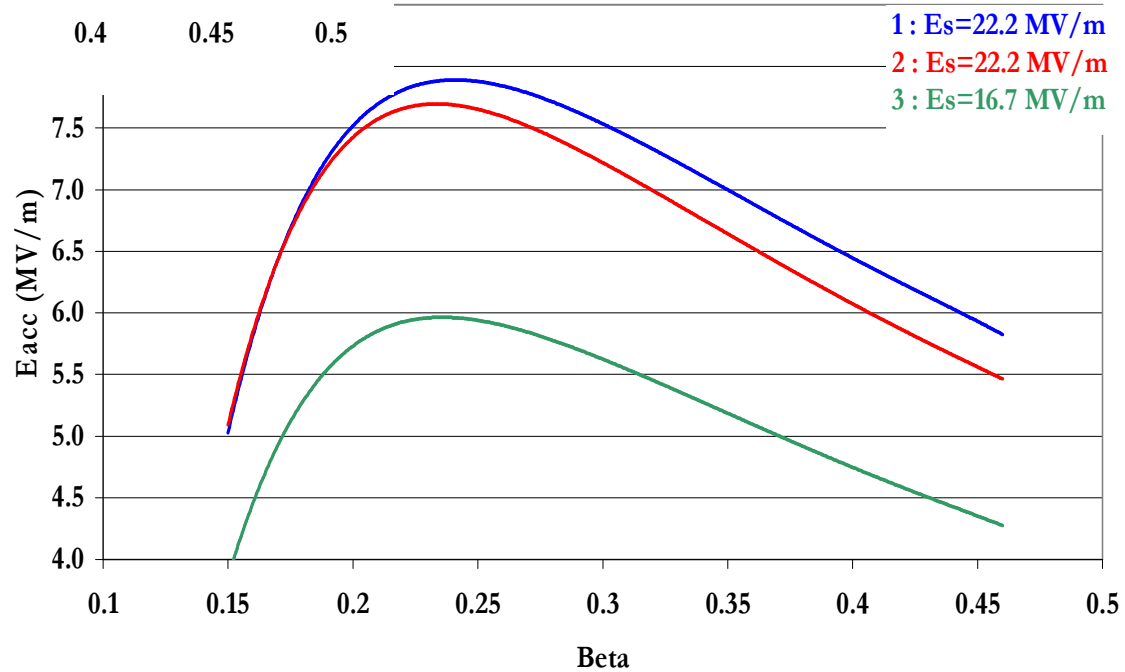




Eacc @ Es=25 MV/m



Eacc @ Bs=60 mT



# Conclusion

Best design

Cylindrical spoke base + racetrack spoke center & reentrant end walls

## *RF parameters*

Frequency (MHz)	358.66
Rs @ 4K (n $\Omega$ )	53
r/Q ( $\Omega$ )	220
G ( $\Omega$ )	101
Es/Eacc	3.06
Bs/Eacc (mT/MV/m)	8.28
Eacc @ Es=25 MV/m (MV/m)	8.18
Voltage gain (MV)	1.64
Optimum beta	0.36

Residual resistance=10 n $\Omega$

Lacc=200 mm

