Deflecting structures with minimized level of aberrations.

Poster TUPB002

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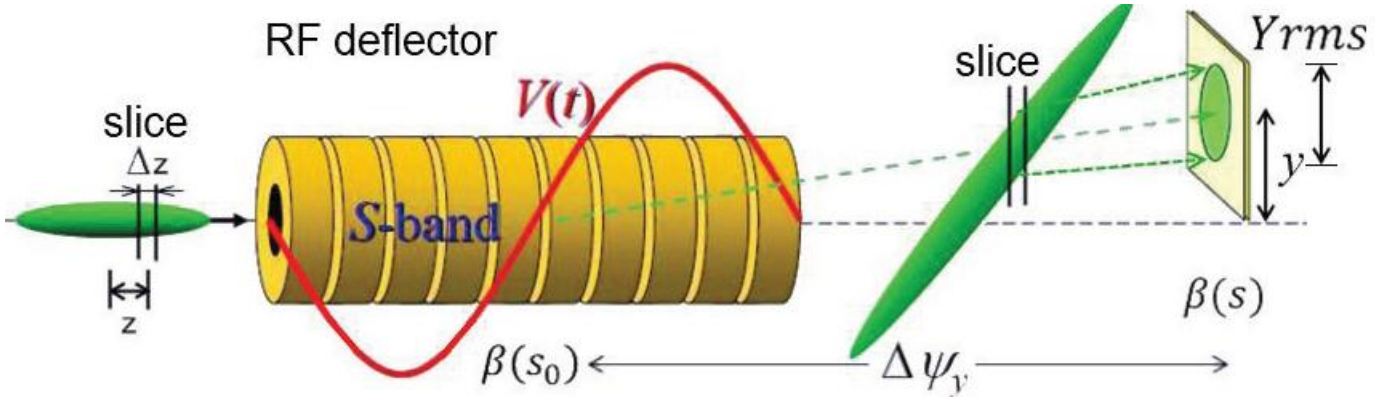
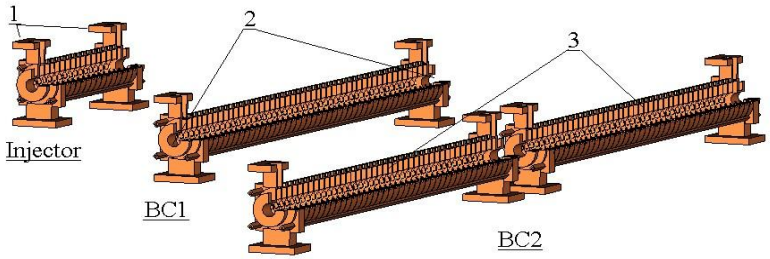
1. Deflecting Structures (DS) were introduced for bunch deflection.

2. At present time DS are mainly used for bunch rotation (bunch longitudinal diagnostic, emittance exchange, luminosity increasing).



INR is responsible for TDS system (now under construction) in the

European XFEL.



INR concept for new DS developments.

Bunch rotation is a Particles Distribution Transformation (PDT) in 6-dimentional phase space.

The tool for PDT should provide a minimal, completely predictable, own distortion in the original distribution.

In DS aberration free is just the synchronous (β=1) harmonic, but not the total field! Especially important for low bunch energy.

Research idea for DS selection and development – 'linear fields'

Practical corrections –
a) - 'as linear as possible';
b) – RF efficient – preferable.

Method

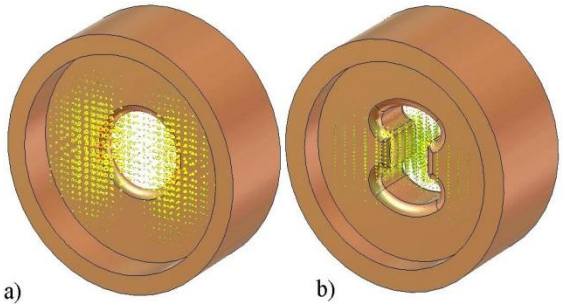
Field distributions analysis + numerical simulations

$$\vec{F}^L = e(\vec{E} + [\vec{v}, \vec{B}]), F_x = eE_d = e(E_x - \beta Z_0 H_y),$$

$$E_j(r,z) = \widehat{E_j(r,z)} e^{i\psi_j(z)} =$$

$$= \sum_{n\to-\infty}^{n\to+\infty} a_{jn}(r) e^{\frac{-i(\Theta_0 + 2n\pi)z}{d}},$$

.....



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$$a_{jn}(0) \sim a_{jn}(a) \cdot exp(-\frac{4\pi^2 n}{\beta\Theta_0} \cdot \frac{a}{\lambda}), \quad |n| \gg 1$$

+ results treatment

.....

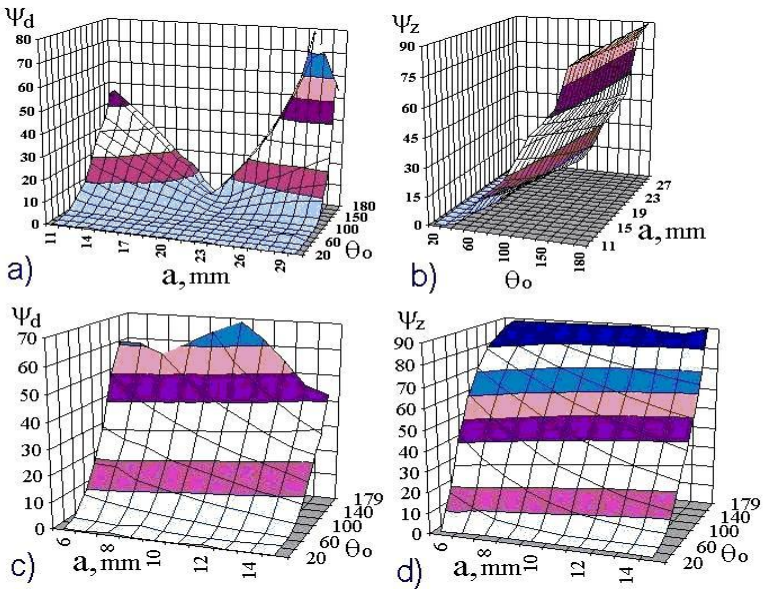
$$\delta\psi_j(z) = \psi_j(z) + \frac{\Theta_0 z}{d}, \quad \Psi_j = max(|\delta\psi_j(z)|),$$

.....

$$|a_{jn}(0)| < \frac{(\widehat{E_j(0,z)}_{max} + \widehat{E_j(0,z)}_{min})\Psi_j}{2n},$$

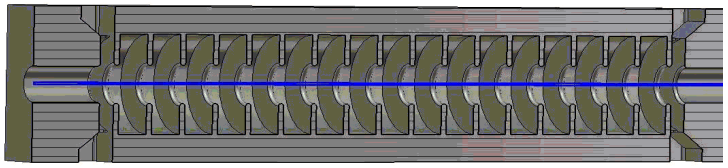
$$a_{jn}(0) = \frac{\int_0^d \widehat{E_j(0,z)} sin(\delta\psi_j(z)) sin(\frac{2\pi n z}{d}) dz}{d}.$$

.....

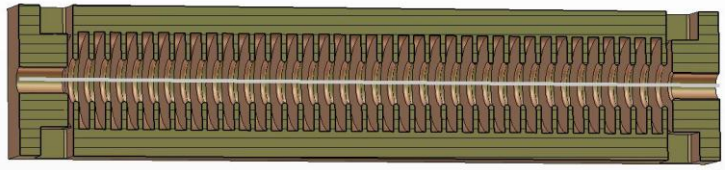


INR – DESY cooperation in DS development

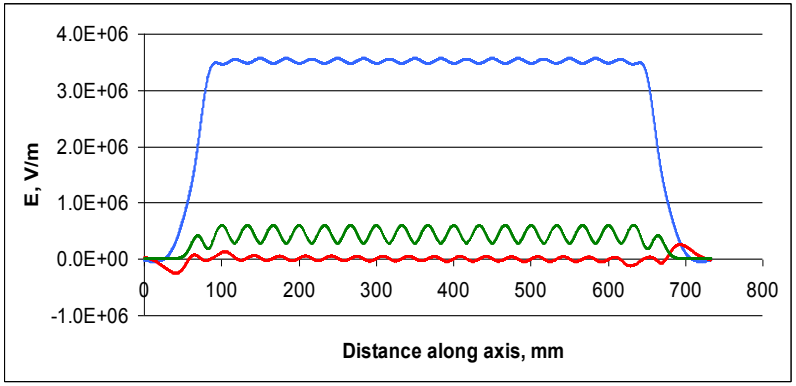
Proposals.
For Traveling Wave operation

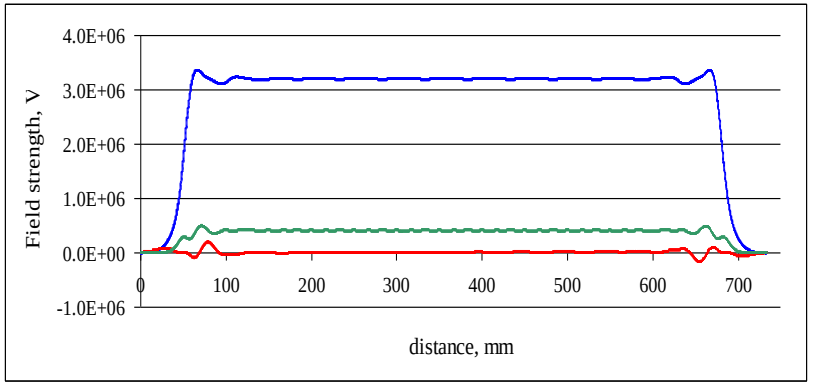


Conventional, LOLA and similar, θ=120^o



θ=60^o, aberrations Ez ↓> 40 times
Ed ↓ > 5 times





The best for 6D PDT

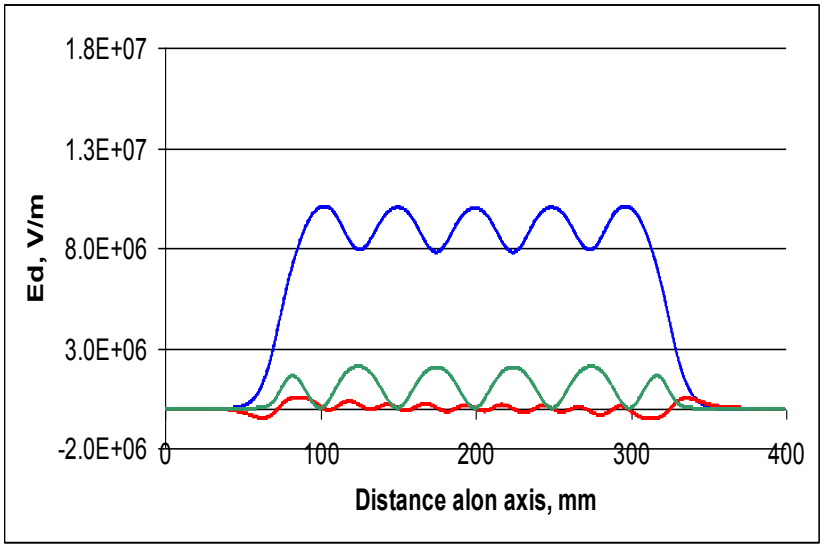
Recipe for choice –
- low θ,
- balanced distribution for transverse E,H components with opposite phasing,
- large aperture radius.

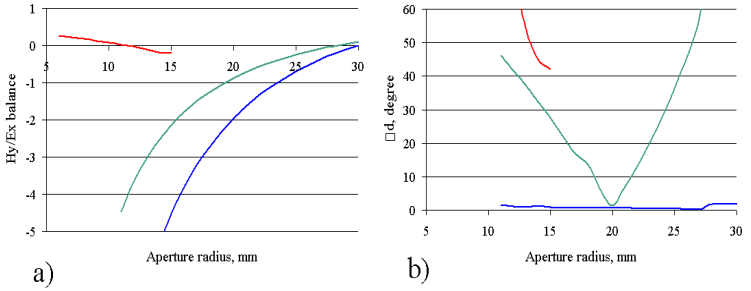
For Standing Wave operation.

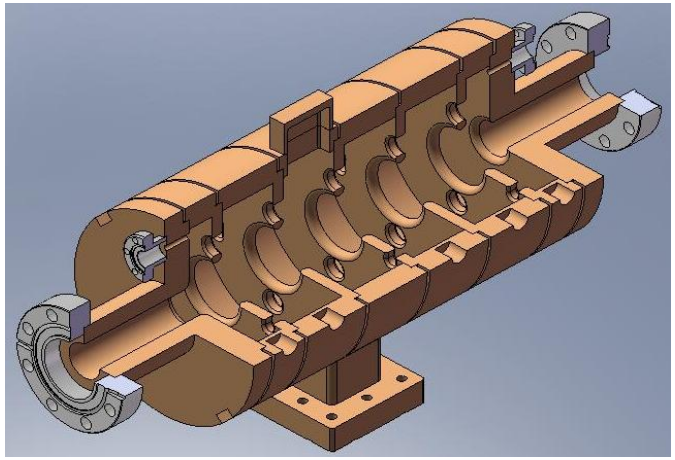
SW operation is more effective in RF for short deflectors. But aberration reduction is possible for Ed only (transverse PDT) !

Either optimized classical

Disk Loaded Waveguide (DLW)





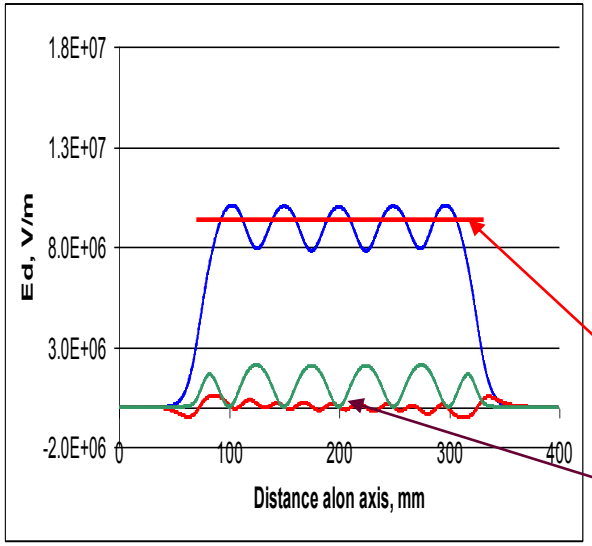


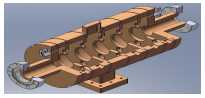
Not the best RF efficiency.

For SW operation

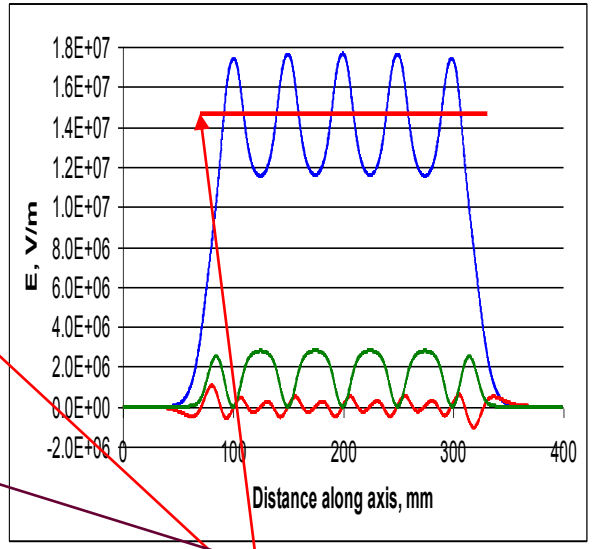
Or – decoupled deflector. Separated control over transverse distributions of E,H field components.

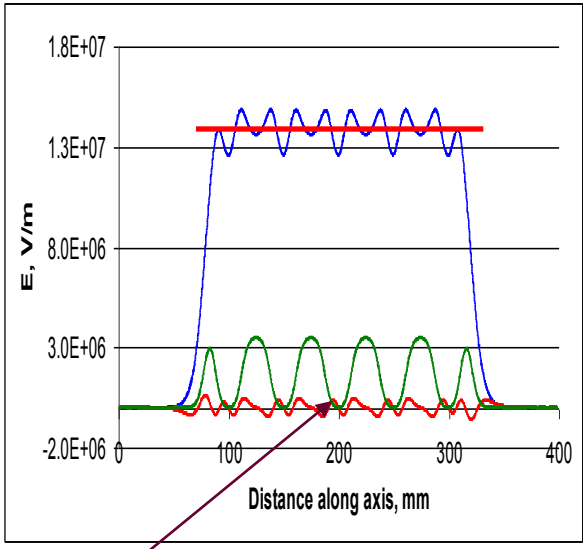
Optimized classical DLW





Decoupled





Essentially higher RF efficiency, flexible field solutions, simultaneously including reduced Ed aberrations.

Thanks to INR TDS group members for motivation.

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Thank You for attention!

For more details -

welcome to poster

TUPB002!