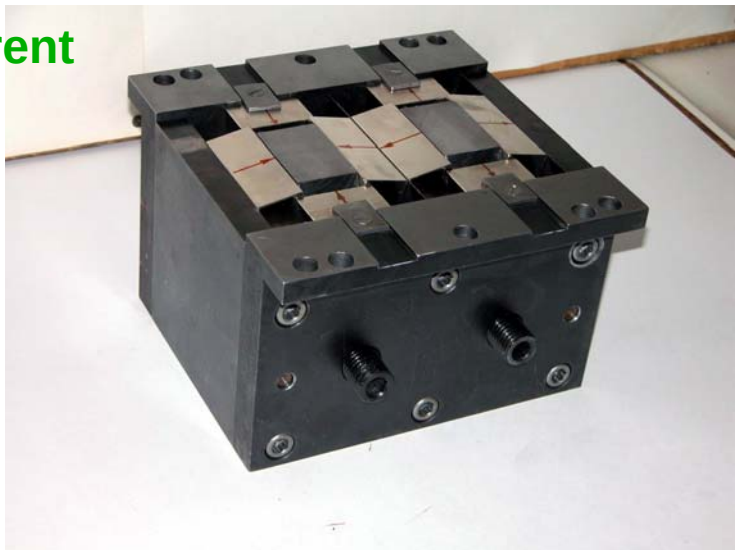
PROGRESS WITH DAMPING WIGGLER DESIGN

M.Korostelev, E.Levichev, P.Vobly

Previous design: permanent magnet wiggler

Period:	**10 cm**
Gap:	**12 mm**
Pole width:	**50 mm**
Length:	**2 m**
Field amplitude:	**1.7 T**
Field quality @ ±1 cm:	**10^{-3}**
Total length:	**160 m**
Total radiation power:	**1.7 MV at 1 A current**

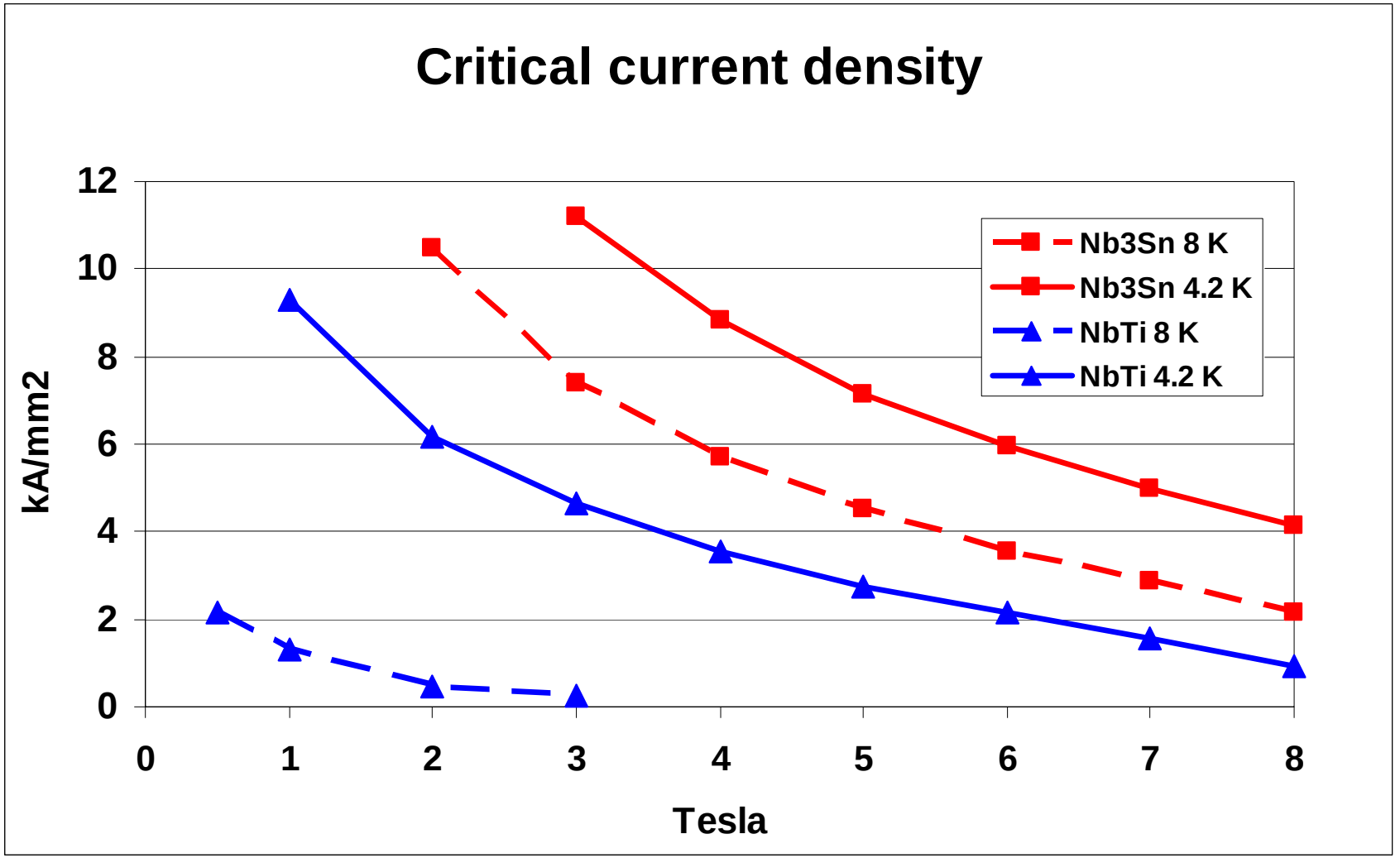
PETRA III 1-period permanent magnet prototype (bottom half) →



SC wiggler

- Higher field amplitude (damping rate ~ B^2)
- Lower period length (resulting emittance reduction).
- Magnet field can be tuned easily (IBS depends on the beam current).

NB_3Sn versus NbTi

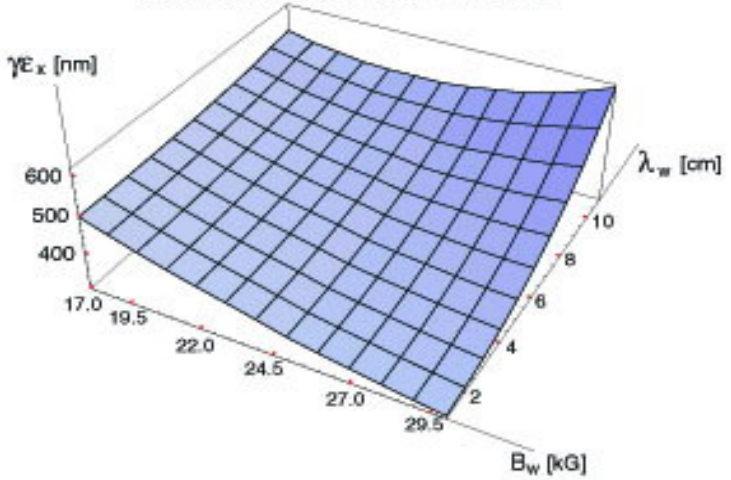


Emittance minimization

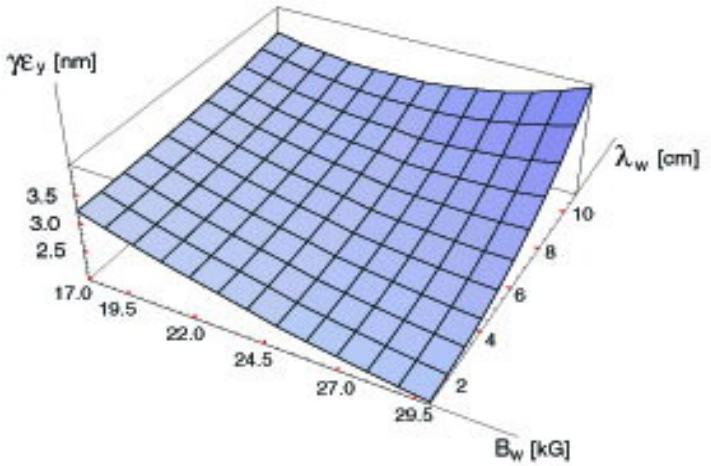
- Additional damping is a cure against IBS emittance growth.
- Wiggler induced damping ~ B^2.
- Wiggler equilibrium emittance ~ $\lambda_W^2 B_W^3$.
- Wiggler always increases energy spread and longitudinal emittance.

Normalized emittances with IBS of the CLIC DR as a function of wiggler period and wiggler peak field at betatron coupling 0.65%

Horizontal Emittance with IBS

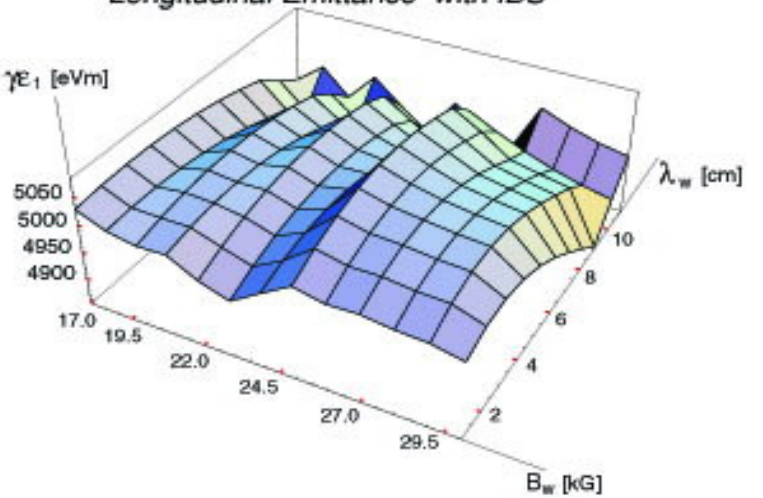


Vertical Emittance with IBS



	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9
1.0	494	472	452	432	415	399	383	365	353	341	329	319	309
2.0	495	473	452	433	417	401	385	367	355	344	333	323	314
3.0	496	475	454	436	419	404	389	372	361	350	340	331	324
4.0	498	478	458	440	423	409	395	379	369	360	351	344	338
5.0	502	482	462	445	429	416	404	388	380	373	366	360	357
6.0	505	487	467	452	437	425	414	400	394	389	385	382	382
7.0	510	492	474	460	446	436	427	415	411	409	408	408	412
8.0	515	499	482	469	457	449	443	433	431	433	436	440	449
9.0	522	507	491	481	470	464	461	453	456	462	469	478	494
10.0	534	520	505	497	487	485	485	484	490	500	513	529	549
11.0	542	526	518	508	505	506	506	514	525	537	556	579	607

Longitudinal Emittance with IBS



Maxim Korostelev 16.09.2005 (CLIC meeting)

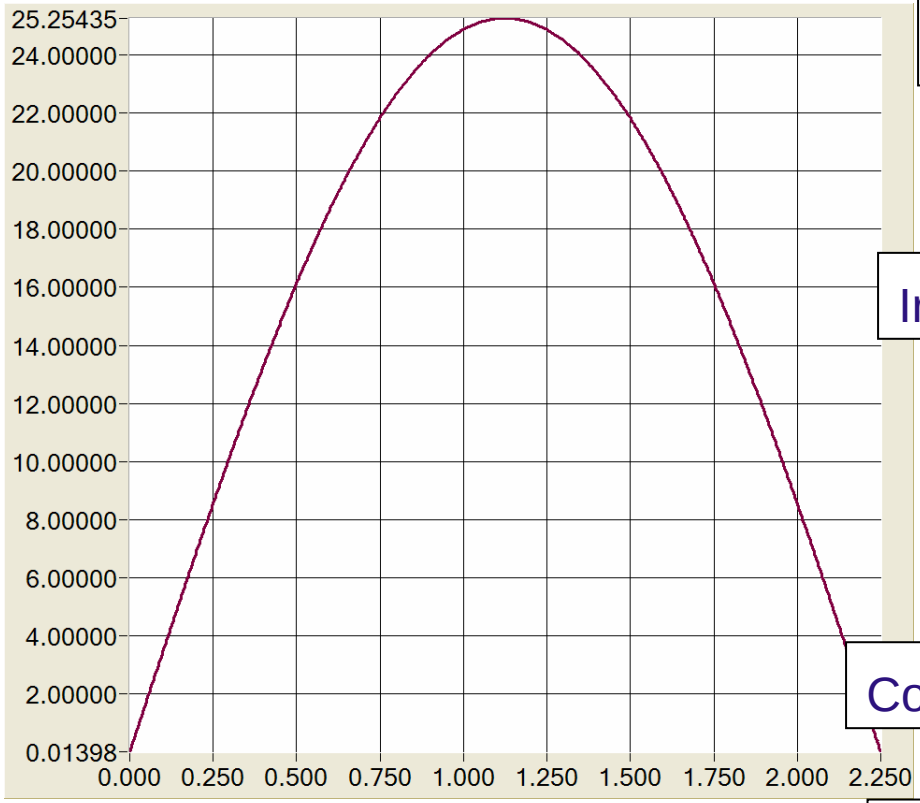
SC wiggler parameters

20 mm (pole gap) – 2x1 mm (He wall) – 2x2 mm (safety vacuum)
- 2x1 mm (N wall screen) = 12 mm (beam aperture).

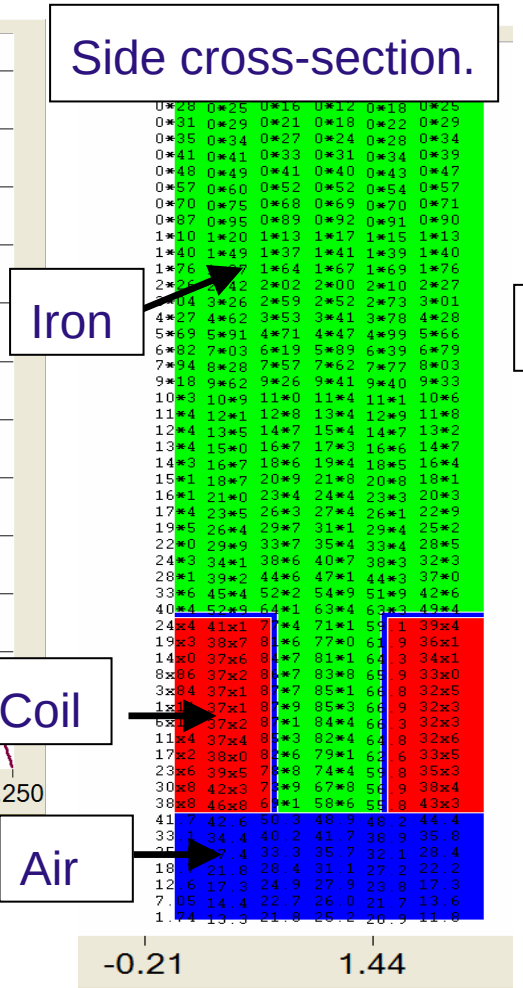
	λ_w *(mm)*	*Iw* (kA-t)	*w*	*I* (kA)	*I/I*$_c$ (%)	H_w (T)	$H_{coil\text{-}max}$ (T)
Nb_3Sn	40	130	72	1.80	100	2.25	7.5
	40	120	72	1.67	85	2.10	7.0
	45	125	84	1.50	75	2.52	7.0
	50	140	84	1.67	85	3.05	7.0
NbTi	50	97	137	0.71	90	2.26	5.0

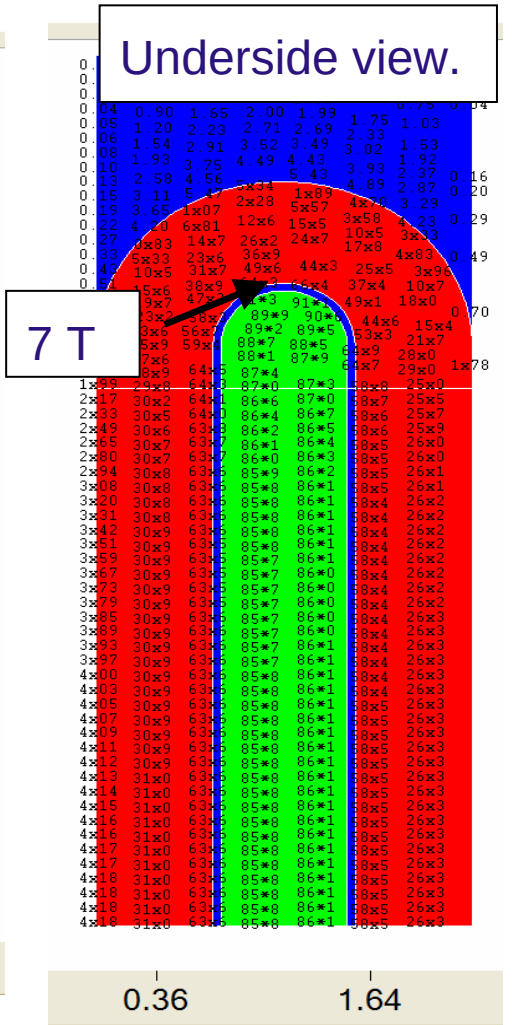
Transverse field quality: $\Delta B/B \sim 10^{-4}$ at ± 1 cm.

Magnetic field calculation



Longitudinal field distribution.





Conclusion

CLIC SC wiggler parameters:

- **Period length** — **45 mm**
- **Field amplitude** — **2.5 T**
- **Pole gap** — **20 mm**
- **Beam aperture** — **12 mm**
- **Superconductor** — **Nb_3Sn**
- **Field quality** — **~10^{-4} at ± 1 cm.**