EFFECTS OF INSERTION DEVICE AT SOLEIL

O. Marcouillé, F. Briquez, C. Benabderrahmane, P. Berteaud, P. Brunelle, M-E. Couprie, J-M. Filhol, A. Loulergue, F. Marteau, M. Massal, A. Nadji, L. Nadolski, M-A Tordeux, M. Valléau, J. Vétéran

Contents

- Operating and planned IDs
- Individual effects of the IDs
  - Tune Shift
  - Additionnal Coupling
- Coupling induced by HU640
- Effect on the orbit
- Simulated effect of the In-Vac wiggler WSV50

Built IDs

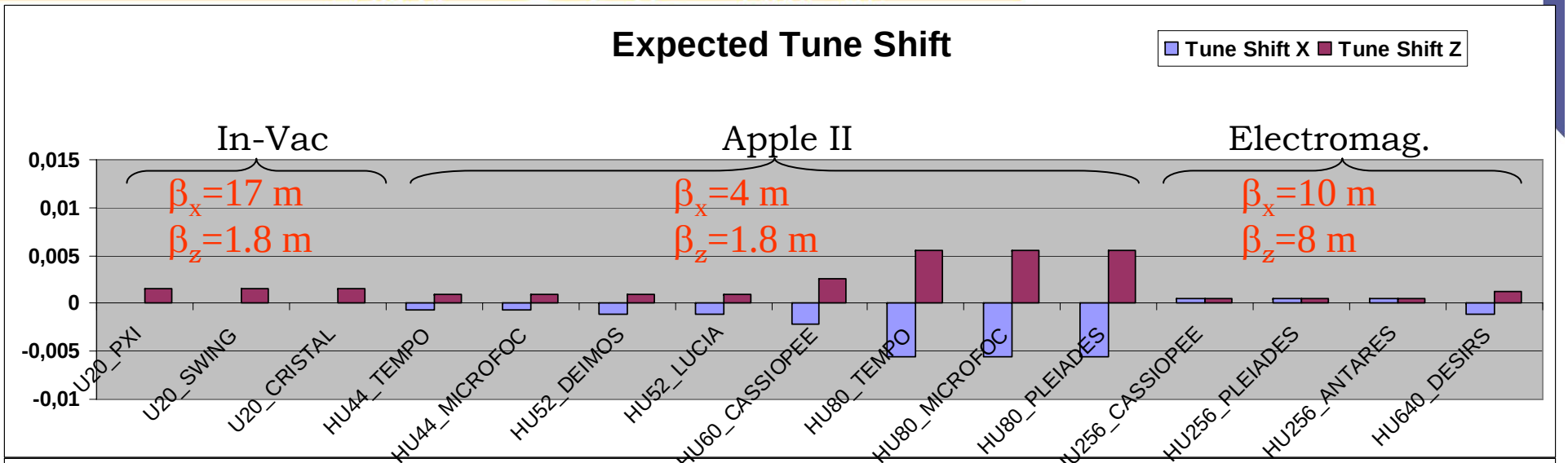
	HU640	HU256	HU80	HU60	HU52	HU44	U24	U20
Beamline	DESIRS	CASSIOPEE PLEIADES ANTARES	TEMPO PLEIADES MICROFOC	ANTARES CASSIOPEE	DEIMOS LUCIA	TEMPO MICROFOC	PROXIMA2 (1)	PROXIMA1 SWING CRISTAL SIXS GALAXIES (1)
Number	1	3	3	2	2	2	1	4
Period [mm]	640	256	80	60	52	44	24	20
Period number	14	12	19	26	30	36	81	98
Type	Electromag	Electromag	Apple-II	Apple-II	Apple-II	Apple-II	In -vac	In -vac
Gap [mm]	19	50 (H) 15 (V)	15.5 - 250	15.5 - 250	15.5 - 250	15.5 – 250	5.5 - 30	5.5 - 30
Polarisation	LH / LV / E	LH / LV / E	LH / LV / E	LH / LV / E	LH / LV / E	LH / LV / E	LH	LH
Peak field [T]	0.09 (H) 0.11 (V)	0.33 (H) 0.44 (V)	0.72 (H) 0.94 (V)	0.82 (H) 0.57 (V)	0.74 (H) 0.50 (V)	0.64 (H) 0. 41 (V)	0.84	0.95
Quasi-Periodic	N	Y	Y	N	N	N	N	N
Energy [eV]	5 – 40	10 – 1000	40 – 1600	100 - 4000	500 - 6000	1000 - 8000	3000 – 18000	3000 – 18000

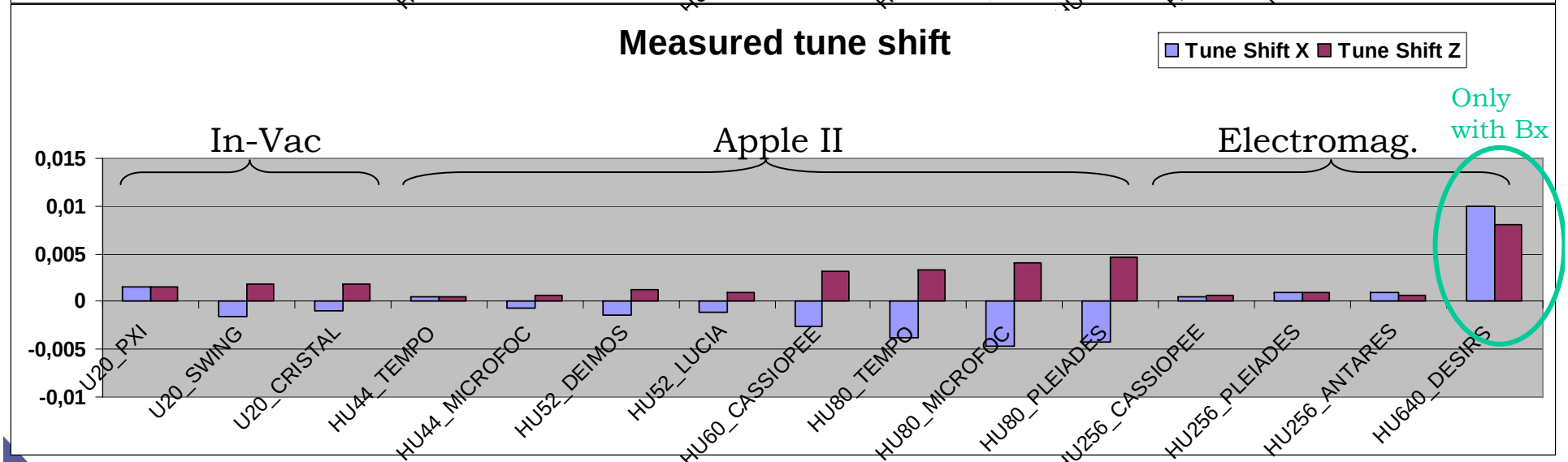
(1) Not installed

Planned IDs

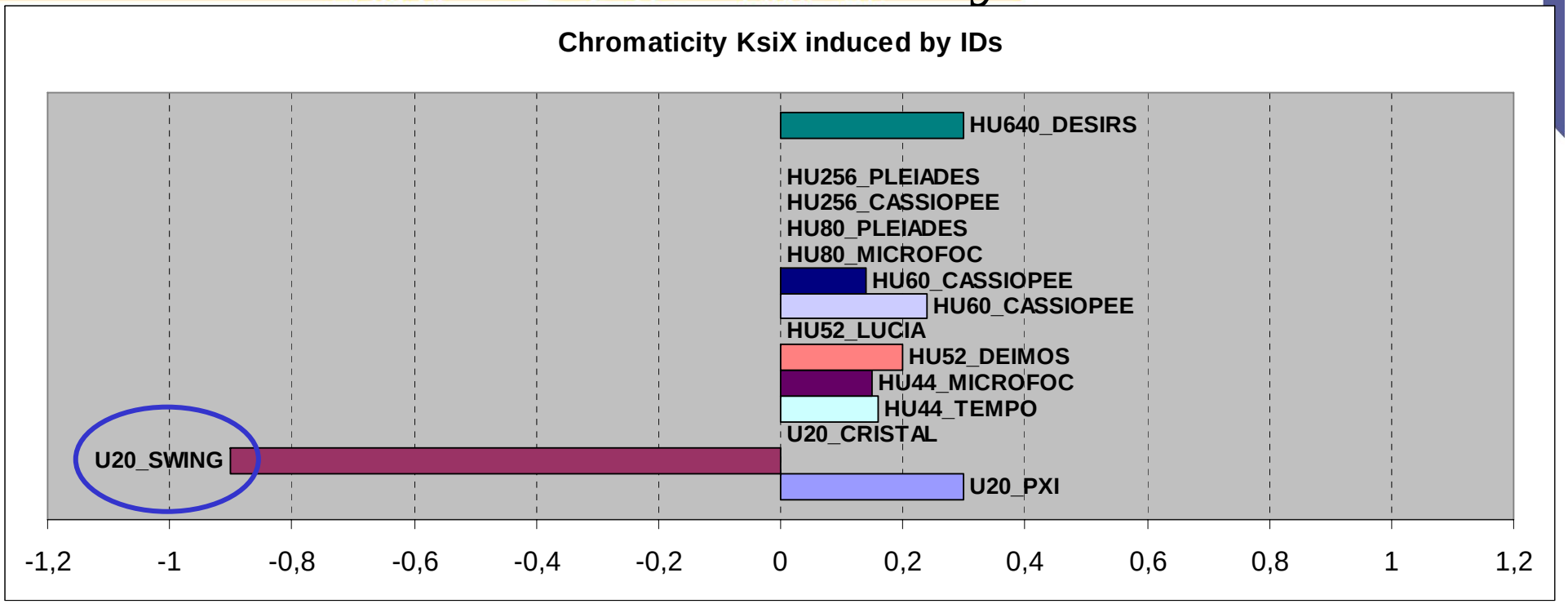
	WSV50	EMPHU65	HU36	HU64	HU42	U18_CRYO	U20	W150
Beamline	PSICHE	DEIMOS	SIRIUS	MICROXMOUS	MICROXMOUS	R & D	NANOSCOPIUM	PUMA + **Slicing**
Number	1	1	1	1	1	1	2	1
Period [mm]	50	65	36	64	42	18	20	150
Period number	38	26	44	24	38	-	98	13
Type	In-vac	Electro Aim. Perm	Apple-II	Apple-II	Apple-II	In-vac Cryogenic	In-vac	Out-vac
Gap [mm]	5.5 - 30	15.5	11 – 250	15.5 – 250	15.5 – 250	5.5 – 30	5.5 - 30	11 - 250
Polarisation	LH	LV / E	LH/LV/ E	LH/LV/E	LH/LV/E	LH	LH	LH
Peak field [T]	2.1	0.24 (H) 0.24 (V)	0.75 (H) 0.53 (V)	0.82 (H) 0.57 (V)	0.64 (H) 0. 41 (V)	1.07	0.95	2.1
Quasi-Periodic	N	N	N	O	N	N	N	N
Energy (eV)	10000 - 50000	5000 - 17000	2000 - 10000	100 - 4000	1000 - 8000	1500-30000	3000 – 18000	1.3 – 1.5

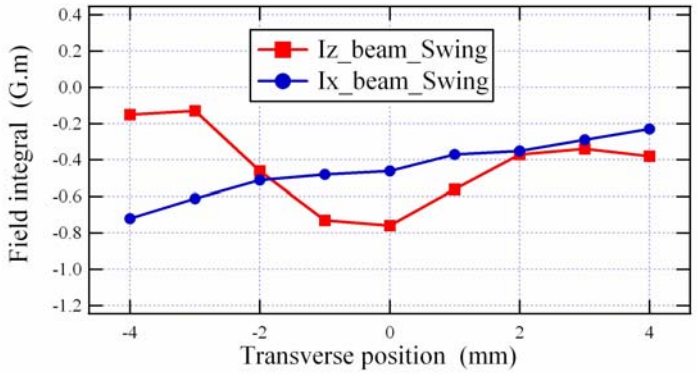
Effect on Dynamics: Maximum Tune Shift





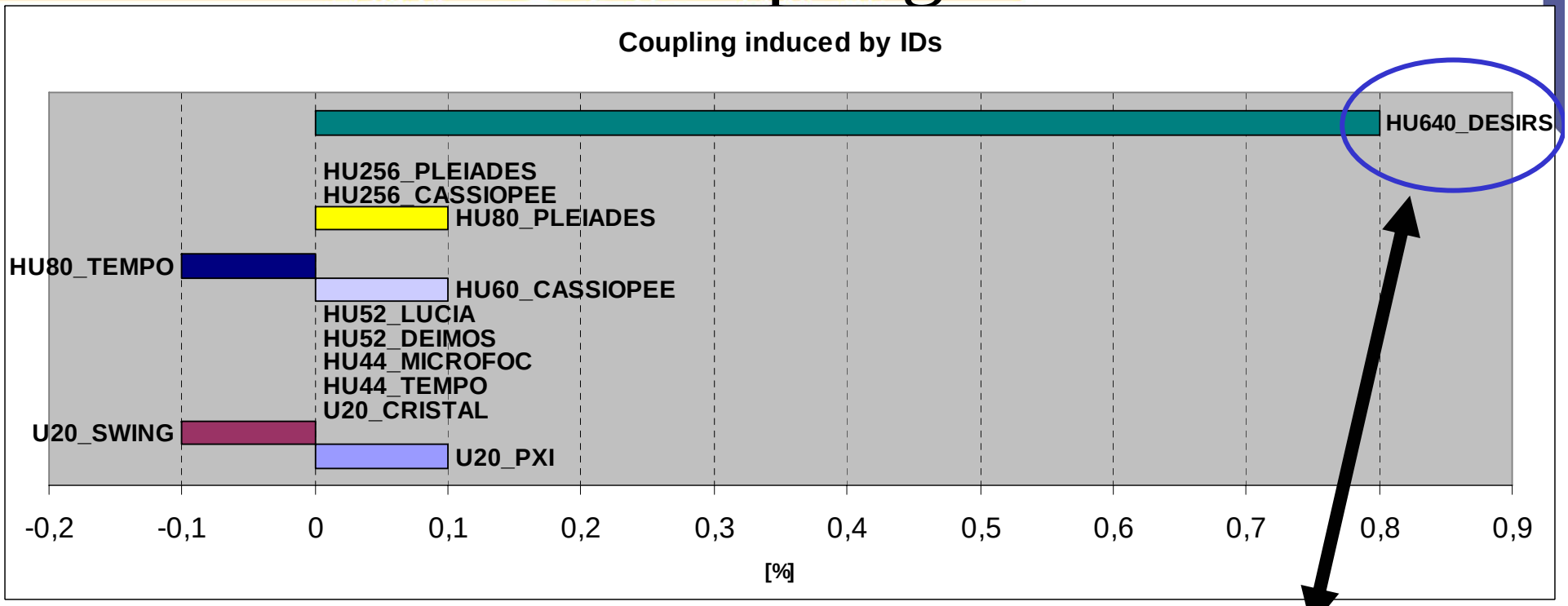
Effects on dynamics: Chromaticity



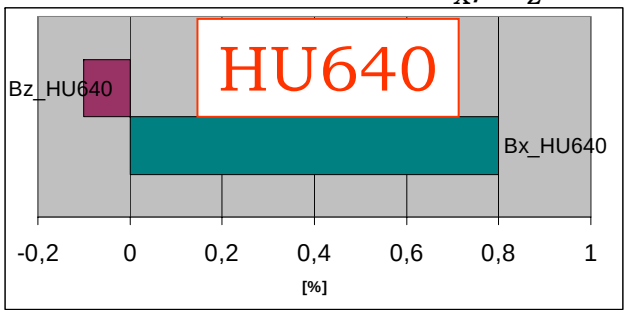


- Chromaticity in X induced by U20_SWING
- No chromaticity induced in Z plane

Effects on dynamics: Coupling

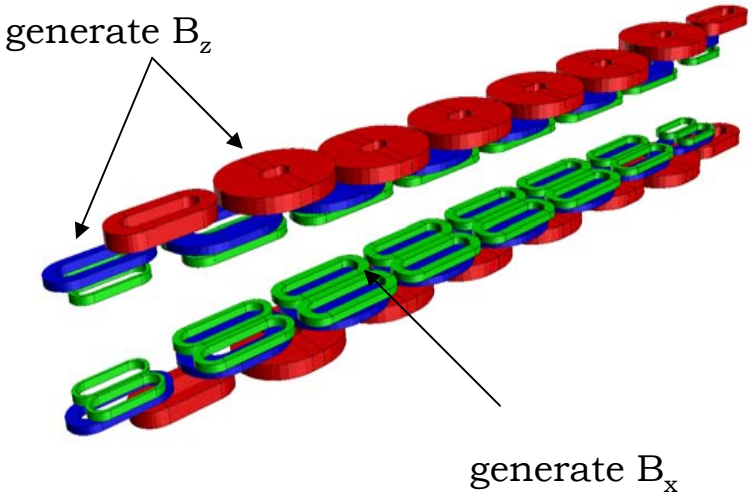


COUPLING Vs B_x/B_z



- Strong coupling induced by HU640
- Results from the B_x Component

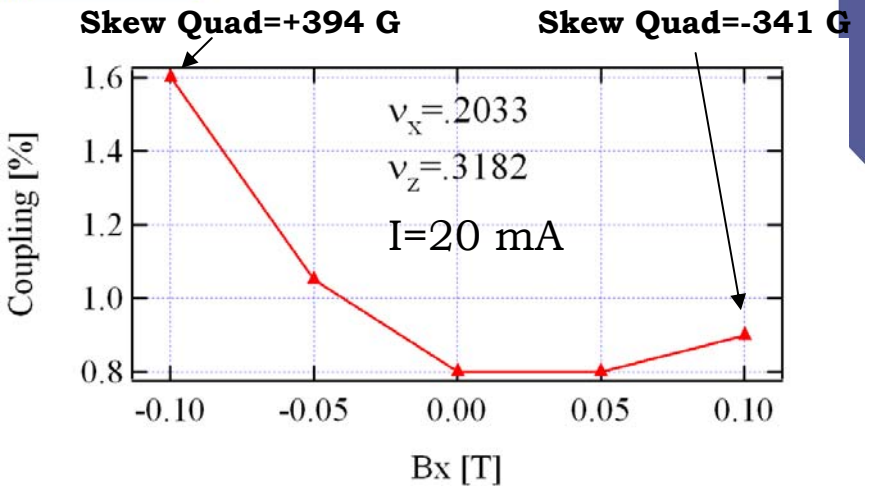
HU640

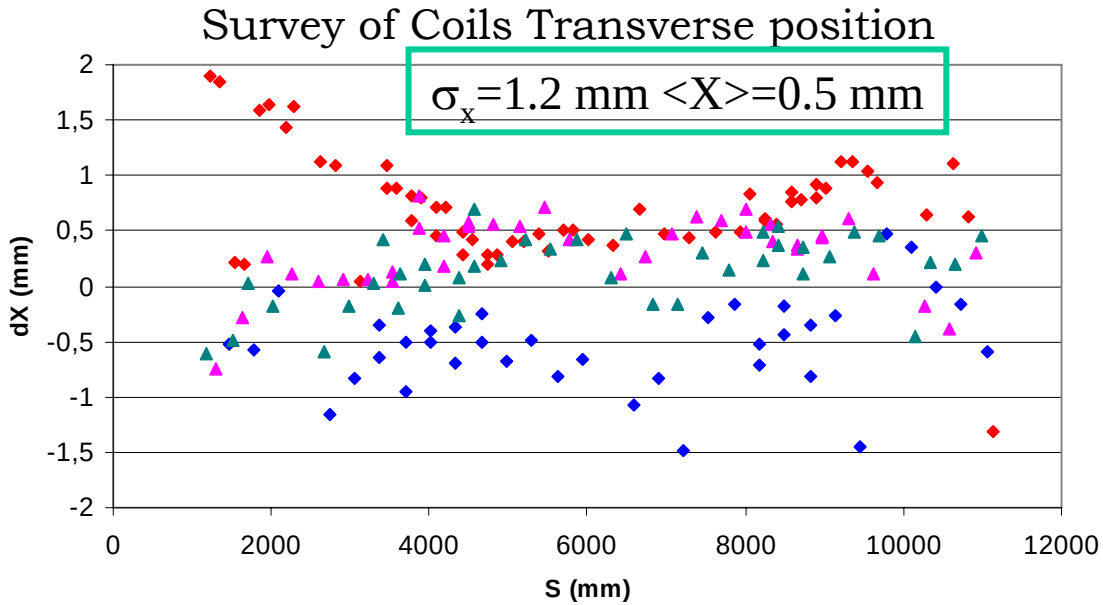


- Electromagnetic ID
- 5eV-40 eV
- Polarization: LH/LV/E
- B_z:0.14 T max. produced by 2 sets of coils (blue/red)
- B_x:0.1 T max.
- 16 periods of 640 mm

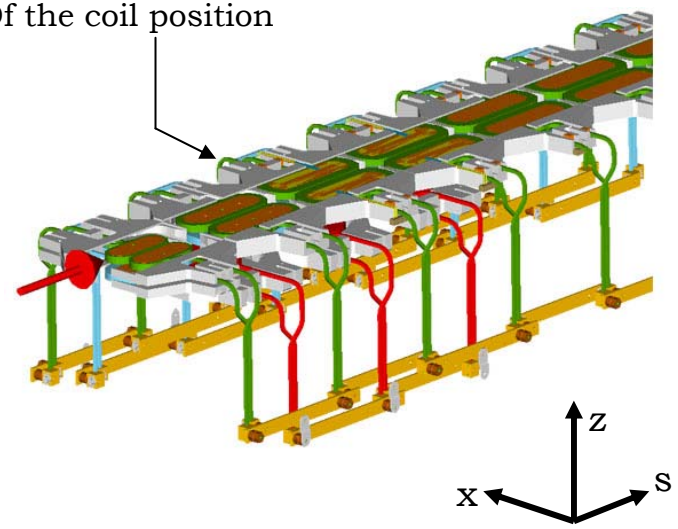
HU640: Coupling induced by the ID

- No coupling Vs B_z
- Significative coupling Vs B_x
- May results from the transverse misalignment of coils
- Skew quad. deduced from the **crossed orbit** (See Talk of L. S. Nadolski) method and the **bumps** method (good agreement)



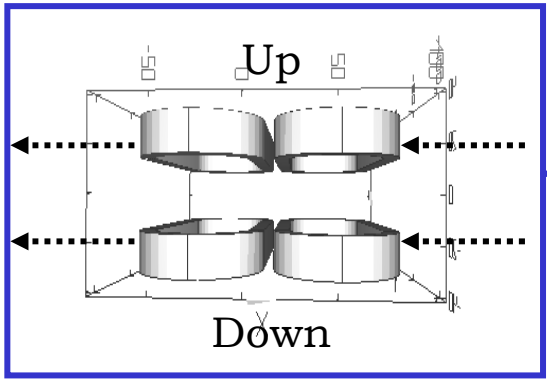


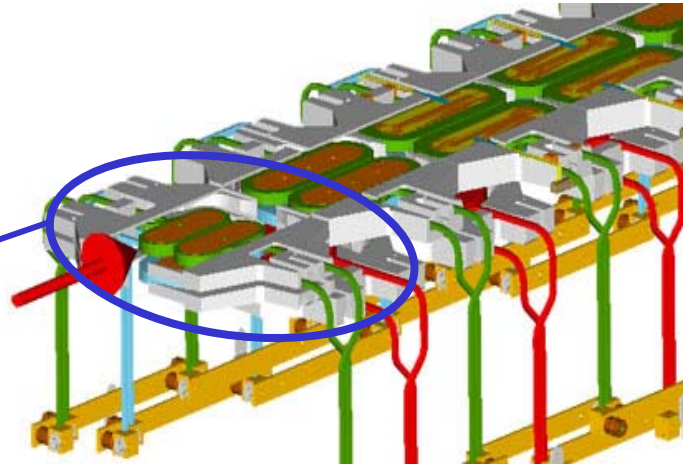
Optical measurement
Of the coil position



HU640: Correction of the Skew quadrupole

- The lateral displacement of B_x end coils results in a change of skew quadrupole
- Calculated and measured calibration
- Preliminary tests

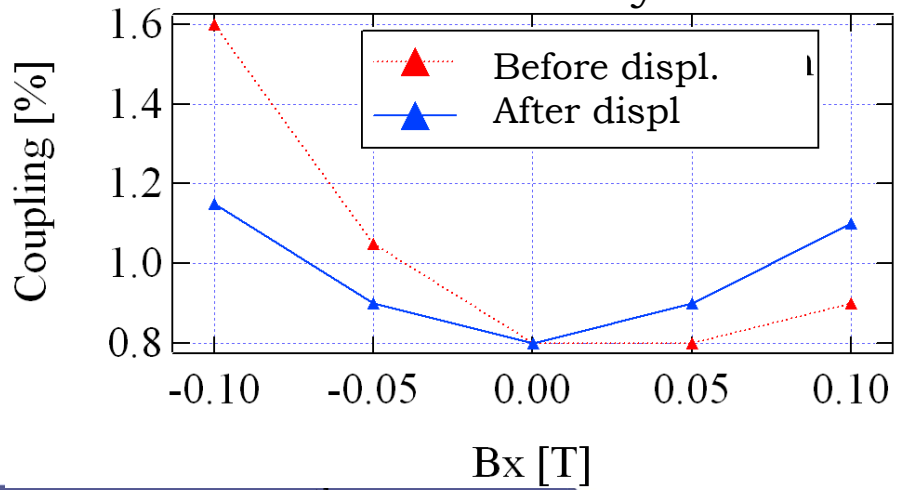




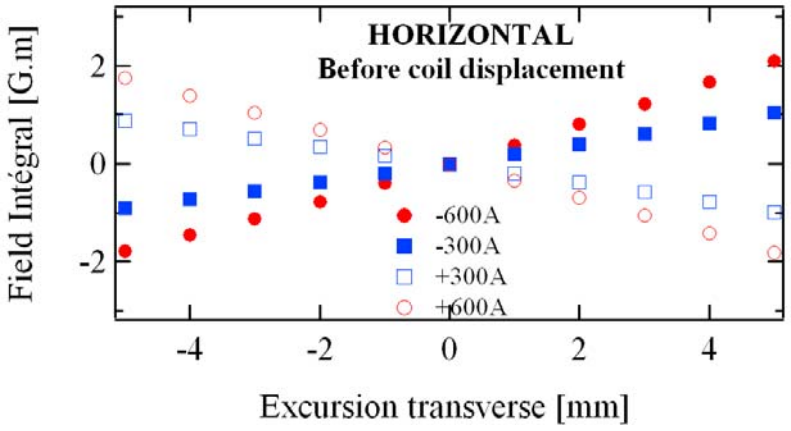
Skew Quad. Induced for 1 mm displacement

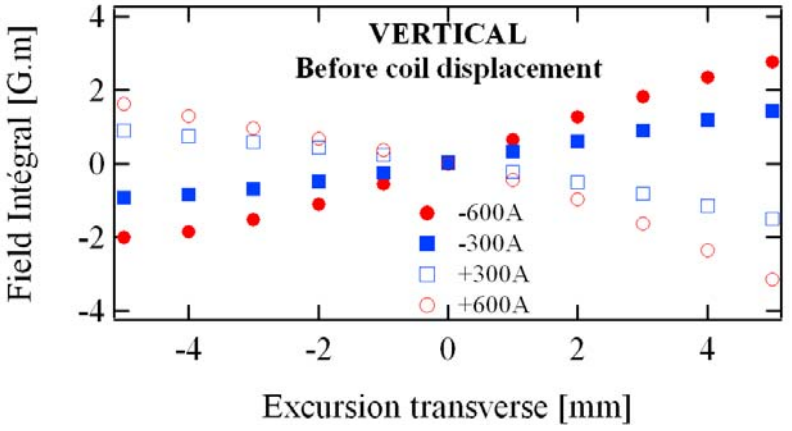
B_x [T]	Calc.	Meas.
-0.1 (-600A)	-184 G	-164 G
-0.05 (-300A)	-82 G	-82 G
0.05 (+300A)	+82 G	+83 G
0.1 (+600A)	+184 G	+176 G

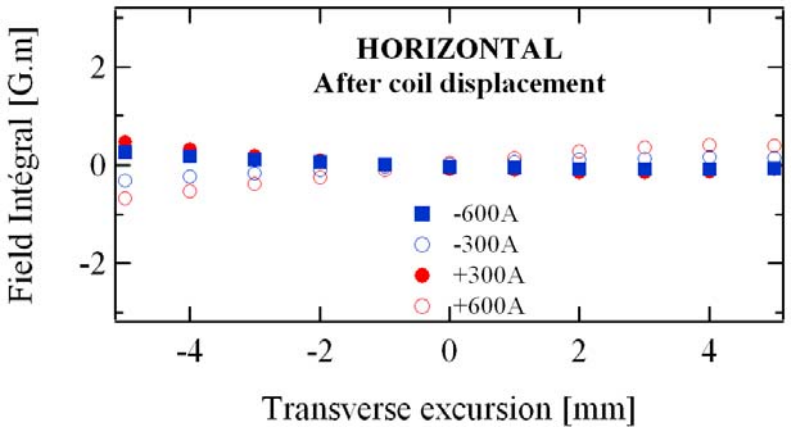
Preliminary tests

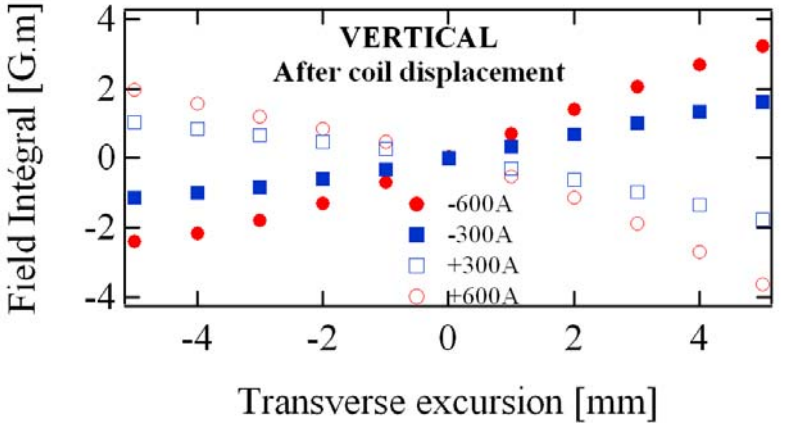


HU640: Field integrals deduced from local orbit bump









HU640: Integrated multipoles deduced from local orbit bump

Before coil displacement

	Horizontal plane			Vertical plane		
B_x	Dipole	Skew Quad.	Skew Oct.	Dipole	Norm. Quad.	Norm. Oct.
-0.1 T	0.016 G.m	**394 G**	-7700 G/m	-0.046 G.m	607 G	-11081 G/m
-0.05 T	0.004 G.m	**193 G**	-2977 G/m	-0.037 G.m	282.2 G	-8390 G/m
+0.05 T	0.02 G.m	**-180 G**	735 G/m	-0.022 G.m	-233 G	15600 G/m
+0.1 T	0.006 G.m	**-341 G**	-784 G/m	-0.0047 G.m	-407 G	38800 G/m

After coil displacement

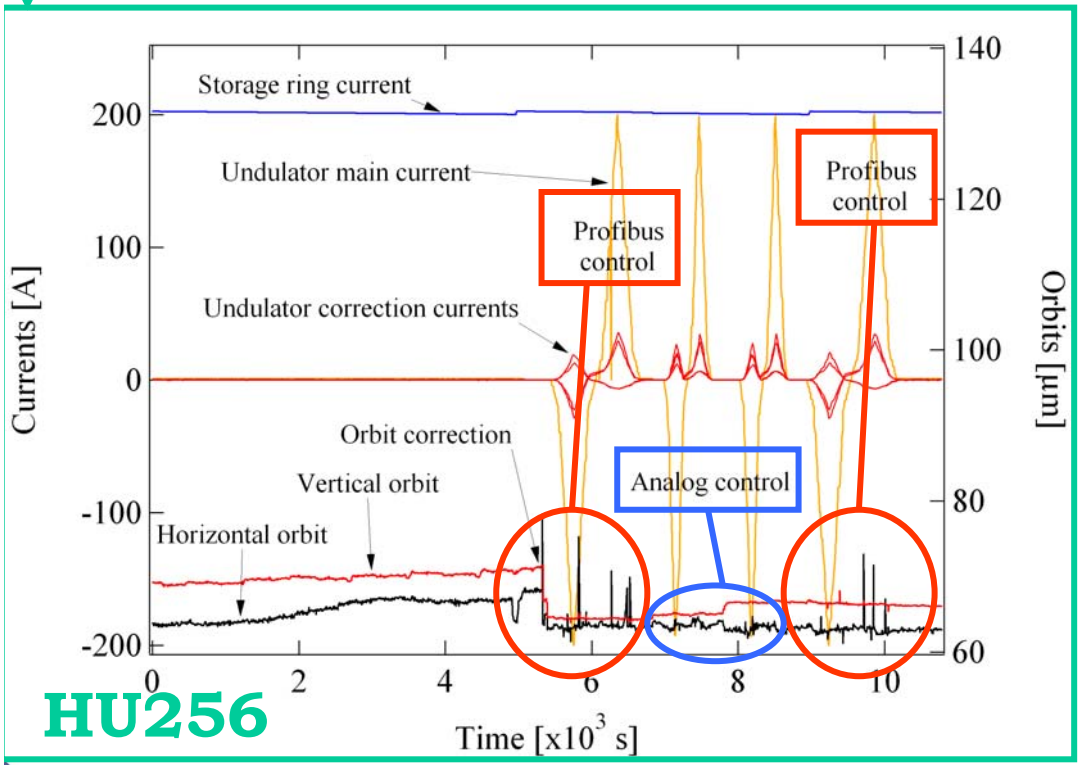
	Horizontal plane			Vertical plane		
B_x	Dipole	Skew Quad.	Skew Oct.	Dipole	Norm. Quad.	Norm. Oct.
-0.1 T	-0.066 G.m	**-59 G**	9500 G/m	-0.01 G.m	690 G	16700 G/m
-0.05 T	0.023 G.m	**-36 G**	4100 G/m	-0.002 G.m	323 G	11300 G/m
+0.05 T	0.015 G.m	**55 G**	-2800 G/m	-0.001 G.m	-271 G	-17200 G/m
+0.1 T	0.04 G.m	**132 G**	-4400 G/m	-0.02 G.m	-488 G	-41200 G/m

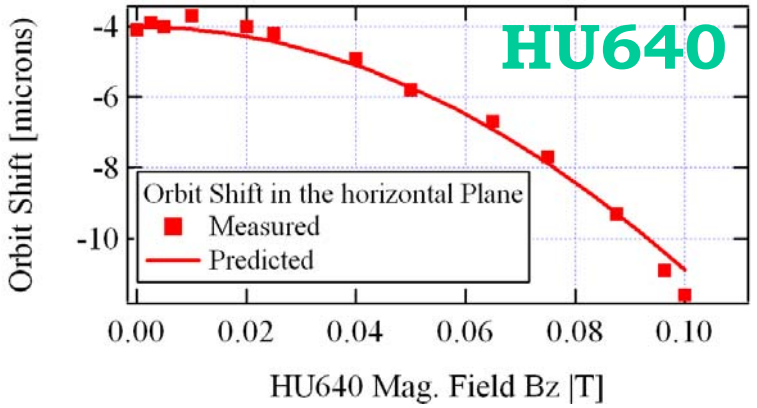
Effect on the orbit

- Residual field integral: Feed Forward Tables
- Orbit Spikes resulting from ID Correctors and Main PS or ID gap : Analog Control under progress for **HU256** and On-flight Feed Forward for motorized IDs (under progress)
- Increase of the electron orbit resulting from the field of the IDs: Transverse shift of the global orbit up to 10 microns: Change in RF frequency (up to 10 Hz)

$$\Delta x(s_i) = -\frac{\eta_x(s_i)}{\alpha} \cdot \frac{K^2 L_u}{4\gamma^2 C}$$

	HU640	HU256	HU80	WSV50	U20
K_{max}	8.87	9.56	7.1	9.8	1.8
L_u [m]	10	3.5	1.6	1.9	1.9
η ond [m]	0.2	0.13	0.13	0.28	0.28
<Δx> [μm] predicted	**8.6**	**2.25**	**0.57**	**2.27**	**0.08**





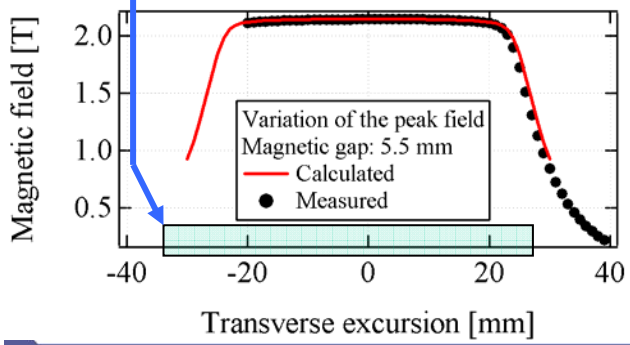
Effect of the In-vac Wiggler WSV50

- InVac Hybrid
- 20 keV-50 keV
- 38 periods of 50 mm
- 2.1 T at min. gap of 5.5 mm
- Tight poles: 60 mm (minimizing Mag. Forces)
- Field homogeneity area<Physical aperture (-35mm-25mm)
- **COMPENSATION** of the dynamic field integral with Magic Fingers

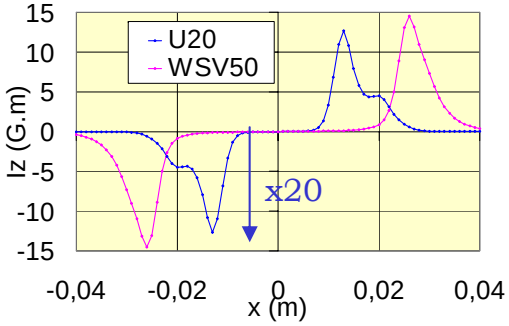
J. Safranek et al, PRST-Accelerators and Beams, Vol.5,010701 (2002)

Phys Aperture

Transverse variation

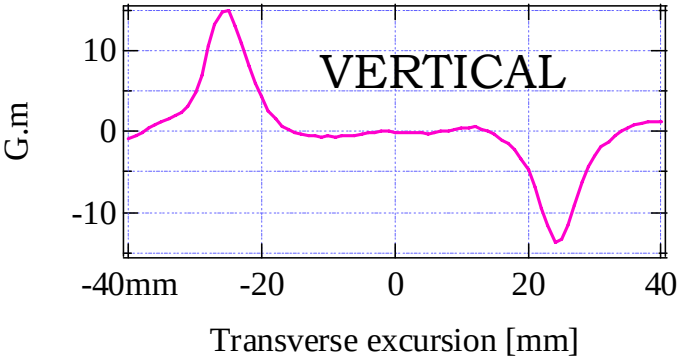


Dynamic integral



COMPENSATION with MF

Measured Field Integral



Simulated Effects of WSV50 on the dynamic aperture

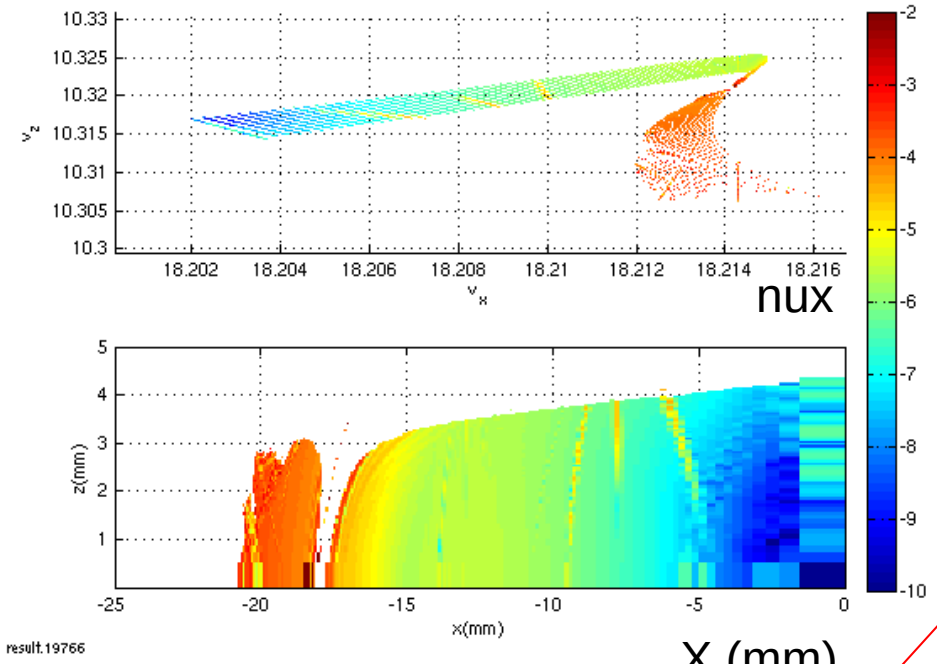
- Tracking is made using the TRACYII code
- 2 maps are used to represent the ID
  - the RADIA 2nd order kick map
  - the 1rst order integral map generated by Magic Fingers: the Magic fingers Map is approximated by the opposite of RADIA 2nd order kick map.
- WSV50 is installed in a short straight section where β_x = 18 m
- The nominal H and V tunes are respectively 18.202 and 10.317
- The focusing of the wiggler is corrected

Results: No Magic Finger Compensation

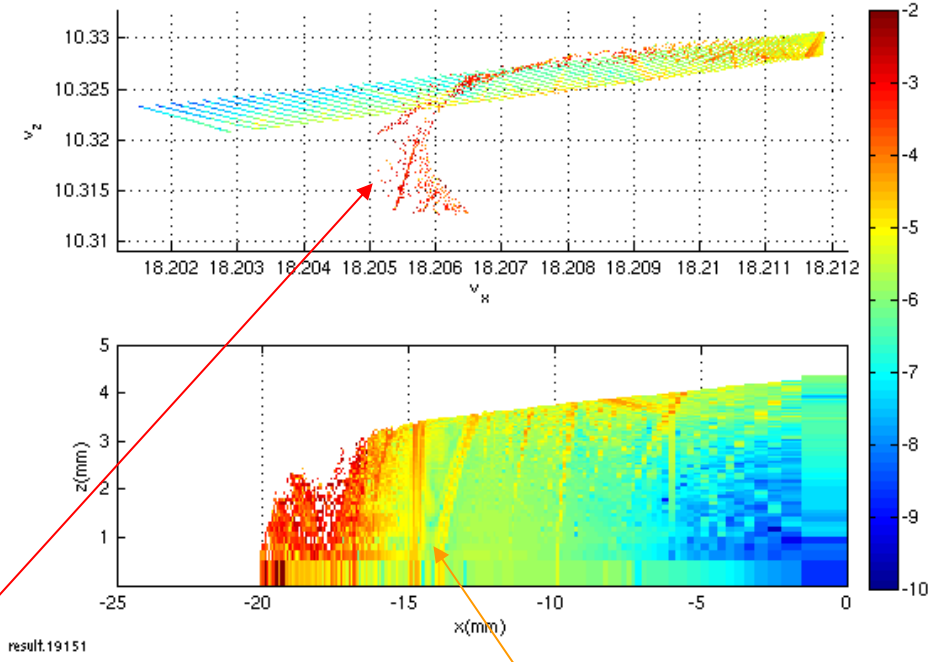
Bare machine

Bare machine + WSV50 gap 5.5 mm

2nd order kick map only



X (mm)



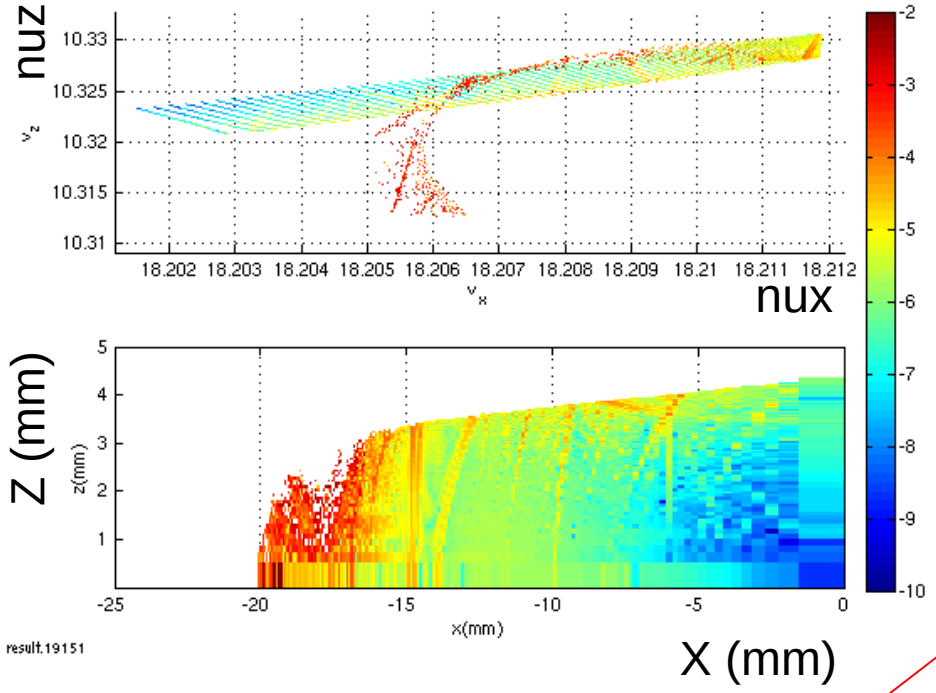
Tune shift with amplitude is significantly modified

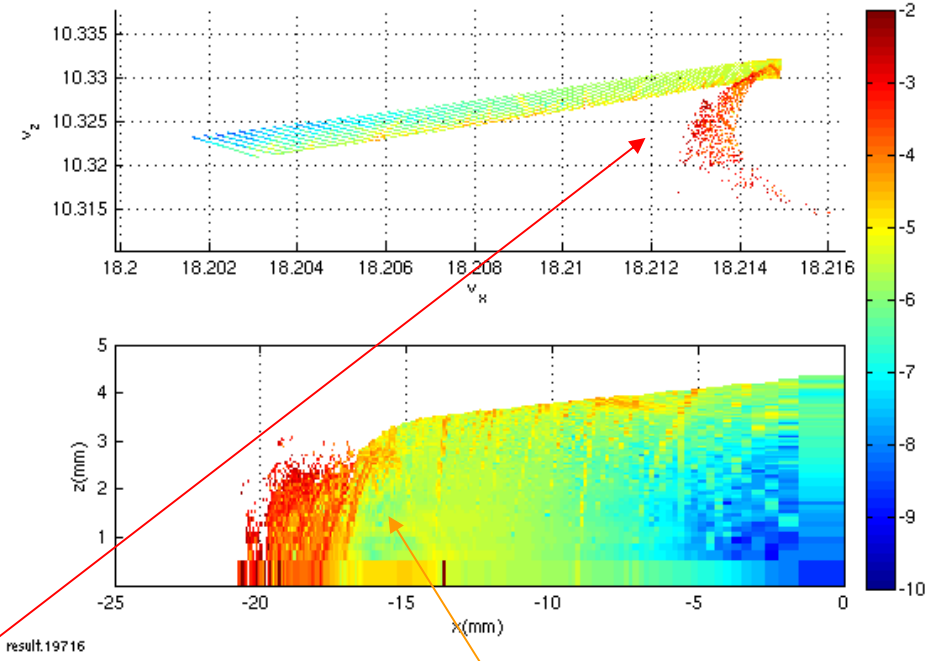
Resonances are excited

Results: Magic Fingers Compensation

Bare machine + WSV50 gap 5.5 mm
2nd order kick map only

Bare machine + WSV50 gap 5.5 mm
2nd order kick map + 1rst order integral map





Tune shift with amplitude is restored

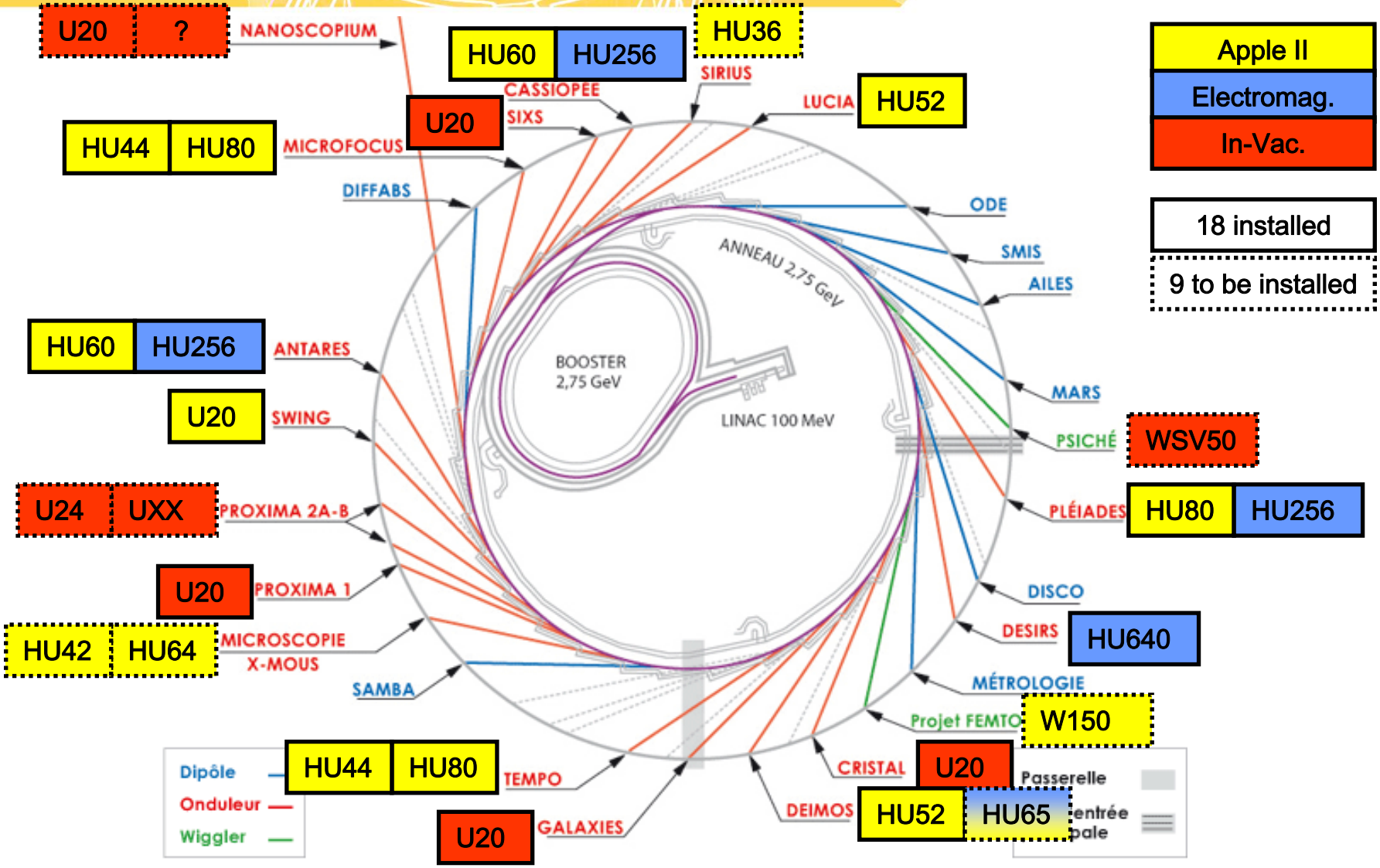
Resonances excitation have disappeared

Summary and conclusions

- Main observed effects are expected through the ID design
- Unexpected effects are produced by HU640:
  - Tune Shift
  - Coupling
- Effects on the orbit
- Compensation of 2nd order kick angle

Extra Sides

Built and planned IDs



Calibration

1 mm Displacement

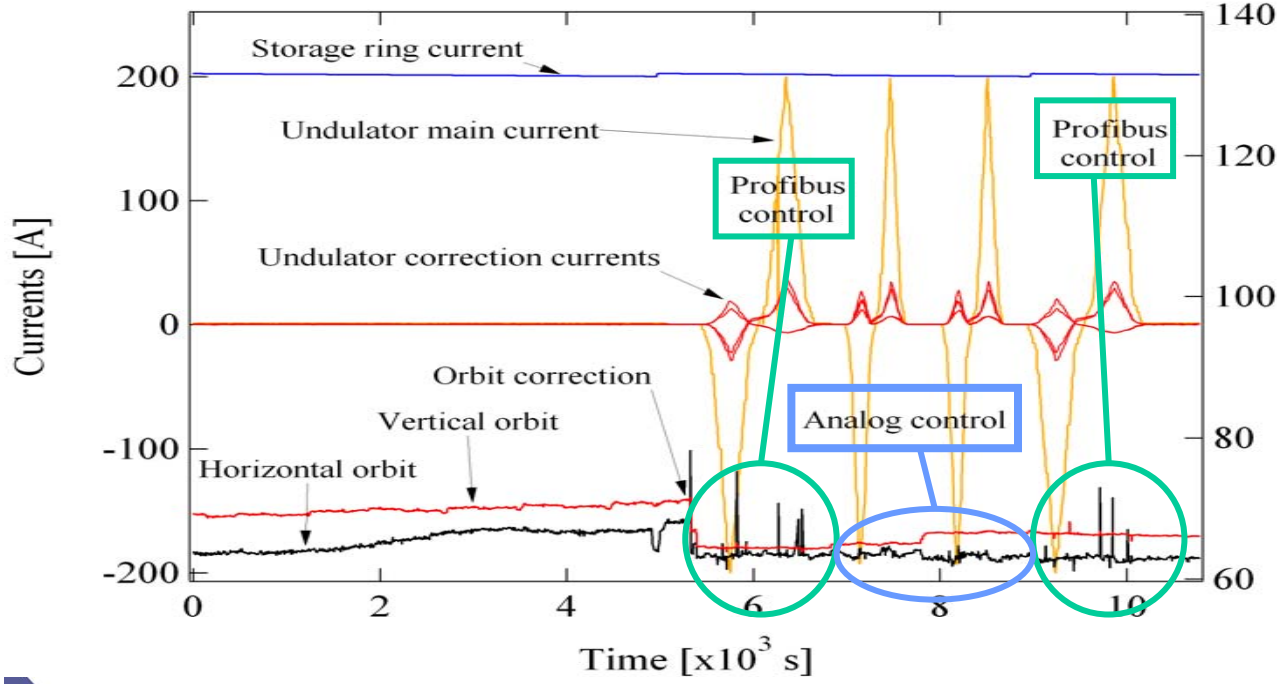
	Horizontal plane			Vertical plane		
B_x	Dipole	Skew Quad.	Skew Oct.	Dipole	Norm. Quad.	Norm. Oct.
-0.1 T	-0.7 G.m	**-226 G**	+13000G/m	+0.16 G.m	+626 G	12000 G/m
-0.05 T	-0.32 G.m	**-118 G**	+6300G/m	+0.09 G.m	+293 G	8200 G/m
+0.05 T	0.29 G.m	**132 G**	-3000G/m	-0.09 G.m	-248 G	-15000 G/m
+0.1 T	0.61 G.m	**+293 G**	-7900G/m	-0.15 G.m	-441 G	-37500 G/m

Back to the original position

	Horizontal plane			Vertical plane		
B_x	Dipole	Skew Quad.	Skew Oct.	Dipole	Norm. Quad.	Skew Oct.
-0.1 T	0.04 G.m	**-62 G**	+8500 G/m	+0.24 G.m	598 G	+13000 G/m
-0.05 T	0.03 G.m	**-35 G**	+4100 G/m	+0.13 G.m	+282 G	9500 G/m
+0.05 T	-0.05 G.m	**+50 G**	-3200 G/m	-0.13 G.m	-232 G	-16000 G/m
+0.1 T	-0.08 G.m	**+117 G**	-3500 G/m	-0.24 G.m	-411 G	-36000 G/m

Reduction of Spikes of closed orbit on HU256

- HU256
  - B_z: 1 unipolar PS
  - B_x: 2 bipolar PS
  - Correctors: 8 dedicated PS
- Orbit spikes: tens of microns
- Result from the missynchronism Between main PS and dedicated Corrector PS



- Development of a new control system (under progress): Analog Control

Reduction of spikes
From 17 µm to 3 µm

Evolution of the ID control system