AUTOMATIC COLLIMATOR IMPEDANCE COMPUTATIONS

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- **Mathematica file which computes from and Excel file sent by Ralph Assmann**
  - **The transverse and longitudinal impedances**
  - **The collective frequency shift for the most unstable coupled- bunch mode and the first head-tail ones**
  - **Stability diagram at 7 TeV (maximum octupoles)**
  - **Resistive heating**

⇒ Preliminary results to be checked…

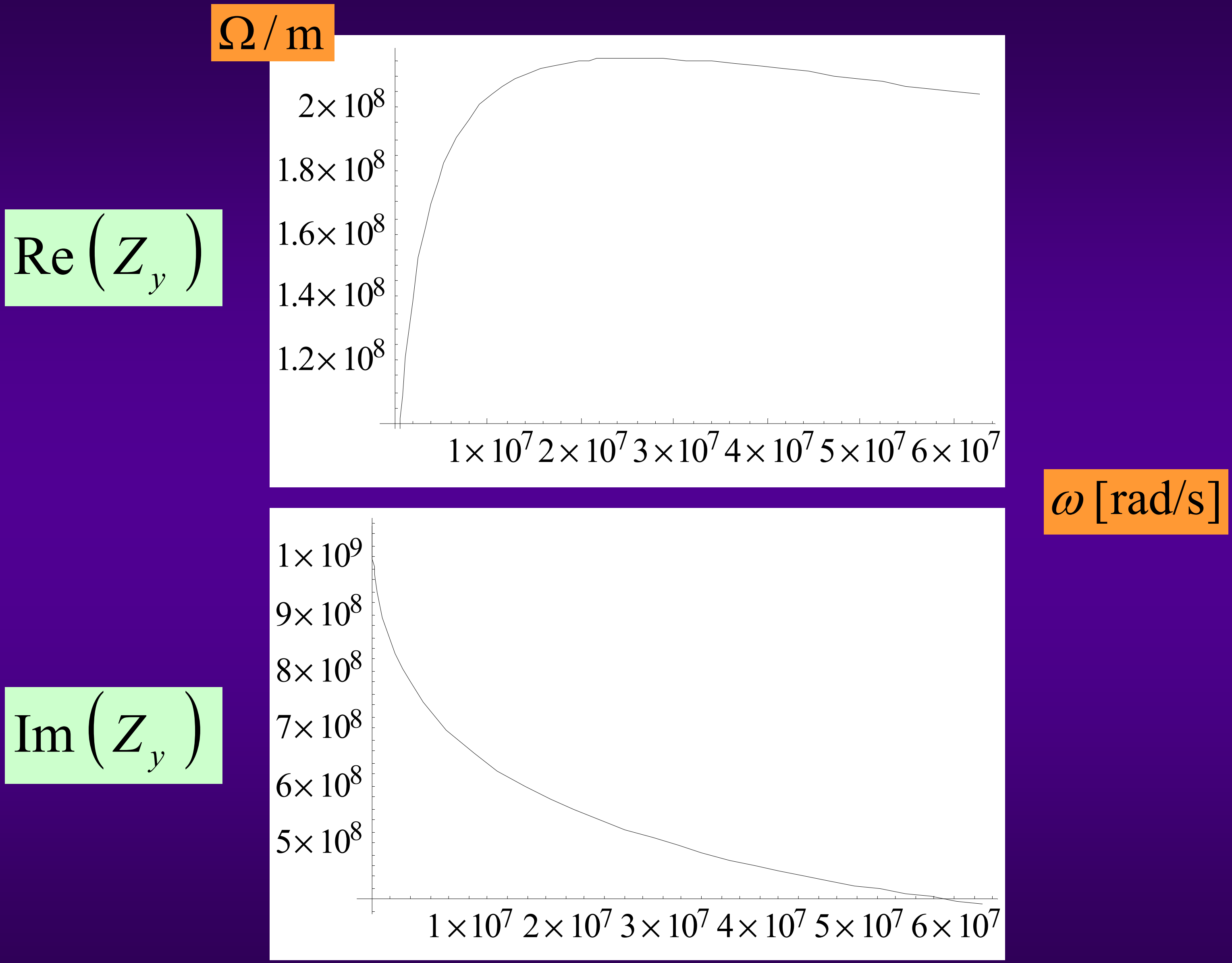
2 Excel files for the moment

Collimator	Standard V6.4				Option 1	(90deg, equal beta, cold Q6)		
	Angle [rad]	betax [m]	betay [m]	a [m]	Angle [rad]	betax [m]	betay [m]	a [m]
TCP01	1.571 V	90.4467	156.436	0.001683	1.571 V	100.1398	132.7538	0.00155
TCP02	0 H	89.1304	158.741	0.00127	0 H	98.68841	134.2914	0.001337
TCP03	2.41 S	87.8347	161.069	0.001477	2.35619 S	97.25751	135.8453	0.001453
TCP04	0.732 S	86.5595	163.419	0.00148	0.7854 S	95.84707	137.4153	0.001453
TCS01	0.002 H	50.6859	290.865	0.001118	1.571 V	103.1845	202.9513	0.002237
TCS02	0.184 H	48.7318	314.911	0.001192	0 H	116.4539	189.6782	0.001694
TCS03	2.919 H	48.4524	319.999	0.001233	2.35619 S	130.8177	177.017	0.001948
TCS04	2.593 S	126.537	248.459	0.001984	0.7854 S	146.276	164.9678	0.001958
TCS05	0.55 S	131.247	241.964	0.001995	1.571 V	253.7377	144.308	0.001886
TCS06	1.569 V	327.641	84.2125	0.001441	0 H	239.6372	155.5171	0.00243
TCS07	1.57 V	303.528	69.2811	0.001307	2.35619 S	226.0695	167.3591	0.002202
TCS08	0.3707 H	66.9155	198.287	0.00144	0.7854 S	213.0347	179.8339	0.0022
TCS09	3.118 H	204.356	64.2144	0.001259	1.571 V	153.7757	236.3401	0.002414
TCS10	1.381 V	63.0066	207.268	0.002232	0 H	164.8921	217.3243	0.002016
TCS11	2.768 S	61.8417	210.21	0.001418	2.35619 S	176.5972	199.2472	0.002152
TCS12	3.1415 H	49.8287	255.915	0.001108	0.7854 S	188.8913	182.1087	0.002138
TCS13	0.592 S	66.1682	319.922	0.001892	1.571 V	155.8329	103.6856	0.001599
TCS14	2.701 H	68.3897	316.965	0.001673	0 H	143.8605	110.6407	0.001883
TCS15	1.611 V	362.633	50.1045	0.001117	2.35619 S	132.5803	118.1204	0.001758
TCS16	1.53 V	356.627	50.395	0.00112	0.7854 S	121.9924	126.1247	0.001749

$\rho \approx 14 \times 10^{-6}\ \Omega\,\mathrm{m}$ $l_P = 0.2\ \mathrm{m}$ $l_S = 1\ \mathrm{m}$

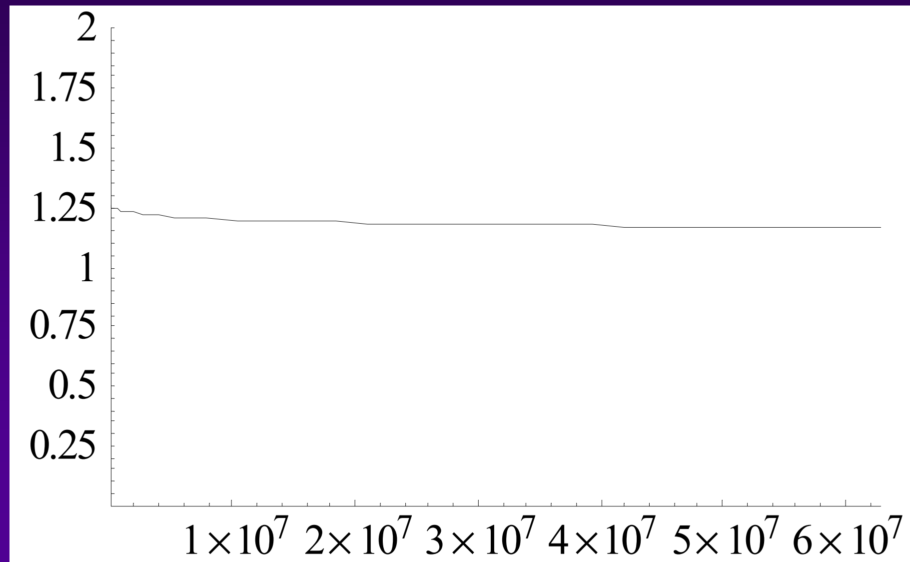
- For each collimator
  - Computation of the longitudinal impedance
    - Classical formula for a round pipe
  - Computation of the transverse impedance
    - Formulae from Luc (with inductive bypass) in a tilted frame (due to the angle of the collimator)
    - Yokoya factors for the two orthogonal planes
    - Tensor transformation from Francesco to come back to the horizontal and vertical planes
    - Betatron factor : Betatron function at the collimator normalized by the average betatron function (R/Q)
- Then sum over all the collimators

Standard V6.4 (1/2)



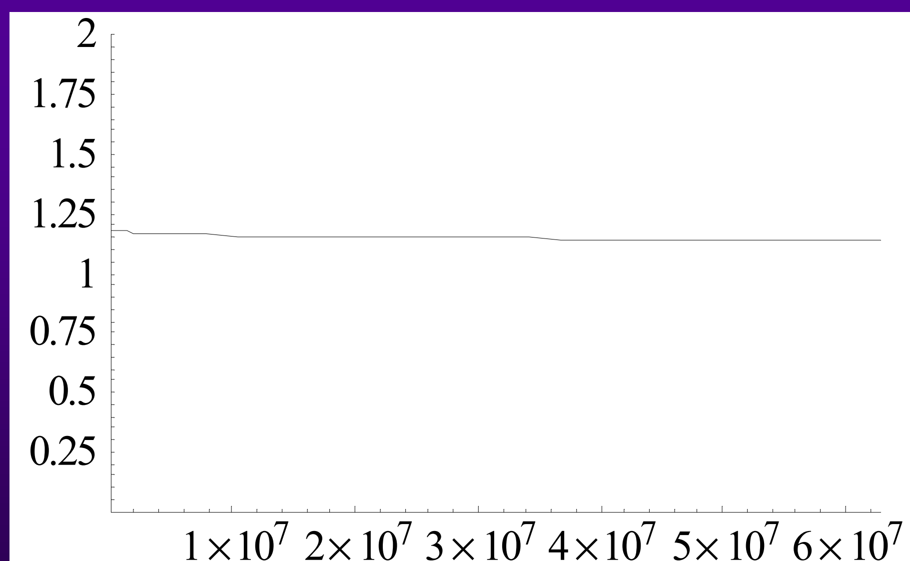
Standard V6.4 (2/2)

$$\frac{\mathrm{Re}\left(Z_y\right)}{\mathrm{Re}\left(Z_x\right)}$$



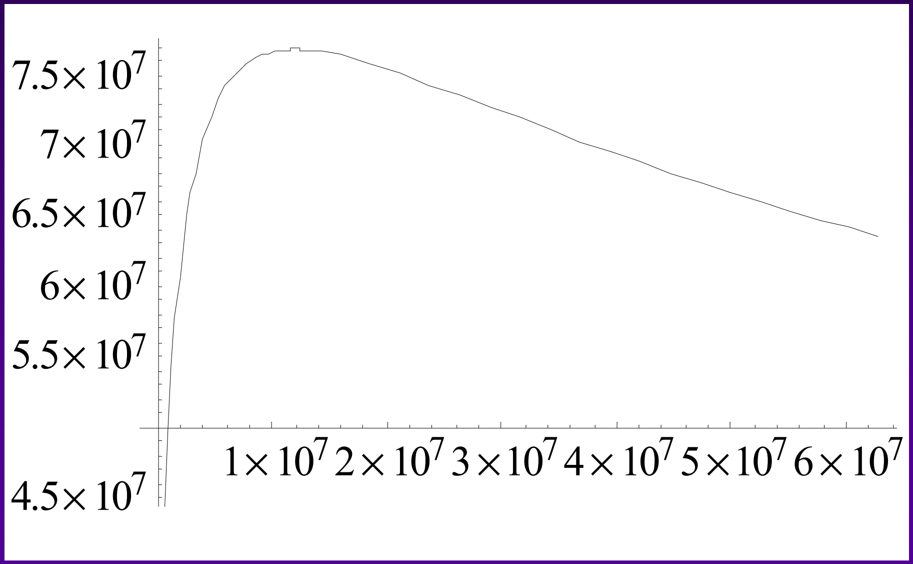
ω [rad/s]

$$\frac{\mathrm{Im}\left(Z_y\right)}{\mathrm{Im}\left(Z_x\right)}$$



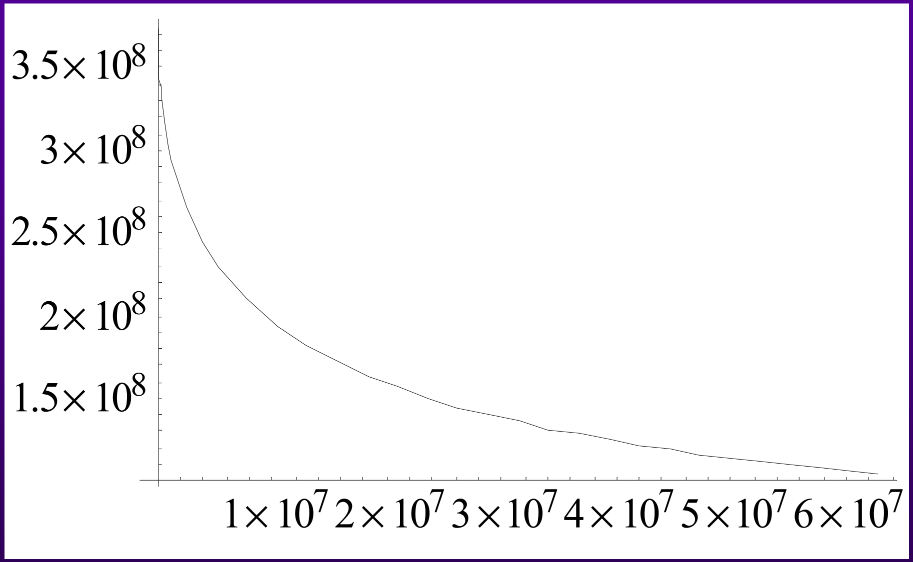
Option 1 (1/2)

$\mathrm{Re}\left(Z_y\right)$



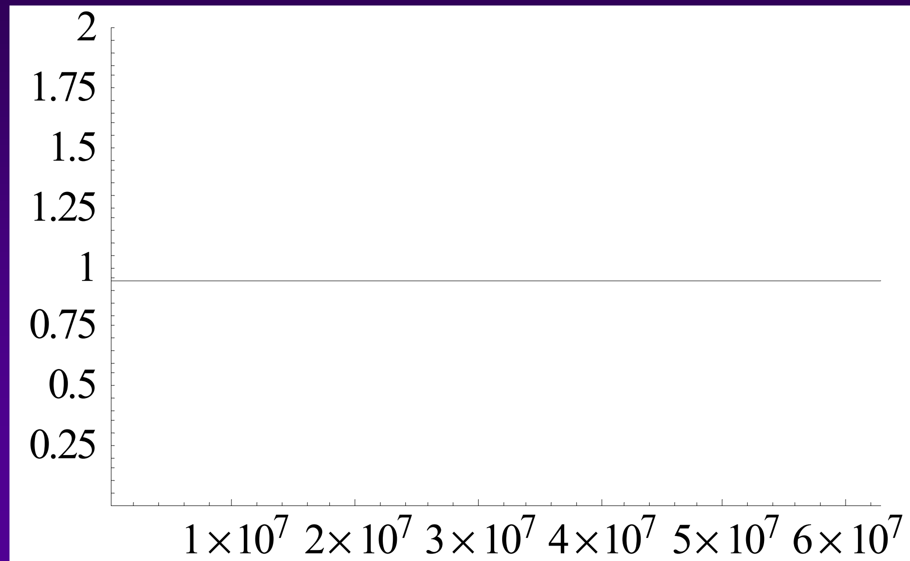
ω [rad/s]

$\mathrm{Im}\left(Z_y\right)$



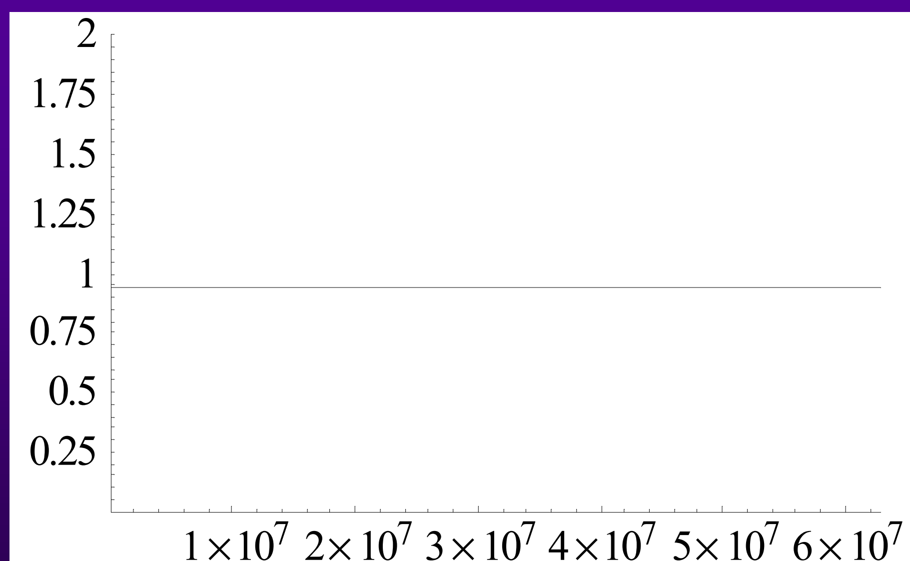
Option 1 (2/2)

$$\frac{\mathrm{Re}\left(Z_y\right)}{\mathrm{Re}\left(Z_x\right)}$$



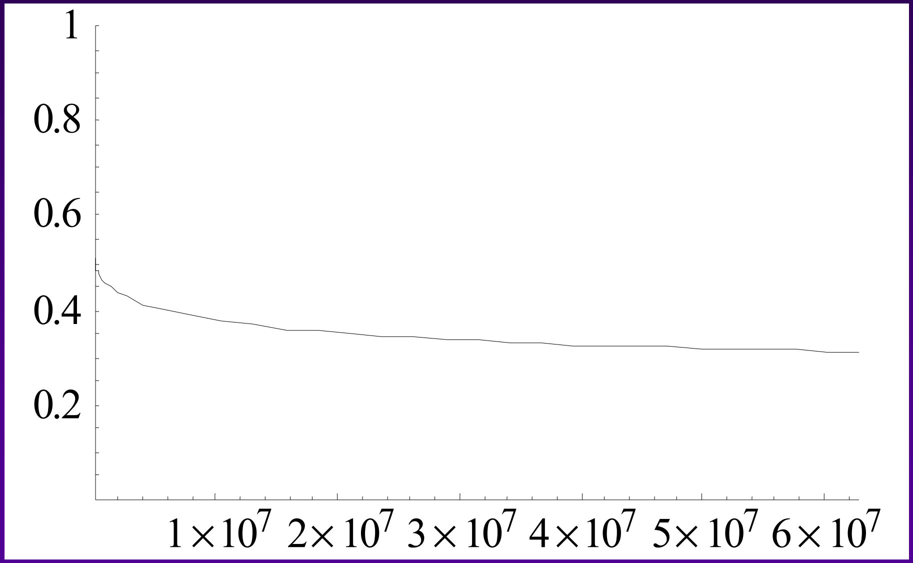
ω [rad/s]

$$\frac{\mathrm{Im}\left(Z_y\right)}{\mathrm{Im}\left(Z_x\right)}$$



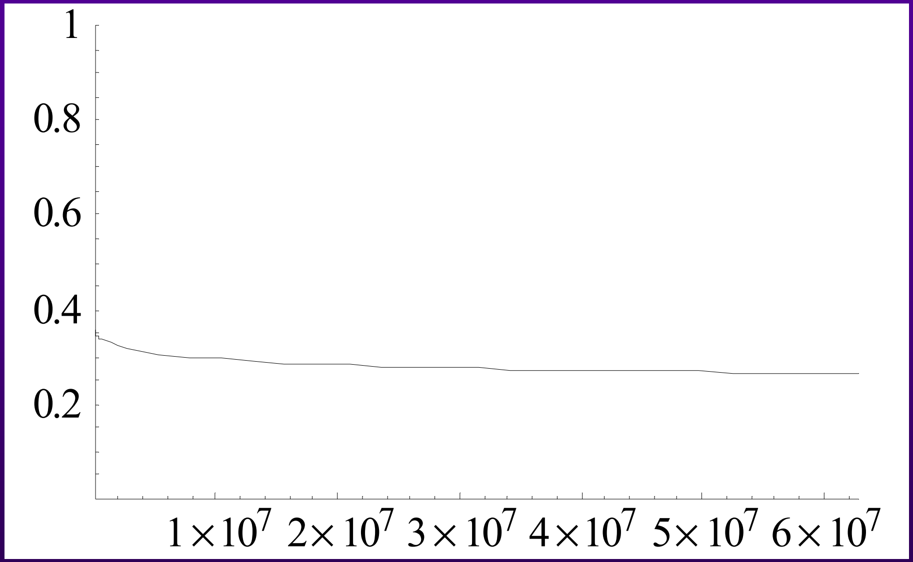
Comparison between Standard V6.4 and Option 1

$$\frac{\mathrm{Re}\left(Z_y^{\mathrm{Option1}}\right)}{\mathrm{Re}\left(Z_y^{\mathrm{StandardV6.4}}\right)}$$

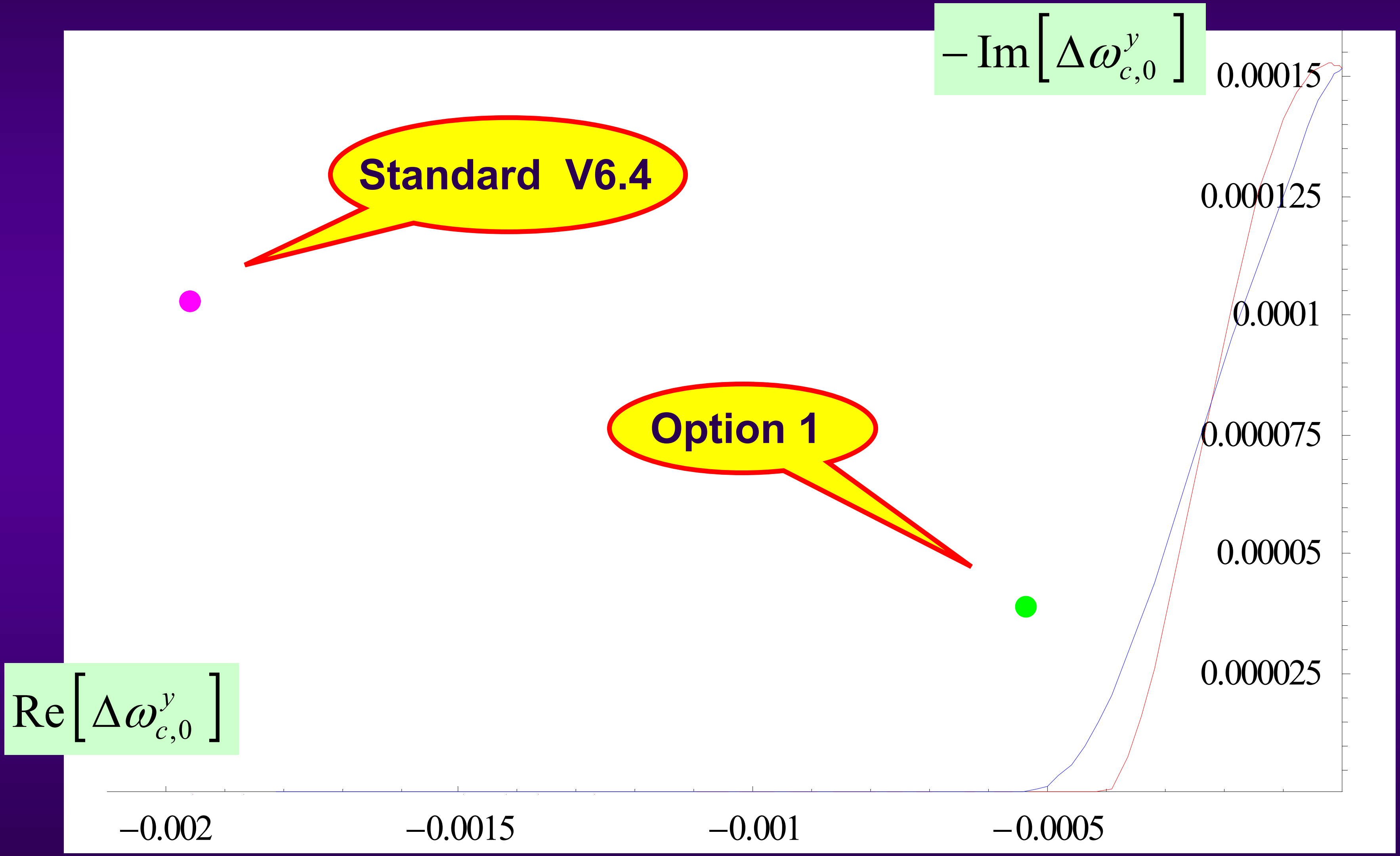


ω [rad/s]

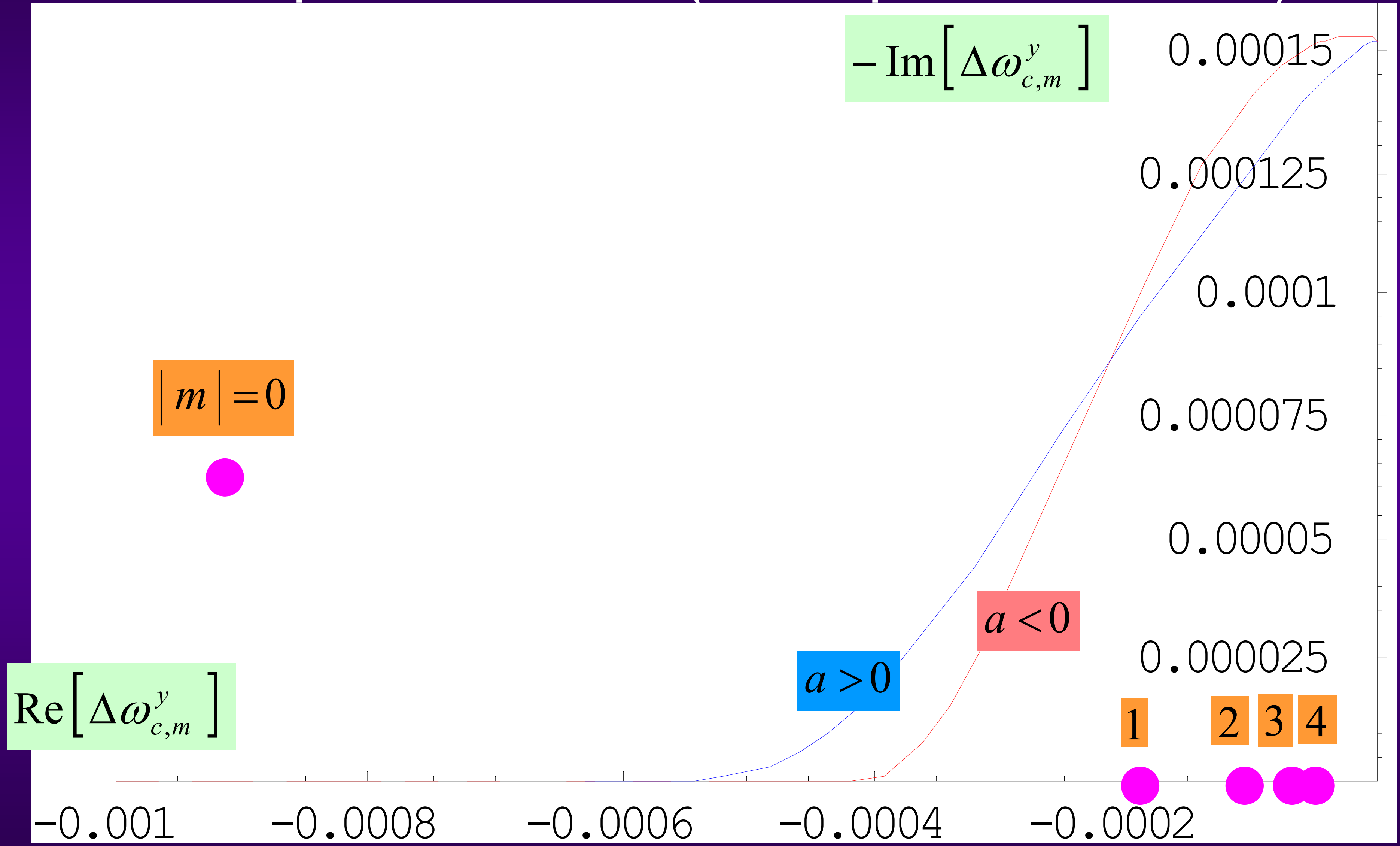
$$\frac{\mathrm{Im}\left(Z_y^{\mathrm{Option1}}\right)}{\mathrm{Im}\left(Z_y^{\mathrm{StandardV6.4}}\right)}$$



Stability diagram (maximum octupoles) and collective tune shift for the most unstable coupled-bunch mode and head-tail mode 0 for Standard V6.4 and Option 1



Stability diagram (maximum octupoles) and collective tune shift for the most unstable coupled-bunch mode and head-tail mode 0 with 1 "equivalent" collimator (see LCE presentation 22/08/03)



Resistive heating = power deposited by the wall currents (General formula for a Gaussian bunch interacting with an effective resistive impedance, and for a circular beam pipe)

- **For Standard V6.4**

$$P_{loss} \approx 210 \text{ W/m} \qquad l_{\text{collimators}} = 16.8 \text{ m} \qquad P_{loss} \approx 3.5 \text{ kW}$$

- **For Option 1**

$$P_{loss} \approx 150 \text{ W/m} \qquad l_{\text{collimators}} = 16.8 \text{ m} \qquad P_{loss} \approx 2.5 \text{ kW}$$

- **For an equivalent collimator of half gap 2 mm, and length 1 m**

$$P_{loss} \approx 140 \text{ W/m}$$