Zbase

- meeting of T. D’Amico, E. Metral and F. Zimmermann on December 2
- semi-successful attempt to run Zbase and create a new directory; often error messages
- Zbase 8000 lines of script plus a number of linked or standalone (?) programs
- adding calculations may be challenging
- conversion of wake into impedance or vice versa via Zbase not evident – does this feature really exist in the code?
- suggestion for presentation or course by Oliver

Impedance of BPMs

There are several types of BPMs. Most of the arc BPMs are buttons. They are discussed by D. Brandt et al. in LHC Project Note 284: *Impedance of the LHC Arc Beam Position Monitors*. The second type of BPMs are hybrid monitors, described by D. Brandt et al. in LHC Project Note 315: *Impedance of the LHC Hybrid Beam Position Monitors BPMC*. Finally, pure stripline monitors were discussed by L. Vos and A. Wagner, LHC Project Report 126 (1997) [longitudinal impedance only].

BPM Table from Rhodri Jones

	BPM type	Number
Orbit System BPMs		
	BPM (Arc)	720
	BPM (DS+Q7)	140
	BPMR	36
	BPMYA	24
	BPMYB	12
	BPMW	36
	BPMWA	8
	BPMWB	16
	BPMC	16
	BPMS	8
	BPMSW	8
	BPMSX	4
	BPMSY	4
	Orbit Total	**1032**
Other Special BPMs		
	BPRS	8
	BPLS	4
	BPQS(H/V)	4
	BPQS	2
	Mobile BPM	8
	BPTX	8
	BQMS	4
	CNGS target	1
	BPMWC?	8
	BPMWD?	2
	BPMWE?	2
	BPMWF?	2
	BPMRF	2

Correspondence between MAD, D. Brandt, and R. Jones not always evident.

BPM data from D. Brandt's report & from LHC optics V 6.4

Type	**Number/ ring**	**$\langle\beta_x\rangle$ [m]**	**$\langle\beta_y\rangle$ [m]**	**Re(Z/n) [mΩ]/ unit**	**Im(Z/n) [mΩ]/ unit**	**Re(Zt) [kΩ/m] /unit**	**Im(Zt) [kΩ/m] /unit**
Striplines?							
BPMC?	7 D. Brandt			0.0693	0.0754	0.82	1.615
BPMSW	16 MAD	47.3 (inj) 427.3 (top)	47.3 (inj) 427.3 (top)				
BPMS	32 MAD	96.6 (inj) 1345 (top)	94.3 (inj) 1284 (top)				
BPMWB	8 MAD	84.9 (inj) 579.0 (top)	73.1 (inj) 413.9 (top)				
BPMR	18 MAD	145.5 (inj) 226.3 (top)	165.3 (inj) 198.6 (top)				
BPMYA	12 MAD	280.3 (inj) 546.2 (top)	271.8 (inj) 420.0 (top)				
BPM	466 D. Brandt MAD	102.4 (inj) 102.4 (top)	107.5 (inj) 107.7 (top)	0.0013	0.011	0.02	0.545

For the striplines, explicit impedance formulae are given in the note by L. Vos and A. Wagner. The impedance has two components, from the cavity and the electrodes, respectively. If the cavity has no taper and no fins, its impedance below cut-off is

$$Z_{co} = \frac{Z_0}{2\pi} j \frac{\omega}{c} \ln\left(\frac{d}{b}\right) \frac{1-e^{-\gamma_0(\omega) l_c}}{\gamma_0(\omega)} \quad \text{where} \quad \gamma_0(\omega) = \sqrt{\left(\frac{\tau_0}{d}\right)^2 - \left(\frac{\omega}{c}\right)^2} \quad \text{for} \quad \omega < \frac{cd}{\tau_0}$$

where τ_0 is the first root of the 0th order Bessel function and *d* the radius of the cavity.
For frequencies above the cut-off of the cavity, but below the cutoff of the pipe, it is

$$Z_{co} = \frac{Z_0}{2\pi} j \frac{\omega}{c} \ln\left(\frac{d}{b}\right) l_c \frac{\sin(\beta_0(\omega) l_c)}{\beta_0(\omega) l_c} \quad \text{where} \quad \beta_0(\omega) = \sqrt{-\left(\frac{\tau_0}{d}\right)^2 + \left(\frac{\omega}{c}\right)^2} \quad \text{for} \quad \omega > \frac{cd}{\tau_0}$$

(I am surprised that there is no additional factor 2 etc. here, which would be suggested by comparison with the previous formula.)

Finally, the impedance of the 4 striplines is

$$Z_e = \frac{Z_0^{\,2}}{2\pi^2 Z_l} \left(\ln\left(\frac{d}{d-h}\right)\right)^2 \left[1 - \cos\left(\frac{2\omega l_e}{c}\right) + j \sin\left(\frac{2\omega l_e}{c}\right)\right],$$

where Z_l typically is 50 Ω. The transverse impedance can be estimated from

$$Z_T = \frac{2c}{b^2 \omega} Z_{\|}$$