MD time request: BBLR EXCITATION (GS)

Subject of the experiment

BBLR distance scan and current scan at 55 GeV/c with WP (0.31, 0.32) and (0.31, 0.285). Using half BBLR1 and 5 s long flattop.

Motivations of the experiment

To investigate how the BBLR effect scales with the energy and to see if, in the 5 s long flattop, we can distinguish a transient and a steady state loss mechanism. Considering half the wire would allow a better control of the beam-wire separation and subsequently the measurements' quality would profit of it.

Other participants

Gerard Burtin, Jean-Pierre Koutchouk, Emanuele Laface, Frank Zimmermann.

Beam conditions

N_b=5 10^{10} ppb, 12 bunches at 25 ns, p=55 GeV/c for a plateau longer than 5 s and $\epsilon_n \geq 1.5$ mm mrad (optimal $\epsilon_n = 5$ mm mrad).

Time request

Parallel MDs: 3, n. of sessions: 3, n. hours/session: 8
Wednesday MDs: —
Long MDs: —

Preferred period

Before the BBLR compensation experiments (since the wires setup are different).

Instrumentation requirements

Half of BBLR1 (BBLR.51771, $I_{MAX} = 250$ A), CO measurement and control, ϵ measurement, FBCT, BCT, QKICKER, MULTIQ and ξ measurement.

Previous publications on the experiment

http://cern-ab-bblr.web.cern.ch/cern-ab-bblr/documentation.htm.

Additional comments

Before the BBLR compensation experiment, we need 1h technical stop to access to the SPS tunnel and prepare the wires setup.

MD time request: BBLR COMPENSATION (FZ)

Subject of the experiment

BBLR compensation at 55 GeV/c and 5 s flattop (parallel) + dedicated MD at 55 GeV/c.

Motivations of the experiment

To investigate how the BBLR compensation effect scales with the energy and to see it in the 5 s long flattop or in longer flattop of the dedicated MD we can distinguish a transient and a steady state loss mechanism. An new range of BBLR2 motion (until 17 mm, wrt the old 19 mm, from the center of the vacuum pipe) would allow a better compensation, perhaps reducing the tune dependence of the compensation itself.

Other participants

Gerard Burtin, Jean-Pierre Koutchouk, Emanuele Laface, Guido Sterbini.

Beam conditions

N_b=5 10^{10} ppb, 12 bunches at 25 ns, p=55 GeV/c for a plateau longer than 5 s and $\epsilon_n \geq 1.5$ mm mrad (optimal $\epsilon_n = 5$ mm mrad).

Time request

Parallel MDs: 1, n. of sessions: 1, n. hours/session: 8
Wednesday MDs:1, n. of sessions: 1, n. hours/session: 8
Long MDs: —

Preferred period

After the the BBLR excitation experiments (since the wires setup are different).

Instrumentation requirements

BBLR1 and BBLR2 ($I_{MAX} = 250$ A), CO measurement and control, ϵ measurement, FBCT, BCT, QKICKER, MULTIQ and ξ measurement.

Previous publications on the experiment

http://cern-ab-bblr.web.cern.ch/cern-ab-bblr/documentation.htm.

Additional comments

—

Programme for 2009 BB MDs

January 26, 2009

Contacts
Jean-Pierre Koutchouk, Guido Sterbini and Frank Zimmermann

0.1 Motivations

The long range beam-beam interaction (LRBB) will be a primary performance limitation of the nominal LHC and imposes severe constraints for an LHC upgrade. Beam lifetime limitations may require an installation of wire compensators after a few years of LHC operation. Space in IR1 and IR5 has been reserved for this purpose. Also any future LHC upgrade scheme is strongly affected by the constraints from the long-range beam-beam interactions. It is therefore fundamental to test the simulated effectiveness of the two proposed remedies (wire compensation and early separation) in an experiment in order to validate the proposed cures and upgrade paths. The SPS experiments are designed to verify/identify/examine both the strengths and the weaknesses of both schemes. They will also allow us to benchmark beam-beam simulation codes by quantifying the accuracy of our prediction, thus enabling a better interpretation of LHC simulation results. More generally, the SPS BBLR experiments will also further our understanding of unstable particle dynamics caused by the beam-beam effect.

The 2008 BB MD program was dedicated to measurements done at 37 GeV/c. In 2009, we would like *to repeat them at 55 GeV/c* (to verify how the effect scales with the energy) *for a longer period of observation* in the cycle (to verify if we can distinguish a steady state and a transient effect).

0.2 Participants

- Gerard Burtin (gerard.burtin@cern.ch, mobile 160555)
- Jean-Pierre Koutchouk (jean-pierre.koutchouk@cern.ch, mobile 163383)
- Emanuele Laface (emanuele.laface@cern.ch, office 73726)
- Guido Sterbini (guido.sterbini@cern.ch, office 73910)
- Frank Zimmermann (frank.zimmermann@cern.ch, mobile 162051)

0.3 Beam requirements

- Beam momentum: 55 GeV/c (for 5/6 s, the more the better)
- Beam intensity : 12 LHC type bunches with $4 \div 5\ 10^{10}$ protons each.
- Beam emittance: no specific needs but $\epsilon_n > 1.5$ mm mrad (optimal value for the MD is $\epsilon_n = 5$ mm mrad).

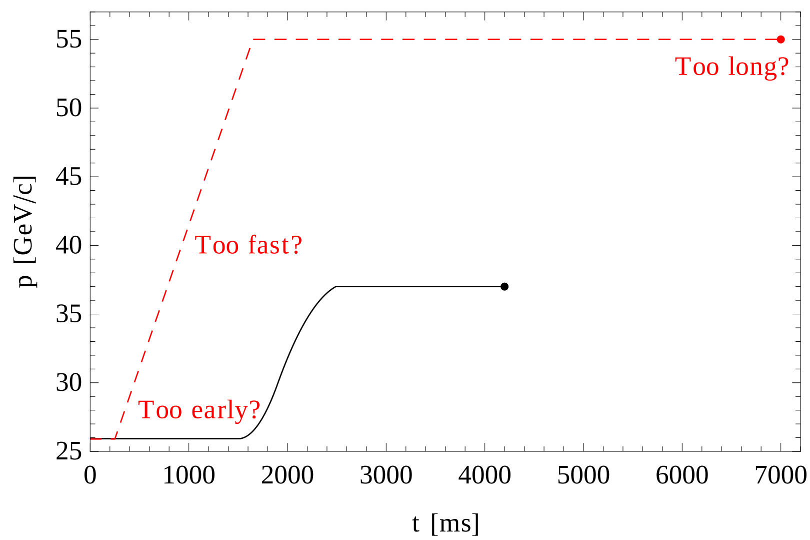

Figure 1: The MD1 cycle we used in BB MD 2008 (solid line) and an example of longer flattop at 55 GeV/c (dashed line).

0.4 Devices' requirements

- BBLR1 and BBLR2 ($I_{MAX} = 250$ A)
- CO measurement and control
- emittance measurement
- FBCT and BCT: continuos beam current monitoring
- QKICKER and MULTIQ: continuos tune monitoring
- chromaticity measurements

Using ROSALI to monitor these quantities would help significantly to steer the MD and to process the data. The possibility of recording the wire current in a SDDS like format would be helpuful. The remote control of BBLR2 position can be hopefully be implemented before the MD.

1 General considerations

In SPS there are 4 wire boxes installed [1]. They are grouped in two families: the BBLR1 (**BBLR.51760** and **BBLR.51771**) is a 60 cm x 2 wires (installed in 2002), the BBLR2 (**BBLR.51772** and **BBLR.51774**) consists of a set of 3 wires (60 cm x 2) on the vertical, horizontal and diagonal plane (installed in 2004). Only the vertical wires are powered. Each wire is below the beam. Each family is powered, independently, in series (I1 and I2).

In March 2008 the BBLR1 was rotated to be on the vertical plane below the beam. An inspection of the status of the 4 wires was done: no deformation or deterioration were observed. When I1 has the same sign of I2 compensation is active, that is to say that BBLR1 and BBLR2 have opposite polarity. When the I1 is negative the BBLR1 mimics a counterotating proton beam (for compensation I2 has to be negative too).

To reduce the beam-wire separation to 5σ can require $3\pi + \pi$ bumps with several orbit correctors: it will depend on the actual value of the beam emittance.

To mimic the effect of 1 BBLR at the nominal LHC bunch current (assuming the 3.75 mrad mm normalized emittance and considering 1.2 m long wire) it is necessary 5.59 Am (8.26 Am for the ultimate): this means 4.66 A (and 6.88 A) on the 1.2 m BBLR (BBLR1 or BBLR2). Last MDs, in SPS we have an emittance ranging from $1 \div 6$ mm mrad. We summarize the quantities in the following table

	Nominal Current		Ultimate current	
	$\epsilon_n = 3.75\ \ \mu$m	$\epsilon_n = 1.5\ \ \mu$m	$\epsilon_n = 3.75\ \ \mu$m	$\epsilon_n = 1.5\ \ \mu$m
1 BBLR	4.66 A	1.86 A	6.88 A	2.75 A
60 BBLRs	279.6 A	111.6 A	412.8 A	165 A

We need to measure and record during each fill the tunes, the closed orbit (x an y), the chromaticity, the current and the emittance of each bunch, the current of the wires (I1 and I2) and the position of BBLR2(1) and BBLR2(2). Unfortunately most of these quantities has to be recorded manually.

1.1 Preparation and check

- We will work at 55 GeV/c.
- Prepare the BBQ (if available) and set up the synchronization of the Q kicker, wire scan for measuring the vertical emittance (should we consider the horizontal emittance too?), the BBLR1 and BBLR2 power supplies (they should be triggered not too near to the ramp), set up LHC working tunes or (0.31, 0.28), no collimation, closed orbit on the reference orbit, Q'≈ 2, transversal planes decoupled.

- Powering the BBLR1 with I1=-250 A (it should be at $-19 - 1.27 =$ 20.27 mm from the wire's center (the minus stands for 'below' the beam) from reference orbit). Check if the ΔQ and Δy are correct. Set I1=0.
- Powering the BBLR2 with I2=-250 A (it should be at $-19 - 1.27 =$ 20.27 mm from the wire's center (the minus stands for 'below' the beam) from reference orbit). Check if the ΔQ and Δy are correct. Set I2=0.

The tune shift due to the wire is given by (l=1.2m):

$$\Delta Q_{x,y} = \pm \frac{r_p \; I_w \; l_w}{2\pi \; \gamma e c} \frac{1}{(d_0 + \Delta d)^2} \tag{1}$$

The orbit change at the wire is given by:

$$\Delta y = \frac{\beta_y \; r_p \; I_w \; l_w}{\gamma e c \; (d_0 + \Delta d) \; \tan(\pi \mathrm{Q})} \tag{2}$$

where r_p denotes the classical proton radius, l_w the length of the wires ($l = 2 \times 0.6$ m= 1.2 m), I_w the wire excitation current, γ the Lorentz factor, d_0 the separation between the beam center and the wire center when the wire is excited, e the proton charge, c the speed of light, and we have assumed a purely vertical separation.

2 MD program

In 2009, we would like to have excitations experiments and compensation experiments.

2.1 Excitation experiments (3×8h parasitic MDs)

2.1.1 Current scan

We would like to reproduce the measurements shown in Fig. 2 at 55 GeV/c for two tunes: (0.31, 0.32) and (0.31, 0.285). We correct the the tunes and the orbit to always have the wanted conditions.

2.1.2 Distance scan

We would like to reproduce the measurements shown in Fig. 3 at 55 GeV/c.

2.2 Compensation experiments

We would like to reproduce the measurements shown in Fig. 4 at 55 GeV/c. We will work at 9.5σ separation (I=250 A on both wires to see a bigger effect).

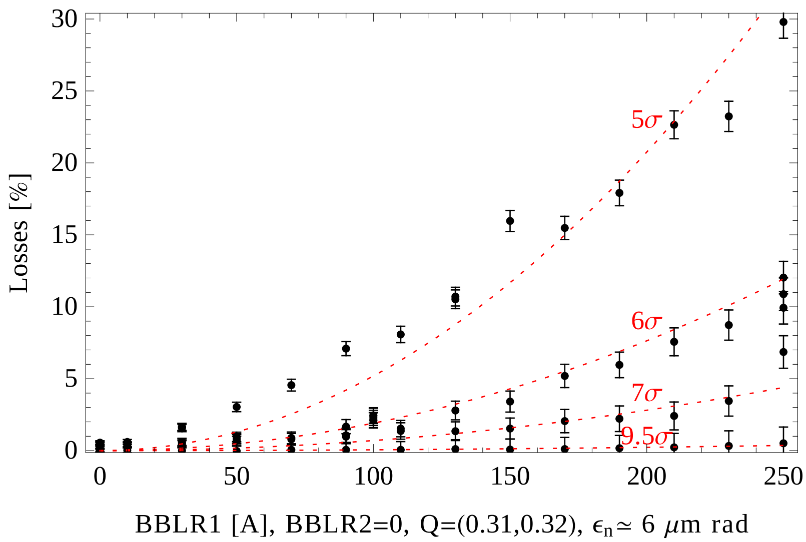

Figure 2: A current scan during 2008 BB MD.

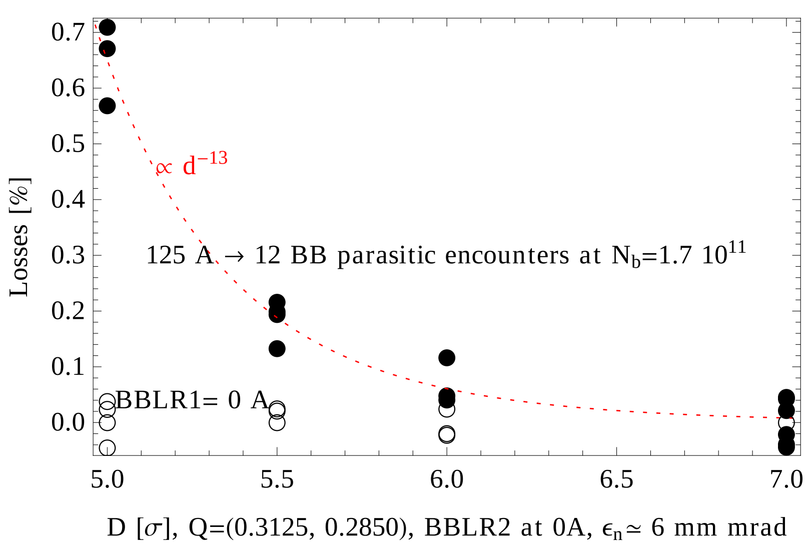

Figure 3: A distance scan during 2008 BB MD.

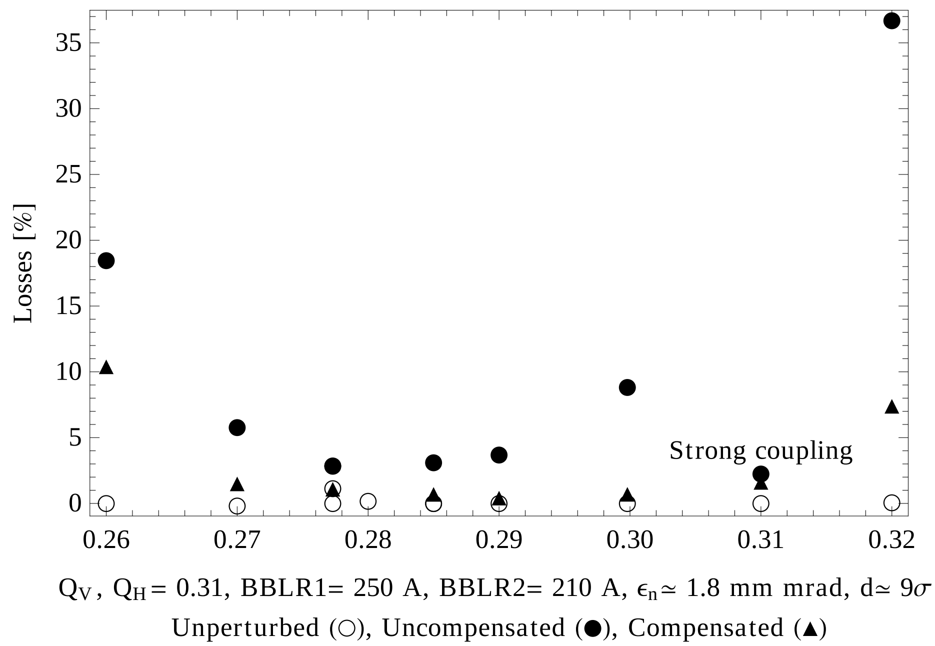

Figure 4: A compensation experiment during 2008 BB MD.

3 Actions to be taken

- We know that the BDV dipoles can stand 5 A in DC mode (K. Cornelis): we need to verify if the power supplies limit them to 3.5 A and/or the software (YASP or the Trim Editor).
- If we decide to power half of the BBLR1 we have to consider 1 hour technical stop to modify the connections (G. Burtin).

References

[1] http://cern-ab-bblr.web.cern.ch/cern-ab-bblr/documentation.htm

4 Appendix

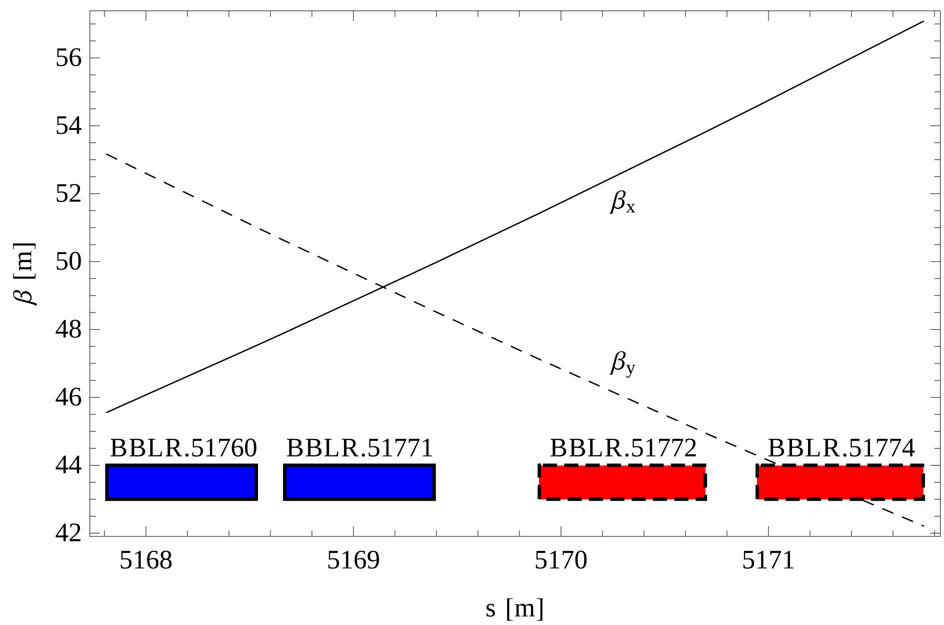

Figure 5: The betatronic functions in the SPS BBLR wires region.

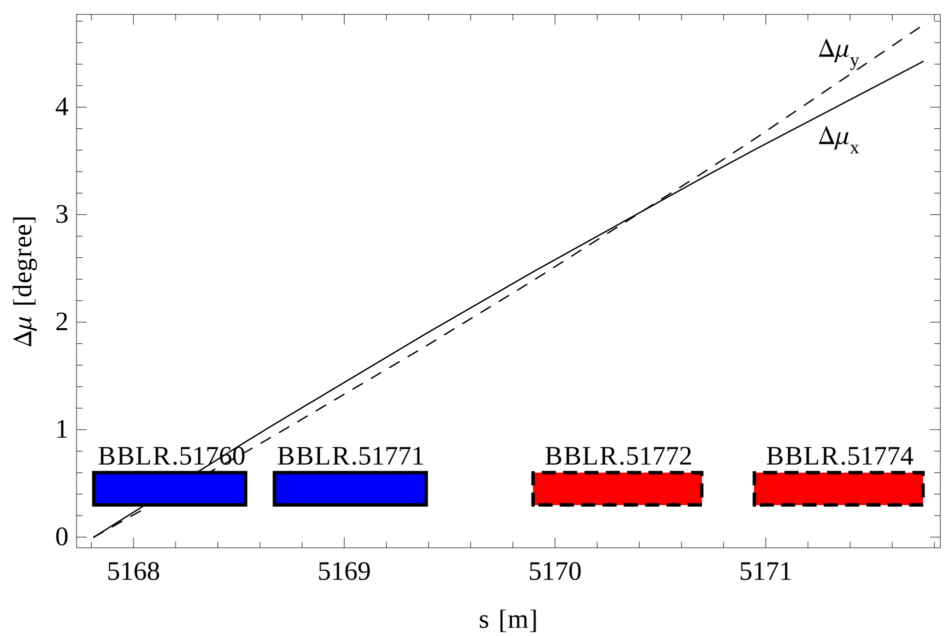

Figure 6: The phase advances in the SPS BBLR wires region.

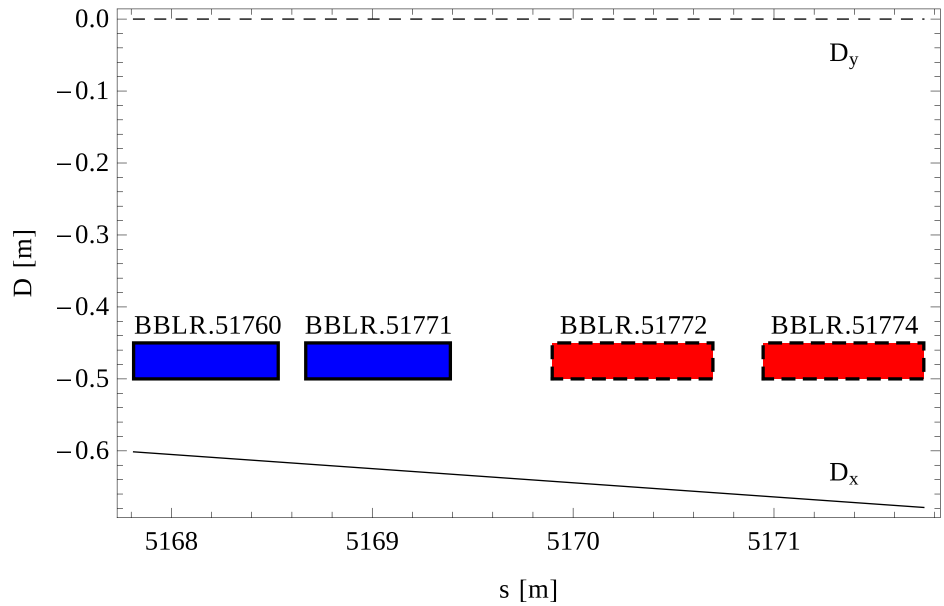

Figure 7: The dispersion functions in the SPS BBLR wires region.

NAME	S	L	BETX	BETY	ALFX	ALFY	MUX	MUY	DX	DPX
MDPH.51754	5164.05	0.25	36.32	65.43	-1.11	1.75	19.55	19.55	-0.53	-0.02
DRIFT_242	5167.81	3.77	45.56	53.16	-1.34	1.51	19.56	19.56	-0.6	-0.02
BBLR.51760	5168.53	0.72	47.53	51.01	-1.39	1.47	19.56	19.56	-0.62	-0.02
DRIFT_39	5168.67	0.14	47.91	50.61	-1.4	1.46	19.56	19.56	-0.62	-0.02
BBLR.51771	5169.39	0.72	49.95	48.54	-1.44	1.42	19.57	19.56	-0.63	-0.02
DRIFT_243	5169.9	0.51	51.42	47.12	-1.47	1.38	19.57	19.56	-0.64	-0.02
BBLR.51772	5170.7	0.8	53.82	44.95	-1.52	1.33	19.57	19.57	-0.66	-0.02
DRIFT_244	5170.95	0.25	54.58	44.29	-1.54	1.32	19.57	19.57	-0.66	-0.02
BBLR.51774	5171.75	0.8	57.08	42.21	-1.58	1.27	19.57	19.57	-0.68	-0.02

Table 1: Optical functions in the SPS BBLR wires region

	BBLR1	BBLR2
s [m]	5168.6	5170.82
β_x [m]	47.73	54.22
β_y [m]	50.83	44.64
D_x [m]	-0.62	-0.66
D_y [m]	0	0
$\Delta\mu_x$ [deg]	2.50058	
$\Delta\mu_y$ [deg]	2.67948	

Table 2: Averaged values at BBLR1 and BBLR2.

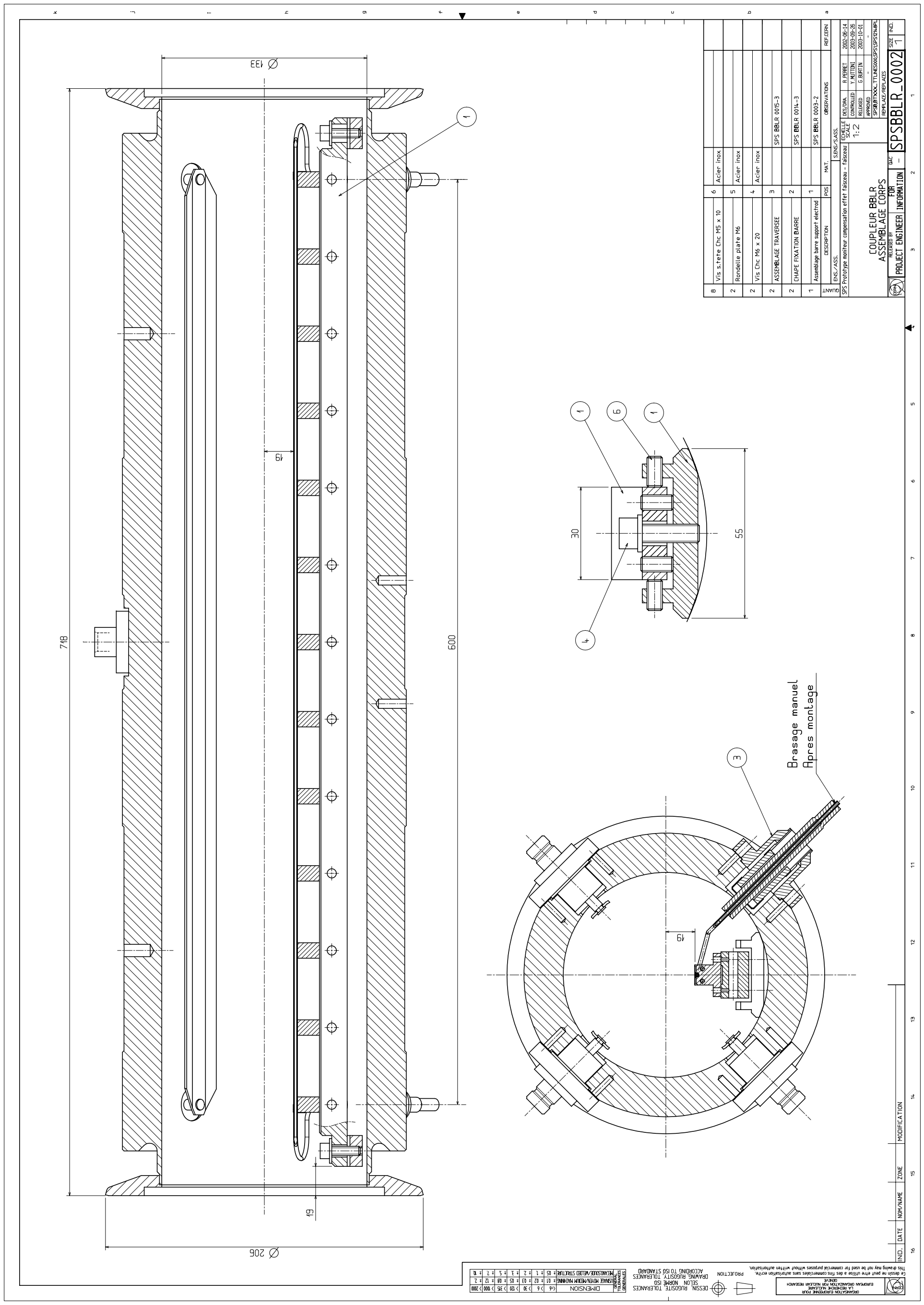

Figure 8: The wire and wire structure of BBLR1.

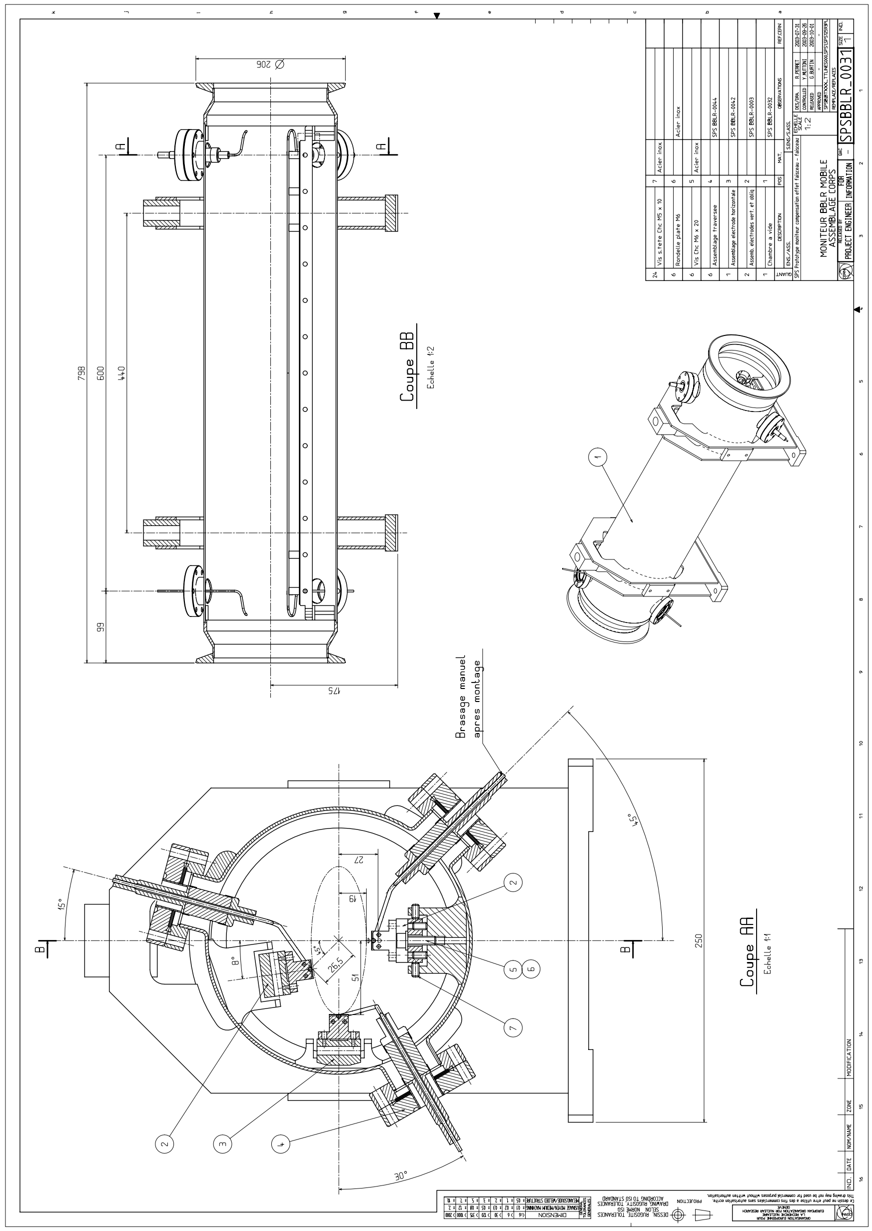

Figure 9: The wire and wire structure of BBLR2.