My poster

A. Plaçais [1] F. Bouly [1]

[1]Univ. Grenoble Alpes, CNRS, Grenoble INP*, LPSC–IN2P3, 38000 Grenoble, France

Why do we want to compensate cavity failures?

The RF cavities in LINACs are subject to failures, which can lead to beam losses. It is a major problem for Accelerator Driven Systems (ADS), as every beam trip cause adverse thermal stress on the structure and as the restart procedure can be time-consuming. A faulty cavity can be compensated for by retuning it's neighboring cavities.

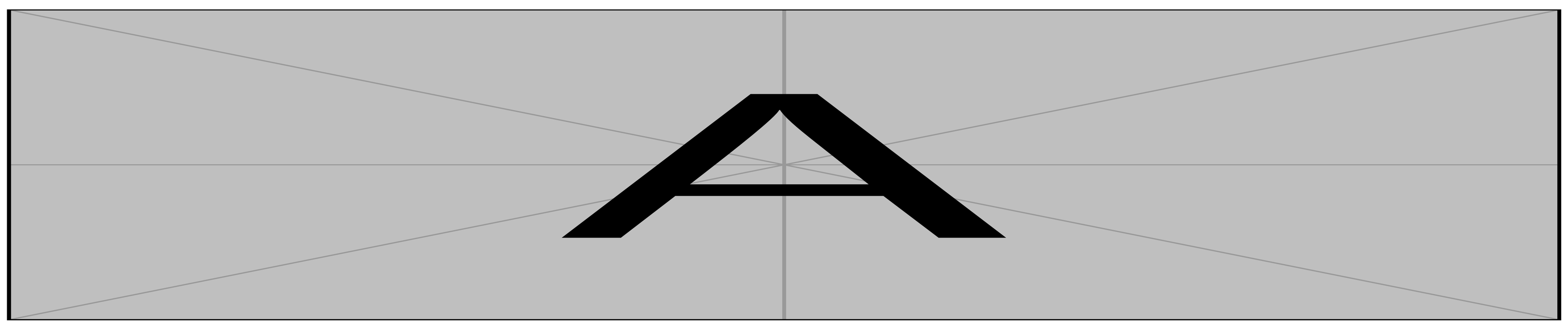


Figure 1. Local compensation of a failed cavity (red). The 5 neighboring cavities (orange) compensate for the fault; cavities in green remain untouched.

Several tools such as TraceWin can find compensation settings. However, the process require a lot of manual work, which is time-consuming and error-prone.

Hence we developed LightWin, a tool to automatically find compensation settings, already tested on the MYRRHA–ADS (i) does it work for another linac?

It is a longitudinal beam dynamics code. For the sake of rapidity: envelope simulations only, hence no multiparticle or space-charge effects (ii) are these approximations too bold?

Presentation of the study case

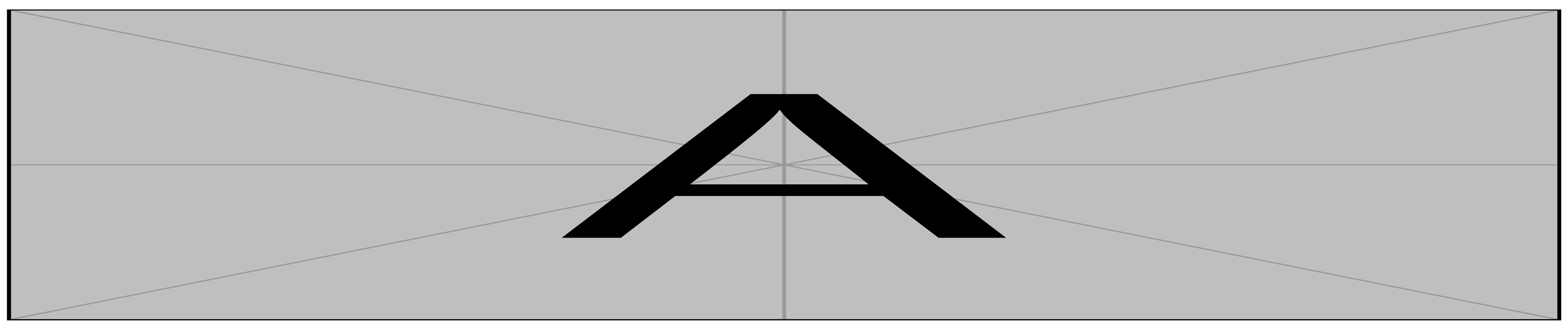


Figure 2. Structure of the JAEA–ADS. We study the 2nd half of EllipR2: $940 \to 1.5$ GeV.

JAEA–ADS is a project of ADS driven by a 20 mA 1.5 GeV proton beam. Cavities accelerating field E_{acc} can be increased by $20\,\%$ for compensation purposes. It's study is particularly interesting for us:

(i) a previous compensation study was realized using TraceWin and will serve as a benchmark;
(ii) it's beam current is high, hence space-charge effects should be significant.

We focus on the last 8 periods of the linac.

Compensation with LightWin (+ TraceWin)

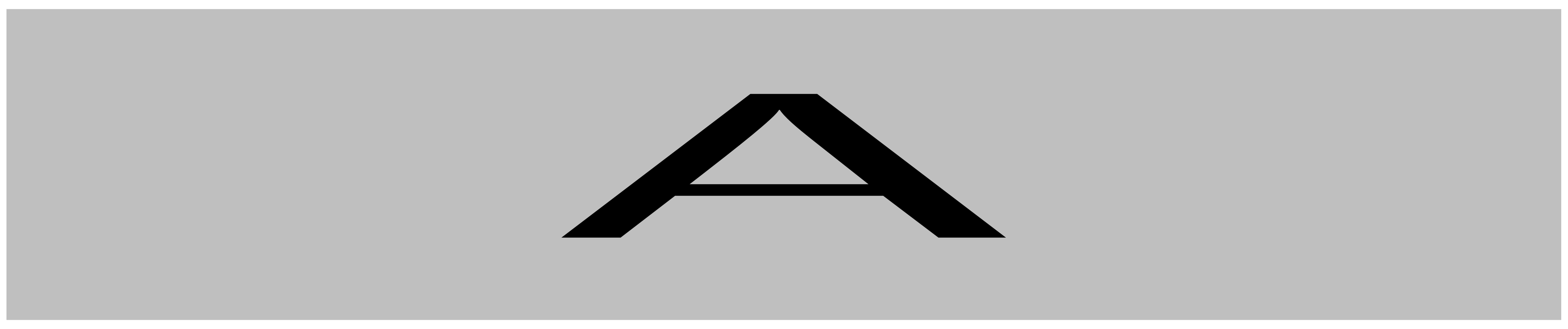


Figure 3. Flowchart of the compensation process.

LightWin (+ TraceWin) *vs* TraceWin only from Ref. : similar performances

Table 1. Beam optics performance for this study. TraceWin results are taken from Ref. . We outlined the beam optics that were better with TraceWin than with LightWin. Both tools are equally performant... but LightWin is automatic.

	$\Delta\varepsilon/\varepsilon_0$ [%]				M			
	Transverse		Longitudinal		Transverse		Longitudinal	
Faulty cavity	LightW	TraceW	LightW	TraceW	LightW	TraceW	LightW	TraceW
257	0.42	1.07	-1.11	1.52	0.03	0.02	0.10	0.09
258	0.11	0.88	-0.27	1.02	0.01	0.01	0.02	0.09
289	-0.01	0.09	-0.10	0.13	0.00	0.01	0.00	0.04
290	-0.06	-0.17	0.10	0.25	0.00	0.03	0.01	0.08
291	0.12	0.04	-0.03	0.13	0.01	0.03	0.03	0.09
292	-0.09	0.04	0.10	0.25	0.01	0.03	0.02	0.09
293	-0.02	0.21	0.17	0.25	0.01	0.03	0.02	0.09
289–293	0.18	1.78	-0.29	-1.27	0.13	0.02	0.35	0.06

Cavity error #289: new cavity settings

Example of cavity error #289, near the end of the linac. *k-out-of-n* compensation method: 5 compensating cavities per error, as in Fig. ??.

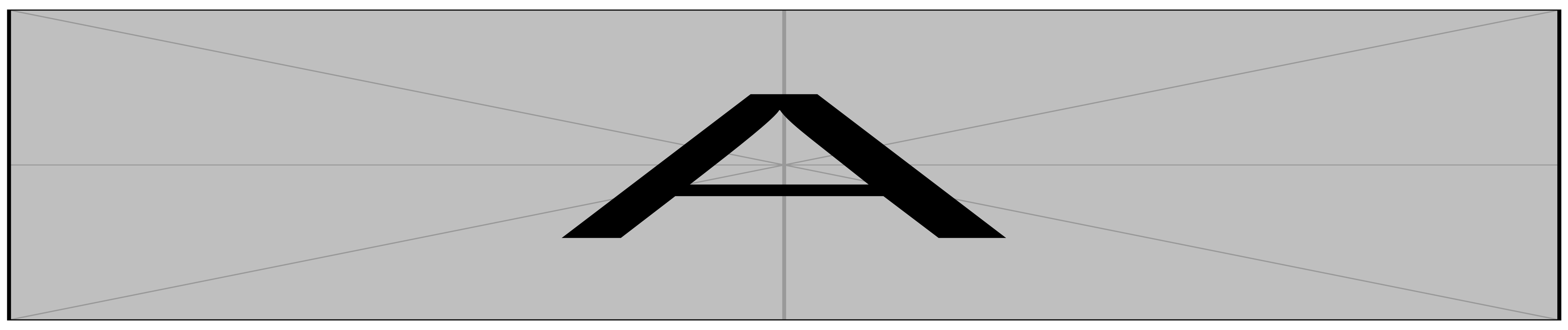


Figure 4. Accelerating fields and synchronous phases of the cavities for the baseline design, the design from this study and the design from previous study Ref.

Cavity error #289: densities

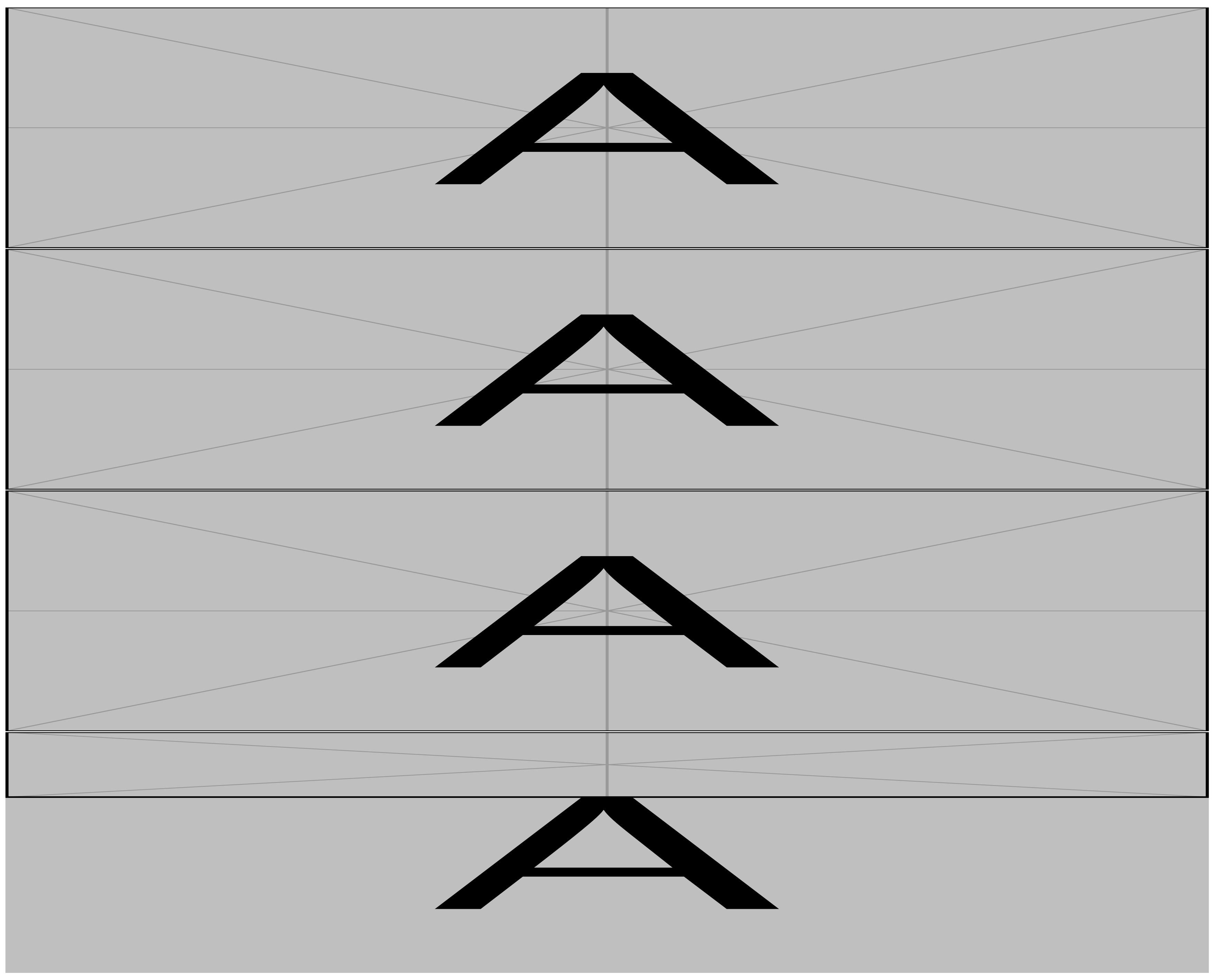
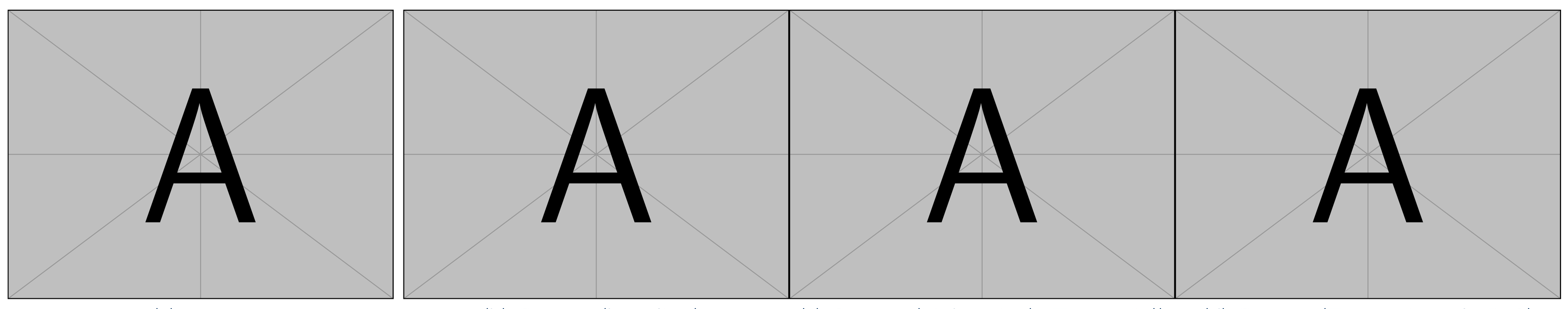


Figure 5. Beam densities in the transverse and longitudinal planes. Calculated with TraceWin, 10^6 particles.



(a) Input (b) Output (baseline) (c) Output (LightWin (+ TraceWin)) (d) Output (TraceWin only Ref.)

Figure 6. Yellow ellipses are $100\,\%$ emittances.

Conclusions and perspectives

We showed that:

- LightWin finds acceptable compensation settings;
  $\to$ similar to TraceWin, but LightWin is automatic;
- neglecting space-charge effects is acceptable in this section.

Future work:

- perform similar study at the start of JAEA–ADS linac;
  - lower energy $\to$ space-charge effects more prominent;
  - if necessary: implement transverse dynamics, space-charge in LightWin;
- new optimisation algorithms;
- explore new compensation paradigm (e.g. for SPIRAL2):
  - no increase in accelerating field...
  - ... but use more cavities for compensation: global compensation.

placais@lpsc.in2p3.fr