F3B zoom anatomy investigation

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Abstract :
The zoom phase is a prime factor of success in an F3B competition. Due to very high speeds, violent manoeuvres, it is dimensioning for the model both is terms of mechanical resistance and aerodynamics. Some original specific transducers have been developed to investigate during this phase with a dedicated flight recorder. The results are given here as reference to provide orders of magnitude. They were conducted with a prototype version of the traction transducer and the lesson learned led to a production transducer that now available.

1. Introduction

The zoom phase of an F3B (or F3J) flight is the most demanding in terms of mechanical dimensioning of the model. It is also a critical phase where a competition is almost surely won or lost. The success of an F3B competition is a subtle mix of pilot’s skills, competitive flight strategy, mechanical resistance and winch/wire optimisation. All of these elements must be at top. An attempt has been made to sort out and rationalize some of these factors.
Electronic devices tools and software have been developed to record useful data during this kind of flights. Specific transducers have been designed. The first results of a test campaign are presented here. The purpose is not to give a definitive answer to the zoom physics, but to give examples of the progresses in investigation that selected measurements can provide.

2. The zoom phase in F3B flight.

People familiar with this discipline will naturally skip this chapter.
The zoom phase strictly occurs at the end of the winch up phase when the pilot develop a violent dive and then up manoeuvre to get all the remaining energy from the winch/wire couple and transfer simultaneously kinetic energy to potential energy to take up a maximum of altitude.

During this phase, tremendous speeds are achieved and the model experiences a high number of Gs during transition between high-speed dive and upward trajectory. The question is how big are they? Few measurements have been made in this field and some figures are circulating among the F3B community with a great variability, most of them coming from theoretical calculations.

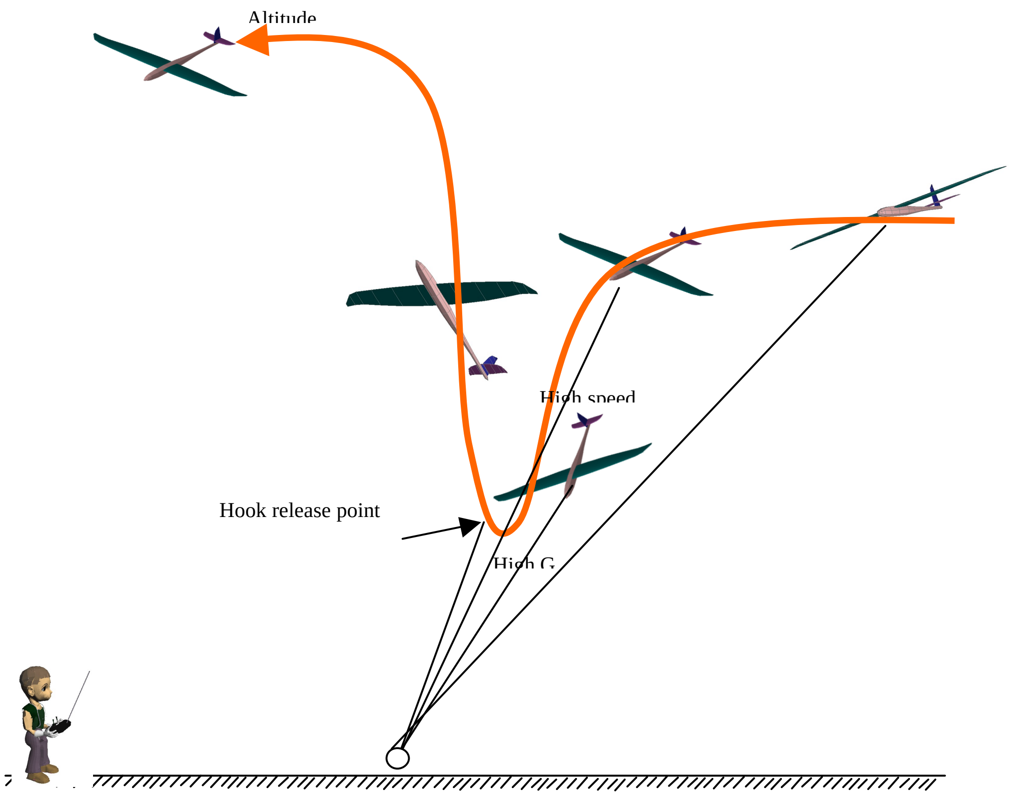


Fig 1 – The F3B zoom flight phase

3. The experimental set-up

Measuring G and speed is rather common thing although for these range of speeds and Gs, some cautions must be taken. Use of Hy G accelerometers and Pitot probe is a must. It is better when G are measured for several directions. At least two.

Measuring the force on the hook during the flight, at the point where occurs the transfer of energy between the winch and the model is quite a challenge. In complement to the interest for flight dynamic, it is also important because it can lead to the construction of process of selection of the most appropriate and efficient wires.

Several configurations were imagined and this one was selected. Others were abandoned because they could not provide the force measurement in all the situations of angle between the model and the wire.

A traction transducer has been introduced between the wire and the parachute, this later one being connected as usual to the hook and the hook to the model.

The transducer is connected through a rather long cable to an onboard Xerus data management system for data recording. The cable has a separation connector designed to disconnect gently when the glider is released.

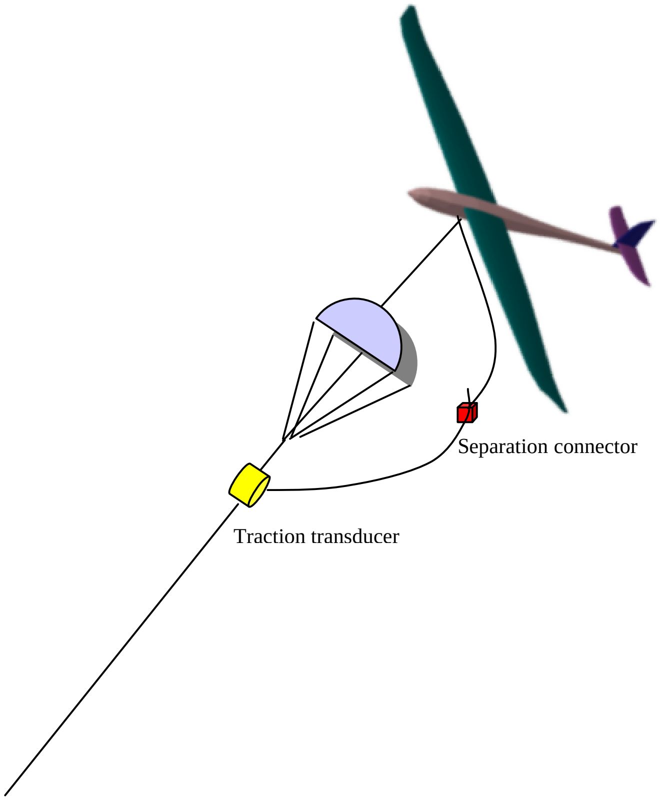


Fig 2 – Wire traction measurement set-up

The transducer was designed from the beginning to be rugged and was cast in elastomeric resin with flashy colour, just in case. The transducer had no electronics inside, the high resolution of the Xerus system allowing it.
The calibration made show that the resolution was 0.5Kg, judged enough for these kind of measurement, and that it was independent of the traction angle.
The Xerus system standard sampling rate of 5 Hz was adopted.

4. Flight experiment

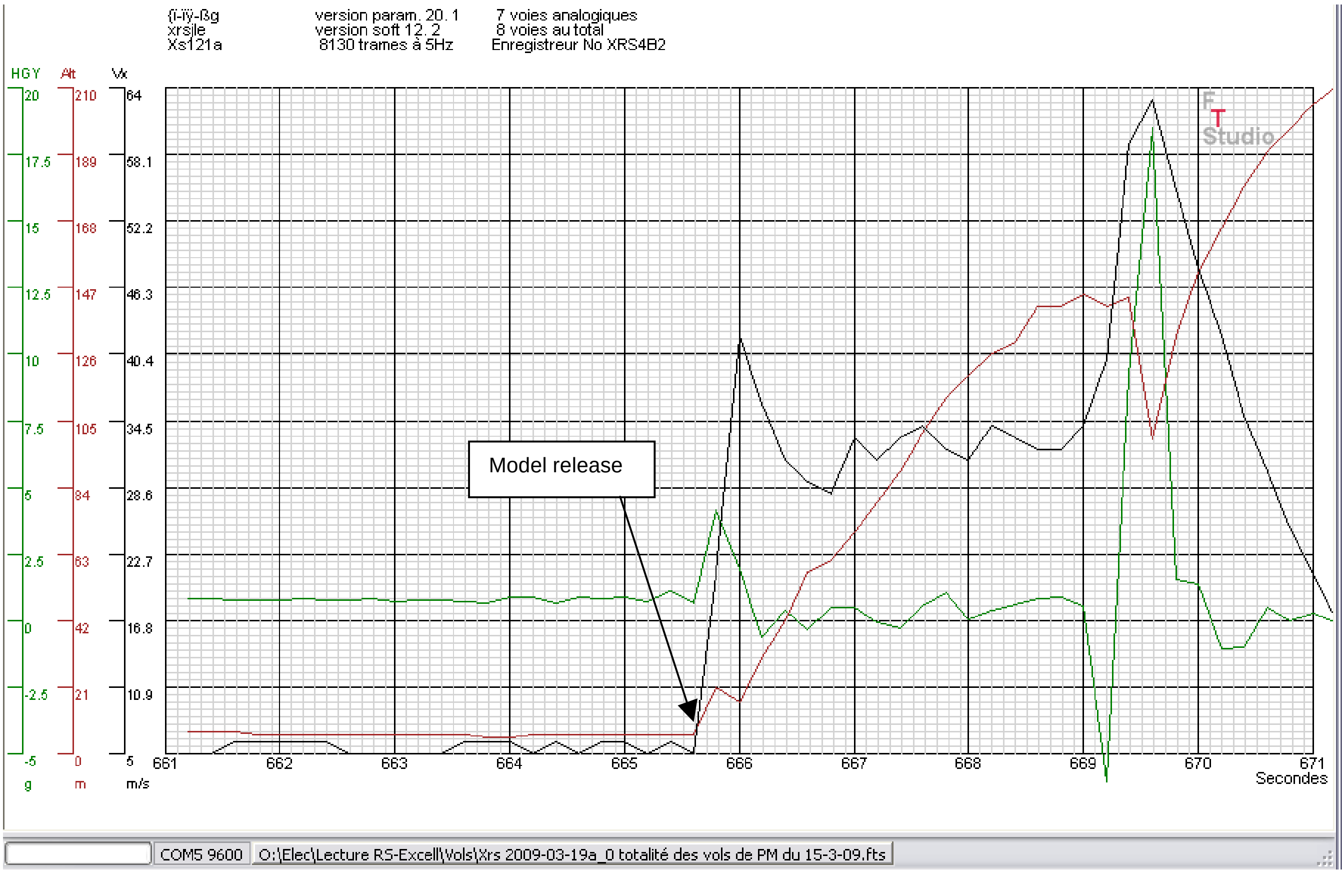
Moving to the Villaroche AAV airfield was done readily and a date was taken with Patrick Médard.
He had already prepared his model, the Radical, and installed the acquisition system.
The flight was a normal F3B flight, but not an extreme one, and at the end the transducer was retrieved perfectly intact and functional.

The data were uploaded with the Flight Test Studio software, stored on the PC, and displayed.

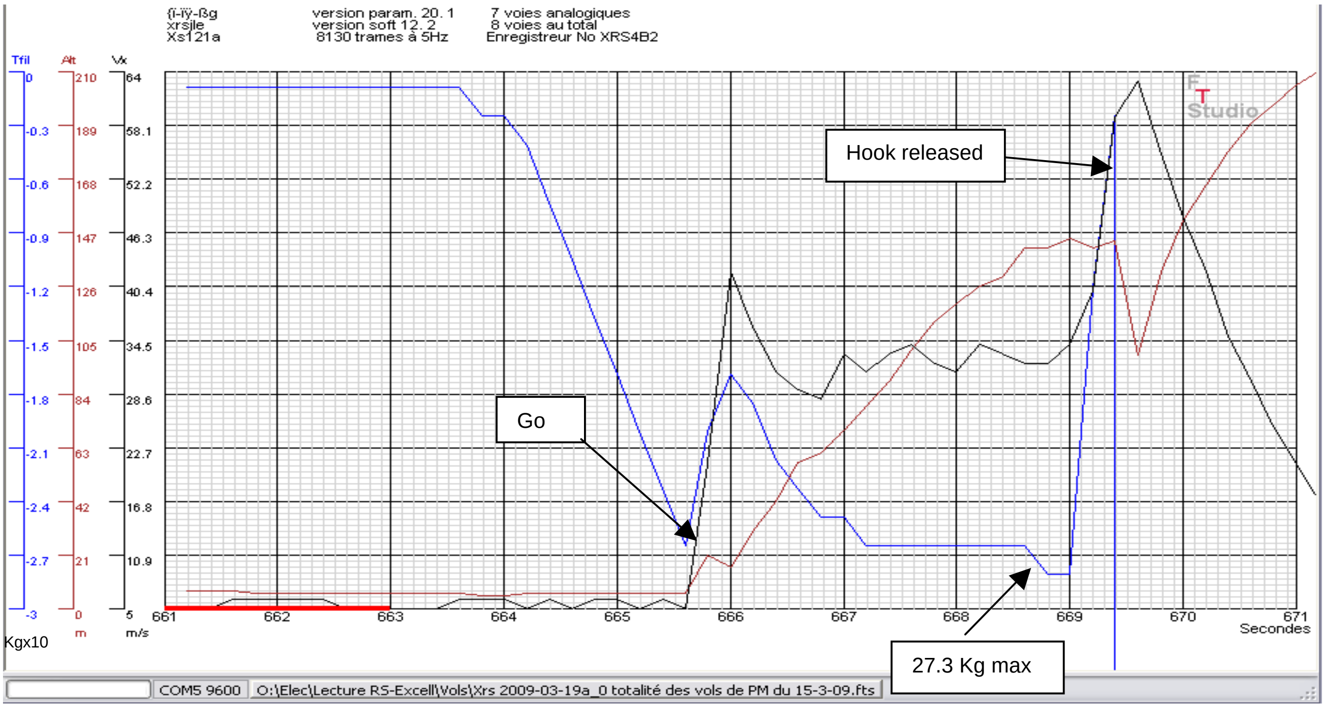
5. Where the reader can judge by himself of the results

The purpose of this paper is not to comment the results from a physical point of view.
The results seem sufficiently convincing to comfort us in the idea that the experimental set-up was correct and efficient.
Maximum values are:

- Airspeed: 63 m/S (227 km/h)
- Altitude: 210 meters
- Radial acceleration: 18.5 G



Plot 1 Airspeed, altitude and acceleration during the zoom



Plot 2 Altitude, airspeed and traction during the same flight

Several flights were repeated with the same kind of convincing results.

6. Production traction transducer

The experimental set up and the transducer have proved to be good choices.
The transducer was improved with the following modifications:

- the mechanical interface was modified from an M3 thread to an M4, more sturdy one because deformations had been observed.
- Electronics has been introduced in the transducer, just to have smoother curves (we could also interpolate by software) and to be useable with other system that may have less resolution than the Xerus system.
- In the same spirit, the sampling frequency was increased to 10 Hz.
- Diminishing the thickness lightened the transducer that was unnecessarily over protected.

This gave birth to the Max 1025 production model of traction transducer.

7. Conclusion

The target of this new transducer has been achieved and a the experience has been used to develop a production model fulfilling all the needs; the experimental set up has been validated and has proved to be safe for the model, for the data management system and for the transducer. The measurements can now be repeated.
The theoretical studies already existing on the F3B/F3J zoom physics can be fed with real values and confronted to a battery of test and measurements.
This set up can contribute to sort out the part of pilot's skill, flight strategy and hardware improvement in the final result.
This transducer opens a new way of optimisation of the hardware used for F3B competition.
It came too late to have any impact on the last world championship this summer.
No doubt that it may have an influence in the next challenge.