

The G91R1B has an important navigation tool that is not related to radio-assistants, such as TACAN. We are in the 50s of the last century, the war has just ended and inertial navigation systems are starting to be tested. The problem is that an inertial navigation system is heavy and expensive and not very precise (it was completely analog). A small Canadian company invented an analog gauge to help long-range navigation on the Atlantic routes

(<https://forum.flightgear.org/viewtopic.php?f=4&t=23163>), this gauge was based on some devices between which a 4-lobed doppler radar, an integrator and a route planning system that sent their data to an effective display gauge (PHI). FGFS (but also many other commercial flight simulators) does not provide for the management of this particular navigation system and therefore it was natural to simulate this device using JSBSim (using NASAL was really crazy because the instrument is analog and must follow a lot precise the position and speed of the plane ... not only but I have always found much simpler and more precise programming in JSBSim than in NASAL ...). Simulating the PHI was not easy either due to the complexity of the instrument, or to finding information on its real operation!



In these months I have developed 4 devices: the PHI viewer, the Wind, the programmer and finally the doppler. Then there is a system for the simulation of the gyrocompass (which is not a magnetic compass!) And for the true speed detection system by reading the values of the pitot tube. In short, a long work, beautiful for a computer engineer who wants to reproduce an analogic processing system of flight data that is the most similar to the real one. I hope to have succeeded and to be able to give you all the same feelings and difficulties of using such a route management system.

The instrument was made independent of the G91R1B so that it could be used for other aircraft ... for example the DC8 was mounted and perhaps also the 707 in the 60s-70s before the advent of inertial platforms. It would be nice to mount it on the 707-200!

How to use it ... First of all, the aircraft must be switched on and the electrical system turned on ... when the two yellow lights on the right are off ... and then the three-phase system (115V-400 Hz) of board is active ... the PHI is correctly powered and therefore can start its configuration for the flight. First you have to build a flight route, to do this I used the flight routing system of FGFS which is nice and well done: "Autopilot" -> "Route manager" ... In this example I used as the departure airport LICT (Trapani Sicily-Italy) and chosen as the destination of arrival the island of Pantelleria (a wonderful island in the middle of the Mediterranean, perhaps destination of Ulysses with the

mythical Calypso). Pantelleria is not far from Trapani, but being in the middle of the sea has no reference points and therefore allows you to have a very particular and slightly distressing flight. However in the meantime we turn on the doppler, it is important not to forget it off because the system, as in reality works, but using pitot data is not very precise ... To activate the doppler you have to put the maopola on the left on ON ... you will see turn on the yellow ALLARM lamp for a few seconds ... as in reality ... the electronics is with thermionic valves and therefore does not switch on immediately ... the program also simulates the heating time (the REC ONLY position is used to keep warm the doppler apparatus).



Then also turn on the PHI by placing the knob at the top left on the PHI position ...



You will find that it is ok when you start to position the needle on the north.

It is also advisable to press button 2 of the air route programmer ... The apparatus had broken the 2-3-4-5 possible while the 1 was a fictitious manual route that I have not yet activated .. but I will soon insert it.



You will now see that the PHI changes the position of the thin needle and some digits are shown .. those are the values of a pre-set route that I currently leave to allow you to make a route without route-manager programming.

Finally we start the router manager, its operation is well described here:

[http://wiki.flightgear.org/Route\\_manager](http://wiki.flightgear.org/Route_manager)



## Route manager

I remember that the route when it is generated is rather rich in points and therefore must be "thinned" so as not to have more than 4 sections that correspond to the 2-3-4-5 buttons of the programmer. In reality it is possible to replace the programmer in flight (as in reality), but it is a function that I have not yet put into practice. It is essential to press the [ACTIVATE] button which creates the link between the PHI route planner and the Route Manager.

As soon as you press [ACTIVATE] you will see the PHI arrow going in the correct direction of the first stretch of the route and the distance count will give you what you need to get to the next "turn" point. Sometimes, if there are reference points, for example a mountain peak or a country / city etc ... it is possible to use this reference to reset the error of the apparatus.



We are now flying and towards the end of the second section I show you what happened ... the blue line is the real flight of the plane, while the purple line is the route to take. As you can see we are close, but a transverse wind not detected by the doppler moves the air route 1-2 miles east ... Actually there is a way to compensate for this error with the Wind gauge, but currently I don't talk about it otherwise you get discouraged immediately and don't try this ancient instrument flight method!

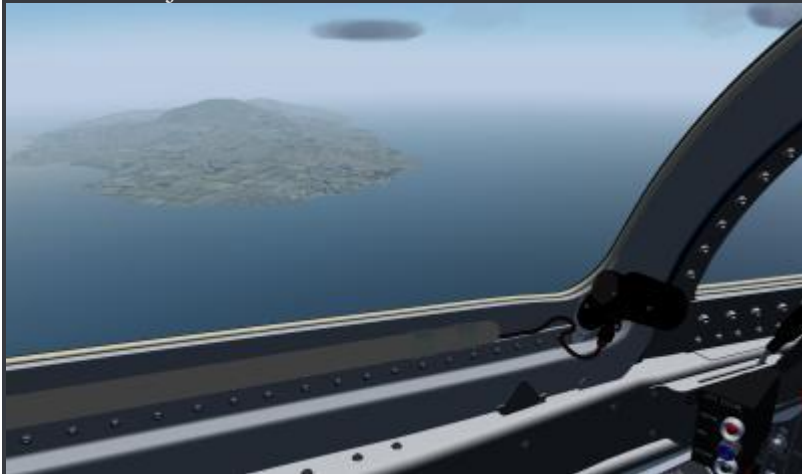


We are at the third stretch of flight and as foreseen by the flight plan ... the beautiful Pantelleria appears with its characteristic extinct volcano ... but with magnificent Roman baths among the rocks on the sea ... I was there at night, with candles, in the middle of winter ... with some friends and I have to say that they were two fantastic hours ...





Here we are just before the final stretch of air route that will take us in front of the landing area.



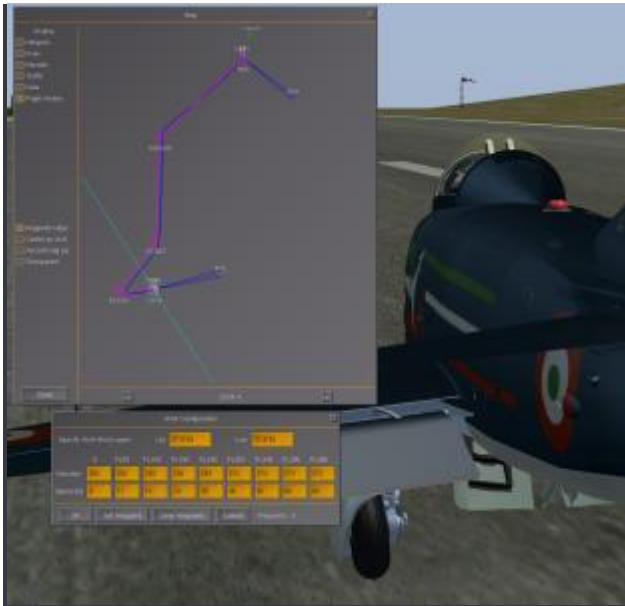
Here we begin to see the problems of the accumulation of error over distance and of leeway, as you can see the instrument indicates that there are 9 miles missing but we are closer (about 6 miles) and this can be a problem for landing .. However, the G91 has a good airbrake ..



Now we see the error well ... 2 miles on 90 miles, or a slightly higher error of 2% ... not bad for those years ... however the 2-3% error was estimated an average error for that type of apparatus (10 nm on 280 nm) and this shows the goodness of the simulation made with FGFS and JSBSim ... but if we knew the direction and speed of the wind we could reduce it.(modificato)



Now let's look at the complete route, the blue line of the plane constantly tends to go to the right (east) due to the wind that shows us the wind-compilation table. In the future I will activate this compensation through the Wind gauge. Actually it already works, but not satisfactorily.



And if the doppler is not active? Don't worry, the flight parameter analysis system allows you to have an estimate of the distance .. this time, however, the distance error is much wider (10%) and therefore the advantages of this method do not bring great improvements compared to the old system of the chronometer-speed ... but at least it takes into account the variations in speed which are very frequent for a bomber fighter. I hope I have told you enough to have fun and learn how to use a very special flight system!