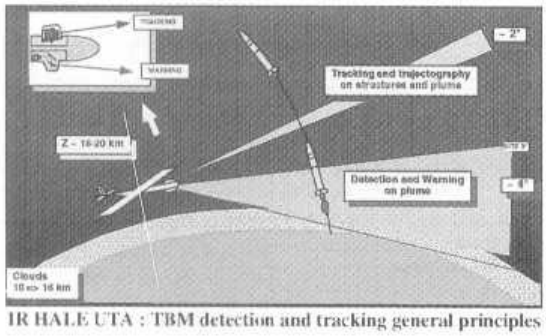
So, the first essential conclusion is drawn : the IR sensor in charge of TBM plume detection has to be carried at rather high altitudes, typically 18 km and higher.

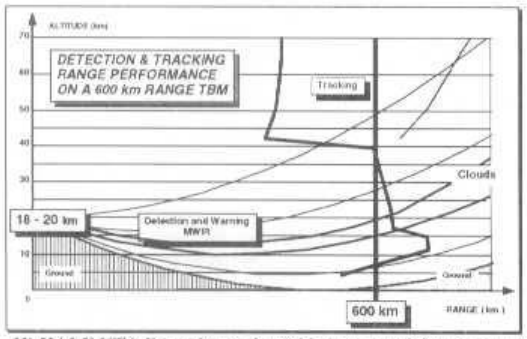
In these conditions, estimated performance is very impressive : TBM plume detection range is found between 600 and 8-900 km, depending on the TBM class (from SCUD B / Al Husayn class, having a range of around 300/600 km, to longer range missiles with ranges up to 2,000 km and more). The detection range is comparable with (sometimes higher than) the missile range ...

As far as the detection and tracking of TBM structures after booster burnout is concerned, the IR band trade-off analysis calls for slightly higher wavelengths, while tracking performance (impact point early and accurate prediction) makes it necessary to reach high observation elevations, typically 60° or more.

Tracking ranges are estimated to be quite equivalent to plume detection ranges on current proliferated missiles, so that a continuous detection and tracking process can be envisioned, on the first part of TBM flights (up to apogee area).



IR HALE UTA : TBM detection and tracking general principles



IR HALE UTA Detection and tracking range performance on a 600 km range TBM

In terms of trajectory prediction accuracy, the results obtained are impressive as well : impact point predictions with accuracy better than 5 km (diameter) are delivered before the TBM reaches its apogee, so that the remaining time for alerting populations or troops in the estimated area ranges from 3 to 6 minutes, depending on the TBM range (300 to 2000 km). This is also the time available for preparing the acquisition of the target by ATBM Point Defense Weapon Systems.

These results are obtained by simply using one passive InfraRed Search and Track sensor (IRST), i.e. without need for distance measurement (which could be provided by Laser rangefinder), and even without need for stereoscopic observation (which would require the association of two airborne systems for each surveyed area and thus multiply the number of loitering airplanes by a factor greater than two).

The gains assessed in presence of Laser rangefinder and / or stereoscopic observation are significant in terms of tracking duration, more than in terms of final accuracy.

	Single sensor observation	Stereo observation or laser telemetry
Flight duration	445 s	445 s
Apogee	163 km	163 km
Time for Apogee	250 s	250 s
Impact with 10 km error	213 s / 155 km	110 s / 80 km
Time before impact	232 s	335 s

Tracking accuracy sequence vs observation configuration

Single passive observer performance appears to be generally sufficient in that area of alert delay, so that the other two solutions do not really bring anything more. The single passive observer is then our basic assumption in the next paragraphs.

4.2 Design overview

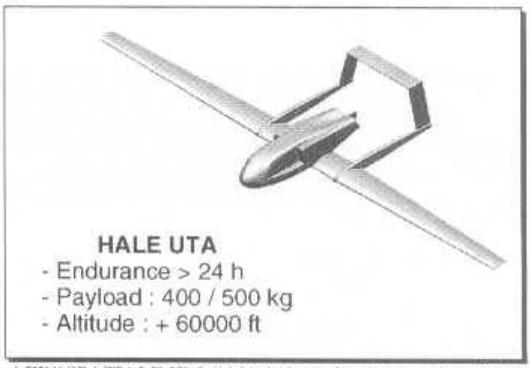
Previous elements define the primary requirements for the IR sensors and High Altitude airplane design.

Associated with a certain permanency needed in surveillance operations, the objective of overall operations cost reduction means searching for a small number of airplanes on the ground per airplane in flight, which leads to Long Endurance requirements. Cost analyses and confrontation with capabilities offered today by aeronautical technologies make it quite easy to design airplanes with 24 hours and more loitering duration.

Such flight duration and the interest of not having large pressurized volumes on such airplanes pull towards unmanned aircraft solutions.

Thus, the concept becomes naturally an IR High Altitude Long Endurance Unmanned Tactical Aircraft (***IR HALE UTA***).

Preliminary design studies of 65000 ft IR HALE UTAs have been undertaken for ensuring the concept's feasibility, inventorying the technical difficulties, confirming system performance, and estimating costs and development / acquisition schedules.



AEROSPATIALE High Altitude Long Endurance Unmanned Tactical Aircraft conceptual design.

These studies have led to 2 major design options, as far as sensor integration is concerned :