Ideas to Reduce Xo in the SHIP Decay Volume

Geoff Barber Imperial College London

January 2016

Replace the air with helium

There are a advantages to replacing air with helium.

The main advantage is that the radiation length and the interaction length of helium versus air are much longer, see table opposite. By using helium at 1 atm there is no need to build a complex pressure vessel and all that entails. All that is required is that a given volume of air is replaced by helium. If a helium balloon were used then the minimum of infrastructure is required. The helium need only be at the minimum pressure required to hold its shape and helium storage balloons are readily available.

Thanks to Ulrik for his help.

	X^o	λ_T	λ_I
Air	303m	508m	748m
Helium	5681m	3120m	4277m
Above is at 20^o / 1Atm			

Balloon Material

The material used for the manufacture of the balloon is a polyester fabric which has a layer of polyurethane film either side.

I have figures for 3 types of fabric

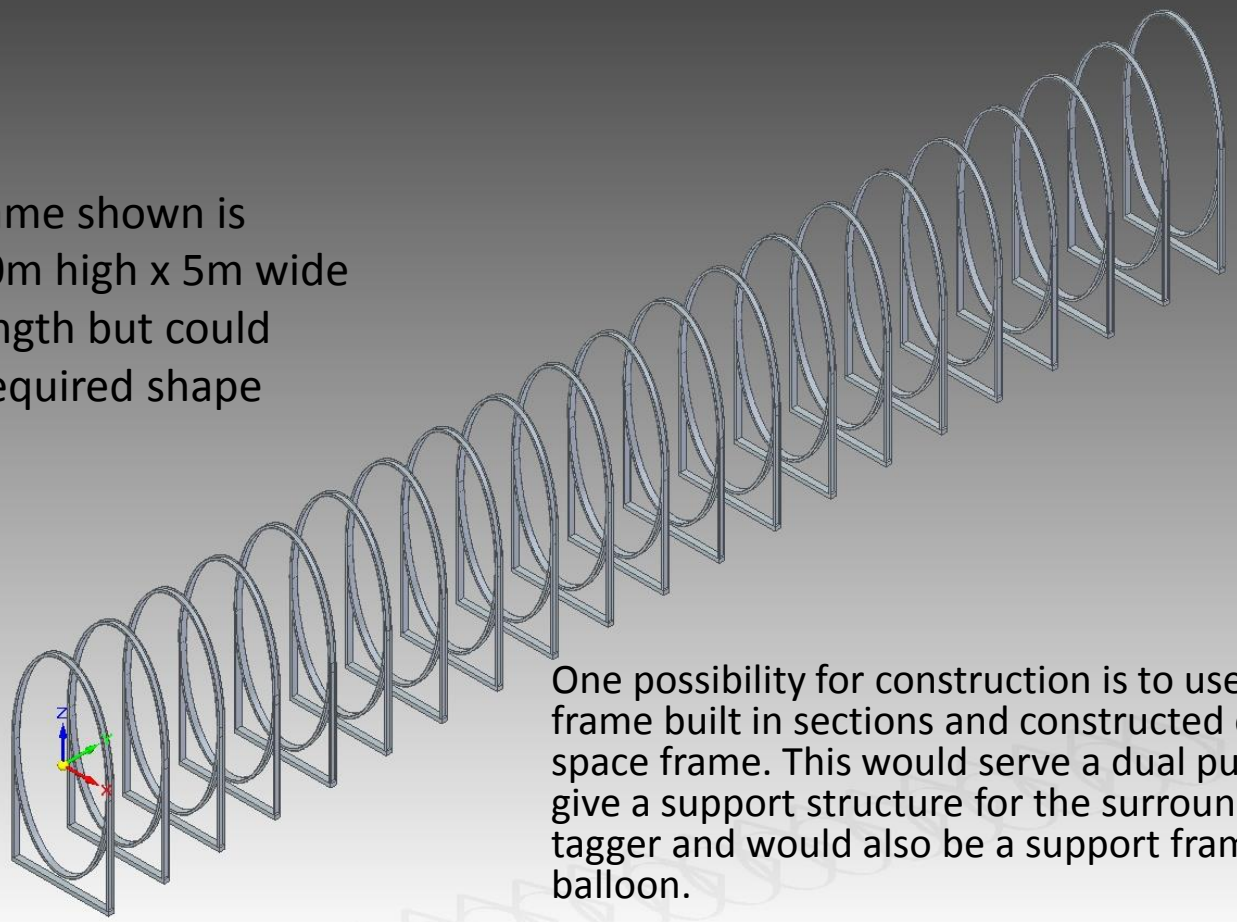
1. ~200g/m^2 , breaking load 550-600N/5cm, leak rate for helium at 1atm is 1-1.5l/m per 24 hrs 0.2mm thick
2. ~340g/m^2 , breaking load 1800-2000N/5cm, leak rate for helium at 1atm is 0.6-0.9l/m per 24 hrs 0.2-0.4mm thick
3. ~390-510g/m^2 , breaking load 2500-2800N/5cm, leak rate for helium at 1atm is ?l/m per 24 hrs 0.4mm thick

I have requested samples of all possible materials from Ballonbau Wörner DE who have been very helpful.
A couple of their products are shown. They state that they can build balloons to a diameter of 22.68m with a volume up to 6100m^3.

More Images

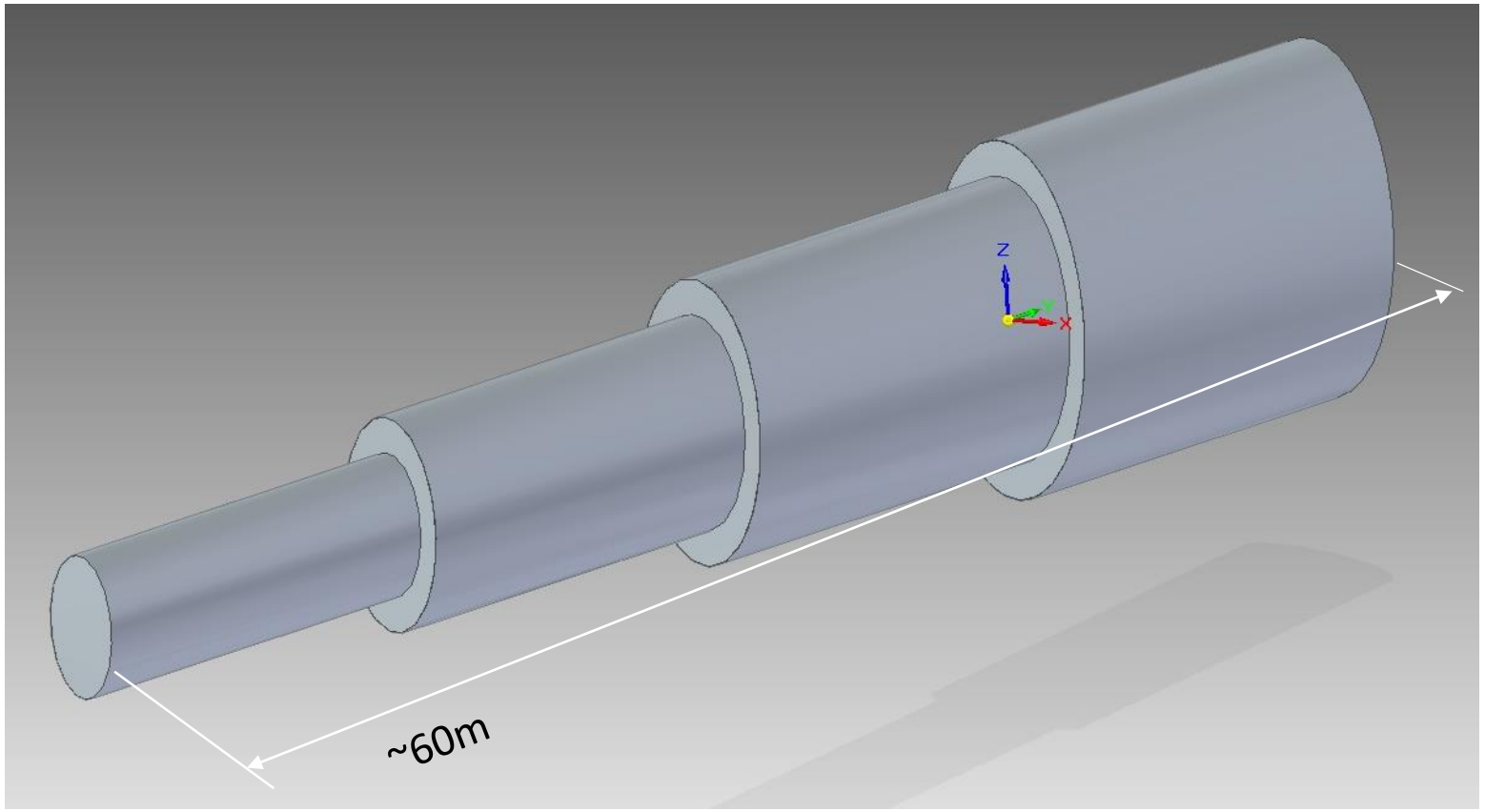
Outer Support frame

Support frame shown is
Elliptical 10m high x 5m wide
~60m in length but could
form any required shape



One possibility for construction is to use a large hooped frame built in sections and constructed on site as a space frame. This would serve a dual purpose, it would give a support structure for the surround background tagger and would also be a support frame for the balloon.

Possibilities



The sequence of 4 balloons
shown start with an elliptical
cross section 4m high x 2m wide
and ends 10m high x 5m wide.
It may also be possible to make conical
balloons this needs to be investigated
should we proceed
It has a volume slightly less than 1300m^3
which could change as required.
To fill 1500m^3 at atmospheric
pressure with low grade Helium (99.996%)
would require 2030 litres of liquid helium
and would cost at todays prices ~£15k
The leak rate for the thicker material,
assuming a surface area of 1100m^2,
would be in the order of 1m^3 / 24 hours
or ~£10, this is from permeation I'm sure
We will loose more through general leaks.

The shape of the balloon can be tailored to suit our requirements (within reason).
As the balloon material is less than 0.5mm thick it may be conceivable to have a run of balloons (shown are 4) this lends itself to constructing a conical volume which will reduce the helium requirements and also decrease the area required for the surround background tagger .

Shapes don’t seem to be a problem

Other Considerations

As stated, there is a leak rate associated with helium therefore the balloon would need to be ‘topped up’ whilst running.

Equipment would be required to recover and ‘clean’ the helium between runs.

A safety regime would need to be established due to the large volumes of gas stored and the possibility of oxygen depletion.

What Next

- The main task is to see if helium is an acceptable medium for the decay volume.
- Explore what shapes sizes of balloon are available, I have asked for rough quotes for:

    A. 1 balloon 10m Ø x 50m long

    B. 3 balloons 10m Ø x 20m long

  This is to get some feel for our options

Work out the methods for keeping the helium ‘fresh’ and how it can be recovered.

Please Note :

This is only an outline of the scheme, therefore any comments, suggestions, ideas, etc. are very welcome.