This is circumvented by using a low probability process repeated many times until success is recorded. The ability to partially read-out a memory many times can be beneficial for this use.

1.8 Meeting the requirements

The capability to shuffle modes and to perform partial readouts are possible in most techniques based on atomic ensembles. Shuffling and combining modes is possible as ensemble based memories are intrinsically multi-plexed in space, such that they in effect are storing an image. There is also the possibility of shuffling temporal modes as has been demonstrated with a raman-feature[8], and is also possible more generally as we'll describe in chapter 6 **??**. The same mechanisms may be used for partial readout.

It is difficult to give hard numbers for other memory parameters due to the large parameter space and range of circumstances. A absoloute lower limit on storage time is the most firm: the minimum average time taken, T, to acheive 1 qubit of entanglement, start to finish, is given mainly by the number of classical signals that must be sent times the time taken for each. For an absoloute best case, if we assume more modes than 1/(failure probability) and the ability to shuffle modes, entanglement may be created while only waiting for a few heralding signals. Thus if we consider a distance pf $\sim$ 1000km (3ms trip) it may be sufficient to have a storage time of $\approx$ 10ms. In the absence of this ideality, the requirements will increase dramatically. Realisitc storage times are often quoted as $>$ 1s. To see this we may consider a rough situation where our 1000km is divided into 10. Each section of 100km of fibre has a loss of 0.99. Thus for a memory time of 10ms to not be limiting us, we would need $>$ 100 modes which may be shuffled and read out in around $1ms$. This is even before we've considered imperfect efficiency, detection losses, phase instability and dark counts, and assuming that our entanglement is being generated using perfect photon-pair sources. Using single-photon generation will slow things down further.

In terms of how to implement a memory for building a quantum repeater, perhaps the most telling requirement is that of storage time. The only media with demonstrated storage times above or even close to 1s are solids[10] and more recently **BEC!** (**BEC!**)s[**?**]. Further as we have stated, the number of modes that may be efficiently stored is fundamentally limited by the available optical depth, which is in turn reliant on the spatial density of absorbers.