**Supplemental Information**

**Determination of ionization and negative ion extraction efficiency without gas**

The ionization and negative ion extraction efficiency in the gas ion source is lower for gas measurement than for graphite measurement (Bronk Ramsey and Hedges, 1987; Middleton, 1984; Middleton et al., 1989). To determine the difference a measurement on a single target was conducted (see Figure 8): standard gas is fed into the ion source via the GIS, then the capillary is shut. From this point on the capillary is emptied and the remaining currents result from the deposited carbon on the target which is the contribution of the long term target memory. The ionization efficiency however is higher than during gas measurement before shutting the capillary. When opening the capillary again and introducing blank gas the 14C counts drop indicated by the blue lines in Figure 8. Since the blank gas is depleted of 14C the counts are only coming from the deposited carbon of the long term target memory. The 14C level is only half compared to the shut capillary which is caused by the poorer vacuum and the competitive ionization of oxygen (Fahrni et al. 2013). Thus, for the analysis of the drop in the 12C current in the article the ion currents measured while the capillary is shut are halved.

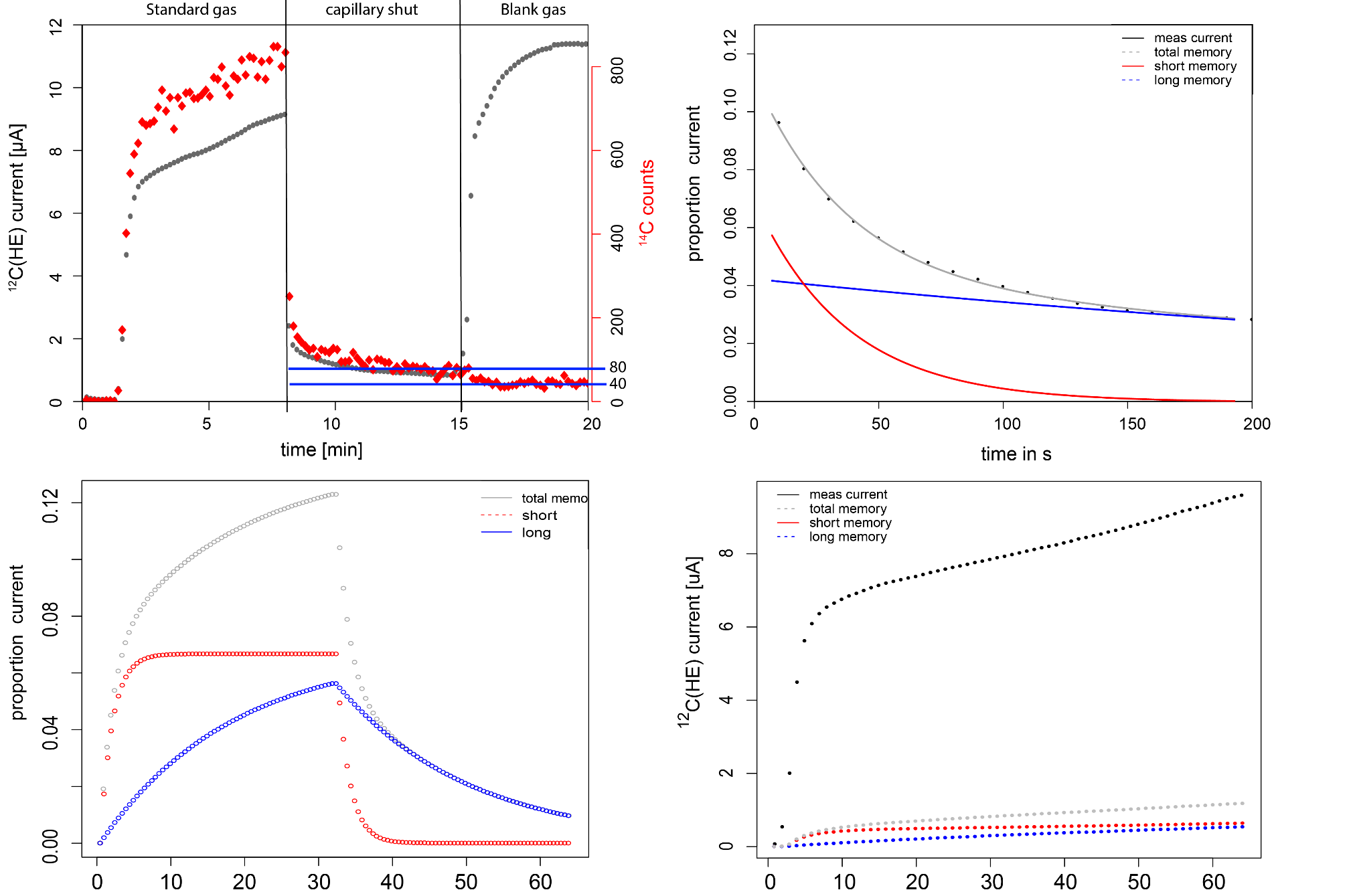
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Figure S1 Measurement on a single target for analysis of ionization and negative ion extraction efficiencies while gas is introduced into the gas ion source (Standard gas and Blank gas) and while the capillary is shut. Blue lines indicate the drop in 14C level when the capillary is opened again which is equivalent in change of ionization and negative ion extraction efficiency.