**Introduction:** The 1995 review [1] of $^{26}$Al in the early solar system presented a summary histogram in which most Ca-Al-rich inclusions (CAIs) plot within a wide peak centered on initial $^{26}$Al/$^{27}$Al ~ $4.5 \times 10^{-5}$. The data used to construct the histogram were mostly acquired by ion microprobe (SIMS) analyses using Cameca ims 3f machines or earlier types. Because of the resulting large uncertainties in initial $^{26}$Al/$^{27}$Al, the apparent width of the histogram peak could, for the most part, be attributed to analytical uncertainty. Specifically, there was no possibility of resolving any real spread in values among different types of CAIs. With the advent of the latest generation of multicollector and large-radius machines, this goal is now possible. We analyzed a new suite of diverse CAIs from the Vigarano CV3 chondrite and obtained high-precision internal isochrons for each of them.

**Analytical procedures:** Polished thin sections of 6 CAIs were fully characterized prior to SIMS analysis, using both a scanning electron microscope and electron microprobe. All isotopic analyses were acquired using the Cameca ims-1280 at the University of Wisconsin-Madison (WiscSIMS), operated under conditions similar to those described in [2]. Magnesium-poor phases (anorthite, gehlenitic melilite) were analyzed using a 4×6 µm beam spot (70pA intensity) and a monocollector electron multiplier pulse-counting system. Spinel, pyroxene, and åkermanitic melilite (2$^{\text{7}}$Al$^{2-}$Mg $<$10) were analyzed using a 20×25 µm beam (7-20nA intensity) with multicollector Faraday Cup (MCFC) detectors to achieve high precision ($\leq 0.1\%$). $^{27}$Al signals were collected on a MCFC detector simultaneously with Mg isotopes in both cases. Both natural and instrumental mass fractionation were corrected using an exponential law with $\beta=0.514$.

**Results:** The CAI included in this study all were extracted from Vigarano 3138, and for brevity, will be identified by their “F” (or “feature”) numbers only. The samples analyzed include two “primitive” (unmelted, possibly condensate) CAIs, F5 (an amoeboid olivine aggregate with melilite-bearing nodules) and F8 (a Fluffy Type A), plus four igneous CAIs labeled F1 (Type B2), F4 (composite Type A-B-C), and F6 and F9 (both Compact Type As). The primitive CAIs both yield well-defined and little-disturbed fossil isochrons (Fig. 1) corresponding to initial $^{26}$Al/$^{27}$Al=(5.13±0.10)$ \times 10^{-5}$ (F5) and (5.25±0.28)$ \times 10^{-5}$ (F8). These values are very close to that given by the “whole CAI” isochron of [3]. Olivine in F5 also yields a very accurate value for initial $\delta^{26}$Mg = −0.02±0.015. The two Compact Type A CAIs yield well-defined undisturbed fossil isochrons (Fig. 2) corresponding to initial $^{26}$Al/$^{27}$Al=(4.24±0.36)$ \times 10^{-5}$ (F6) and (5.17±0.31)$ \times 10^{-5}$ (F9). These CAIs are nearly identical in mineralogy and texture, yet the two isochron slopes are distinctly different. The anorthite in the Type B2 CAI F1 (Fig. 3) is completely disturbed isotopically, and $^{27}$Al/$^{24}$Mg extends to much higher values (~1700) than expected for pristine igneous anorthites in Type B CAIs (e.g. [4]). However, melilite and pyroxene in F1 are only slightly disturbed and, with most spinel, yield a fossil isochron (Fig. 4) corresponding to initial $^{26}$Al/$^{27}$Al = (4.65±0.17)$ \times 10^{-5}$. However, whereas spinel enclosed in melilite and pyroxene is undisturbed, all spinel enclosed in anorthite plots well above the isochron (Fig. 4). Finally, CAI F4 is a composite object, containing a Type A xenolith enclosed in a Type B that in turn is enclosed within a very Si- and Mg-rich mantle that also contains chondrule fragments enclosed in its outermost regions. Al-rich melilite and spinel in the Type A xenolith yield a fossil isochron (Fig. 5) corresponding to initial $^{26}$Al/$^{27}$Al = (4.70±0.09)$ \times 10^{-5}$. Pyroxene and Mg-rich melilite in the outermost mantle yield a fossil isochron (Fig. 5) corresponding to initial $^{26}$Al/$^{27}$Al = (2.23±0.22)$ \times 10^{-5}$, and phases in the intermediate Type B zone are mixed (not shown).

**Discussion.** The observation that three primitive CAIs (including one from [5]) yield initial $^{26}$Al/$^{27}$Al values very close to the whole-CAI value of (5.23±0.13)$ \times 10^{-5}$ determined by ICP-MS [3] suggests that the time period between primordial fractionation of Mg from Al (presumably by condensation) and first CAI formation was very short, < a few × 10$^6$ years. However, the highly processed (partially melted) CAIs are clearly resolved into a wide range of initial $^{26}$Al/$^{27}$Al, from 4.2$ \times 10^{-5}$ to 5.17$ \times 10^{-5}$. Final melting of the composite CAI, F4, in the chondrule-forming region, extends this range down to 1.7$ \times 10^{-5}$. Episodic melting of CAIs thus continued nearly 3$ \times 10^8$ years after initial CAI formation, and remelting of F4 in the chondrule-forming region took place ~0.9 My after initial CAI formation. The finding of isotopically-disturbed spinels enclosed within anorthite in F1 was unexpected, yet it confirms previous experimental diffusion coefficient measurements of that phase by [6], who stated that “The Al-Mg system in spinel would be most disturbed among the CAI minerals”. However, it requires a ready
Mg donor. Spinel enclosed in anorthite will exchange its magnesium, but spinel enclosed in melilit or pyroxene mostly will not. High-precision ICP-MS and SIMS isotope data on CAIs seem to be converging on a refined value for initial $^{26}\text{Al}/^{27}\text{Al}$: $(5.2 \pm 0.2) \times 10^{-5}$ (Fig. 6).