Let $\sigma_2(n) = \sum_{k \backslash n} k^2$. Then, $\sigma_2(n)$ can be expressed as the Dirichlet convolution of 1 and n^2. To find the $1n = 10^{15}$-th prefix sum of σ_2, consider

$$\sum_{i=1}^{n} \sum_{k \backslash i} k^2 = \sum_{ij \leq n} j^2$$

.

Since one of i, j must be at most $\lfloor \sqrt{n} \rfloor$, we can express this as

$$\sum_{ij \leq n} j^2 = \sum_{i=1}^{\lfloor \sqrt{n} \rfloor} \left(1 \cdot \sum_{j=1}^{\lfloor n/i \rfloor} j^2 \right) + \sum_{j=1}^{\lfloor \sqrt{n} \rfloor} \left(j^2 \cdot \sum_{i=1}^{\lfloor n/i \rfloor} 1 \right) - \sum_{i=1}^{\lfloor \sqrt{n} \rfloor} 1 \sum_{j=1}^{\lfloor \sqrt{n} \rfloor} j^2.$$

Let $\rho_2(n) = \sum_{i=1}^{n} \sigma_2(n)$. Then, the above expression becomes

$$\sum_{i=1}^{\lfloor \sqrt{n} \rfloor} \rho_2(\lfloor n/i \rfloor) + \sum_{j=1}^{\lfloor \sqrt{n} \rfloor} j^2 \cdot \lfloor n/i \rfloor - \lfloor \sqrt{n} \rfloor \cdot \rho_2(\lfloor \sqrt{n} \rfloor)$$

.

This sum can be evaluated in $\mathcal{O}(\sqrt{n})$.