We show a formula for the distribution of discriminants of monic polynomials over a finite field. For an odd prime power $q$, integer $m \geq 2$, and $d \in \mathbb{F}_q$, let $|V^m_d(\mathbb{F}_q)|$ be the number of monic polynomials in $\mathbb{F}_q[x]$ of degree $m$ with discriminant $d$. We express $|V^m_d(\mathbb{F}_q)|$ as a discrete Fourier transform of Gauss sums, computable in polynomial time.

For $d \neq 0$, we show

$$|V^m_d(\mathbb{F}_q)| = \chi(d) \sum_{c=1}^{q-1} \frac{G_{\mathbb{F}_q}(c)^m q^{B_{m-1}(c)-B_m(c)} \tau_q(-1) \tau_q(d)c^{ \frac{cm(m-1)}{2}}}{G_{\mathbb{F}_q}(cm)}$$

where $\tau_q$ is a multiplicative character of order $q-1$, $\psi$ a nontrivial additive character, $G_{\mathbb{F}_q}(c)$ is the Gauss sum $G_{\mathbb{F}_q}(\tau_q^c, \psi)$, $\chi$ is the quadratic character, and

$$B_k(c) = \begin{cases} \frac{k \gcd(c, q-1)}{q-1}, & \text{if } (q-1)|ck \\ 0, & \text{otherwise} \end{cases}$$

For the discriminant, we compute the local $L$-functions, explicitly verify the Weil Conjectures, express the global $L$-function in terms of Hecke-characters, and deduce classical and new discriminant distribution results. (Received September 23, 2018)