



Red Hat build of Cryostat 2

Using Cryostat to manage a JFR recording

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Abstract

Learn how you can use Red Hat build of Cryostat to manage JDK Flight Recordings (JFRs) that monitor the performance of Java Virtual Machines (JVMs) that are located in containerized applications. You can use Cryostat 2.4 to start, stop, retrieve, archive, import, and export JFR data for JVMs.

Table of Contents

| | |
|------------------------------------------------------------------------|-----------|
| PREFACE | 3 |
| MAKING OPEN SOURCE MORE INCLUSIVE | 4 |
| CHAPTER 1. SECURITY OPTIONS | 5 |
| 1.1. UPLOADING AN SSL CERTIFICATE | 5 |
| 1.2. STORING AND MANAGING CREDENTIALS | 7 |
| CHAPTER 2. ARCHIVE JFR RECORDINGS | 10 |
| 2.1. ARCHIVING JDK FLIGHT RECORDER (JFR) RECORDINGS | 10 |
| 2.2. DOWNLOADING AN ACTIVE RECORDING OR AN ARCHIVED RECORDING | 12 |
| 2.3. UPLOADING A JFR RECORDING TO THE CRYOSTAT ARCHIVES LOCATION | 13 |
| CHAPTER 3. EVENT TEMPLATES | 16 |
| 3.1. USING CUSTOM EVENT TEMPLATES | 16 |
| CHAPTER 4. INTEGRATED APPLICATIONS | 20 |
| 4.1. VIEWING A JFR RECORDING ON GRAFANA | 20 |

PREFACE

The Red Hat build of Cryostat is a container-native implementation of JDK Flight Recorder (JFR) that you can use to securely monitor the Java Virtual Machine (JVM) performance in workloads that run on an OpenShift Container Platform cluster. You can use Cryostat 2.4 to start, stop, retrieve, archive, import, and export JFR data for JVMs inside your containerized applications by using a web console or an HTTP API.

Depending on your use case, you can store and analyze your recordings directly on your Red Hat OpenShift cluster by using the built-in tools that Cryostat provides or you can export recordings to an external monitoring application to perform a more in-depth analysis of your recorded data.



IMPORTANT

Red Hat build of Cryostat is a Technology Preview feature only. Technology Preview features are not supported with Red Hat production service level agreements (SLAs) and might not be functionally complete. Red Hat does not recommend using them in production. These features provide early access to upcoming product features, enabling customers to test functionality and provide feedback during the development process.

For more information about the support scope of Red Hat Technology Preview features, see [Technology Preview Features Support Scope](#).

MAKING OPEN SOURCE MORE INCLUSIVE

Red Hat is committed to replacing problematic language in our code, documentation, and web properties. We are beginning with these four terms: master, slave, blacklist, and whitelist. Because of the enormity of this endeavor, these changes will be implemented gradually over several upcoming releases. For more details, see [our CTO Chris Wright's message](#).

CHAPTER 1. SECURITY OPTIONS

You can configure security settings for Cryostat, so that you can better protect your Cryostat instance.

An application can send an API request that includes the JMX Authentication header to Cryostat. Cryostat must then pass an authentication challenge, so that Cryostat can connect to the application. The Red Hat build of Cryostat Operator stores credentials in memory for the duration of establishing a connection between Cryostat and the target JVM application.

Cryostat can encrypt and store credentials for a target JVM application in a database that is stored on a persistent volume claim (PVC) on Red Hat OpenShift. Cryostat supports SSL/TLS on the HTTP request that adds credentials to the database and on the JMX connection that uses those credentials to connect to the target application. Cryostat also encrypts the credentials within the database by using a passphrase that is either provided by the user or that is generated by the Red Hat build of Cryostat Operator.

1.1. UPLOADING AN SSL CERTIFICATE

If you receive an SSL error message from the **Recordings** or **Events** tab in your Cryostat web console, you must upload an SSL certificate for your target JVM. Otherwise, you cannot access Cryostat tools, such as tools for creating a JFR recording.

Prerequisites

- Entered your authentication details for your Cryostat instance.
- Created a target JVM from the **Dashboard** panel.
- Downloaded the SSL certificate for your target JVM.

Procedure

1. Navigate to the **Recordings** menu or the **Events** menu on your Cryostat instance.

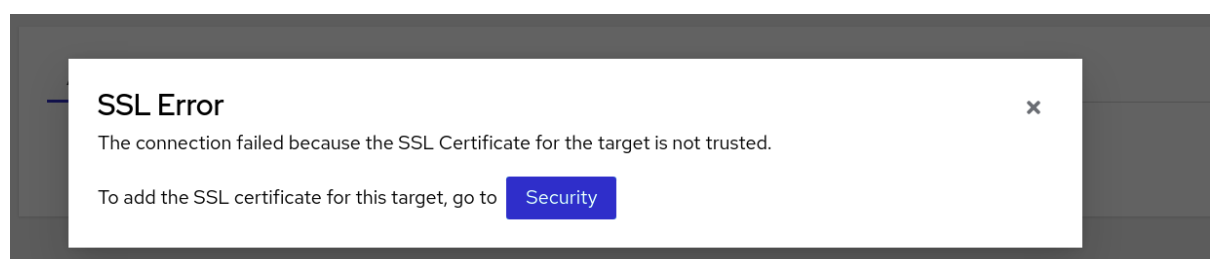


NOTE

The remaining steps use the **Recordings** menu as an example, but you can follow similar steps on the **Events** menu.

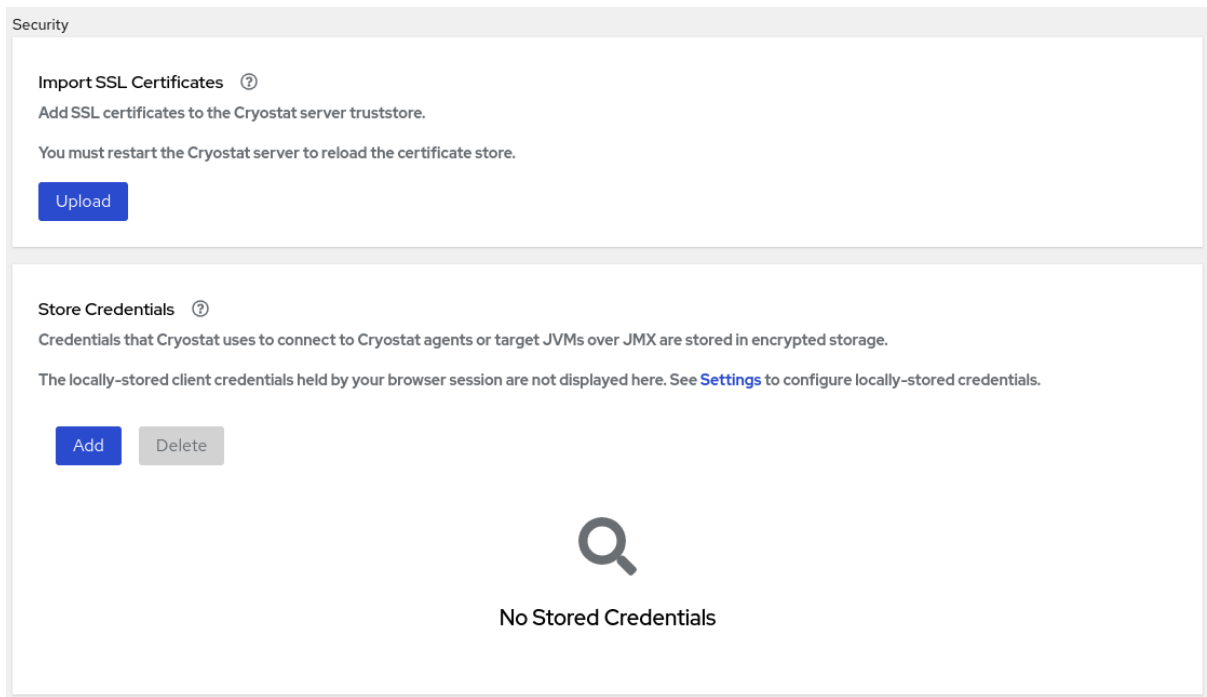
2. From the **Recordings** panel, select your target JVM from the drop-down list. You will receive a prompt if your target JVM does not contain a trusted SSL certificate, as demonstrated in the following example:

Figure 1.1. SSL error message



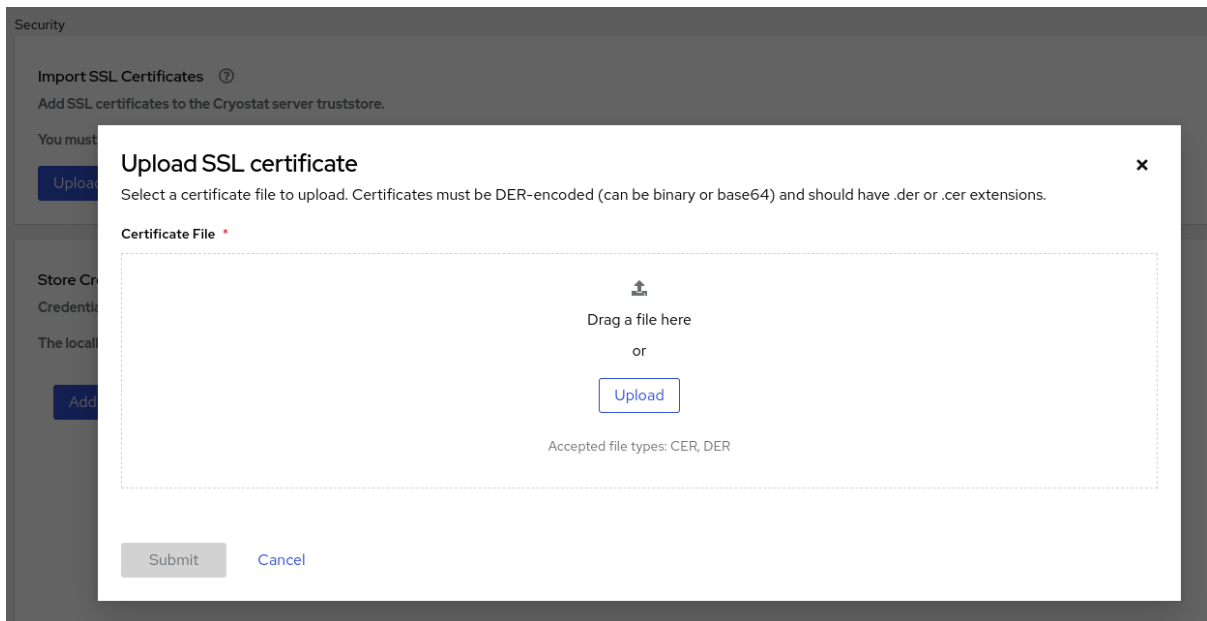
3. Click the **Security** button. A window opens on the Cryostat web console that shows the **Security** dialog box.

Figure 1.2. Security dialog box

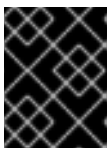


4. Click the **Upload** button. An **Upload SSL certificate** window opens on your Cryostat web console.

Figure 1.3. Upload SSL certificate window



5. Click the **Browse** button and locate the SSL certificate on your local system.



IMPORTANT

Your SSL certificate must be DER-encoded in either **binary** or **base64** format. Cryostat supports **.der** and **.cer** file extensions.

6. Restart your Cryostat instance.
7. Navigate to the **Recordings** menu on your Cryostat instance.

- If you get prompted with an **Authentication Required** message on your web console, enter your credentials. Some target JVMs require you to authenticate before you can access the data for auditing purposes.

Additional resources

- See [Persistent storage using local volumes \(Red Hat OpenShift\)](#)

1.2. STORING AND MANAGING CREDENTIALS

If you enable Java Management Extensions (JMX) authentication or HTTP authentication for your target JVM application, Cryostat prompts you to enter your credentials before Cryostat can access any of the application's JFR recordings.

When you click the **Recordings** or **Events** menu item on the Cryostat web console, an **Authentication Required** window opens on the console. You must enter the username and password of the target JVM application. You can then view the recordings or perform any additional recording operations on the application.

Figure 1.4. Example of a Cryostat Authentication Required window

Cryostat stores credentials that it uses to connect to Cryostat agents or target JVMs.



IMPORTANT

If you need to restart your target JVM application, ensure that you complete one of the following tasks to avoid losing JFR recording data for the application:

- Click the **Recordings** menu item on the Cryostat web console and archive your JFR recording.
- Create an automated rule that schedules Cryostat to copy a snapshot recording to the storage location for the Cryostat archives.

When you want to monitor multiple target JVMs by creating an automated rule, you can configure Cryostat to store and then reuse your credentials for each target JVM connection. By using this configuration, you do not need to re-enter your credentials whenever you want to revisit the JFR recording for your application on the Cryostat web console.

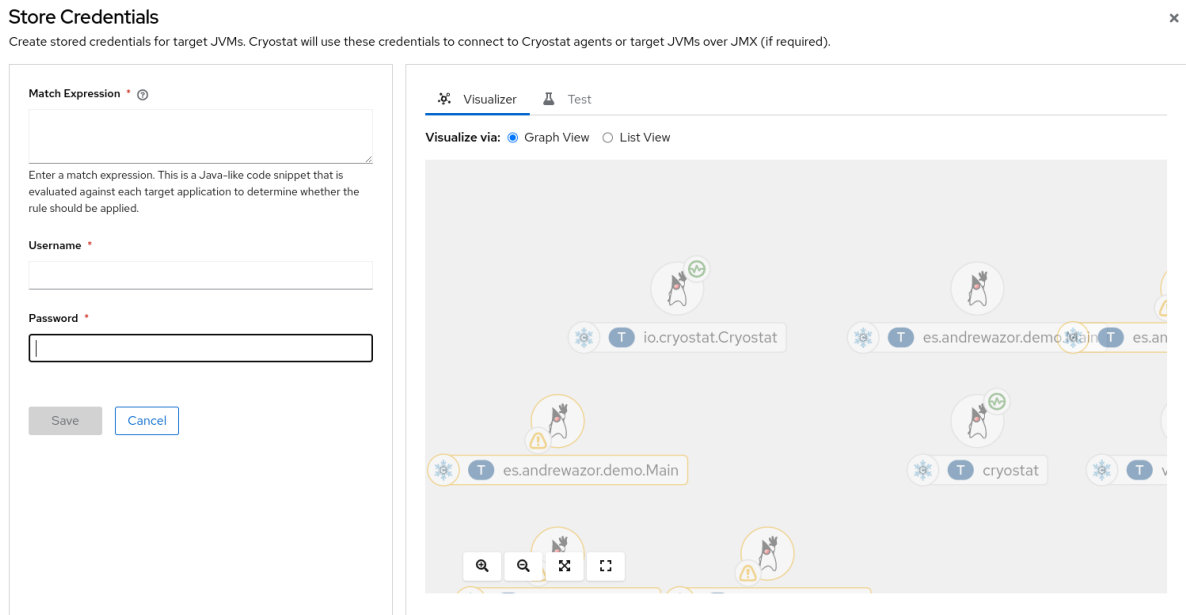
Prerequisites

- Enabled JMX or HTTP authentication for your target JVM application.

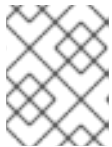
Procedure

1. Click the **Security** menu item.
2. From the **Store Credentials** window, click the **Add** button. The **Store Credentials** window opens.

Figure 1.5. Example of a Store Credentials window



3. In the **Match Expression** field, specify the match expression details.

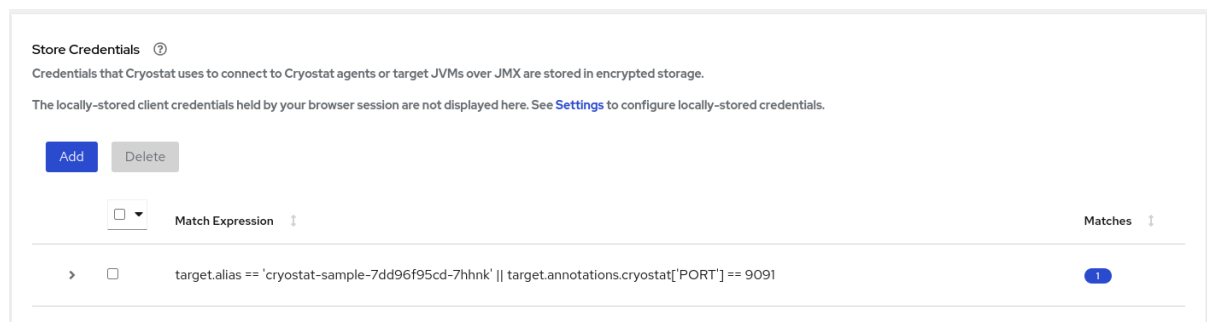


NOTE

Select the question mark icon to view suggested syntax in a **Match Expression Hint** snippet.

4. Click **Save**. A table entry is displayed in the **Store Credentials** window that shows the **Match Expression** for your target JVM.

Figure 1.6. Example of a table entry on the Store Credentials pane



IMPORTANT

For security purposes, a table entry does not display your username or password.

5. *Optional:* If you want to delete your stored credentials for a target JVM, you can select the checkbox next to the table entry for this target JVM and then click **Delete**.

CHAPTER 2. ARCHIVE JFR RECORDINGS

You can archive active JFR recordings to avoid potential data loss from JFR recordings. You can download or upload the archived JFR recording, so that you can analyze the recording to suits your needs.

You can find archived JFR recordings from the **Archives** menu in chronological order under one of three headings: **All Targets**, **All Archives**, and **Uploads**. Depending on what actions you performed on a JFR recording, the recording might display under each table.

2.1. ARCHIVING JDK FLIGHT RECORDER (JFR) RECORDINGS

You can archive active JFR recordings to avoid potential data loss from JFR recordings. Data loss might occur when Crystat replaces legacy JFR recording data with new data to save storage space or when a target JVM abruptly stops or restarts.

When you create an archived recording, Crystat copies the active JFR recording's data and stores the data in a persistent storage location on your Crystat instance. The Red Hat build of Crystat Operator builds this persistent storage location onto the associated persistent volume claim (PVC) on the Red Hat OpenShift cluster.

You can archive any JFR recording, regardless of its configuration. Additionally, you can archive snapshots from a JFR recording.

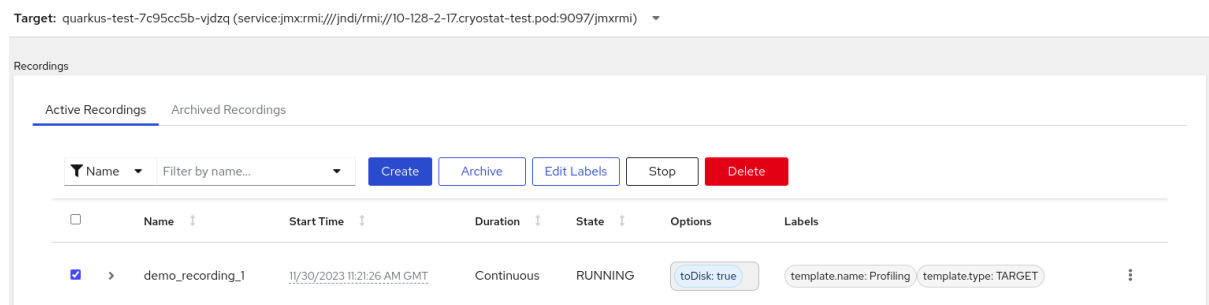
Prerequisites

- Entered your authentication details for your Crystat instance.
- Created a target JVM recording and entered your authenticated details to access the **Recordings** menu. See [Creating a JDK Flight Recorder \(JFR\) recording](#) (Creating a JFR recording with Crystat).

Procedure

1. On the **Active Recordings** tab, select the checkbox for your JFR recording. The **Archive** button is activated in the **Active Recordings** toolbar.

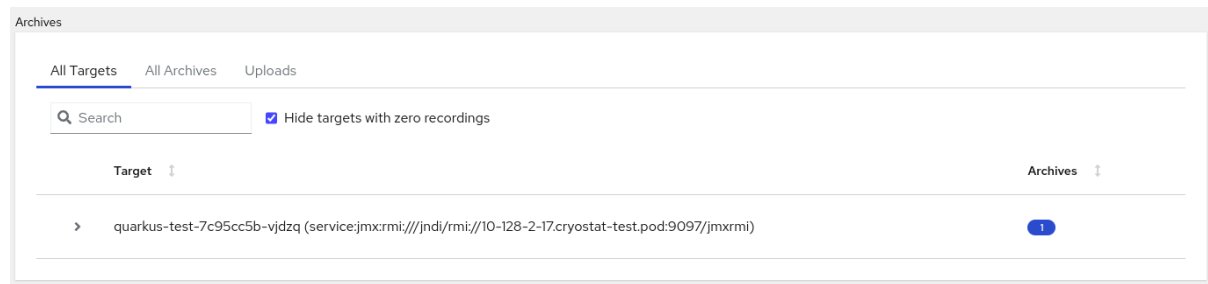
Figure 2.1. Archive button for your JFR recording



2. Click the **Archive** button. Crystat creates an archived recording of your JFR recording. You can view your archived recording from under the **Archived Recordings** tab along with any other recording that relates to your selected target JVM.

Alternatively, you can view your archived recording from under the **All Targets** table.

Figure 2.2. Example of a listed target JVM application that is under the All Targets table



TIP

To remove a target JVM entry that does not have an archived recording, select the **Hide targets with zero recordings** checkbox.

After you click on the twistie (v) beside the JVM target entry, you can access a filter function, where you can edit labels to enhance your filter or click the **Delete** button to remove the filter.

- From the **All Targets** table, select the checkbox beside each target JVM application that you want to review. The table lists each archived recording and its source location.
- Go to the **All Archives** table. This table looks similar to the **All Targets** table, but the **All Archives** table lists target JVM applications from files that Cryostat archived inside Cryostat.

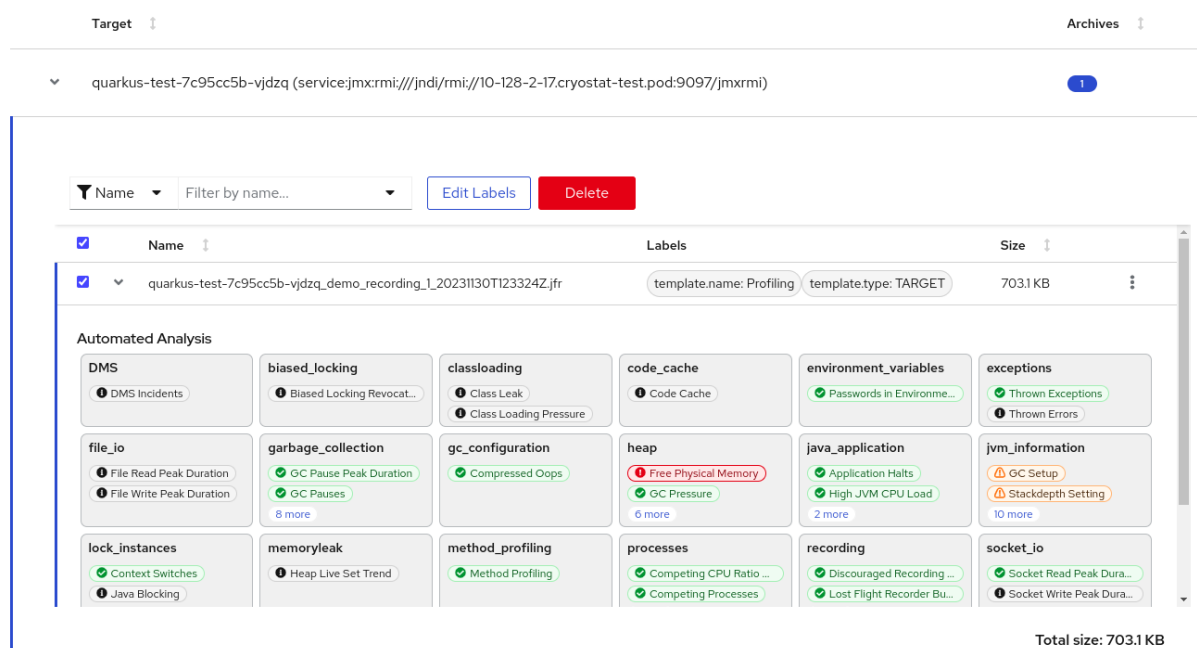


NOTE

If an archived file has no recognizable JVM applications, it is still listed on the **All Archives** table but opens within a nested table under the heading **lost**.

- Optional:* To delete an archived recording, select the checkbox next to the specific archived JFR recording item, and click **Delete** when prompted.

Figure 2.3. Deleting an archived JFR recording





NOTE

Cryostat assigns names to archived recordings based on the address of the target JVM's application, the name of the active recording, and the timestamp of the created archived recordings.

Additional resources

- See [Persistent storage using local volumes \(Red Hat OpenShift\)](#)

2.2. DOWNLOADING AN ACTIVE RECORDING OR AN ARCHIVED RECORDING

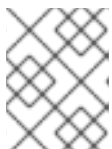
You can use Cryostat to download an active recording or an archived recording to your local system.

Prerequisites

- Entered your authentication details for your Cryostat instance.
- Created a JFR recording. See [Creating a JDK Flight Recorder \(JFR\) recording](#) (Creating a JFR recording with Cryostat).
- *Optional:* Uploaded an SSL certificate or provided your credentials to the target JVM.
- *Optional:* Archived your JFR recording. See [Archiving JDK Flight Recorder \(JFR\) recordings](#) (Using Cryostat to manage a JFR recording).

Procedure

1. Navigate to the **Recordings** menu or the **Archives** menu on your Cryostat instance.

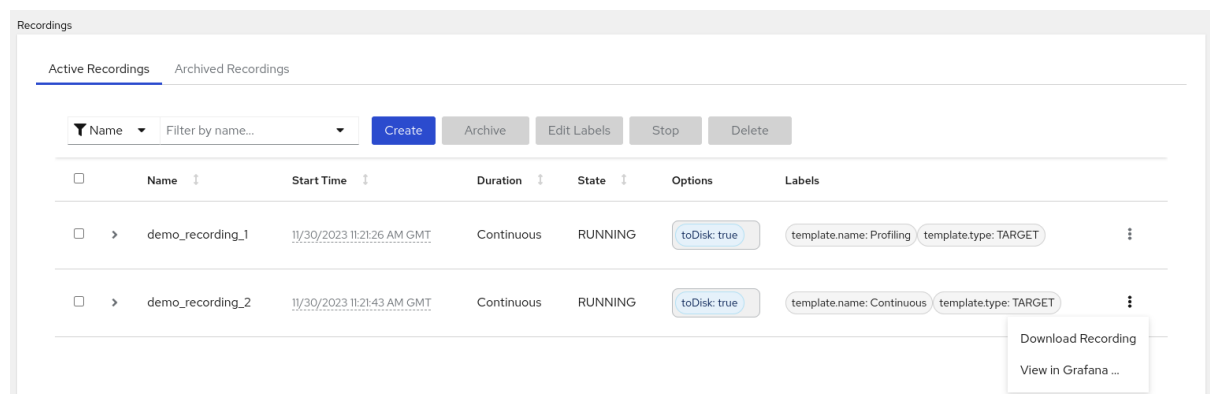


NOTE

The remaining steps use the **Recordings** menu as an example, but you can follow similar steps on the **Archives** menu.

2. Determine the recording you want by clicking either the **Active Recordings** tab or the **Archived Recordings** tab.
3. Locate your listed JFR recording and then select its overflow menu.

Figure 2.4. Viewing a JFR recording's overflow menu



4. Choose one of the following options:
 - a. From the overflow menu, click **Download Recording**. Depending on how you configured your operating system, a file-save dialog opens. Save the JFR binary file and the JSON file to your preferred location.
 - b. From the **All Targets** table, select the overflow menu for your listed JFR recordings. Click **Download** to save the archived file along with its JSON file, which contains metadata and label information, to your local system.
5. *Optional:* View the downloaded file with the Java Mission Control (JMC) desktop application.



NOTE

If you do not want to download the **.jfr** file, but instead want to view the data from your recording on the Cryostat application, you can click the **View in Grafana** option.

2.3. UPLOADING A JFR RECORDING TO THE CRYOSTAT ARCHIVES LOCATION

You can upload a JFR recording from your local system to the archives location of your Cryostat.

To save Cryostat storage space, you might have scaled down or removed your JFR recording. If you downloaded a JFR recording, you can upload it to your Cryostat instance when you scale up or redeploy the instance.

Additionally, you can upload a file from a previous Cryostat instance to a new Cryostat instance. Cryostat analysis tools work on the recording uploaded to the new Cryostat instance.

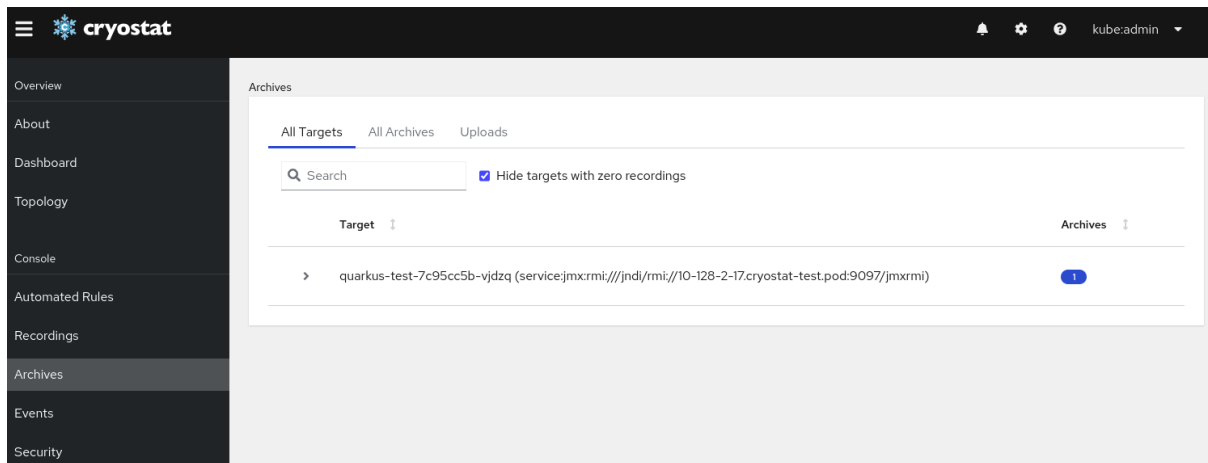
Prerequisites

- Entered your authentication details for your Cryostat instance.
- Created a JFR recording. See [Creating a JDK Flight Recorder \(JFR\) recording](#) (Creating a JFR recording with Cryostat).
- See [Downloading an active recording or an archived recordings](#) (Using Cryostat to manage a JFR recording).

Procedure

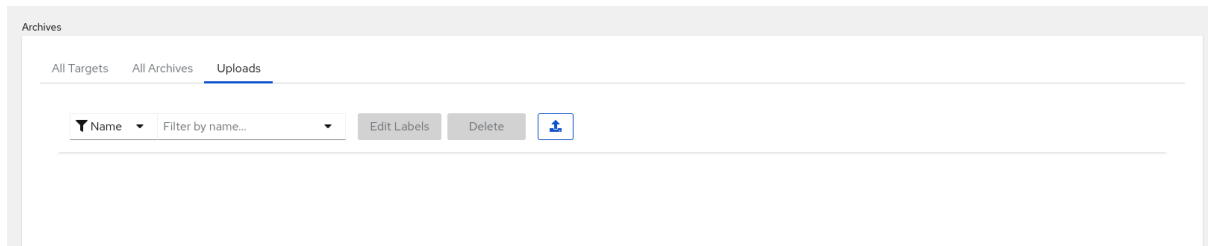
1. Go to the **Archives** menu on your Cryostat instance.

Figure 2.5. Archives menu on the Crystat web console



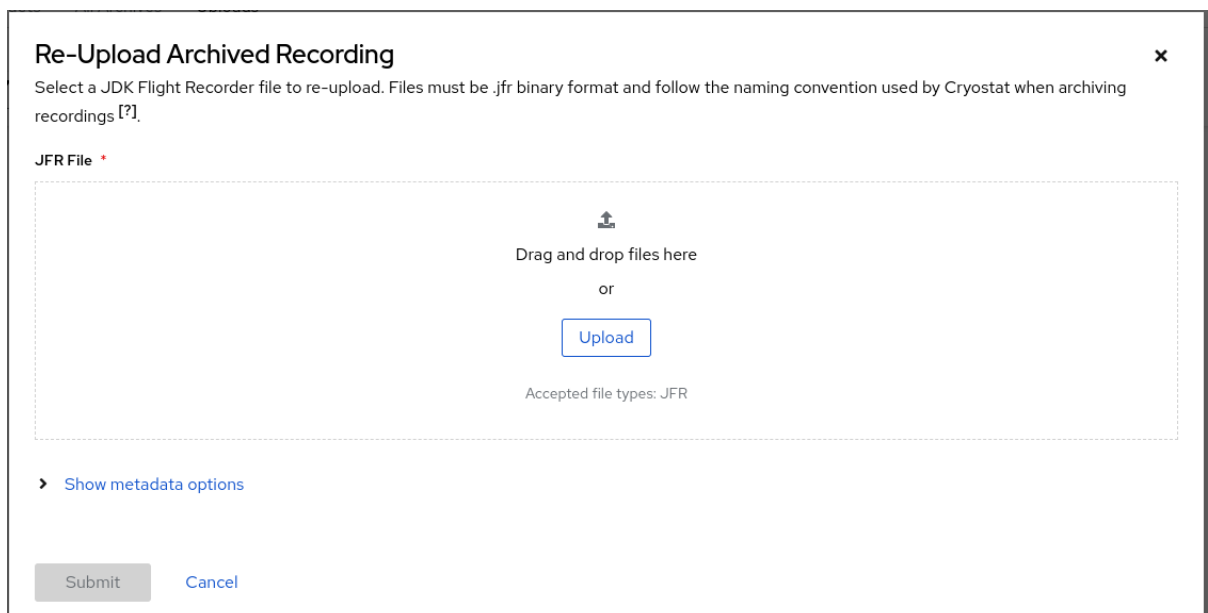
2. *Optional:* From the **Uploads** table, you can view all of your uploaded JFR recordings. The **Uploads** table also includes a filtering mechanism similar to other tables, such as the **All Targets** table, and other output. You can also use the filtering mechanism on the **Archives** menu to find an archived file that might have no recognizable target JVM application.

Figure 2.6. The Uploads table in the Archives menu



3. Click the upload icon. A **Re-Upload Archived Recording** window opens in your Crystat web console:

Figure 2.7. Re-Upload Archived Recording window



4. In the **JFR File** field, click **Upload**.
5. Locate the JFR recording files, which are files with a **.jfr** extension, and then click **Submit**.

**NOTE**

Alternatively, you can drag and drop **.jfr** files into the **JFR File** field.

Your JFR recording files open in the **Uploads** table.

Figure 2.8. Example of a JFR recording that is in the Uploads table

The screenshot shows a web interface for managing archives. At the top, there are tabs for 'All Targets', 'All Archives', and 'Uploads'. Below the tabs, there is a search bar with a dropdown menu for 'Name' and a text input for 'Filter by name...'. To the right of the search bar are buttons for 'Edit Labels', 'Delete', and a blue download icon. Below these elements is a table with the following structure:

| <input type="checkbox"/> | Name ↑ | Labels | Size ↑ | |
|--------------------------|---------------------------------------------------|--------|-----------|---|
| <input type="checkbox"/> | > quarkus-test-agent_default_20230606T085613Z.jfr | - | 368.77 KB | ⋮ |

CHAPTER 3. EVENT TEMPLATES

Cryostat includes default event templates that you can use to quickly create a JFR recording for monitoring your target JVM's performance.

3.1. USING CUSTOM EVENT TEMPLATES

You can choose either one of the following default event templates when creating a JDK Flight Recorder (JFR) recording:

- Continuous template, which collects basic target Java Virtual Machine (JVM) data for either a fixed duration or until it is explicitly stopped.
- Profiling template, which collects in-depth target JVM data for either a fixed duration or until it is explicitly stopped.

By using either of these default event templates, you can quickly create a JFR recording for monitoring your target JVM's performance. You can edit either event template at a later stage to suit your needs. For example, the default event templates do not contain application-specific custom events, so you must add these custom events to the custom template.

Cryostat also supports the **ALL** meta-template, which enables a JFR to monitor all event types for a target JVM. Default values exist for each event type. The **ALL** meta-template does not contain an XML definition, so you cannot download an XML file for the **ALL** meta-template.

Prerequisites

- Installed Cryostat 2.4 on Red Hat OpenShift by using the **Installed Operators** option.
- Created a Cryostat instance in your Red Hat OpenShift project.

Procedure

1. On the **Dashboard** panel for your Cryostat instance, select a **Target JVM** from the drop-down list.
2. *Optional:* On the **Topology** panel, you can define a target JVM by selecting the **Add to view** icon. After you select the icon, a window opens for defining a custom target connection URL.
 - a. In the **Connection URL** field, enter the URL for your JVM's Java Management Extension (JMX) endpoint.
 - b. *Optional:* In the **Alias** field, enter an alias for your JMX Service URL.
 - c. Click **Create**.

Figure 3.1. Create Target dialog box

- From the navigation menu on the Cryostat web console, click **Events**. An **Authentication Required** dialog might open on your web console. If prompted, enter your **Username** and **Password** in the **Authentication Required** dialog box, and click **Save** to provide your credentials to the target JVM.



NOTE

If the selected target JMX has SSL certification enabled for JMX connections, you must add its certificate when prompted.

Cryostat can encrypt and store credentials for a target JVM application in a database that is stored on a persistent volume claim (PVC) on Red Hat OpenShift.

- Under the **Event Templates** tab, locate your listed event template and then select its more options menu.
- From the more options menu, click **Download**. Depending on how you configured your operating system, a file-save dialog opens. Save the file to your preferred location.

Figure 3.2. Example of an event template's more options menu

Target: quarkus-test-7c95cc5b-vjdzq (service:jmx:rmi:///jndi/rmi://10-128-2-17.cryostat-test.pod:9097/jmxrmi) ▾

| Name | Description | Provi... | Type |
|------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------|
| ALL | Enable all available events in the target JVM, with default option values. This will be very expensive and is intended primarily for testing Cryostat's own capabilities. | Cryostat | Target |
| Continuous | Low overhead configuration safe for continuous use in production environments, typically less than 1% overhead. | Oracle | Target |
| Profiling | Low overhead configuration for profiling, typically around 2% overhead. | Oracle | Target |

- Open the file with your default file editor and edit the file to meet your needs. You must save your file to retain your configuration changes.

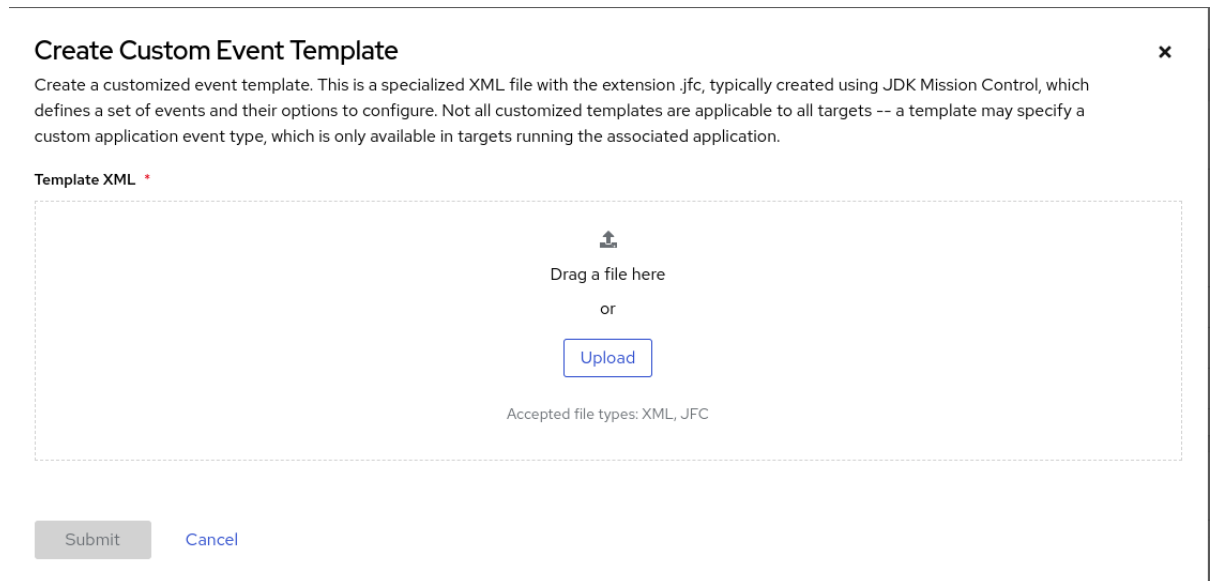


NOTE

You can add values to the **description** and **provider** attributes that can help with identifying your file at a later stage.

- From the **Events** menu, go to the **Event Templates** tab then click the **Upload** icon. A **Create Custom Event Template** window opens in your Crystat web console.

Figure 3.3. Create Custom Event Template window



- Click **Upload** and use your default file editor to upload one or more configured event template files to the Crystat web console. You can also drag and drop the files into the **Template XML** window.
- Click the **Submit** button. The **Event Templates** tab opens on your Crystat web console, where you can now view your custom event template.
- Optional:* After you create your event template, you can choose one of the following options for using your template to create a JFR recording:
 - From the **Automated Rules** menu, click **Create** and then select an event template from the **Template** list.
 - From the **Events** menu, locate your listed event template, then from the more options menu, select **Create Recording**.
 - From the **Recordings** menu, under the **Active Recordings** tab, click **Create**.

Additional resources

- See [Creating a JDK Flight Recorder \(JFR\) recording](#) (Creating a JFR recording with Crystat)
- See [Uploading an SSL certificate](#) (Using Crystat to manage a JFR recording)
- See [Archiving JDK Flight Recorder \(JFR\) recordings](#) (Using Crystat to manage a JFR recording)

- See [Enabling or disabling automated rules](#)(Using automated rules on Cryostat)

CHAPTER 4. INTEGRATED APPLICATIONS

Cryostat integrates with specific applications that can enhance how you analyze data from your JFR recording.

4.1. VIEWING A JFR RECORDING ON GRAFANA

Cryostat 2.4 integrates with the Grafana application, so you can plot JFR recording data in Grafana. You can view plot data in time interval sections to precisely analyze the performance of your target JVM application.

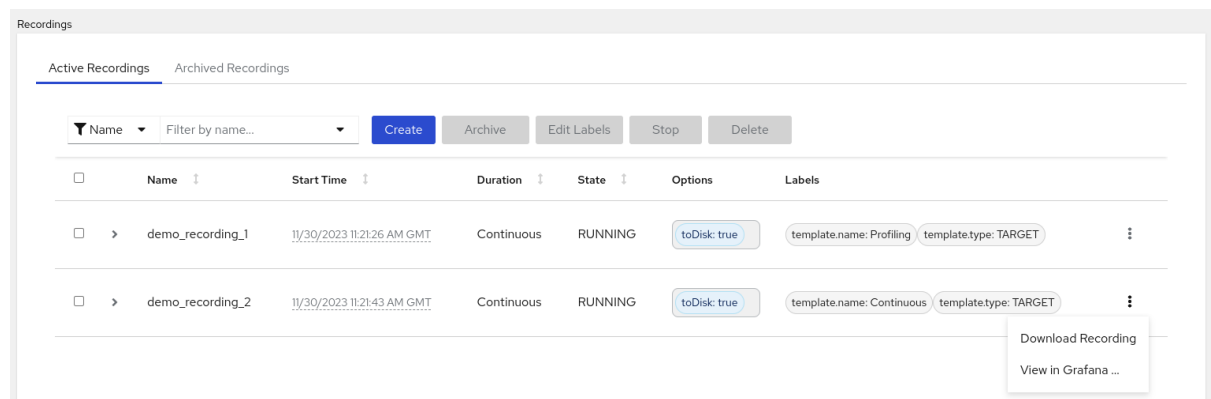
Prerequisites

- Entered your authentication details for your Cryostat instance.
- Created a JFR recording. See [Creating a JDK Flight Recorder \(JFR\) recording](#) (Creating a JFR recording with Cryostat).

Procedure

1. Go to the **Recordings** menu or the **Archives** menu on your Cryostat instance.
2. Depending on your needs, click either the **Active Recordings** tab or the **Archived Recordings** tab.
3. Locate your JFR recording and then select the overflow menu.

Figure 4.1. Overflow menu items available for an example JFR recording



4. From the overflow menu, click the **View in Grafana** option. The Grafana application opens in a new web browser window.
5. Click the sign-in icon on the Grafana dashboard.
6. Determine your credentials by issuing the following commands in your terminal.

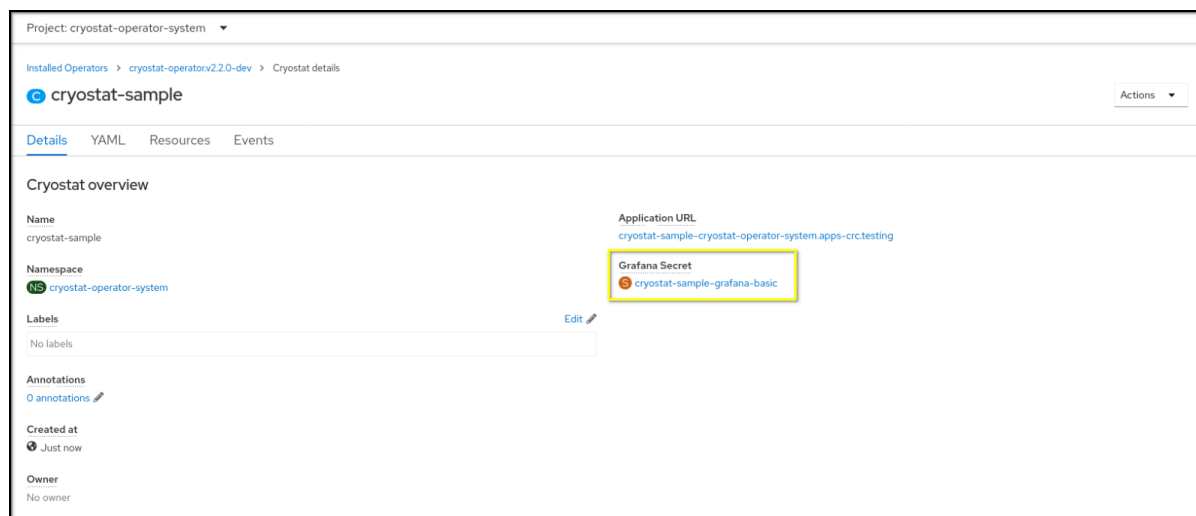
```
<cryostat_name>=$(kubectl get cryostat -o jsonpath='{$.items[0].metadata.name}')
```

```
oc get secret $<cryostat_name>-grafana-basic -o
jsonpath='{$.data.GF_SECURITY_ADMIN_USER}' | base64 -d
```

```
oc get secret $<cryostat_name>-grafana-basic -o
jsonpath='{$.data.GF_SECURITY_ADMIN_PASSWORD}' | base64 -d
```


You can also locate your credentials from the **Grafana Secret** custom resource (CR) on the **Cryostat details** page on Red Hat OpenShift.

Figure 4.2. The Grafana Secret CR on the Cryostat details page on OpenShift



7. Enter your credentials in the Grafana web console login page. A dashboard window opens and shows your JFR recording's data in various time-series plots.
8. *Optional:* Interact with any plot by selecting a time-series segment on the plot. Grafana expands the on-screen data to show only the data for that time interval.

Figure 4.3. Example of a Grafana dashboard with plotted graphs



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