

USING AN EXPERT SYSTEM FOR ACCELERATORS TUNING AND AUTOMATION OF OPERATION FAILURE CHECKS

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- **Motivations**
- *SOLEIL Expert System Building Blocks*
 - *Passerelle*
 - *Drools*
 - *CDMA*
- *Use Case*

⇒ In daily operation an operator has to perform many manual checks

- Are the control system services working fine (*i.e is the archiving system really logging data ?*)
- Is the alarm detected by a supervision application linked to a control system sub module or is it an equipment problem ?
- Is beam correctly delivered to beamlines ?

- Same kind of problems **analysis** to do again and again
- Many **different applications** to interact with
- Diagnose quality is operator **knowledge** dependent
- Very **error-prone**

Why not automate all these tasks?

⇒ In case of abnormal operation (beam loss)

- Collect data for analysis (extract archived data, post-mortem data,...)
- Check the elog book or an accelerator expert to see what is the relevant recovery process to apply
- Perform in sequence the advised operation/rules for the given situation

- No uniform way to **collect data** from different sources
- Lack of centralization accelerator operation **expertise**
- Non automated repetitive **sequences** of operations
- Very **error-prone**

Why not use an expert system ?

- *Motivations*
- ***SOLEIL Expert System Building Blocks***
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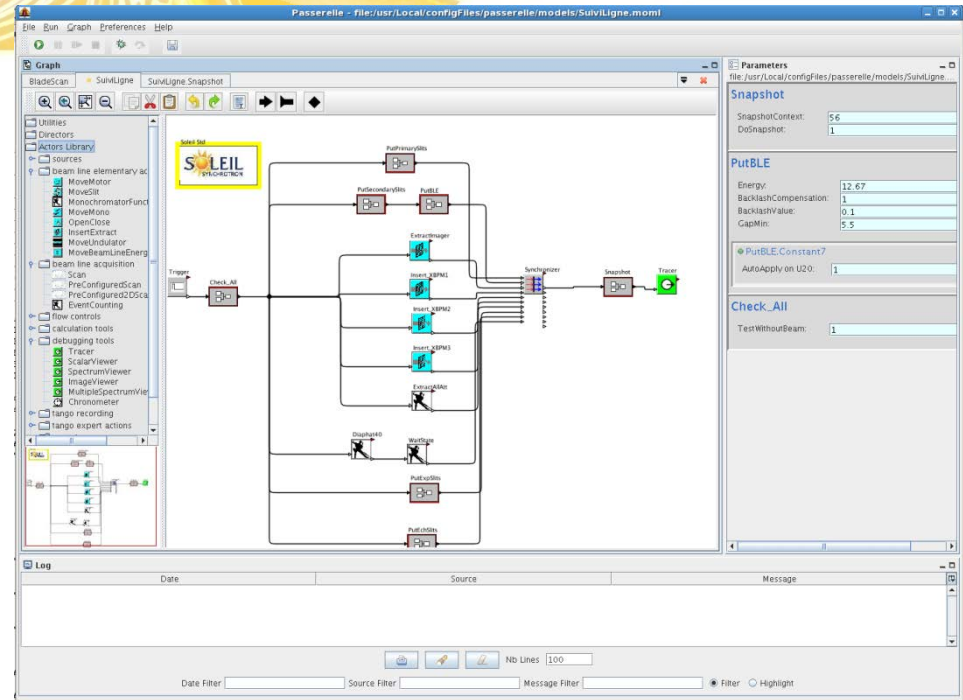
Automation of an analysis/diagnosis process workflow takes care of :

- Collecting and consulting the available data for analysis
- Formulating decisions/diagnosis rules
- Preparing advised actions to repair the problematic situation

- Need for a workflow modeling environment : **Passerelle**
- Need for a uniform data access layer : **CDMA**
- Need for a rules based environment : **Drools**

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PASSERELLE
allows to
graphically
design complex
workflows and
execute them



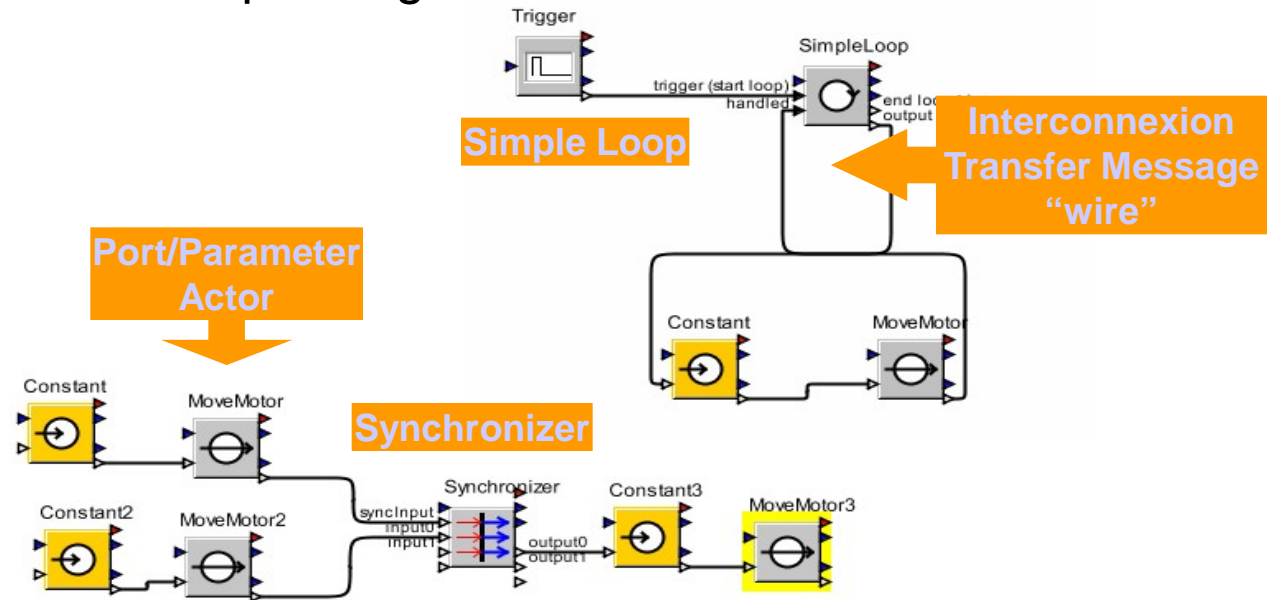
- PASSERELLE is provided by a company called ISENCIA
 - ✓ Specialized in process driving for industrial companies.
- PASSERELLE is based on an environment for scientific modelisation and simulation: **PTOLEMY** (*developed by the Berkeley University*)

<http://ptolemy.eecs.berkeley.edu/ptolemyII/>

PASSERELLE : principles

- Workflows are developed by connecting « boxes » and « wires »:
 - The « boxes » are called **ACTORS** : they execute an action.
 - The « wires » are called **MESSAGES**: they transfer data.
- The graphic language for editing sequences provides all functionalities to build complex logics:

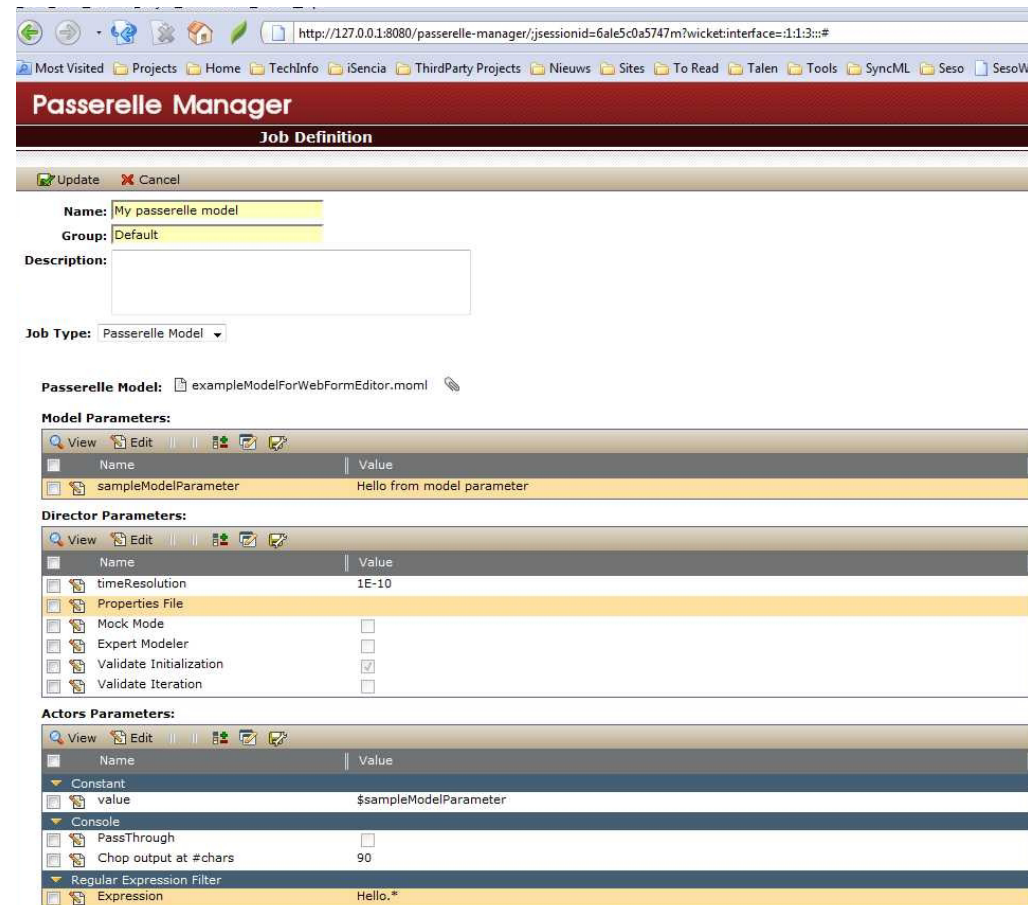
- Loops
- Comparison
- Error Management
- Parameterization



PASSERELLE : Remote Execution Environment through a Web interface

Full-featured remote access via standard web technology

- ✓ Allows workflows design, execution, monitoring etc on a secure and robust server-based platform
- ✓ Automated scheduling of workflows executions
- ✓ Monitoring and diagnostics of workflows execution
- ✓ A relational DB stores :
 - Workflows definitions
 - their configuration
 - the analysis rules
 - the execution traces



Passerelle Manager
Job Definition

Update Cancel

Name: My passerelle model
Group: Default
Description:

Job Type: Passerelle Model

Passerelle Model: exampleModelForWebFormEditor.moml

Model Parameters:

Name	Value
sampleModelParameter	Hello from model parameter

Director Parameters:

Name	Value
timeResolution	1E-10
Properties File	
Mock Mode	<input type="checkbox"/>
Expert Modeler	<input type="checkbox"/>
Validate Initialization	<input checked="" type="checkbox"/>
Validate Iteration	<input type="checkbox"/>

Actors Parameters:

Name	Value
Constant	
value	\$sampleModelParameter
Console	
PassThrough	<input type="checkbox"/>
Chop output at #chars	90
Regular Expression Filter	
Expression	Hello.*

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■ **Jboss Drools is an inference system**

- It can be seen as an advanced “if-then” programming language interpreter



■ **Rules engine**

- ▶ Is based on a declarative (“what to do”) programming model
 - ▶ *instead of the usual imperative (“how to do it”) programming*
- ▶ It evaluates a collection of registered “facts” in a “knowledge base”
- ▶ New facts can be derived by the rules, and added to the knowledge base
- ▶ This can trigger (other) rules again

- ❑ Drools is an easy-to-use Java API which can be integrated in a “normal” Java program in 2 different ways:
 - Using the standard Java Rules API (JSR 94)
 - Or using a proprietary Drools API (more feature-rich)

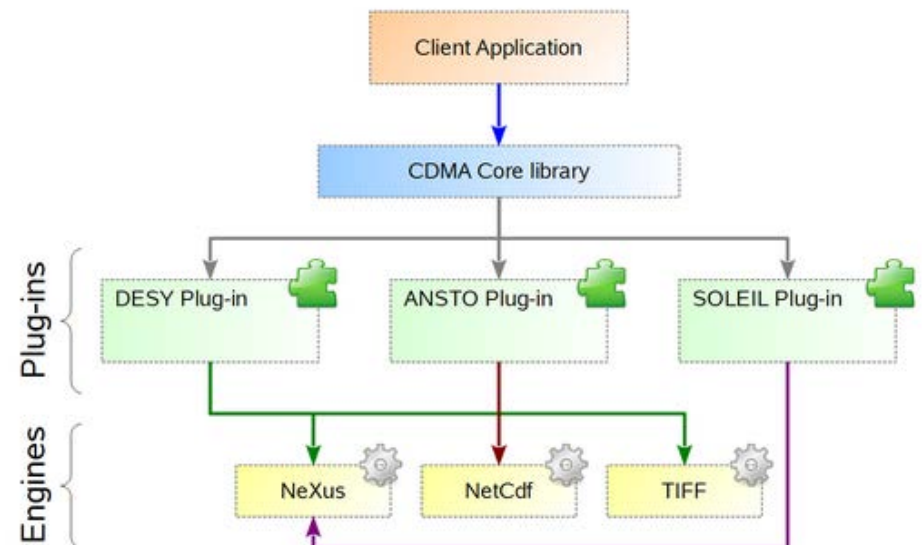
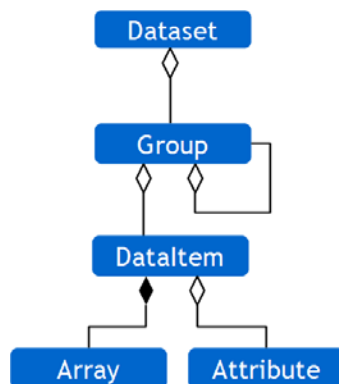
- ❑ Rules can be defined in different ways
 - Using the usual Java programming mixed with “when/then” Drools syntax (which allow complex and powerful rules to be defined))
 - Using Domain specific languages (user-friendly)
 - Using Decision tables (spreadsheet definition)

- **We developed a library of Passerelle actors for**
 - ▶ **Data collection**
 - Adaptation of existing Tango actors (AttributeReader etc)
 - SQL-Database-Reader (CDMA plugin)
 - HDF files reader (CDMA plugin)
 - ▶ **Analysis**
 - Drools Expert actors which bridges the Passerelle and Drools worlds
 - ▶ **Diagnosis**
 - Report generator (based on the eclipse BIRT package)

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CDMA API : An abstraction to access data

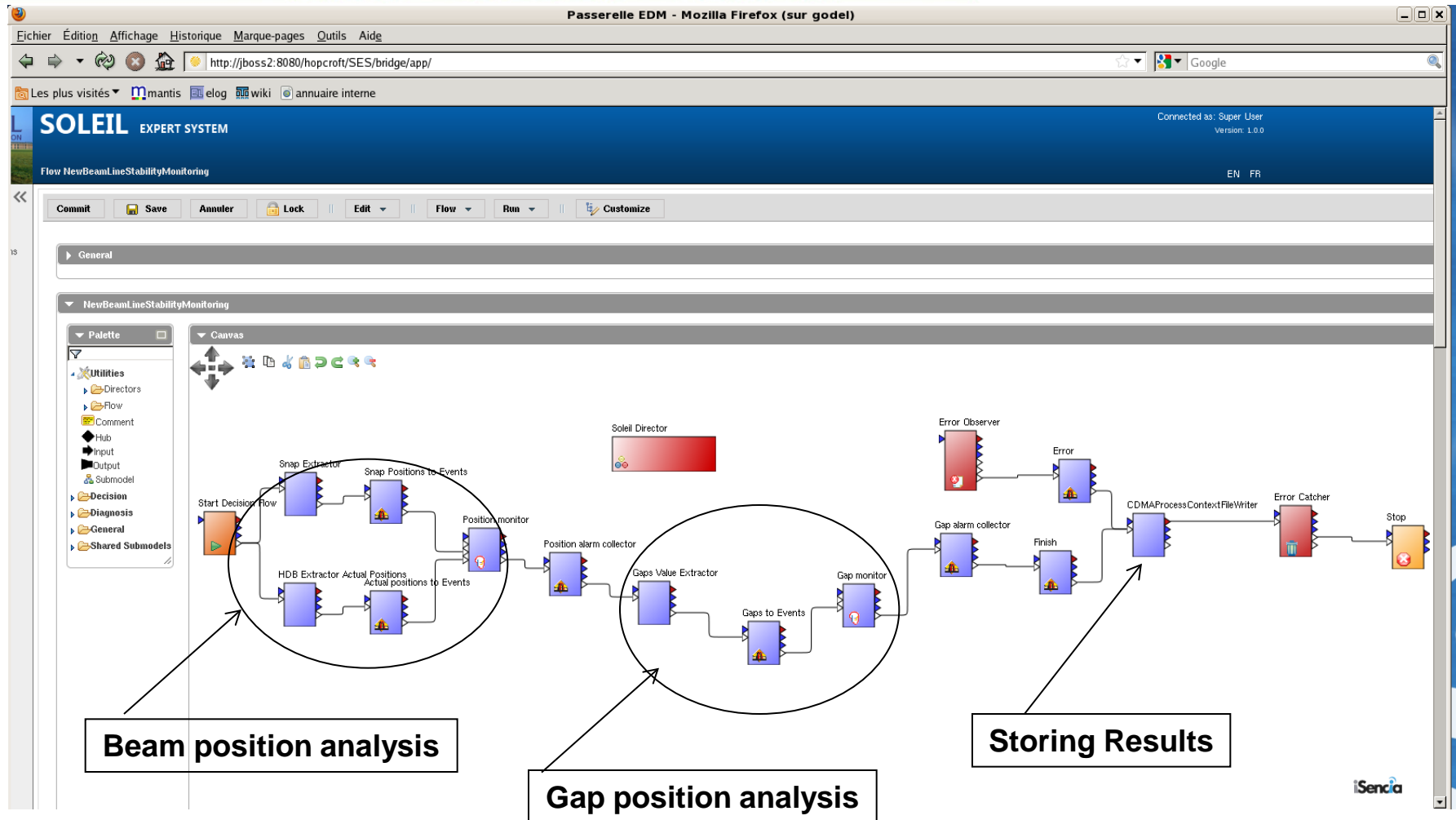
- ❑ CDMA is an API providing a unified data layer
 - ❑ independently of the kind of the data source (database, HDF5 files)
- ❑ CDMA key points are :
 - ❑ An abstract interface to navigate in a uniformed way through data sources using a unique data model
 - ❑ A plugin system to cope concretely with the real kind of data source (database, HDF5 files)
 - ❑ A dictionary mechanism to cope with data organization in the data sources
- ❑ CDMA is an open source collaboration project :
 - ❑ <http://code.google.com/p/cdma/wiki>



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The Simplified prototype we developed for this scenario does :

- Data collection phase
 - Gets from a database the “Reference storage beam orbit”
 - Compare It to last 10 seconds “Archived Beam Positions”
- Data analysis/diagnosis
 - If these 2 orbits differ see if any of the insertion devices gap positions has changed during the last 100 seconds
 - Store all these collected data thanks to CDMA layer
- Diagnosis report
 - Done through the BIRT reporting package



Passerelle EDM - Mozilla Firefox (sur godel)

Eichier Édition Affichage Historique Marque-pages Outils Aide

http://boss2:8080/hopcroft/SES/bridge/app/

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SOLEIL EXPERT SYSTEM Connected as: Super User
Version: 1.0.0

Visionner EN FR

Expert

- Conversations
- Historiques des Conversations

Dépôt

- Images
- Translations
- Project

Séquences

- Conversations
- Séquences
- Alertes
- Sous-modèles partagées
- Batch Flows
- Groupes de Séquences

Définitions des Règles

- Modules de Règles
- Fichiers de Règles

Données de Test

- Analyse
- Rapports
- Jobs
- Simulateur
- Système
- Sécurité
- Aide
- Changer mot de passe
- Déconnectez-vous

Back

Id: 7825
Creation TS: 2013-09-27 15:48:41
Status: FINISHED
Type: Position alarm collector
Initiator: Position alarm collector
Executor:

Name	Value
Case ID	78
Creator	.New Beam Line Stability Monitoring#sep7820.Position alarm collector
Request ID	7820

Result Items **Result Blocks** **Events** **Tasks**

Type: Name: Value: Colour:

List Of Beam Positions Deviating from their reference

Colour	Name	Value	Discriminator
	Resultblock [id=109, type=Position alarms]		
	ANS-C01/DG/CALC-SDL-POSITION-ANGLEangleX	8.5091690973660326	STRING_RESULT
	ANS-C01/DG/CALC-SDL-POSITION-ANGLEangleZ	5.48083273116612	STRING_RESULT
	ANS-C01/DG/CALC-SDL-POSITION-ANGLElpositionX	76.911	STRING_RESULT
	ANS-C01/DG/CALC-SDL-POSITION-ANGLElpositionZ	4.8082668035461325	STRING_RESULT
	ANS-C02/DG/CALC-SDM-POSITION-ANGLEangleX	8.116821658788139	STRING_RESULT
	ANS-C02/DG/CALC-SDM-POSITION-ANGLEangleZ	24.34039012239571	STRING_RESULT
	ANS-C02/DG/CALC-SDM-POSITION-ANGLElpositionX	3.5700000000000009	STRING_RESULT
	ANS-C02/DG/CALC-SDM-POSITION-ANGLElpositionZ	62.92255109105668	STRING_RESULT
	ANS-C03/DG/CALC-SDM-POSITION-ANGLEangleX	9.513143652612099	STRING_RESULT
	ANS-C03/DG/CALC-SDM-POSITION-ANGLEangleZ	28.479842111127027	STRING_RESULT
	ANS-C03/DG/CALC-SDM-POSITION-ANGLElpositionX	55.75166517054227	STRING_RESULT

An example of a possible Reason : Deviation of an Insertion device Gap Positions

Passerelle EDM - Mozilla Firefox (sur godel)

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Back

Id: 7828
Creation TS: 2013-09-27 15:48:46
Status: FINISHED
Type: Gap alarm collector
Initiator: Gap alarm collector
Executor:

Name	Value
Case ID	78
Creator	.NewBeamLineStabilityMonitoring#sep7820.Gap alarm collector
Request ID	7820

Result Items Result Blocks Events Tasks

Type: Name: Value: Colour:

Colour	Name	Value	Discriminator
	Resultblock [id=111, type=Gap alarms]		
	ANS-C07/EVM-HU52.11/gap	2.3369	STRING_RESULT

One Insertion Gap Position has changed

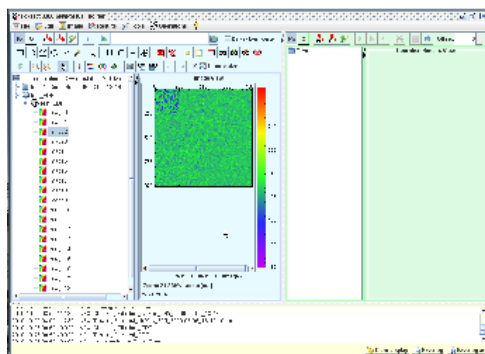
An expert system is a promising environment to cope with the problem of automating diagnosis of abnormal accelerator operation

- Foreseen
 - To perform a complete beam stability diagnosis workflow
 - To develop a beam Post mortem diagnosis workflow which integrate knowledge from all accelerator experts
- The most challenging will be to
 - Convince our operators and physicists to put (part of) their knowledge in an expert system
 - But the very high requirements in term of beam stability and beam availability will be an important driver

Thanks for your attention



CDMA API : Accessing data through keywords thanks to its dictionary mechanism



keywords
Declaration
file

```
<data-def name="Experiment name">
  <!-- ex: EXAFS, SAXS,... -->

  <item key="mono_energy">
  <item key="mono_type">

</data-def>
```



0100110
1001110
0100110
11110...

keywords
Mapping
file

```
<map-def name="Experiment name">
  <!-- ex: EXAFS, SAXS,... -->

  <item key="mono_energy">
    <path>path/to/user/mono/energy</path>
  </item>
  <item key="mono_type">
    <path>path/to/user/mono/type</path>
  </item>
  ...
</map-def>
```