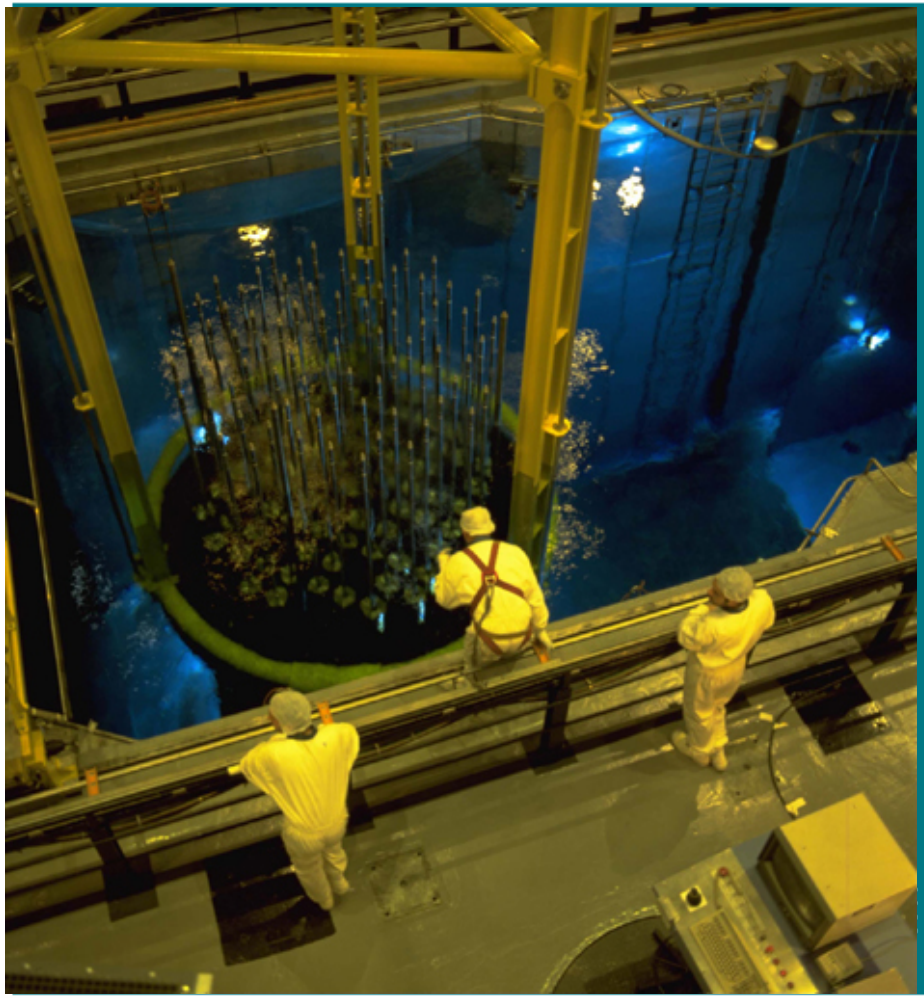

New CZT measurement device

Comparison with EMECC measurements in EDF PWRs

Alain ROCHER: EDF/UNIE
Matthieu LONGEOT – Gilles RANCHOUX: EDF/SEPTEN
Léon PIOTROWSKI: EDF/R&D
Bernard JEANNIN: EDF/Management Head

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Characteristics of the Gamma EMECC system

Characteristics of the Gamma CZT spectrometer

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CZT campaign balance: 2006-2008

CZT Implementation:

- **Comparative Exam Units A & B**
- **Cold Shutdown before / after Oxygenation**
- **CVCS and RHRS decontamination**

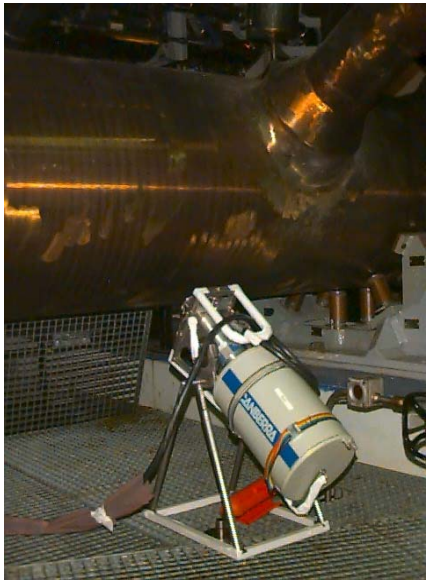
Conclusions and Prospect

Characteristics of the Gamma EMECC system Designed by the CEA

EMECC

Ensemble de **M**esure et d'**E**tude de la **C**ontamination des **C**ircuits

(**A**ssembly of **M**easuring and **S**tudy of **C**ircuit **C**ontamination)



Background Information

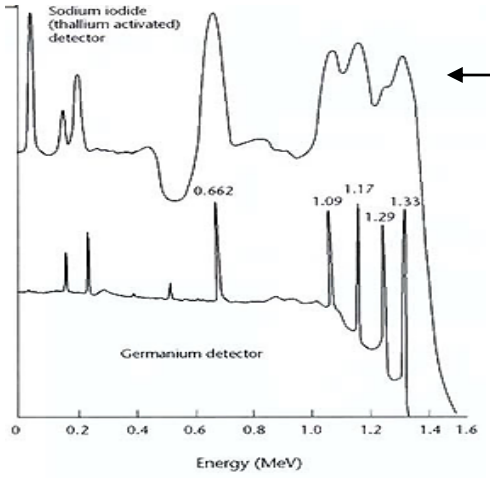
-**Has deposited activity measurements inside PWR since 1971**

- **Specificity of EMECC:**

Detector : Germanium cooled by liquid nitrogen

+ Collimator

Ge →



← **NaI**

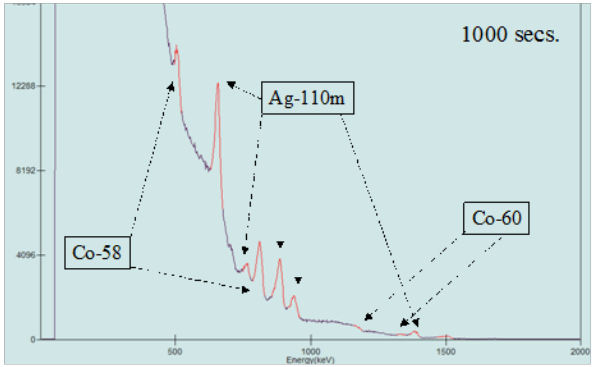
Characteristics of the Gamma CZT spectrometer

Compact probe &
w/o cooling

Connecting cable: 20m

Used by NPP's since 2006

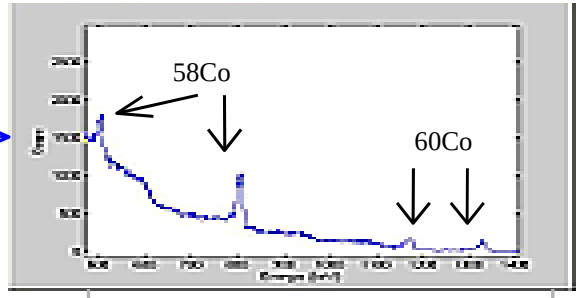
- Sensor : Cd-Zn-Te (semi conductor)
- Energy range: 300 keV to 1.8 MeV
- Sensitivity : 0.1 to 10 mSv/h
  60 or 500 mm^3 sensor
- Acquisition time : 1000 s



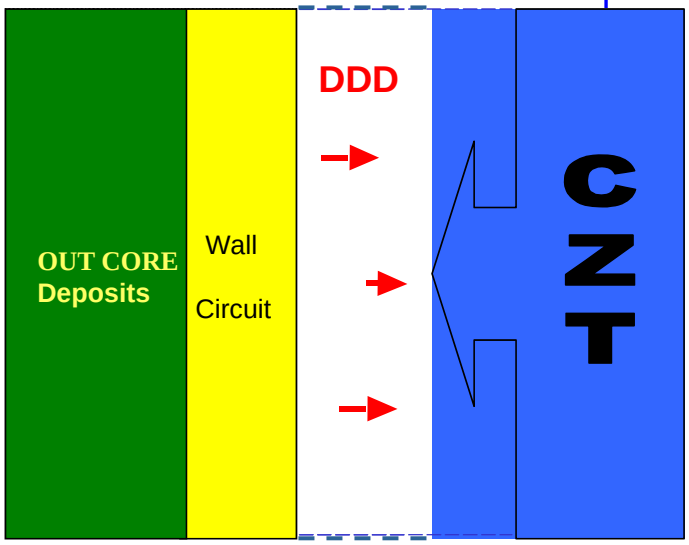
Operation principle of the CZT in NPP

ANALYSIS

100 keV - 1800 keV



MEASURE



Sensor collimator
Acquisition time # 1000 s

Contribution
% DDD
Sv/h

% Co58
% Co60
% …

RADIOPROTECTION

Wall attenuation

Contribution
% DEPOSIT
Bq

% Co58
% Co60
% …

SOURCE TERM

Comparative exam : CZT vs EMECC ultra pure Ge

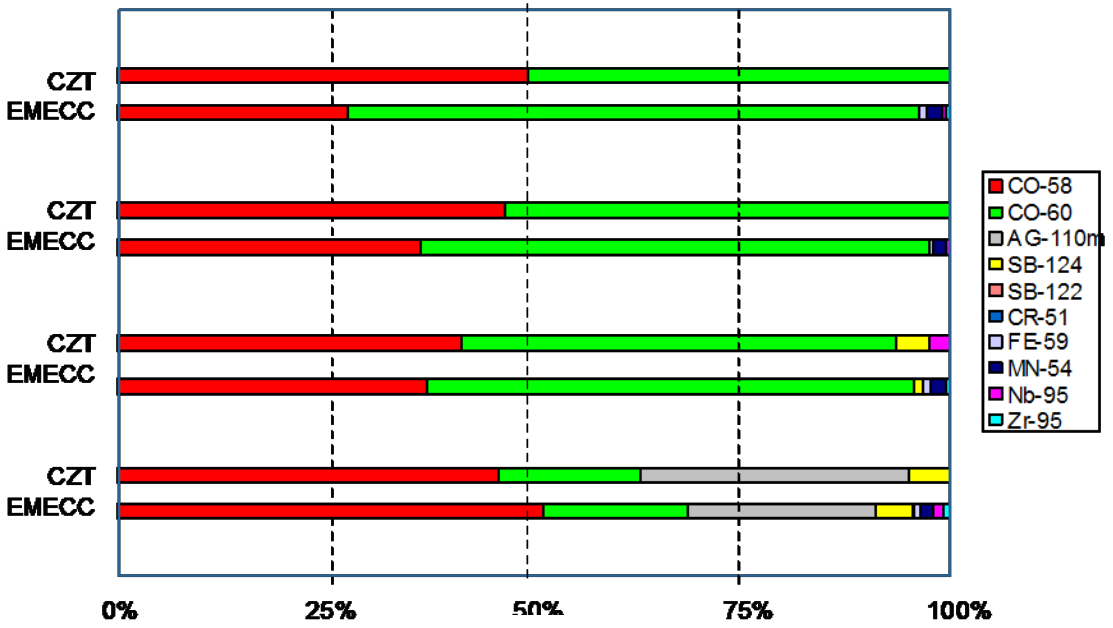
Plant with I-600 Steam Generator tubing: Alloy 600

RCS – Hot Leg

RCS – Cold Leg

RCS – Cross Over Leg

CVCS – NR Echanger



Radio isotope contribution to the dose rate

CZT measurements are in line with a margin of about 10 % between CZT and EMECC

Outage Systematic Schedule

8 points Before and After Oxygenation

CHEMICAL and VOLUME CONTROL SYSTEM
P1 : CVCS – Upline purification
P2 : CVCS – Outline purification
P3 : CVCS – Non regenerative heat exchanger
REACTOR CAVITY DRAINING
P4 : Spent Fuel Pit Cavity
PRIMARY AND AUXILIARY SYSTEMS
P5 : RCS – Hot leg
P6 : RCS – Cold leg
P7 : SIS – Outline RCS valve
P8 : RHRS – Heat exchanger

P7 : 1300 MW

RCS-172VP / RC702

Harmonization : comparative examination - assessment

CZT assessment : 2006-2008 *(1/2)*

Average values expected: Co60, Co58, Ag110m

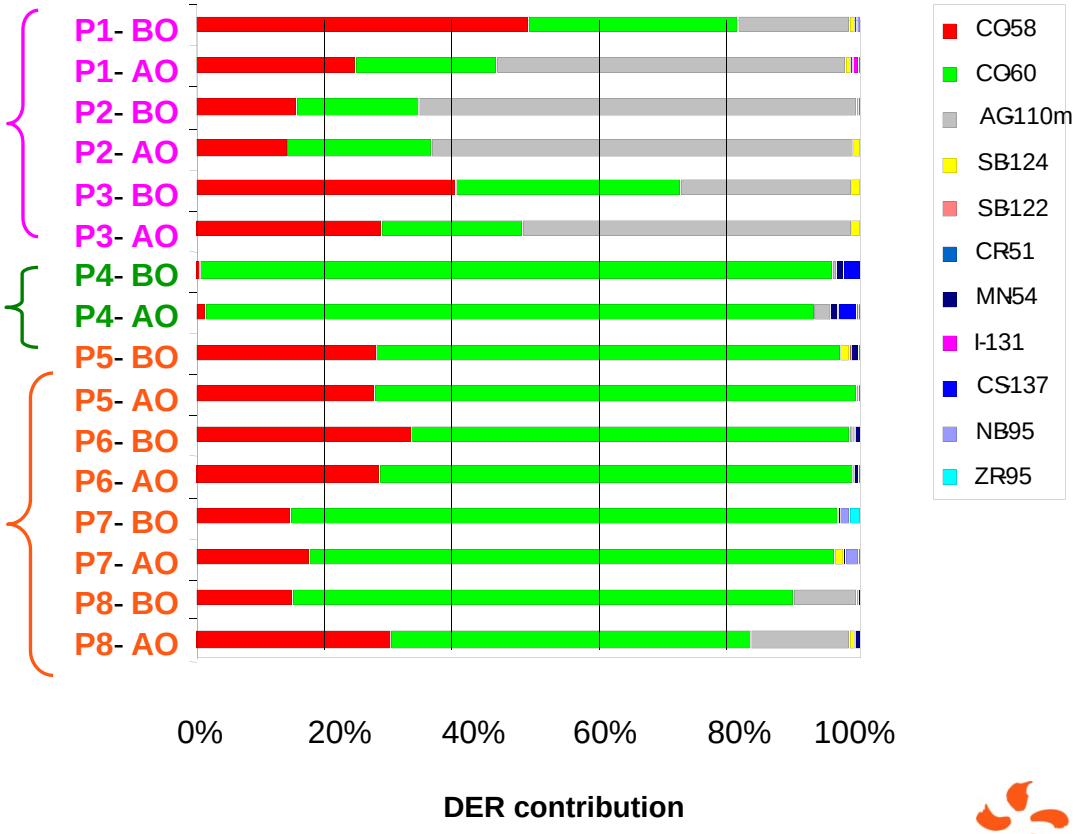
CVCS: large differences between the units Co58-60 and Ag110m

Reactor cavity: 100 % Co60

RCS: Co58 (15-45%) - Ag110m (# 0%)

SIS: similar to loops but Co60 higher

RHRS: between RCS and CVCS



CZT assessment : 2006-2008 *(2/2)*

Efficient device to identify the ratio to the dose rate

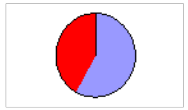
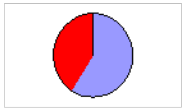
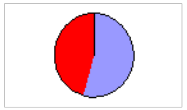
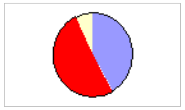
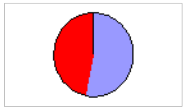
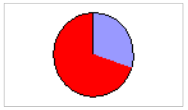
- **Unable to quantify the ratio of radio isotopes < 5 %**
- **Margin of error ± 10 %**
- **Ratio analysis and time evolution is examined**

Device to be implemented

Interest in measurement schedule confirmed by:

- **Identification of specific pollutions to be treated**
- **Useful complementary information for the source term management**

CZT IMPLEMENTATION: Comparative examination of NPPs A & B
Same Operation Duration and Design

Co58 Co60 Sb124	HOT LEG	COLD LEG	SIS Valve
UNIT A	 Ddd : 0,44mSvh	 Ddd : 0,60mSvh	 Ddd : 1,50mSvh
UNIT B	 Ddd : 0,54mSvh	 Ddd : 0,40mSvh	 Ddd : 0,48mSvh

Over-contamination : Co60 - SIS valve (Unit B)

Filtration porosity : thinner for A

⇨ decrease of the filtration porosity (1 to 0.45 µm) for B

CZT IMPLEMENTATION: Cold ShutdownTransient
Before & After Oxygenation

Co58 Co60 Ag110m	CVCS Heat Exchanger	HOT LEG	COLD LEG
UNIT C Before oxygenation	 Ddd : 1,0 mSv/h	 Ddd : 0,34 mSv/h	 Ddd : 0,50 mSv/h
UNIT C After oxygenation	 Ddd : 0,42 mSv/h	 Ddd : 0,54 mSv/h	 Ddd : 0,40 mSv/h

Over-contamination : Ag110m - CVCS after oxygenation

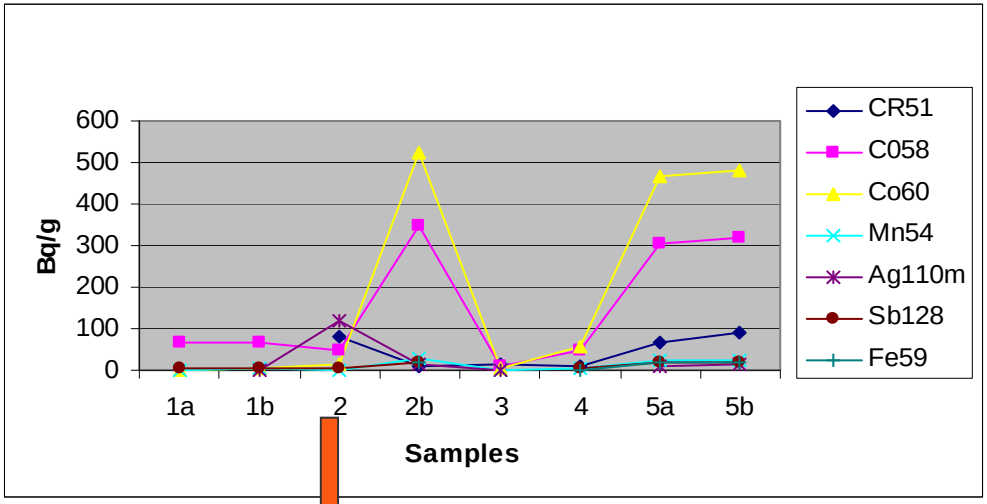
CVCS resin saturation during the shutdown transient
⇨ Macroporous resin use (colloids removal)

CZT IMPLEMENTATION: CVCS and RHRS decontamination

Decontamination process : depends on the radio isotope to removed

DR : 70% Ag110m + 20 %Co60 + 10% Co58

Emmag process



Emmag qualified process :
Ag removal

Dissolution Ag110m

RESULT

Decontamination Factor **> 3**

Outage Systematic Schedule - CONCLUSIONS

Since 2006, the RP services have been equipped with a portable CZT gamma spectrometer. We consider it to be an indispensable tool for contamination diagnosis and for the prevention of over-contamination.

The CZT measurements are complementary to the water analyses carried out by chemists.

After three years of experience, CZT-Users confirmed the need of the spectrometer to understand contamination phenomena.

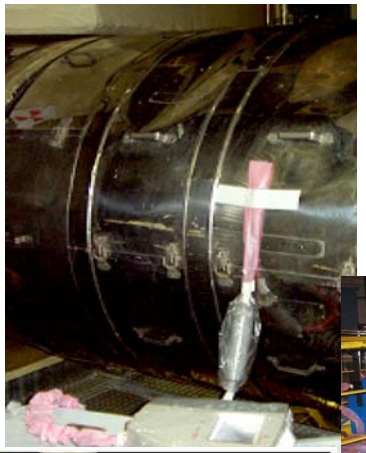
The spectrometer is easy to use. It is very important for the NPPs operators to implement a specific schedule of measurements during each shutdown.

CZT Prospect : wall contamination measurements : GBq/m²

Integration of software to calculate the deposited activity of selected geometry.

→Assessment of local decontamination efficiency (before and after cartography).

Heat exchanger

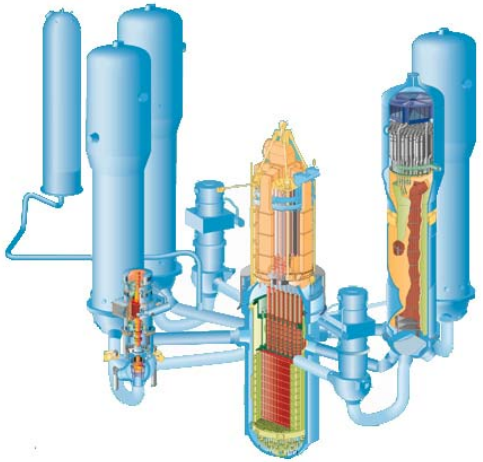


Decontamination

Fuel pit storage

tanks

Outage Systematic Schedule



Loops, …