



CANBERRA

CAMs and High Level ^{220}Rn Releases

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Overview

- ▶ **George Besse II: new Areva centrifugal enrichment facility in Central France**
 - ◆ **Modular construction – eventually > 200 iCAM/MFS**
 - ◆ **GBII South: enriches mined U only**
 - ◆ **GBII North: will enrich reprocessed U as well**
- ▶ **Reprocessed U will have significant Thorium content: ^{220}Rn !**
- ▶ **First sign of a centrifuge leak will be ^{220}Rn release**

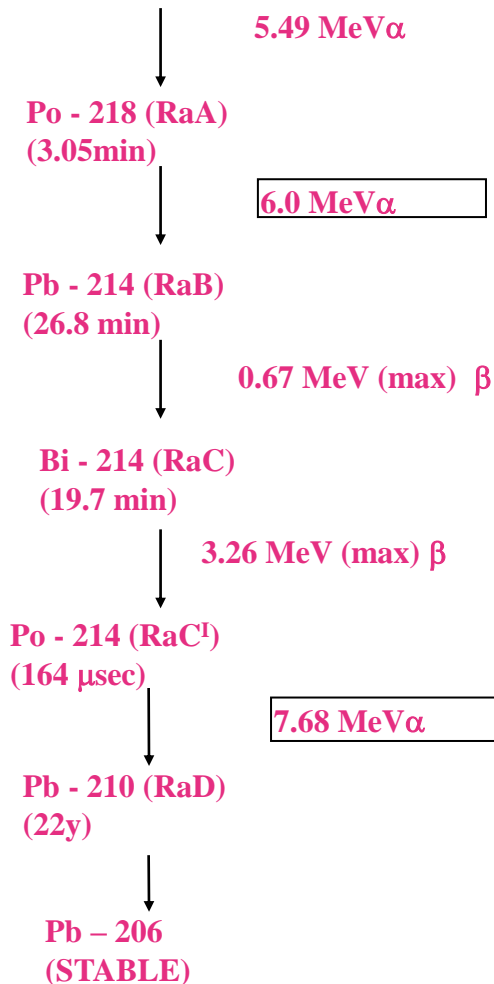


'Fresh' ^{220}Rn : the problem

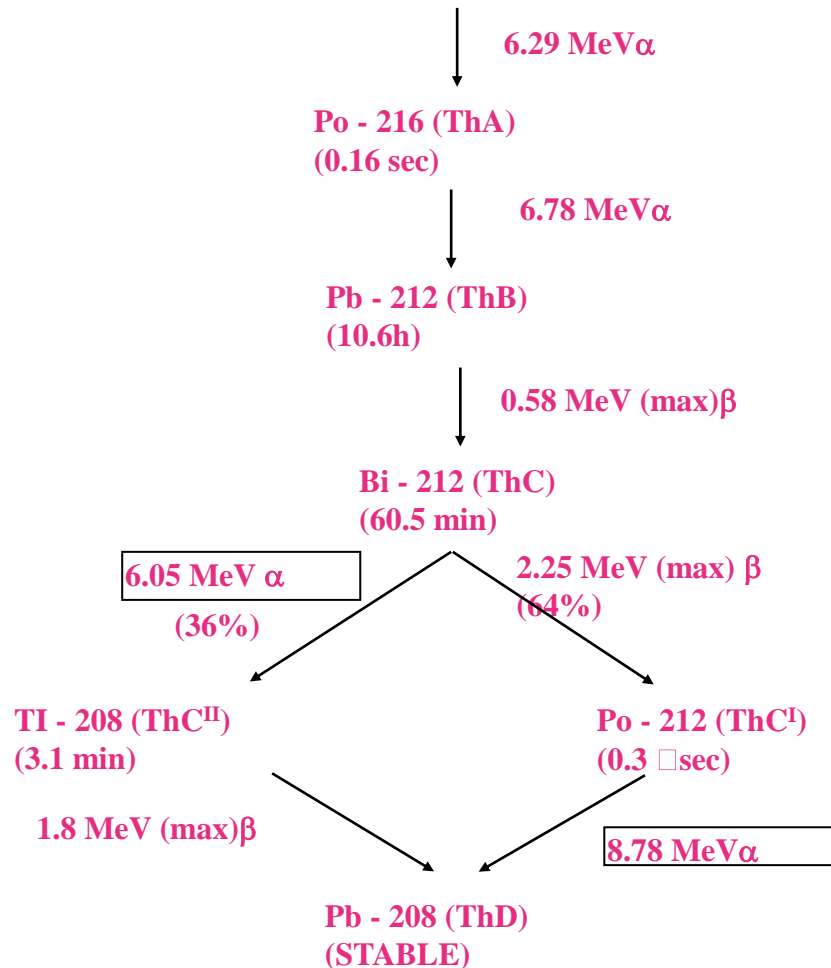
- ▶ ^{222}Rn & ^{220}Rn interfere with U, Pu measurement in Alpha CAMs
 - ◆ Compensation is necessary for radon events in the long-lived region of the alpha spectrum
- ▶ Normal compensation methods assume only ^{218}Po , ^{214}Po ^{212}Bi and ^{212}Po peaks in spectrum
 - ◆ Assumes 'aged' ^{220}Rn of geological origin
- ▶ When 'fresh' ^{220}Rn (thoron) is present at high levels a peak from ^{216}Po at 6.78 MeV could be seen on CAMs
- ▶ ^{216}Po alpha at 6.78MeV may compromise the compensation
 - ◆ Normal levels in ambient air are too low to interfere with the radon compensation as ^{216}Po half life is only 0.16 s
- ▶ Indication of centrifuge leak
- ▶ If leak is distant CAM may only see ^{212}Po

Radon & Thoron Decay

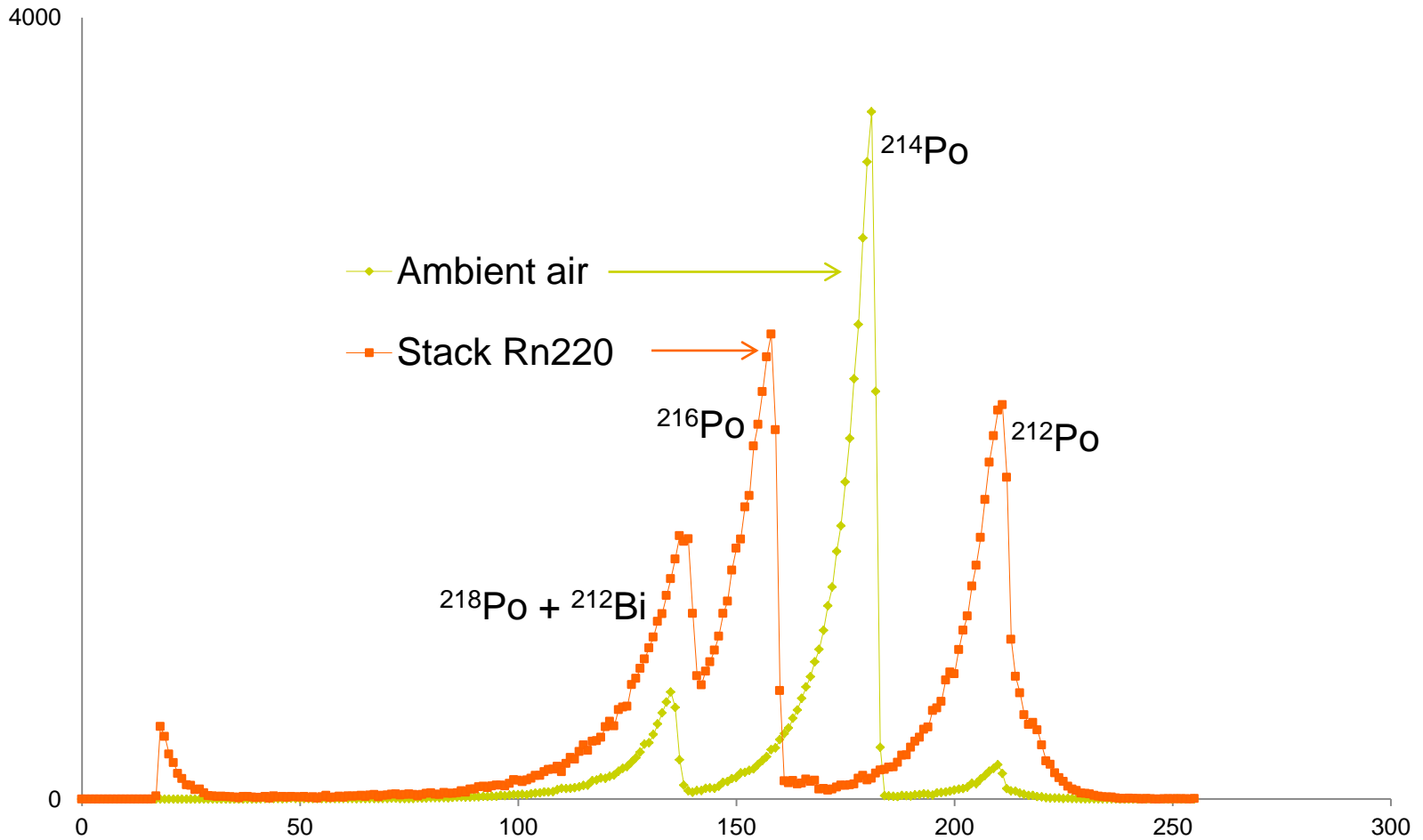
Rn-222 (RADON)
(3.82d)



Rn - 220 (THORON)
(54.5 sec)



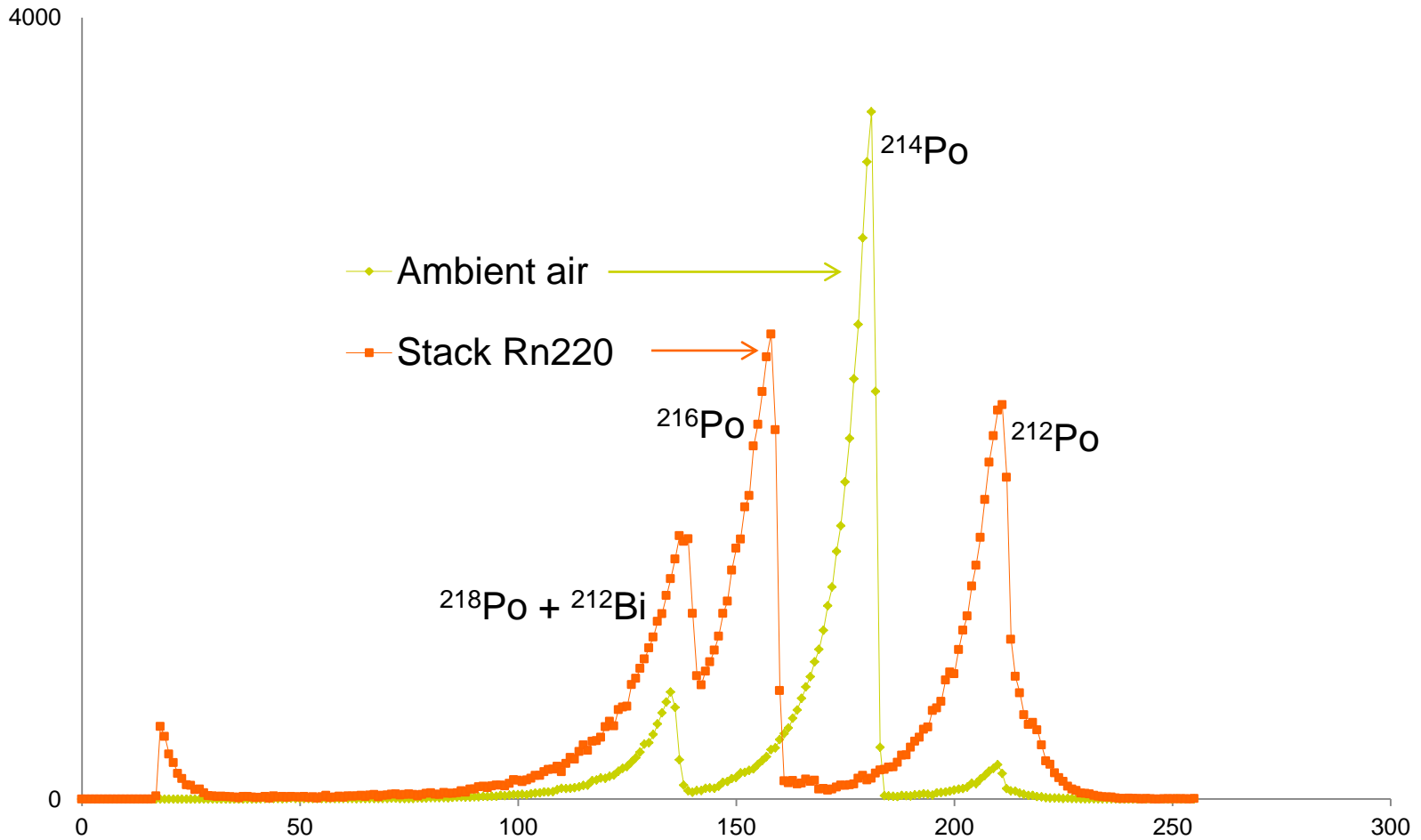
Example Alpha Spectra



Interim solution

- ▶ **Steps taken to mitigate against the effect of high ^{220}Rn :**
 - ◆ **Alarms set on high levels of ^{216}Po and ^{212}Po**
 - Based on gross counts in two ROIs around ^{216}Po and ^{212}Po peaks
 - ◆ **^{216}Po collects on filter – short half-life - 0.145s - therefore activity proportional to air concentration**
 - ◆ **^{216}Po alpha net peak area evaluated using fixed pre-set tail parameter**
- ▶ **If significant ^{220}Rn release detected U/Pu region compensation is limited to prevent overcompensation**
- ▶ **If leak is distant CAM may only see ^{212}Po so response to leak may be slow**

Example Alpha Spectra



Implementation

▶ Modifications to CAM algorithms

- ◆ Alarms set on high levels of ^{216}Po & ^{212}Po
- ◆ Compensation limited if alarms triggered

▶ Validation

- ◆ Off-line computer model simulations to validate and optimise algorithms
- ◆ CAM runs with various ambient radon (^{222}Rn) levels performed to verify performance as a normal CAM with without ^{220}Rn and no false alarms on the new ^{220}Rn detection function
- ◆ Suitable ^{220}Rn sources being sought for active testing: suggestions welcome!

Performance

- ▶ **Performance estimates based on computer simulations**
 - ◆ **Detection limit, time to trigger alarm and false alarm rate interdependent**
 - Ambient radon level 50 Bq/m³
 - False alarm rate at 5 sigma
 - Alarm set within 300s after the event
 - ◆ **Detection limit has been determined as ~300 Bq/m³ of ²²⁰Rn**
 - ◆ **At this ²²⁰Rn concentration the radon compensation would still function**
 - ◆ **3000 Bq/m³ ²²⁰Rn would be detected in less than 15s**

Summary and Future development



- ▶ **The addition of a ^{220}Rn detection function to the CAM will provide a timely indication of centrifuge leakage and also of potential failure of the radon compensation**
- ▶ **An alternative solution to allow the radon compensation to continue to function when ^{220}Rn is present is being examined to be implemented as part of ongoing development**
 - ◆ **Based on adding an additional peak detection and tail strip step**

iCAM Algorithms: Other progress

- ▶ **V2.10.5 (incl remote head) independently certified to IEC61508 SIL1 (Safety & Integrity Level 1)**
- ▶ **Bayesian Method: Bayesian time series analysis adds ability to evolve activities and concentrations of all components of alpha & beta background due to Rn/Th progeny**
 - ◆ Including 'invisible' components!
- ▶ **Ability to separate isotopes w coincident peaks by analysing time series evolution**
 - ◆ Eg measurement of ^{242}Cm in the presence of ^{222}Rn – in hand – this is not possible via spectrum analysis as peaks are almost exactly coincident
- ▶ **Both features coming in V3 firmware release**
- ▶ **Presentations on these features next year?**