# Sub-microsecond $\alpha$ -particle emitters

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On behalf of the TASCA E115 Collaboration

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lpha decay	Experiment and set-up	Correlation analysis	Nuclear structure	Outlook
Outline				

- $\square \alpha$  decay
- Experiment and set-up
- Correlation analysis
- A Nuclear structure
- Outlook







 $\alpha$  decay

### The Chart of Nuclides



 $\alpha$  decay

### The Chart of Nuclides





TASCA-separator. Source: Phys. Rev. C, 83:054618.

Even	t
1	Pixel
2	Time
3	Beam ON/OFF
4	Silicon detector particle energies (Full energy and reconstructed)
5	Germanium detector photon energies (x rays and $\gamma$ rays)

Aim: Select the data for just one decay path, i.e. <sup>219</sup>Ra-<sup>215</sup>Rn.



#### Correlation analysis

## "imp- $\alpha_1$ - $\alpha_2$ " correlated events

<sup>215</sup> Th	<sup>216</sup> Th	<sup>217</sup> Th	<sup>218</sup> Th	<sup>219</sup> Th	<sup>220</sup> Th	<sup>221</sup> Th	<sup>222</sup> Th	<sup>223</sup> Th
<sup>214</sup> Ac	<sup>215</sup> Ac	<sup>216</sup> Ac	<sup>217</sup> Ac	<sup>218</sup> Ac	<sup>219</sup> Ac	<sup>220</sup> Ac		<sup>222</sup> Ac
<sup>213</sup> Ra	<sup>214</sup> Ra	<sup>215</sup> Ra	<sup>216</sup> Ra			<sup>219</sup> Ra t <sub>1/2</sub> : 10 ms		<sup>221</sup> Ra
<sup>212</sup> Fr	<sup>213</sup> Fr	<sup>214</sup> Fr		$E_{\alpha}: \begin{array}{c} 7.68 \\ 7.98 \end{array}$	MeV	<sup>218</sup> Fr <sub>1/2</sub> : 20, 1 m	8	<sup>220</sup> Fr
<sup>211</sup> Rn	<sup>212</sup> Rn			<sup>215</sup> Rn <sub>t1/2</sub> : 2 μs		7.615 7.680 M 7.867	eV	<sup>219</sup> Rn
<sup>210</sup> At	<sup>211</sup> At	$E_{\alpha}: 8.68$	MeV	$^{214}At_{_{1/2}:~\sim~0.5~\mu}$	8		<sup>217</sup> At	<sup>218</sup> At
<sup>209</sup> Po	<sup>210</sup> Po	<sup>211</sup> Po <sub>t1/2</sub> : 0.5 s		8.772 8.820 M 8.877	eV	<sup>215</sup> Po	<sup>216</sup> Po	<sup>217</sup> Po
$E_{\alpha}$ : 7.45	MeV	<sup>210</sup> Bi	<sup>211</sup> Bi	<sup>212</sup> Bi	<sup>213</sup> Bi	<sup>214</sup> Bi	<sup>215</sup> Bi	<sup>216</sup> Bi
<sup>207</sup> Pb	<sup>208</sup> Pb	<sup>209</sup> Pb	<sup>210</sup> Pb	<sup>211</sup> Pb	<sup>212</sup> Pb	<sup>213</sup> Pb	<sup>214</sup> Pb	<sup>215</sup> Pb



 $\alpha$  decayExperiment and set-upCorrelation analysisNuclear structureOutlook"imp- $\alpha_1$ - $\alpha_2$ "correlated events





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lpha decay

Experiment and set-up

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Outlook

# Decay level scheme <sup>219</sup>Ra-<sup>215</sup>Rn















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## Outlook

- Evaluate the constructed decay level scheme on the basis of Geant4 simulations.
- Use theoretical models to calculate the structural- and  $\alpha\text{-decay}$  properties of  $^{219}\text{Ra}$  &  $^{215}\text{Rn}\text{:}$ 
  - Large scale shell model calculations.
  - Contemporary  $\alpha\text{-decay}$  models developed in Lund.
- Establish a final interpretation of the Ra-219 & Rn-215 decay path.
- Study three other odd-even isotopes in the same region.

Knut och Alice Wallenbergs





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Half-life $t_{1/2}$ of Ra-219				















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### Coincident photons Ra-219





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