SPIRAL1: a versatile user facility

L. MAUNOURY – GANIL – Caen
on behalf of Upgrade SPIRAL1 team

Outlines

1) MOTIVATIONS

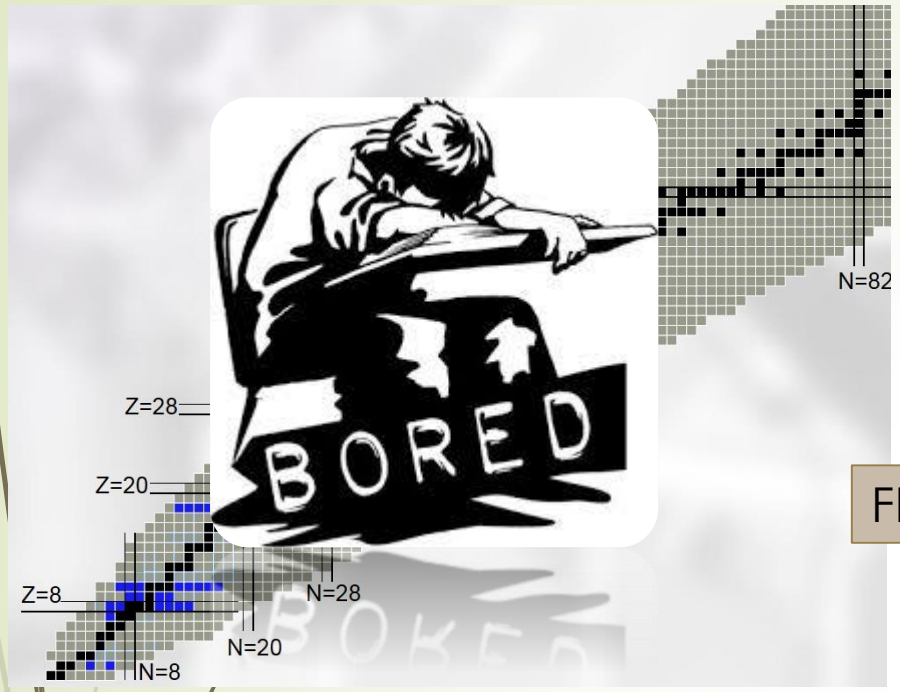
2) 1+/N+ AT GANIL

3) COMMISSIONING

4) ONGOING R&D

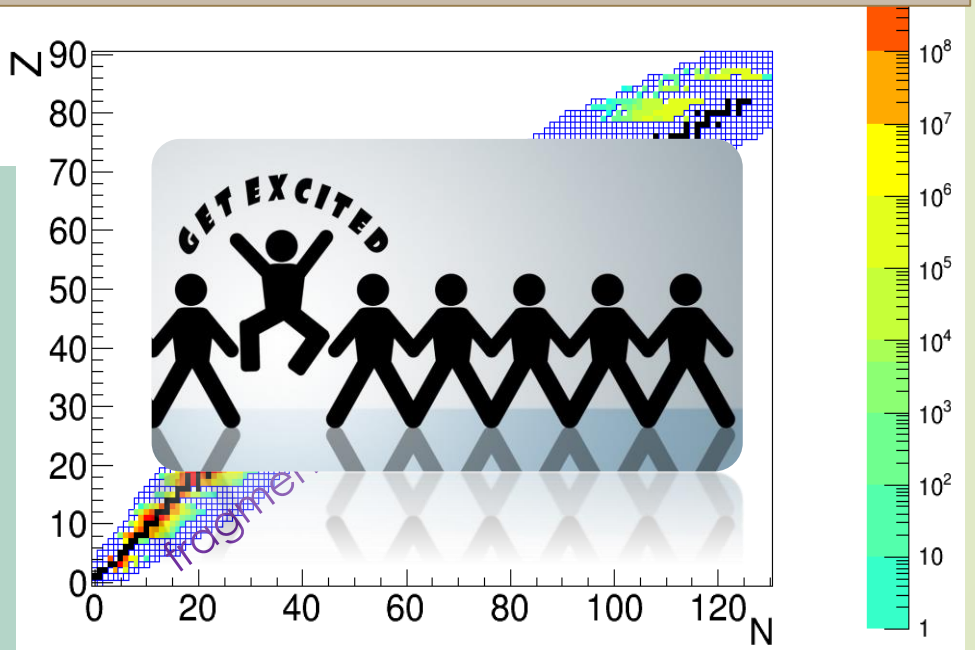
5) CONCLUSION

Motivations



Since 2001 SPIRAL1 under operation
Mainly RIB's from gaseous elements
7 elements: He, C, O, F, Ne, Ar, Kr
35 beams provided / $T_{1/2}$ > 100ms

FEBIAD (or NANOGAN) + Charge breeder

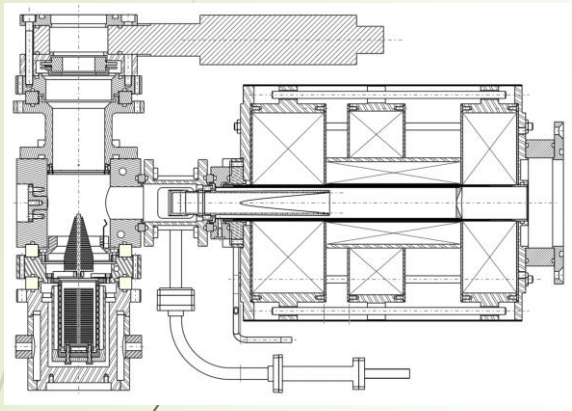


Physicists need more exotic beams to study the nuclei properties
⇒ SP1 should extend its RIB's palette
⇒ 1+ / n+ method
⇒ Dedicated TISS (FEBIAD + C target)
⇒ Charge breeder
⇒ CIME as post-accelerator
⇒ New target m < Nb but C primary beam

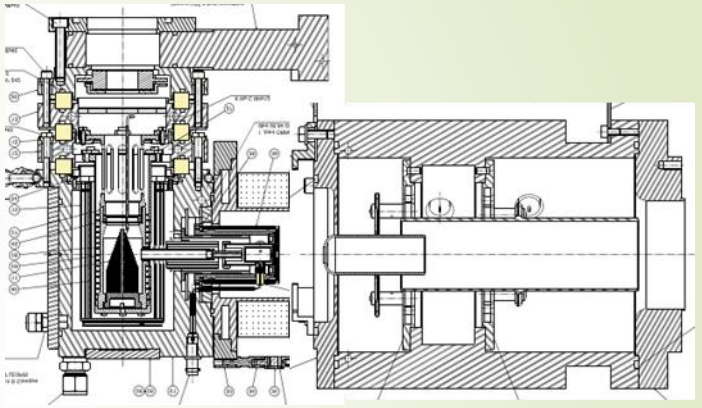
1+/n+ at GANIL: recipe

Step1: TISS

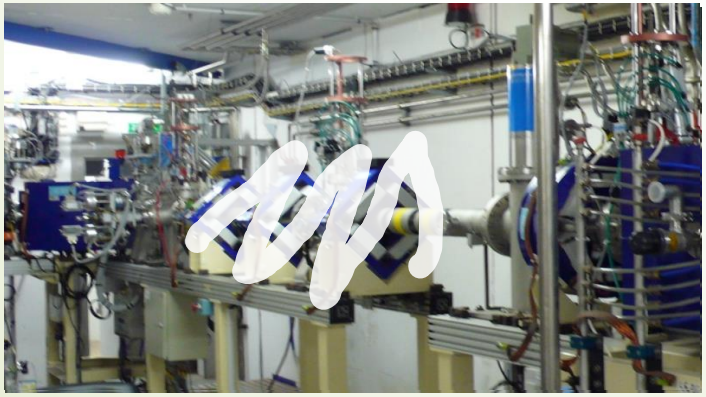
TIS NANOGAN



TIS FEBIAD



Step2: CB



Step3:

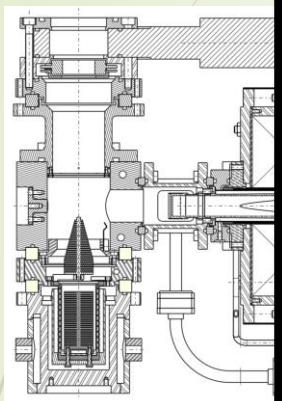
Connect to current GANIL beam lines

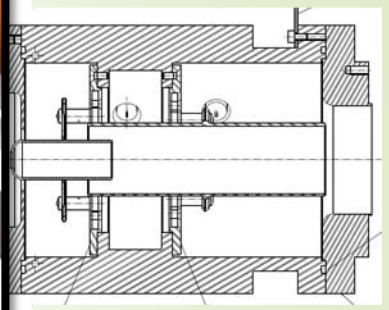
1+/n+ at GANIL: recipe

Step1: TISS

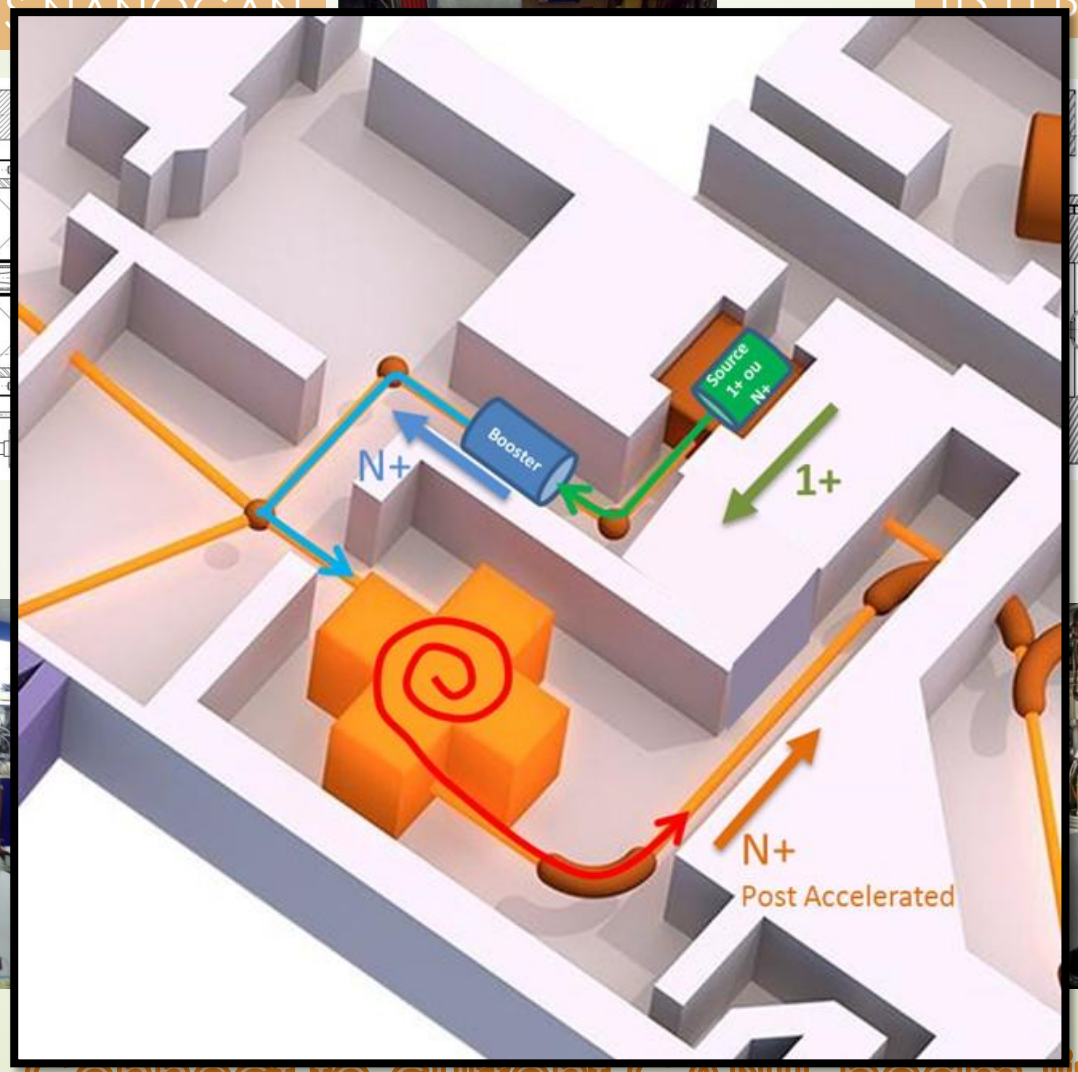
TIS NANOGAN

TIS FEBIAD





Step2: CB



Step3:

Connect to current GANIL beam lines

1+/n+ at GANIL: Multipurpose facility

Beam user possibilities

Low Energy Beams :

DESIR

The low energy platform for studying property of nuclei

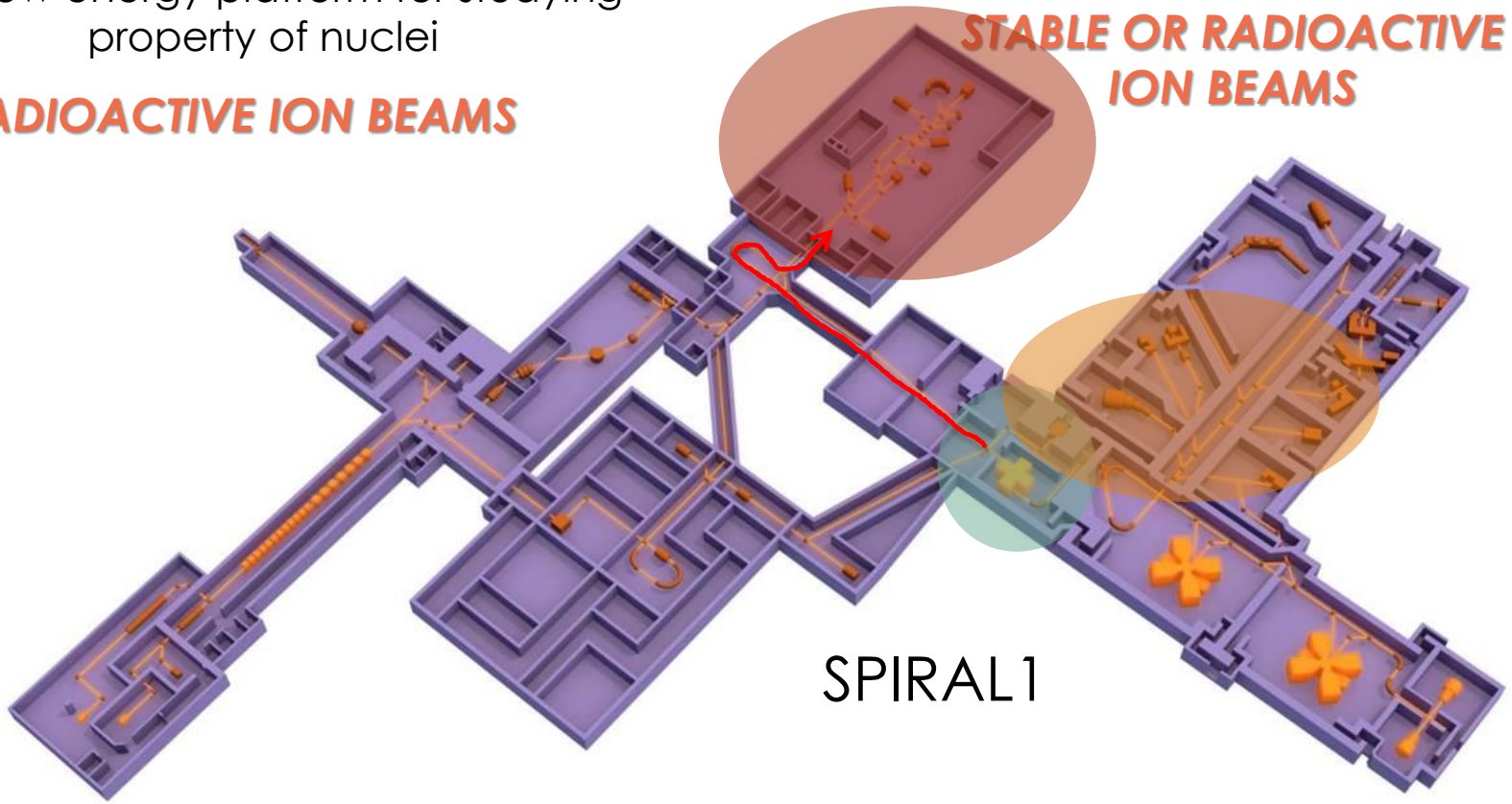
RADIOACTIVE ION BEAMS

Accelerated Beams :

GANIL experimental areas

AGATA, Vamos, LISE,…

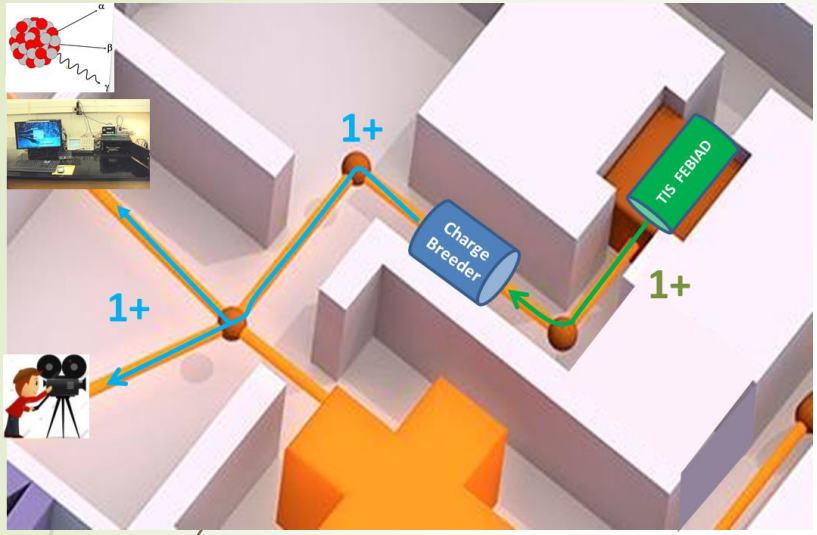
STABLE OR RADIOACTIVE ION BEAMS



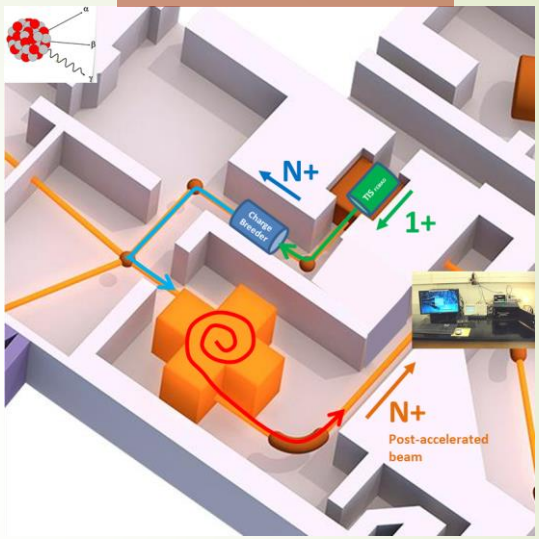
SPIRAL1

1+/n+ at GANIL: Multimode facility

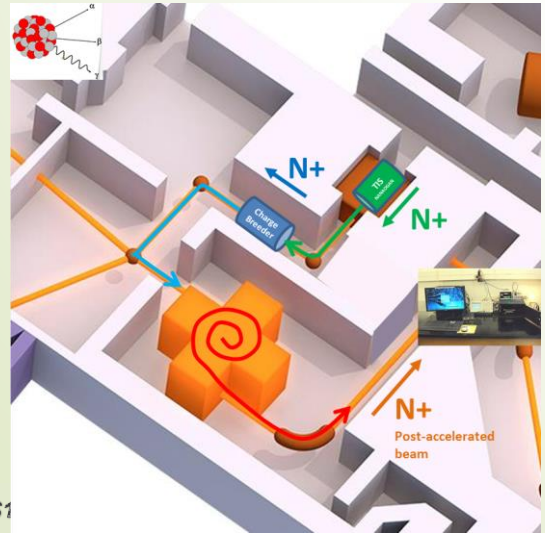
Shooting through mode 1+



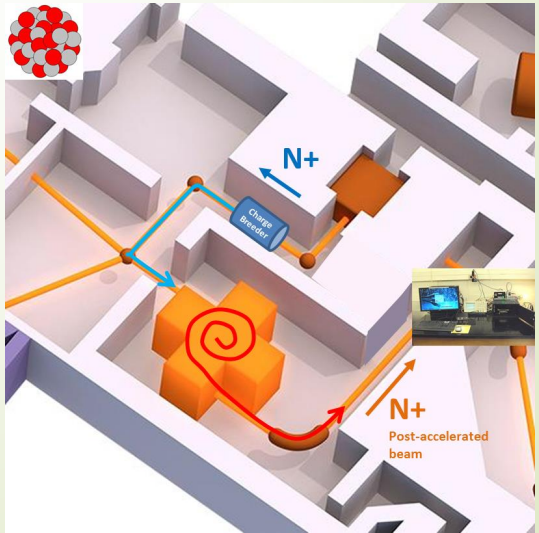
1+/N+ mode



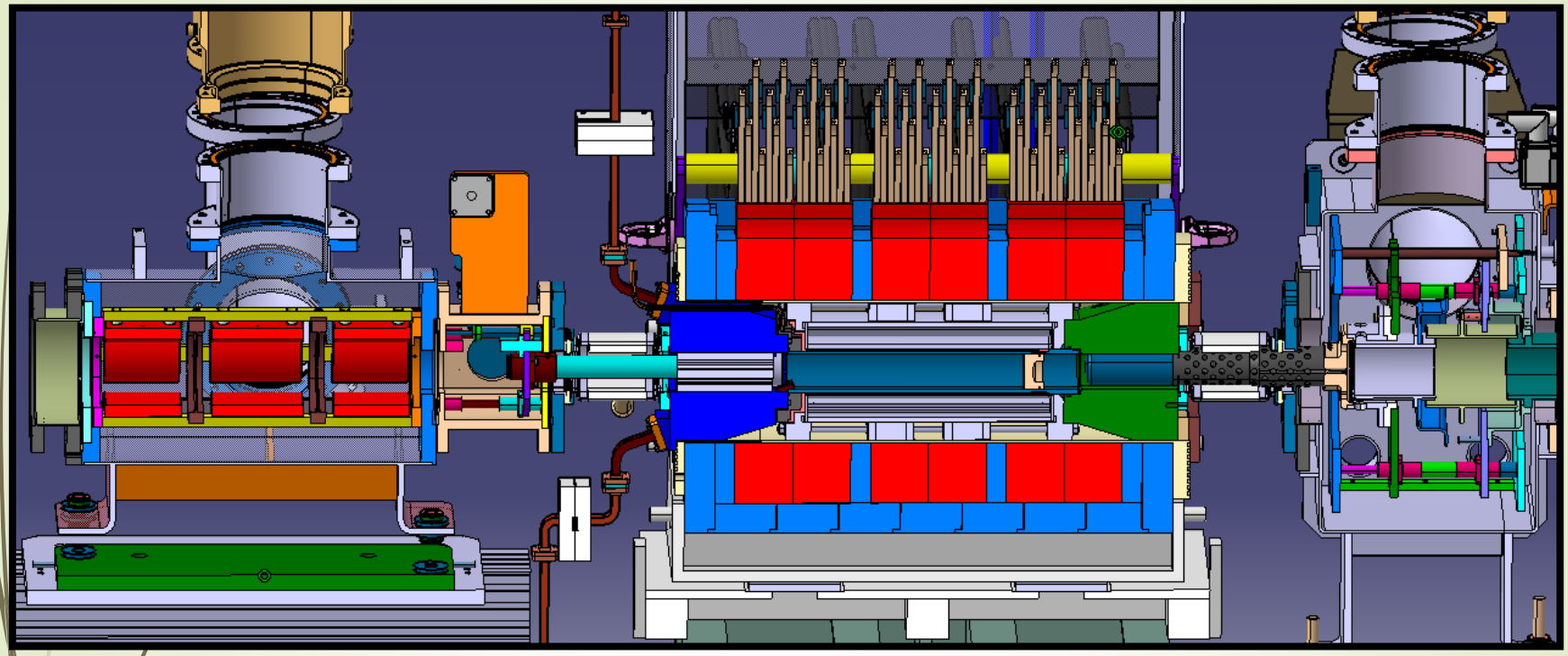
Shooting through mode N+



Charge breeder as injector



Commissioning: SP1 CB



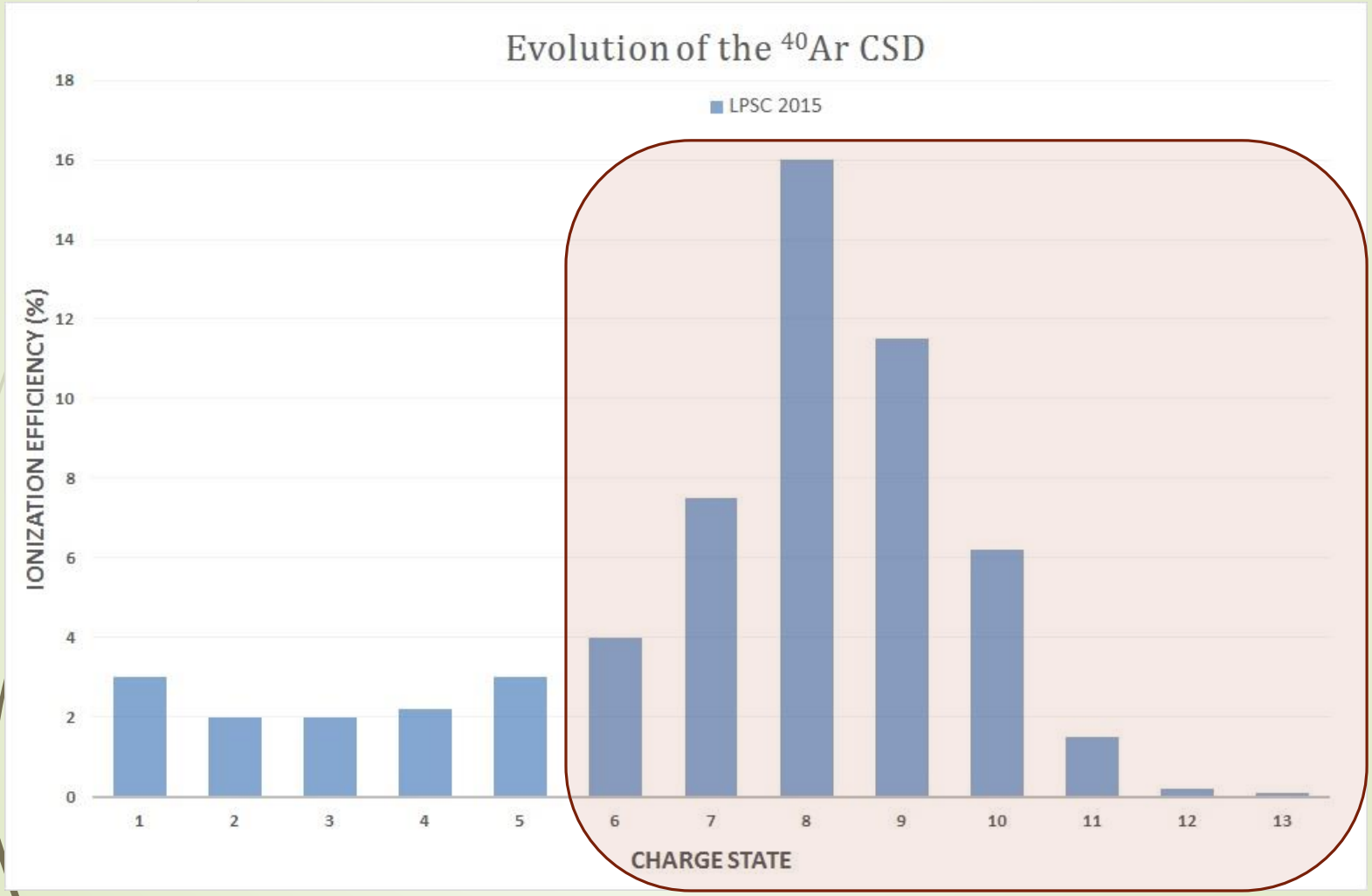
Features

- ✓ Two RF ports 14.5 GHz and 8-18 GHz
- ✓ New design of gas and RF injection
- ✓ Symmetrisation of the iron plug
- ✓ Movable deceleration tube
- ✓ Plasma chamber made of Al

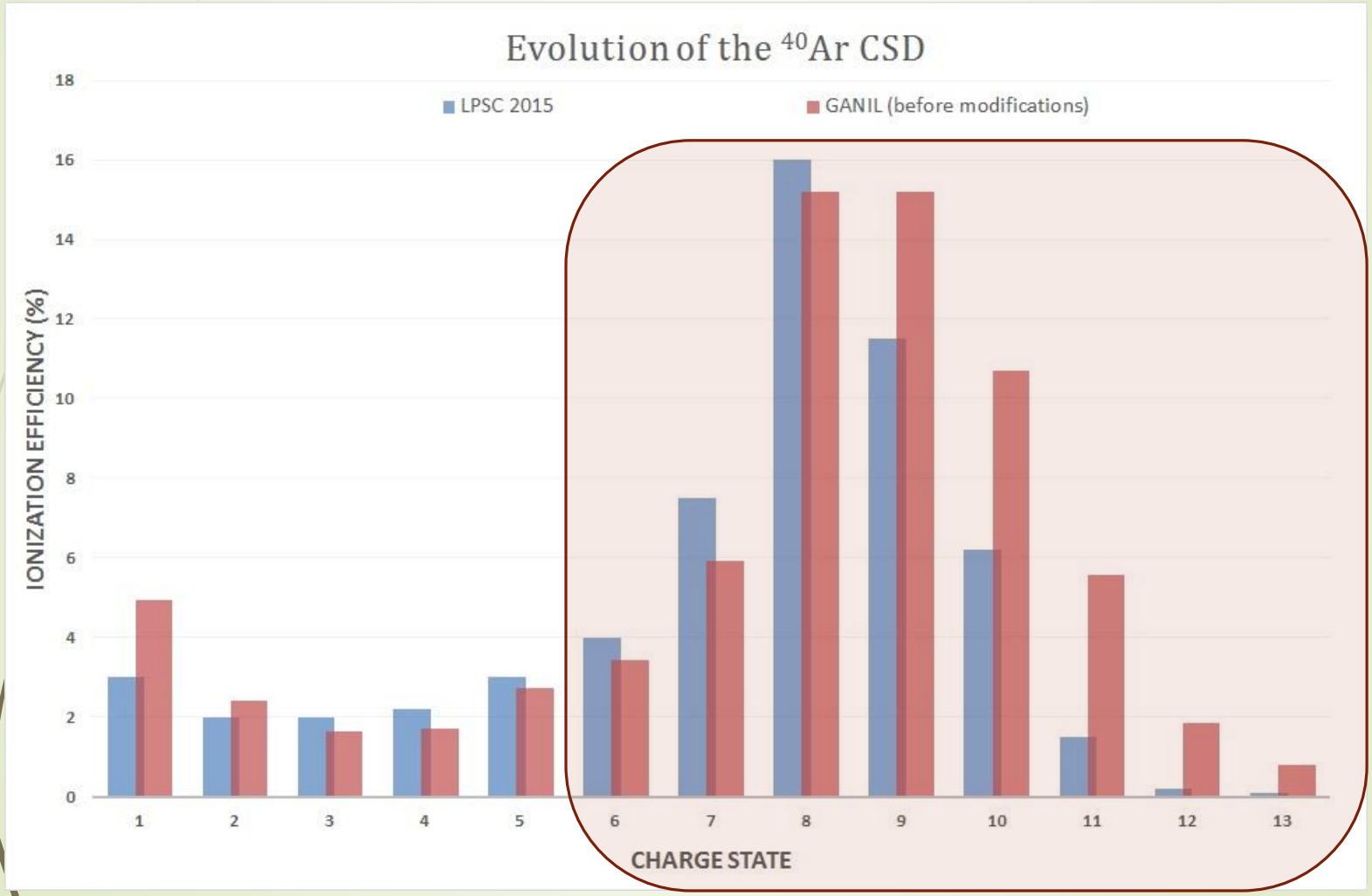
Last modifications

- ✓ Soft iron add-ons on injection
- ✓ Soft iron rings location optimization
- ✓ Plasma electrode location

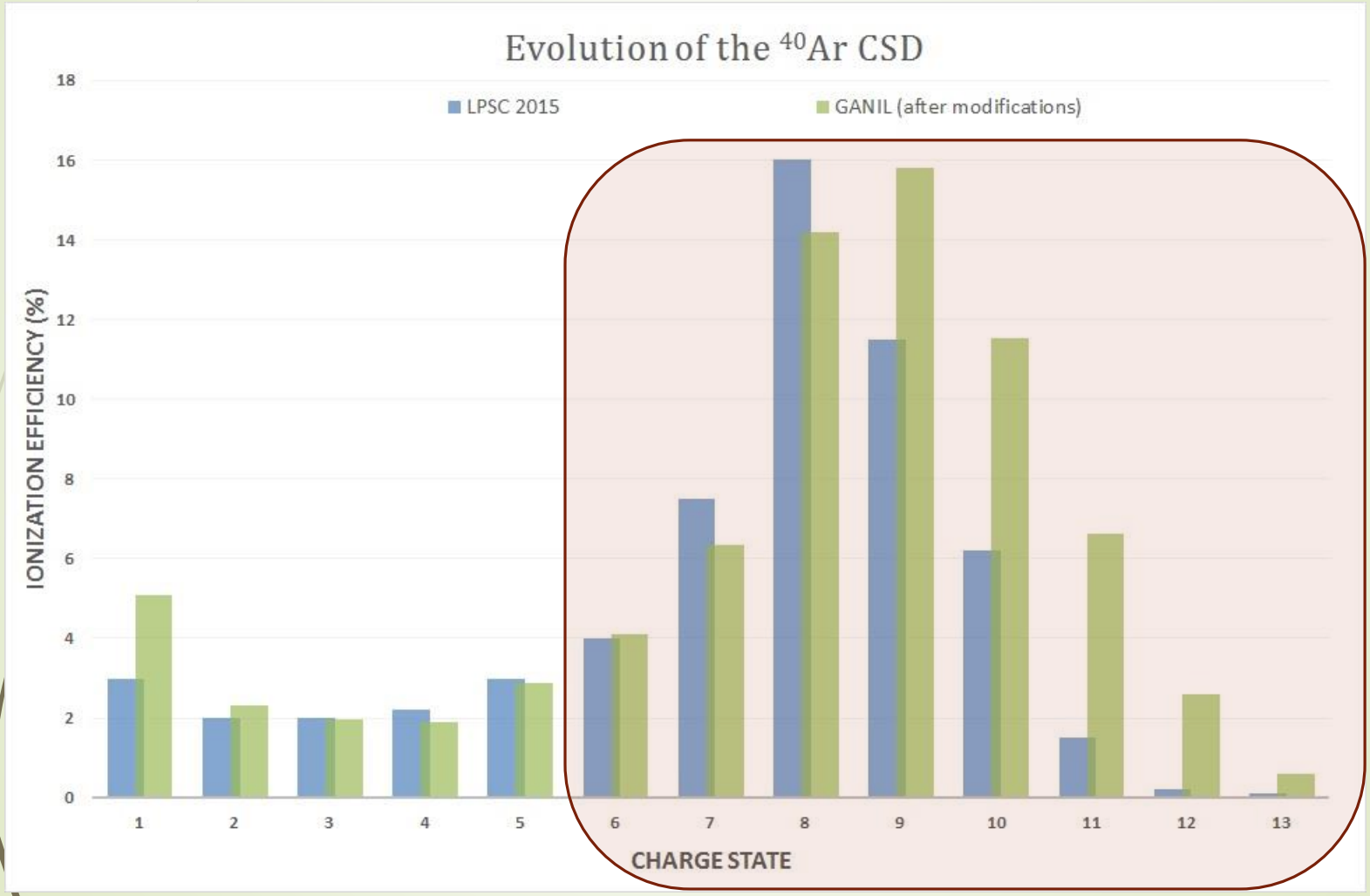
Commissioning: Ar CSD



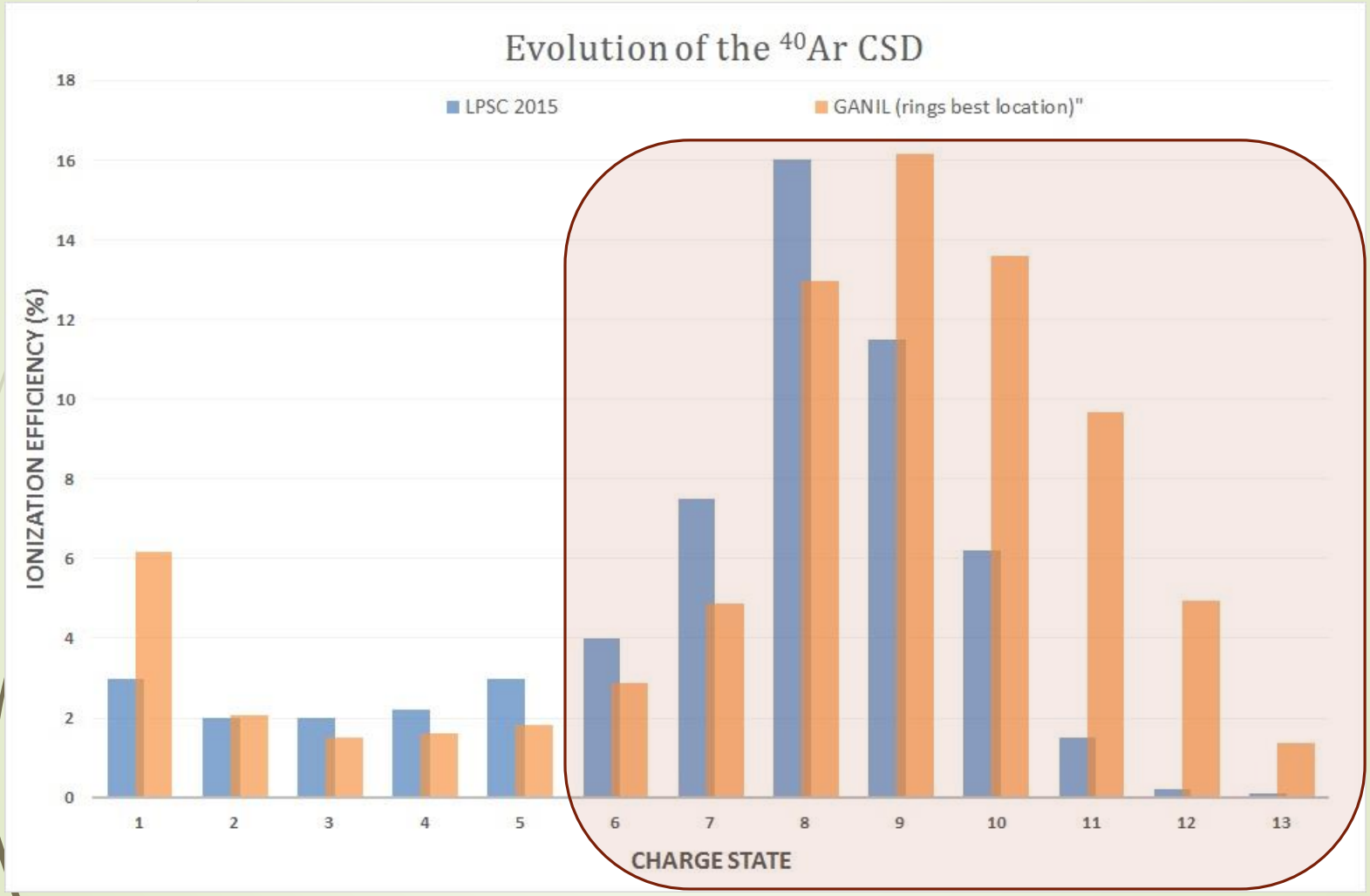
Commissioning: Ar CSD



Commissioning: Ar CSD



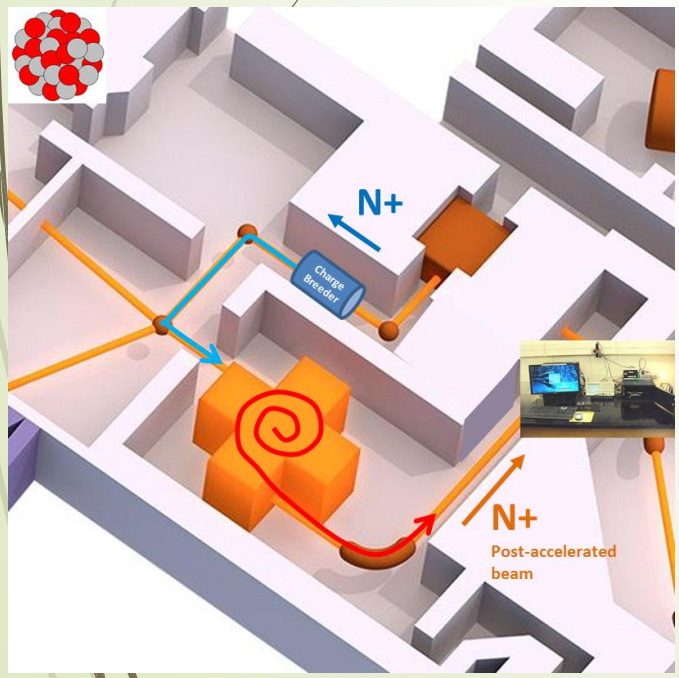
Commissioning: Ar CSD



Commissioning: RUN1

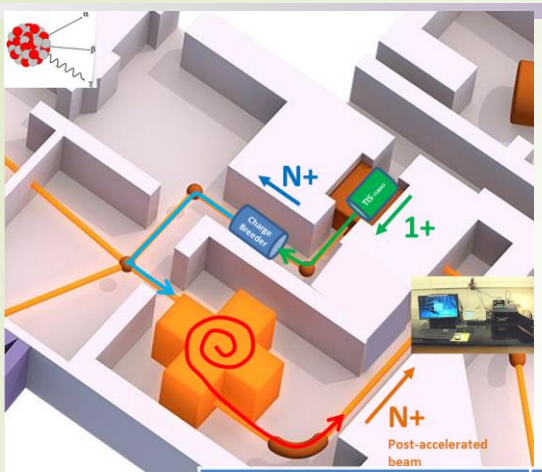
Ion beam	LPSC 2015	GANIL Commissioning
$^{40}Ar^{11+}$	12.9%	12.1%
$^{23}Na^{7+}$	6%	3.2%
$^{23}Na^{8+}$	5.3%	3.6%
$^{39}K^{9+}$	13%	14.5%

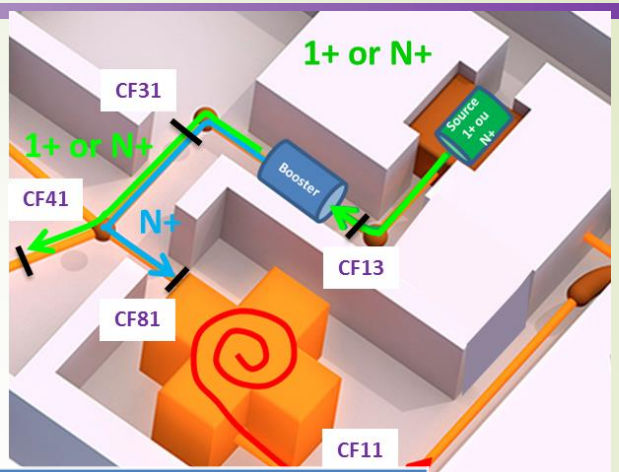
Radioactive Ion	Efficiency
$^{37}K^{9+}$ $T_{1/2}$ = 1.24s	5.3% without optimisation



Stable ion beam	Request	SP1 Charge Breeder
E725	^{36}Ar@3.2MeV/A	$^{36}Ar^{7+}$@15kV
EM97	^{84}Kr@2MeV/A ^{84}Kr@5MeV/A ^{84}Kr@7MeV/A	$^{84}Kr^{11+}$@14,3kV $^{84}Kr^{17+}$@21.5kV $^{84}Kr^{20+}$@28.8kV
EM97	^{129}Xe@2,5MeV/A ^{129}Xe@5MeV/A ^{129}Xe@7MeV/A	$^{129}Xe^{22+}$@13.3kV $^{129}Xe^{22+}$@26.6kV $^{129}Xe^{27+}$@32.7kV

Commissioning: global efficiency





Steps	1+/N+ mode		N+ Shooting through	
	Goals	**Done**	Goal	**Done**
$\varepsilon_{\text{transp} \Rightarrow \text{CF13}}$	80%	**>80%**	50%	**40%-70%**
$\varepsilon_{\text{transf } 1+\Rightarrow N+}$	7%	**5-15%**	/	**/**
$\varepsilon_{\text{transp} \Rightarrow \text{CF31}}$	50%	**>80%**	65%	**60%-75%**
$\varepsilon_{\text{transp} \Rightarrow \text{CF81}}$	80%	**70-95%**	80%	**>75%**
$\varepsilon_{\text{Accel.}}$	20%	**15-30%**	20%	**35-42%**
Total	**0.45%**	**0.54%**	**5.2%**	**7%**

(EM $^{39}K^{9+}$) (E744 $^{14}O^{4+}$)

Commissioning: summary

Modifications of the facility regarding the safety – security requirements

- Modification of the LEBT
- Modification of the ancillaries to host the SP1 charge breeder

- TIS FEBIAD connected to the SP1 carbon target
- Provide metallic beam I**>2^{E}+6pps**

- Operating time **~ 1mois**

- Optimization of the SP1 charge breeder => minimum CB efficiency of 7%
- Settings of the new beam optics

Commissioning: summary

Modifications of the facility regarding the safety – security requirements

- Modification of the LEBT
- Modification of the ancillaries to host the SP1 charge breeder

Commissioning is over

Operation time starts

- TIS FEBIAD connected to the SP1 carbon target
- Provide metallic beam I**>2^{E}+6pps**

- Operating time **~ 1mois**

- Optimization of the SP1 charge breeder => minimum CB efficiency of 7%
- Settings of the new beam optics

ONGOING R&D

Target Ion Source FEBIAD

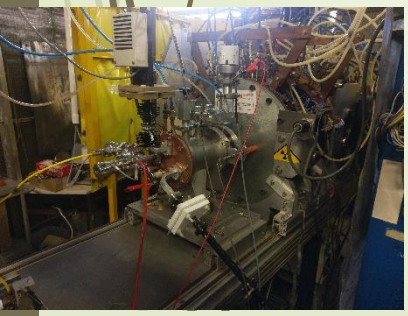
- ✓ Heat shielding ⇨ insulator protection against heat
- ✓ Chicane ⇨ insulator protection against C vapor
- ✓ Coolling FEBIAD chamber ⇨ to suppress unwanted anode current

GOAL => ONE MONTH OPERATION

P. Delahaye invited speaker at EMIS CERN 2018

SP1 Charge Breeder

- ✓ Plasma density ⇨ *talk of Arun Annaluru*
- ✓ Charge breeding time measurements
- ✓ Magnetic tip ⇨ increase CB efficiencies light elements LPSC
- ✓ Double frequency ⇨ enhance beam stability + increase HCI



GTS modification

- ✓ Towards a 1+/N+ system ⇨ *talk of Ville Toivanen*

Conclusion

- ✓Commissioning is over – Operation period begins

- ✓Almost all the goals are

Additional work on FEBIAD longevity is required
Increase CB efficiency of light elements is needed

- ✓A Multimode – Multipurpose facility is available for physicists

Thank you for your attention