Super-FRS In-kind Contributions

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SFAIR, Uppsala University, October 11, 2014

Part I: Expression of Interest

SFAIR has, so far, expressed interest in two in-kind contributions crucial to the Super-FRS (accelerator) infrastructure:

1. **A scintillator system for the Super-FRS (Lund)**
2. **A Super-FRS data acquisition system (Chalmers)**

1. A Scintillator System for Super-FRS

Needed are accurate position and time-of-flight (ToF) measurements for:

⇒ identification of fragments

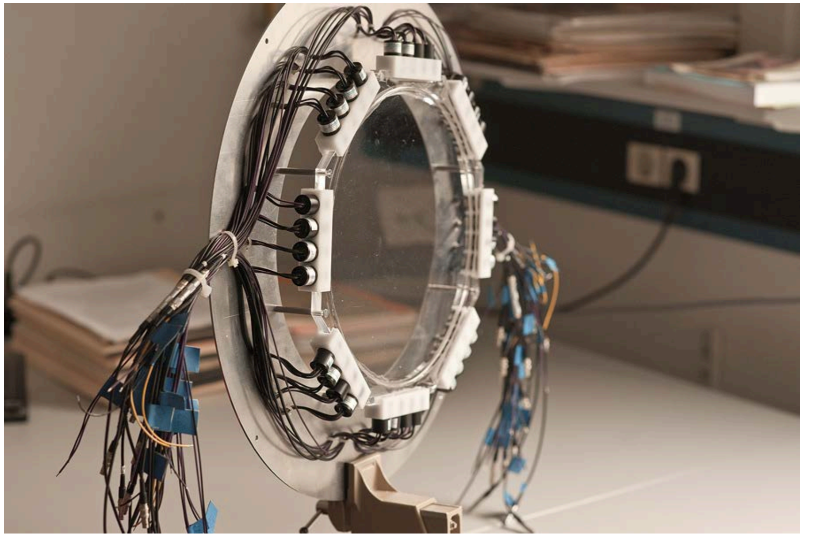
⇒ tracking and Super-FRS calibration

Needed performance:

⇒ high resolution

⇒ need to be able to sustain high rates of ions without loss of resolution

General Approach



⇒ **Use a design based on the LYCCA (Lund-York-Cologne Calorimeter) ToF detector (R. Hoischen *et al.*, NIMA 654 (2011) 354**

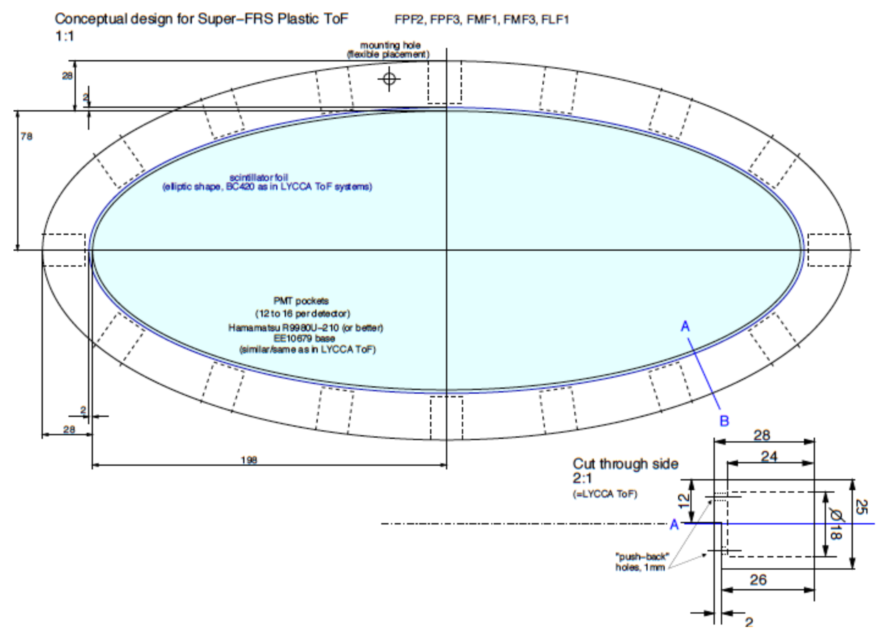
⇒ **idea: collect as many photons as possible; many independent measurements**

⇒ **Very high time resolution:**

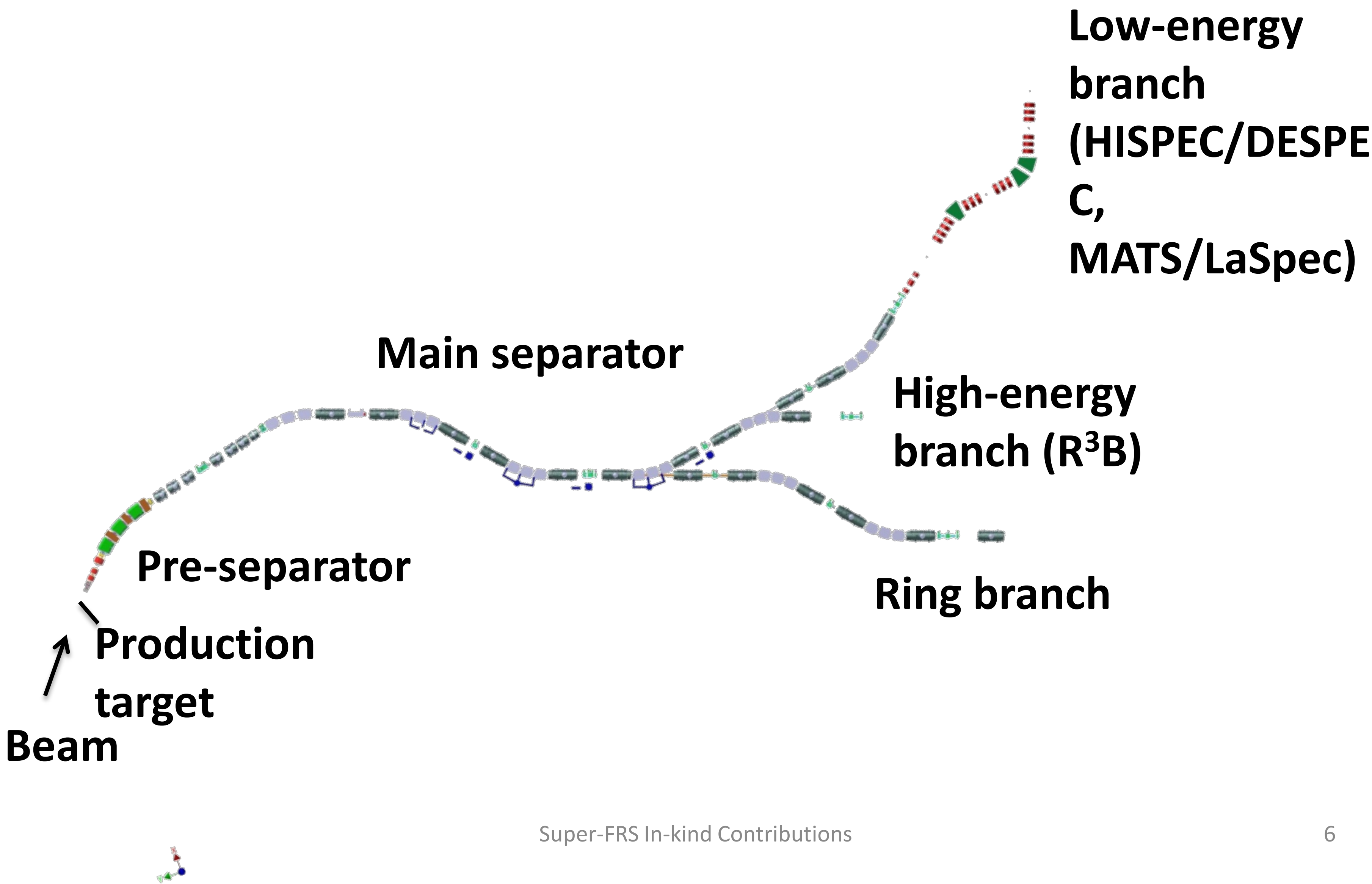
6.4 ps RMS for ^{124}Xe at 80 A MeV

Realization

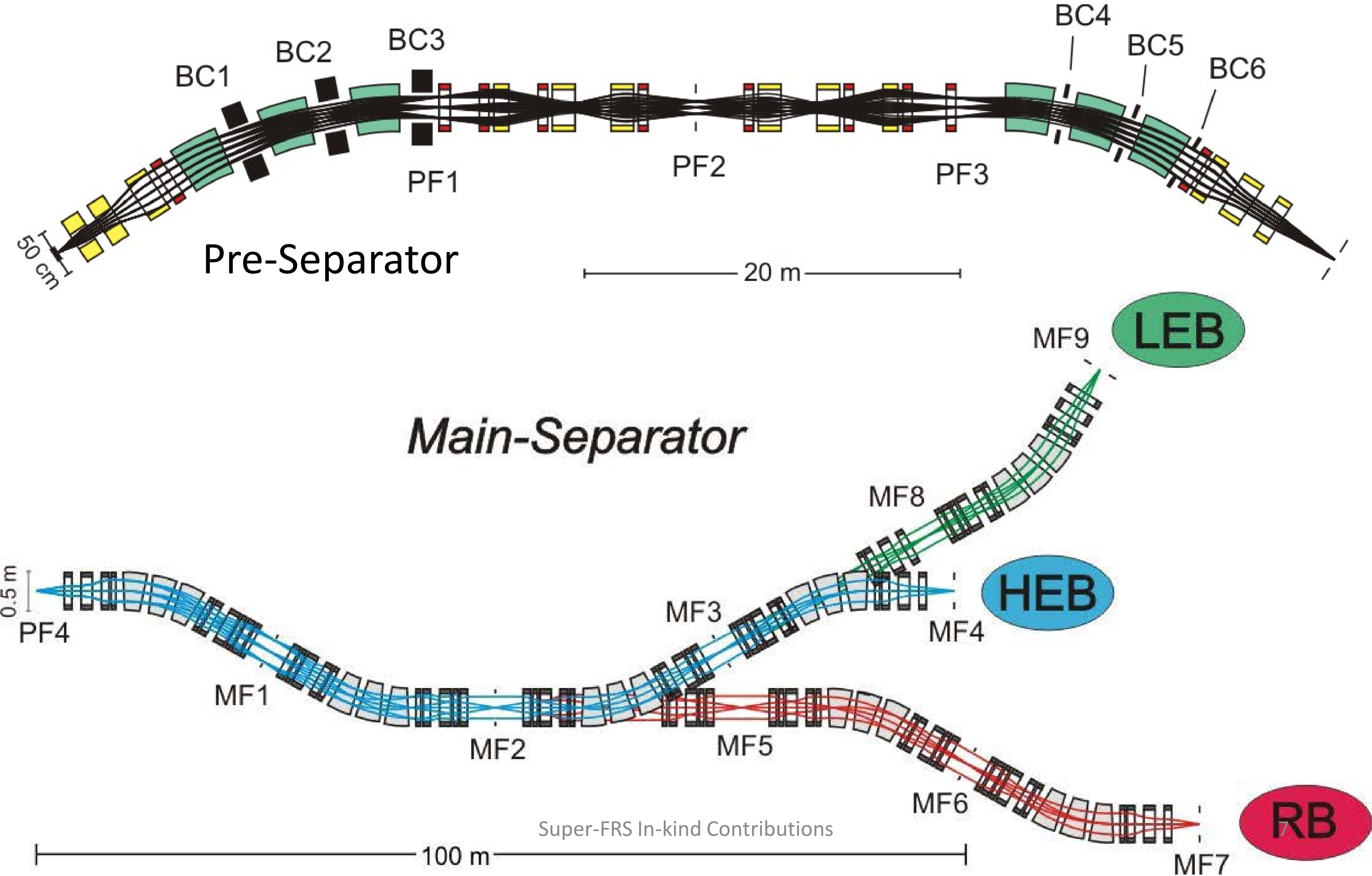
- $\Rightarrow$ **build 4-5 detectors (elliptic shape) with 12-16 PMTs, each.**
- $\Rightarrow$ **use front end cards that are able to obtain energy-loss information using a time-over threshold approach (LAND FEE cards).**
- $\Rightarrow$ **use VULOM-based TDCs (VFTX).**
- $\Rightarrow$ **electronics has been developed by GSI and was used already in experiments.**
- $\Rightarrow$ **expect a resolution of less than 50 ps FWHM**



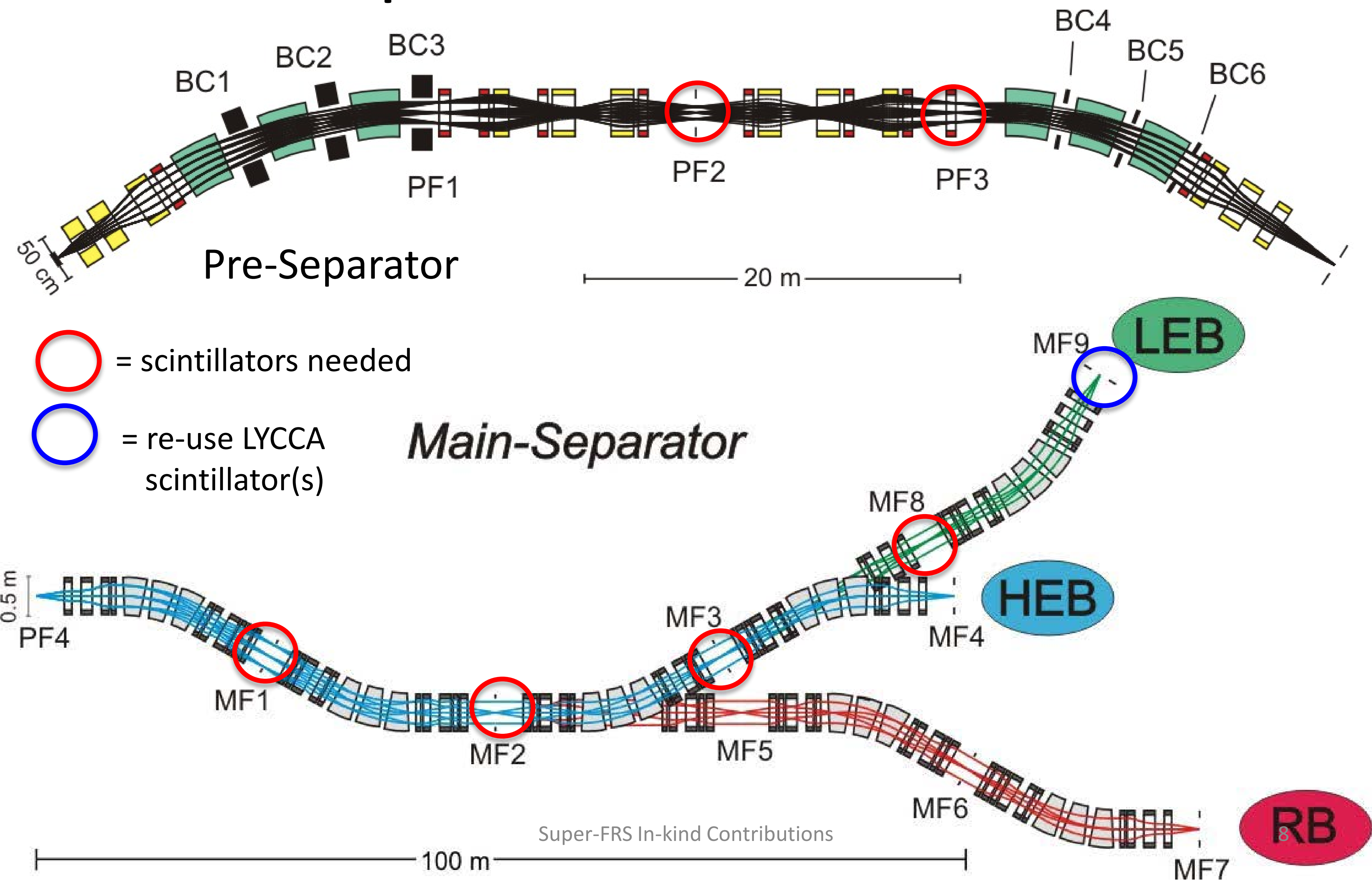
Super-FRS Layout



Super-FRS Focal Planes



Super-FRS Focal Planes



Advantages

$\Rightarrow$ **crucial for all NUSTAR experiments**

$\Rightarrow$ **excellent performance**

$\Rightarrow$ **proven technology**

$\Rightarrow$ **expertise in Lund**

2. A Super-FRS data acquisition system

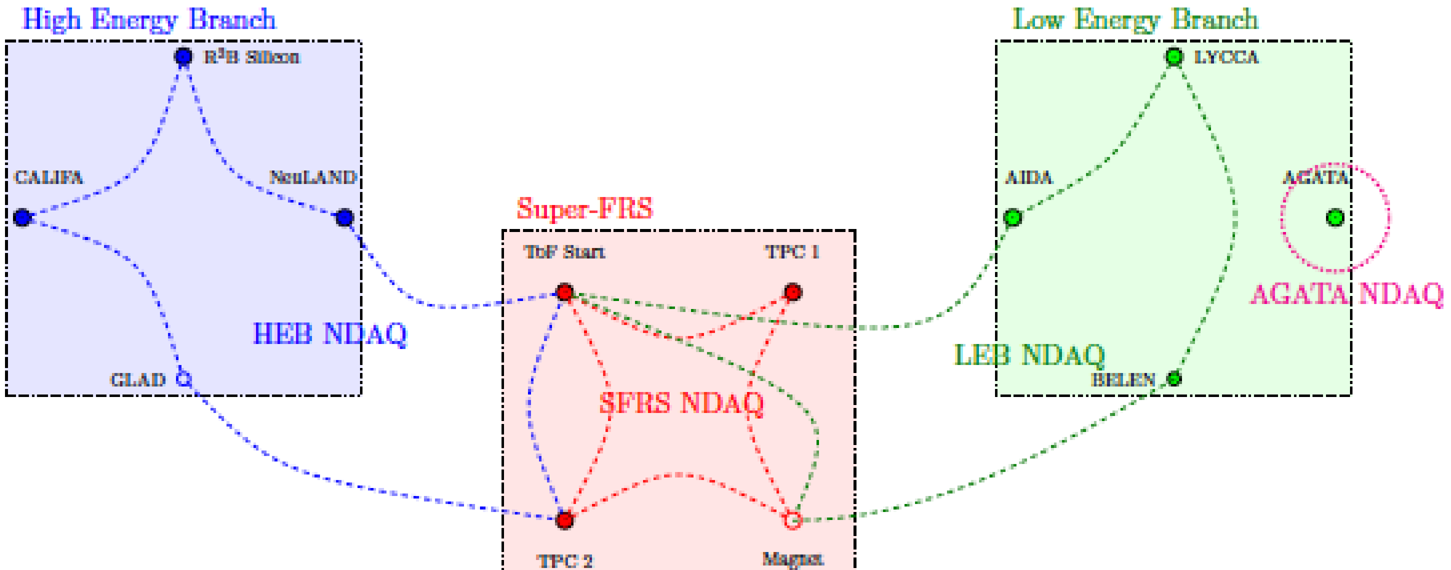
⇒ will be part of the NUSTAR Data Acquisition System (NDAQ)

⇒ background: all NUSTAR experiments need data from Super-FRS detectors
=> common approach + fixed infrastructure

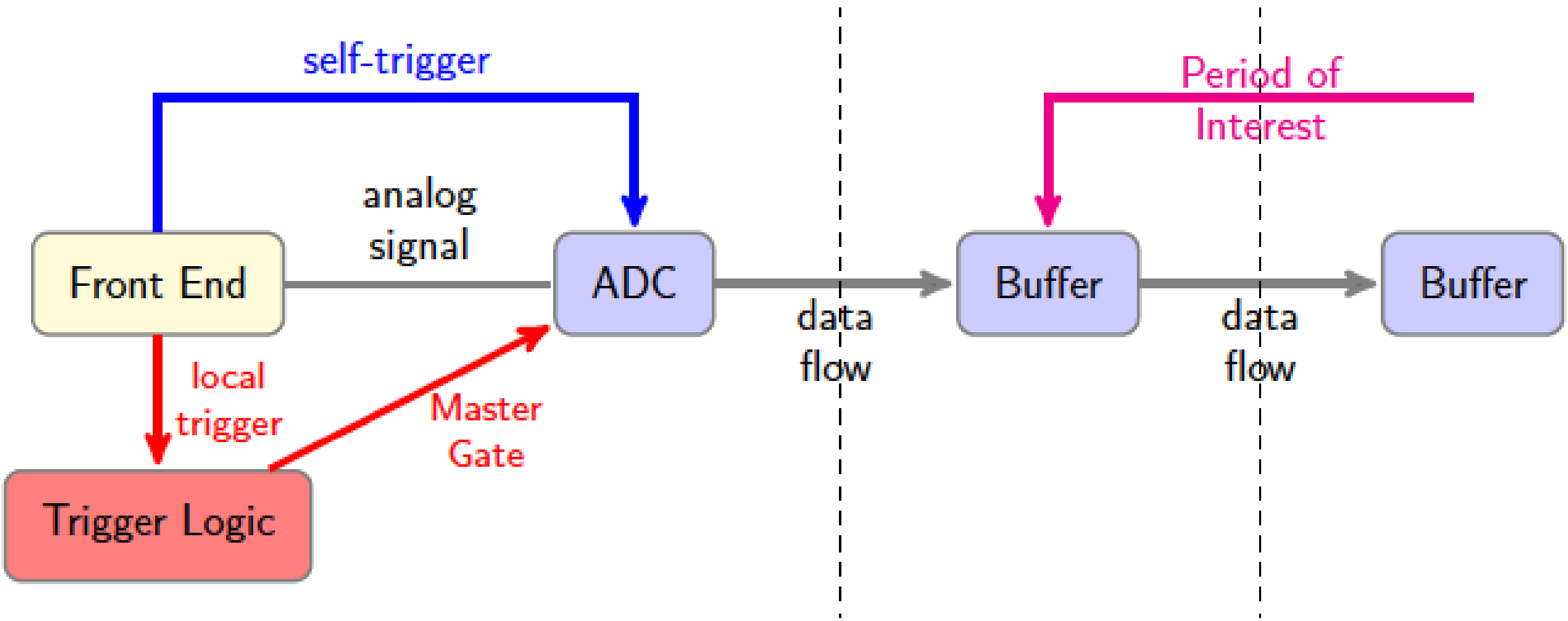
⇒ basic principles of NDAQ:

  ⇒ continuous operation; distributed DAQ

  ⇒ sub-systems (nodes) work either independently or are connected as needed

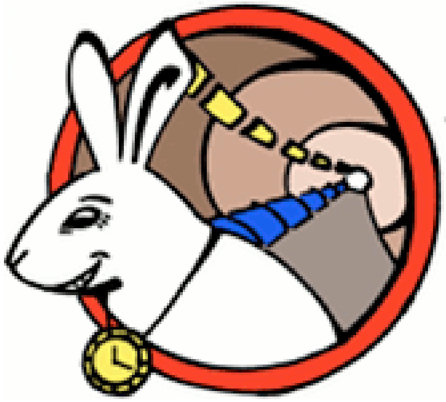


Operating Modes



Two fundamental ways of taking data:
triggered and trigger-less (free running)
$\Rightarrow$ NDAQ supports both as well as a hybrid mode.

Events and Timing



Independent sub-systems produce sub-events (triggered mode), which are time-stamped:

$\Rightarrow$ **White Rabbit provides an absolute time reference**
$\Rightarrow$ **BuTiS is used for high-accuracy time measurements (most important here: time-of-flight measurements)**

Sticky Events

Have information on hardware (detector or magnet parameters) in the listmode data stream:

⇒ needed for analysis
⇒ more reliable than human-recorded information
⇒ requires interfacing with hardware

Part II: Possible other In-kind Contributions

The two already mentioned topics have a cost-book value of 76 + 305 = 381 kEUR. Remaining money for in-kind contributions: 1.07 – 0.38 = 0.69 kEUR.
Three possibilities (PSP cost codes already assigned) for Super-FRS (accelerator) in-kind contributions:

1. **A control system for the fields of the Super-FRS magnets (385 kEUR)**
2. **Super-FRS infrastructure and control systems (329 kEUR)**
3. **A Super-FRS robot system (214 kEUR)**

1. Magnet Field Control

⇒ **Magnet field control for 27 units**

⇒ **NMR or Hall probes**

⇒ **Item for tendering and buying only;**
i.e. a plain invest item.

⇒ **3 units less than cost-book, because NMR or Hall probes would have a too short lifetime in the pre-separator - due to their sensitivity to radiation damage**

=> use only current measurement here.

2. Infrastructure and Control

⇒ **beam diagnostics and instrumentation**
⇒ **95 channels in the cost book**
⇒ **possible synergy with Super-FRS DAQ (sticky events)?**
⇒ **item still under much discussion at GSI**
⇒ **requires no only tendering/buying but also some manpower**
⇒ **very interesting with respect to our expertise.**

Robot System

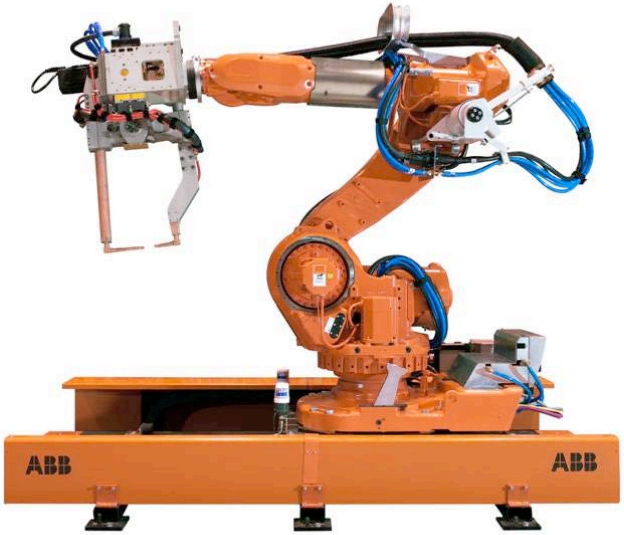
⇒ **Robot system needed due to high radiation levels.**

⇒ **robot for second dipole stage of the pre-separator (PF2 and PF4).**

⇒ **Requires engineering time.**

⇒ **Finland might be interested.**

⇒ **No expertise in SFAIR up to now**



Summary

SFAIR expressed already interest in scintillators and a data acquisition system for the Super-FRS: Both items were approved by relevant FAIR bodies.

Is there a possibility for SFAIR to take on further in-kind tasks?
Options:
- **magnet field control (385 kEUR)**
- **infrastructure and control (beam diagnostics) (329 kEUR)**
- **robot system (214 kEUR)**

Which one(s)?

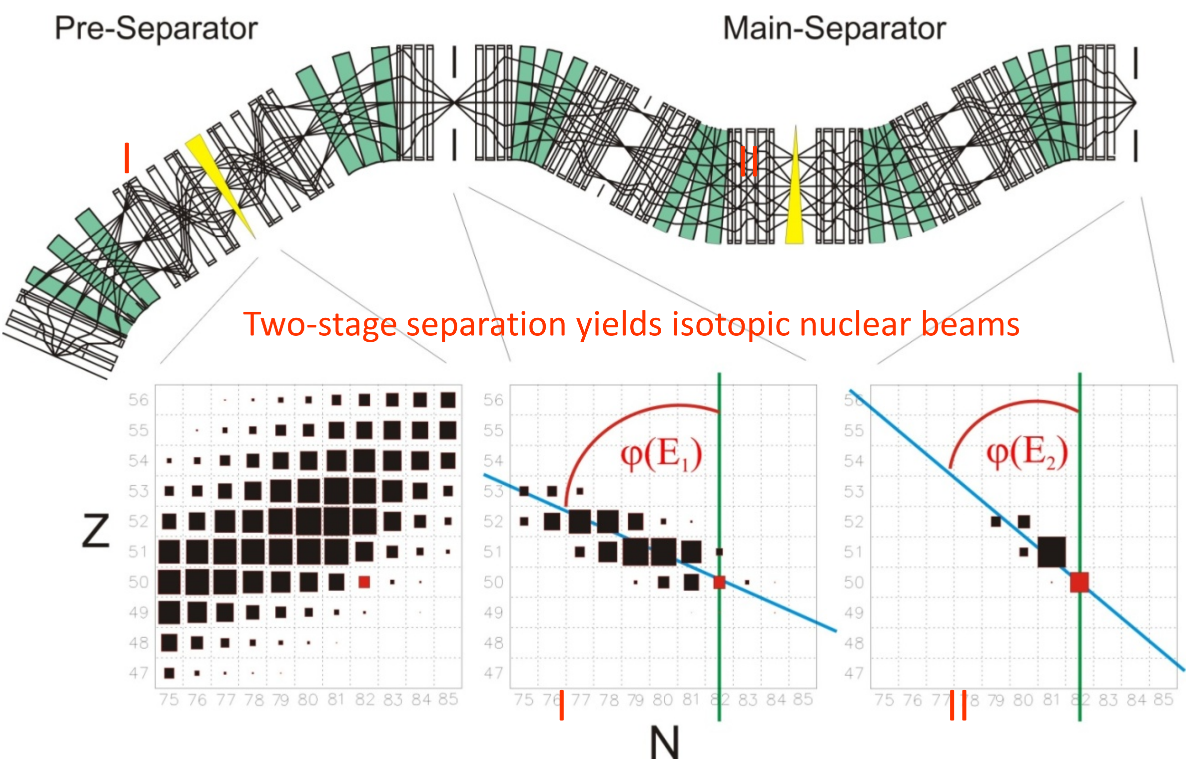
Feel free to discuss!

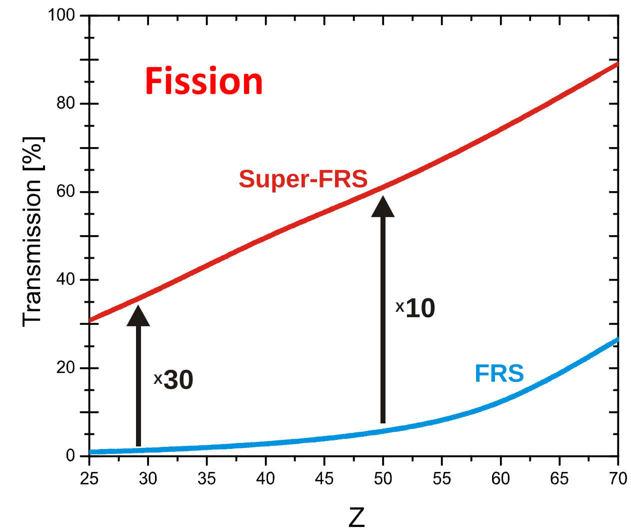
Acknowledgements

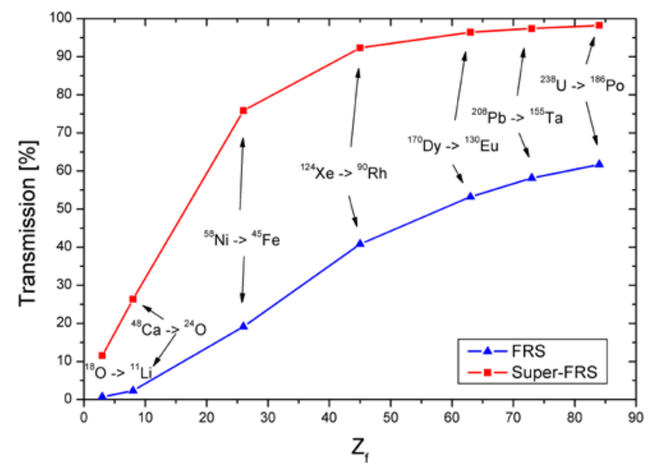
A. Charpy, A. Chatillion, R. Gernhäuser, H.T. Johansson, N. Kurz, I. Lazarus, T. Le Bleis, B. Loeher, T. Nilsson, C. Nociforo, S. Pietri, C. Pucknell, D. Rudolph, H. Schaffner, H. Simon

BACK-UP SLIDES

The Super-FRS

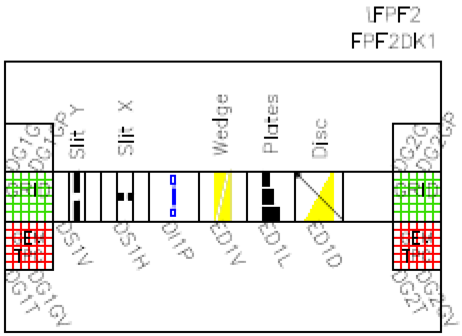


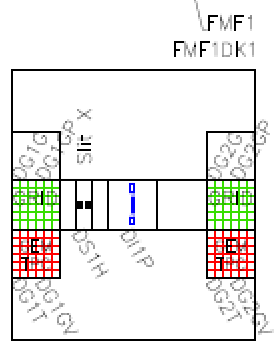


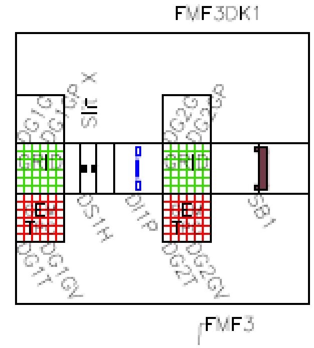


- High acceptance for projectile fragments and fission products
- Two-stage separation absolutely needed for clean beams
- **More than one order of magnitude transmission gain relative to FRS**

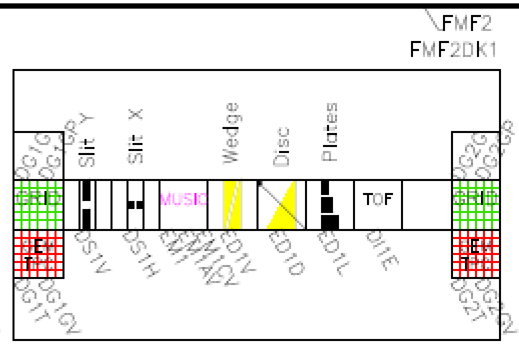
Plastics scintillators at the Super-FRS



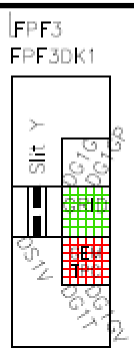




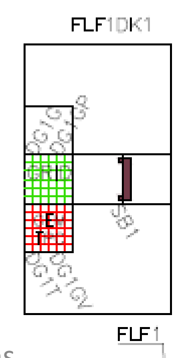
3 plastic scintillators **needed**, (1 pre-separator design at FPF2, 2 main-separator design at FMF1/FMF3) to be used for calibrations.



1 finger scintillator at FMF2 will be provided by the HISPEC/DESPEC collaboration.



1 **additional** plastic scintillator (pre-separator design FPF3) for trigger only.
This position is critical because there is not so much space available.



1 **addtional** plastic scintillators (main-separator design FLF1) for trigger only.

Table of plastics scintillators at the Super-FRS

focal plane	Nr.	detector	size type	x (mm)	y (mm)	D (cm/%)	max rate / spi
FPF0						0	
FPF2						-2.58	
	2	GEM-TPC	A	380	80		$<10^7$
	1	plastic	A	380	100		
FPF3						4.07	
	1	plastics	B	380	150		
	1	GEM-TPC	B	380	150		$<10^7$
FPF4						0	
FMF1						6.4	
	2	GEM-TPC	A	380	80		10^7
	1	plastic	A	380	100		
FMF2						-5.24	
FMF3						6.4	
	2	GEM-TPC	A	380	80		10^7
	1	plastic	A	380	100		
FHF1						0	

GEM-TPC in vacuum	Type	Nr.	
	A=	4	
	B=	0	
	C=	0	
total		4	(+6)

plastics in vacuum	Type	Nr.
	A=	4
	B=	1
	C=	0
		5

GEM-TPC no twin	Type	Nr.
	A=	3
	B=	1
	C=	0
total		4

focal plane	Nr.	detector	size type	x (mm)	y (mm)	D (cm/%)	max rate /spill
FLF1						-5.63	
	1	plastics	A	380	100		
	1	GEM-TPC	A	380	80		$<10^7$
FLF2						0	

The thicknesses foreseen **1 mm** and **3 mm**.

Good timing resolution required for all, except the one at FPF3.

Super-FRS Layout