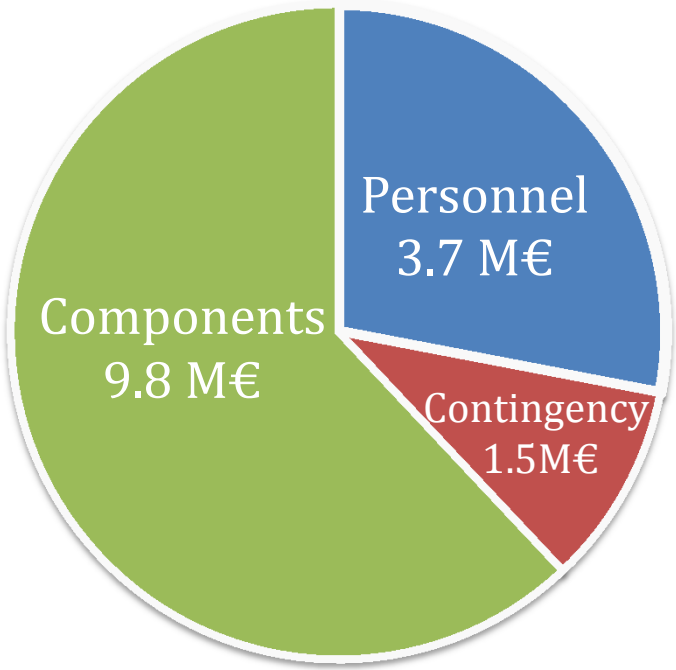
Cost Category C

"ESS management defined a preliminary budget of 15 M€ for this instrument project "

10 % contingency

Allocated budget : 13.5 M€
Labor Value 3.7 M€
Components share : 9.8 M€



Configurations

- The 3 configurations share the following budget items:
  labor value
  neutron guide
  shielding & exp cave
  heavy shutter
  detector vessel
  infrastructures

- What´s different?

	Cost category	Competitive	Full scope
extraction of cold neutrons	NO	YES	YES
detector coverage	≤19 %	≥ 50 %	100 %
SEE	cryofurnace	basic	full
Choppers	basic	T0, FAN	2 T0
PA	NO	YES	YES
Collimators	NO	YES	YES

Configurations: summary of budget

	within cost category C	competitive	full scope	proposal
Beam transport and conditioning system	6260	7361	7731	7110
Sample exposure system	70	289	1737	200
Scattering characterization system	2408	5090	6085	4220
Experimental cave	725			650
Control Hutch	25			30
Sample preparation area	26			0
Utilities distribution (Infrastructure)	185			0
Support infrastructure	44			0
Integration control and monitoring	56	94		0
labor	3711			4080
contingency	1501	1950	2262	2642
consumables				1000
total cost in k€:	**15010**	**19499**	**22624**	**19932**

Cost of the optics

Swiss Neutronics: budgetary information July ‘16

Supermirrors	2.3 M€
Mechanical equipment	0.6 M€
Installation & alignment	0.1 M€
TOTAL	3 M€

Design as close as possible to recommended ESS-standard

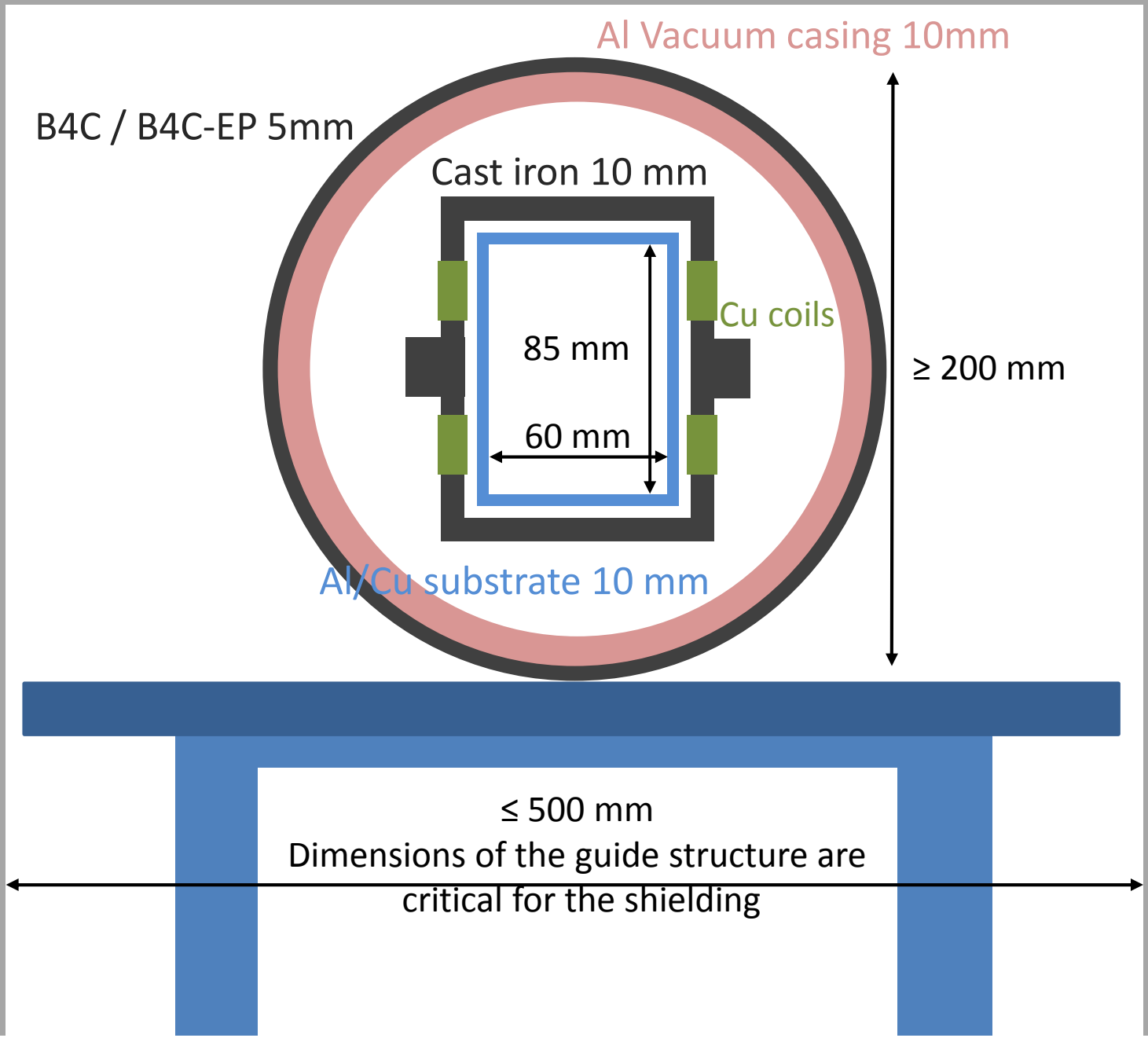
Shielding: ESS-cost calculation process

… “agreed process with ESS management that should provide a 10% error bar on the positive side meaning that the safety shielding budget should not increase by more than 10% with the available information” …

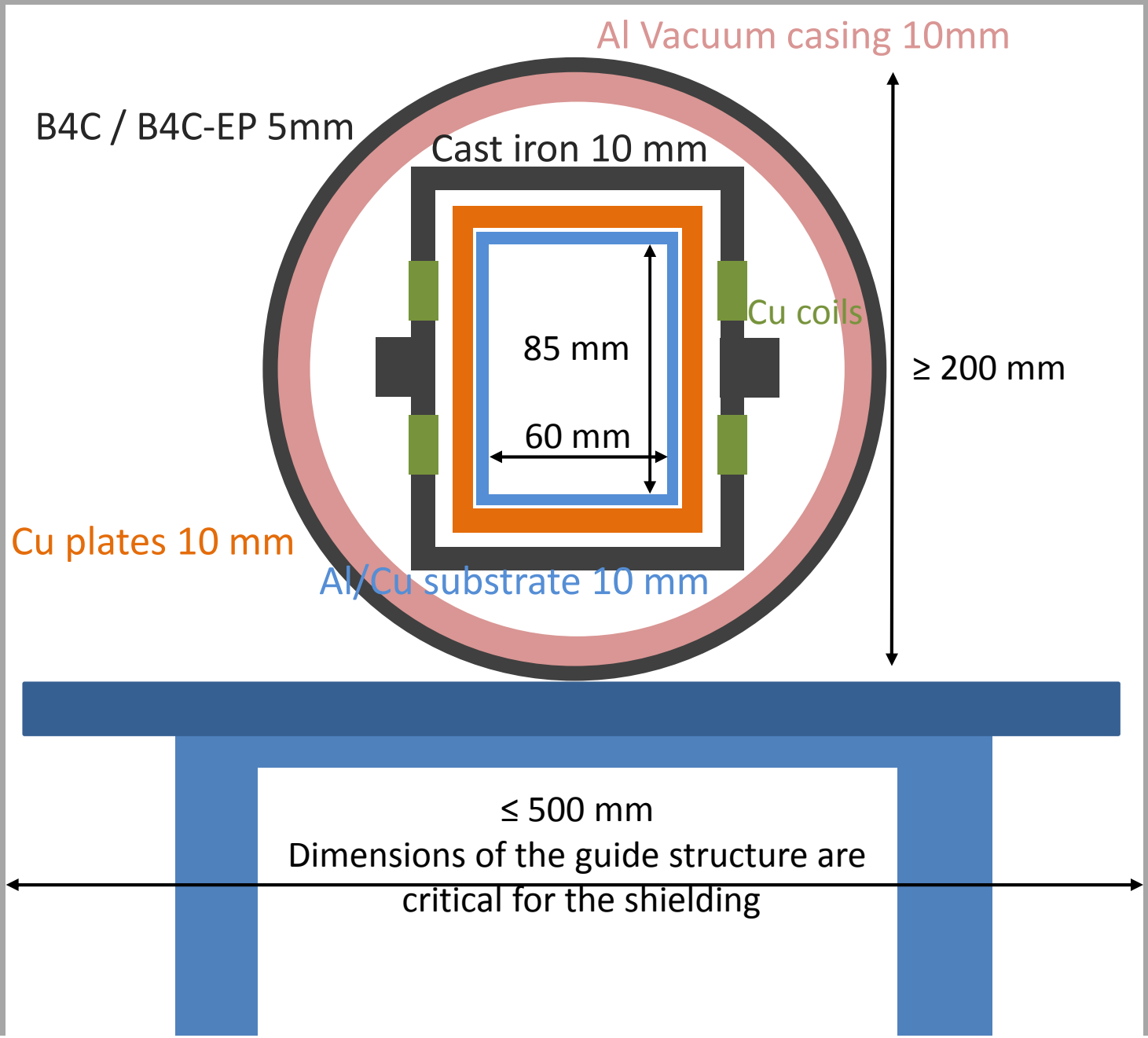
	Steel (m)	Concrete (m)
< 28 m	bunker	
28 m < L < 45 m	0.35	0.3
45 m < L < 50 m	0.25	0.3
50 m < L < 162 m	0.18 m < x < 0.28 according to m-index	0.6
162 m < L < 172 m	Experimental Cave	

Engineering design ?
Potential savings communal shielding

Shielding


Al Vacuum casing 10mm
B4C / B4C-EP 5mm
Cast iron 10 mm
Cu coils
85 mm
60 mm
≥ 200 mm
Al/Cu substrate 10 mm
≤ 500 mm
Dimensions of the guide structure are critical for the shielding

Shielding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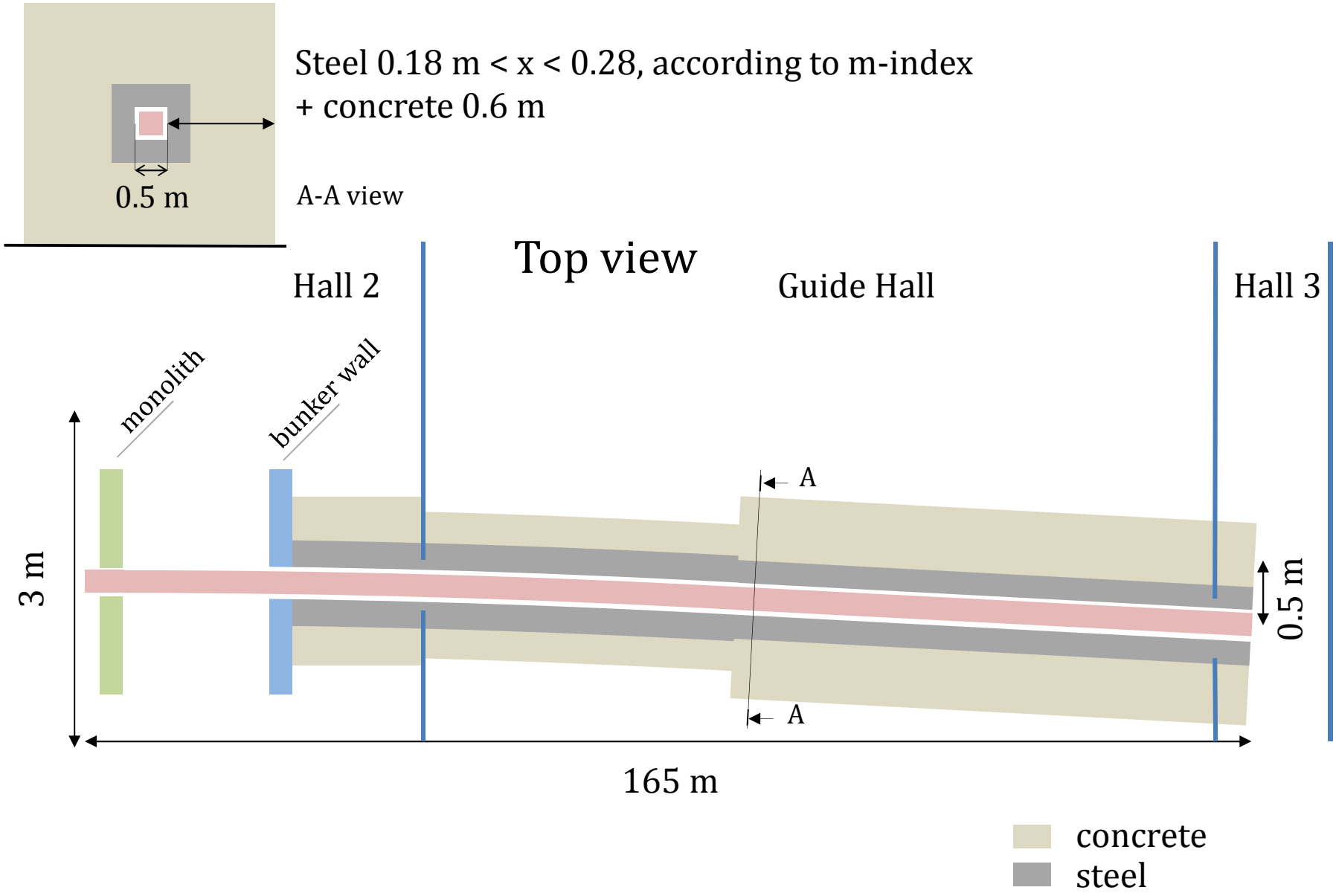
B4C / B4C-EP 5mm
Cast iron 10 mm
Cu coils
85 mm
60 mm
≥ 200 mm
Cu plates 10 mm
Al/Cu substrate 10 mm
≤ 500 mm
Dimensions of the guide structure are critical for the shielding

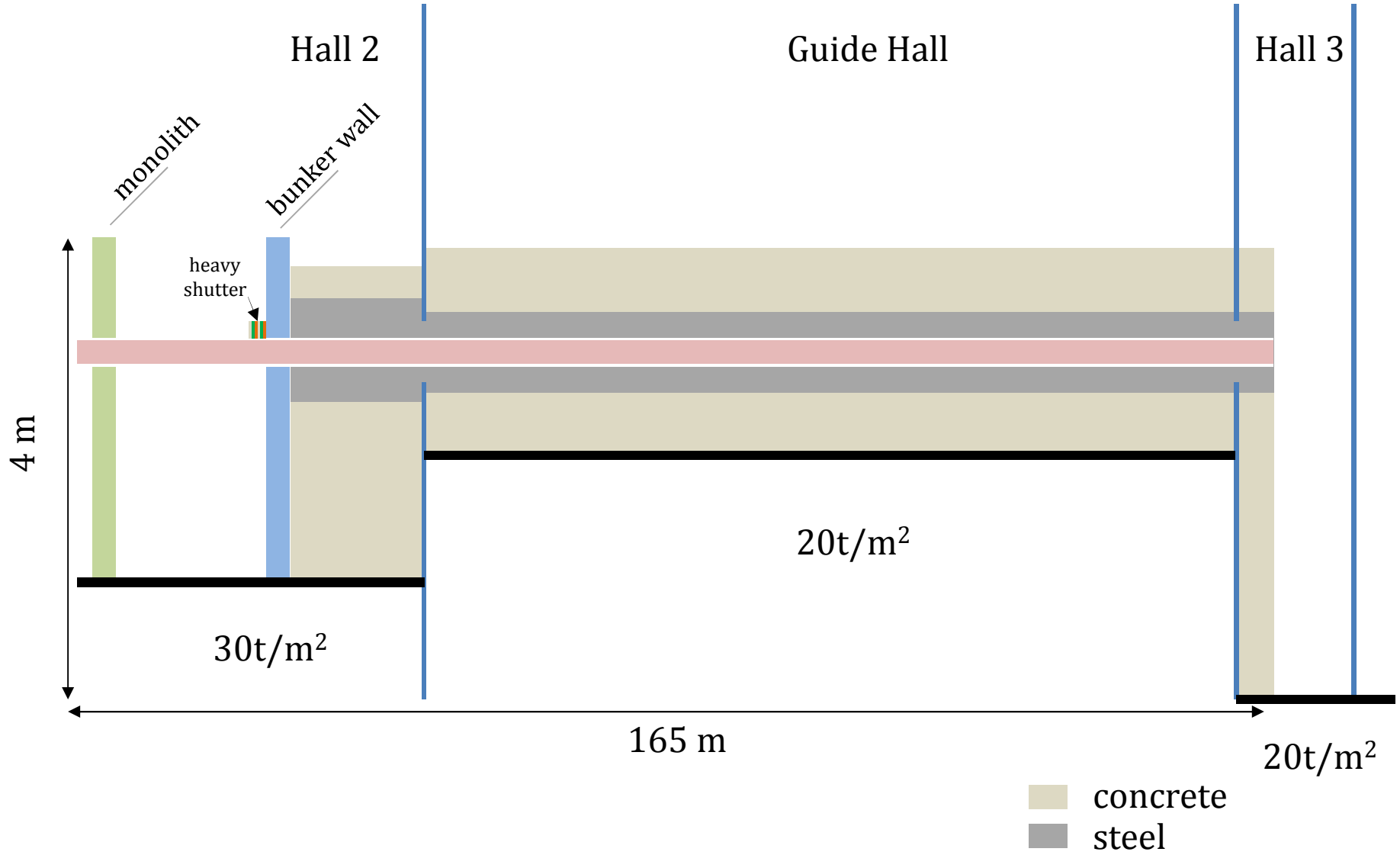
Shielding: ESS-cost calculation process



TOTAL
1355 t concrete
712 t steel

Expected cost: 1,5 M€

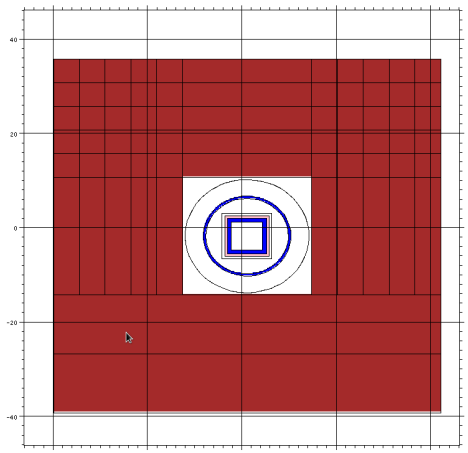
Side view

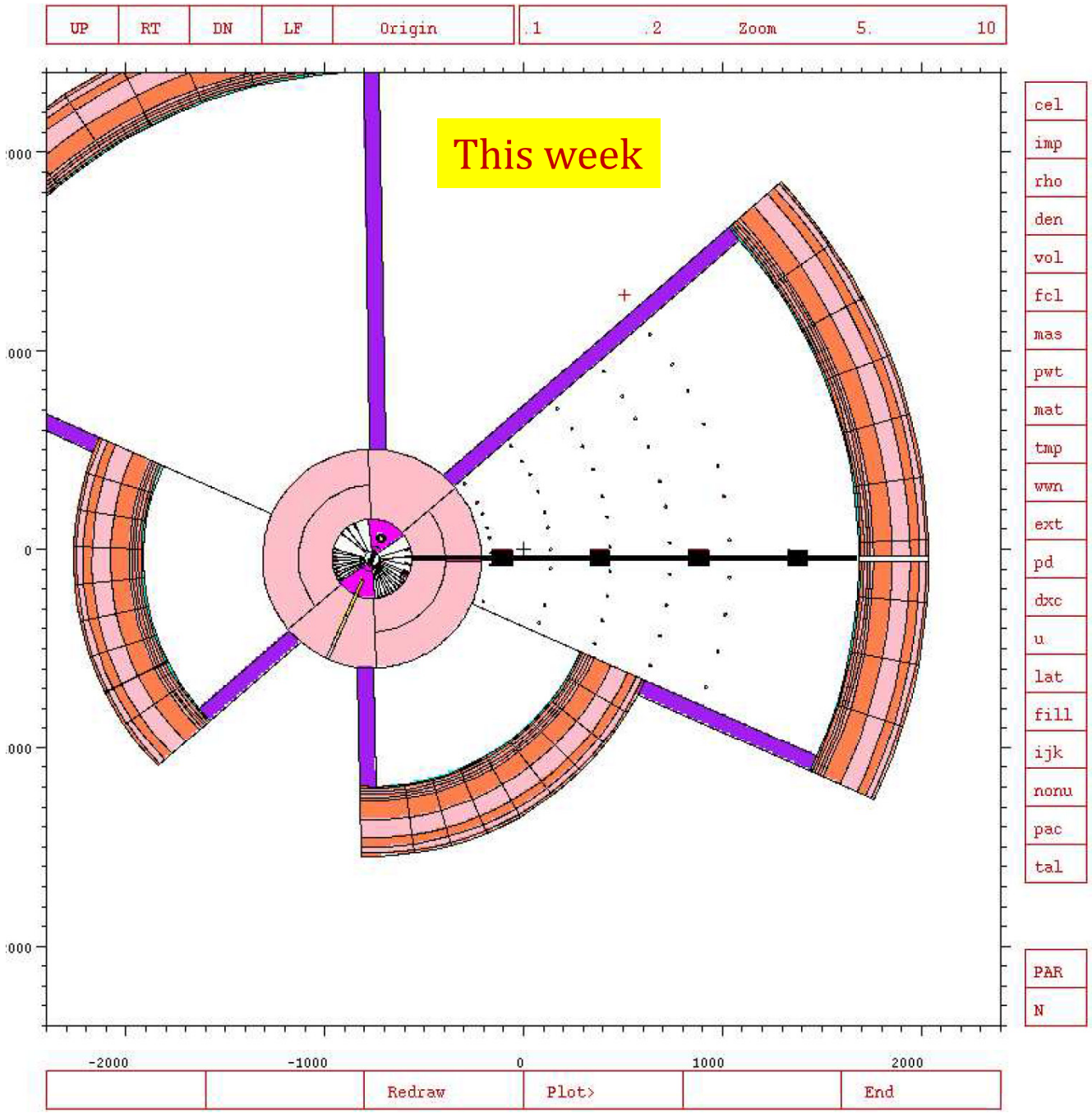


Shielding:

Review
phase 1 → phase 2

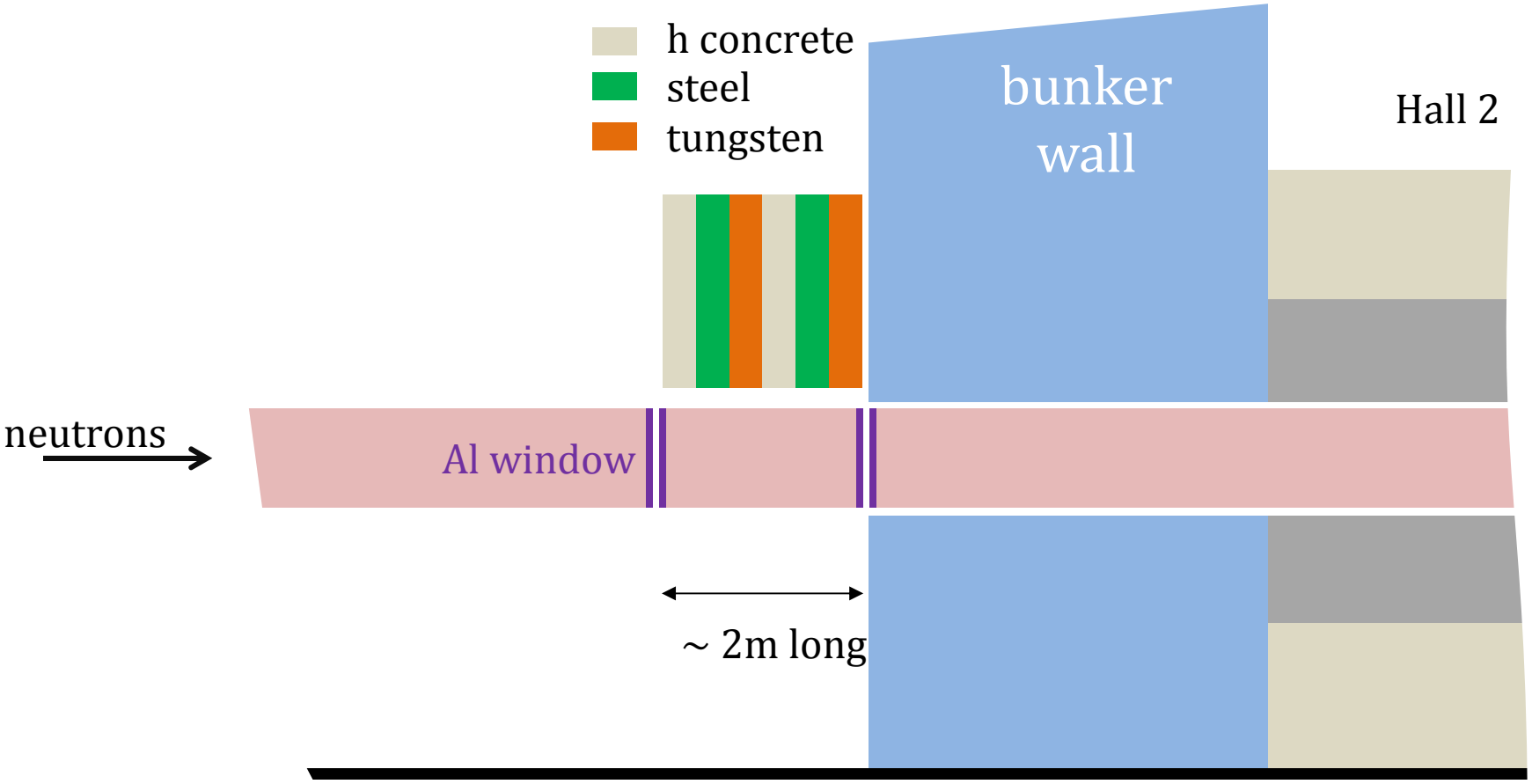
MCNP simulations going on to optimize the shielding for bg and for cost

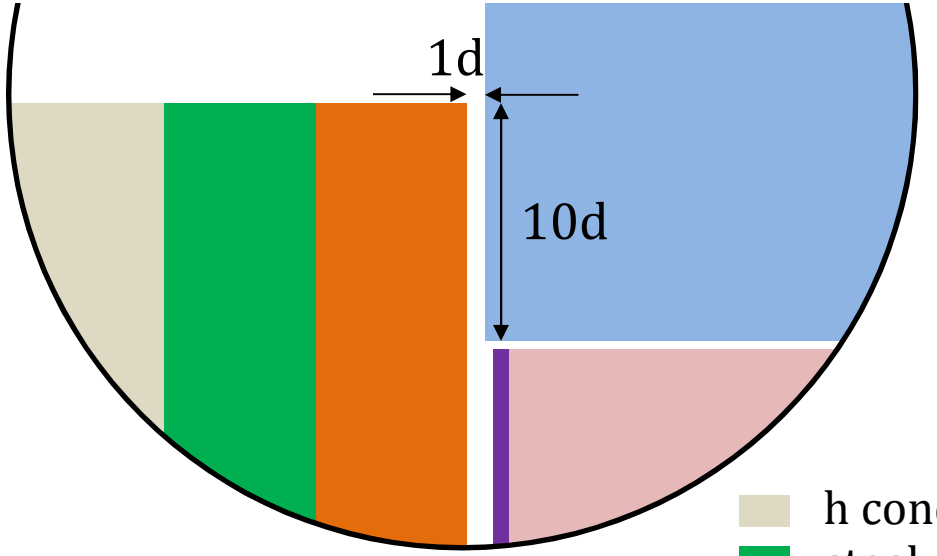




Heavy shutter preliminary concept

Rotating ?
Inside the wall ?
Shall carry the guide field





d = 3 mm
Cross section ≤ 26 x 26 cm^2
Weight: 4 t
Expected cost: 168 k€

h concrete
steel
tungsten

bunker wall

Hall 2

neutrons

Al window

Goal :
1.5 µSv/h

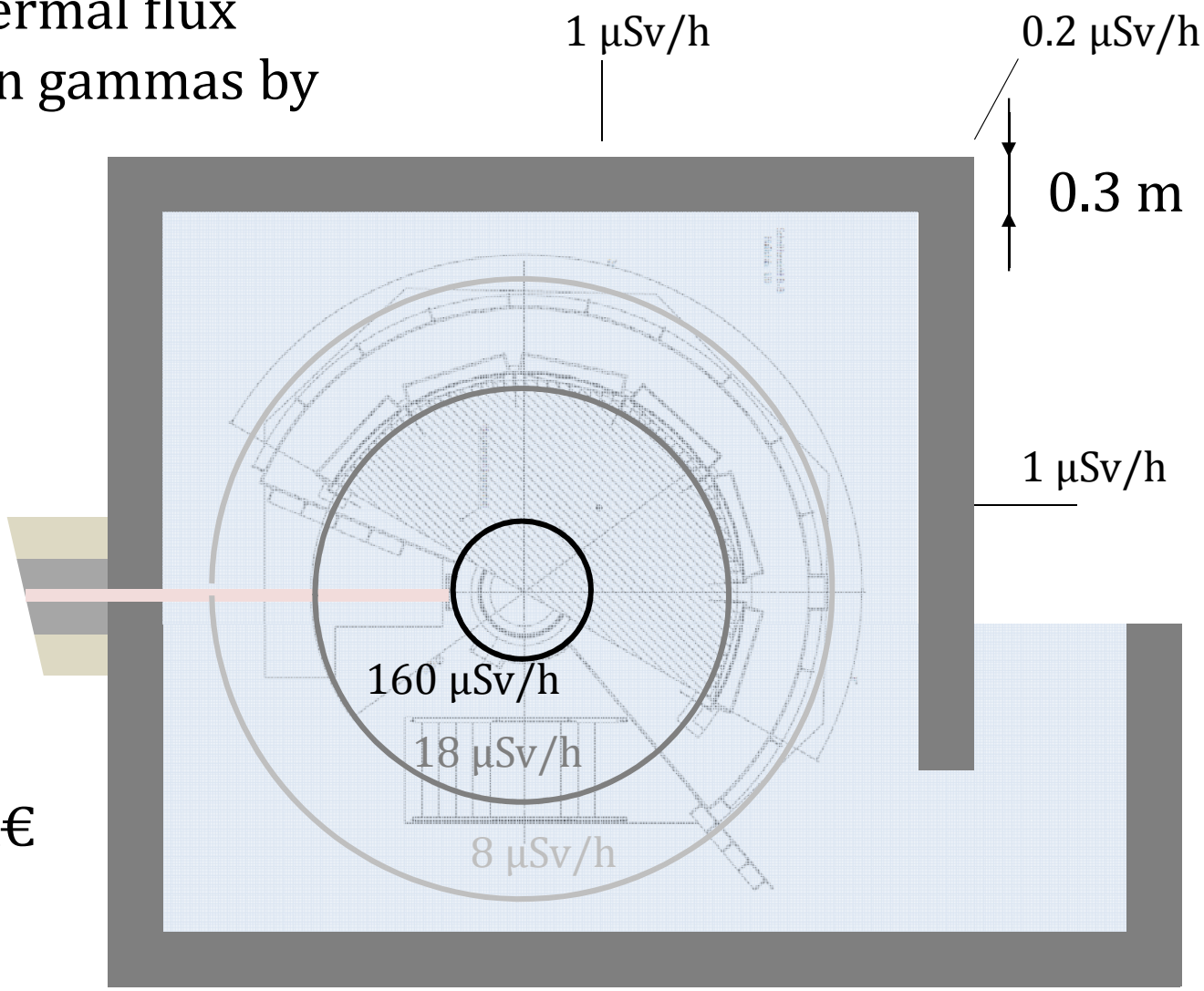
Experimental Cave

No direct view → thermal flux
≤10^9 n/s converted in gammas by
3 cm^3 FeCd

6 m high walls

Load = 4.5 t/m^2

Expected cost: 418 k€



Infrastructures budgetary information from

- ESS-0063538 defines the ESS-NSS contribution

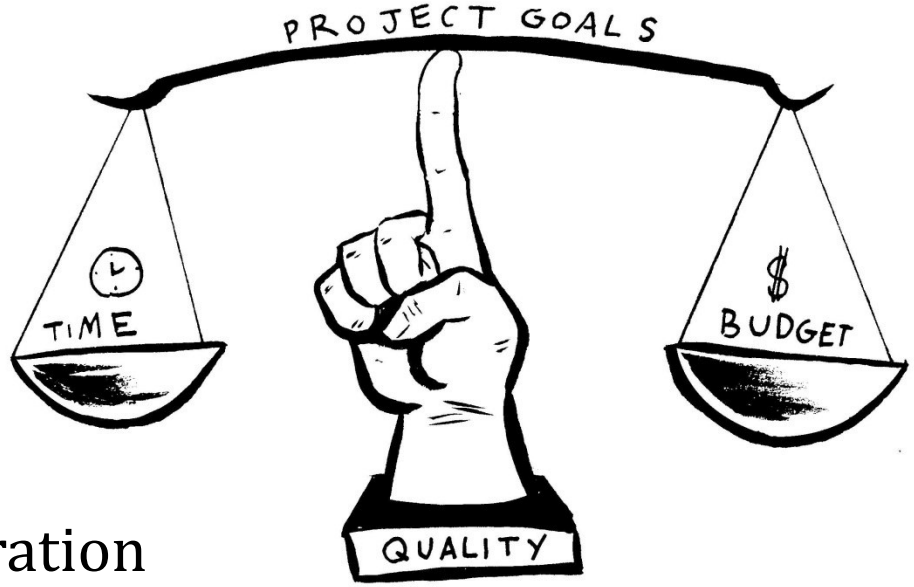
Vacuum system for 326.7 k€
ICS standards
DMSC scope includes INS software + in-KIND for QENS software

Installation in instrument budget: 2 FTEy at 48€/h

- Lead Engineer NSS

Utilities infrastructure: power and other media, SEE panels, connection to ventilation, lighting, water leak detection, video, public address
Utilities distribution + cooling system
Modification of bunker wall + gamma shutter
For a total cost: 300k€

Scope setting Meeting configurations



Full scope configuration

Competitive configuration

- does not fit into cost category
- main driver: scientific case coverage
- performance reduced
- upgradable by design to reach full scope

Within cost category configuration

- early success is compromised

Configuration 1 : within cost category C (15 M€)

DO NOT INCLUDE:

the bender for extraction of cold neutrons	-30% science case
the T0 chopper	2 orders of magnitude S/N
the FAN chopper	NO QENS ps time domain
collimators of the incident beam	NO large length scales
radial oscillating collimator	1 order of magnitude S/N
PA devices	-50 % science case
insufficient detector coverage	NO mapping capabilities

STRONG Negative scientific impact

Reduced Q-E range

Reduced performance at the same flux gain

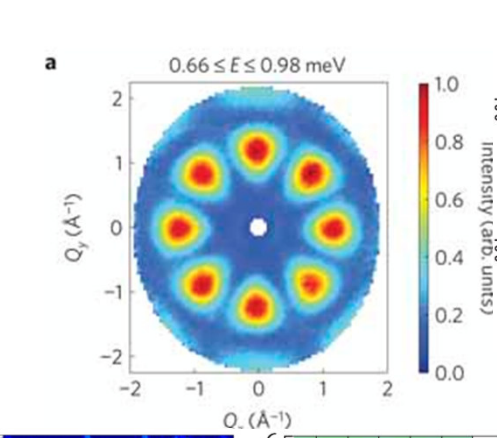
No PA -50% science case

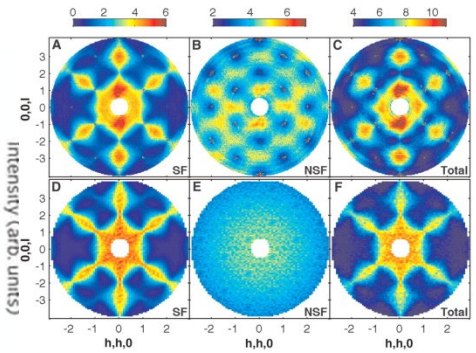
Not optimal S/N

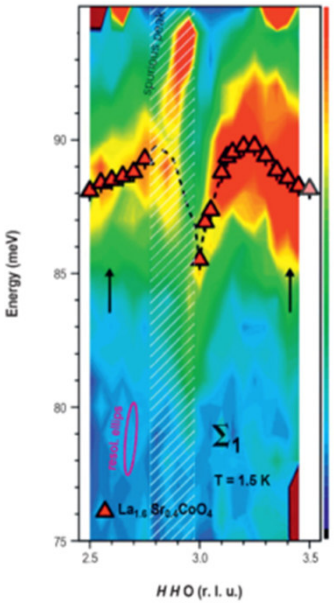
Only T control available (mK range not achieveable)

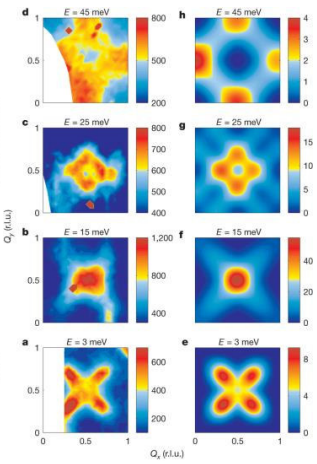
No HR using cold neutrons

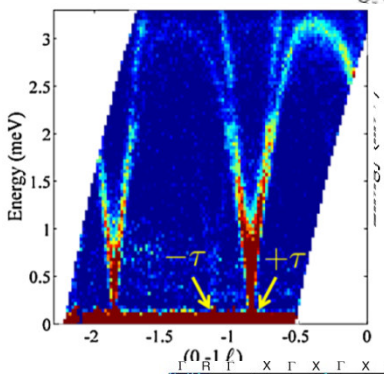
T-REX Science Cloud

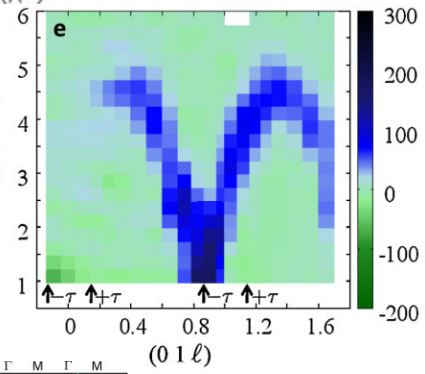


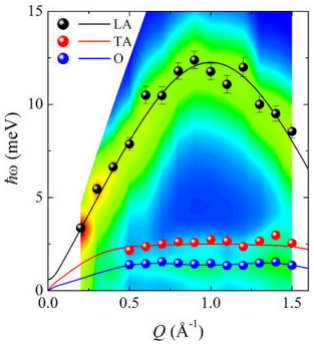


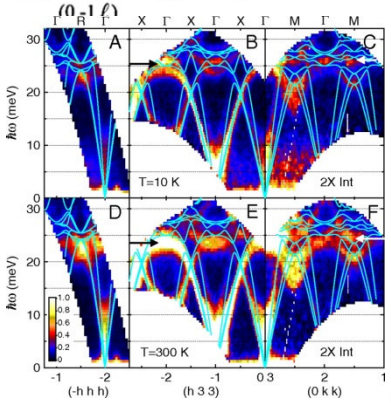


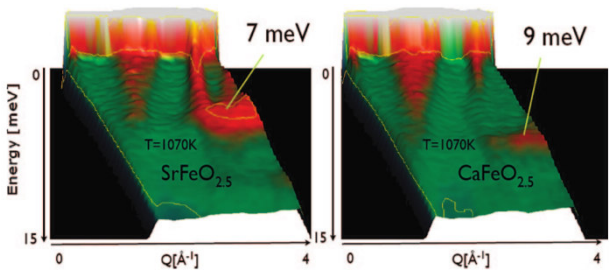


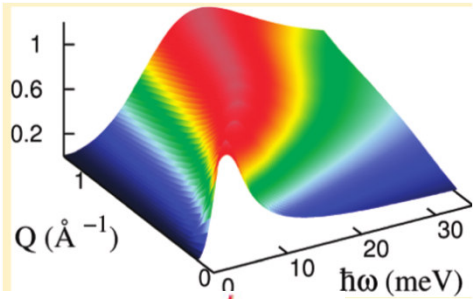


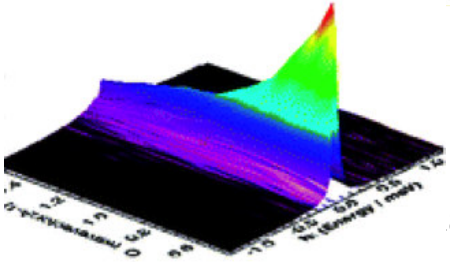




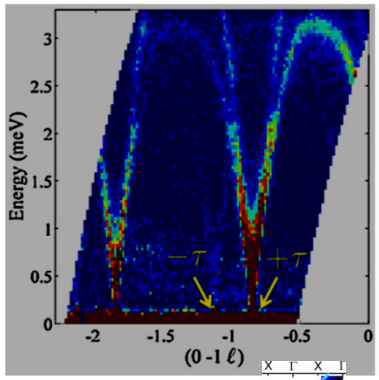


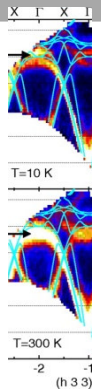


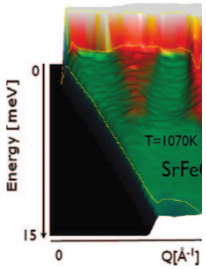


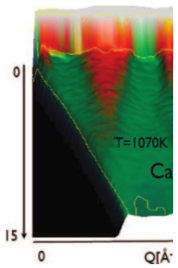


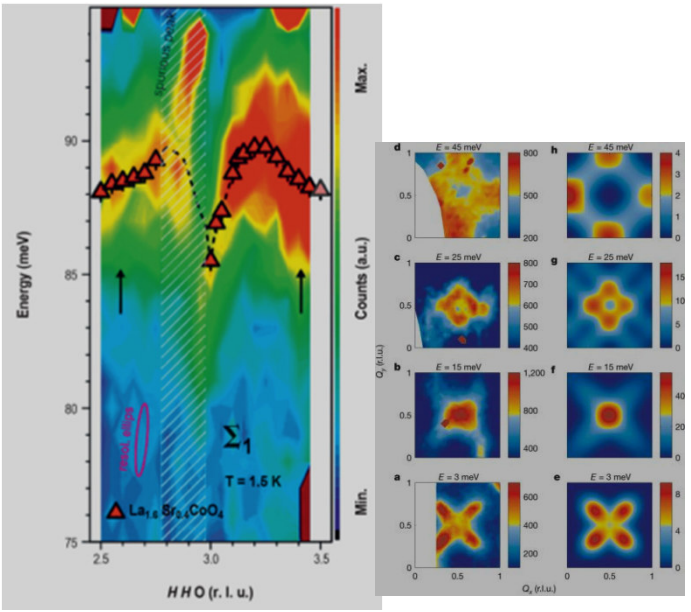
STRONG impact

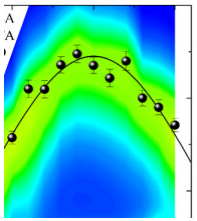


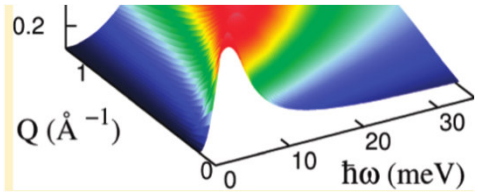












Upgrade path:

Increase detector coverage might take too long and be too expensive

Reduced performance for PA cold neutrons

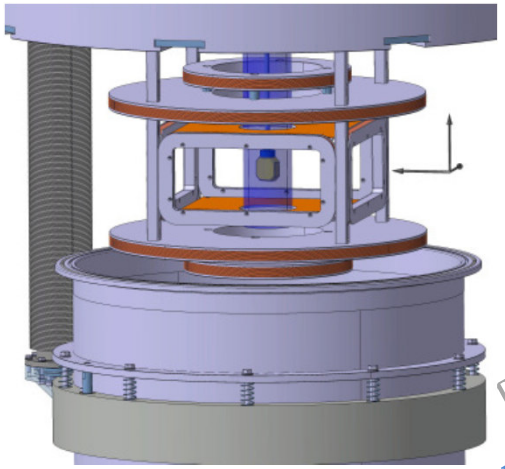
Uncertain for bender and T0 chopper inside bunker

FAN chopper

How to reconquer 50% of science case

x-y-z analysis

Wide angular range



Magic PASTIS

Exp cave

FANC MC

PSC

ГОС

LoS

Hall 3

guide field along the guide (20 Gauss)

^{3}He cell

155 m

bender

shutter BWC

1 2

Guide Hall

-0.2°

90 m

Hall 2

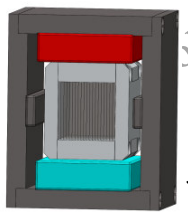
curved guide R=19.5 km

bunker

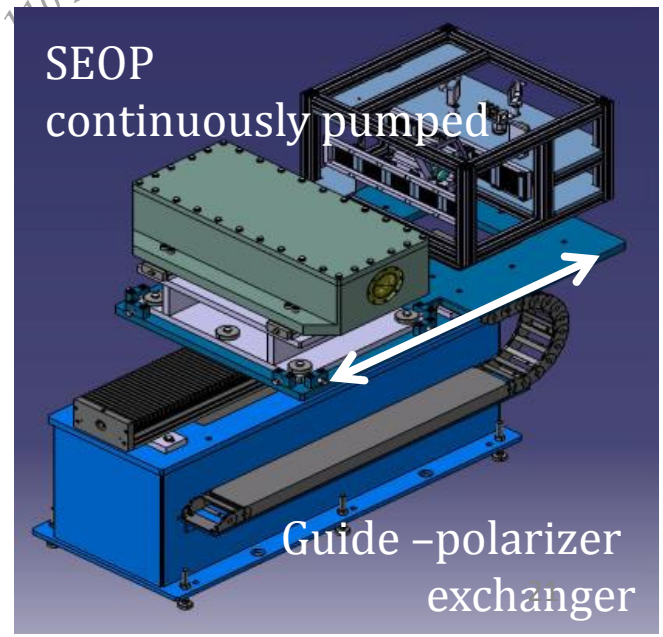
50 m

28 m

6 m

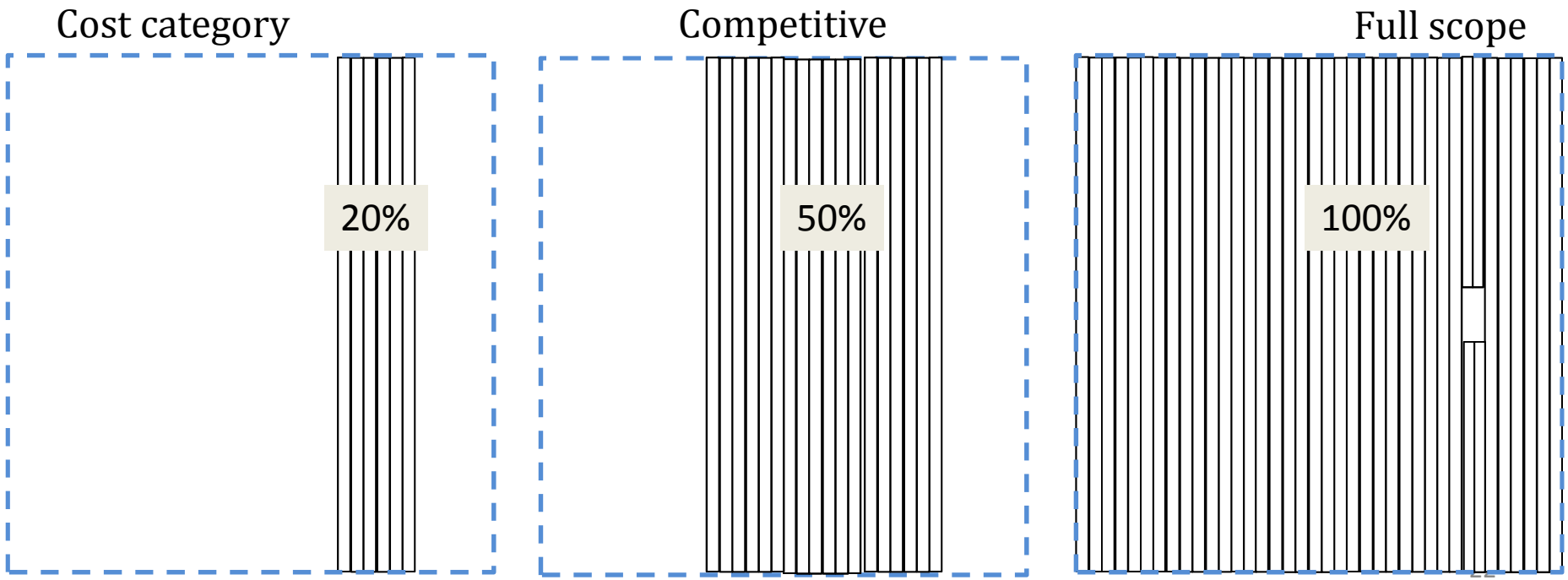


Expected cost: 547 k€



Configuration 1 : upgrade of detector coverage

Upgrade path description	MG detectors	^{3}He PSD tubes
Increasing detector coverage from Configuration 1 to “Competitive”	2.35 M€	2.35 M€
Increasing detector coverage from Configuration 1 to “Full Scope”	3.48 M€	6.06 M€



Configuration 1 : how to improve S/N

T0 chopper is necessary for thermal instrument

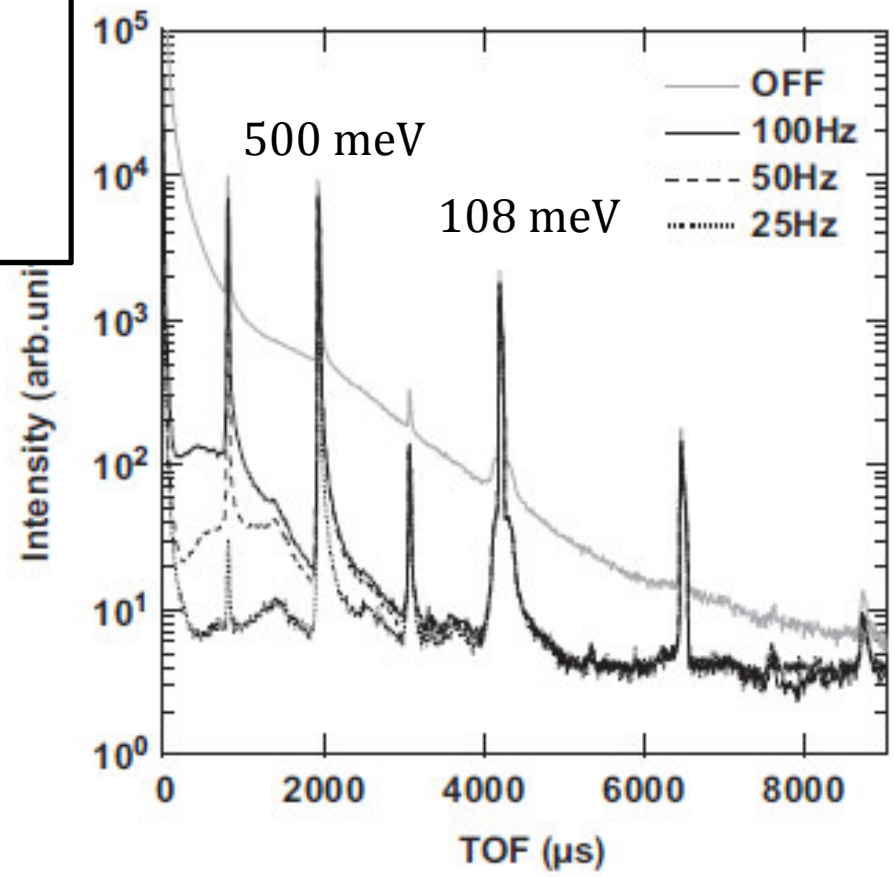
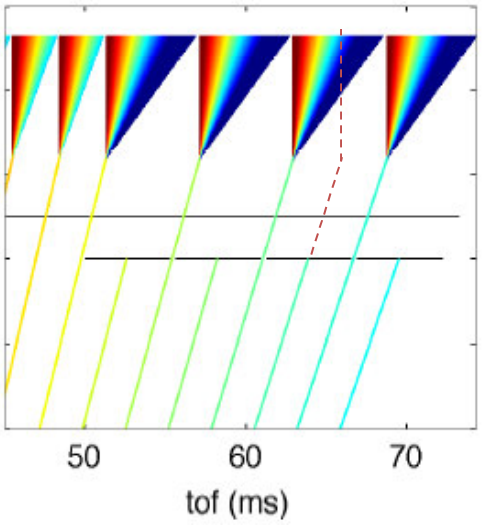


Fig. 11. Effect of T0 chopper on background-noise reduction for monochromatic neutron beam. The TOF spectra for the T0 chopper operation at 100 Hz, 50 Hz, 25 Hz, and in no operation (OFF) condition are indicated.

Low background is often considered a proof of design quality → Early reputation

S. Itoh, NIMA, 661 (2012) 86-92

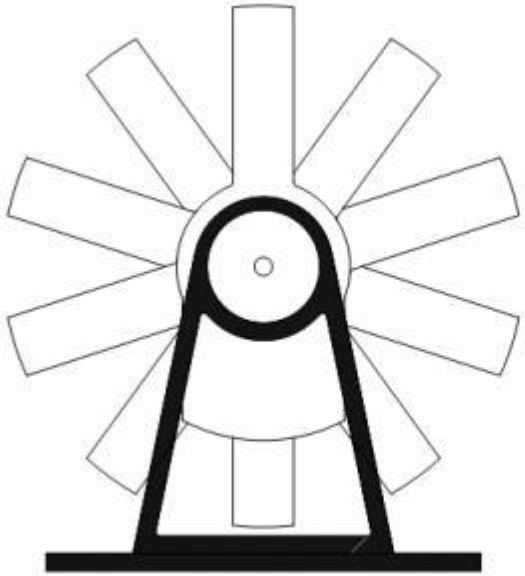
Configuration 1 : how to .. QENS at ps



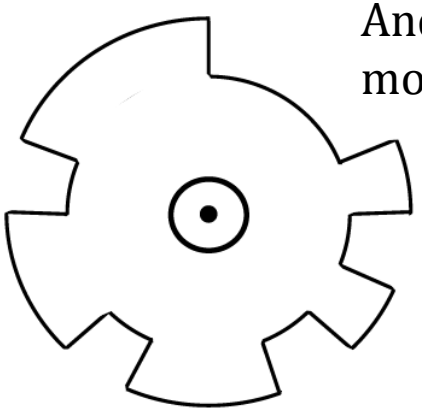
detector

M-chopper

FAN chopper



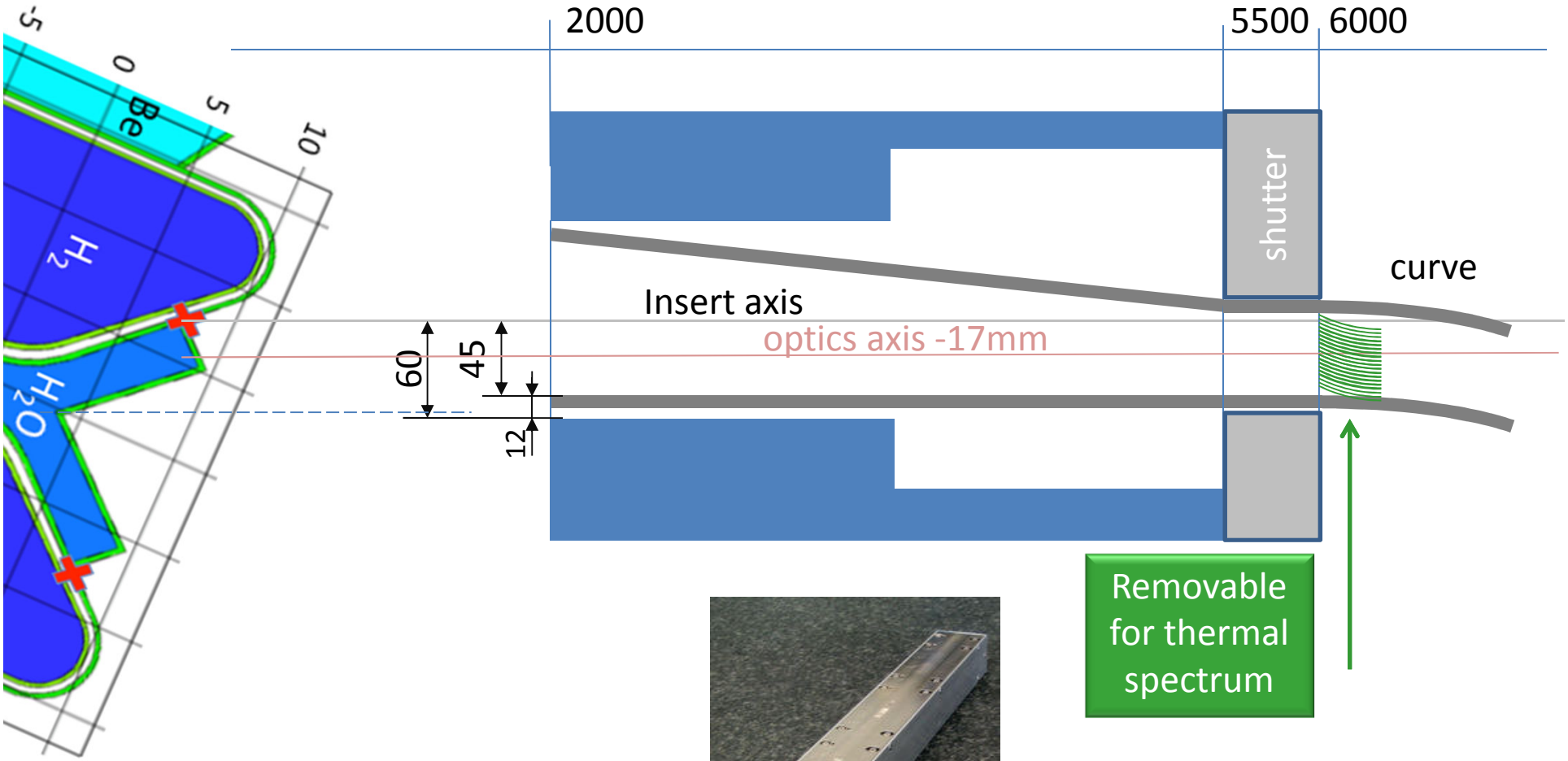
Test @ LET shows that control system must be improved



Alternatives can be as expensive as FAN chopper And mechanically more complex

Russina, JoP **251** (2010) 012079

Configuration 1 : how to .. QENS at ps



SWISS NEUTRONICS DESIGN

Expected cost: 85 k€

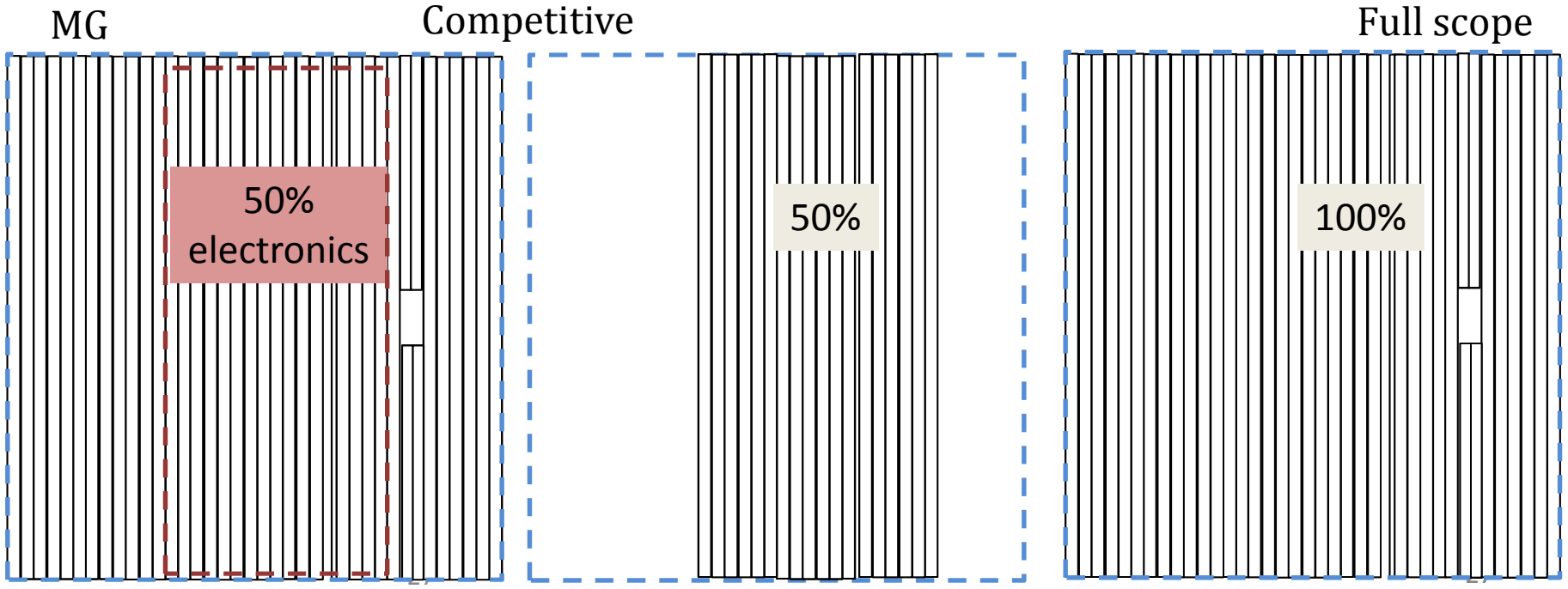
Configuration 2 : T-REX Competitive (only its skeleton)

	Basic components
Beam transport and conditioning system	7361
Sample exposure system	289
Scattering characterization system	1451
Experimental cave	725
Control Hutch	25
Sample preparation area	26
Utilities distribution (Infrastructure)	185
Support infrastructure	44
Integration control and monitoring	94
labor	3711
Contingency (only on this items)	1545
total cost in k€:	**15456**

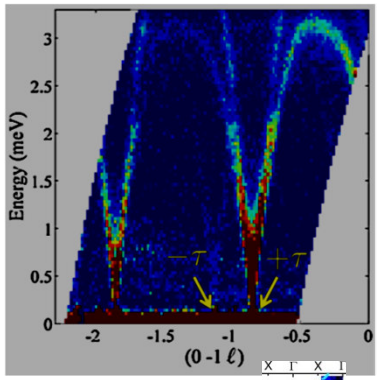
THIS CALCULATION DOES NOT INCLUDE DETECTORS AT ALL !!!

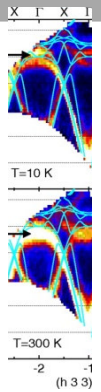
Configuration 2 : detector coverage

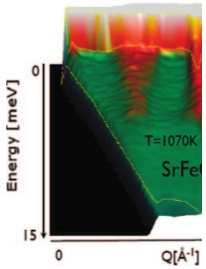
Upgrade path description	MG detectors	^{3}He PSD tubes
Increasing detector coverage from "Competitive" to 75% coverage	0.5 M€	1.9 M€
Increasing detector coverage from "Competitive" to "Full Scope"	1.1 M€	3.7 M€

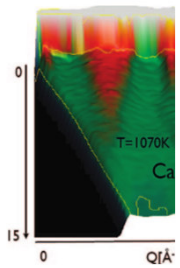


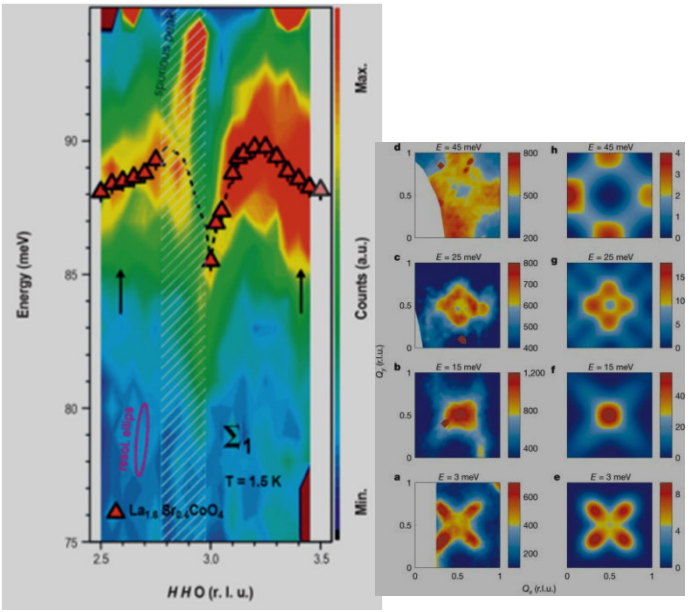
Cost Category

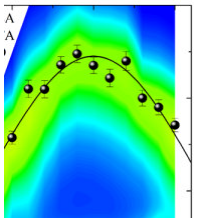


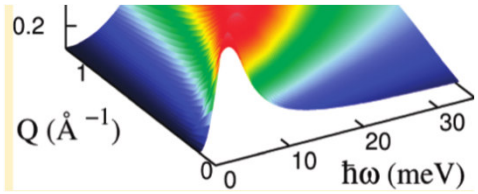




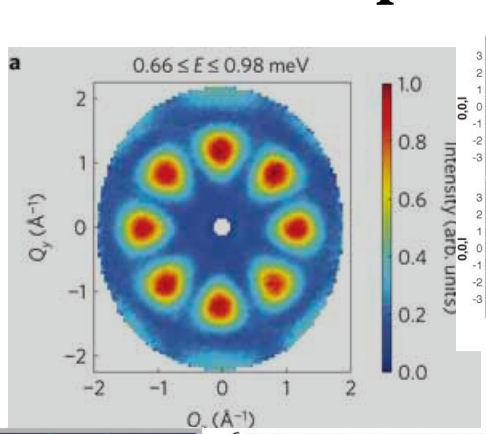


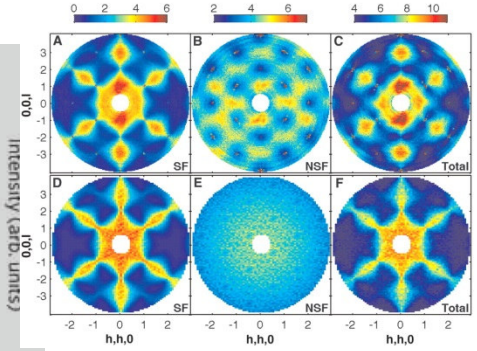


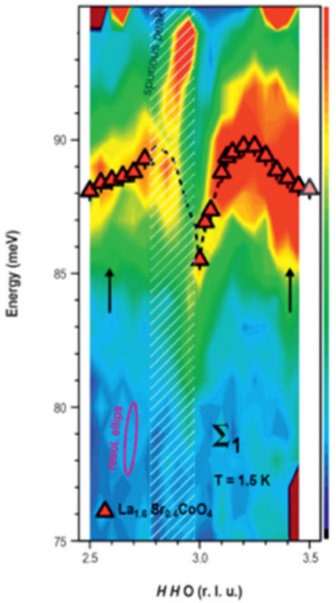


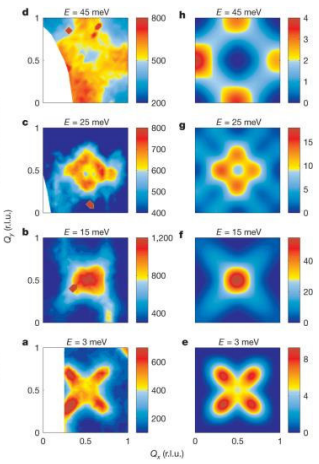


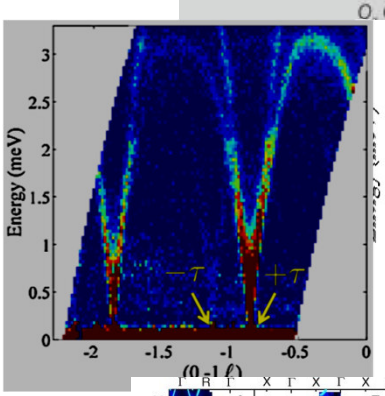
MODERATE impact

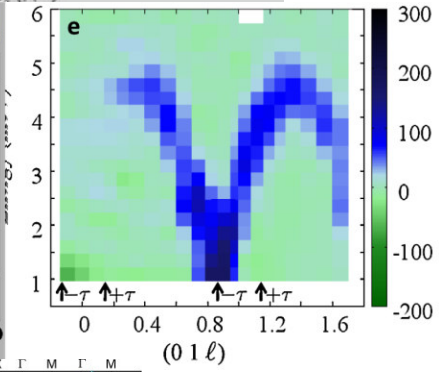


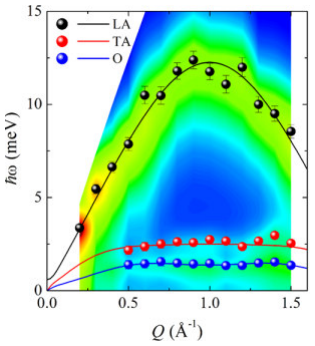


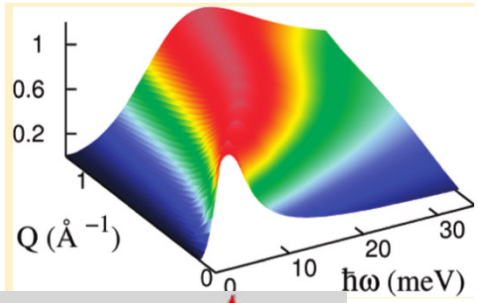


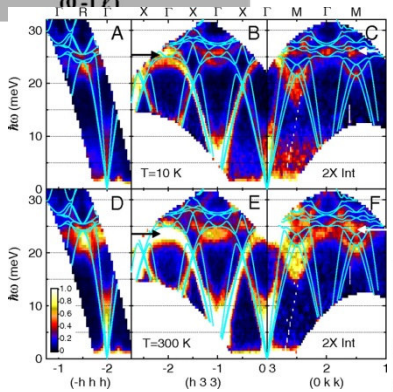


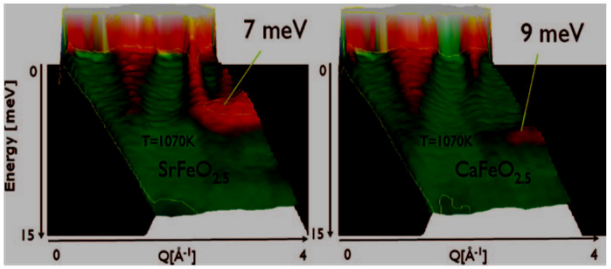


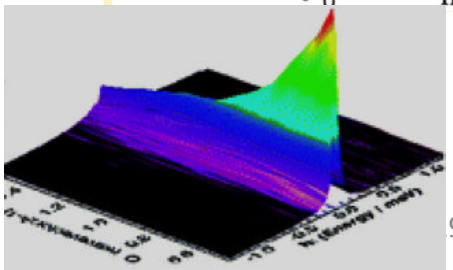




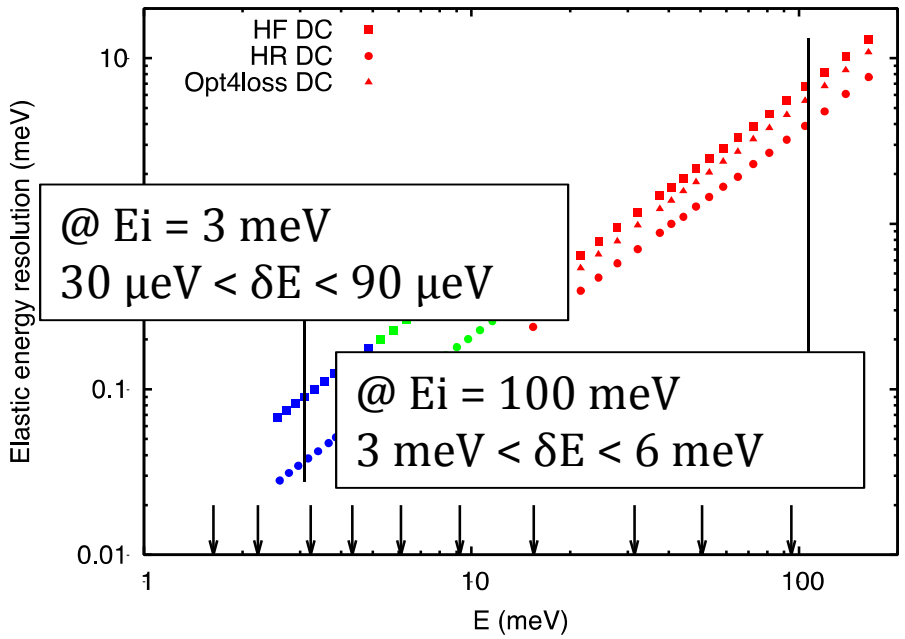


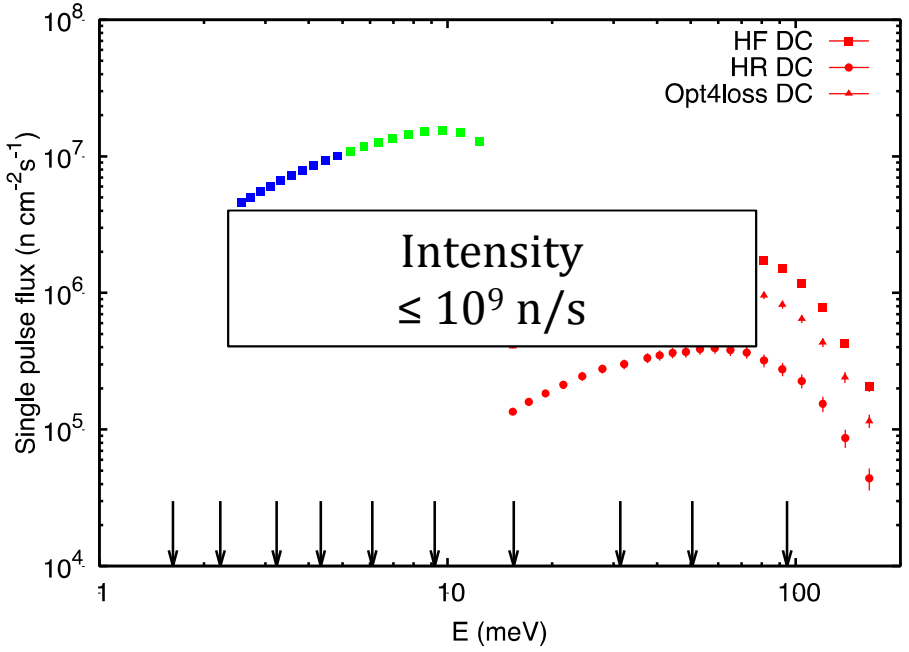






Configuration 2 : T-REX Competitive to all existing DGCS

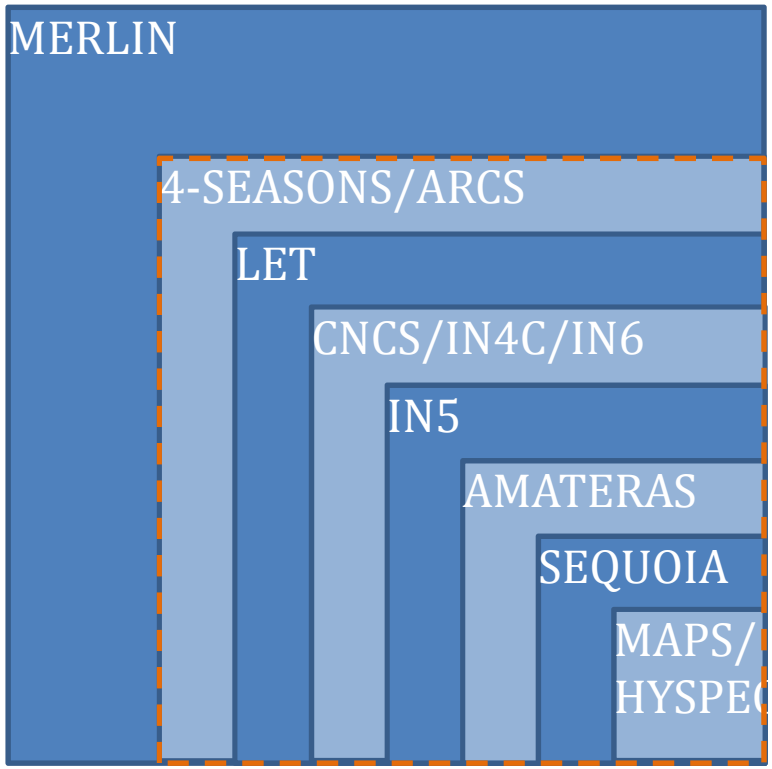




Ei range from 2 to 160 meV

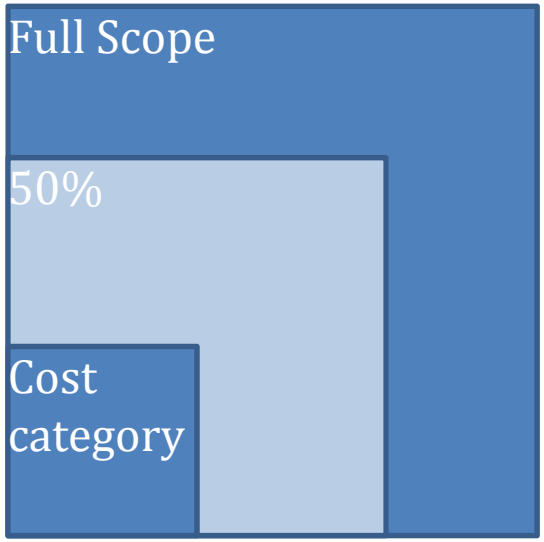
	Incident energy E_i (meV)	Elastic en. res. (μeV)	Flux $(n/s/cm^2)$	T-REX Elastic en. res. (μeV)	T-REX Flux $(n/s/cm^2)$ single E_i	T-REX Flux $(n/s/cm^2)$ full band
LET	5	102	$5.6\ 10^4$	80	$1.4\ 10^6$	$1.3\ 10^7$
IN5	3	104	$6.8\ 10^5$	90	$6.0\ 10^6$	$7.1\ 10^7$
CNCS[1]	3	36	$1.6\ 10^5$	34	$7.9\ 10^5$	$1.3\ 10^7$
AMATERAS[1,2]	3	36	$1.5\ 10^5$	34	$7.9\ 10^5$	$1.3\ 10^7$
	20	200	$6.7\ 10^4$	330	$1.8\ 10^5$	$5.6\ 10^6$
4-SEASONS[1,2]	100	4000	$4.0\ 10^4$	3900	$2.2\ 10^5$	$5.6\ 10^6$

Configuration 2 : T-REX Competitive solid angle



PANTHER
hot commissioning
2018

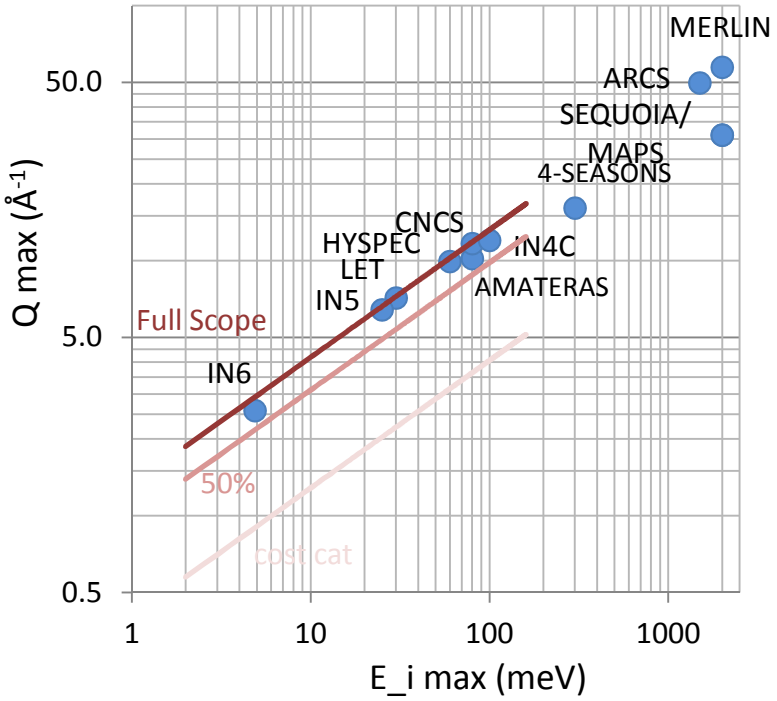
T-REX



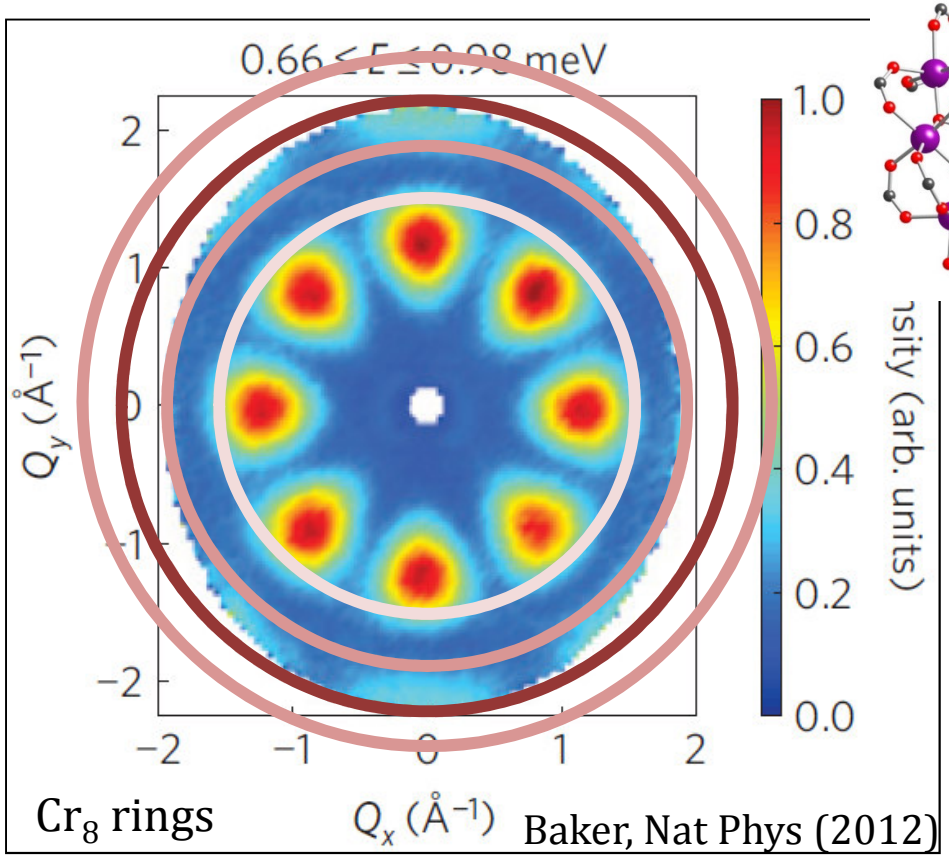
Configuration 2 : T-REX unique with 5D mapping

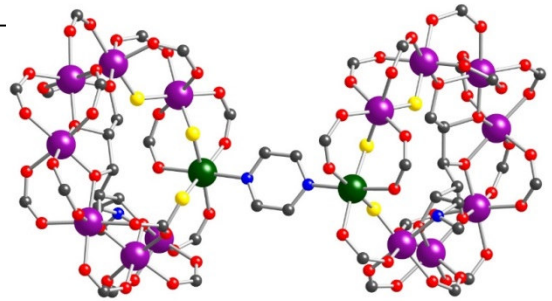
5D mapping

Polychromatic experiments
+ PA unique feature



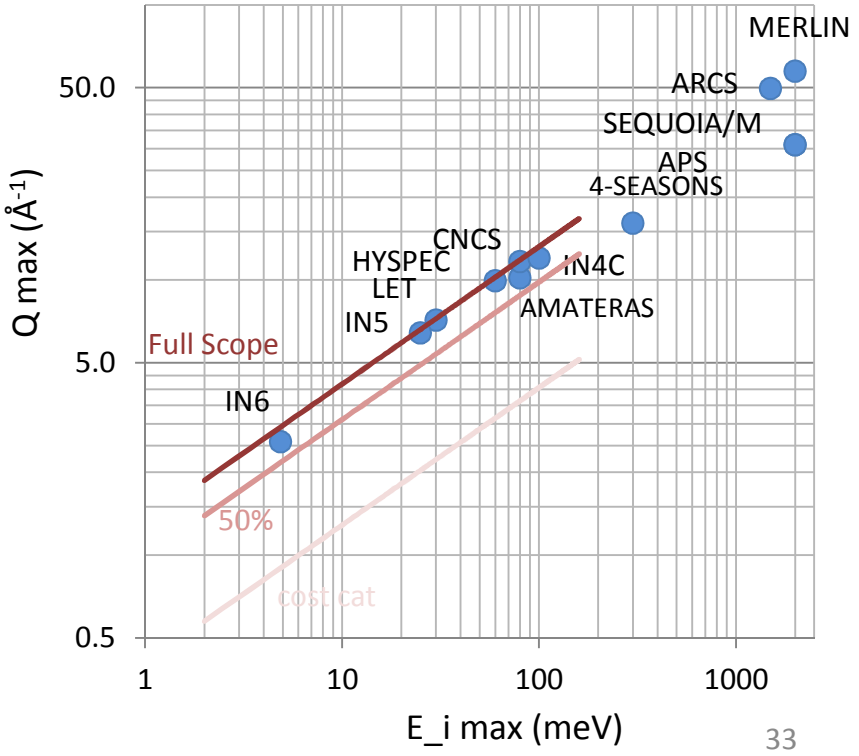
Detection area vs scientific impact





making qbits

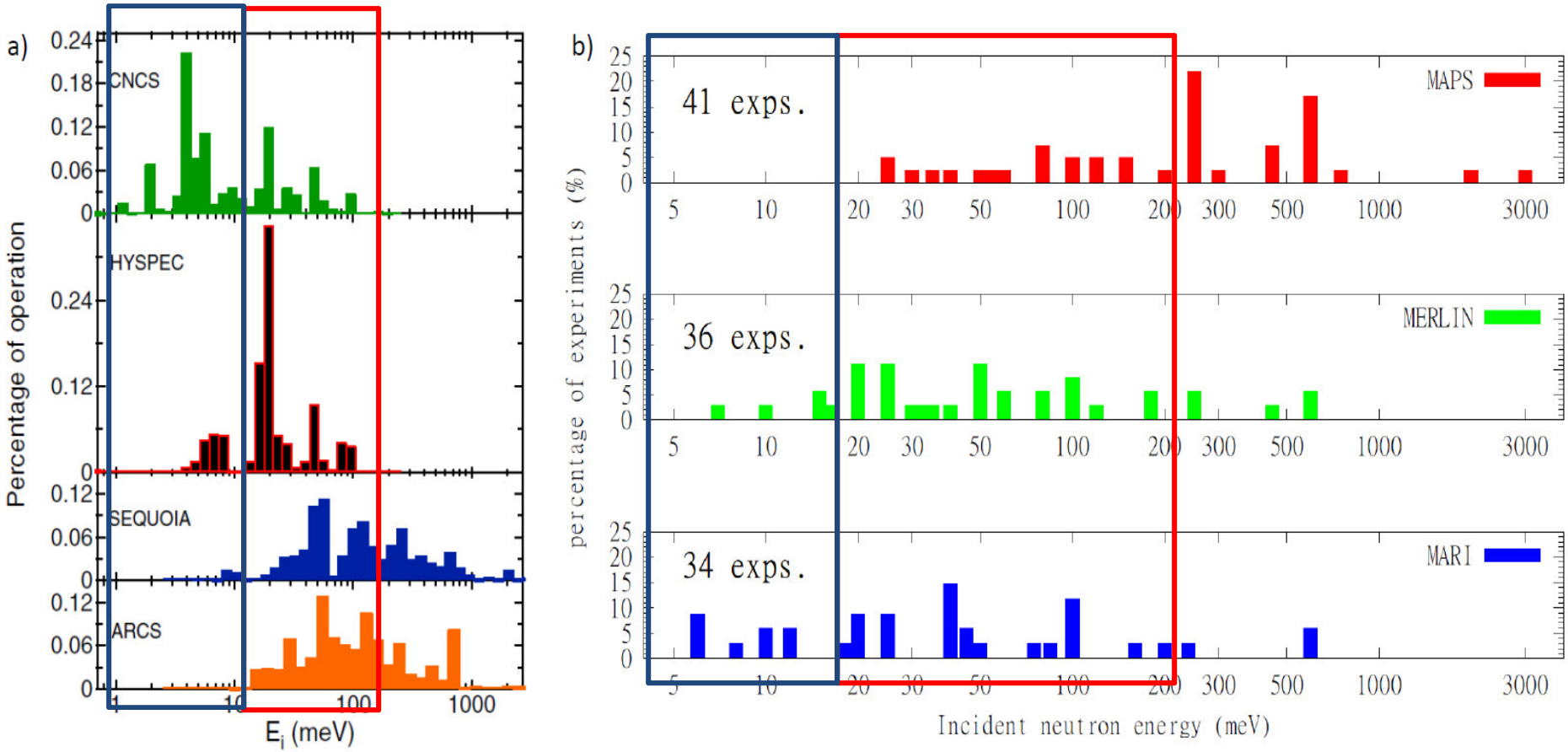
IN5 equivalent resolution at longer wavelength



Cold-n energy
HR (E , Q)
4D INS
Spin correlations
Q-range is the limiting factor

T-REX CAN meet users demand

20-30% + 30%-40% = more chances of early success

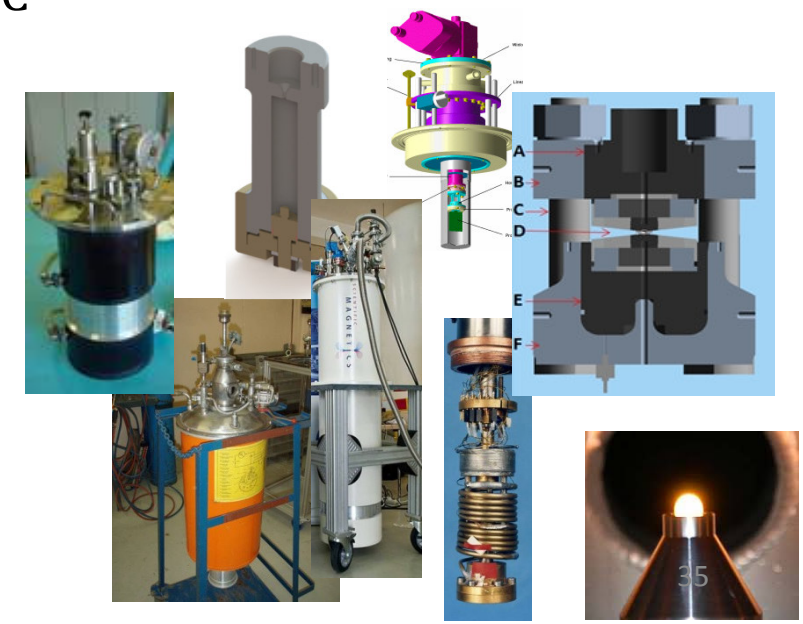


Sample Environment Priorities (Cost + ESS pool based)

Configuration 1	Competitive	Full Scope	Future upgrade
Orange cryofurnace	CCR ILL Furnace Clamp cells < 3 GPa 6kV HV supply +219k€	3He Sorption Stick Humidity Chamber Vertical cryomagnet 7T (1) Paris-Edinburgh Cell (1) Gas cells < 1 GPa (2) Gas Handling (2) +1448k€	IR furnace (1) ES Levitator Pump & Probe set-up

Rely on ESS-pool on day1

Top-down, side access possible
Magic PASTIS < 1m diameter
Sample area shall enable installation of XL SEE
<1000 kg, height < 1.7 m, d < 0.8 m



And beyond Configuration 3 : Upgrade

Sample Environment Equipment	
Detectors	
One more T0C	+200 k€
Faster choppers	~ M€
4-P choppers	~ 0.5M€
Supermirror analyser	~ M€

Flux is good, but we need your support to transform it into high impact scientific output

T-REX will be unique with 5D mapping over wide E range