MAGiC configurations

Comments from the STAP

- “Polarization of both cold and thermal beams, and with full XYZ analysis of scattered cold neutrons is essential to the science program”.
- “The ability to study very small samples is world-beating and should be available from Day 1.”
- “Having 60 out of 160 deg. of large detector coverage for the thermal beam is acceptable for initial performance“
- “Provision of SE’s including magnetic fields up to at least 10 T and dilution fridges is important.”

General comments

- The design is upgradable to full scope

- Cost Category B = skeleton
- Balanced
- Full scope

- Desired upgrades will be presented

Cost Category B : 11.96 M€

Shielding & Cave		**1411**	
Shielding		954	
First Ellipse	476		Uwe design*material costs
Polarizer	99		Uwe design*material costs
Second Ellipse	159		Uwe design*material costs
Heavy Shutter	200		PSI estimate
Fast Shutter	20		Validated by Phil
Exp. Cave		457	
Walls & Roof	296		Concrete price: 80 cm thick
Base Level	53		Concrete price: 60 cm base
B4C	108		217 m2 @ 5mm thickness

Shielding:

- Cost from recent material quotations or deliveries
- Shielding design from MCNPX calculations

Heavy shutter: 6 drums rotating in bunker wall

Exp. cave:

- Calculation based on 1e10 γ/s @ 2MeV at sample position
- B4C on walls: 1e-8 transmission @ 1.2 Å

Cost Category B : 12.00 M€

Shielding & Cave		1411	
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Cost Category B configuration

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Base Level	53		Concrete price: 60 cm base
B4C	108		217 m2 @ 5mm thickness

Instrument Infrastructure		**505**	
Sample prep. lab.	25		Glove box, Fume, Binocular, Small material
Control Hutch	100		2 floors, computers, desk, chairs, coffee machine, fridge
Crane/hook	30		1T hook
Utilities	50		SAD request
Polished Concrete	9.6		16 m2 for detector support
PSS	100		Mean cost
Various cost	190		Mechanical assembly of concrete, metallic beam for support, mezzani

Cost Category B configuration

Man power		2118
Phase 1	399	39 months
Phase 2	403	40 months
Phase 3	448	41 months
Phase 4	786	78 months
Travel	82	

MCA		362
Hardware	65	32 motors + encoders + cable estimates
Man power	219	MCAG quote
Utilities	78	MCAG quote

Choppers		750
PSC	500	JCNS estimate
SC	125	JCNS estimate
BC	125	JCNS estimate

Manpower:

- Preliminary Gantt diagram
- Travel extrapolated from Phase 1 travel costs

MCA: validated by MCAG

Choppers: JCNS estimate (not including installation and commissioning)

Cost Category B configuration

Neutron Optics & Polar		**4695**	
Optics		**2577**	
Super-mirrors	2047		Swiss Neutronics
Vacuum Housing	470		ILL based estimate
Focusing	0		Scaling from guide
Divergence	0		LLB estimate (DREAM)
Collimator	0		Eurocollimator quote
Bender	60		Analyzer scaling
Polarization		**2118**	
Analyzer	1885		PSI: materials, coating, manpower, overhead
Guide field	83		Magnets+soft iron
Saturation field	90		Magnets+soft iron
Rotator	10		2 rotators
Flipper	30		HF flipper
XYZ	20		Multicoil setup

Optics:

- Guide geometry and coating optimized (McStas)
- Simple and robust monolith insert

Polarization:

- Incident beam polarization
- Scattered beam XYZ polarization analysis
- Flipper, guide/saturation fields, rotators prototyped !

Cost Category B configuration

Sample Env.		90
Sample table	40	Huber like
Magnet	0	Estimate from IRFU
Cryostat	0	LLB estimate
Dilution Fridge	0	LLB estimate
Piezo actuators	0	Attocube
Various	50	Utilities

No dedicated sample environment

- MAGiC will fully rely on the ESS pool equipment
- ~50% beam time make use of a magnet: strong support from ESS required !

Sample table.

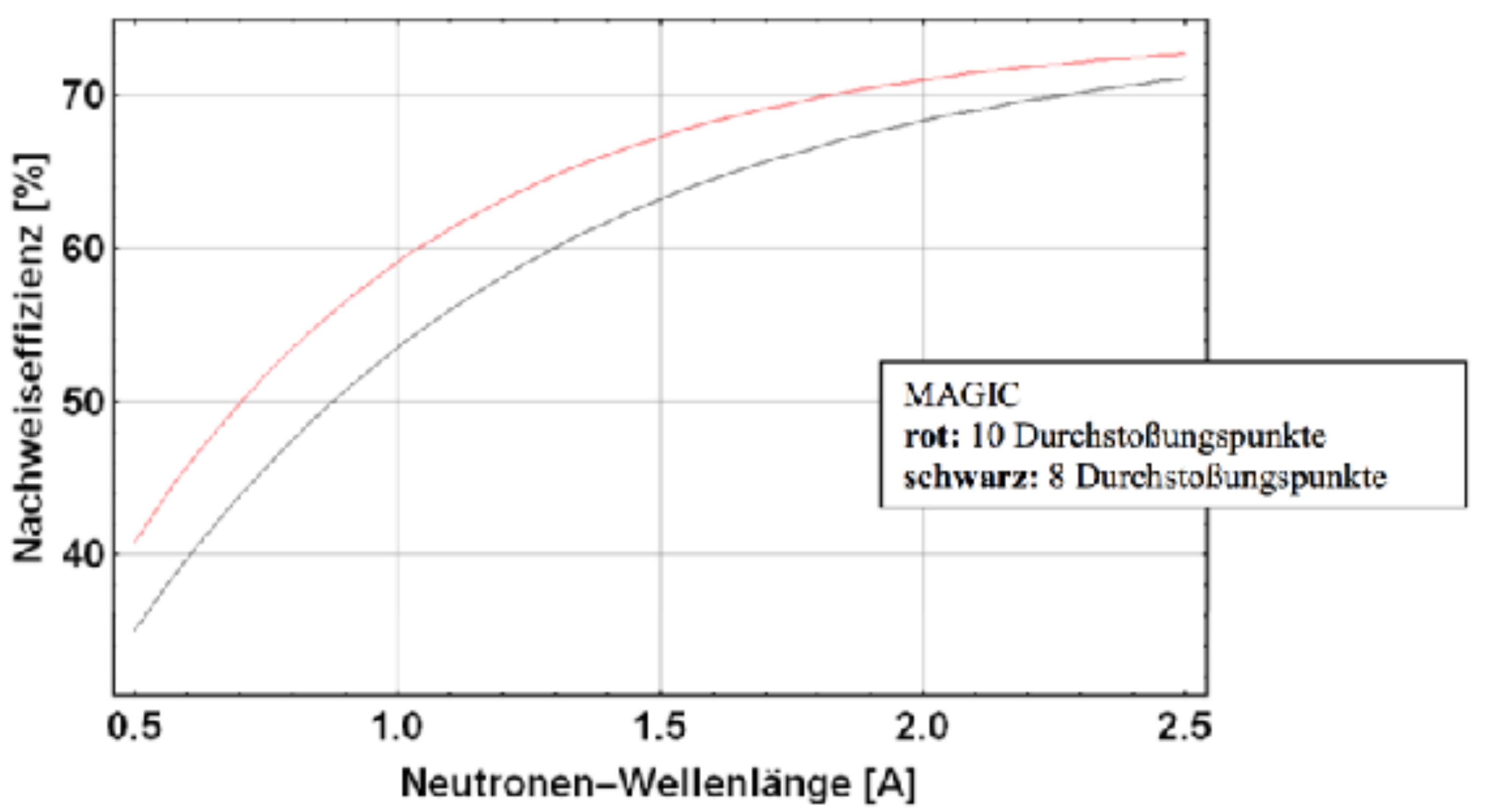
Provision for utilities included.

Cost Category B configuration

Detectors & Monitors		874	
Monitors	40		2 PSD/TOF monitors
Large detector 1	590		36x48 @ 80% eff
Small detector	244		120x6 @ 100% eff
Bottom detector	0		6T2 technology estimate

« *Large* » detector:

- Reduced detector coverage: 37.5° x 48° (h x v)
- 80% of nominal efficiency **(non upgradable)**



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Monitors	40		2 PSD/TOF monitors
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Bottom detector	0		6T2 technology estimate

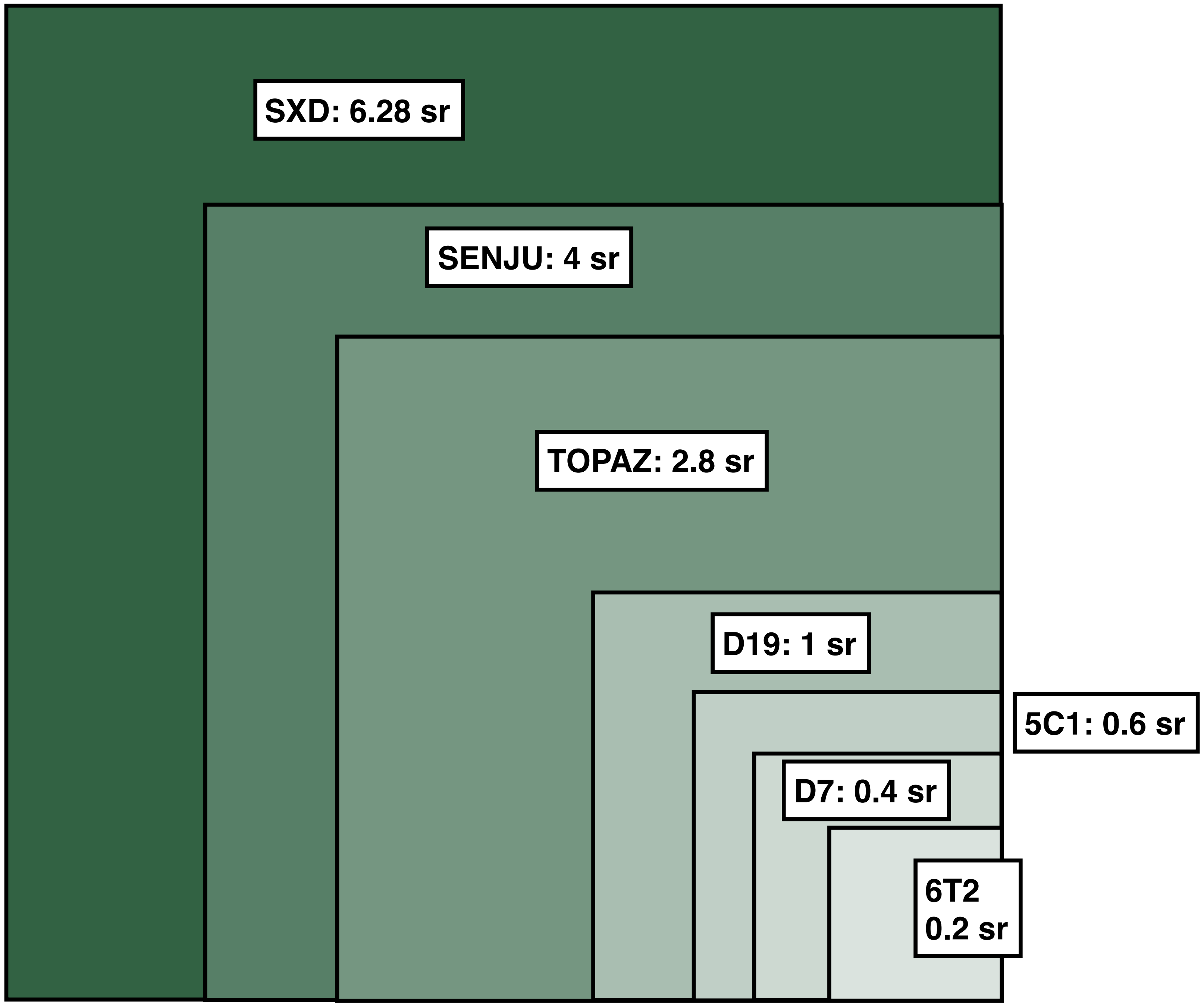
« *Large* » detector:

- Reduced detector coverage: 37.5° x 48° (h x v)
- 80% of nominal efficiency **(non upgradable)**
- Dedicated to half-polarized experiments

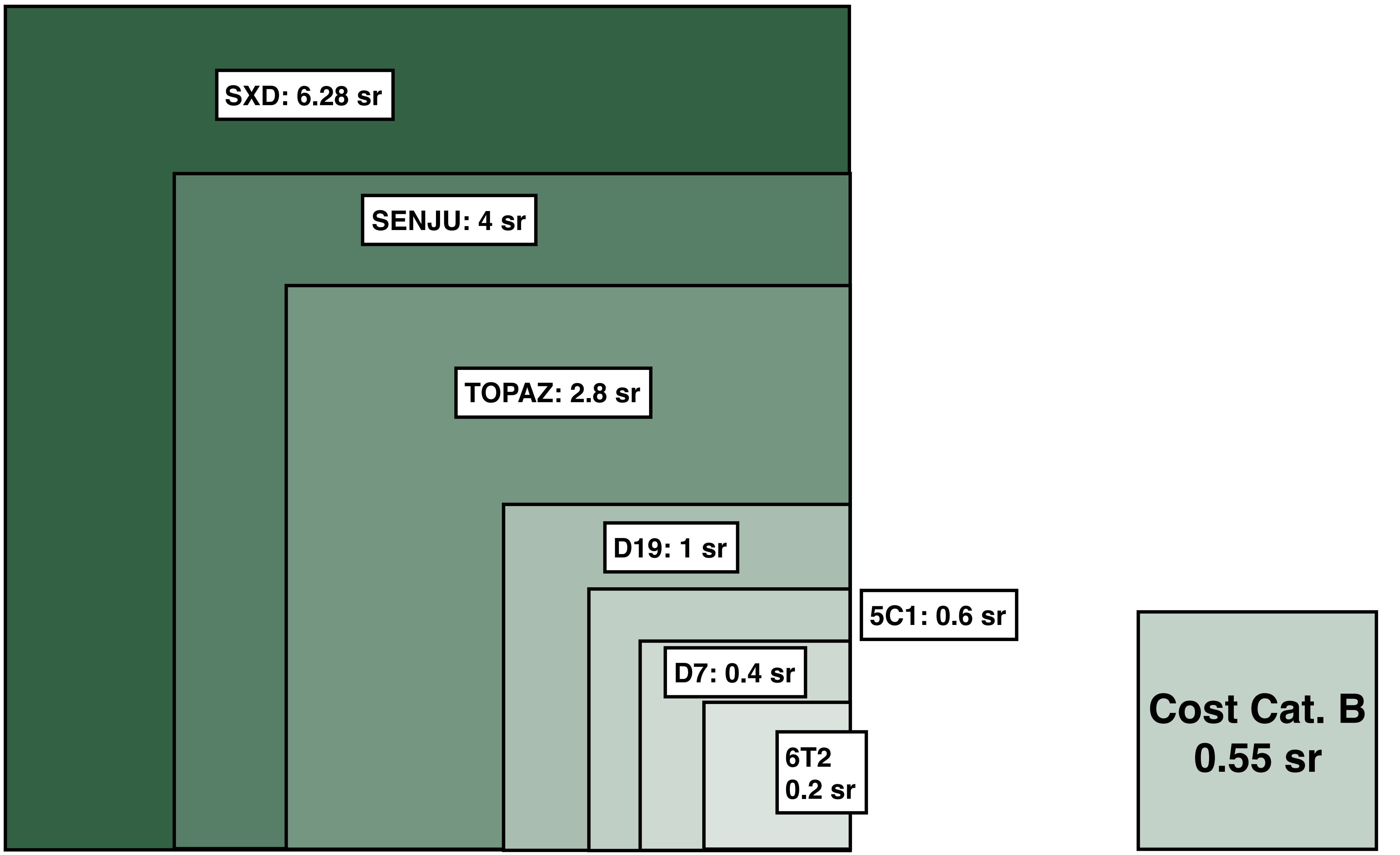
Small detector:

- 120° x 6° (h x v)
- Dedicated to polarization analysis experiments

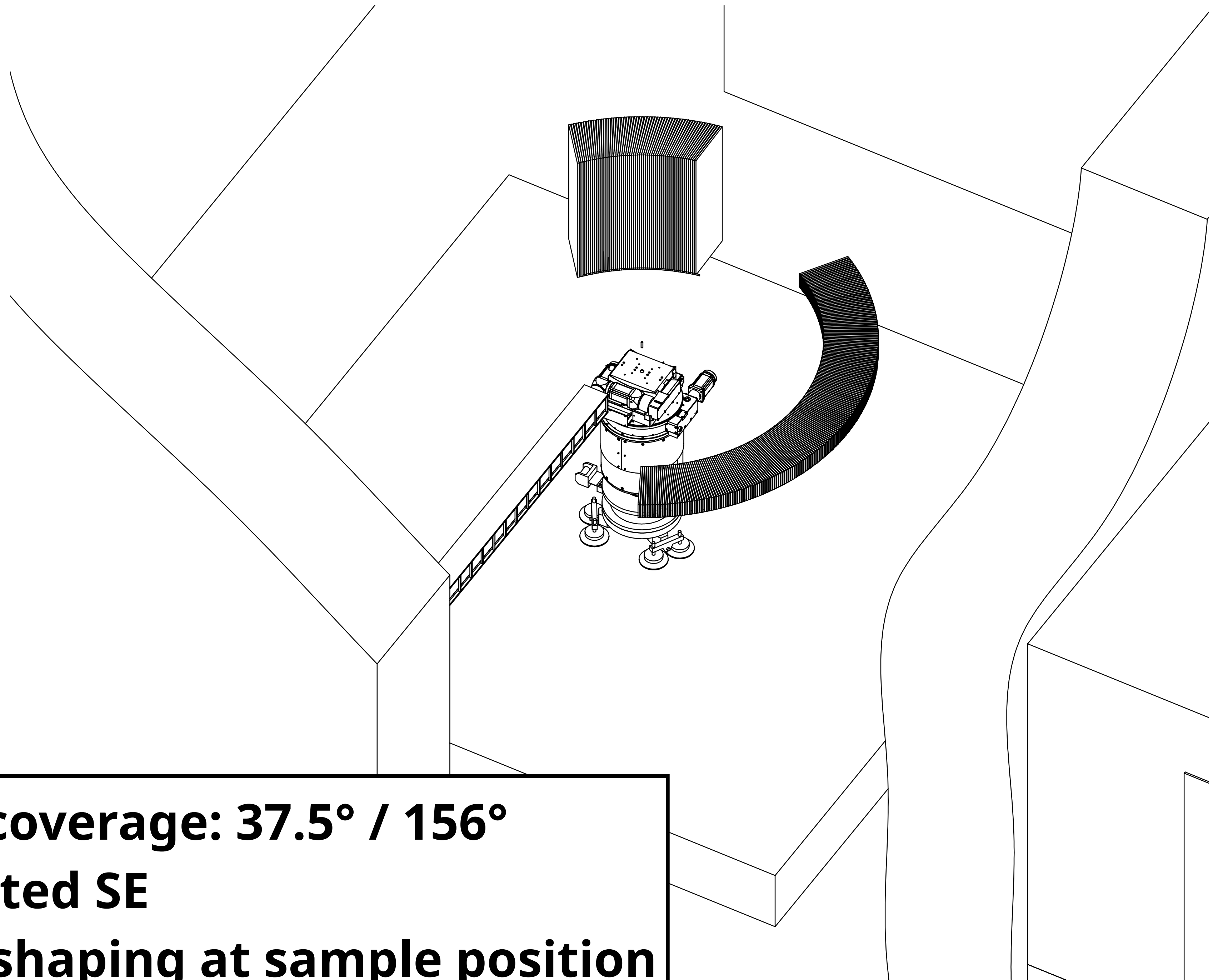
Cost Category B configuration



Cost Category B configuration



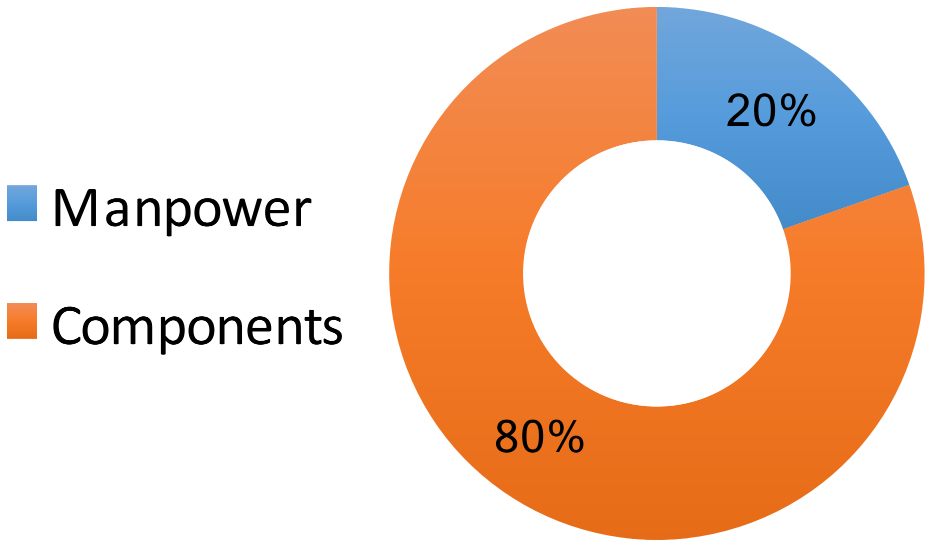
Cost Category B configuration

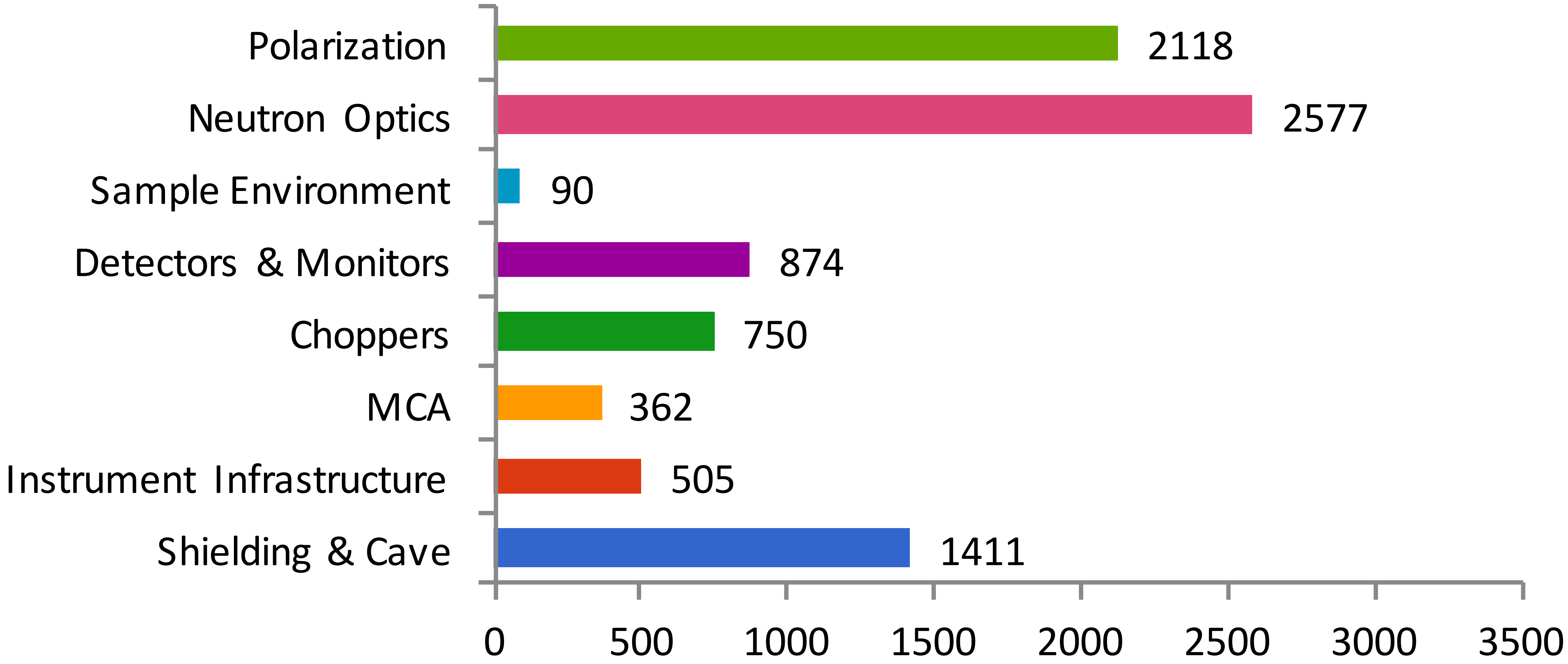


Detector coverage: 37.5° / 156°
No dedicated SE
No beam shaping at sample position

Cost Category B configuration

Manpower: **2119 k€**
Components: **8686 k€**
Contingency: **1201 k€**
Total: **12006 k€**

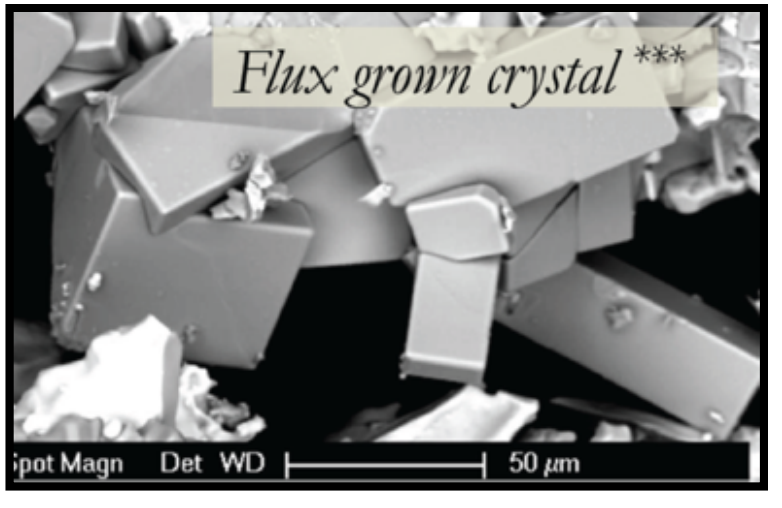




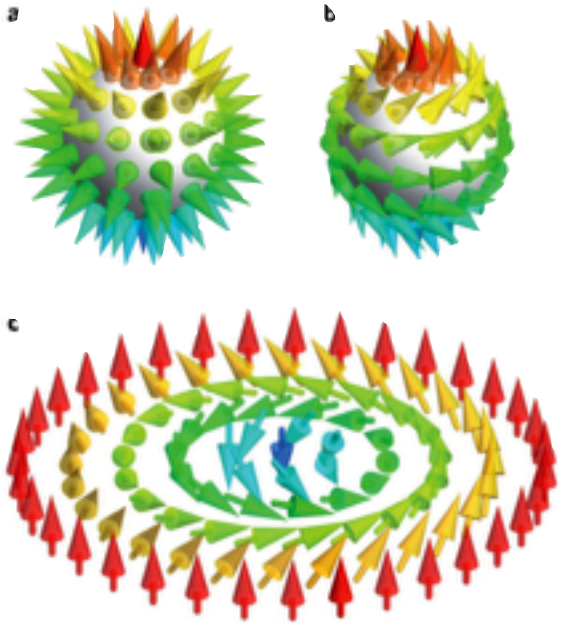
Impact on the science case

With full support of the SE pool

Micro-crystals



Long periodicity



Nature Physics **7**, 673–674 (2011)

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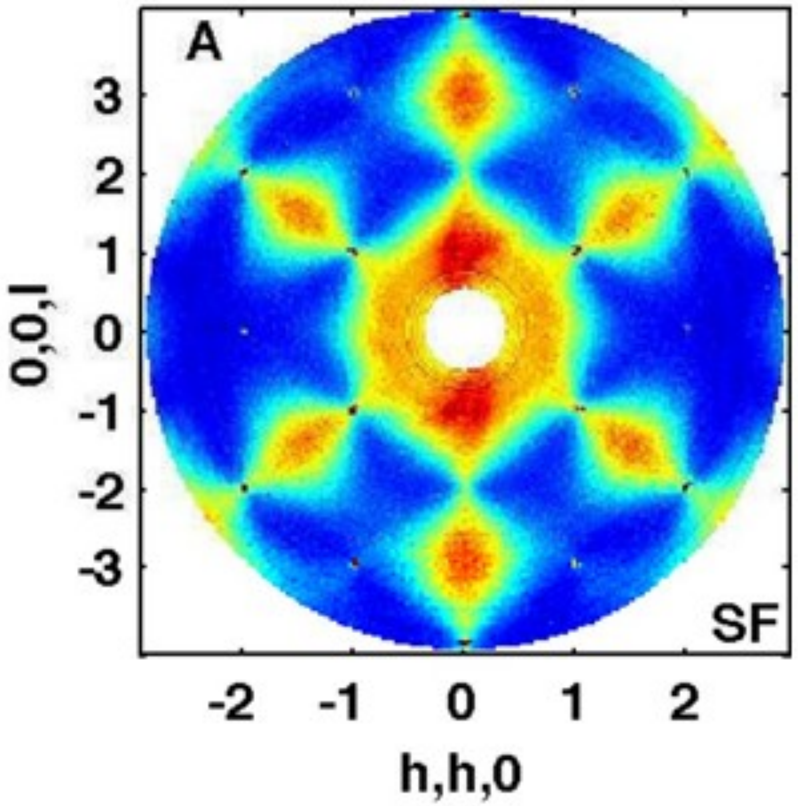
- “Provision of SE’s including magnetic fields up to at least 10 T and dilution fridges is important.”

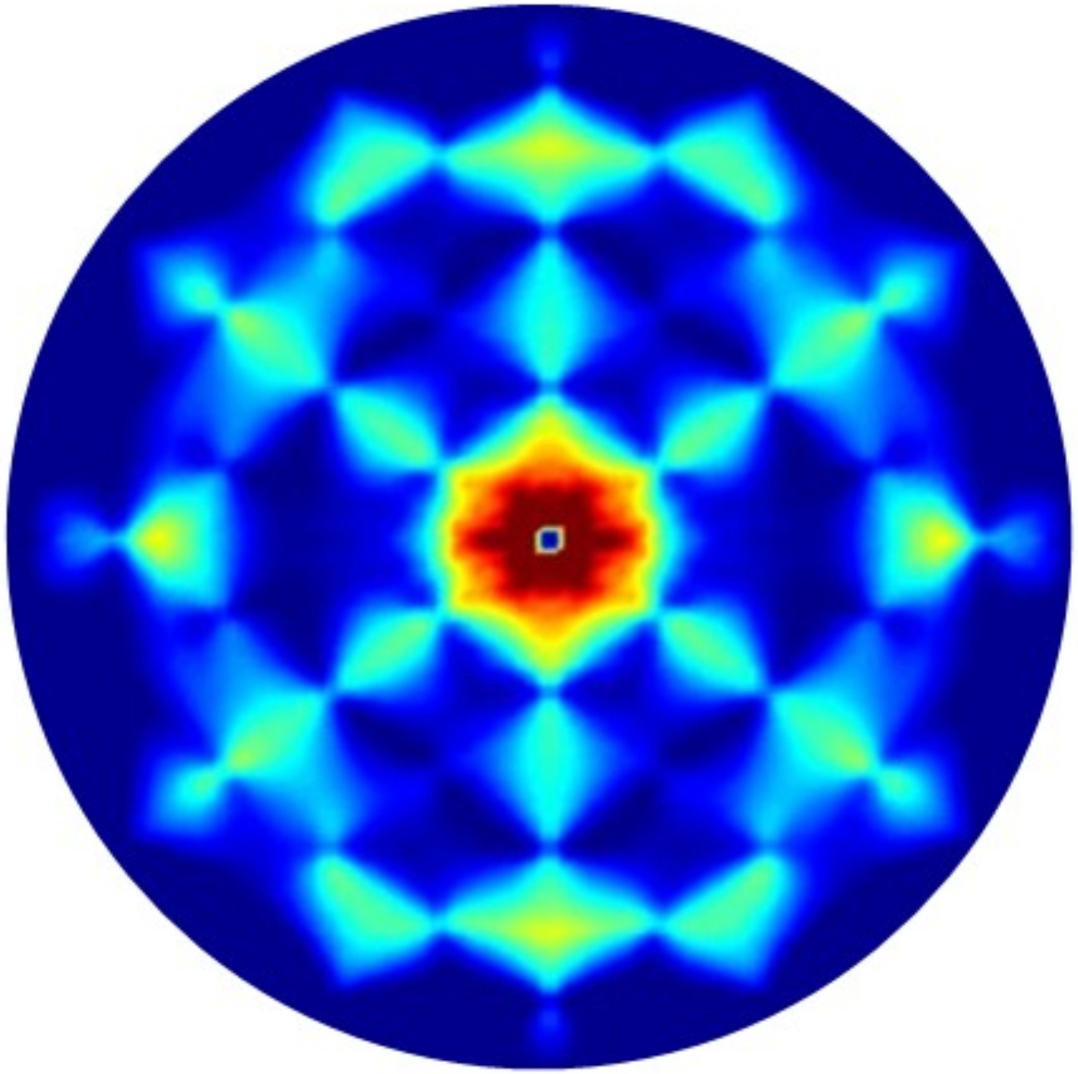
Performance at 2 MW

Polarization analysis

MAGiC: 1.2.10^9 n/s/cm^2

upgraded D7: 2.10^7 n/s/cm^2



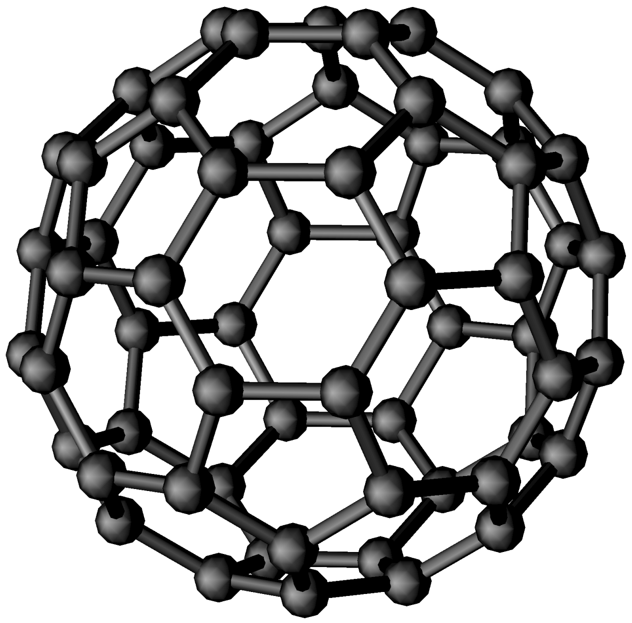


D7 detector: 2x MAGiC

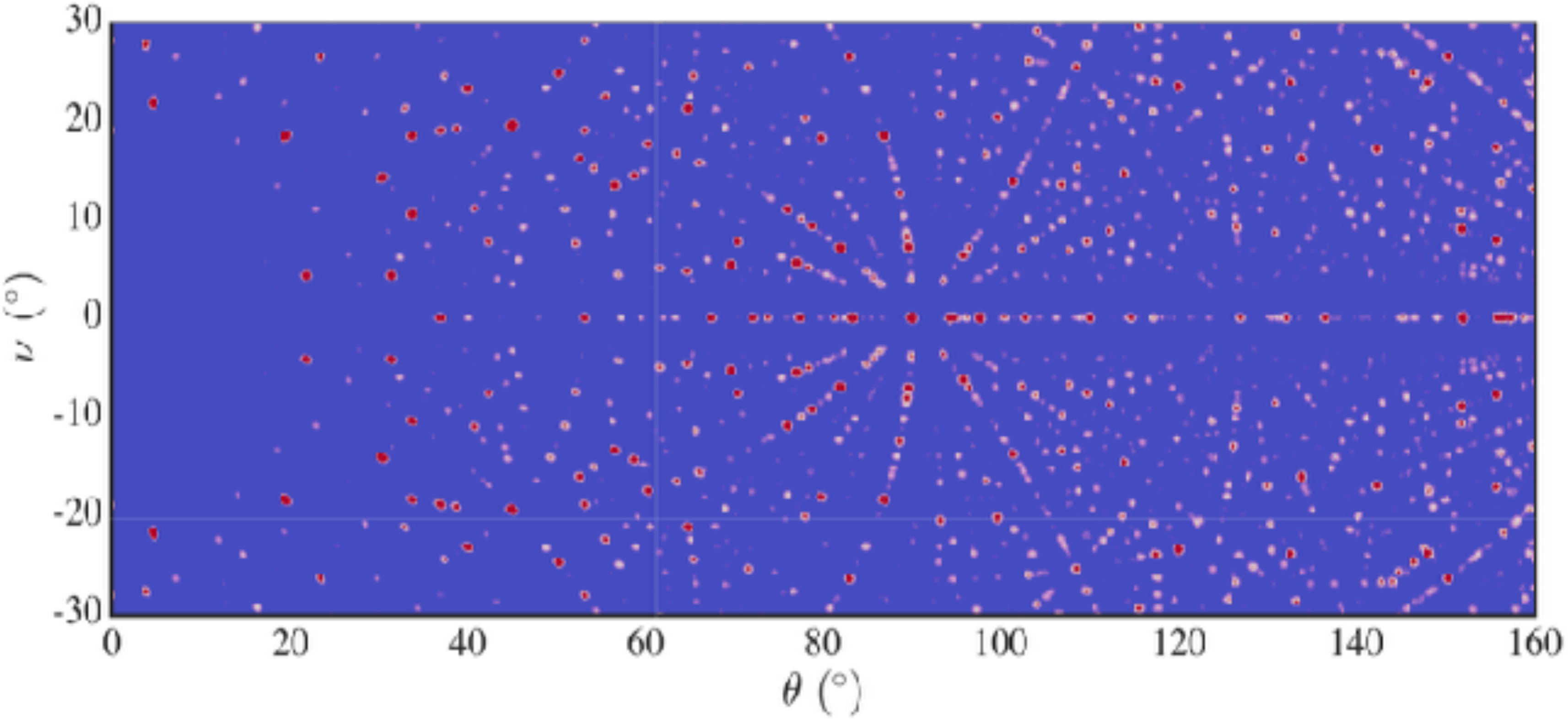
Expected gain: **30**

Performance at 2 MW

Thermal data collection



1 mm^3 sample



40 s per frame
100 frames per data collection

Full acquisition ~ 1 hour

Topaz (SNS) : 12 hours

Expected gain: ~10

Balanced configuration

Cost Category configuration +

Sample Env.	1435	
Sample table	40	Huber like
Magnet	**1000**	**Estimate from IRFU**
Cryostat	**50**	**LLB estimate**
Dilution Fridge	**250**	**LLB estimate**
Piezo actuators	**45**	**Attocube**
Various	50	Utilities

+1345 k€

Optics	2862	
Super-mirrors	2047	Swiss Neutronics
Vacuum Housing	470	ILL based estimate
Focusing	**75**	**Scaling from guide**
Divergence	**100**	**LLB estimate (DREAM)**
Collimator	**110**	**Eurocollimator quote**
Bender	60	Analyzer scaling

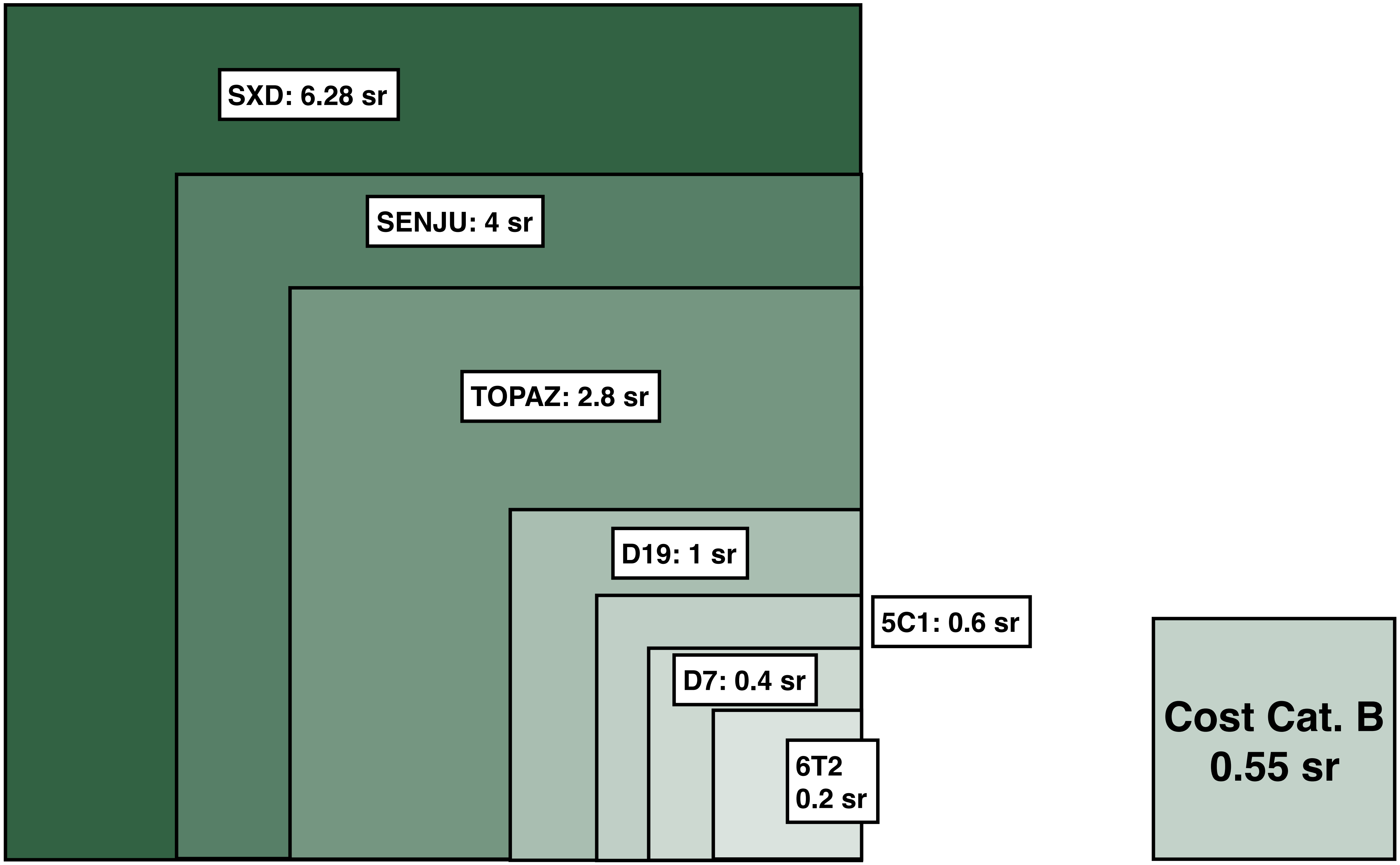
+285 k€

Detectors & Monitors	1360	
Monitors	40	2 PSD/TOF monitors
Large detector 1	**1076**	**60x48 @ 100% eff**
Small detector	244	120x6 @ 100% eff
Bottom detector	0	6T2 technology estimate

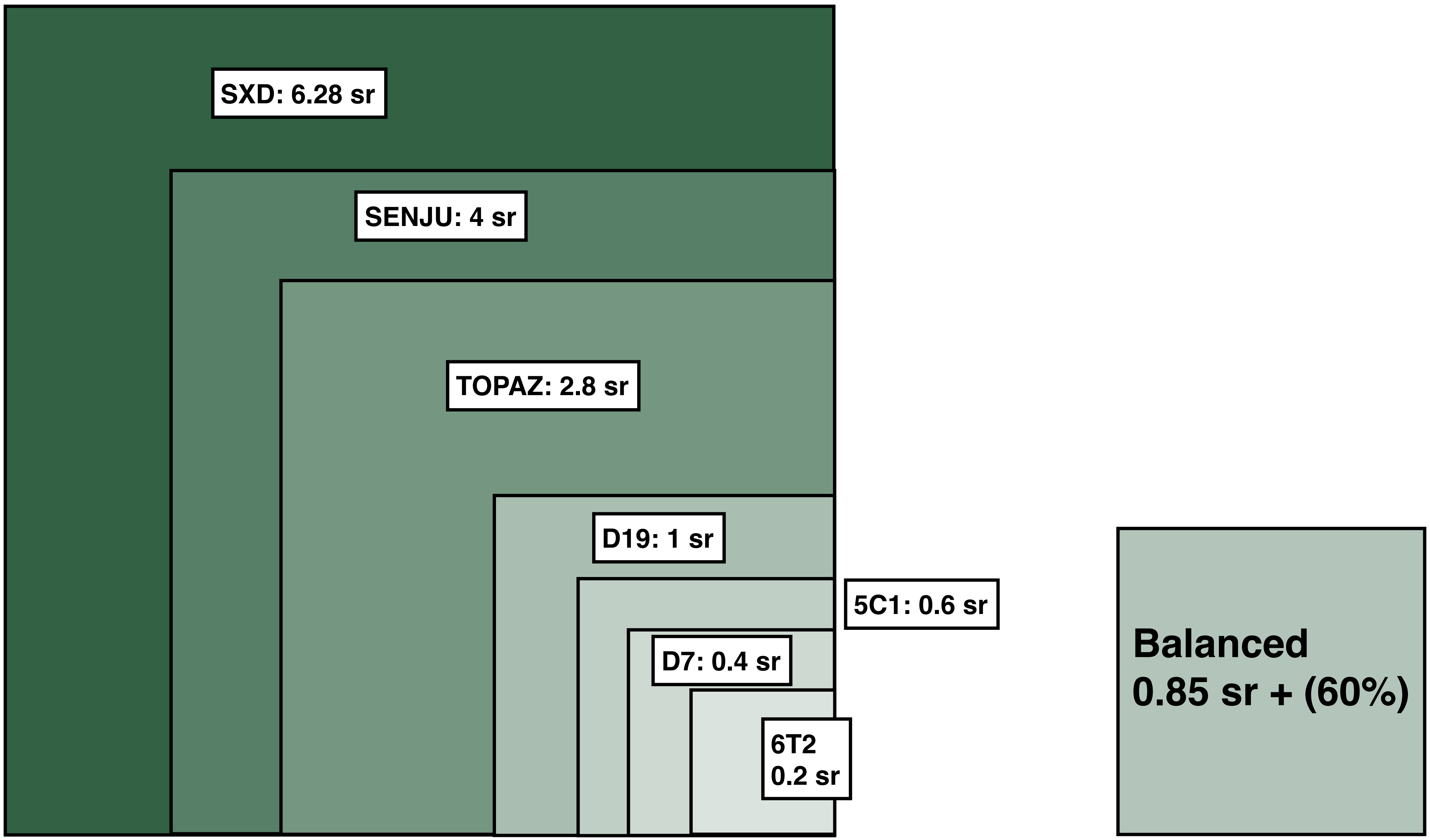
+486 k€

Total: 12920 k€ + 11% = 14356 k€

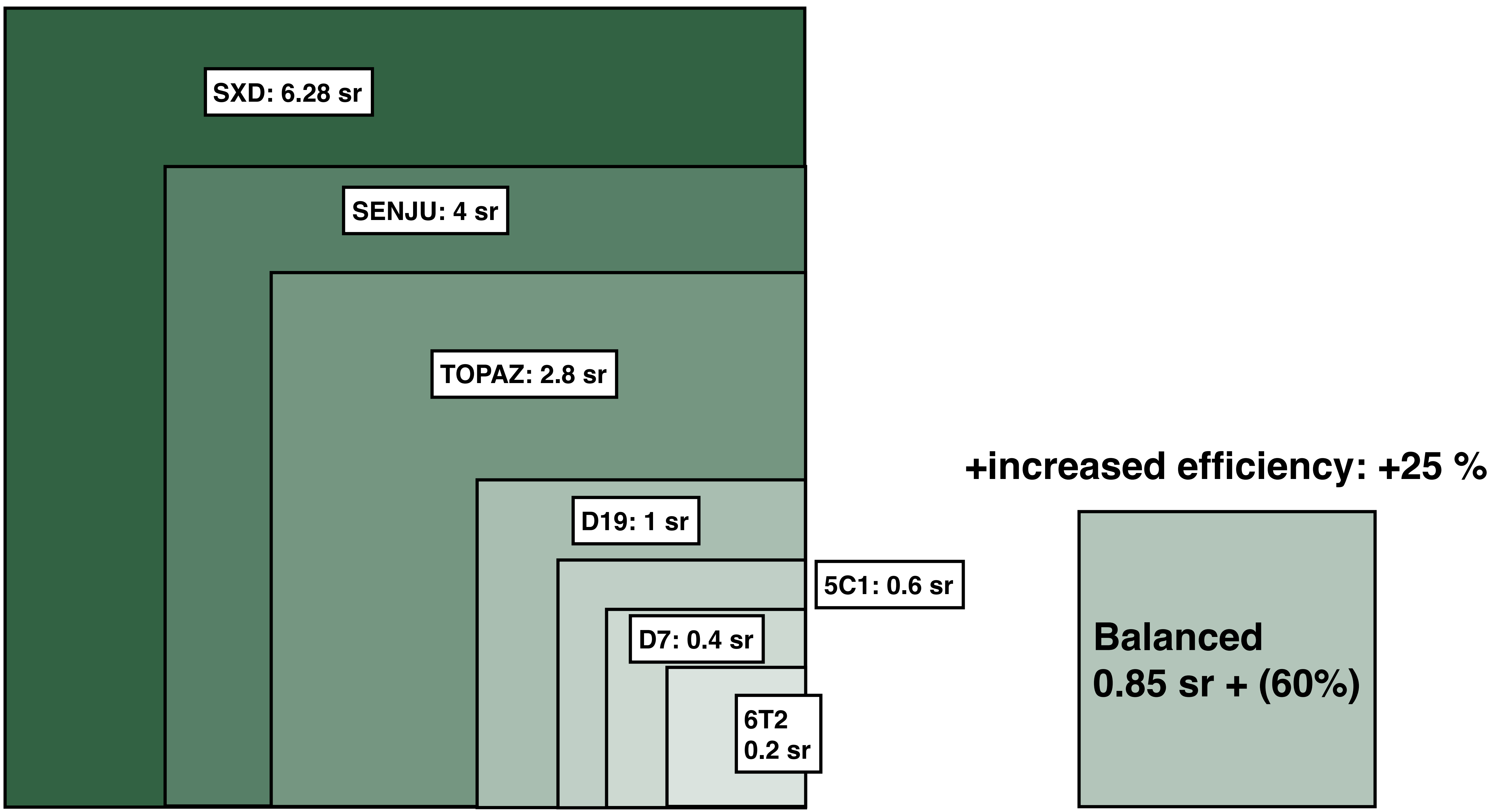
Balanced configuration



Balanced configuration



Balanced configuration



Balanced configuration

Sample environment:

Dilution fridge: **250 k€**

10 T split-pair vertical magnet with 156°x48° aperture: **1000 k€**

Cryostat (LHe): **50 k€**

Sample stick goniometers and XY translation tables: **45 k€**

TOTAL: 1345 k€

MAGiC will be autonomous for most of its needs

Beam Shaping:

Focusing device (1x1 mm): **75 k€**

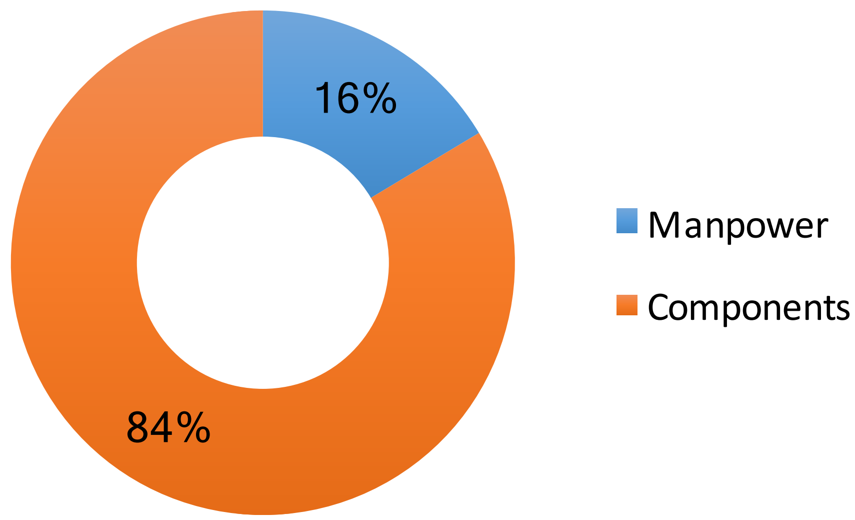
Collimators: **110 k€**

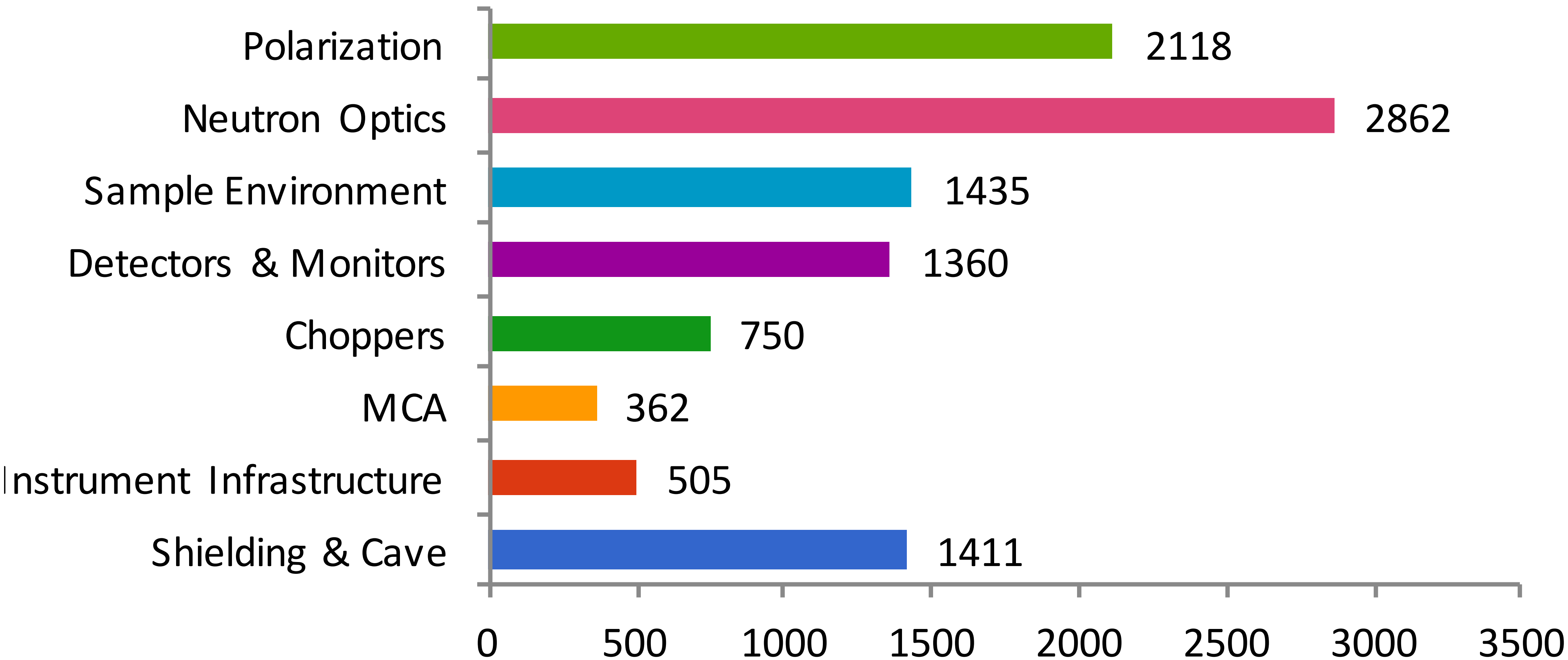
Divergence: **100 k€**

TOTAL: 285 k€

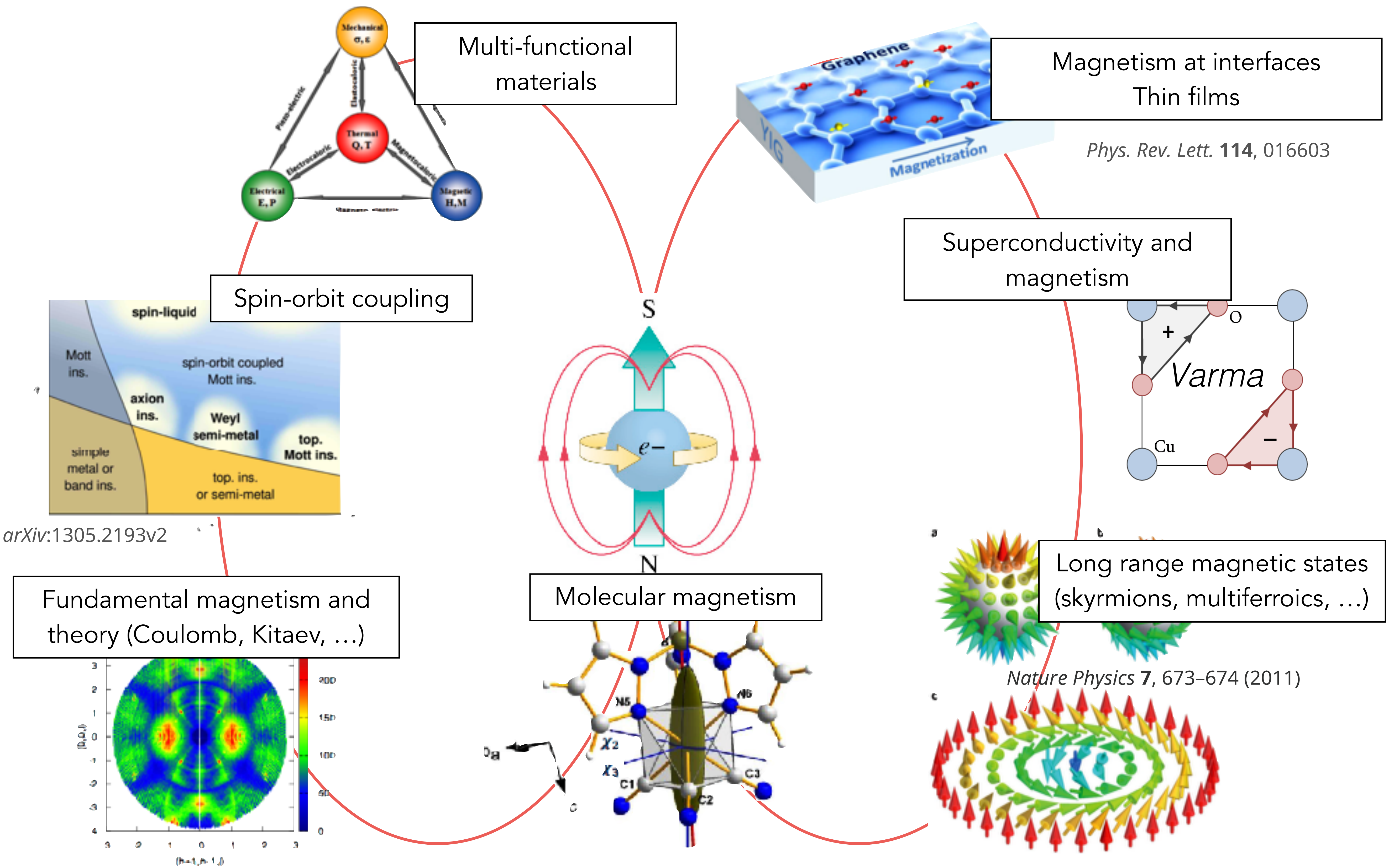
Balanced configuration

Manpower: **2119 k€**
Components: **10802 k€**
Contingency: **1436 k€**
Total: **14357 k€**





Impact on the science case



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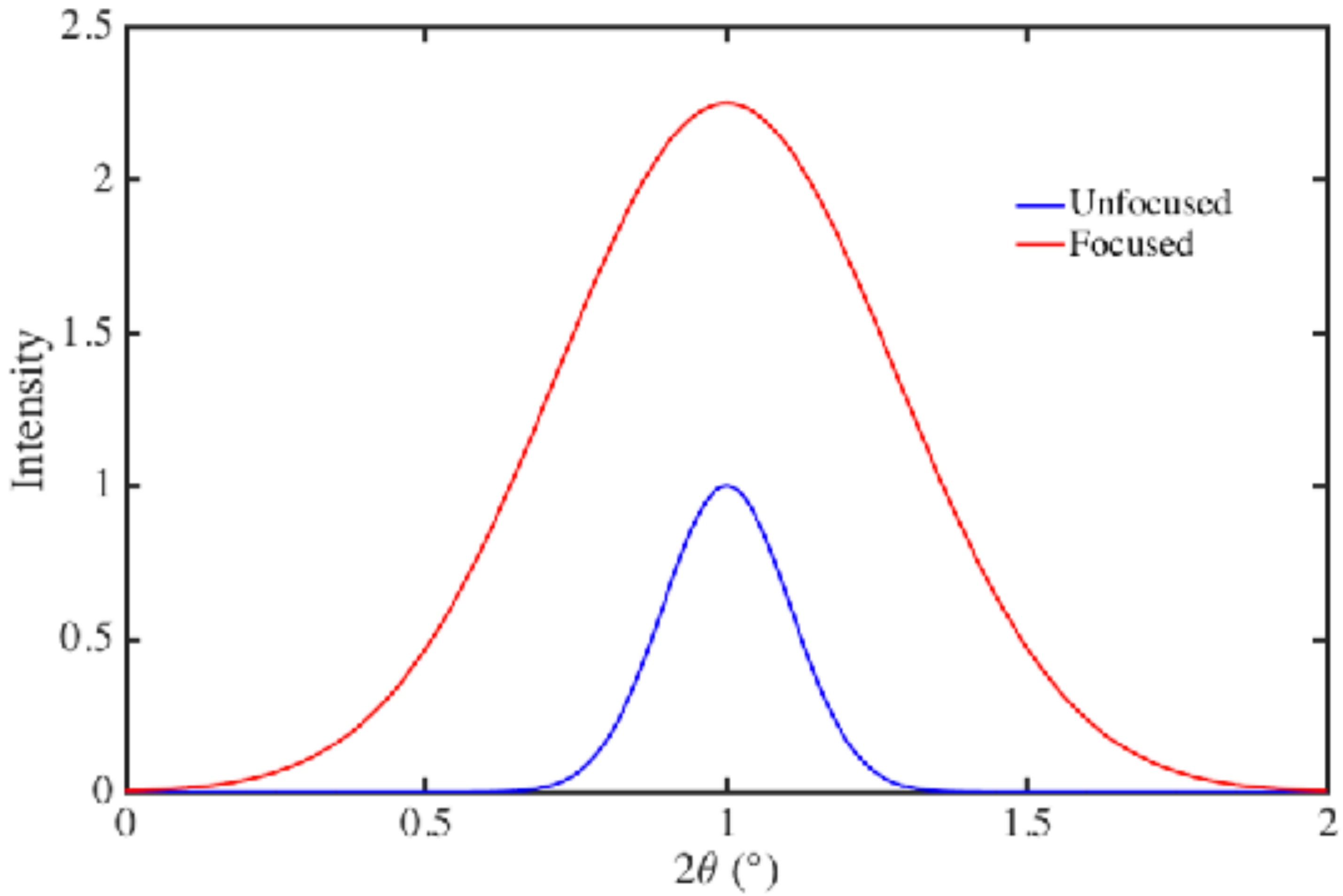
Performance at 2 MW

- Small crystals: integrated intensity x 6



- Half-polarized / Unpolarized experiments
  - Detector area: +60%
  - Efficiency: +25%

Total: 100% performance increase

Full Scope configuration

Balanced configuration +

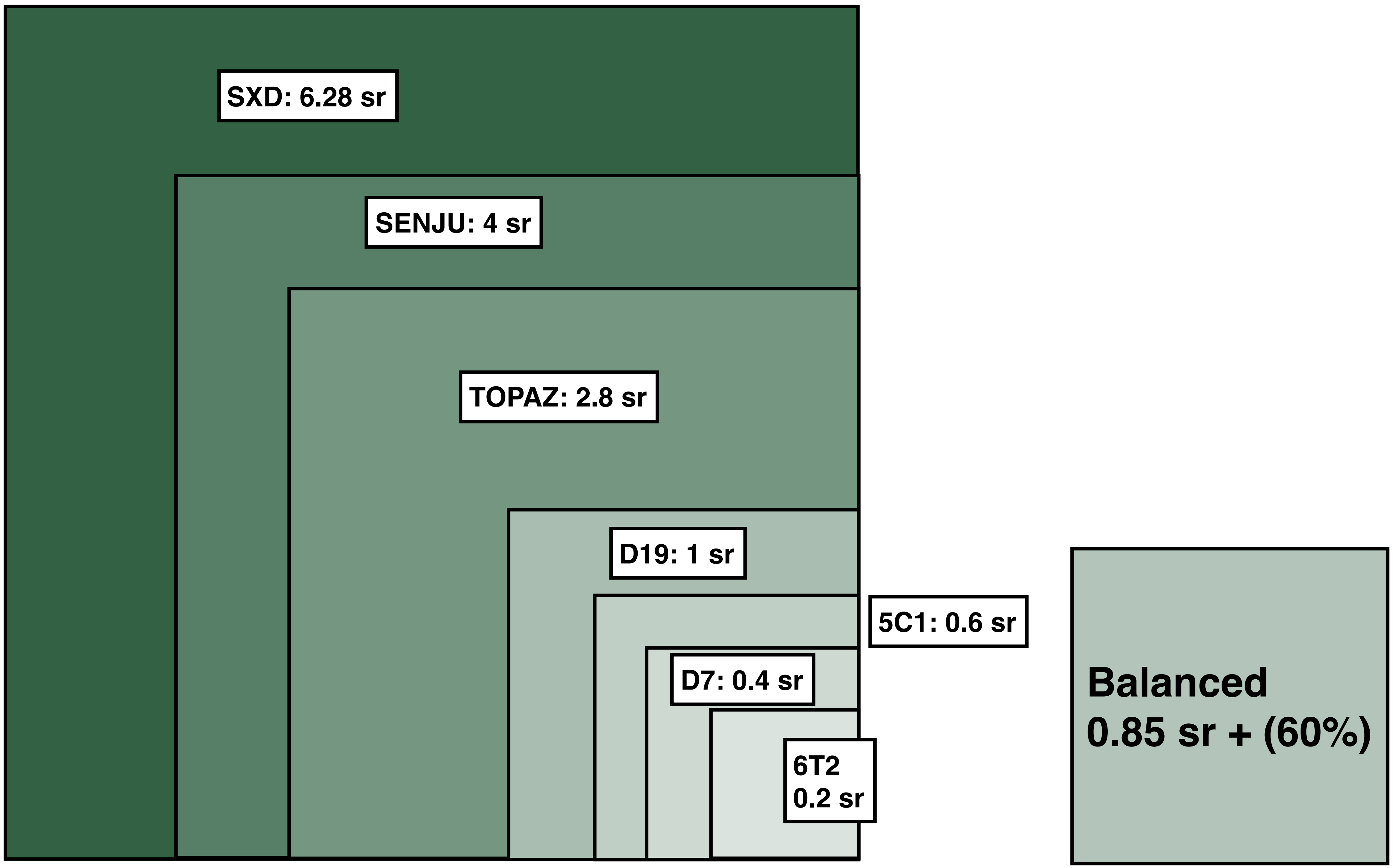
Detectors & Monitors		3036	
Monitors	40		2 PSD/TOF monitors
Large detector 1	**2632**		**156x48 @ 100% eff**
Small detector	244		120x6 @ 100% eff
Bottom detector	**120**		**6T2 technology estimate**

+1676 k€

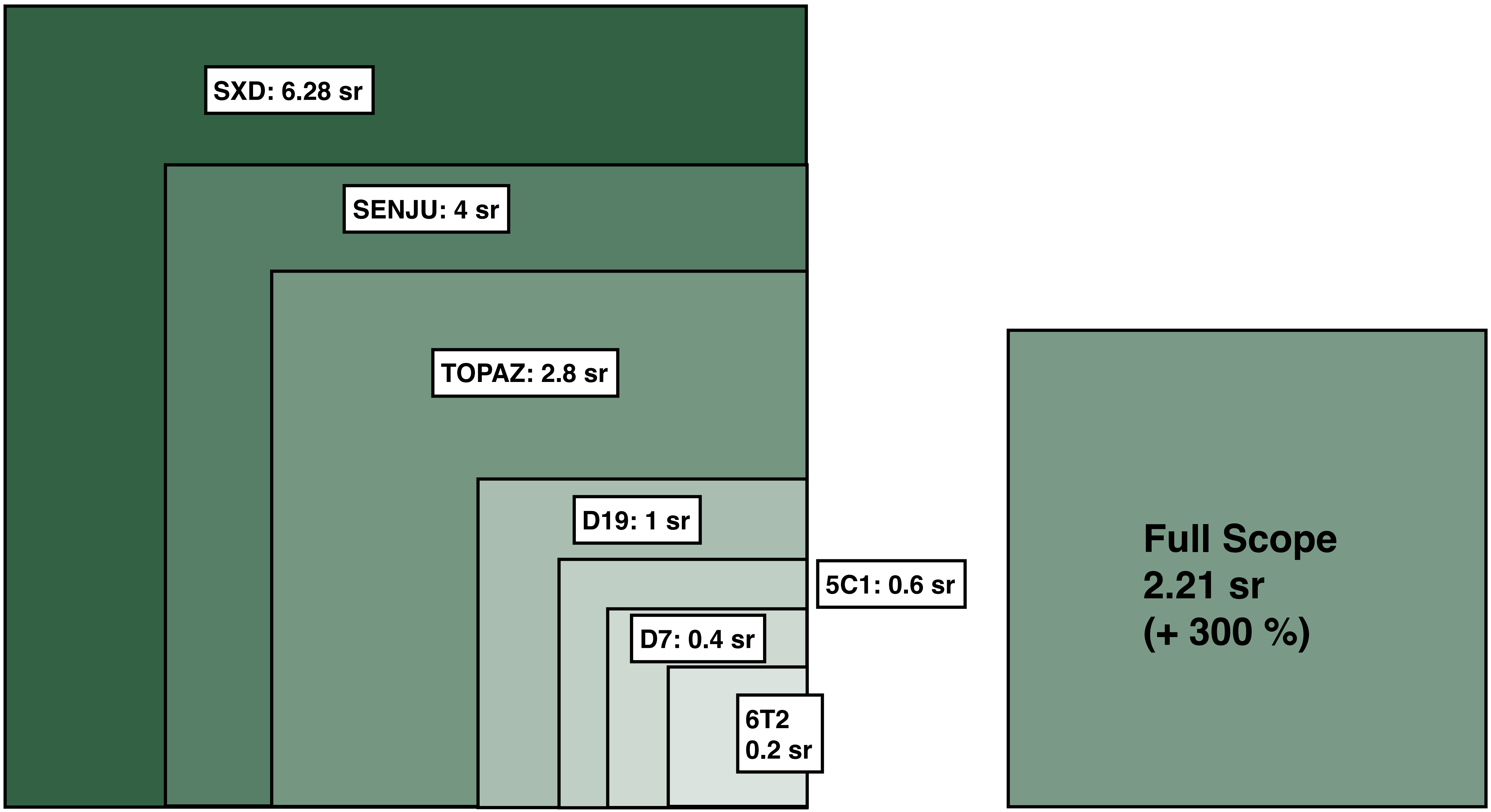
Bottom detector: magnetic contributions parallel to B

Total: 14596 k€ + 11% = 16218 k€

Full Scope configuration

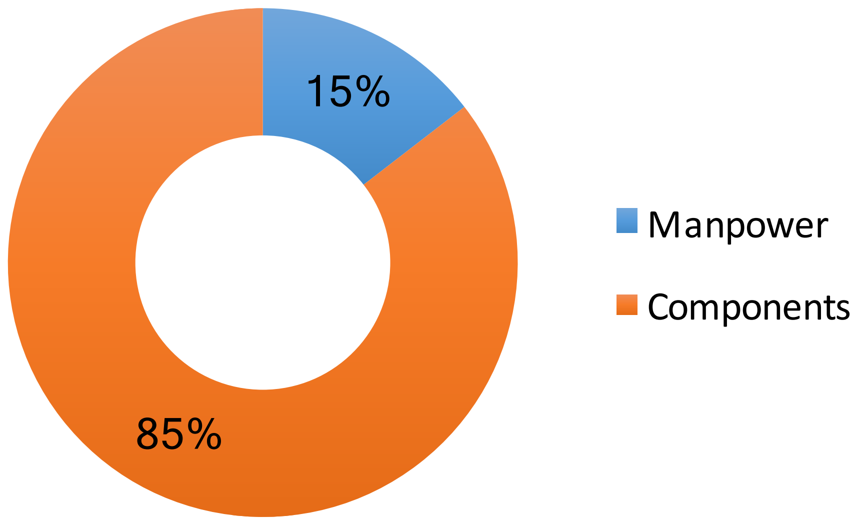


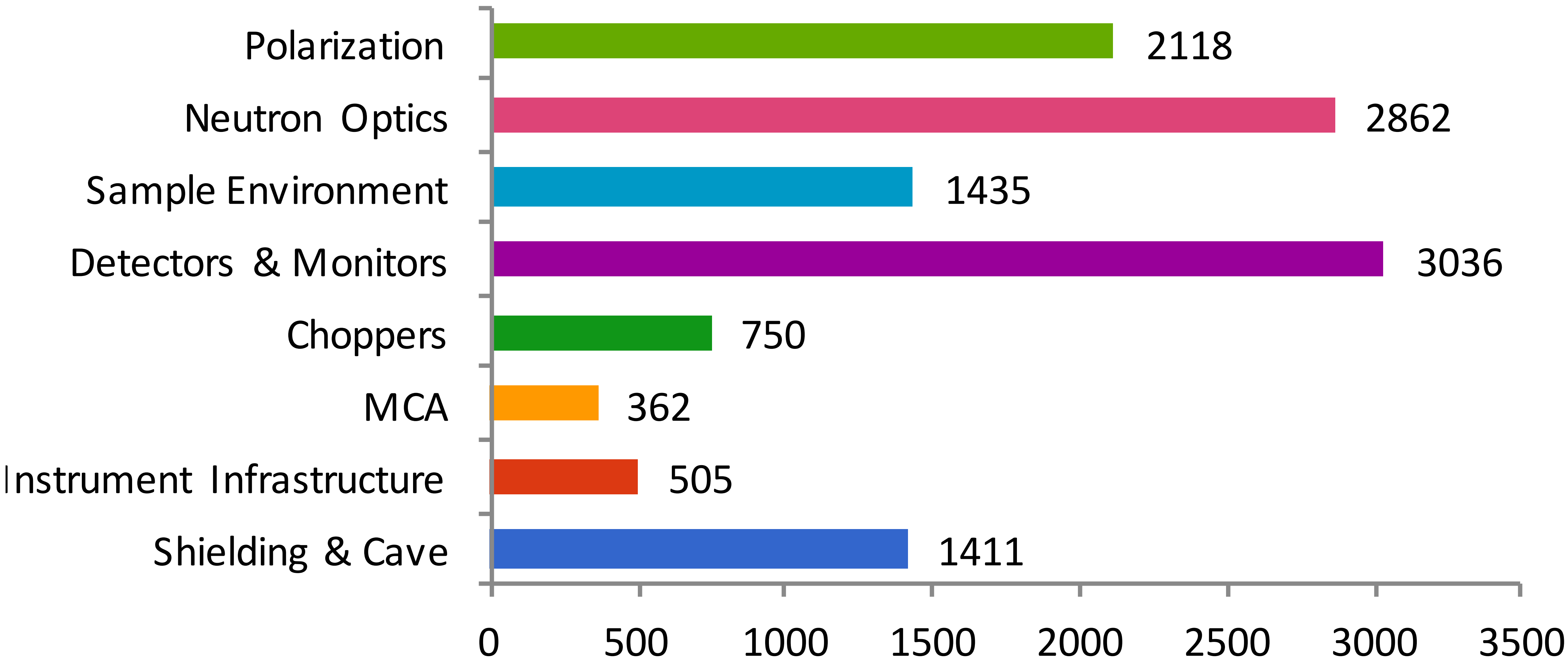
Full Scope configuration



Balanced configuration

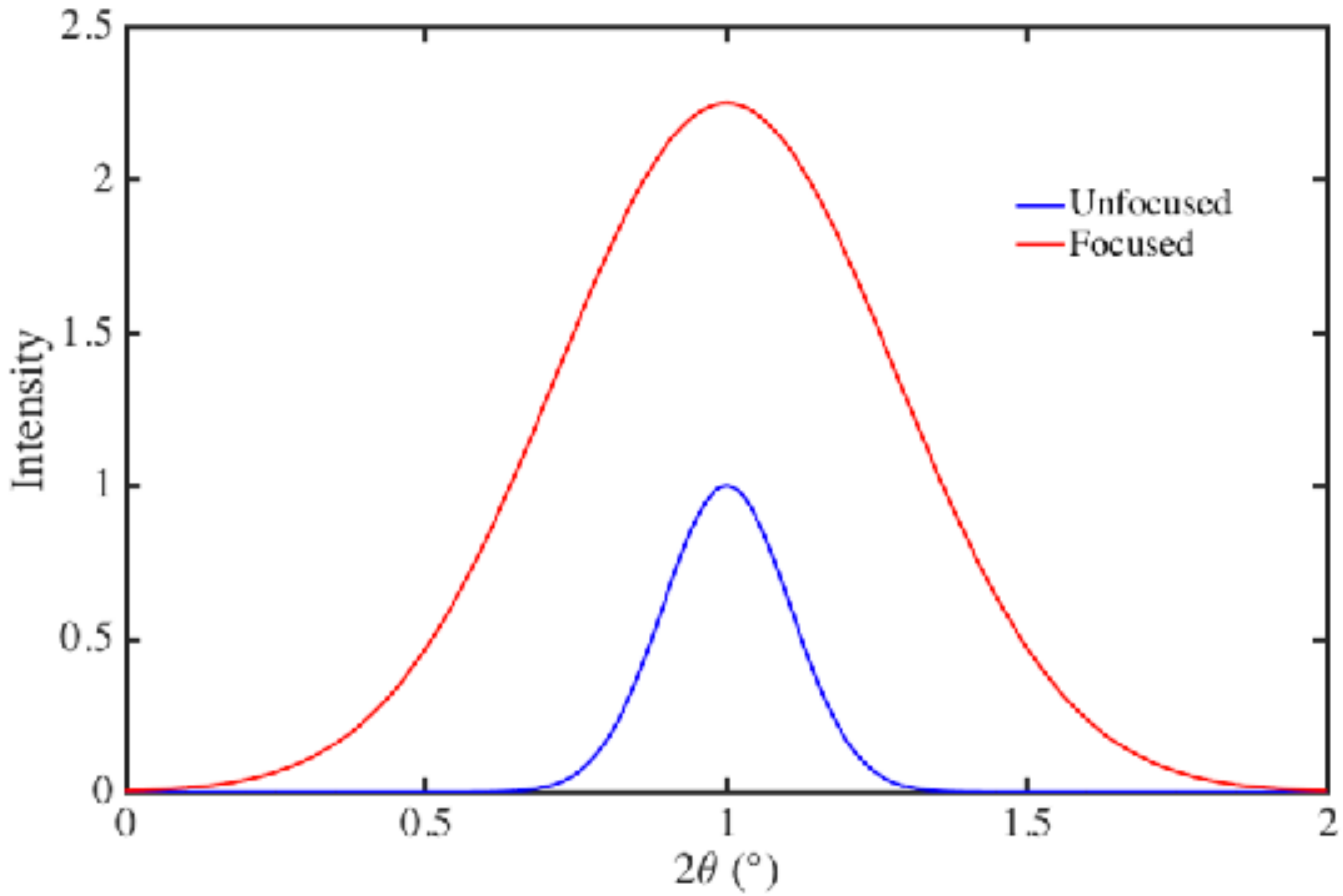
Manpower:	**2119 k€**
Components:	**12478 k€**
Contingency:	**1622 k€**
Total:	**16219 k€**





Performance at 2 MW

- Small crystals: integrated intensity x 6



- Half-polarized / Unpolarized experiments
  - Detector area: +400%
  - Efficiency: +25%

Total: 500% performance increase

Beyond full scope

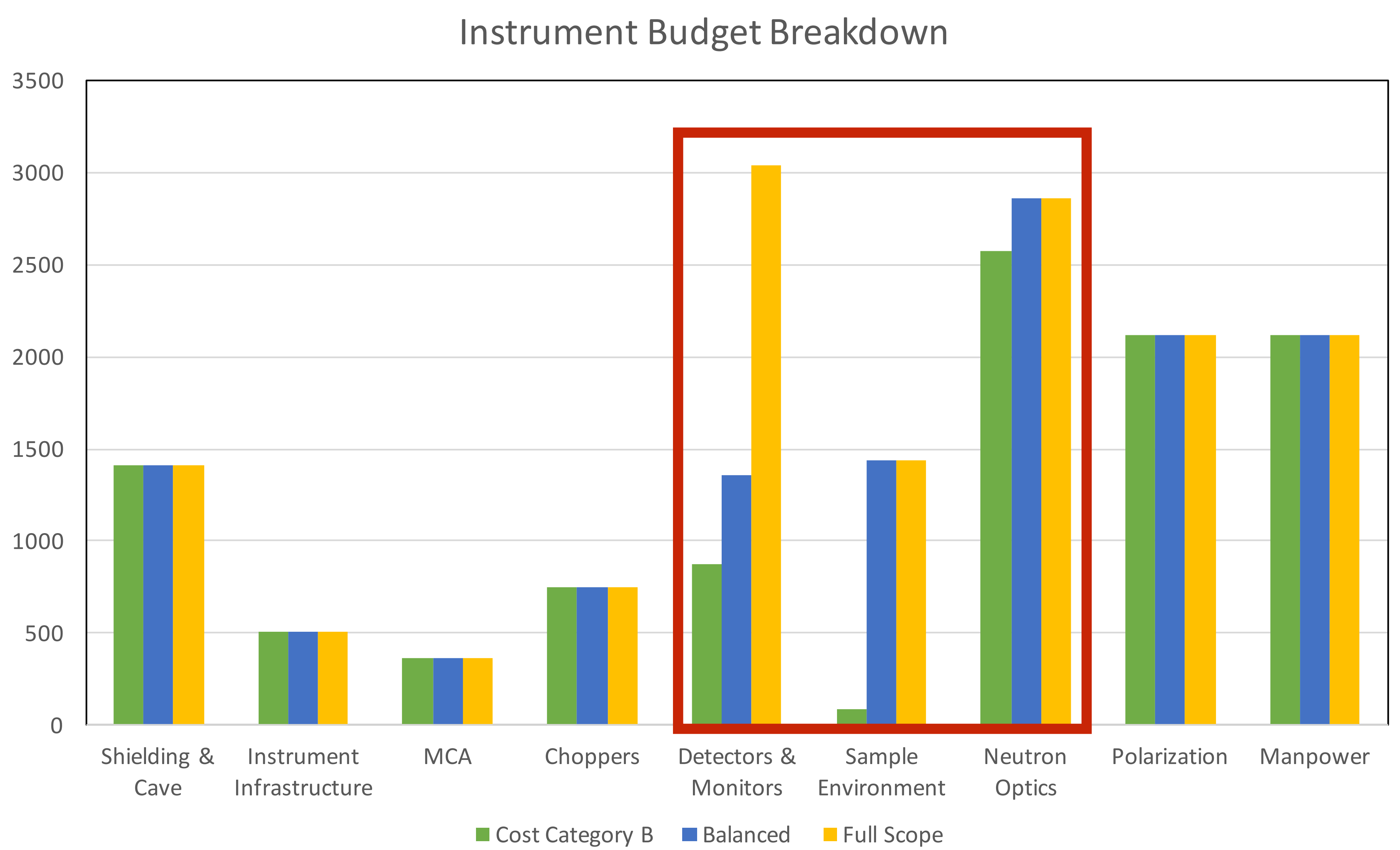
- Pulsed magnetic field
  - 60T conical magnet, 140 ms pulse and 20s / day
  - 500 k€ (magnet) + 1000 k€ (capacitor bank)

- Thermal neutron polarization analysis
  - ^{3}He cells if support from ESS
  - Cost TBD

- 15 T vertical magnet
  - Small vertical aperture
  - Possible share with other instruments (BIFROST ?)
  - 1000 k€

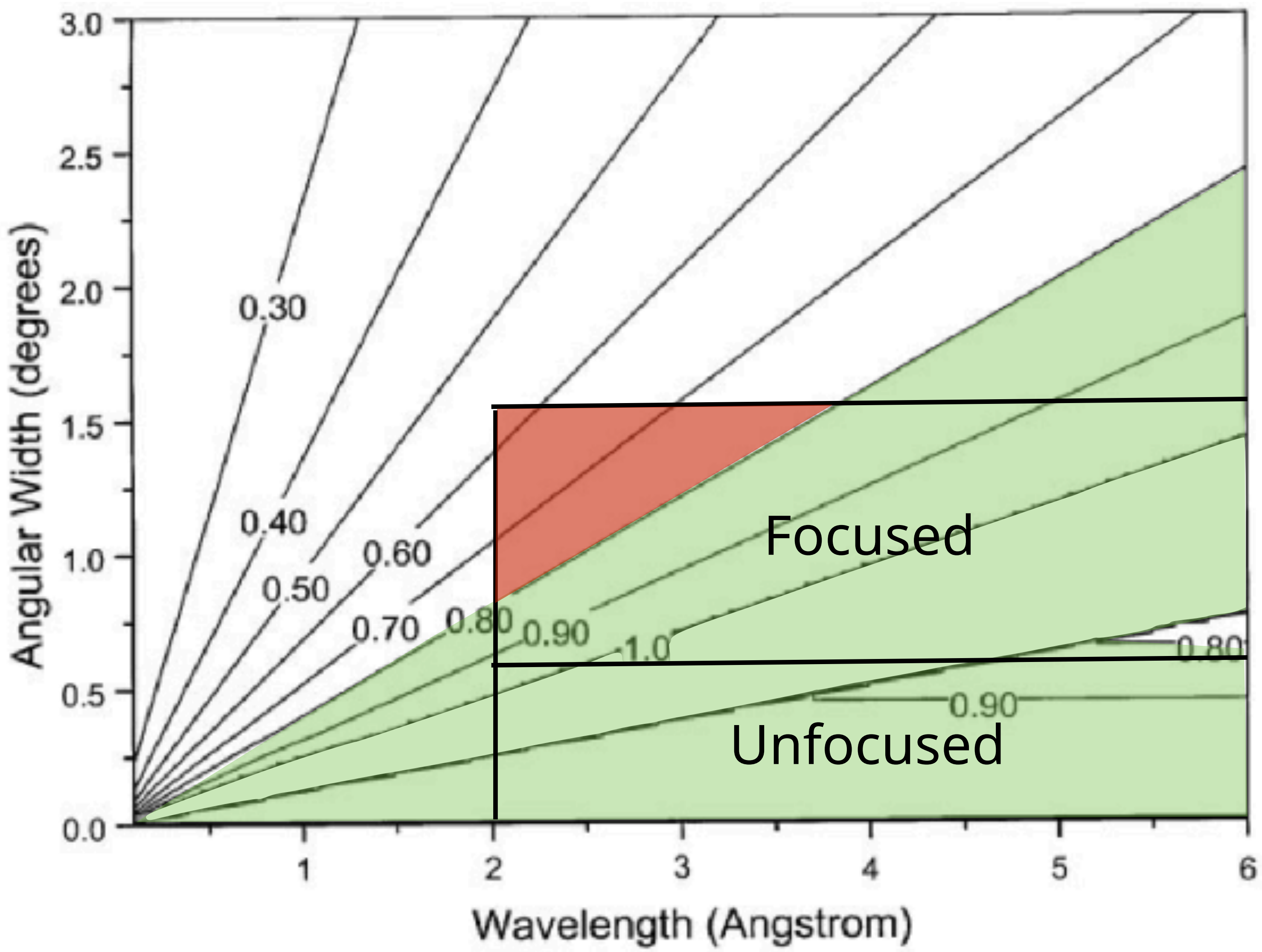
Conclusion

- 3 configurations:



- Each of them are excellent compared to existing single crystal diffractometers !

SM vs ^{3}He cells



L.D. Cussen *, D.J. Goossens , T.J. Hicks

Nuclear Instruments and Methods in Physics Research A 440 (2000) 409}420

^{3}He cells better for large divergence
=> spectrometer !
3He cells are easily removed
=> unpolarized instrument

SM has better FoM
No logistic
No maintenance costs
No additional data correction

=> ideal for a permanently
polarized diffractometer