Cost Optimisation of Beamline Shielding

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But First This... A Standard Guide

- Divergence defined for λ_{min}, λ_{opt} w/ optimised focussing (fully analytic)
- Phase space matching for zig-zag reflections (fully analytic)
- Const. section curved/bender in middle (fully analytic)
- Compression expansion phase space matched (fully analytic)
- Paper in draft...
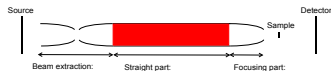
Starting Numbers — Direct Beam (Straight)

- 0.90 m steel + 0.4 m concrete $\leq$ 14 m
- 0.50 m steel + 0.4 m concrete $\leq$ 25 m
- 0.35 m steel + 0.3 m concrete $\leq$ 45 m
- 0.25 m steel + 0.3 m concrete $\leq$ 50 m
- Comes from Stuart's work on ODIN etc.


If you see the flash, duck and cover!

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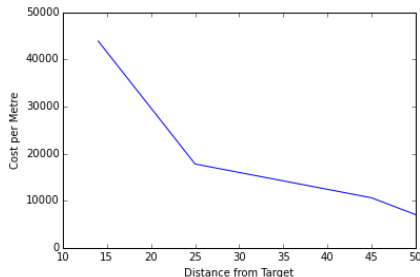
Supermirrors — Gamma Output

- A pleasant(?) "not surprise" is that supermirrors are all bad
- Once you are past 50 m on a straight *guide*, this is more important physics for cost than high energy component
- $m > 4$ is 30% more expensive than $m = 2$ in shielding
- Look at NMX, curved ballistic guides with $m < 2$
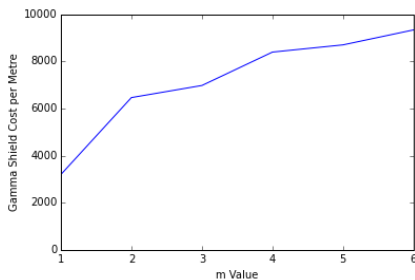
Straight Guide Cost Drivers

- Heavy shutter (RAL, PSI, SNS)
- T0 chopper (ESS-CG, SNS, RAL)
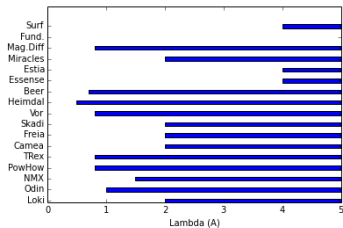- Thick beamstop and instrument cave (RAL, SNS, PSI)

References

- D. Mildner — NIMA 290 (1990) p.189
- P. M. Bentley, C. S. Zendler, O. Kirstein, Phys Rev ST AB (submitted)
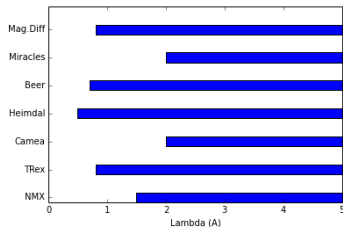- Part of Annual Review 2013 and "Mini Review" 2014

Reference Suite Instruments

- 3 groups of instruments
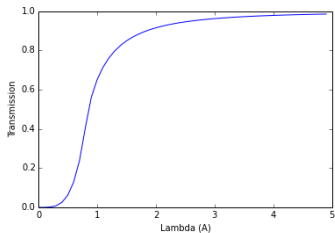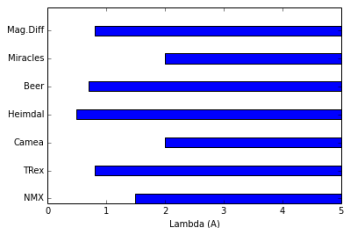- $\lambda \geq 4$Å
- $\lambda \approx 2$ Å
- $\lambda \sim 1$ Å

Long Reference Suite Instruments

- 2 groups of instruments
- $\lambda \approx 2$ Å
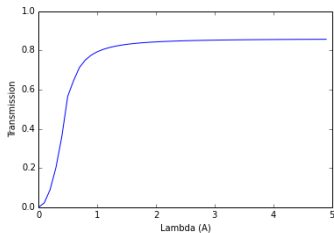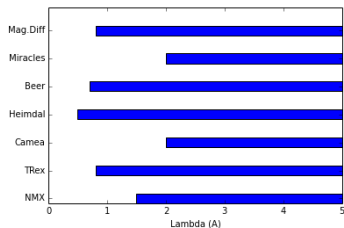- $\lambda \sim 1$ Å

Curved Guide for 150 m 1Å

- Line of sight lost within 75 metres
- $m = 1.5$
- $width = 4$ cm
- $R = 17580$ m
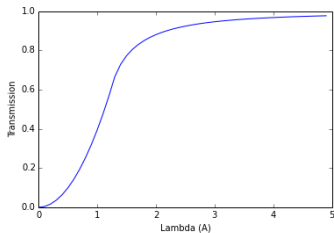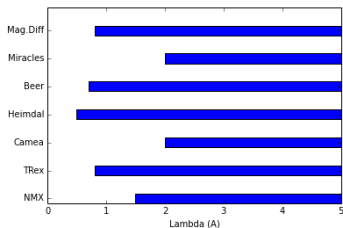- Another iteration may be needed for one or two instruments

Bender for 150 m 1Å

- Line of sight lost within 25 metres
- $m = 3.0$
- $width = 4$ cm
- $channel = 0.5$cm
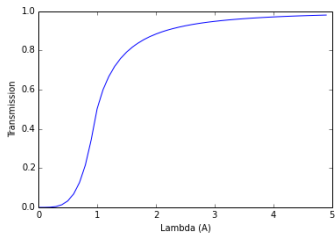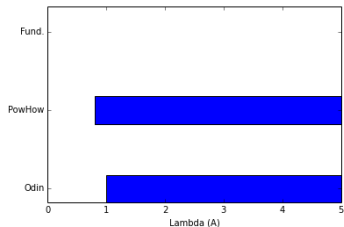- $n_{channels} = 8$
- $R = 1250$ m
- Cost = 1.5 M€

Bender for 150 m 2Å

- Line of sight lost within 25 metres
- $m = 2.5$
- $width = 4$ cm
- $channel = 2.0$cm
- $n_{channels} = 2$
- $R = 1250$ m
- Cost = 350 k€

Other Instruments

- Can do the same thing for other lengths, wavelengths etc.

Standardised Guide Systems of Different Lengths

- Total costs for curved guides are lower than straight guides.
- Using benders to lose line of sight in the bunker does not look to be cost-effective at this stage.
- Gains are roughly proportional in each case, so a suite cost comparison is not too inaccurate...
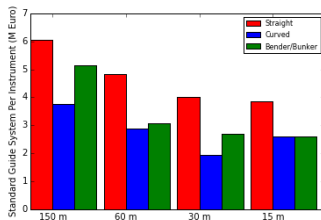
Potential Savings

- Baseline = optics as proposed by scientists
- "Standard" = straight guides allowed, reduced specs on optics
- "Curved" = no straight guides allowed
- "Bender" = Get out of line of sight within 20 metres (bunker).
- Total savings up to 24 M€.
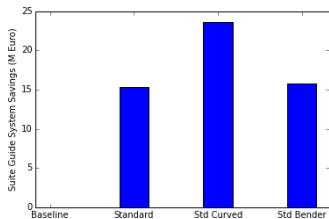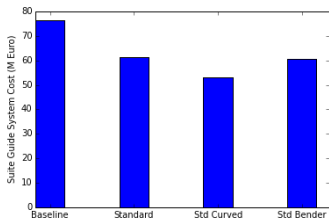
BASIS (SNS)

- Same result
- Curving significantly cheaper (and better background)

Other Considerations

- Access to components affects up-time
- Choppers will break, especially T0 choppers; curved guides less so.

Conclusions

- Need to have credible cost optimisation for management
- There are (non-ideal) plausible solutions to further cost savings
- Failure to do this effectively as a team will probably result in an imposed strategy for the suite
- Now is the last chance to find a solution voluntarily

Do This Later in 2016

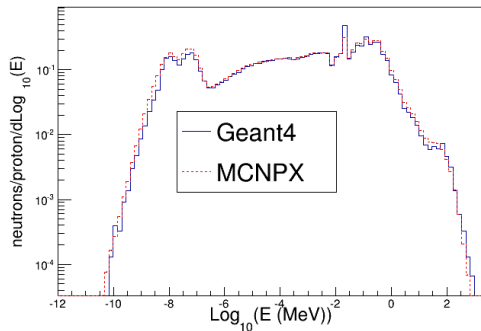# Do This Now (With Friends)

Thank You

Thank you for your attention

Cross-Checking Models

- ESS TDR target monolith modelled in GEANT4 (Doug) and MCNP (Konstantin Batkov, Target Division)
- Modelling in excellent agreement
- Validation of both guide and shielding models is part of NOSG Phase 1 & 2 processes

DiJulio, Batkov *et al*

Multiple Line of Sight

- Losing line of sight if possible saves cost
- Certainly helps with background
- Diminishing returns after $2\times$ LOS
- Twice line of sight is recommended strategy for cost and background
- Instrument project should look at at least one option