BTeV Corrector Update
031218

?? **IHEP/UNK Correctors – superferric approach – presented by Sergei Kozub, 12/5/03**

- **designed & built sc multipole correctors for UNK; superferric correctors for UNK;**
- **sc dipole corrector for Tevatron Electron lens**
- **scaled existing design to BTeV requirements (Zlobin/Kashikhin cos(n?) design): feasible**

(Note: nested corrector designs had quench training/re-training problems in background fields)

From recent summary given by Deepak:

?? **Cos (n?) approach – S. Zlobin & Va. Kashikhin – next step is refinement of field quality; end vs. body studies**

?? **Flat coil array (concept) – Vl. Kashikhin – addressing design issues raised over last few weeks; further work on mechanical design**

Draft note: Superconducting Multipole Corrector for BTeV, V. S. Kashikhin, TD-03-049

IHEP/UNK SuperFerric Correctors

Cross Sections

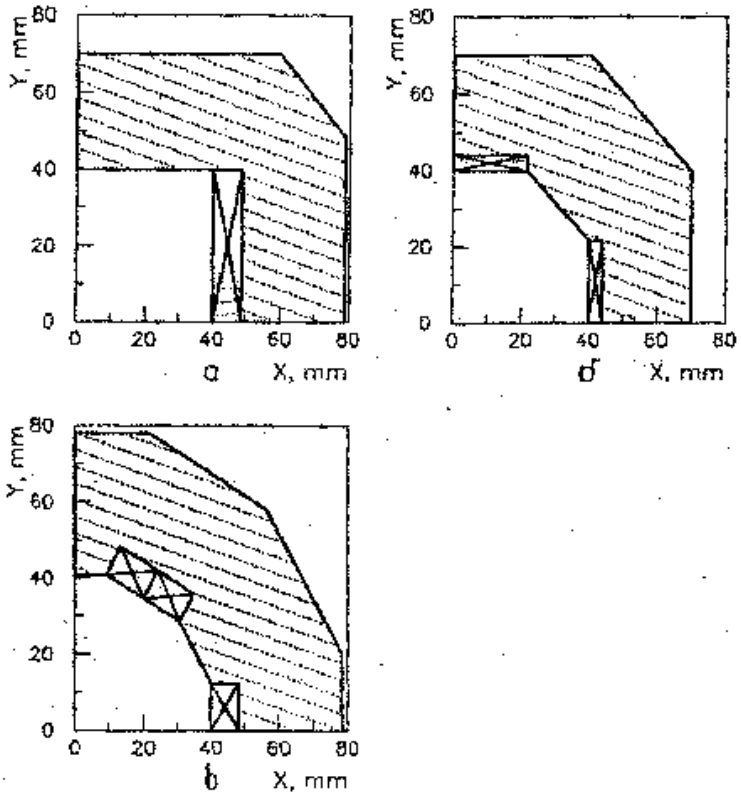

Figure 5. Cross - section of UNK dipole (a), quadrupole (б) and sextupole (b) correctors of super ferric type.

IHEP/UNK SuperFerric Correctors

Load Lines

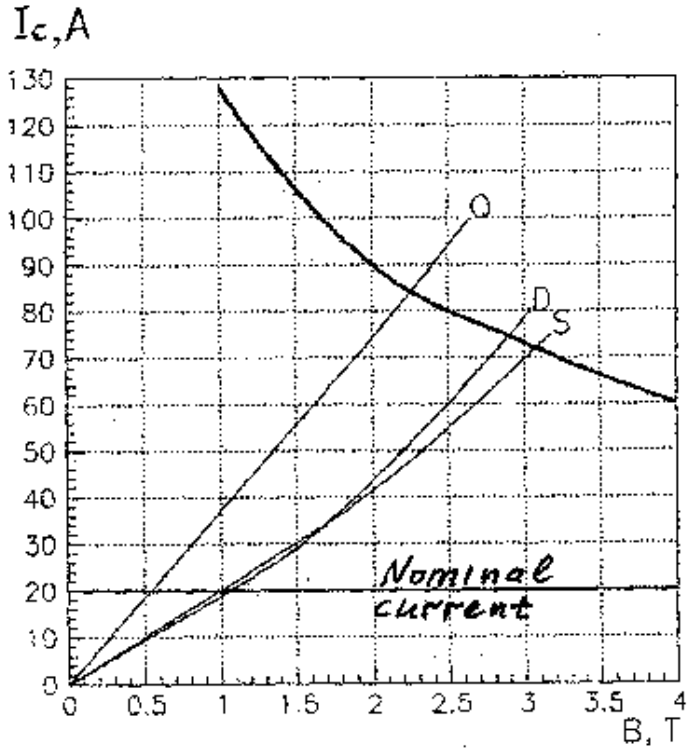

Figure 6. Dependence of critical current on magnetic field at 4.2 K temperature for SC wire of 0.3 mm diameter. D, Q, S – load line of dipole, quadrupole and sextupole correctors for point of coil with maximum magnetic field.

Flat Coil Array

Questions from Peter Garbincius

a. I'm not too worried about the **"complexity" of powering** that Bob Kephart mentions. However, I do worry that all possible current configurations are taken into account for quench margin and mechanical stability (for quenching and field quality) under the various coil pack to coil pack force directions for all of the powering configurations

b. I do not know what the **field quality** will be. It will not be as good as the cylindrical shells since there is more granularity in the coil configurations. I don't know what the field criteria will be for correctors. ***And a trim quad for the LHC*** (inner?) ***triplet***. Is it appropriate to do a field map calculation at this time?

c. There are **two other corrector magnet configurations needed**:
   i. **SKEW SEXTUPOLE** - easily accommodated by rotating current configurations by 30-degrees
   ii. **SKEW QUADRUPOLE** - which doesn't have a simple "pole" configuration for the flat coil array. It looks to me, doing a super-position of two attainable "pole" quadrupoles that a skew quad can be oriented as(looking down bore of quad and time on a clock)

coil	12:30	current	+0.5*I
	1:30		+I
	2:30		+0.5*I
	3:30		-0.5*I
	4:30		-I
	5:30		-0.5*I
	6:30		+0.5*I
	7:30		+I
	8:30		+0.5*I
	9:30		-0.5*I
	10:30		-I
	11:30		-0.5*I

d. In looking over Mike Church's spreadsheet with the needed correctors at each station, it is apparent that not all correctors are needed everywhere leading to some simplification. For example, except a the triplet spool, H and V dipoles are not needed at the same station.

e. Would one want to include the ***triplet trim quad*** in this multi-powering corrector scheme or should it be separate function?

So my biggest concerns are field quality (calculations could show whether this is an issue), and quench stability under all powering configurations from both current/field/short sample and mechanical motion stability concerns.

Peter

Flat Coil Array

Answers from Vladimir Kashikhin

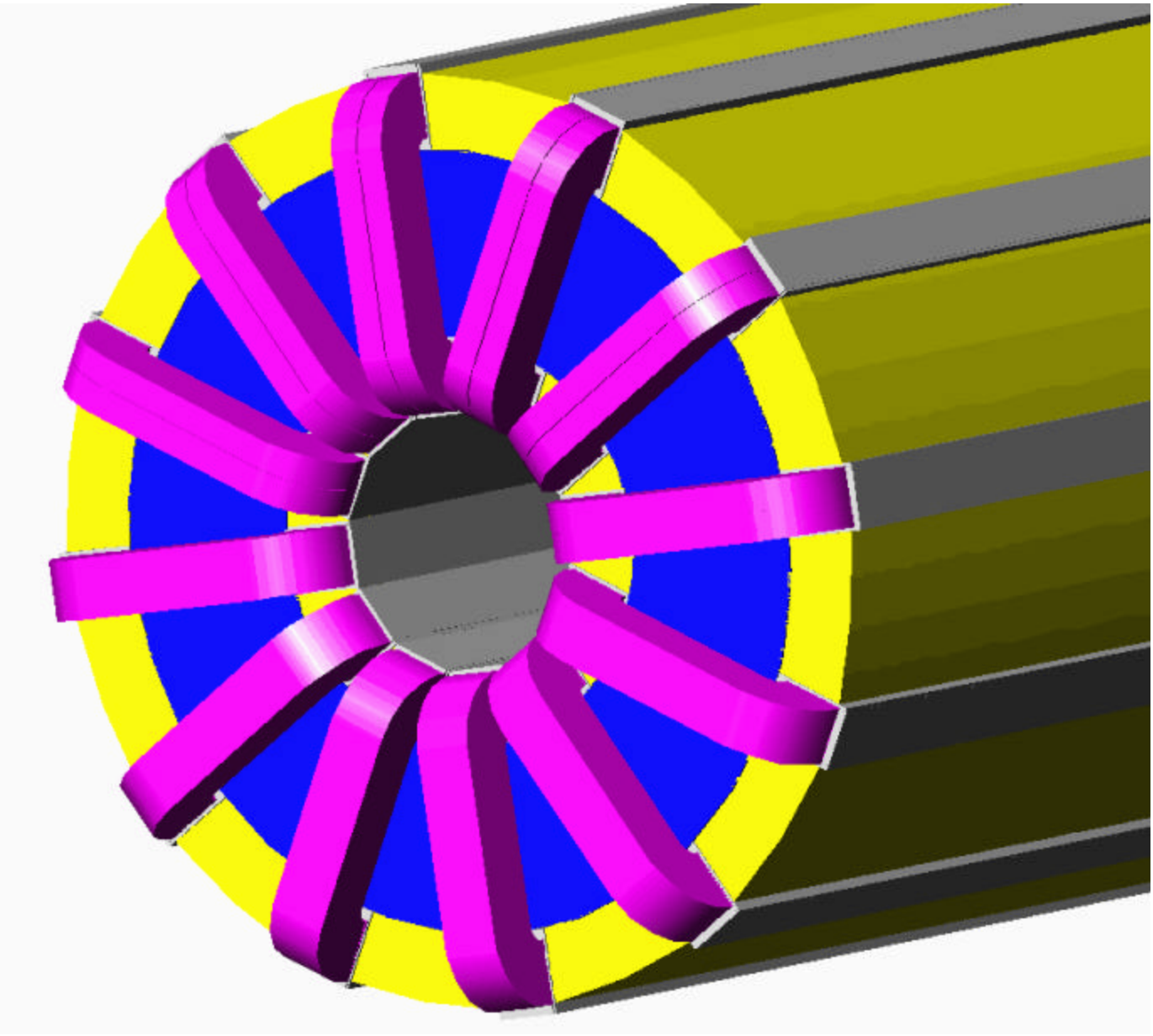

Fig. 1 General view of corrector magnet

Vladimir Kashikhin, cont.

Corrector Main Parameters

Integrated dipole field (any angle to axis), T*m	0.48
Integrated quadrupole gradient (any angle to axis), T	25
Integrated sextupole strength, T/m	450
Effective length, m	1.5
Inner coil radius, mm	40
Inner core radius, mm	63
Outer core radius, mm	120
Operational current, A	50-55
Coil number of turns	850-930
Bare strand diameter, mm	0.5
Strand diameter with insulation, mm	0.63
Coil area, mm^2	368
Cold mass outer diameter, mm	290

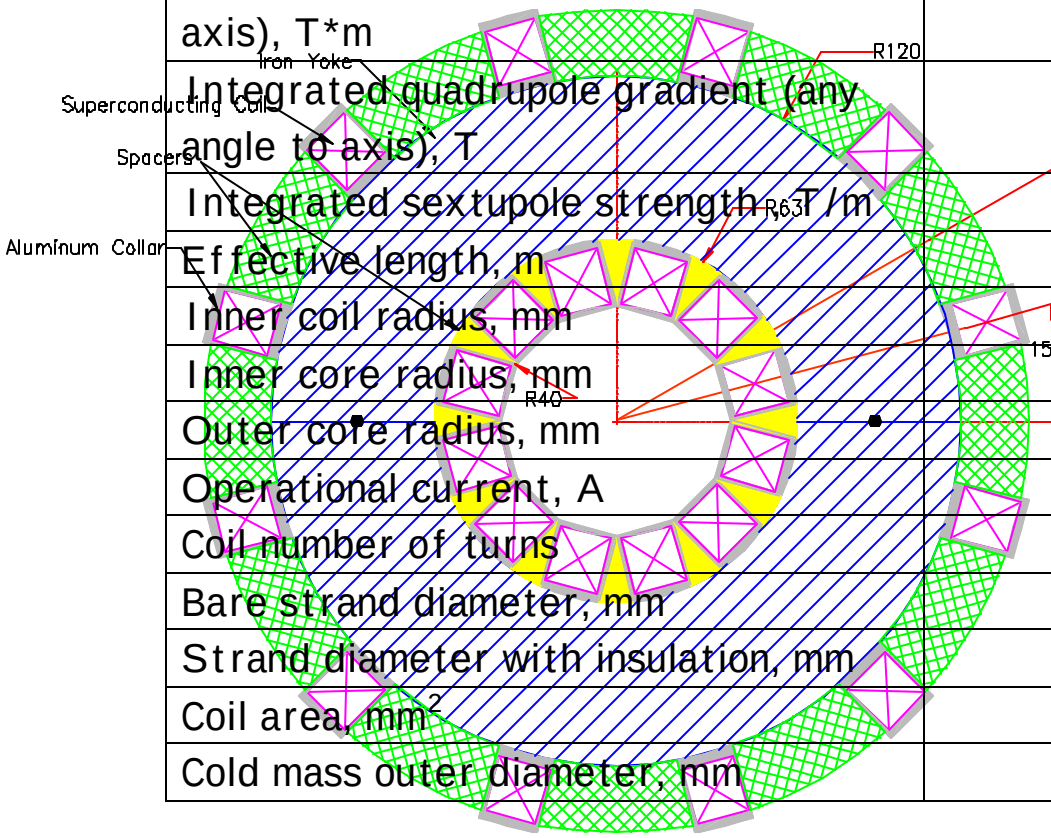

Fig. 2. Corrector cross-section

Magnetic Field Quality

Tevatron dipole: 4.3T x 6.11m = 26.3 T*m

1 Unit of Tevatron field distortion at reference radius 25.4 mm equal in Multipole Corrector (effective length 1.5m) :

Dipole integrated field 0.48T*m **54.8 units**

Quadrupole integrated gradient 25 T, integrated field 0.635 T*m **41.4 units**

Sextupole integrated gradient 450 T/m, integrated field 0.29 T*m **90.7 units**

Skew quadrupole integrated gradient 7.5 T, integrated field 0.19 T*m **138.4 units**

Trim Quadrupole integrated gradient 8.5 T, Integrated field 0.216 T*m **121.8 units**

Normal dipole+quadrupole+sextupole

Table 2

Dipole field, T	0.32
Dipole max component of current, A	I_{d1} = 7.9
Field harmonics in 10^{-4} at 25.4 mm radius	b_3=-0.0004, b_5=1.14, b_7=0.5,b_9=0.03, b_{11}=-5.6, b_{13}=-1
Quadrupole gradient, T/m	17.0
Quadrupole component of current, A	I_q=23.2
Quadrupole harmonics in 10^{-4} at 25.4 mm radius	b_6=1.25, b_{10}=-27.6
Sextupole gradient, T/m^2	301.0
Sextupole component of current, A	I_s=18.9
Sextupole harmonics in 10^{-4} at 25.4 mm radius	b_9=-127
Total current at all component max field, A	50.0
Maximum flux density in the yoke at max currents, T	1.6

Skew quadrupole

Easily obtained by field rotation of 45° or magnet by 15°. It is also possible power coils 0.5I , I , 0.5I ,…

Field quality: a4=-1.42, a6=-0.27, a8=1.08, a10=27.7 compared to an *'allowed level'* of 138.4 units.

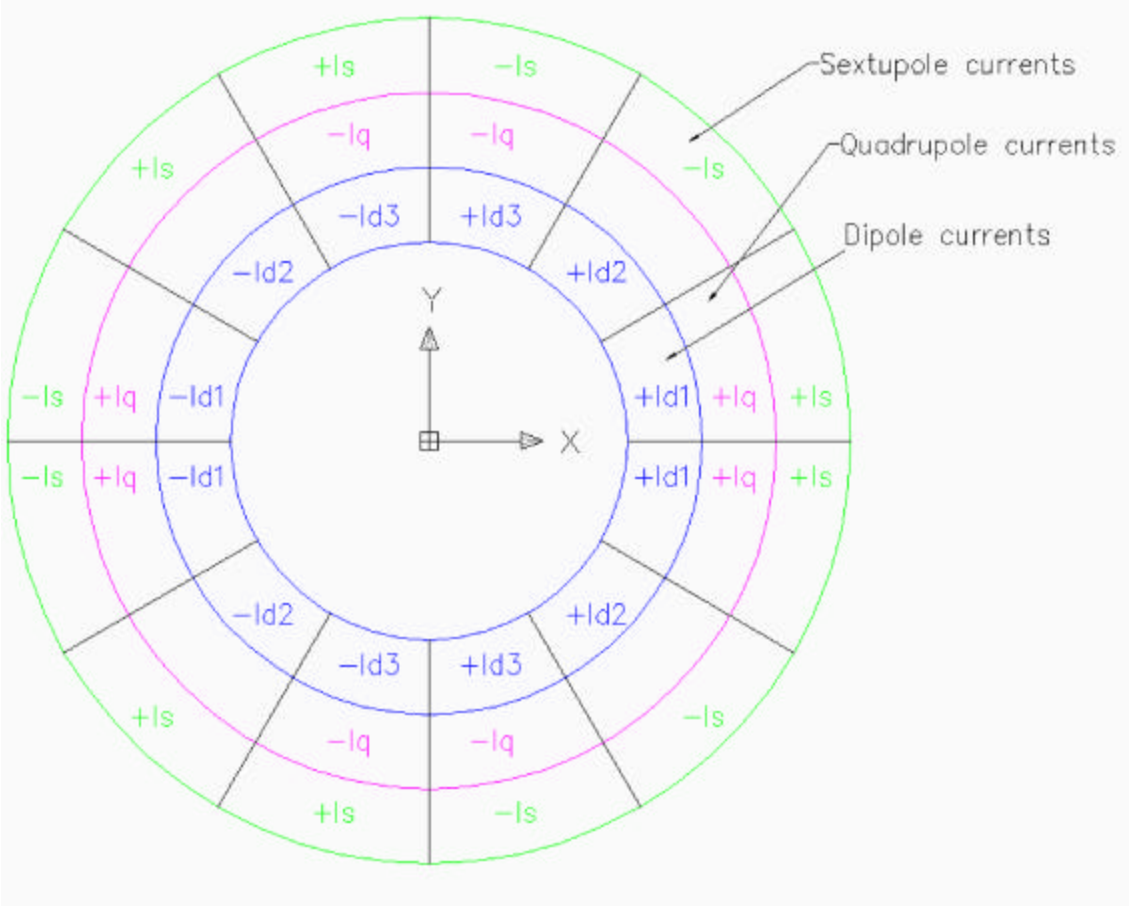

Fig. 3 Total coil current components

Physical elements between B43 and C17 derived from JJ btev MAD file
M. Church 11/8/03

Notes: 1) lengths are in meters; z coordinate is 0 at B38
2) PS current and integrated field strengths are @ 980 GeV low beta lattice or max allowable

name	type	location	new/old	cold/warm	bipolar	Corrector Config.	V dipole	H dipole	quad	skew quad	sextupole	skew sextupole	octupole	comments
packb43	X1 spool	B43-1a	new	cold	3*yes	**Dv Qn Sn**	.48 T-m max		25 T-m/m max		450 T-m/m2 max			lose SS, O coils
packb44	X1 spool	B44-1a	new	cold	3*yes	**Dh Qn Sn**		.48 T-m max	25 T-m/m max		450 T-m/m2 max			
packb45	P spool	B45-1a	used	cold	3*yes	**Dv Dh Qs**	L=.762, .42 T-m max	L=.762, .42 T-m max		L=.762, 7.5 T-m/m max				gain VBPM, HBPM, H, SQ coils; leads toward the tunnel wall; lose Q, S coils; H probably not required?
spoolb45	cold spool		new	cold										how to accommodate this piece?
packb46	P spool	B46-1a	used	cold	3*yes	**Dv Dh Qs**	L=.762, .42 T-m max	L=.762, .42 T-m max		L=.762, 7.5 T-m/m max				gain VBPM, HBPM, V coil; lose Q, S coils; leads toward the tunnel wall
packb47	X2 spool	B47-1a	new	cold	2*yes	**Dv Qs**	.48 T-m max			7.5 T-m/m max				gain VBPM, SQ coil; lose Q, S, SS coils
packb48	X2 spool	B48-1	new	cold	2*yes	**Dh Qs**		.48 T-m max		7.5 T-m/m max				gain HBPM, SQ coil
DR48C0	56" spool? H spool?	B48-6	new or used	cold										this should be within the separator warm straight; or put a spool in here; could be H spool with HTS leads for Tev bus? Could be A or B spool
packc0u	X2 spool	B49-1a	new	cold	3*yes	**Dv Dh Qs**	.48 T-m max	.48 T-m max		7.5 T-m/m max				gain H, V, SQ coils; is there enough room in the spool for all this? Does this spool contain the leads?

name	type	location	new/old	cold/warm	bipolar	Corrector Config.	V dipole	H dipole	quad	skew quad	sextupole	skew sextupole	octupole	comments
packc0d	X2 spool	C11-2a	new	cold	3*yes	**Dv Dh Qs**	.48 T-m max	.48 T-m max		7.5 T-m/m max				gain H, V, SQ coils; is there enough room in the spool for all this? Does this spool contain the leads?
packc12	X2 spool	C12-1	new	cold	2*yes	**Dv Qs**	.48 T-m max			7.5 T-m/m max				gain VBPM, SQ coil; lose O coil; safety leads typically are on every other spool; on this side of the IR they are on odd-numbered spools – used to be even-numbered
packc13	X2 spool	C13-1a	new	cold	2*yes	**Dh Qs**		.48 T-m max		7.5 T-m/m max				gain HBPM; lose Q, S coils
packc14	P spool	C14-1a	used	cold	3*yes	**Dv Dh Qs**	L=.762, .42 T-m max	L=.762, .42 T-m max		L=.762, 7.5 T-m/m max				gain VBPM, HBPM, H, SQ coils; lose Q, S coils; leads toward the tunnel wall
spoolc15	cold spool		new	cold										same as spoolb45; should this go between the spool and feedcan also?
packc15	P spool	C15-1a	used	cold	3*yes	**Dv Dh Qs**	L=.762, .42 T-m max	L=.762, .42 T-m max		L=.762, 7.5 T-m/m max				gain VBPM, HBPM, V, SQ coils; lose Q, S coils; leads toward the tunnel wall
packc16	X1 spool	C16-1a	new	cold	3*yes	**Dv Qn Sn**	.48 T-m max		25 T-m/m max		450 T-m/m2 max			
packc17	X1 spool	C17-1a	new	cold	3*yes	**Dh Qn Sn**		.48 T-m max	25 T-m/m max		450 T-m/m2 max			lose SQ, O coils

Summary

?? **3 approaches to corrector design under consideration**
- **cos(n?) design – discreet**
- **flatcoil design – combined**
- **superferric design – discreet**

?? **Cos(n?) and superferric designs are 'conventional' – based on modifications to existing corrector designs**

?? **Flatcoil array design is new: some additional work (aka R&D) required but has potential advantages**

?? **Length issue in spools – corrector impact**
- **detailed design of ends – coil, support structure, magnetic shielding – next step in evaluation process**

?? **Error budget for correctors**
- **what are the limits on error fields ?**

?? **Baseline ? *technical / schedule / budget* baseline(s) need to be developed (but that probably won't happen in the order given…)**