ISOLDE Powering and ELENA

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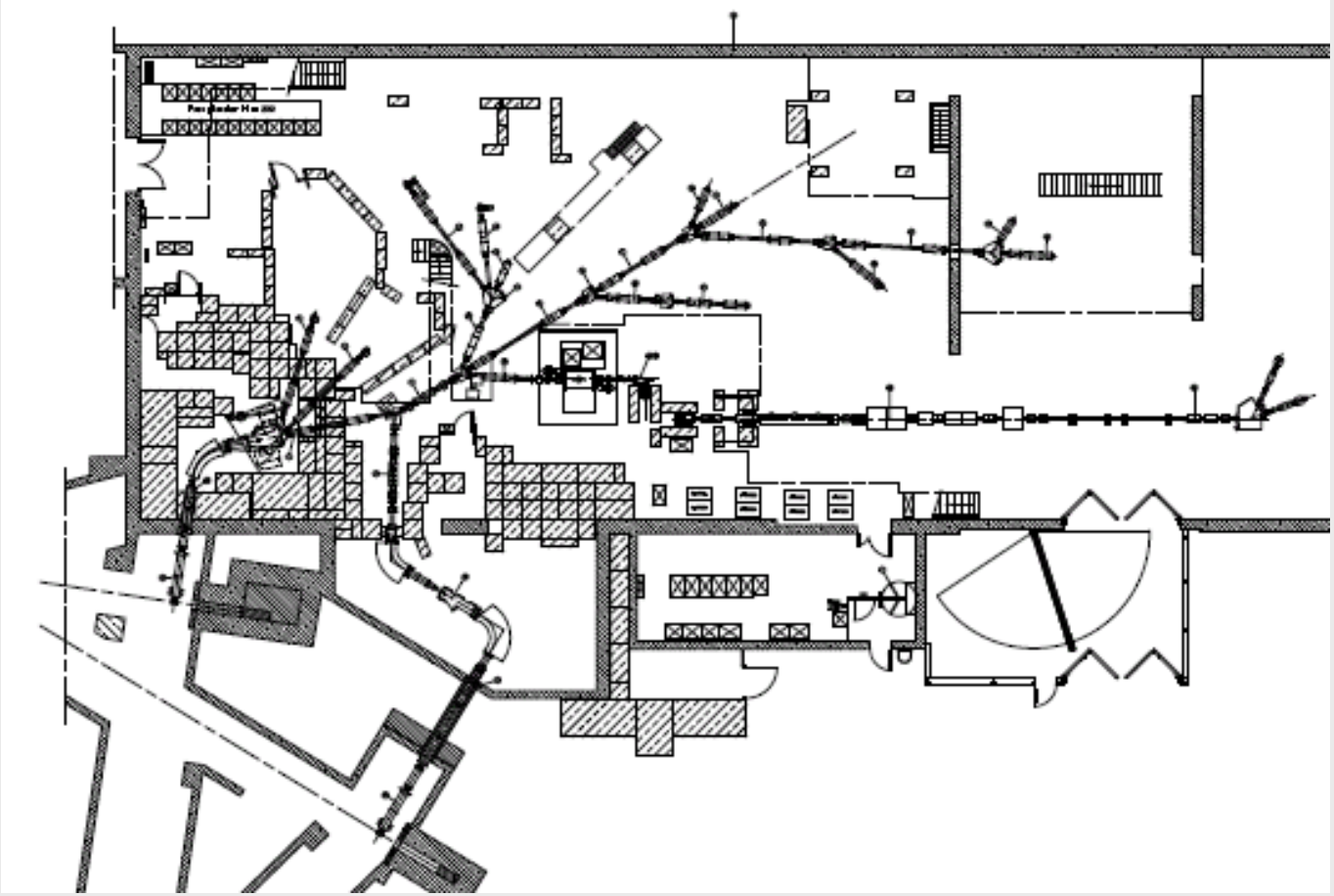
Intro

- Introduction - powering the ISOLDE complex
- DC Systems v pulsed systems
- Powering Bends, Quads and Steerers
- Controls and diagnostics
- Estimate of ELENA requirements
- Conclusions

Introduction - powering the ISOLDE complex

- Machine layout



Introduction - powering the ISOLDE complex

- The ISOLDE complex, with many beam lines, is a diverse user of beams, beam treatment and experiments
- Currently the entire complex uses >500 systems under the management of TE-EPC
  - Grouped into >50 different types
  - Range from [10V to 60kV] and [500uA to 1kA]
- The many beam treatments in the complex leads to a large diversity of equipment (see Fredrik Wenander presentation)
  - Also due to the historical ‘growth’ of the complex through CERN and non-CERN developments

Introduction - powering the ISOLDE complex

- The power converter types at ISOLDE

	Machine		
Converter Type	ISOLDE	REX-ISOLDE	Grand Total
24VBAT [±150A, ±24V]	1		1
50/750-2 CH1 [±0.05A, ±1500V]		2	2
50/750-2 CH2 [±0.05A, ±1500V]		2	2
50/750-2EX CH1 [±0.05A, ±750V]		2	2
50/750-2EX CH2 [±0.05A, ±750V]		2	2
590 2CH [±0A, ±7500V]		4	4
590 CH Neg [±0A, ±7500V]		2	2
590 CH Pos [±0A, ±7500V]		2	2
6018-4 CH1 [±0.01A, ±500V]		2	2
6018-4 CH2 [±0.01A, ±500V]		2	2
6018-4 CH3 [±0.01A, ±500V]		2	2
6018-4 CH4 [±0.01A, ±500V]		2	2
601C-2 CH1 [±0.05A, ±500V]		2	2
601C-2 CH2 [±0.05A, ±500V]		2	2
700V [±0A, ±700V]	108	10	118
AF99032 [±60A, ±20V]		1	1
D-15V-1000A [±1000A, ±15V]	2		2
D-15V-600A [±600A, ±15V]	2		2
D-300V-5A [±5A, ±300V]	4		4
D-30V-100A [±100A, ±30V]	4		4
D-52V-30A [±10A, ±30V]	2		2
DC24-D1000 [±0.0005A, ±1000V]	32		32
DC24-D3500 [±0A, ±3500V]	148	24	172
GAN 960715-1 [±0A, ±200V]		4	4
HCE 35-12500 [±0.002A, ±-12500V]		1	1
HCE 35-2000 [±0.015A, ±-2000V]		1	1
HCE 35-20000 [±0.001A, ±20000V]		2	2
HCE 7+2000 [±0.003A, ±2000V]		2	2
HCE 7+3500 [±0.002A, ±3500V]		3	3
HCE 7+6500 [±0.001A, ±6500V]		1	1
HCE 7-12500 [±0A, ±-12500V]		2	2
HCE 7-3500 [±0.002A, ±-3500V]		2	2
HCE 7-6500 [±0.001A, ±-6500V]		2	2
HCN 120M-60000 [±0.002A, ±60000V]		1	1
HCN 140-65000 [±0.002A, ±65000V]	1		1
HCN 140M-65000 [±0.002A, ±65000V]		2	2
HCN 7EM+1250 [±0.005A, ±1250V]	2		2
HCN 7EM+2000 [±0.003A, ±2000V]	10	1	11
HCN 7EM+3500 [±0.002A, ±3500V]	21		21
HCN 7EM+6500 [±0.001A, ±6500V]	10		10
HCN 7EM-1250 [±0.005A, ±-1250V]	2		2
HCN 7EM-12500 [±0.0005A, ±12500V]	1		1
HCN 7EM-2000 [±0.003A, ±-2000V]	10		10
HCN 7EM-20000 [±0.0003A, ±20000V]	2		2
HCN 7EM-3500 [±0.002A, ±-3500V]	22		22
HCN 7EM-6500 [±0.001A, ±-6500V]	10		10
HCN 90M-3000 [±0.03A, ±3000V]	2		2
LNCE6000-1NEG [±0.001A, ±-6000V]		16	16
LNCE6000-1POS [±0.001A, ±6000V]		16	16
MN42-200 [±42A, ±200V]	1		1
MN65-352 [±350A, ±65V]		1	1
MN70-480R [±70A, ±480V]	2		2
MPS 858 [±A, ±V]		22	22
PC : NTN 1000 M-25 [±25A, ±40V]	4		4
P0621P [±0.02A, ±30000V]		2	2
HEINZINGER PCU 50-200 [200A,50V]		4	4
REXTRAP [±0.1A, ±200V]		6	6
SM7020-D [+20A, +70V]		1	1
SR6PN6		1	1
TRSF-ISOL-TRAS [±A, ±380V]	3		3
XFR 12-100 [±100A, ±12V]		1	1
Grand Total	406	157	563

DC electrostatic powering

- Recommendation
  - Minimise the flavours found in the accelerator
  - Cheaper; easier to operate and maintain;
- As the systems are DC
  - Very low power is required
  - Systems are physically small -> up to 30 per rack

Design examples

from left:

HCE 7 - 6500	HCE 7 - 20000	HCE 35 - 35000	HCE 350 - 2000
6,5kV / 1 mA	20kV / 0,3 mA	35kV / 1 mA	2kV / 150 mA

DC electrostatic powering

- The power converter types used for ISOLDE transfer lines and recommended for use on future projects

	Machine		
Converter Type	ISOLDE	REX-ISOLDE	Grand Total
HCE 35-12500 [±0.002A, ±-12500V]		1	1
HCE 35-2000 [±0.015A, ±-2000V]		1	1
HCE 35-20000 [±0.001A, ±20000V]		2	2
HCE 7+2000 [±0.003A, ±2000V]		2	2
HCE 7+3500 [±0.002A, ±3500V]		3	3
HCE 7+6500 [±0.001A, ±6500V]		1	1
HCE 7-12500 [±0A, ±-12500V]		2	2
HCE 7-3500 [±0.002A, ±-3500V]		2	2
HCE 7-6500 [±0.001A, ±-6500V]		2	2
Grand Total	0	16	16

- If the proposals don't fit with the accelerator needs
  - Straight forward to extend up to 35kV and 35W
  - Try to standardise!

http://www.fug-elektronik.de/webdir/PDF/e/e_datasheet_HCE.pdf

Pulsed electrostatic powering

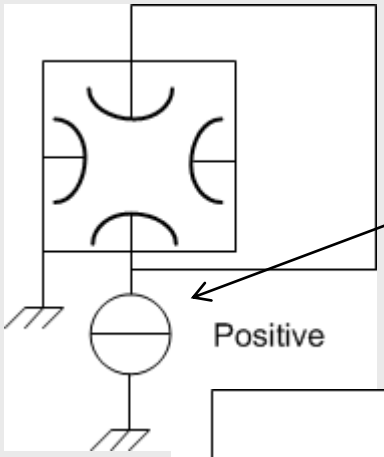
- Additional constraints on the choice of power converter
  - Power source needs to sink and source current quickly
  - Peak current and power is much higher
  - The voltage rise and fall time is a critical parameter
  - Not available ‘off the shelf’ from commercial suppliers

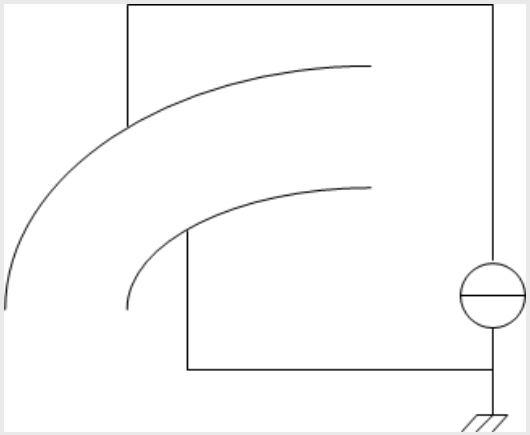
- EPC currently have very few pulsed systems in the ISOLDE complex
- Kickers are required for ejection from ring and into experimental areas
- These are generally the responsibility of the TE-ABT group
  - Check if the ABT group already have appropriate technology

- ELENA will probably need pulsed quads to compensate dipole effects
  - Typical solution would switch rapidly between 2 DC sources using semiconductor switches; other solutions can be envisaged.
  - Synergy with kicker technology? Otherwise some development required.

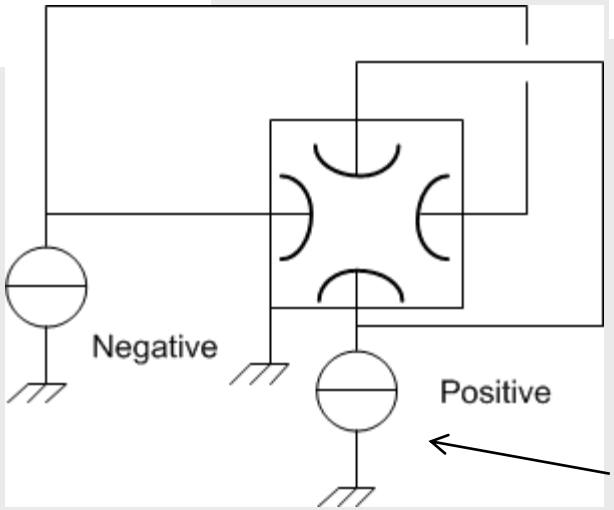
Powering bends, quads and steerers

- Preferred configurations if permitted by optics:

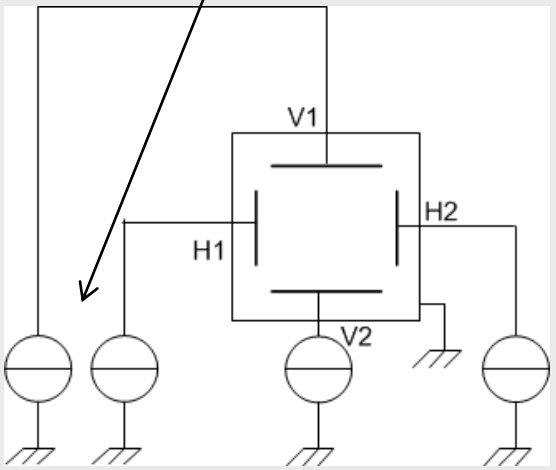




Bending configuration



Quad configurations



Steerer configuration

Controls and diagnostics

- For DC systems, we currently use PLCs in the ISOLDE complex
  - Provides a slow control and acquisition solution for general monitoring
  - Acquisition of output voltage and power system state is generally sufficient
  - Specification of setpoint and measurement performance? 10^{-4} resolution and 10^{-4} absolute ?

- Acquisition of Pulsed Systems
  - In addition to the slow (PLC) control, triggers and fast acquisition are required
  - Standard solutions available from the CO group would typically be used
  - Check also synergies with the TE-ABT group

An ELENA TL shopping list for power

Function	Machine Qty	PC Qty	19” Racks
Quads	~20	~20 – 40	~2
Bends	~6	~6	~0.25
Steerers	~20	~80	~3
Pulsed	~5	~10	~1

Approx budget: 500 kCHF

Conclusions

- Simple approach is best for the many small DC power sources required
  - Only a few types need to be considered compared to ISOLDE complex
  - Straightforward to extend to 35kV for modest cost
- Pulsed approach needs much more care
  - Load capacitance, switching times, diagnostics
  - Possibly the TE-ABT group have a solution ready to go?
- Consideration should be given to diagnostics requirements
  - Acquisition rate and acquisition performance (eg 10^{-4} absolute measurement performance required?)