Modifications to baseline proposal

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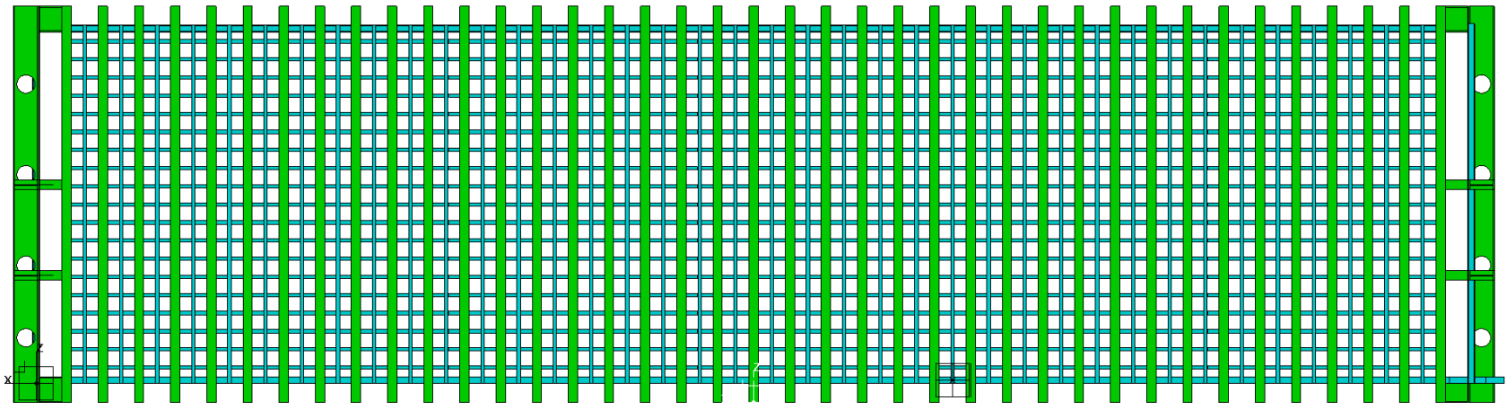
Modified pitch and main beams

- Current baseline design doesn't match with requirements as:
  - Crane capacity exceeded (beams of 977 kg/m = 17 tons for 17.4 m length; crane capacity 10 tons)
  - Profiles are non-standard: composed girders are subject to strength capacity penalties
  - Splicing seems rather critical; size of possible preassembled corner joints limited by shaft size
- Alternative: more frequent and lighter standard beams (at shorter pitch of 1.6 m)



Similar beam (bridge) constructions

Advantages … if it works

- Main beams are available off the shelf profiles and hot rolled
  - This can be a very important requirement for the review !
  - No capacity penalty as from composed/welded girders
  - Beam class is rather good – beams are available in different steel grades
  - HL 1100 x 607: confidence it could work (work is restarting on those)
  - HL 1100 x 548: first verifications shows it may work as well (TBC)
- Beam weigh within crane capacity (10 tons):
  - HL 1100 x 607: the longest vertical beams will (almost) cope the crane capacity: 607 kg x 17.4 m = 10.56 tons
  - HL 1100 x 548: 548 kg x 17.4 m = 9.5 tons → OK for crane
- Both new beams (at new pitch) give some total weigh gain:
  - HL 1100 x 607: 37 units (instead of 25): (37*10.56)/(25*17)=8%
  - HL 1100 x 548: 17%
  - Plus saving on 1 grid vertical beam / unit cell
- More uniform pressure distribution on shorter grid (less bulging out)
- Moment connection at base better distributed
- Room left between main belts for access and inspection
- New beam profiles are slightly smaller in high (OK for cavern)

Shortcomings

- A new iteration on verifications is still required
- Manholes may force to adopt the heaviest of the two new beams proposed
- Some increase in the number of (bolted) joints at base and grid/belts connections
- Final unit beam weight will increase due to the above.

Work Ahead

- There is still a lot of work required for the review, and the current baseline does not cope with some main requirements (as mentioned earlier):
- We need to propose a solution without major flaws in which we have reasonable confidence.
- No time available x alternative design: this modification does not affect much the previous baseline design proposed and leaves time later for optimisation.
- Urgent no to cover the work still ahead for the review:
  - Still some verifications by FEA
  - Eurocode verifications (joints, beam capacity, stability, Scia complete model)
  - All design work: 3D model, members, joints, all details : LOT OF WORK THAT MUST START
  - All assembly / installation scenarios to be studies and documented

Poutrelles européennes à très larges ailes

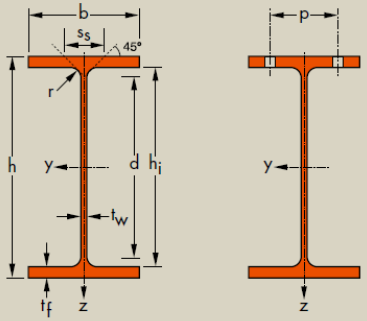
Dimensions: ASTM A 6/A 6M - 12
Tolérances: ASTM A 6/A 6M - 12
HL 1000 AA - M+HL 1100, EN 10034: 1993
Etat de surface: conforme à EN 10163-3: 2004, classe C, sous-classe 1

European extra wide flange beams

Dimensions: ASTM A 6/A 6M - 12
Tolerances: ASTM A 6/A 6M - 12
HL 1000 AA - M+HL 1100, EN 10034: 1993
Surface condition: according to EN 10163-3: 2004, class C, subclass 1

Europäische Träger mit besonders breiten Flanschen

Abmessungen: ASTM A 6/A 6M - 12
Toleranzen: ASTM A 6/A 6M - 12
HL 1000 AA - M+HL 1100, EN 10034: 1993
Oberflächenbeschaffenheit: Gemäß EN 10163-3: 2004, Klasse C, Untergruppe 1



Désignation Designation Bezeichnung		Dimensions Abmessungen						Dimensions de construction Dimensions for detailing Konstruktionsmaße					Surface Oberfläche	
	G	h	b	t_w	t_f	r	A	h_i	d	Ø	p_{min}	p_{max}	A_L	A_G
	kg/m	mm	mm	mm	mm	mm	mm^2	mm	mm		mm	mm	m^2/m	m^2/t
HL 1100 A•	343	1090	400	18,0	31,0	20	436,5	1028	988,0	M 27	116	294	3,710	10,83
HL 1100 B•	390	1100	400	20,0	36,0	20	497,0	1028	988,0	M 27	118	294	3,726	9,549
HL 1100 M•	433	1108	402	22,0	40,0	20	551,2	1028	988,0	M 27	120	296	3,746	8,657
HL 1100 R•	499	1118	405	26,0	45,0	20	635,2	1028	988,0	M 27	124	300	3,770	7,560
HL 1100 x 548*/Δ	548	1128	407	28,0	50,0	20	698,3	1028	988,0	M27	126	302	3,794	6,921
HL 1100 x 607*/Δ	607	1138	410	31,0	55,0	20	773,1	1028	988,0	M27	128	304	3,820	6,294

Notations pages 215-219 / Bezeichnungen Seiten 215-219

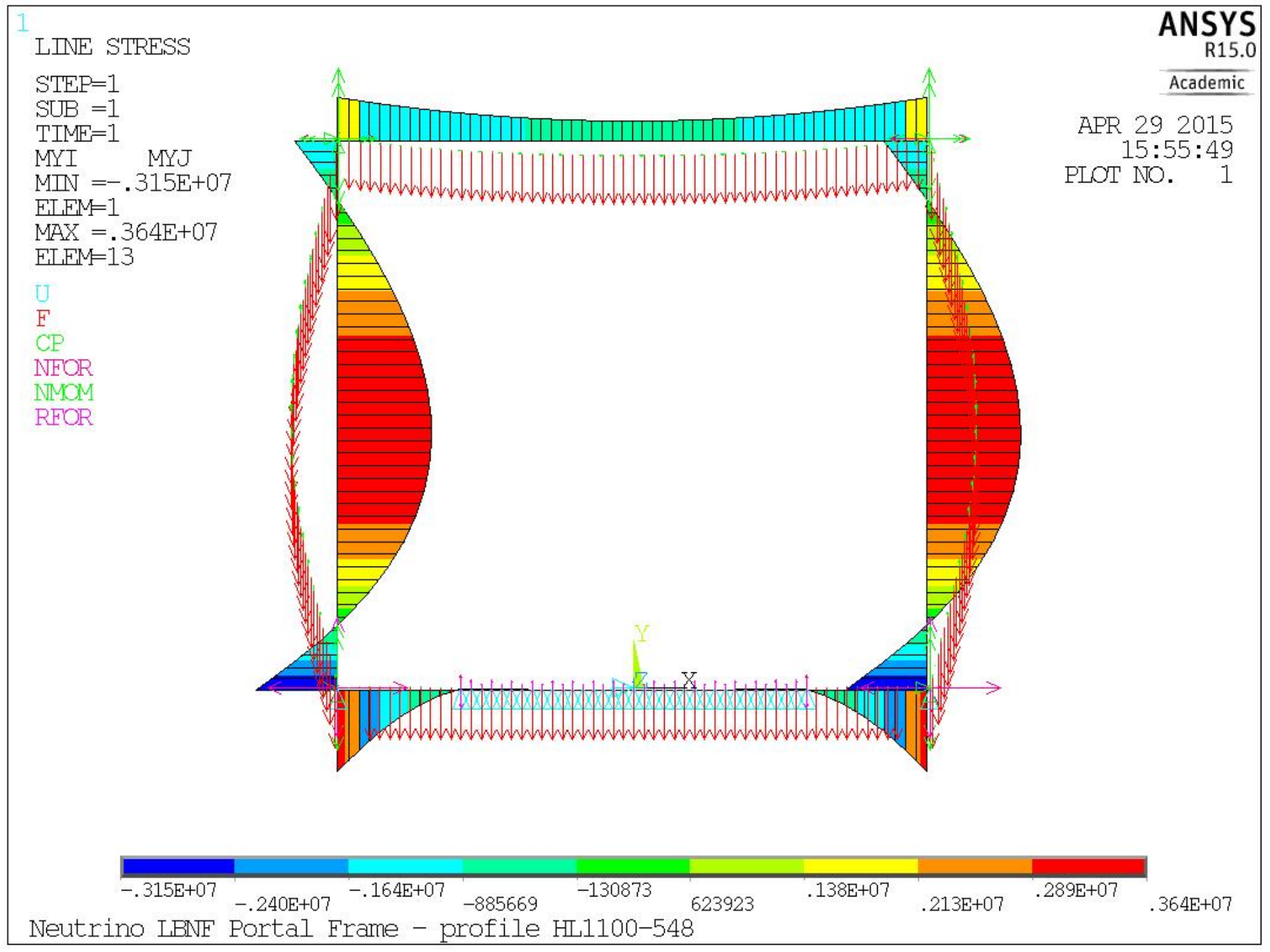
Désignation Designation Bezeichnung		Valeurs statiques / Section properties / Statische Kennwerte													Classification EN 1993-1-1: 2005						EN 10025-2: 2004	EN 10025-4: 2004	EN 10225:2009
		axe fort y-y strong axis y-y starke Achse y-y					axe faible z-z weak axis z-z schwache Achse z-z								Pure bending y-y			Pure compression					
	G	I_y	W_{ely}	W_{ply}♦	i_y	A_{vz}	I_z	W_{elz}	W_{plz}♦	i_z	s_s	I_t	I_w		S235	S355	S460	S235	S355	S460			
	kg/m	mm^4 x10^4	mm^3 x10^3	mm^3 x10^3	mm x10	mm^2 x10^2	mm^4 x10^4	mm^3 x10^3	mm^3 x10^3	mm x10	mm	mm^4 x10^4	mm^6 x10^9										
HL 1100 A	343	867400	15920	18060	44,58	206,5	33120	1656	2568	8,71	103,4	1037	92710		1	1	2	4	4	4	✓	HI	HI
HL 1100 B	390	1005000	18280	20780	44,98	230,6	38480	1924	2988	8,80	115,4	1564	108700		1	1	1	4	4	4	✓	HI	HI
HL 1100 M	433	1126000	20320	23160	45,19	254,4	43410	2160	3362	8,87	125,4	2130	123500		1	1	1	4	4	4	✓	HI	HI
HL 1100 R	499	1294000	23150	26600	45,14	300,4	49980	2468	3870	8,87	139,4	3135	143400		1	1	1	2	4	4	✓	HI	
HL 1100 x 548	548	1446000	25630	29510	45,50	325,3	56380	2771	4349	8,99	151,4	4205	163200		1	1	1	2	4	4	✓	HI	
HL 1100 x 607	607	1613000	28350	32790	45,68	361,2	63450	3095	4877	9,06	164,4	5628	185300		1	1	1	1	3	4	✓	HI	

HI = HISTAR©

Steel Grades

- Steel S355 (EC properties for t>40mm)
  - σ_y=335 MPa → σ_y/1.5=223 MPa
  - UTS=470 MPa → UTS/3.5=134 MPa

- Small Improvements by moving to S450 (EC properties for t>40mm):
  - σ_y=410 MPa → σ_y/1.5=273.3 MPa
  - UTS=550 MPa → UTS/3.5=157 MPa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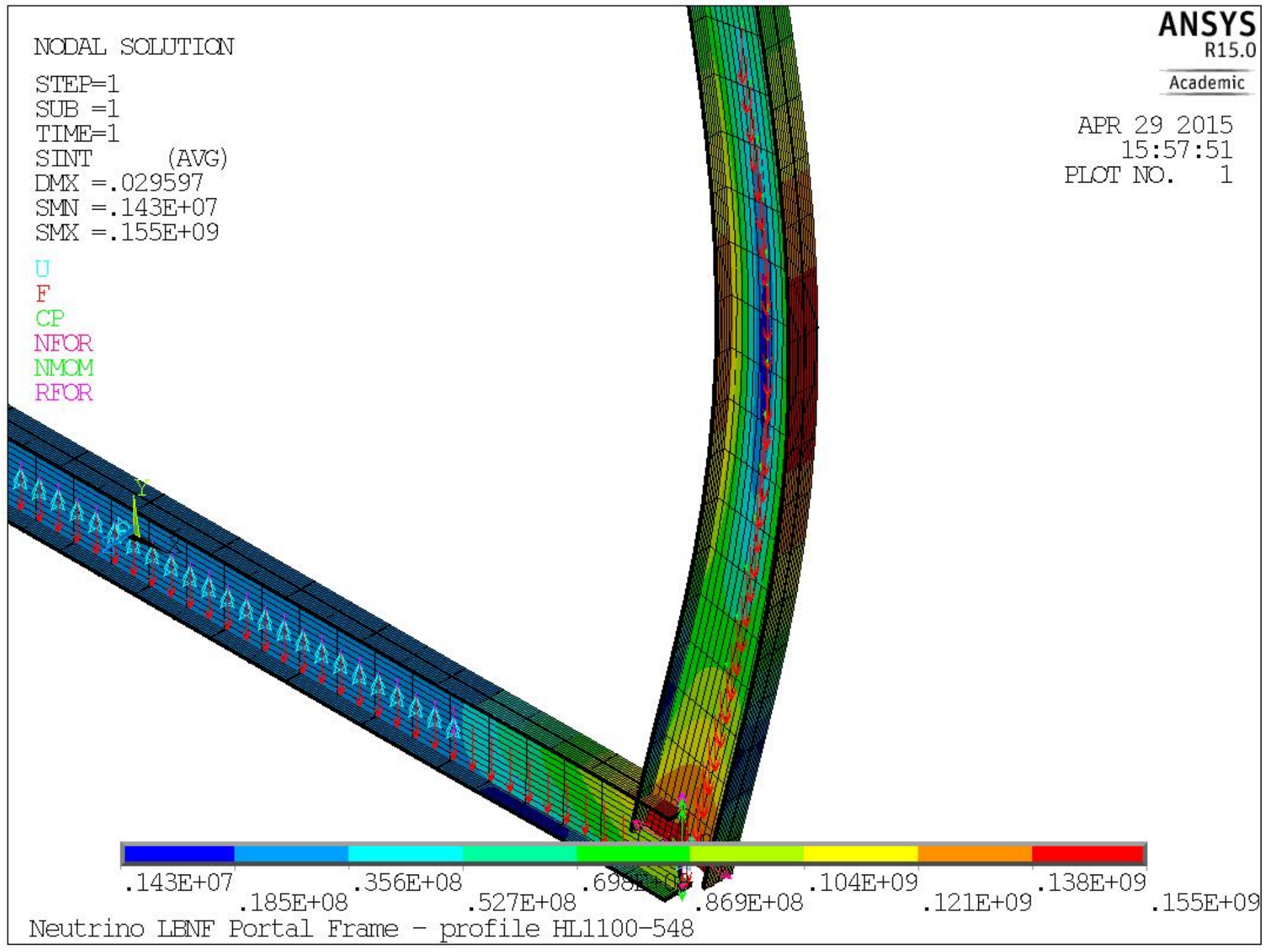
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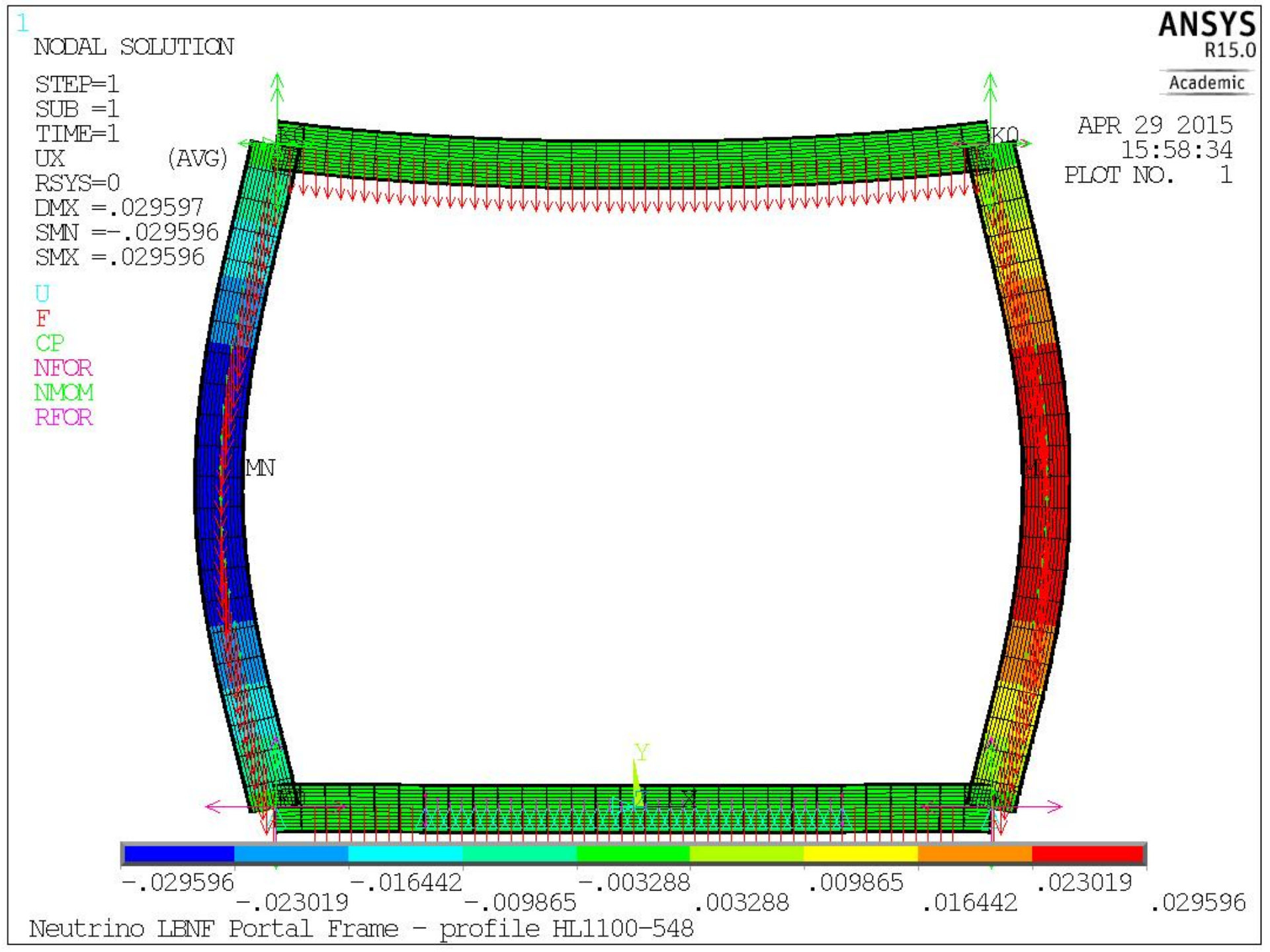
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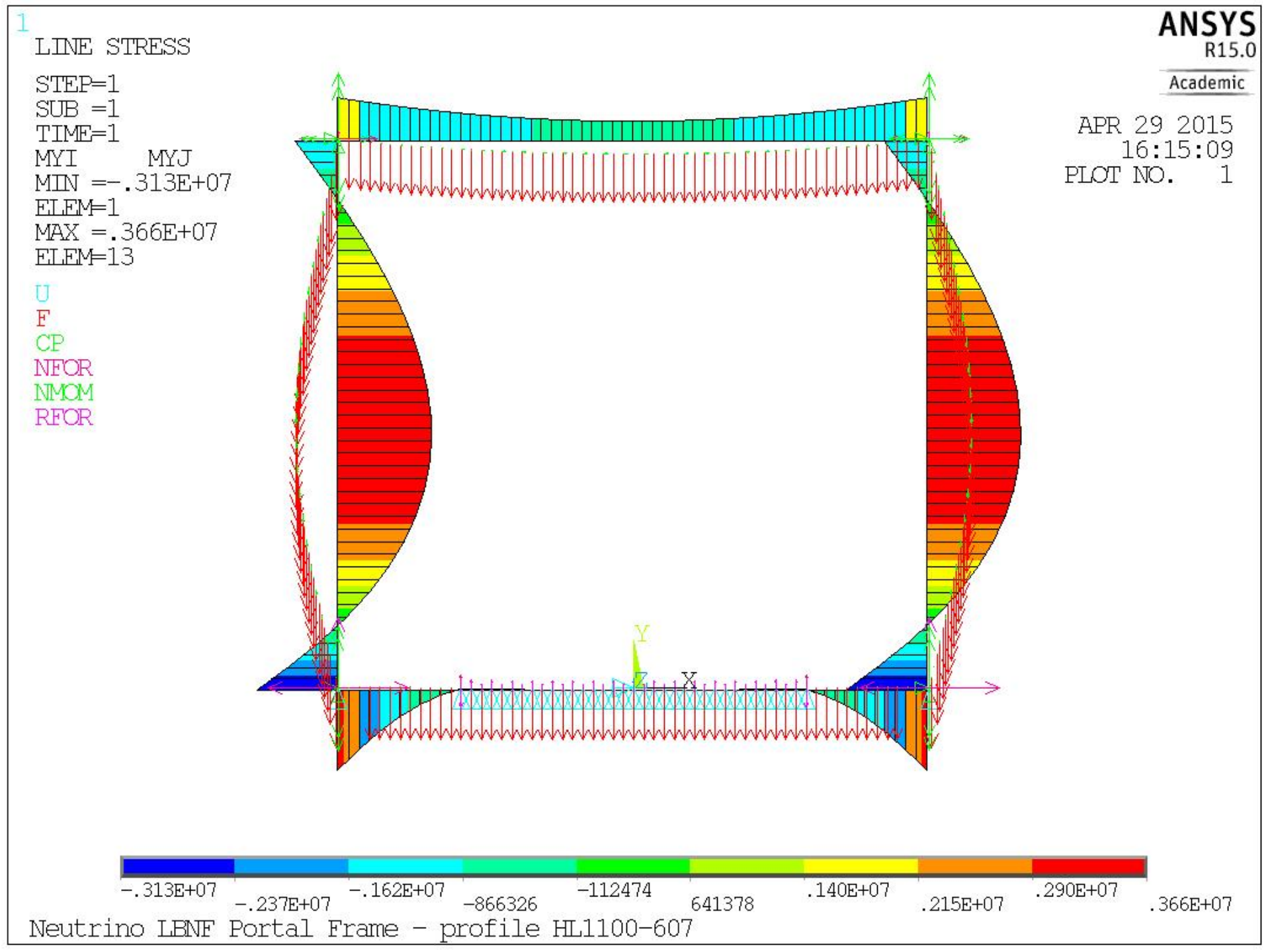
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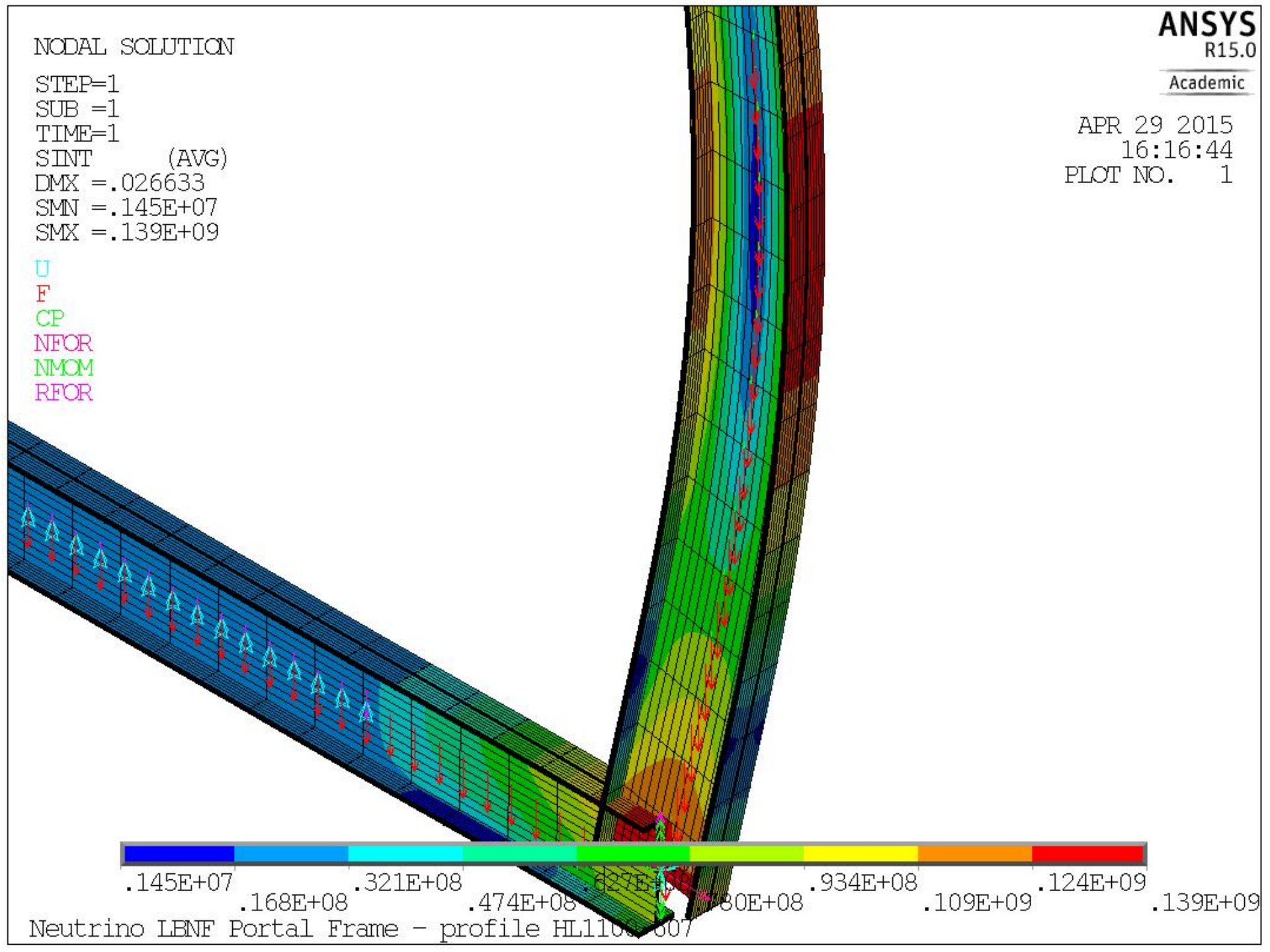
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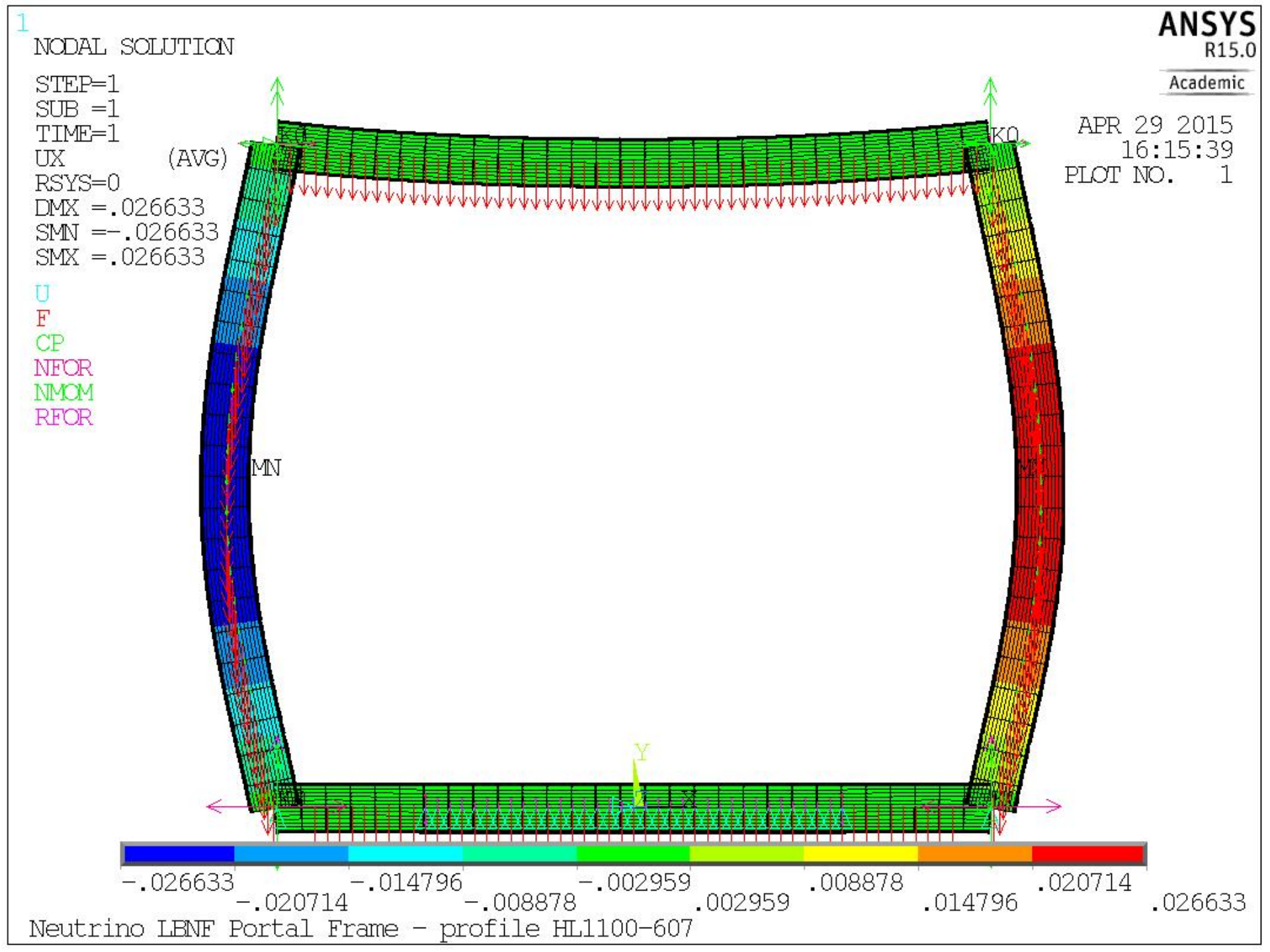
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